The Research Bureau

Boosting Broadband:

Access, Performance, Improvements, and Funding

Report 22-01

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Research in the Public Interest

Worcester Regional Research Bureau, Inc.

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Online Resources: A Tableau Data Dashboard was made to supplement this report and is available on The Research Bureau's website at www.wrrb.org. The dashboard covers broadband access, connection speed, and examines Worcester Public Schools student access data to serve as an additional public resource for exploring broadband data.

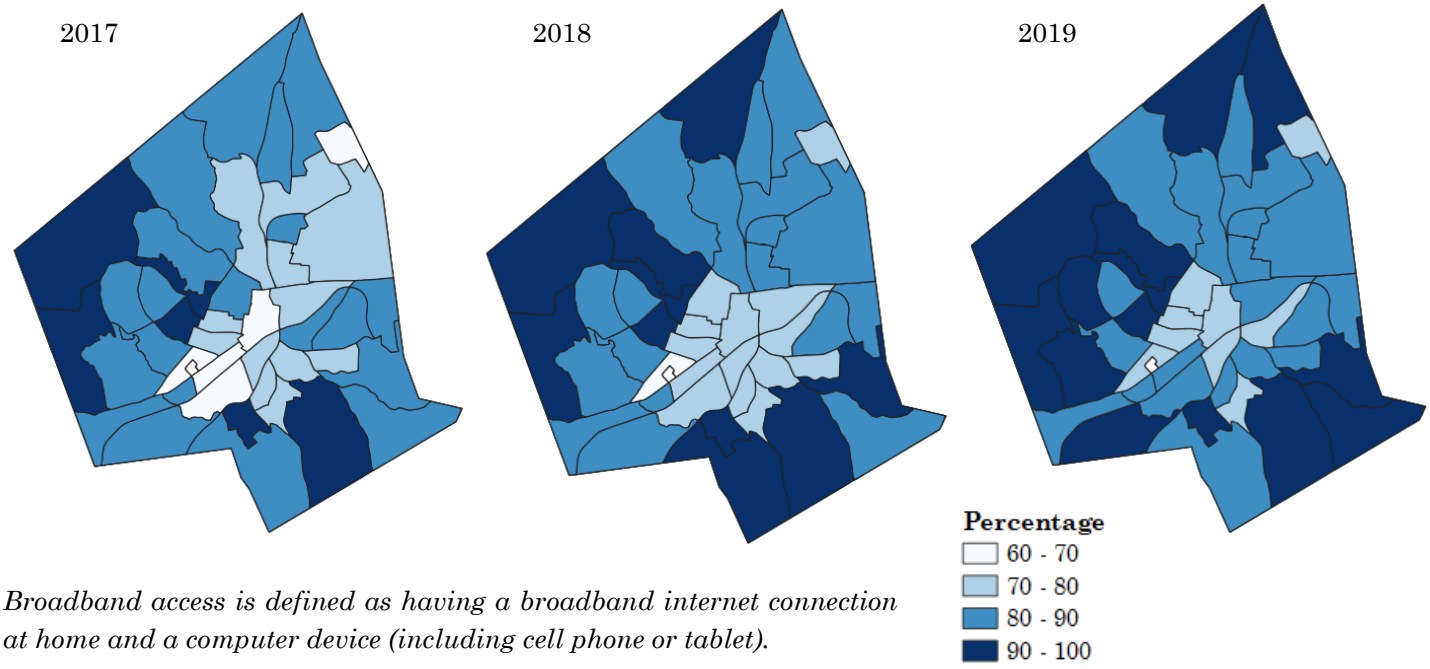
Introduction

The COVID-19 pandemic caused major changes in how businesses and schools operate. The Pew Research Center estimates that 71% of workers whose jobs could be done remotely are now working remotely. Only 20% of these workers were previously working remotely. This shift to remote work seems likely to persist into the future, with a majority of those now working from home hoping to remain remote. Worcester Public Schools (WPS) was one of the school districts that transitioned to online learning during the pandemic as did the higher education institutions in the city. Pandemic-induced changes to everyday life in Worcester highlighted the lack of broadband access and the weaknesses of existing infrastructure. A notable illustration of the city's dependency came on Jan. 4, 2021, when Charter Spectrum experienced a significant outage on the first day of remote schooling after the holidays.

In July of 2020, the Worcester Regional Research Bureau released a report, *Broadening Broadband*, that documented access issues, examined municipal broadband as a potential remedy, and laid out the city's challenging broadband market. Charter-Spectrum acts as a near total monopoly, which restricts consumer choice and bargaining power. Following a recommendation in that report, the City created a Municipal Broadband Taskforce (including the WRRB) to investigate improvements to broadband infrastructure.

This document expands on that report, by looking at three years of data, examining internet connection speed, and WPS student access. This report is structured in four sections, each centered around a core question: How has broadband access in Worcester changed over the past three years? How is our current broadband infrastructure performing? What can be done to improve broadband in Worcester? How are the federal and state governments supporting broadband access initiatives?

Map 1: Percentage of Households with Broadband Access by Census Tract



Broadband access is defined as having a broadband internet connection at home and a computer device (including cell phone or tablet).

Source: 5-year American Community Survey

Part 1: How has broadband access in Worcester changed over the past three years?

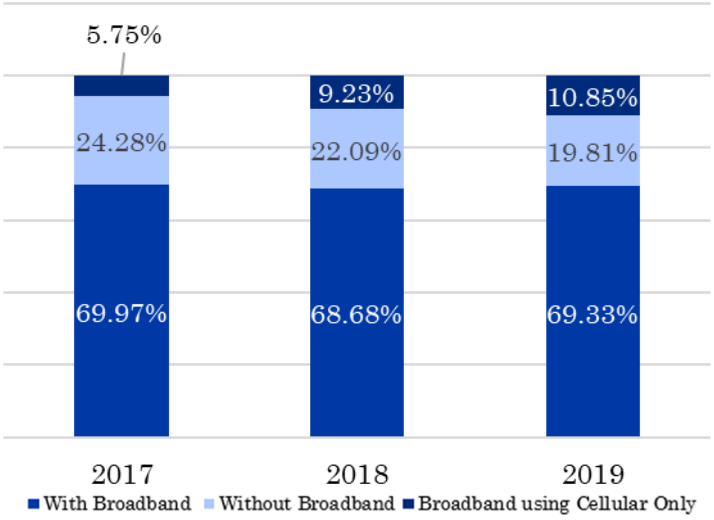
To better understand how broadband internet access has changed, this report uses American Community Survey (ACS) data from 2016 through 2020.

The Federal Communications Commission (FCC) defines broadband internet connections as an always on connection having a download speed of at least 25 Mbps and an upload speed of at least 3 Mbps. ACS data is subject to human error on the part of the respondent, since they may not know if their internet connection speed meets the FCC threshold for broadband. However, what is most meaningful from this survey data is examining changes to broadband access over time.

Broadband Connections Over Time

Over the past four years, a greater share of Worcester's population has a broadband internet connection. In 2017, 24.28% of Worcester households did not have a broadband connection at home, falling to below 19% in 2020. At first glance this progress is an encouraging sign, however to better understand the state of broadband internet in Worcester it is important to disaggregate the available data.

Chart 1: Household Broadband Access by Year

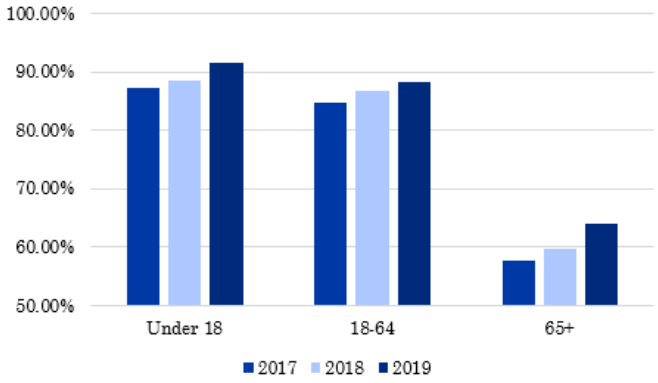


Source: 5-year American Community Survey

Not all broadband connections are equal. Speed of a connection can be a major limiting factor for users. Type of device connecting to the internet also impacts what the user is able to do. A laptop or desktop computer offers numerous applications that are unavailable to cell phone users, many of which are necessary for work from home.

More households have a broadband internet connection but that growth is almost entirely driven by cell phone users (Chart 1). If you remove cell phone only users, broadband access has actually shrunk in the city over the past four years. This highlights a key question about broadband internet in the city - is measuring broadband access alone sufficient for understanding the digital divide? The answer depends entirely on the goals of the City and its view towards the internet.

Chart 2: Broadband Access by Age

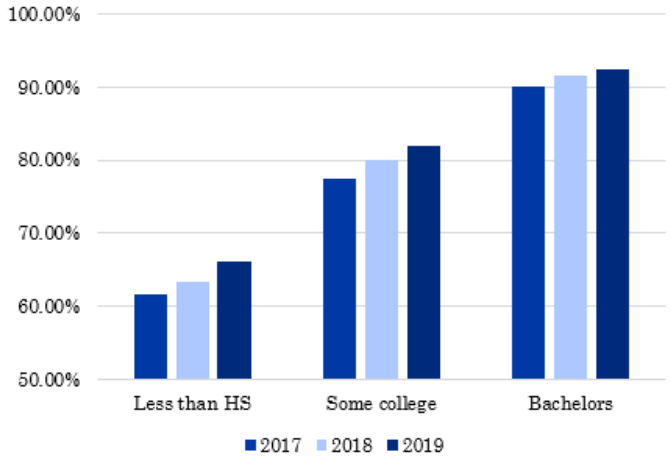


Source: 5-year American Community Survey

There are two primary barriers to internet access, access to a broadband internet connection and the quality of computing devices. Charts 2, 3, 4, 5, and 6 all present demographic data on broadband access in Worcester. Broadband access is defined as having a computer (laptop, desktop, tablet, or cell phone) and a broadband internet connection at home. A large digital divide in the city exists along age lines and levels of education. Older Worcester residents (65 years and older) and Worcester residents with less formal education are more likely to not have a broadband connection.

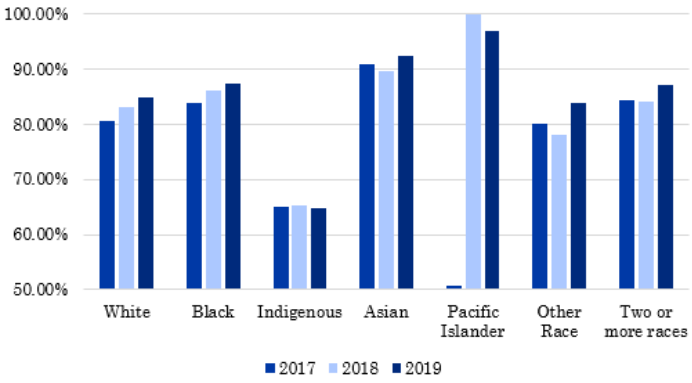
Some of the broadband access gap is due to individual preferences. A 2021 Pew Research poll found that 70% of individuals without a broadband internet connection did not want one. This finding is consistent with previous Pew Research findings but is based on a relatively small sample of 1,502 U.S. adults. While these results may not directly translate to Worcester, they do suggest that some people may not want broadband at home.

Chart 3: Broadband Access by Education



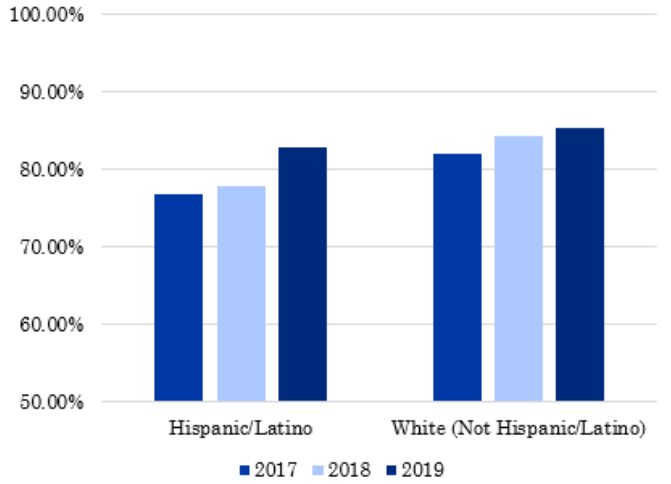
Source: 5-year American Community Survey

Chart 4: Broadband Access by Race



Source: 5-year American Community Survey

Chart 5: Broadband Access by Ethnicity



Source: 5-year American Community Survey

Chart 6 presents one of the most concerning disaggregation of the digital divide in Worcester. In 2019, only 61% of low-income households had a broadband internet connection at home, compared to 93.7% of households earning more than $75,000 annually. Research has found that broadband access improves economic outcomes for households, allowing individuals easier access to job applications, e-recruiting, and expanded digital fluency skills. It is difficult to quantify broadband access' impact on household income, but the economic opportunities it provides are unquestionably valuable. During the pandemic, the need for telehealth has grown, a critical resource only available to those who can get online. The benefits of a broadband connection on civic engagement and participation are also significant.

Chart 6: Broadband Access by Household Income

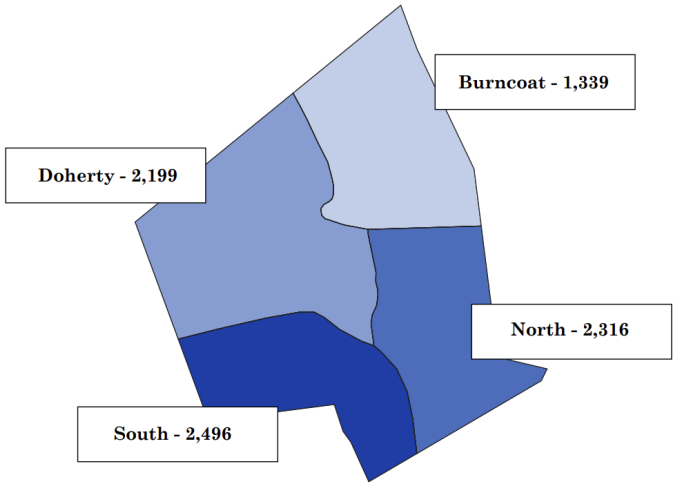
Source: 5-year American Community Survey

Worcester Public Schools

ACS data is subject to some margin of error. The survey uses a representative sample of the population and individuals can misinterpret the

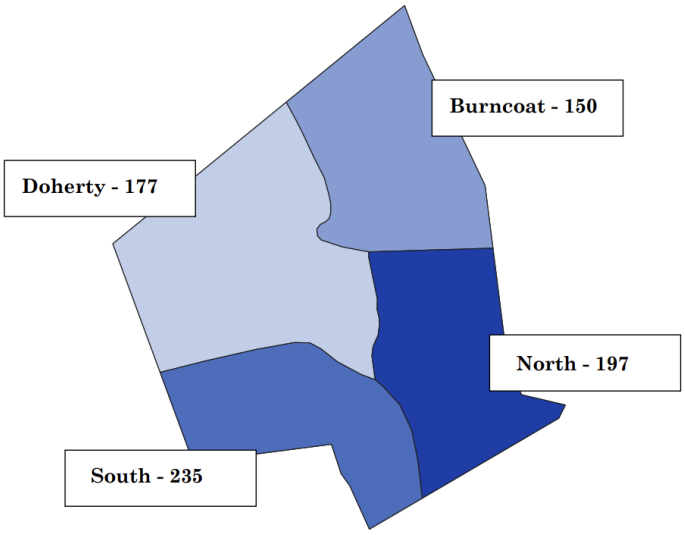
questions. In partnership with the Worcester Public Schools, Education Superhighway (a national education non-profit) conducted an analysis of broadband access for WPS households. Data was provided from the ISPs operating in Worcester describing what households do not currently have broadband internet access and what households cannot have broadband internet access. Exact reasons for why households cannot have access were not provided, but potential explanations are outstanding bills, lack of existing coax cable to building or unit, and complications for multi-unit buildings.

Map 2: WPS Students Without A Broadband Subscription (March 2021), by Quadrant



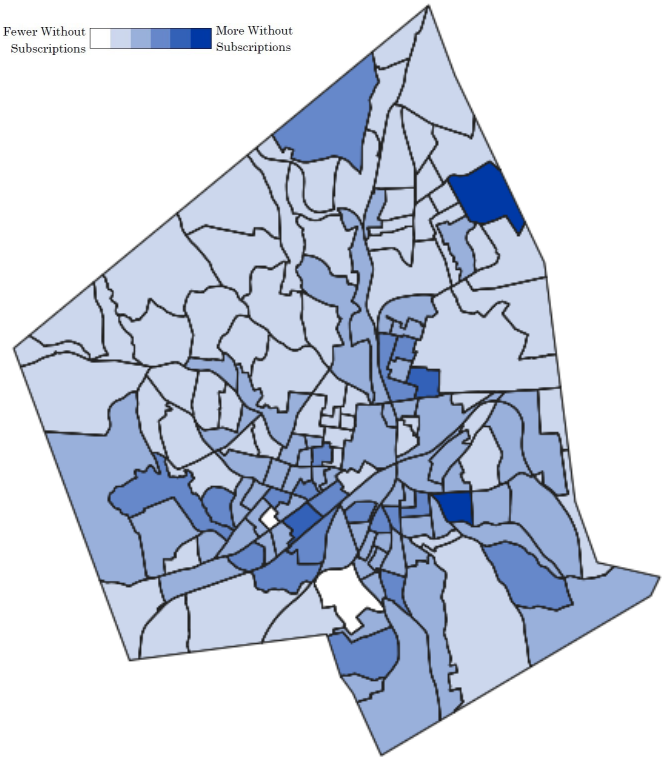
Source: Worcester Public Schools

Map 3: WPS Students That Cannot be Serviced ISPs (March 2021), by Quadrant



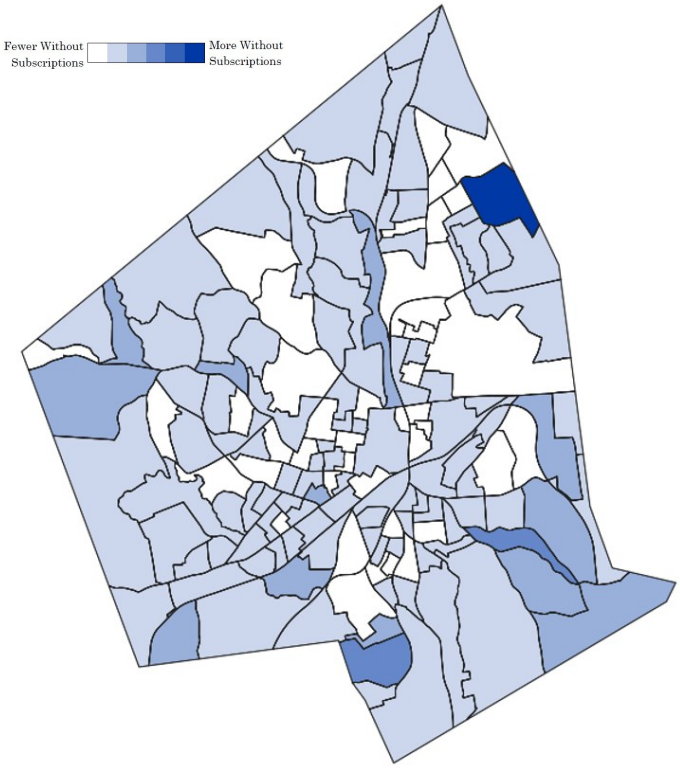
Source: Worcester Public Schools

Map 4: WPS Students Without A Broadband Subscription (March 2021), by Census Tract



Source: Worcester Public Schools

Map 5: WPS Students That Cannot be Serviced by ISPs (March 2021), by Census Tract



Source: Worcester Public Schools

In March of 2021, 8,509 WPS students did not have broadband internet service at home. 788 WPS students could not be serviced by major ISPs operating in the city. It is important to stress that this data was collected in March of 2021. It is possible that this number would change as families transition in and out of WPS.

Examining the school quadrants (maps 2 and 3), find issues of access across the city but particularly in the North, South, and Doherty quadrants. Maps four and five show concentrated lack of access in Main South and Great Brook Valley. 34% of WPS students lacked broadband service at home and 3.1% of students could not receive service at their homes.

FCC Assistance to Households

As a federal response to the pandemic, the FCC launched the Emergency Broadband Benefit (EBB) program in May 2021. Using $3.2 billion in federal funding to assist low income families particularly hard hit by the pandemic, this program provided up to $50 a month to qualifying households for a subsidy to their internet bill. Using FCC data, Chart 7 shows the number of households in Worcester that were enrolled in the EBB by local

Chart 7: 2021 EBB Enrollment as of…

Zip Code	Sept. 1	Oct. 1	Nov. 1	Dec. 30	*Maximum Cumulative Subsidy by Zip Code*	2022 ACP Enrollment as of March	*Maximum Monthly Subsidy by Zip Code*
01602	308	391	485	660	*$92,200*	738	*$22,140*
01603	554	716	890	1,150	*$165,500*	1,371	*$41,130*
01604	843	1,010	1,265	1,687	*$240,250*	1,962	*$58,860*
01605	1,113	1,401	1,705	2,201	*$321,000*	2,563	*$76,890*
01606	233	297	354	458	*$67,100*	540	*$16,200*
01607	250	324	406	538	*$75,900*	619	*$18,570*
01608	209	279	346	450	*$64,200*	547	*$16,410*
01609	553	700	877	1,095	*$161,250*	1,257	*$37,710*
01610	1,011	1,285	1,603	2,081	*$299,000*	2,439	*$73,170*
01611	23	31	34	39	*$6,350*	47	*$1,410*
TOTAL	**5,097**	**6,434**	**7,965**	**10,359**		**12,083**	
Maximum Monthly Subsidy by Date	*$254,850*	*$321,700*	*$398,250*	*$517,950*		*$362,490*	

zip code and month of enrollment, while detailing the maximum monthly potential subsidy by both zip code and month. By December 2021, Worcester had a total of 10,359 households participating in the EBB, for a total of $517,950 in maximum monthly benefits for city residents.

According to Education Superhighway, both the EBB program and its predecessor the Lifeline Program, experienced limited adoption compared to potential participants. As of 2019, Lifeline had 7.7 million households enrolled out of 32.5 million eligible, for an adoption rate of 24%, and as of October 2021, only 16.4% of EBB eligible households were enrolled, or 6.1 million out of 37 million.

Since the EBB was intended as an interim measure, in 2022 participants are transitioning into a new long-term $14 billion Affordable Connectivity Program, which "helps ensure that households can afford the broadband they need for work, school, healthcare and more." EBB participants continued to receive benefits from this new program until March 2022, to allow them time to transition to the new program guidelines. This program has substantially larger funding to serve anticipated need over the next five years, while offering qualifying families up to $30 monthly towards internet service, as well as a one-time discount of up to $100 for the purchase of a laptop, desktop, or tablet. As shown above, by March 2022, Worcester's enrollment in the ACP had grown to 12,083 households, and WPS is undertaking an outreach campaign to boost awareness by student families.

In March of 2020, the WPS transitioned to all students learning remotely. Utilizing $360,000 in Emergency Connectivity Funds, WPS provided 7,700 Wi-Fi hotspots to students without consistent internet connections at home. To address students' needs for devices to access the internet, WPS spent $7.2 Million to purchase 23,000 Chromebooks. These stop-gap measures support the need during an emergency, but requires adequate budget resources as a long term initiative. WPS began hybrid learning in March of 2021, however, as more educational resources transition to being online, students without internet access at home will continue to find themselves at a disadvantage.

To serve their schools and facilities, WPS has a total of 2,661 Wi-Fi access points in the schools, updated every five years with funding from the E-Rate program. The latest such update will replace 1,600 access point, with E-Rate covering 85% of the $3.2 Million cost. These access points are served by a lit fiber network provided by Crown Castle, with E-Rate covering 90% of the costs.

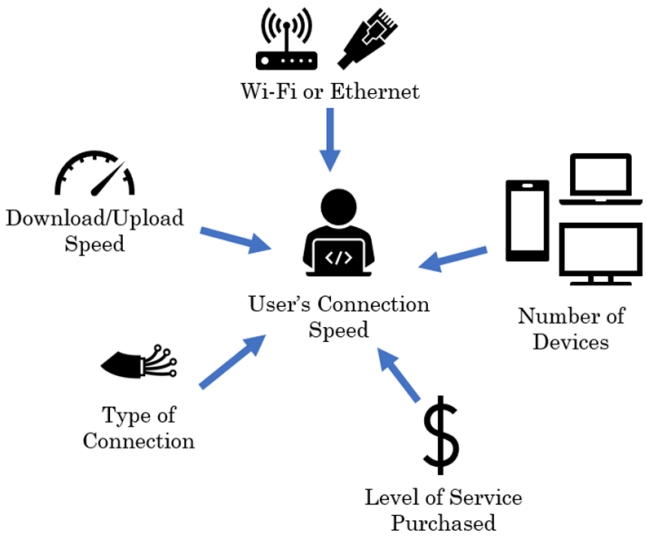
COVID-19 forced school districts across the country to adapt new technology plans for remote learning. The City of Las Vegas opted to implement a long-term solution to the problem by creating a city-wide broadband network. In December of 2020, Las Vegas finalized a city-wide wireless network using CBRS technology. The City used $1 million of federal COVID aid to help fund the project. It took the City just 45 days to deploy the necessary hardware for the project.[4] The City plans to use the private network to implement Smart City programs in the future.

Takeaways

- **Broadband access has improved in Worcester across all demographic groups:** More people in Worcester are getting online each year. The share of households without a broadband connection fell nearly five percentage points since 2016.
- **Expanded cell phone usage is driving broadband access:** Cell phone users are driving broadband expansion in the city. Just looking at total broadband numbers presents an encouraging view of broadband internet access in Worcester. However, if the goal is to expand economic opportunities, a laptop or desktop computer provides more resources than a cell phone.
- **Large disparities in broadband access still exist:** Even as broadband access in the city improves, low income households lag behind. A free market approach could allow for more access with different levels of service. However, Worcester does not operate in a traditional free market, with one ISP providing service to over 99% of the city. As such, government attention is necessary to address such access gaps.

Part 2: How is our current broadband infrastructure performing?

A shift to remote work and remote learning puts additional strain on the city's broadband infrastructure. To understand policy priorities and options it is crucial to have a cursory knowledge of what factors impact the speed of internet connection for a user.



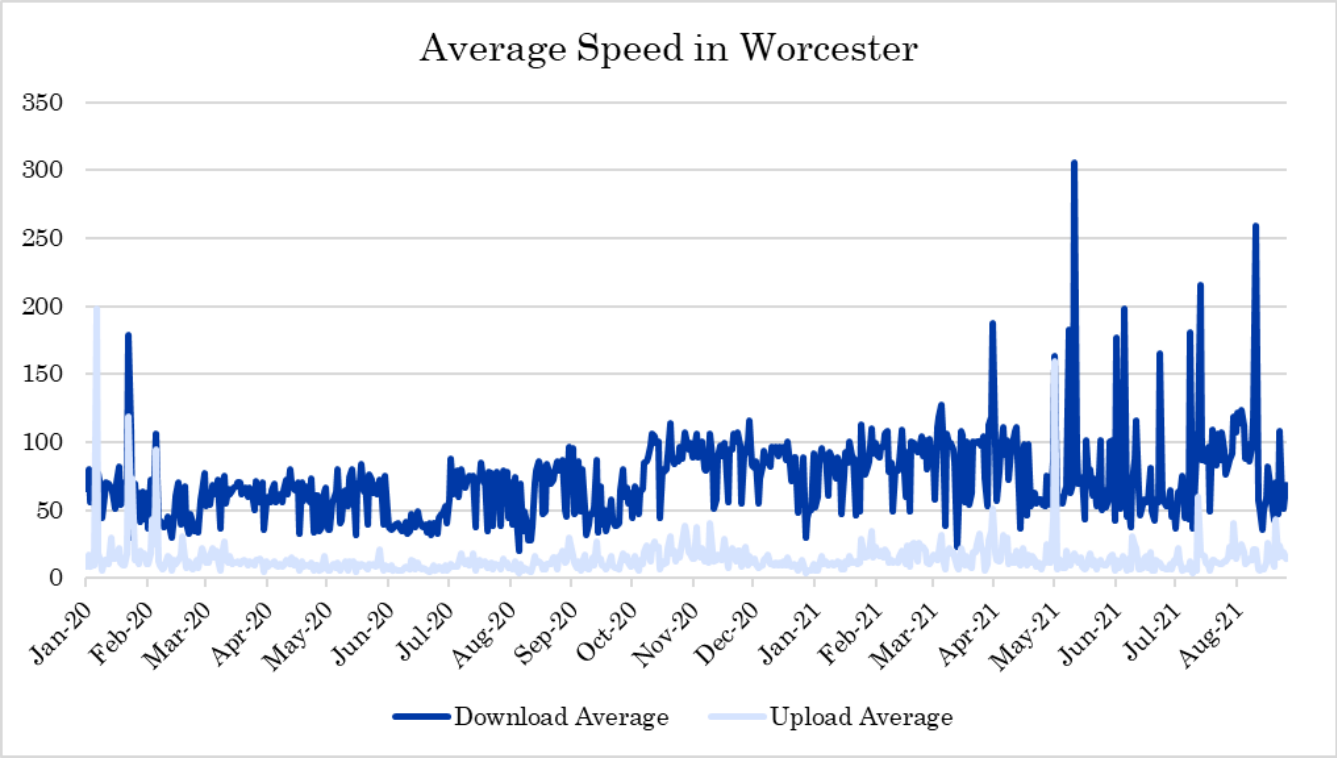
Type of Connection

The six most commonly deployed methods of connecting to the internet are dial up, DSL, cable, satellite, fiber, and cellular. Dial up uses public switched telephone network lines to connect, sending an analog signal. Digital subscriber line (DSL), connects via telephone lines, but unlike dialup DSL sends digital data. Cable uses cable television lines to connect a user's modem to a cable modem termination system via coaxial cables. Satellite connections are established when a signal is transferred from a ground station to an orbiting satellite then back down to the user's home dish. Fiber connects the user to the internet with fiber optic cables. Fiber cables use light pulses to transmit information instead of electronic pulses. Cellular users connect to the nearest cell tower by sending radio frequencies from their device.

All six of these methods of connection are used by various Internet Service Providers (ISPs) across the country. Satellite is commonly used in rural areas where establishing cable connections is difficult and inefficient. Dial up has largely been phased out by DSL as it uses the same infrastructure but is superior in speed. Cable connections are the most commonly used by Americans, much of this due to the existing cable infrastructure and the faster speed they offer compared to DSL. Cellular connections continue to get faster. 5G (Fifth Generation) mobile networks use the same general technology as 4G but sends the signal using higher radio frequencies and smaller, closer together transmitters. Fiber optic cables provide significantly more bandwidth than copper cables of the same size. Fiber offers the highest speeds but is limited by its infrastructure. Many communities lack fiber as an option for internet connection because they do not have cables installed or cables are "dark," not active.

Internet user's connection type is dependent upon the infrastructure available. Cost removed, fiber provides the fastest service but is not available to many households. Cellular connection speeds in one city may be drastically different than those available in another due to the number of transmitters present.

Chart 8: Average Speed in Worcester



Source: Measurement Lab (M-Lab)

Level of Service Purchased

Most ISPs offer customers choice when it comes to speed of connection. In Worcester, Charter-Spectrum offers three levels of speed for three different prices. The prices below may vary based upon promotional deals, bundles, or subsidies. Regardless of changes in exact cost, Charter-Spectrum provides faster service for more money.

Cost	Speed
$49.99/month	Up to 200 Mbps Download
$69.99/month	Up to 400 Mbps Download
$109.99/month	Up to 1 Gbps Download

Source: Charter-Spectrum Advertised Costs in Worcester

Download/Upload Speed

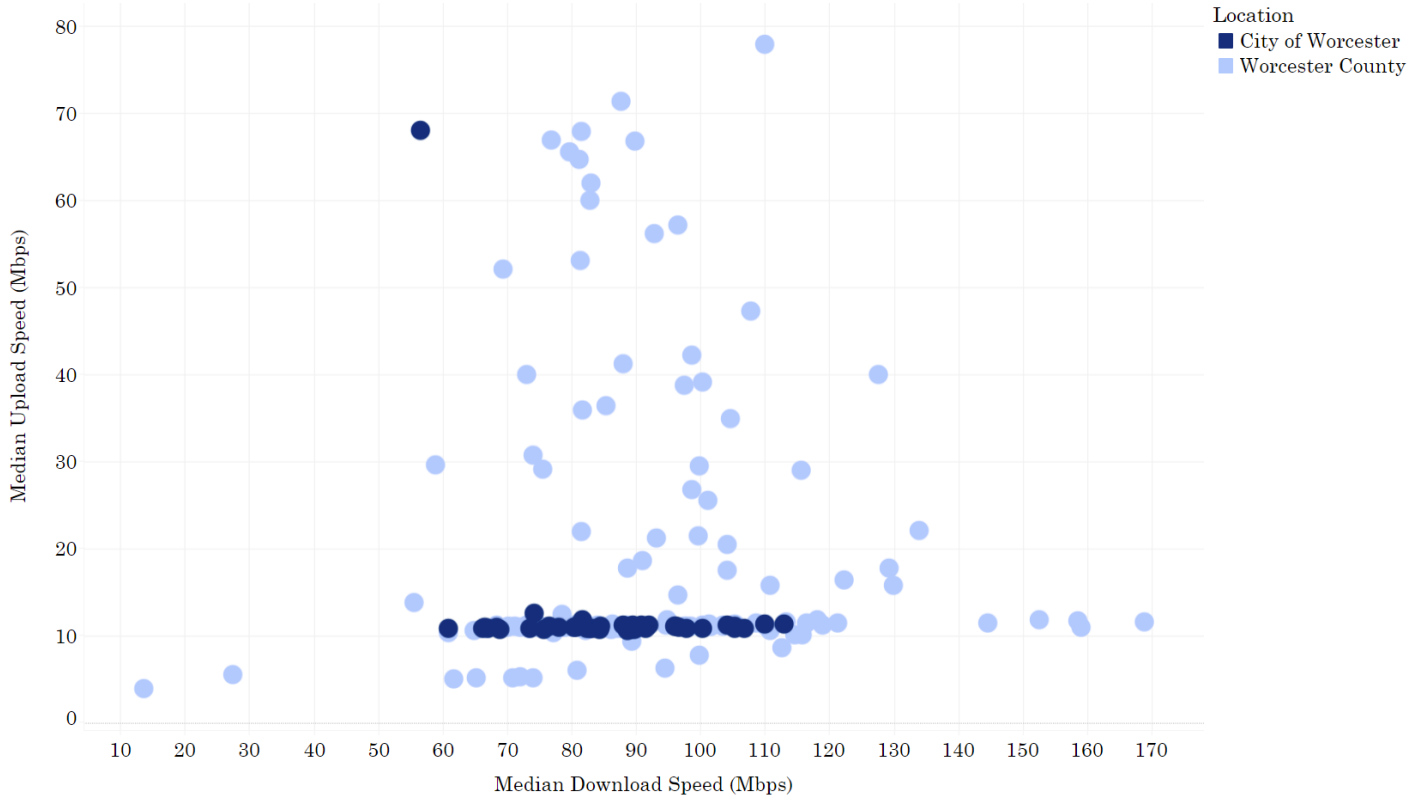
Connection speed is given as two values, download and upload speed. The download speed measures how much information you receive per second from the internet. The upload speed measures how much information you share per second to the internet. Cable internet provides asymmetrical download and upload speeds. Download speed is a factor for loading web pages, downloading files, and streaming content. Upload speed is a factor for video conferencing, sending emails, gaming, or uploading files to the cloud.

Upload speed has become more important over time, and the need for greater upload speed was accelerated during the pandemic. Remote schooling and remote work rely heavily on video conferencing software which requires fast upload speeds.

Wi-Fi or Ethernet

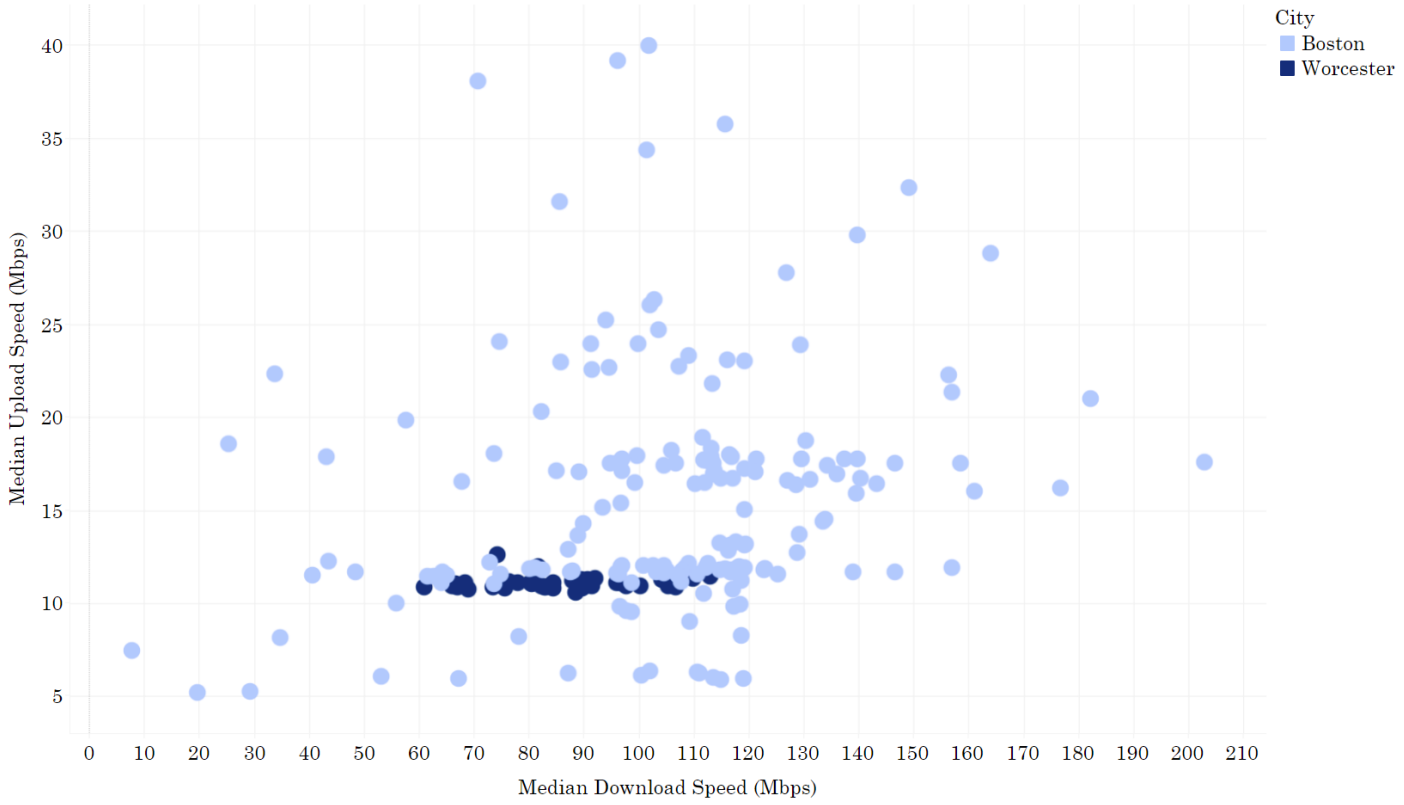
Modems are devices used to connect a home to the internet by cabled connection. Modems convert the connection from coax, DSL, or fiber to ethernet. An ethernet cable is then used to connect the modem to the router. The router creates a private network that all devices in the home can access and moderates the flow of traffic from those devices. Routers can be wired or wireless. A wireless router communicates with the Wi-Fi network in the home to allow devices to connect wirelessly. A wired router requires users

Chart 9: Connection Speed in Worcester and Worcester County



Source: Ookla

Chart 10: Connection Speed in Worcester and Boston



Source: Ookla

to connect their device directly to the router with an ethernet cable.

Wired connections in the home will almost always be faster than wireless. Wi-Fi speed is slower because of obstacles to the signal within the home (walls or floors), distance, signal strength, and interference from other devices. When possible, users should use a wired connection to maximize speed.

Number of Devices

A device using bandwidth reduces the amount of bandwidth available for other devices in a home network. Desktop computers, laptops, tablets, cell phones, smart TVs, smart appliances, and other devices all operating at the same time compete for bandwidth. As available bandwidth decreases, users may experience interruptions in their online activity.

Performance of Current Infrastructure in Worcester

Worcester residents are predominantly served using coax-cable internet through Charter-Spectrum. Due to all of the factors affecting internet speed, it is rare for users to achieve the maximum speed advertised by the ISP. As a result, it is important to analyze not just advertised data, but also independently aggregated user data.

Ookla provides user generated data on the median upload and download speed for users in each census tract. Their data is collected through consumer-initiated testing at SpeedTest (a free website to check internet connection speed). Ookla employs a methodology to reduce bias and ensure that high volume testers are not over-represented.

The Ookla and M-Lab data (Charts 8, 9, and 10) provide useful context to understanding Worcester's current internet infrastructure. Median and average daily download speeds show

a range of values clustered near 90 Mbps but with large variance. Users have the ability to pay for faster or slower download speeds through their ISP which leads to increased variance. This makes analyzing download speed challenging, are the speeds we see the result of insufficient infrastructure or the product of users purchasing slower speeds?

Upload speed data shows the limits of Worcester's current internet infrastructure. Ookla data shows Worcester's upload speeds to be 11 Mbps. Median download speed had a range of nearly 50 Mbps, which again could be due to individual's preference for higher or slower speed based on cost. Median upload speed had a range of only 1 Mbps. Across the city upload speed is the same. The M-Lab average daily upload speed presents a similar picture, with upload speeds centered around 11 Mbps.

Upload speeds are usually not advertised by ISPs. The FCC recommends a minimum of 3 Mbps upload speed for video conferencing. That is the minimum speed and is below the group video calling upload speed of 3.8 Mbps that Zoom recommends for customers.

The COVID-19 pandemic forced many people to work from home. Increased need for online video conferencing makes upload speed a crucial feature. Three users simultaneously video conferencing through using the same internet subscription could cause delays in data communication and video or audio quality issues.

Takeaways

- Examining speed data for Worcester highlights the lack of consumer choice that exists in a monopoly. 99.9 percent of Worcester residents have only one choice for a broadband ISP, Charter–Spectrum. While consumers are offered choice on download speed there is not clear choice for upload speed. The COVID-19 pandemic highlighted the importance of upload speed. The internet of the future may require greater speed of connection to access everyday applications.
- It is possible that Charter–Spectrum's current level of service (download and upload speed) is sufficiently meeting the needs of Worcester residents. User experience and customer satisfaction data is necessary to prove or disprove this point. According to Ookla data, internet download speeds in 2009 averaged 5 Mbps. By 2018, that average increased to 96.25 Mbps. At a certain point, cable internet connections will reach their ceiling in terms of available bandwidth. Whether or not Worcester has reached that point with Charter–Spectrum is unclear, but policymakers should consider the future of internet demand when making any infrastructure decisions.

Part 3: What can be done to improve broadband in Worcester?

The City's creation of a Municipal Broadband Taskforce reflects community interest in improving broadband and support from the City Administration, City Council, and School Committee. This section aims to inform policymakers and the public about possible changes the City could implement.

Fiber

Fiber internet connections use fiber optic cables to transmit data. The cables are composed of long thin strands of glass or plastic that are bundled together. Light waves capture data and pass it through the cables. This allows for data to be transmitted at nearly the speed of light. A key component of fiber is that it provides symmetrical upload and download speeds. Unlike coax cables, fiber connected users will not be stuck with slower upload speeds.

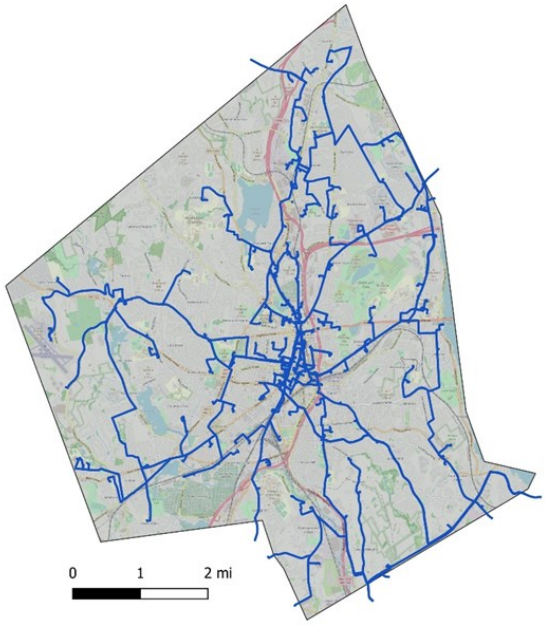
Fiber is an expensive technology to deploy. The US Department of Transportation estimated an

average cost $27,000 per mile of cable laid. There are additional costs to connecting a home to a fiber network. Drop cables need to be run between the home and the fiber cable. Homes also need an Optical Network Terminal (ONT) to convert the optical signal to an electrical signal that can then communicate with a user's router and devices.

In 2012, the GAO examined "dig once" policies for the federal DOT. The report explored the option of installing a fiber optic conduit when highway construction was being conducted. Open conduits could be used to run fiber cables in the future, both by private ISPs and municipal broadband agencies. Another practice adopting by many municipal governments engaged in broadband initiative is 'micro-trenching', or using a shallower and narrower cut to install fiber. These relatively simple concepts should be considered in Worcester, since they could reduce the expense and difficulty of installing fiber.

In Worcester, there already exists extensive fiber infrastructure that are unused and referred to as "dark fiber". This issue was the focus of a Worcester Fiber Connectivity Report in 2015 by the Worcester Regional Chamber of Commerce, which has advocated for increased usage and marketing of fiber to highlight its economic potential. Currently Crown Castle, a communications infrastructure company owns the private dark fiber network in the city (Map Six). Going forward, Verizon is in the early stages of a multi-year plan with the intention to build out a citywide fiber network that would provide broadband and voice services.

Map 6: Crown Castle Fiber Network

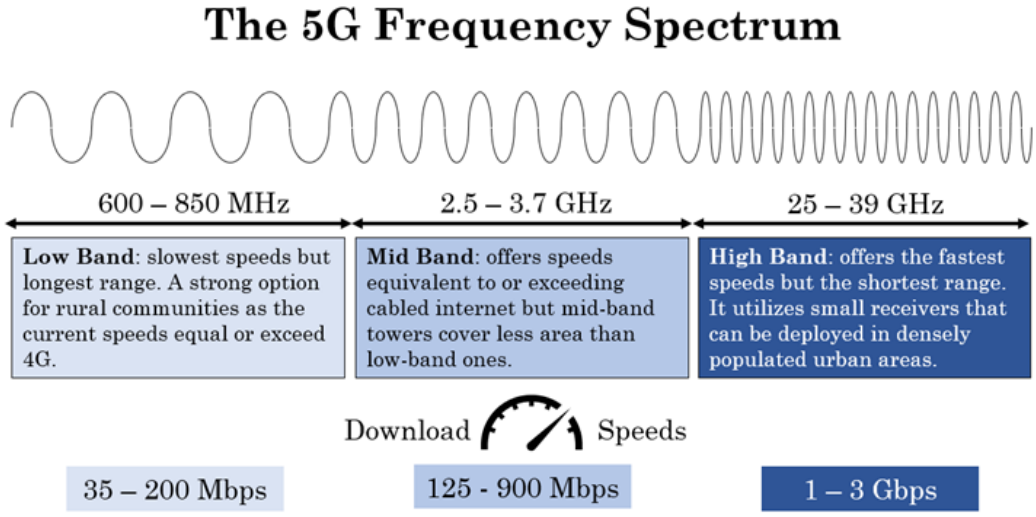


Source: Crown Castle

CBRS and 5G

5G is the fifth generation of cellular technology and it will offer faster speeds to users. 5G, like the older forms of cellular networks, uses radio waves to connect the user's device to a cell tower and subsequently to the internet. The primary advantage of 5G is that it offers increased bandwidth which leads to faster download speeds.

Cellular networks use radio waves to communicate information. To increase the speed of communication there are two options, increase available bandwidth or increase wave frequency. Bandwidth can be thought of as the highway that the information is traveling along. A larger

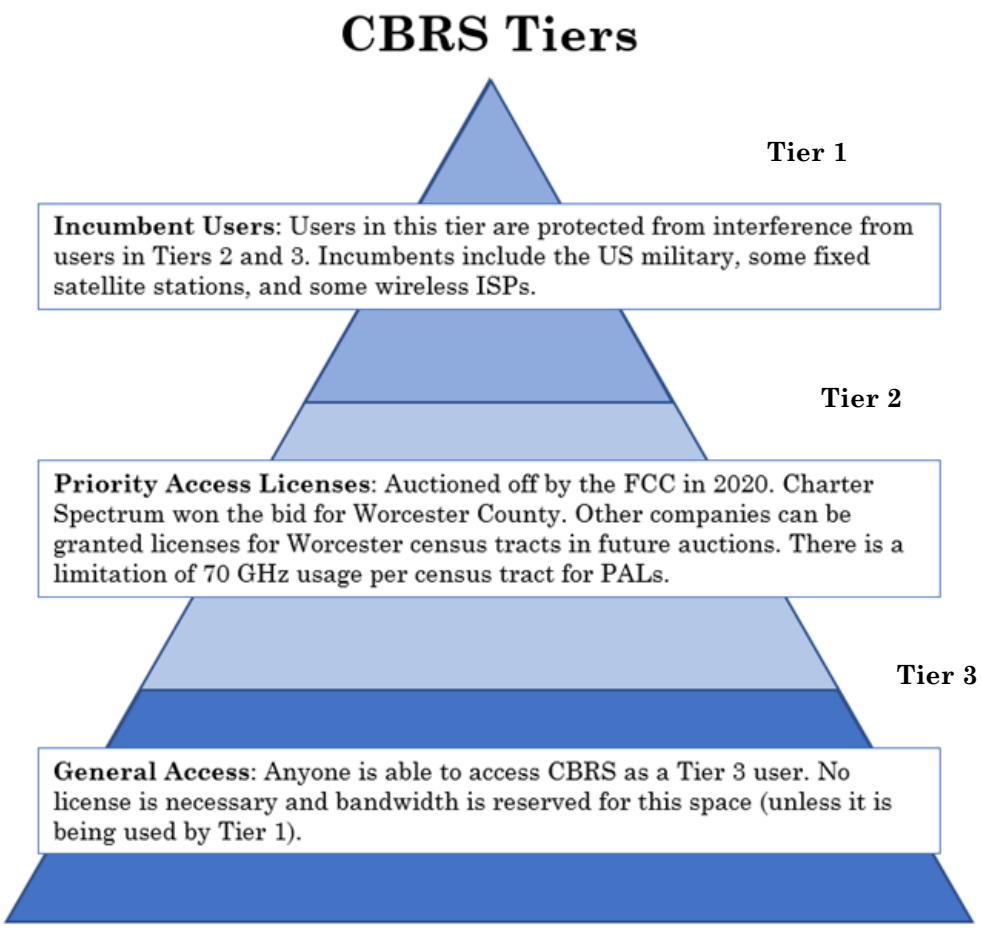


highway is subject to fewer traffic jams and more bandwidth allows for less signal interference. The problem with 4G networks is that the frequencies they rely on are already extremely crowded, limiting available maximum bandwidth. 5G utilizes different frequencies that are less crowded and can transfer more information faster.

5G is used in three different brackets of bandwidth, low-band, mid-band, and high-band (millimeter wave). Longer radio waves provide greater range but less bandwidth. Short radio waves (high band and millimeter wave) provide the largest bandwidth and fastest speeds but have the least range. High band 5G can encounter interference from building walls.

Citizens Broadband Radio Service (CBRS) is a radio frequency spectrum that falls within the 5G range. It uses frequencies between 3.5 and 3.7 GHz (putting it in the higher end of Mid-Band 5G). Historically, CBRS has been used by the United States military. In April 2015, the FCC opened CBRS for shared commercial use. In order to preserve bandwidth for existing military functions, the FCC created three tiers for sharing the frequency.

CBRS uses a Spectrum Access System (SAS) to manage traffic. This system is robust and effective at directing traffic on CBRS frequencies to ensure high speeds and low levels of interference. CBRS is exciting because it can be operated without a costly license, opening up potential for deployment as a municipal broadband system. Currently, many user devices do not support CBRS but that looks likely to change in the coming years. CBRS is still an emerging technology, which presents exciting areas for growth, but there are associated risks with any investment in a unproven technology.



Other Communities:

Concord Mass: In 2009 Concord Municipal Light Plant (CMLP) began laying a 100 mile fiber network. The fiber network passes by 95 percent of homes and businesses in Concord. The initial cost of the project was $3.9 million and it was funded by an increase in electricity taxes. Concord's goal when creating Concord Light Broadband was to develop a smart grid. The fiber network has helped the city manage electrical loads during peak hours, remotely measure meters, and measure solar energy generation.

As of 2020, Concord Light Broadband serves 1,484 subscribers in the town. Customers are given three options for level of service, each with symmetrical download and upload speed. Concord Light Broadband also saw three speed increases in service from 2015 to 2018, each of which was passed on to the customer at no additional cost.[10] Concord Light Broadband has not increased the cost of service once. In 2020 CLB generated over $1.3 million in revenue which covered the operating expenses. CMLP additionally gains revenue from leasing dark fiber portions of its network.[11]

Cambridge: In October 2021, the City of Cambridge awarded a contract to CTC Technology to "analyze options and implement solutions to provide broadband." Cambridge has a goal of providing residents and businesses the access to the best possible broadband internet while stressing the importance of digital equity. In 2016, Cambridge's Broadband Task Force worked with the City Manager to create a plan to close the digital divide in the city and views municipal broadband as the ultimate goal. The City's contract process highlighted three important factors, accessibility, financial sustainability, and technological longevity.

Quincy: Quincy's Broadband Committee is working with EntryPoint Networks to develop an open access fiber municipal broadband network. To do so, the City would invest $75 million in needed fiber infrastructure that would provide opportunities for multiple ISPs to compete for customers. The Broadband Master Plan lays out the strategy work done by these partners and presents several key ideas. A market analysis was conducted alongside a community engagement plan. Assessing current market supply and consumer demand is crucial when developing a City infrastructure project. A community survey found that only 2.05% of residents said they would not support the network, 79.81% viewed internet speed as being very important, and 65.89% rated their current ISP as poor or fair.

Salem: In 2018, the City of Salem, which was primarily served by ComCast's Xfinity, selected SiFi Networks to develop a new fiber network. Through a thirty year deal with the City, the company is investing $35 million to use public right of ways to build and operate the Salem FiberCity network, which will be "open access to enable numerous internet service providers to deliver gigabit internet services to residents and businesses throughout the city." GigabitNow has been selected as an ISP, and while there is a contractual dispute between the company and a contractor, construction is underway using micro-trenching techniques.

Greater Springfield: In July of 2021, Springfield announced the start of a feasibility study into a municipal broadband network using fiber. Chicopee, South Hadley, and Agawam are all launching municipal broadband programs and Westfield has a robust network called Whip City Fiber. West Springfield is also launching a $1.8 million municipal broadband pilot connecting some neighborhoods to the municipal system.

A primary challenge for Springfield is that the City does not own the municipal light and power system. The existing electrical poles and related infrastructure are owned by private companies. This poses an extra cost as space on poles for fiber cables would need to be leased. Worcester faces a similar issue with private companies operating the electrical grid in the city. However, the results of the feasibility study in Springfield will offer useful data for Worcester policymakers.

Shrewsbury: Shrewsbury operates its own municipal electric department called Shrewsbury Electric and Cable Operations (SELCO). As

mentioned in The Research Bureau's previous report, *Broadening Broadband*, SELCO began the deployment of a fiber-to-home network in 2019. The project cost is budgeted at $30 million, half of which the City had saved for infrastructure improvements and the other half is being financed by a municipal bond. A 2020 income statement showed SELCO having a total operating revenue of $32,288,450, leading to a net income for the City of $4,655,622.[13]

Hartford: In response to the COVID-19 Pandemic, in the summer of 2020 the City of Hartford, Connecticut announced construction of a City wi-fi network. The network would use mobile data towers to provide "at minimum LTE-standard speeds throughout the city at all times and at no cost to residents." The project received a capital investment of $3.8 million, with $3 million of that funding coming from the Dalio Foundation and the Hartford Foundation for Public Giving.

As of October 2021, this project led to public Wi-Fi in four Hartford neighborhoods: Northeast Hartford, Frog Hollow, Clay Arsenal and Asylum Hill, with construction underway in the Blue Hills Avenue neighborhood as well. At that point, the network served approximately 28,500 users, with an average of 4,500 on a daily basis. The City of Hartford is examining the potential use of federal funding for further network installation and expansion.

Takeaways

- Make a plan and test it**:** Springfield is moving forward with a feasibility study on city wide fiber. West Springfield is testing out fiber in certain neighborhoods. These policy decisions follow the steps taken by CMLP in Concord. Worcester should evaluate potential responses for feasibility, cost effectiveness, and eligibility for outside funding.
- Invest with an eye towards the future: Other communities again provide a useful policy template for Worcester to follow. Catalyzing additional private investment in fiber such as Verizon's ongoing installation and/or investing in a municipally led broadband network can require innovative policies and substantial capital investment but lead to significant direct and indirect returns for the City. The benefits for the consumer are further illustrated in the speed increases to citizens in Concord.

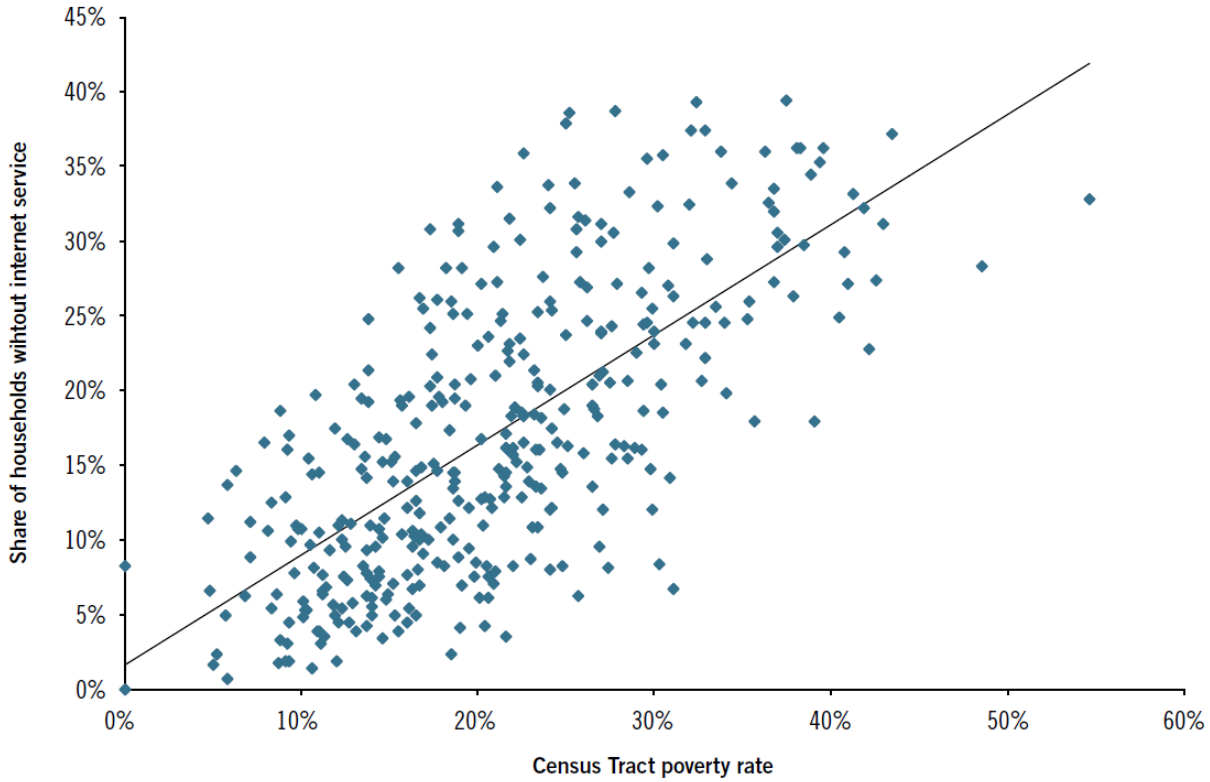
Part 4: How are the Federal Government and Commonwealth of Massachusetts supporting broadband access initiatives?

The passage of the American Rescue Plan Act of 2021 (ARPA) presents a unique opportunity to improve broadband infrastructure in the City of Worcester. ARPA provides $10 billion for capital projects at the local level that help enable work, education, health, and remote options. Expanded broadband internet access is being prioritized in that fund. As referenced in the U.S. Department of the Treasury's Final Rule, "With increased use of technology for daily activities and the movement by many businesses and schools to operating remotely during the pandemic, broadband has become even more critical for people across the country to carry out their daily lives."

ARPA has led to Worcester receiving $110 million directly in relief funds, as well as another $36 million via county-designated funds. The City has conducted a community input process on the priorities for these funds and is appointing Ad-Hoc committees to provide oversight. The City Manager is currently planning to invest $5,960,000 of the ARPA funds on broadband infrastructure "to focus on solutions and potential enhancements of state and federal resources that might coming our way."

On the state level, there has been growing recognition of the need to address broadband

Figure 2: Relationship between poverty and internet access, Gateway City Census Tracts



Source: American Community Survey, 2014-2018 sample

Source: MassINC's Gateway Cities Innovation Institute report Going for Growth: Promoting Digital Equity in Massachusetts Gateway Cities

access issues, particularly in urban areas. Subsequent to the WRRB's Broadening Broadband report, MassINC released a statewide report, *Going for Growth: Promoting Digital Equity in Massachusetts Gateway Cities* that used statewide data to show in the above Figure 2 a correlation between internet access and neighborhood poverty rates.

Legislatively, this attention has come in such efforts as the July 2021 report of the Health Equity Task Force and the October 2021 report of Senate's Committee on Reimagining Massachusetts Post-Pandemic Resiliency, both of which outline the digital divide and potential state responses. The pandemic's highlighting of the importance of broadband access led to the establishment of a Special Commission on Equity and Access to Telecommunications Services, to "make recommendations to address inequity and the digital divide for students and families with limited access to telecommunications services", and is expected to issue a report in the spring.

State agencies have focused on this issue as well, with programs launched in January 2021 coordinated by the Massachusetts Technology Collaborative (MTC)'s Massachusetts Broadband Institute. Most notably for Greater Worcester, this included establishing the Mass Internet Connect program to provide qualifying job seekers with an internet subsidy (originally state funds that transitioned to the EBB program), hotspots, device access, and digital literacy resources though MassHire Career Centers. This program has been extended until June 30, 2022, and as of February 7, Workforce Central had 393 participants, with Worcester's Career Center serving 149 with Chromebooks, 147 with digital literacy, and 12 with internet subsidies. Other state initiatives included new regional digital equity programs aimed at Gateway Cities through support for initiatives by the Essex County Community Foundation and the Metropolitan Area Planning Council.

Additionally, MTC has issued an RFP that would

create a statewide broadband coverage map that draws on data from providers and other sources to show served and unserved locations throughout the Commonwealth.

Beyond these ongoing efforts, the Commonwealth of Massachusetts has also received $5.286 billion in ARPA funds. Under the U.S. Treasury Department's Final Rule, funds can be used for:

"The construction and deployment of broadband infrastructure projects... if the infrastructure is designed to deliver, upon project completion, service that reliably meets or exceeds symmetrical download and upload speeds of 100 Mbps… Treasury encourages Recipients to focus on projects that will achieve last-mile connections. Recipients considering funding middle-mile projects are encouraged to have commitments in place to support new and/or improved last-mile service. Recipients are encouraged to prioritize investments in fiber-optic infrastructure where feasible, as such advanced technology better supports future needs. Treasury also encourages Recipients to prioritize Projects that involve broadband networks owned, operated by or affiliated with local governments, non-profits, and co-operatives."

While over $2.5 billion remains unexpended, in December Governor Baker signed into law a $2.55 billion plan to support residents and communities that were disproportionately impacted by COVID-19. The spending plan includes $50 million for a Broadband Innovation Fund to "close the digital divide by facilitating equitable broadband service adoption in unserved and underserved communities," expanding digital literacy, and empowering communities to use digital tools through the provision of devices, connectivity and training.

In addition to the ARPA funds, the Infrastructure Investment and Jobs Act provides key support for improving broadband access beyond the $3 billion establishment of the Affordable Connectivity Program and $7 billion for schools under the Emergency Connectivity Fund. The bill has $65 billion set aside specifically for broadband access, with $42.45 billion for state grants that can be used for a wide range of projects, including data collection, infrastructure, and adoption projects. The National Telecommunications and Information Administration will be implementing these programs, and as of February 2022 received 557 comments that are under consideration in developing the Notice of Funding Opportunity for each program.

Through the application process, states will have to prepare a five year plan drawing on input from local governments and regional entities. Subsequent to plan approvals, states can utilize the funds for sub-grants addressing needs for data collection, broadband mapping, and planning, connecting community anchor institutions, providing services to multi-family residential buildings, and affordable internet-enabled devices.

As the second largest city in New England, experiencing disproportionate impacts from the pandemic, Worcester warrants attention and investment through these funds and resulting initiatives.

Takeaways

- Resources are available from the state and federal governments: Worcester has an unprecedented opportunity to leverage those resources in local responses, by positioning the city with needed evaluative and planning responses in line with eligibility requirements.
- Further opportunities are emerging: As the Commonwealth conducts initiatives such as the new $50 million broadband initiative, the MTC mapping project, and preparing the five year plan required by the Infrastructure Act, the City will have further opportunities to secure support and attention to needed broadband access improvements.

Conclusion

The 2020 Census showed that Worcester's population exceeded 200,000 for the first time since the 1950s. As the city continues to grow, it should strive to keep up with the latest technology. Access to the internet is quickly becoming a necessity in our society. Worcester has seen improvements in internet access, but those improvements have been driven by expanded cell phone usage and may not translate into the societal benefits of a conventional broadband subscription. Worcester's connection speed, particularly the upload speed, poses challenges to remote learning, work, telehealth, and daily use of the internet.

While the city's broadband access needs have never been clearer, there has never been such availability of federal and state support for new initiatives. Municipal government, community organizations, and other stakeholders need to coordinate responses to address current community needs and position the city for long-term success.

Despite the many challenges facing municipal government during the pandemic, the City of Worcester has made improving broadband access a priority, through the work of professionals within City Administration, School Department, and elected officials serving on the City Council and School Committee. This attention has led to the prioritization of ARPA funds and other resources, as well as the establishment of the Municipal Broadband Taskforce to convene involved officials and outside resources (including the WRRB) to examine how to best improve access to broadband.

The Taskforce is assisting the City in conducting the needed analysis of potential responses, with particular attention to their operational feasibility, cost effectiveness, and eligibility for outside funding. Their evaluation should include examining private sector initiatives from current ISP Charter-Spectrum and Verizon's investment in a citywide fiber network, as well as examples elsewhere in Massachusetts and New England that could involve public-private collaborations and/or inter-municipal partnerships.

With the complexity and technological elements of any response, the City will likely need to draw on outside technical assistance to provide further guidance and expertise. The ARPA funds designated for broadband access use by the City

City's Public Wi-Fi Network

The City's Fiscal 2022 Capital Improvement Plan includes $420,000 to continue efforts to provide the public with Wi-Fi access at appropriate municipal locations. These funds are being used to add 5-6 sites to current locations:

- **City Hall Common**
- **City Hall Interior**
- **City Hall Municipal Service Center**
- **Coes Knife Park**
- **Dept. of Public Works at 18 East Worcester**
- **Dept. of Public Works at 20 East Worcester**
- **Dept. of Public Works at 29 Albany St**
- **Dept. of Public Works at 76 East Worcester**
- **Dept. of Public Works at Hope Cemetery Admin Office**
- **Dept. of Public Works at Parks Department**
- **Dept. of Public Works at Water Treatment**
- **Elder Affairs**
- **Green Island Blvd**
- **Green Hill Golf Club House**
- **Green Hill Park**
- **Grove St Fire Admin**
- **Grove St Fire Training**
- **Institute Park**
- **McKeon Road Fire Station**
- **Polar Park - Ash Street**
- **Polar Park - Canal Street**
- **Polar Park - Gold Street**
- **Polar Park - Green Island Blvd**
- **Polar Park - Madison Street**
- **Polar Park - Summit Street**
- **Polar Park - Washington Street**
- **Regional Emergency Communications Center at 2 Coppage Drive**
- **South Worcester Park**
- **Stearns Tavern**
- **Technical Services**
- **Union Station Bus**
- **Union Station Interior**
- **Union Station Train**
- **Worcester Health and Code at Meade Street**
- **Worcester Police Department**

Manager should be utilized strategically to position the City for further state and federal funding.

Beyond the Taskforce's work, the City should evaluate potential municipal policies and practices such as dig-once conduit policies and micro trenching for utility work that could support broadband infrastructure, ongoing investment in public Wi-Fi (see sidebar) should be strengthened, and whenever possible areas of higher need prioritized. The City and School Department's internal broadband network and investments could provide key foundational elements in any new broadband network. The City and School Department's distribution of hotspots and Chromebooks to students requires ongoing financial support, so should be institutionalized within budgets.

The City's prioritization and deliberation of broadband access initiatives also presents an opportunity for community education and outreach. Given strong stakeholder interest, there should be further engagement for the Taskforce's work and attention to potential municipal responses. The School Department's outreach campaign on the Affordable Connectivity Program should be supported and expanded by community stakeholders beyond students, to ensure the broadest possible reach to all eligible households in the city.

On the state level, due to emerging broadband initiatives and the Commonwealth's fiduciary role for ARPA and federal infrastructure funding, there are some clear actions that would complement and maximize the impact of City responses. In developing broadband access initiatives for the $50 million in appropriated ARPA funds, there should be continued prioritization for Gateway Cities such as Worcester that have experienced disproportionate impacts from the pandemic. When appropriating the remaining $2.5 billion in state-designated ARPA funds, municipal governments should be consulted on how to best support their responses.

The ISP service data collected in the MA Technology Collaborative's mapping project should be provided to municipal governments and utilized to prioritize technical guidance and assistance. When broadband outages occur, ISP's should provide the same public notification process that is required of other utilities. The development of the five year digital equity plan should result in an ongoing and explicit engagement with municipal officials and affected constituencies that is also reflected in the award criteria for subsequent sub-grants.

Much is happening on the national, state, and municipal level to provide a historic level of attention and resources to expanding broadband access, and there is a clear and documented need for action to address Worcester's needs. While the City's deliberative and comprehensive approach to examining potential responses is underway, it is critical this effort be continued across the ongoing leadership shifts in City government and the School District.

Worcester's ongoing attention to the needs of broadband access should allow the City to capitalize on the new federal and state-level initiatives, but this would still need to involve significant public investment, high complexity, likely private or public partners, and be carried out as a multi-year response. City leaders, community stakeholders, and the public should support continued action on this critical need, given its impact on Worcester's competitiveness and economic, commercial, and residential success.

Worcester Regional Research Bureau, Inc.