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Boston Digital Equity Assessment

Prepared for the City of Boston
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Executive summary

This study documents the rise of competitive broadband service in Boston; describes steadily increasing City efforts to close gaps in broadband affordability, devices, and skills; characterizes the remaining gaps in these areas as defined by stakeholders and available data; and makes near-term policy recommendations to address these gaps in light of current federal funding opportunities. This report also provides a high-level estimate of the cost of building a third competitive fiber network in the City, in addition to the residential services of Comcast and Verizon.[1]

Summary of findings

This report presents three major findings:

High-speed wired broadband is ubiquitously available in Boston, and a new competitive dynamic has emerged with Verizon's Fios service

Boston is served by two competitive high-speed broadband providers—Comcast cable and Verizon fiber or Fios service—something that was not the case only a few years ago. Boston is an exception among large U.S. cities in getting a fiber provider to compete citywide with the existing cable company.

- Comcast service is effectively ubiquitous in Boston, with the company reporting that all premises are either served or serviceable within seven to 10 days without costs to residents other than in exceptional circumstances.

- Verizon's fiber buildout is in the late stages, with its Fios fiber service now available in 78 percent of the City. The major exceptions are Beacon Hill, the Financial District, and Downtown. In other neighborhoods, the company says individual apartment buildings may not be wired if Verizon could not obtain permission from the building's owner.

- Comcast and Verizon affirmed as part of this engagement that they offer identical services, service quality, and pricing everywhere they serve in Boston. Those offerings top out at 1.2 Gigabits per second (Gbps) download, 35 Megabits per second (Mbps) upload for Comcast and up to 940 Mbps download, 880 Mbps upload for Verizon Fios.

- The cable provider Astound (formerly RCN) and the fixed wireless providers Starry and NetBlazr also provide competition in many areas of the City.

- Mobile services are improving throughout the City, with some residents reportedly using mobile service as their primary service.

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[1] A future phase of this report will provide results of web-based and in-home tests of Comcast's service.

A report on broadband availability in Boston begins in the [Task 1 report](#).

City programs were created and then expanded in recent years to address broadband gaps related to affordability, devices, and skills—but gaps remain

Accessibility of broadband—especially for low-income households in Boston—requires overcoming a range of challenges, including:

- Navigating enrollment for available low-cost programs and subsidies;

- Obtaining and maintaining well-functioning devices;

- Acquiring the skills needed to install, maintain, and effectively use broadband and computers; and

- Managing higher bills after introductory prices expire.

These challenges have led to digital inequities in Boston, as in all other cities. In response, the City has in recent years provided a range of programs and services. When the Covid-19 pandemic triggered a substantial rise in the need for broadband for remote schooling and work, the City greatly expanded these efforts. For example:

- The City launched a [Digital Equity Fund](#) in 2018. Last year it provided $478,900 to 19 Boston nonprofit organizations.

- Using funds from the federal Emergency Connectivity Fund (ECF)[2], created in response to the Covid-19 pandemic, Boston invested

  - $10 million to maintain large-scale distribution of Chromebooks, wireless hotspots (10,000 were distributed for home connectivity), and vouches for wired broadband subscriptions to Comcast's low-cost program, called Internet Essentials, through the Boston Public Schools, and

  - $2.2 million to support the deployment of 3,000 Chromebooks and wireless hotspots (also called wireless home routers) to Boston Housing Authority residents.

- The City funds Tech Goes Home (TGH), a nonprofit that provides training and free laptops to low-income residents including recent immigrants. The City provided $500,000 annually to TGH starting in 2012; in 2016, the City increased this funding to $1 million annually, and in 2022, the City granted TGH an additional $2 million in American Rescue

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[2] https://www.fcc.gov/emergency-connectivity-fund

Plan Act (ARPA) funding. TGH reports that in the past three years, 11,561 Bostonians have graduated from a TGH program and received 8,186 devices.

- The City created the role of Digital Equity Advocate in 2015 within the Broadband & Cable office of DoIT to provide coordinated programmatic support to entities including the Boston Housing Authority, Boston Public Schools, Age Strong Commission, Boston Public Health Commission, and the Mayor's Office for Immigrant Advancement (MOIA).[3]

Significant gaps remain. Stakeholders interviewed as part of this study said households still face substantial challenges related to broadband affordability, devices, and skills. And national survey data illustrate a subscription and device gap. In data collected by the U.S. Census Bureau's American Community Survey between 2016 and 2020, 19.4 percent of Boston respondents said they did not own any desktop or laptop computer, and 13 percent of households reported lacking either a wired or mobile broadband subscription. This figure implies 35,000 Boston households lack any residential or mobile subscription. In other national surveys, 45 percent of respondents cite the high cost of broadband service and 37 percent cite the high cost of devices as reasons for not subscribing.[4]

The ACS survey data do not capture changes since 2020. Some Boston households counted in the ACS survey numbers as lacking residential or mobile service may be served through programs such as those outlined above. Additionally, the new federal Affordable Connectivity Program (ACP), which provides a $30 monthly subsidy for broadband bills, is now used by 29,192 Boston households.[5] However, CTC estimates that approximately 86,000 Boston households may be eligible based on income alone, though some are likely already be served by other programs and others do not wish to receive service. And stakeholders said many Boston residents face challenges with enrollment, affordability, devices, and skills.

Lastly, in the decade since it launched in Boston, Comcast says its Internet Essentials program (which now provides 100 Mbps download, 10 Mbps upload service to eligible low-income families) had enrolled 27,000 Boston households. This figure refers to all enrollments between 2011 and May 2022. Comcast declined to share the number of subscribers with active enrollments in Internet Essentials, making it difficult to assess the current impact of the program.

Although wired broadband is technically far superior to mobile service, many low-income users will choose free hotspots (which provide connectivity from mobile services) over free higher-

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[3] Mark Racine, CIO at Boston Public Schools, Lydia Agro, community relations at BHA, Commissioner Emily Shea, Age Strong, Yusufi S. Vali, Director, Mayor's Office for Immigrant Advancement, Kurt Mansperger, former CTO at the BPL.

[4] https://www.pewresearch.org/internet/2021/06/03/mobile-technology-and-home-broadband-2021/

[5] Data as of August 1, 2022

speed and more reliable wired connections if given the choice. For example, Tech Goes Home says its learners are 50 times more likely to take a free mobile hotspot than a free signup code for a Comcast Internet Essentials subscription.

Regardless of the connectivity choice, Boston Public Schools has substantial capacity in its hotspot and Internet Essentials subscription efforts to serve people in need. Student families in need of a free hotspot or a free subscription to a 100 Mbps download wired service can still obtain one or the other.

Table 1 presents a sampling of efforts to address Boston's digital divide efforts by the City, broadband providers, and through federal programs.[6]

Table 1: By the numbers: A sampling of major City, provider, and federal subsidy efforts in Boston

Program or Source	Number	Description/Provider
Affordable Connectivity Program (ACP)	29,192[7]	Number of Boston households receiving $30 monthly federal subsidy for household broadband as of August 1
Emergency Connectivity Fund	13,000	Number of hotspots & wireless routers with Chromebooks made available by Boston Public Schools, Boston Public Library, and Boston Housing Authority.
City-funded Internet Essentials	3,500	Available codes (many not yet used) for Comcast Internet Essentials subscriptions offered through Boston Public Schools and Tech Goes Home
City-funded student Hotspots (2020-2021)	10,000	Number provided by the Boston Public Schools
City-funded Hotspots and Tablets (2020-2021)	6,000	Number funded through Verizon Smart City partnership
Total Internet Essentials (via Comcast, 2011 – 2021)	27,000	Historical total number of Internet Essentials subscriptions provided by Comcast since 2011, though the company will not provide current enrollment numbers
City-funded devices, connectivity, and training through Tech Goes Home, 2011-2021	15,000	Households funded with these services and devices by Boston's 21st Century Access Fund

Key observations and takeaways from stakeholders—representing the Boston Public Library, Boston Public Schools, Boston Housing Authority, Age Strong Commission, Mayor's Office for

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[6] Table summary provided by Boston's Broadband and Cable office and various City departments and Comcast.

[7] This number was calculated based on USAC's ACP enrollment and claims tracker which reports ACP enrollment numbers by zip code. To calculate the ACP enrollment for Boston as of August 1, 2022, we added the ACP enrollment for the following zip codes: 02108, 02109, 02110, 02111, 02113, 02114, 02115, 02116, 02118, 02119, 02120, 02121, 02122, 02124, 02125, 02126, 02127, 02128, 02129, 02130, 02131, 02132, 02134, 02135, 02136, 02199, 02210, and 02215.

Immigrant Advancement, Tech Goes Home, and Boston Neighborhood Network—include the following:

- Significant progress has been made but the need for programs of all kinds remains large, with ACP enrollment support emerging as a top need.

- Residents have difficulty signing up for the ACP and other low-cost programs. These challenges include confusion over the process, issues getting the required documents together, language and accessibility barriers, and mistrust and hesitancy based on past interactions with broadband providers.

- Community-based organizations are among the most effective conduits for digital equity initiatives because they have established relationships. This is particularly significant for residents who have limited English ability and those who are older. However, many organizations are constrained by time, staff, and available funds.

- Outreach materials and programs must be offered in multiple languages, and the Mayor's Office for Immigrant Advancement also stressed that these materials must be culturally appropriate.

- Although online versions of classes and enrollment support services are useful, older adults often need digital skills training or reduced-price internet program sign-ups to be offered in person.

- Different personal situations require different connectivity solutions, with mobile hotspots often being the best solution for people having an unstable home situation.

A report on digital equity barriers, efforts to mitigate them by the City and others, remaining gaps, and recommendations appear in the Task 2 report.

Building a new City-owned fiber-to-the-premises (FTTP) network would cost an estimated $825 million to $961 million, depending on the number of households who elect to take service

At the City's request, CTC developed a conceptual, high-level fiber to-the-premises (FTTP) network design and cost model for all of Boston that is aligned with industry best practices and would be able to support a variety of architecture options and business models.

Such an effort would cost an estimated $721.6 million for the backbone and distribution network capable of serving 399,864 passings in Boston, or $1,800 per passing. The cost for the network electronics, subscriber drops, and customer premises equipment (CPE) would vary based on the number of households taking service (the "take-rate"). These network elements are estimated

to cost between $103.3 million and $239.8 million, depending on the take-rate. In total, the overall cost of the network is estimated to be between $824.9 million and $961.4 million, or between $3,430 and $6,880 per subscriber.

This network would be built as a separate network from the existing City fiber, which is leased from private providers and cannot be put to commercial uses by the City. And though substantial federal funds for broadband are now available, as noted below, these funds would not be available for a new citywide municipal fiber network in Boston. The funding streams are intended for unserved or underserved areas, most of them rural; Boston is already universally served according to the definitions in the legislation.

A report on this fiber design and cost estimate appears in the [Task 3 report](#).

Summary of recommendations

Recent federal funding streams create significant near-term opportunities to expand broadband enrollment and reduce device and skills gaps through the expansion of a variety of City and nonprofit programs.

The Infrastructure Investment and Jobs Act (IIJA) provides $65 billion for broadband-related projects and cybersecurity grants, including $42.45 billion in Broadband Equity, Access and Deployment (BEAD) grants available to states that apply for grants for deployment, data collection and mapping, provision of affordable broadband to multi-family buildings, and broadband adoption programs.

In addition, the IIJA's Digital Equity Act creates the following new programs:

- State Digital Equity Planning Grant Program ($60 million)

- State Digital Equity Capacity Grant Program ($1.44 billion)

- Digital Equity Competitive Grant Program ($1.25 billion)

The IIJA also allocated $14.2 billion to provide a $30-a-month voucher to low-income residents to pay for internet service (the Affordable Connectivity Program or ACP). Other than the ACP, all monies will be channeled through the states, which must first create plans for making subgrants.

The release of the IIJA's funds by the National Telecommunications and Information Administration (NTIA, the federal agency administering the programs) will mean the City will likely be able to fund digital equity plans by working with the state's Broadband Office—the Massachusetts Broadband Institute (MBI) within the MassTech Collaborative. City officials have already begun to collaborate with that office and the Massachusetts Department of Telecommunications and Cable (MassDTC).

However, as noted above, a citywide municipal fiber buildout would not receive any federal funds, which are intended mainly for rural unserved or underserved areas; Boston is already universally served. Moreover, the addition of Verizon's Fios service means most Boston consumers now enjoy genuine competition among high-speed wired broadband providers. Residents will soon have full access to both Comcast and Verizon, both of which built out citywide. And all of the City's major providers are offering services eligible for the ACP subsidy.

(A timeline of the City's federal advocacy and outreach on broadband and digital equity and inclusion funding from 2020 to 2022 is provided in Appendix A: Timeline of federal advocacy and outreach on broadband and digital equity and inclusion by the City of Boston (2020-2022).*)*

With these opportunities in mind, this report makes the following recommendations, provided in Section 0 at the end of the Task 2 report and summarized here:

Accelerate enrollment efforts in the Affordable Connectivity Program: The FCC's Affordable Connectivity Program (ACP) can help ensure affordable, reliable internet options for residents. The City has already begun accelerating enrollment efforts, and we concur with this strategy and recommend directing available monies or future state or federal funds to this purpose—especially by leveraging the efforts of community-based organizations (CBO).

Build coordination among various agencies in the City to further increase impact: The Digital Equity Fund has proven as a successful collaboration between the Department of Innovation and Technology, the Age Strong Commission, and the Equity & Inclusion Cabinet. The Boston Public Library has partnered with the Boston Housing Authority to distribute devices to patrons. Boston Public Schools has made 10,000 hotspots available to students for school use.

Furthering collaboration between entities on a larger scale will make it possible to efficiently streamline and address areas of need and will align with ACP enrollment support efforts. We recommend the City establish bi-monthly meetings to synthesize efforts among these entities and standardize metrics to monitor progress over time.

Coordinate with the Commonwealth as the rules for obtaining federal funds take shape: As new federal funding is granted to the state, the bulk of these funds will go to the Commonwealth of Massachusetts and then be distributed to local municipalities or specific programs.

Though not available for citywide municipal broadband, these funds can advance digital equity in other ways. As noted above, funding will be distributed to localities through the rules and programs described in a forthcoming Massachusetts state plan. As noted, the Massachusetts Broadband Institute will be the Commonwealth's lead agency; and the City has already connected directly with MBI to communicate the City's digital equity concerns and funding priorities. The City should continue this direct line of communication to potentially help shape the state plan.

For example, federal funding could be applied to supporting a new iteration of the Digital Equity Fund, enabling the City to expand the fund size and total number of awardees. Among other things, this funding can be used to get CBOs to promote and enroll residents in the ACP.

Continue to foster relationships with CBOs to further impact on the ground: The City has a strong track record of working with CBOs to engage within the City's wide range of communities. Programs funded through the Digital Equity Fund and partnerships like Tech Goes Home champion collaboration and promote success in community-based work. Given this track record, we recommend the City continue to invest in this work and to work with CBOs to formulate strategies to increase their reach and impact.

Promote participation in existing device subsidy programs to free up City resources for other digital equity efforts: Devices, while an integral part of the digital equity framework, should be de-emphasized in City funding efforts so that the City's resources can be put toward other efforts like funding CBOs to support ACP outreach, which covers broadband subsidies as well as a subsidy of up to $100 for a "connected device" (e.g., laptop, desktop, or tablet computer). The ACP is the major new opportunity in this area, and its funds are finite. Other programs—such as Comcast's Internet Essentials $149.99 laptop program and similar programs from other providers—are also supporting device acquisition without a need for City funds.

Build more comprehensive reporting requirements for City-funded programs to measure digital equity efforts over time: The City has captured the importance of reaching certain demographics and addressing problems through the Digital Equity Fund. To further and quantify this impact, we recommend using available monies or future state or federal funds to supporting thorough, comprehensive data collection about the impact of these efforts.

ANALYSIS OF BROADBAND AVAILABILITY

1 Summary of task report

This report section analyzes the residential broadband market in the City of Boston, explains how that market has changed over the past six years, and assesses the present availability of broadband across the City.[8] In early 2016, most residents only had one option: Comcast. Some also had access to a smaller competitive cable provider, Astound (formerly RCN), and in certain buildings, the fixed-wireless provider NetBlazr. Today a new fiber provider is Boston's incumbent local exchange carrier, Verizon. Verizon is in the final stages of a citywide buildout for their fiber product, Fios, that Verizon reports now reaches 78 percent of premises. And a new fixed wireless provider, Starry, is making aggressive inroads, making the Boston broadband market highly competitive. Verizon is working toward a full buildout. Starry would not discuss its plans but appears to be expanding.

1.1 An overview of fixed broadband

This task report is concerned mainly with fixed residential broadband, but we also provide a report on how mobile services have improved in Boston in recent years. Fixed residential broadband is delivered by the following technologies.

- **Fiber** – also called fiber optic or fiber-to-the-premises (FTTP) or fiber-to-the-node (FTTN) – is the fastest broadband transmission technology. Like coaxial cables, fiber optic cables are attached to utility poles or installed underground, then connected to a subscriber's home. Fiber can deliver 1 Gbps now, though fiber ISPs also typically offer multiple service levels at lower speeds and costs. Although not yet widely offered, the current technologies enable 10 Gbps or faster service over fiber.

- **Cable** – internet service delivered over the same Hybrid Fiber/Coaxial (HFC) cable that brings cable TV into a home and is also called cable modem broadband service. In the case of Comcast's Boston plant, the company has upgraded its distribution networks to fiber twice over the last 15 years, allowing it to deliver very fast service—up to 1.2 gigabit per second (Gbps) download.

- **Fixed wireless** – internet service delivered via access point antennas mounted on towers (or rooftops) to a subscriber antenna at a home or business. Subscriber antennas can be located indoors or outdoors depending on the distance to the access point and the amount of "clutter" between the subscriber antenna and the access point. Outdoor

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[8] The Federal Communications Commission says that a broadband connection (as opposed to a lower-speed internet connection) provides download speeds of at least 25 megabits per second (Mbps) and upload speeds of at least 3 Mbps (or "25/3"). In practice, users may need much more than this, and higher speeds are widely available in Boston.

antennas may be attached to a building or a mast on the premises Fixed wireless is often an option in areas where ISPs have not constructed wires to users' homes. However, fixed wireless technologies may not consistently deliver broadband speeds.

● **DSL** (Digital Subscriber Line) – an older technology used to deliver internet service over copper telephone lines. In areas where the telephone company offers DSL, the service is available to homes and businesses that are within a certain distance from the phone company's local facility – usually limited to a range of a few miles. DSL is the slowest of the internet services delivered over wires and is now largely or completely phased out in Boston as the old, copper switched plant is almost completely retired by the incumbent telephone company with the approval/consent of the Mass. Department of Telecommunications and the Federal Communications Commission.

1.2   Key findings and preliminary assessment

The key findings of this report phase—which is focused on documenting fixed broadband availability and pricing—are as follows:

● **Wired broadband infrastructure:** Thanks to the aggressive construction and deployment schedule of Verizon, the Boston market is about to achieve ubiquitous broadband competition by two wireline providers – Verizon and Comcast. With the notable exception that Verizon Fios is not yet widely available on Beacon Hill, the Financial District, or Downtown Boston—and beyond isolated cases where building owners denied entry to broadband providers—the City of Boston has no gap in wired internet infrastructure or service availability and no disparity in the types of services or pricing offered by providers across neighborhoods they serve. Indeed, Boston is nearly to the point of ubiquitous high-speed broadband competition by two of the five fixed broadband providers, with a third competitor available in some areas.

● **Fixed wireless infrastructure**: Services continue to expand, but not enough data is available to make a clear determination about whether neighborhood-level disparities exist. It is important to note that fixed wireless deployments depend on clear lines-of-sight and access to high-elevation buildings, and thus, by their nature, fixed wireless services provide options where available, but typically are not comprehensive solutions in an urban environment.

The service territories, service offerings, and pricing of the major fixed broadband providers appear in the body of the report. We highlight two maps of the two largest market players—Comcast and Verizon— that illustrate Boston's newly competitive wired broadband market. **Both companies affirmed as part of this engagement that they offer identical service offerings, service quality, and pricing everywhere they serve in Boston.** Those offerings top out at 1.2

Gigabit per second (Gbps) download, 35 Mbps upload for Comcast and up to 940 Mbps download, 880 Mbps upload for Verizon Fios.

Figure 1 shows the Comcast coverage in Boston. The company asserted that all premises within the shaded area are serviceable within seven to 10 days without extraordinary construction or costs to residents except in exceptional circumstances where a contribution is necessary to bring service to a premises.

Verizon Fios is in the late stages of a fiber buildout. Verizon says fiber is now available in 78 percent of the City, with the exceptions of Beacon Hill, the Financial District, and Downtown, which present special construction challenges, as mentioned. In other neighborhoods, the company says individual apartment buildings may not be wired if Verizon could not obtain permission from the building owner. Figure 2 shows Verizon's fiber coverage through the end of 2020; updated maps showing coverage through the end 2021 will be made public later in 2022.

Figure 1: Comcast service territory where up to 1.2 Gbps download, 35 Mbps upload service is available
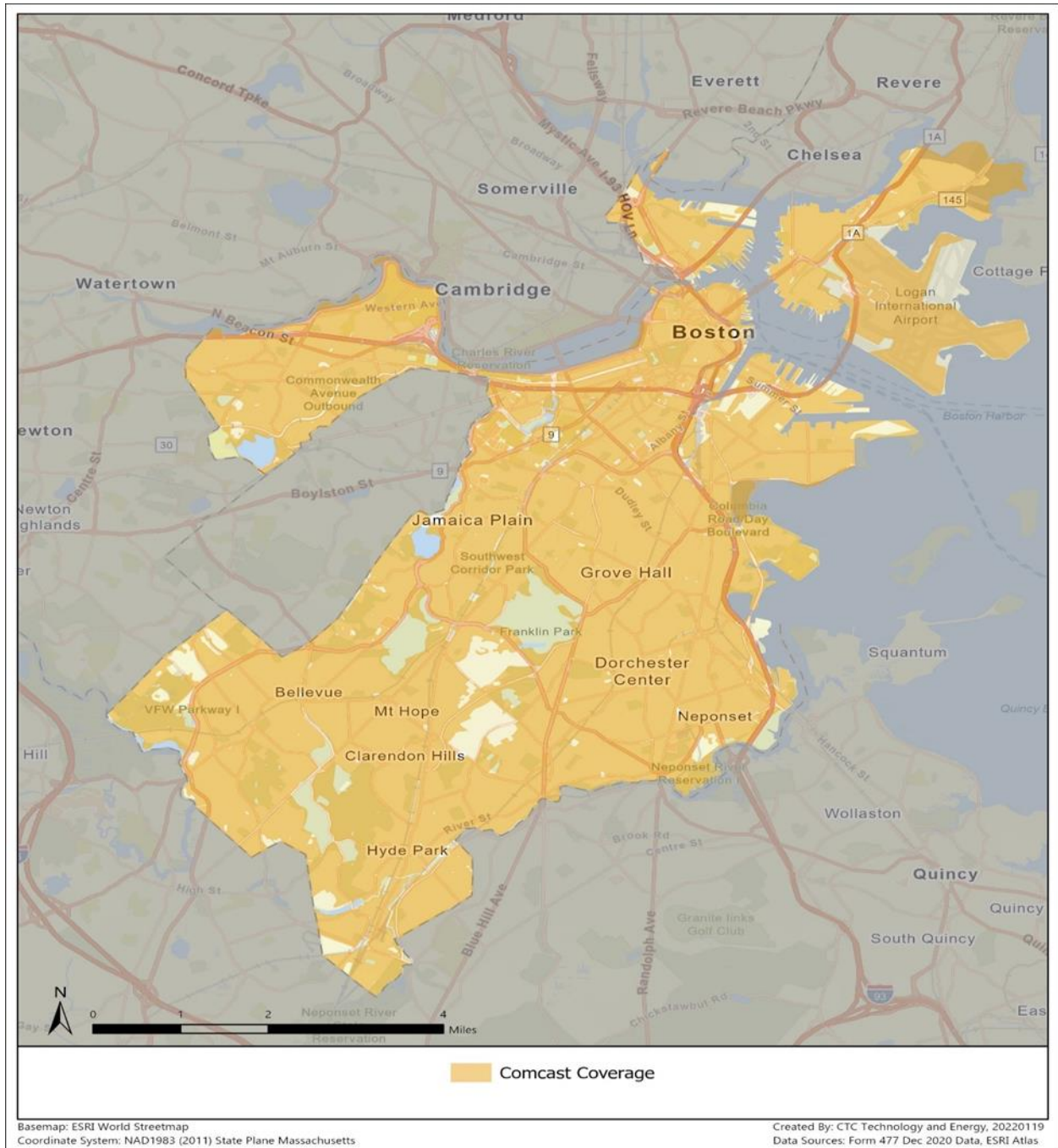
Figure 2: Verizon fiber coverage where up to 940 Mbps download, 880 Mbps upload service is available
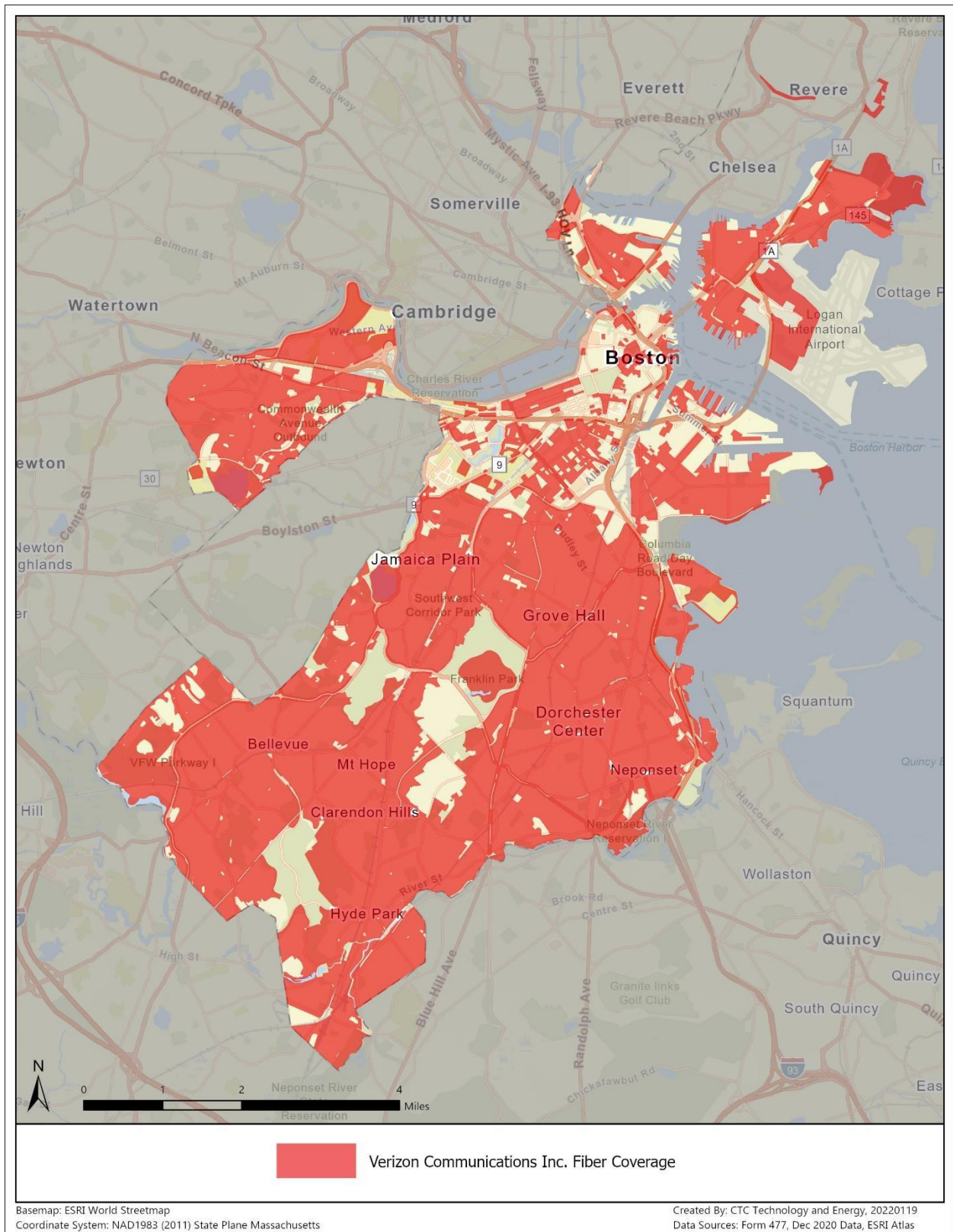
2 Perspective on potential sources of perceived broadband gaps

A number of factors unrelated to infrastructure or service quality can produce broadband access gaps, or a perception of gaps, or the experience of substandard service that is unrelated to what the ISP is providing to the premises.

2.1 Other sources of broadband gaps

In Boston, as in urban areas across the country, broadband gaps often include ones of affordability, uneven access to computers, and uneven skills levels, rather than a lack of infrastructure. Moreover, the pricing strategies of the major broadband providers—typically increasing prices after an initial trial period—can compound affordability problems.[9]

2.2 Census survey data can be misleading

Certain federal data can also sow confusion. While the presence of two questions on computer use and internet access are welcome additions to the U.S. Census Bureau's American Community Survey (ACS), one sometimes sows confusion: "At this house, apartment, or mobile home – do you or any member of this household have access to the Internet?" An answer of "no" to this question is not further explored by the ACS. But this answer can—understandably—be interpreted as meaning no broadband service is available, as opposed to that the respondent has not elected to take service. If a respondent has not elected to take service, it does not mean that no service is available.

2.3 Bandwidth is shared across groups of uses

Users of any standard residential broadband services—as opposed to far more expensive business plans that guarantee certain speeds and repair times under something called a "service level agreement"—will likely experience dips and slowdowns at peak times on all kinds of internet connections because, unless a user has a dedicated line, bandwidth is shared across groups of users. Additionally, while it is true that the experience in the home can be affected by problems on an ISP's network, it is also true that the in-home experience can be diminished by improper router choice or configuration, excessive distance from Wi-Fi access points, multiple simultaneous users within the home, intensity of application usage (such as video streaming and gaming), and presence of malware on user devices. All of these factors can produce the perception of service problems.

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[9] The digital equity phase and subsequent report mentioned above will cover this in more detail.

3   Fixed broadband coverage in Boston by provider

This section provides a more detailed discussion of each of the major fixed broadband providers serving the City of Boston. "Fixed broadband" refers to wired service and fixed wireless service but excludes mobile or satellite service. The fixed broadband services reviewed below all offer high download speeds in excess of 500 Mbps and, in most cases, 1 Gbps, while generally allowing customers to transfer unlimited data (thought Comcast sets a cap at 1.2 Terabyte (TB) of data per month, then adds additional fees). These services meet the current minimum needs of modern families, as identified by a number of federal and state programs.[10]

Mobile and satellite service do not provide consistent or adequate residential broadband speeds or service quality. Satellite services tend to be more expensive than their fixed broadband competitors, charge extra data usage fees, and can be susceptible to latency and weather issues. The mobile market has increasingly shifted from extra data usage fees to "throttling" user's service performance when they have exceeded monthly data limits during higher demand periods. Mobile services generally are limited to download speeds of either 25 or 10 Mbps and often face line-of-sight issues. Due to these differences, mobile internet services have consistently been interpreted as a separate market and not a viable substitute for fixed services.[11]

However, as the FCC notes, recent mobile market developments have enabled mobile internet providers to support a portion of the more data-intensive applications once available only over fixed broadband services. These developments are discussed in Section 5. The rest of this section is about fixed broadband providers – wired (Comcast and Verizon) and fixed wireless providers (NetBlazr and Starry).

Five major fixed broadband providers serve Boston.

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[10] For example, the U.S. Treasury identified the need for 100/100 Mbps services to meet the minimum needs families with two telecommuters and two to three remote learners, suggesting that larger families would need higher performance capabilities. U.S. Treasury, "Coronavirus State and Local Fiscal Recovery Funds," Interim Final Rule, 31 CFR Part 35, p. 72. In its CSLFRF final rules, the Treasury broadened area eligibility requirements in recognition that states and localities may need to upgrade networks already achieving this speed to satisfy "a broader set of reasons" for higher performance criteria. U.S. Treasury, "Coronavirus State and Local Fiscal Recovery Funds: Final Rule," *Federal Register*, Vol. 87, No. 18, 44087, January 27, 2022. Similarly, the Treasury's Capital Projects Fund, NTIA's Broadband Infrastructure Program, and the broadband programs of several states, including Minnesota, Illinois, and Alabama, have established reliable 100/100 Mbps as a minimum standard.

[11] E.g., FCC, "Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion," 2020 Broadband Deployment Report, GN Docket No. 19-285, Para 11, April 24, 2020, citing 2019 Broadband Deployment Report, 34 FCC Rcd 3857, 3861-62, para. 11 and 2018 Broadband Deployment Report, 33 FCC Rcd 1660, 1666-67, para. 18.

- **Comcast** is the **incumbent cable provider** operating the rebuilt legacy cable system initially built by Cablevision as the primary cable franchiser in Boston. Its service territory encompasses the entire city.

- **Astound (formerly RCN),** a **second cable provider**, provides service territory in parts of Boston and also offers fiber service at a few locations in the City.

- **Verizon** is a **competitive cable provider, local exchange carrier, and competitive wireless provider** in Boston. Verizon's fiber service territory encompasses the City with portions of Beacon Hill, the Financial District, and Downtown, awaiting Fios services as the fiber buildout continues.

- **Starry** is a relatively new **fixed wireless provider** that is expanding its service in select portions of Boston and surrounding municipalities.

- **NetBlazr** is a longer-serving Boston **fixed wireless provider** with service in the northern portions of Boston. It shared information on building-level coverage.

3.1   Data collection methods

CTC's market assessment includes data collection and analysis of where fiber, cable, DSL, and fixed wireless internet infrastructure and services exist, and what service offerings and pricing are available to consumers. We also presented forms submitting written questions to Boston providers and conducted follow-up interviews.

Finally, we considered Federal Communications Commission's (FCC) Form 477 data. For the past two decades, Form 477 data has been best source to understand residential broadband service availability. Twice a year, all facilities-based internet providers must file the FCC Form 477, requiring them to identify what internet services they provide by maximum advertised download and upload speeds and the technology used.[12]

The Form 477 program allows ISPs to claim that they serve the entire census block if they can provide services to just one household (emphasis added) in that area within a reasonable time "without an extraordinary commitment of resources." About half of census blocks are smaller than a tenth of a square mile, but others in some rural areas can encompass miles.[13] If a single

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[12] See Federal Communications Commission (FCC), "Modernizing the FCC Form 477 Data Program," WC Docket No. 11-10, Report and Order, Jun 27, 2013, paras. 6-24, ("2013 FCC 477 Modernization Order"). The program's three major updates in 2004, 2008, and 2014 dramatically improved the quality of the data gathered by shrinking the reporting area from each ZIP code to each census block and requiring more specific performance data, but its flaws have become increasingly pronounced. FCC, "FCC Form 477 Local Telephone Competition and Broadband Reporting," p. 17, December 6, 2016, https://transition.fcc.gov/form477/477inst.pdf.

[13] See FCC, "More About Census Blocks," p. 1, October 27, 2020,https://transition.fcc.gov/form477/Geo/more_about_census_blocks.pdf.

household is near an existing network, the ISP can claim the entire census block is served while also demanding thousands of dollars to connect other households in such "served" blocks.[14] These issues are primarily found in rural and not urban areas but must still be considered.

Of note, the Form 477's flaws are well-known, prompting two major Congressional actions over the past few years for better maps prepared by the FCC and the National Telecommunications and Information Administration (NTIA). ISPs will be required to provide more detailed information about individual addresses.[15] The DATA Act also provided the FCC with the means to ensure better ISP reporting practices, allowing it to gather its own data to verify suspect claims and issue significant penalties for inaccurate information.[16]

While we wait for these new maps, we rely on Form 477 data which, as mentioned, is generally reliable in urban areas with respect to cable and fiber services. With respect to fixed wireless, it is less reliable because wireless coverage does not neatly fit in census blocks.

We also researched websites of broadband providers to confirm service is available and to collect pricing and service option information. The pricing we report is, in all cases, the non-promotional pricing. We disregard initial promotional rates.[17]

All research was conducted between December 2021 and February 2022. We also conducted a limited analysis of ISP's historical pricing data, where available, to examine trends in pricing.

3.2 Comcast coverage, service levels, and pricing

As part of its cable license agreement with the City of Boston, Comcast is required to provide cable and video service throughout the City. Comcast affirmed that all residences in Boston—whether they be single-family homes, apartments (multiple dwelling units or MDUs), or public housing units—that are covered by Comcast "receive the same service offerings, service quality, and pricing." The company added that if coverage gaps exist at individual locations (what the company calls "cold" locations), it is because Comcast was not included in the development

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[14] See, e.g., Jon Brodkin, "When Home Internet Service Costs $5,000—or Even $15,000," *Ars Technica*, January, 16, 2019, https://arstechnica.com/information-technology/2017/01/when-home-internet-service-costs-5000-or-even-15000/.

[15] The Broadband Data Act defines a 'shapefile' as "a digital storage format containing geospatial or location-based data and attribute information — ''(A) regarding the availability of broadband internet access service; and ''(B) that can be viewed, edited, and mapped in geographic information system software." Broadband Deployment Accuracy and Technological Availability Act (Broadband DATA Act), Public Law 116-130, 116th Congress, 134 STAT. 229.

[16] 47 U.S.C. § 643.

[17] This approach matches the FCC's general approach on pricing. The FCC defines "average monthly price" as the "measure of the average monthly Internet-only plan prices after the promotion period ends; both average monthly price and average promotional price are calculated." FCC, "2020 Communications Marketplace Report," GN Docket No. 20-60, p. 77, fn. 353, December 31, 2020.

process of the building. Figure 3 shows the map of this coverage (repeating from above), with gaps generally reflecting features like parks, cemeteries, and rights-of-way.

Figure 3: Comcast service territory where up to 1.2 Gbps download, 35 Mbps upload service is available
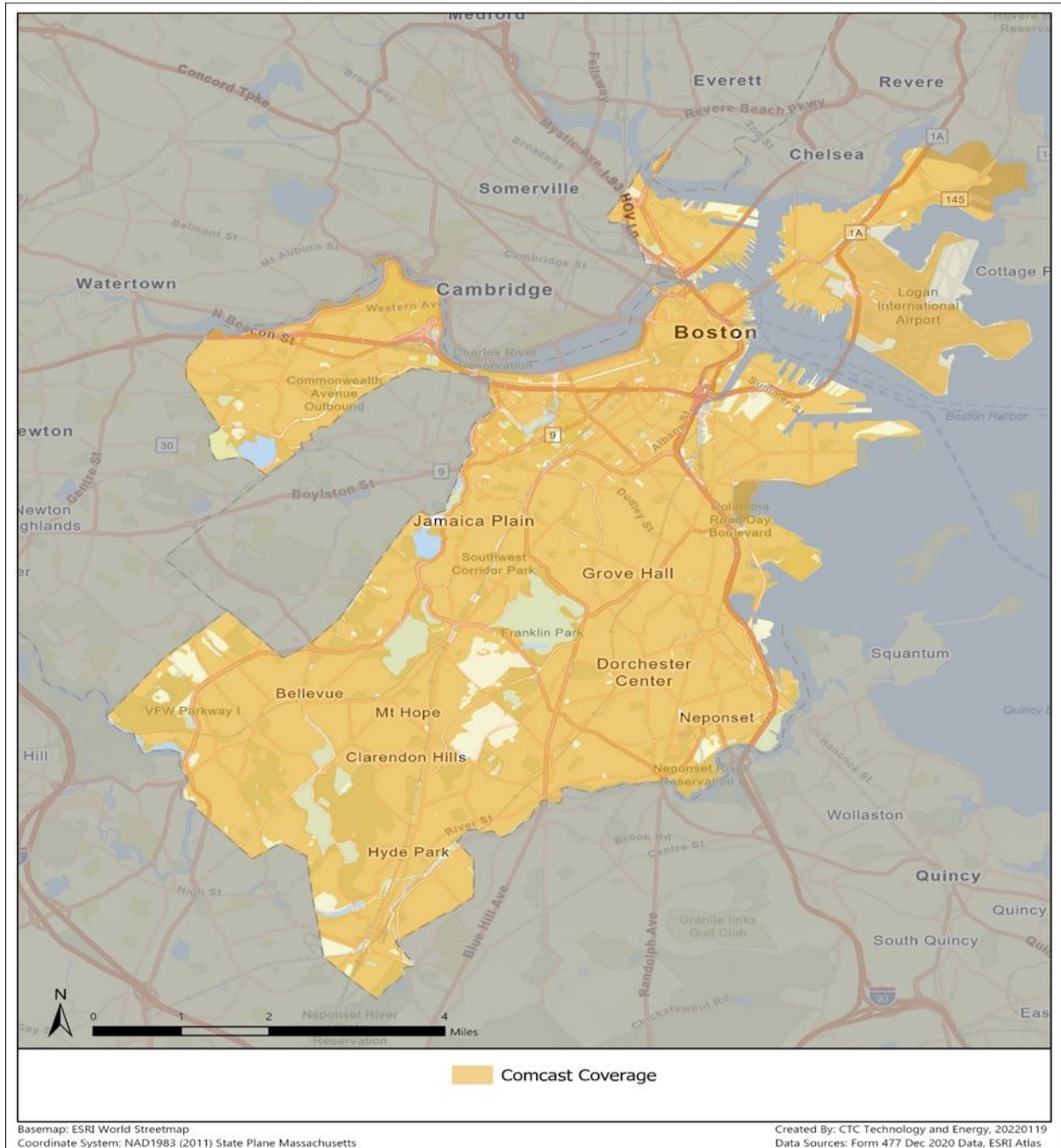
Citing competitive concerns, Comcast declined to detail specific network upgrade work it has undertaken, which includes technical improvements known as node splitting.[18] But the company stated that Comcast's network plan for Boston "is driven by our constant monitoring of usage levels across the City and that the resulting data drives decision on node-splitting and other improvements in the network electronics or backbone fiber.

3.2.1   Comcast Broadband service plans

Comcast offers eight main plans (Table 2), including a low-cost plan, Internet Essentials, for eligible households who are not already Comcast customers. In some circumstances Comcast can also provide residential fiber service with 3 Gbps symmetrical service at $299 per month, but this is not widely available. We checked addresses throughout Boston on the Comcast retail website and found identical service and pricing offers.

Table 2: Comcast service plans

Service	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Notes
Internet Essentials and Internet Essentials Plus	50/10 100/10	$9.95 $29.95	See section below for more information about this program for eligible low-income subscribers
Performance Starter Internet	50/5 Mbps	$65.00	No paperless billing discount
Performance Internet	100/5 Mbps	$80.95	No paperless billing discount
Performance Pro Internet	300/5 Mbps	$95.95	$10/month discount for paperless billing; $10/month discount for 1 year term agreement; $45/month discount for first 2 years
Blast! Internet	400/10 Mbps	$100.95	$10/month discount for paperless billing; $10/month discount for 1 year term agreement; $20/month discount for first year

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[18] In a hybrid cable and fiber network like Comcast's, customers share bandwidth on a given node or branch of the network. To increase bandwidth available to users, network operators will split one node into two, decreasing the number of premises sharing the same node. This allows greater bandwidth to become available to the remaining premises.

Service	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Notes
Extreme Pro Internet	800/15 Mbps	$105.95	$10/month discount for paperless billing; $10/month discount for 1 year term agreement; $25/month discount for first year
Gigabit	1200/35 Mbps	$110.95	$10/month discount for paperless billing; $10/month discount for 2-year term; $10/month discount for first year without a term agreement and for the first 3 years with a 2-year term agreement

We also sought historical broadband pricing for Comcast. Even adjusting for inflation, Comcast's lower speed plans have each increased. For higher speed plans, prices have decreased. Almost every plan offered by Comcast in 2017 has been upgraded to faster speeds.

Table 3: Comcast's historical and current pricing[19]

Current Speed	Current Price	Historical Speed	Historical Pricing	Historical Price Adjusted for Inflation
50/10 Mbps (internet essentials)	$9.95	Started at 15/2 and was increased several times	$9.95	$11.42
50/5 Mbps	$65.00	25/3	$49.95	$57.35
100/5 Mbps	$80.95	60/5	$59.95	$68.83
300/5 Mbps	$95.95	75/10	$74.95	$86.05
400/10 Mbps	$100.95	100/10	$89.95	$103.27
800/15 Mbps	$105.95	250/15	$149.95	$172.16
1200/35 Mbps	$110.95	940/20	$299.95	$344.37

[19] This data is based on a 2017 Comcast rate card for King County, Pierce County, and Snohomish County, Washington. However, Comcast utilizes the same standard rates everywhere it operates in the country so the data should still accurately reflect Comcast's standard rates in Boston, in 2017.

3.2.2   Comcast's Internet Essentials program for qualifying households

Comcast since 2011 has offered its Internet Essentials program, under which eligible low-income customers pay $9.95 per month for a wired internet connection. Boston was the first City receiving the program. Internet Essentials also includes added benefits; customers can purchase a Dell PC or Chromebook for $149.99,[20] and can access out-of-home Wi-Fi on Comcast's Wi-Fi hotspots across the country.[21]

Comcast states that it has enrolled approximately 27,000 Boston households in the Internet Essentials program since it began in 2011. This is a cumulative number of enrollments; Comcast would not disclose current enrollment, which will naturally be lower because of customers canceling, moving, or failing to pay. There is substantial potential for increased use of the program. Boston benefited from being Comcast's first Internet Essentials partner back in 2011.

In response to the Covid-19 pandemic, Comcast increased the program's connection speeds, first to 25 Mbps download, 3 Mbps upload, then to 50 Mbps download, 5 Mbps upload and finally, at the end of 2021, to 50 Mbps download, 10 Mbps upload and added "Internet Essentials Plus" at 100 Mbps download, 10 Mbps upload.[22] Figure 4 shows Comcast's timeline.

Figure 4: Comcast's Internet Essentials timeline

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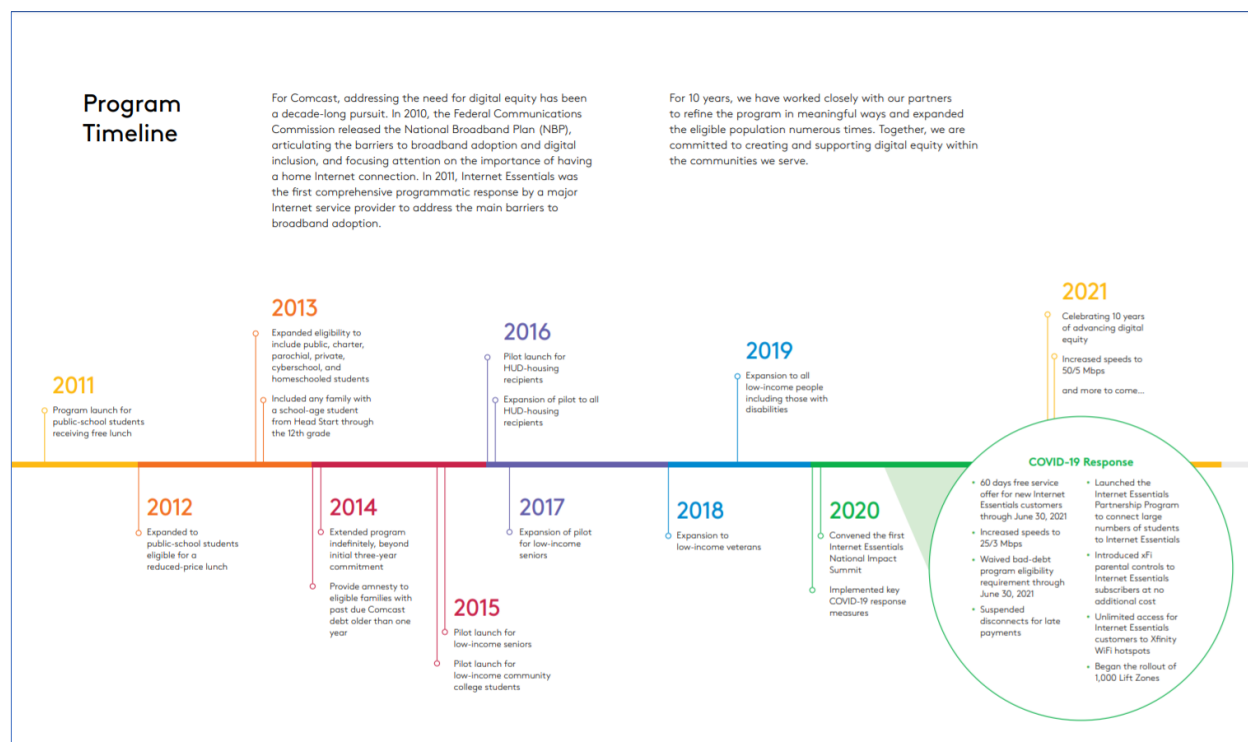
[20] "Internet Essentials Programs," Comcast, https://www.internetessentials.com/ (accessed January 2022).

[21] "Internet Essentials Programs," Comcast, https://www.internetessentials.com/ (accessed January 2022).

[22] "Internet Essentials Programs," Comcast, https://www.internetessentials.com/ (accessed February 2022).

When the program started in 2011, Comcast only allowed families with children that qualified for the National School Lunch Program to apply. The company later expanded the program to four qualifying groups:[23]

- Families that have a child who qualifies for the National School Lunch Program (NSLP)

- Families that receive HUD housing assistance

- Low-income veterans who receive federal or state public assistance

Comcast later expanded eligibility requirements multiple times to include:

- Families who qualify for Medicaid

- Families who are approved for Supplemental Nutrition Assistance Program (SNAP) benefits

- Families who are eligible for Temporary Assistance for Needy Families (TANF)

- Families who are eligible for the Low-Income Home Energy Assistance Program (LIHEAP)

- Families who are eligible for the Women, Infants, and Children (WIC) program

- Families who are eligible for tribal assistance

- Families who have received a Federal Pell Grant from a local community college (not applicable in Massachusetts; this is for Colorado and Illinois only)

- Families who have a family member who qualifies for Supplemental Security Income (SSI)

Even with the expanded eligibility requirements, however, Comcast stipulates that a customer of the Internet Essentials program must not have received service from Comcast within the past 90 days.[24] This makes it difficult for people who were already paying for service to switch to the more affordable Internet Essentials plan (for example, if job loss means a customer now qualifies for the lower-cost service).

3.2.3   Bulk purchase and Internet Essentials

The next section describes Boston's digital equity initiatives, assesses gaps, and provides recommendations. But it is worth noting that to close broadband affordability gaps, the City of Boston through Tech Goes Homes and the Boston Public Schools have also subsidized approximately 3,500 Internet Essentials subscriptions in the past two years during the Covid-19

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[23] "Internet Essentials Programs," Comcast, 2019, https://www.internetessentials.com/ (accessed January 2022).

[24] Comcast, "FAQs," 2019, https://www.internetessentials.com/get-help (accessed January 2022).

pandemic. To facilitate this, the state amended an existing contract vehicle for managed municipal services from Comcast to allow municipal governments to 'bulk purchase' Internet Essentials for school families.

In fiscal year 2021, the Boston Public Schools received a digital equity grant of $660,000 from the state Department of Elementary and Secondary Education (DESE), allowing BPS to purchase Chromebooks and 2,000 Internet Essentials vouchers directly from Comcast. Additionally, the City of Boston funds a nonprofit digital equity group, Tech Goes Home, and funds the acquisition of 1,500 Internet Essentials accounts, annually, using this bulk purchase mechanism.

Comcast negotiates bulk-service agreements with apartment building owners on a case-by-case basis based on number of units, the level of service desired, the need for construction, and the length of the contract. If an agreement has an exclusivity provision, the company asserted that typically such a provision would be as to marketing or as to use of physical plant installed and owned by Comcast. It said the challenges it faces include land restrictions, property owner cooperation, developer cooperation, and permitting processes, particularly when it comes to emergency permits.

3.3   Verizon Fiber coverage, service levels, and pricing

Through early 2016, Verizon was only offering slow internet service, known as DSL, over its copper phone lines. But following a Boston-Verizon cooperation agreement in early 2016[25] aimed at improving wireless and wired service, Verizon began building out its fiber-to-the-premises (FTTP) fiber service and connecting customers. This "Network Transformation Project" began in the Nubian Square area of Roxbury and in the West Roxbury and Dorchester neighborhoods. The company states that through the end of 2021, 78 percent of Boston households have access to Fios Internet. To date, all neighborhoods have this service available with the exception of Beacon Hill, Downtown and the Financial District, which are currently being built out. Verizon also helped provide connectivity to residents during the COVID-19 Pandemic by reallocating approximately $2.5 million of the $4.7 million the provider had committed to funding smart city applications in Boston to fund hotspots and data plans to support Boston Public School students.

In its engagement with CTC, Verizon affirmed that it offers the same service levels, service quality, and pricing for Fios Internet to all premises it serves, whether single-family homes, apartments, condos, or public housing units. Figure 5 highlights the areas where Fios Internet is offered. The map was created from data filed by Verizon with the FCC on March 1, 2021, and depicts availability through December 31, 2020. The buildout has been extended since then, but updated maps will not be available until later this year.

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[25] Verizon and City of Boston, "Verizon/City of Boston - Cooperation Agreement," March 24, 2016, https://www.cityofboston.gov/images_documents/Boston-Verizon-cooperation_tcm3-53269.pdf.

Figure 5: Verizon fiber coverage where up to 940 Mbps download, 880 Mbps upload service is available
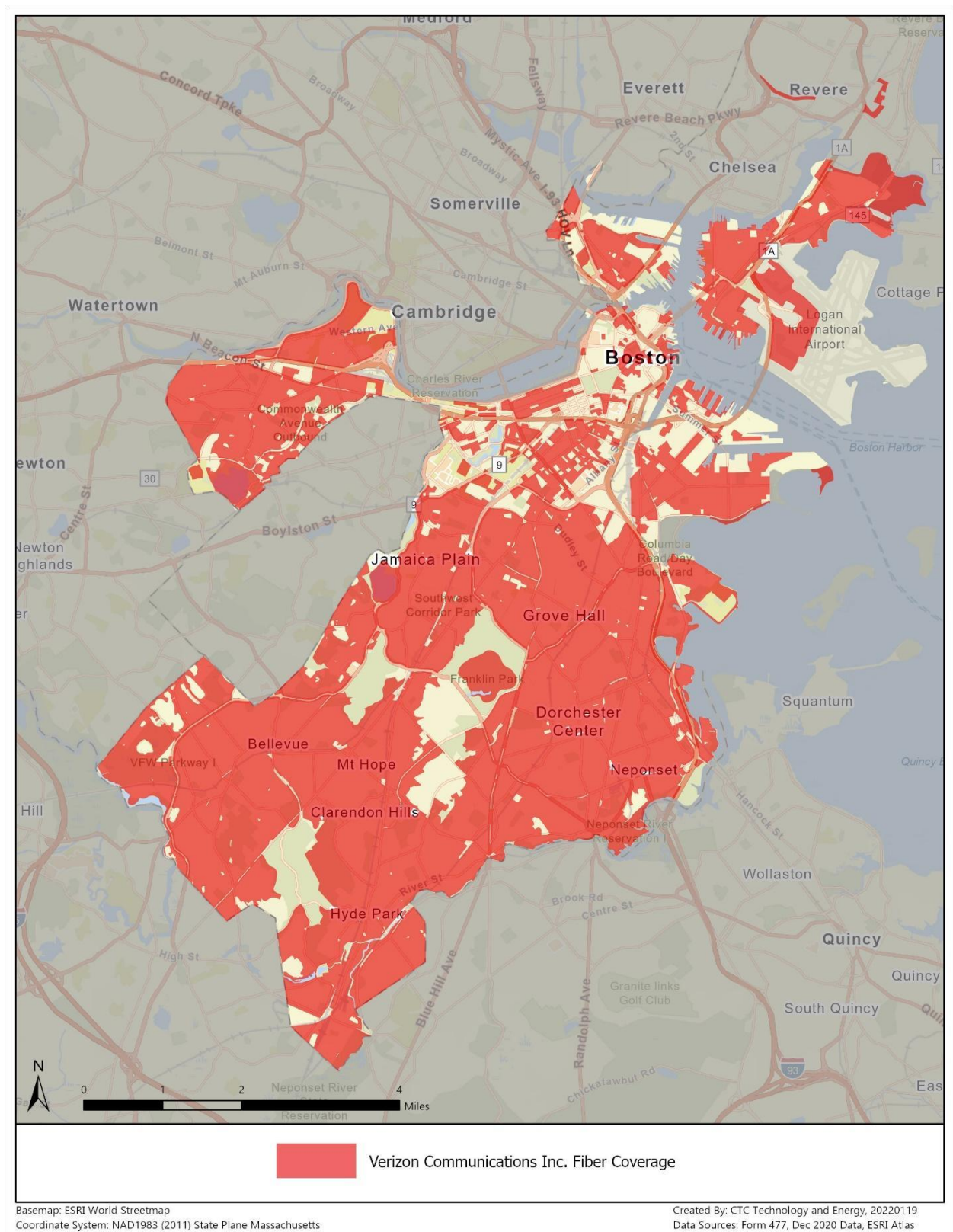
3.3.1   Verizon Fios service plans and pricing

Verizon, which markets its fiber plans as Fios home internet, offers three tiers of service. We checked addresses throughout Boston on the Verizon retail website and, if service was available, we found identical pricing and service offerings. Table 4 summarizes these offerings.

Table 4: Verizon Fios home internet service plans

Service	Advertised Download/Upload Speeds [26]	Monthly Price (non-promotional)	Notes
Better Browsing Plan	300/300	$49.99	Does not include $15 or $20/month equipment rental fee or a $99 installation fee; Equipment can be purchased for $300. Customers can sign up for a paperless autopay discount of $10.[27]
Better Streaming Plan	500/500	$74.99	Does not include $15 or $20/month equipment rental fee or a $99 installation fee; Equipment can be purchased for $300. Customers can sign up for a paperless autopay discount of $10.
Better Everything Plan	940/880	$99.99	Does not include a $99 installation fee; Equipment is included in the base price. Customers can sign up for a paperless autopay discount of $10.

Verizon customers who qualify for the ACP can participate in Fios Forward, a broadband offering that delivers uncapped download and upload speeds of at least 300 megabits at no cost after application of the ACP subsidy. In addition to its Fios fiber services listed above, Form 477 data also indicate Verizon has a small number of remaining legacy DSL customers in Boston. CTC checked a sample of addresses in Boston on the Verizon website and found that most were actually able to receive fiber service. Some addresses on Beacon Hill had no Verizon service at all, including no DSL. In another neighborhood, the Fenway, CTC found one apartment building, 24 Queensberry Street, with no Verizon service. A Verizon representative said that Verizon had

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[26] Speed and pricing data for Verizon plans were collected in May of 2022. At this time, the Verizon website stated the speed increase for the Better Streaming plan (originally 400/400 Mbps) and the Better Browsing plan (originally 200/200 Mbps) were temporary.

[27] To receive the $10 discount, Verizon requires customers to enroll in autopay using a debit direct-from-bank card.

made multiple attempts to contact the building owner to gain permission to bring service to the building but had not received a response. Verizon says it continues to reach out to property owners and managers to obtain permission to bring fiber for Fios services to residents of apartment complexes in every Boston neighborhood.

It is likely that Form 477 data, which dates to December 2020, understates the current availability of Verizon Fios in Boston.

3.3.2   Analysis of pricing history for Verizon Fios service

Compared to 2017, Verizon has increased speeds faster than pricing, even when adjusting for inflation, [28] and has added a mid-tier 400/400 Mbps offering.

Table 5: Verizon's historical and current pricing[29]

Current Speed	Current Price	Historical Speed	Historical Pricing	Historical Price Adjusted for Inflation
300/300	$49.99	50/50	$39.99	$45.91
500/500	$74.99	Not available	N/a	N/a
940/880	$99.99	940/880	$69.99	$80.63

3.3.3   Verizon Fios Forward affordable broadband service with ACP

Verizon recently announced the Fios Forward plan for qualifying Fios customers, i.e., customers who qualify for ACP. The plans offer three tiers of broadband service and no setup/enrollment fee, the router is included and, at the entry level of 300 Mbps, the service is fully covered by the federal ACP subsidy.[30]

3.4   Starry coverage, service levels, and pricing

Starry is one of the two fixed wireless providers in Boston, the other being NetBlazr. Following early "beta testing" in 2017, Starry began offering service in 2018 and has been aggressively expanding in the Boston metropolitan area. Starry provides coverage by means of an antenna strategically placed on higher buildings to which it has access. However, the wireless technology

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[28] "CPI Inflation Calculator," BLS, https://www.bls.gov/data/inflation_calculator.htm, (accessed January 2022).

[29] Historical pricing taking from a 2017 Verizon announcement: "Verizon Launches Fios Gigabit Connection Service Delivering Millions of Customers the Speeds They Deserve," https://www.verizon.com/about/news/verizon-launches-fios-gigabit-connection-service-delivering-millions-customers-speeds-they, (accessed January 2022).

[30] See "Verizon Fios Forward – Fios Home," Verizon, https://www.verizon.com/home/fios-forward/?CMP=OLA_CON_ACQ_99999_NA_20210101_NA_M20200260_00001, (accessed April 28, 2022). Customers eligible for the ACP may receive 300/300 tier service free after the ACP discount is applied, or may apply their discount to the other tiers.

and their business model limit coverage to buildings within a certain range and line of sight from these antenna sites.

As part of this engagement, Starry affirmed that all residences in Boston in range of Starry service (access antenna) receive the same service and service quality. Starry added that on occasion, it offers different speed plans to test market appetite for certain tiers of service or offers special promotions to encourage broadband adoption (e.g., free months of service); but with those exceptions, the company's standard and basic plans are available to all subscribers and include no additional fees for installation, maintenance, or equipment rental.

Citing competitive concerns, the company would not disclose its precise coverage area or customer numbers in the City of Boston, only in the "Boston metropolitan area," which it defines as anything within 40 kilometers (24.8 miles) from the center of Boston. This definition is not useful to understanding the extent of the company's availability in Boston itself. During our outreach in December, the company claimed a subscriber count of 12,078 in the "Boston metropolitan area." Figure 6 shows Starry service territory according to Form 477. But Form 477 shows full coverage in a given census block even if just one building can receive service. Given that fixed-wireless service is generally only available to particular buildings, this map overstates true availability. As noted above, Starry only provided customer numbers for the "Boston metropolitan area."

Figure 6: Starry service territory in Boston
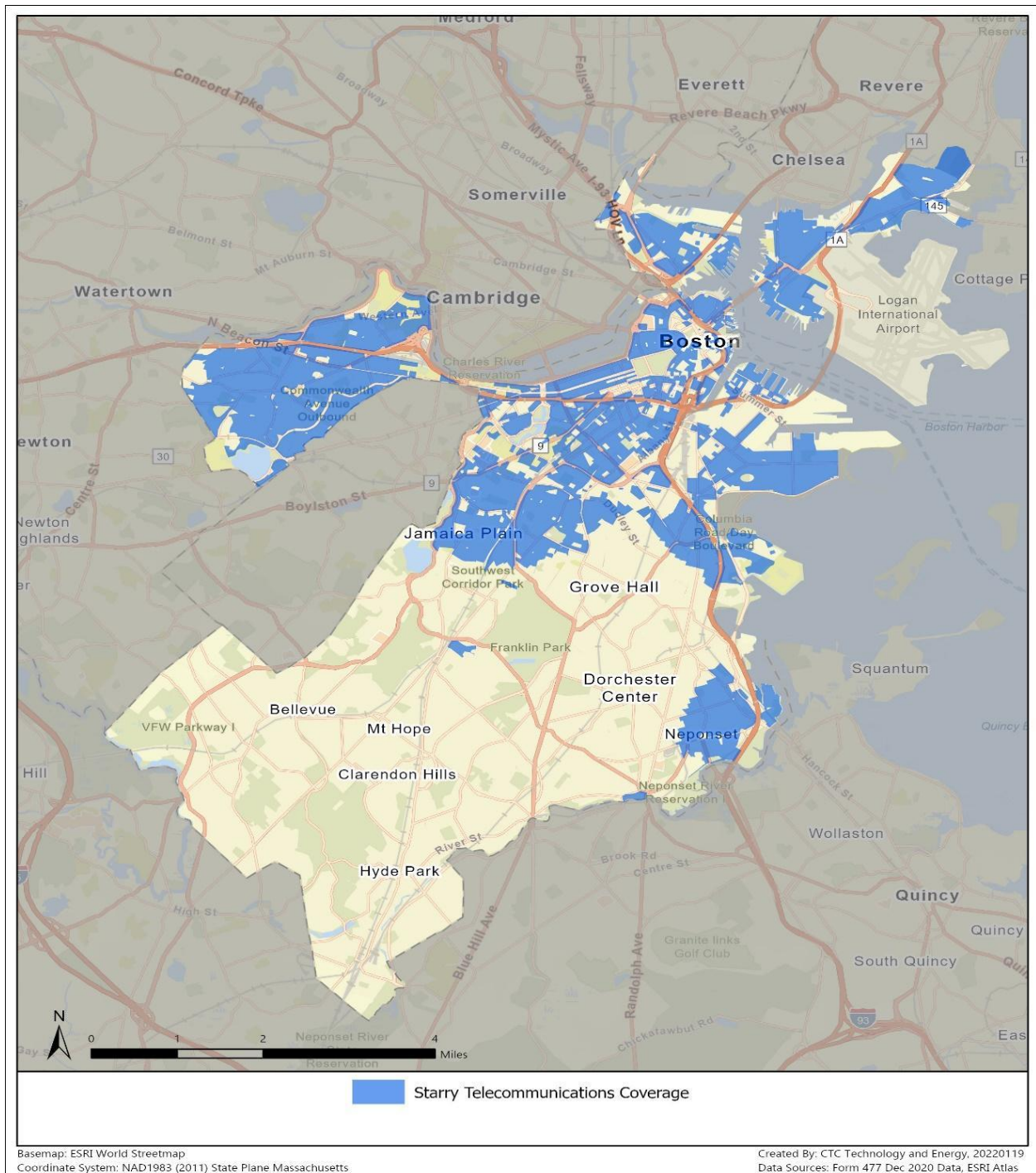
3.4.1 Starry service plans and pricing, including "Starry Connect" low-cost program

Starry, offers several ties of service, including symmetrical service at its lowest speed tiers. Table 6 summarizes these offerings.

Table 6: Starry service plans

Service	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Notes
Starry Connect	30/30	$15.00	Only available in Starry Connect Communities (public and affordable housing)
Starry Basic	50/50	$30.00	Have a promotion for first 2 months free
Starry Internet	200/100	$50.00	Have a promotion for first 2 months free
Starry Pro	500/250	$65.00	Plan only made available periodically to test market appetite
Starry Gigabit	1000/500	$80.00	Plan only made available periodically to test market appetite

Starry did not report total numbers of premises that can receive service in the Boston metropolitan area but did say that this total includes approximately 7,800 units in low-income housing, including in some Boston Housing Authority buildings. Residents of such developments are automatically eligible for the low-cost "Starry Connect" service for $15 monthly.

The company defines such developments as ones where at least 90 percent of the units are owned by a public housing authority, are subsidized by federal, state, or local dollars, or are income-restricted or rent-regulated/stabilized under a local or state or federal affordability program, or officially classified as workforce housing by a local housing agency.

In terms of historical pricing, a Starry representative said the company has not changed its pricing for its basic 200 Mbps plan ($50) since launch but has added additional speed tiers (both lower and higher) at different prices.

3.5 NetBlazr coverage, service offers, and pricing

NetBlazr is the second fixed wireless provider in Boston with a limited customer base of individual larger apartment buildings, making it a niche player in Boston. The company explained in its engagement with CTC that it has a focus on multi-family buildings of 35 units or more. It can only service residences in such a building with permission of the property owner or manager and only

if there is a line-of-sight from the new building to an existing part of the company's network. In such cases, they then install a wireless receiver on top of the new building and use in-building wiring to reach customer premises.

NetBlazr affirmed that it offers the same services, quality, and pricing to all residents of the buildings it connects. The company said that there are some buildings where it offers services but cannot provide higher speed tiers (above 100/100 Mbps) due to older wiring within the building. This limits the user experience, but such users at least have this option available to them in the first place.

Federal Form 477 data is not particularly useful in the case of NetBlazr, because service is limited to individual buildings. Buildings served by NetBlazr are in the northern half of the City as illustrated by Figure 7, below.

Figure 7: NetBlazr service territory in Boston
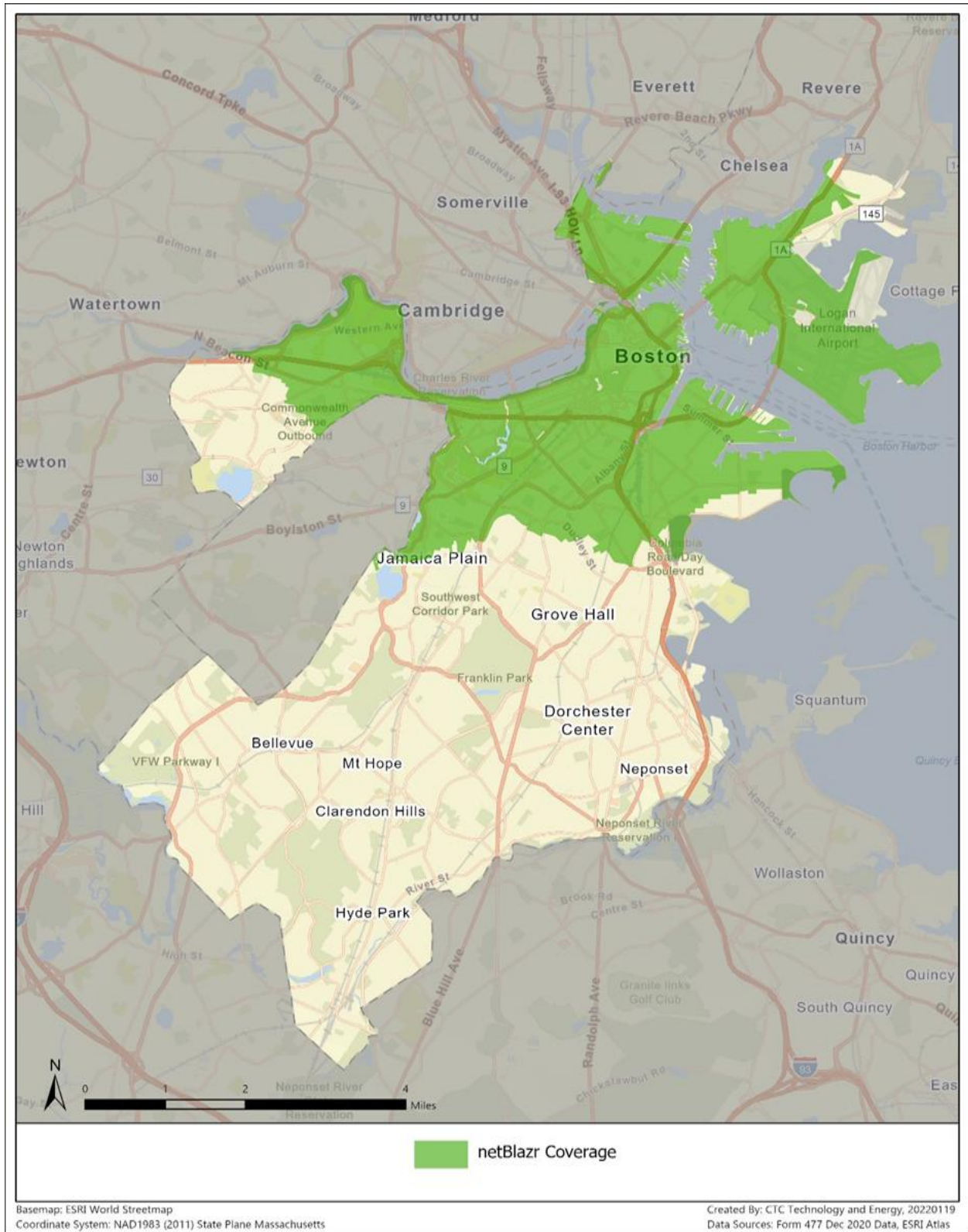
NetBlazr, offers three service plans, Concierge Internet (one payment), Concierge Internet (monthly payment), and Standard Internet. Table 7 summarizes the services offered.

Table 7: NetBlazr service plans

Service	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Notes
Concierge Internet (one payment)	500-1000/500-1000	$600/year	Plan availability and speeds are based on locations. Starry does not provide in home equipment (router/modem). Note, this plan uses an annual payment system rather than a monthly one.
Concierge Internet (monthly payment)	500-1000/500-1000	$59.95	Plan availability and speeds are based on locations. Starry does not provide in home equipment (router/modem).
Standard Internet	100-200/100-200	$39.95	Plan availability and speeds are based on locations. Starry does not provide in home equipment (router/modem).

As of May 2022, NetBlazr became an ACP provider. The company launched a 300/300 Mbps ACP offering for $30 per month, making it free to residents who get a $30 monthly ACP credit.

CTC was unable to identify any historical pricing data for NetBlazr.

3.5.1   NetBlazr programs for low-income residents

Other than the ACP offering described above, NetBlazr does not have a reduced-price service for individual low-income households but has done bulk deals to provide low cost or no cost services in several subsidized housing complexes.

For example, NetBlazr has a bulk agreement with Roxbury Tenants of Harvard for services to all the units in their Mission Park complex and, in 2017, did a three-way project between the City of Boston, Korea Telecom and NetBlazr to provide free services to Haynes House residents using newly introduced Korea Telecom (KT) equipment that supported broadband over phone wiring. NetBlazr said it continued those free services for more than two years until that wiring was destroyed during building renovations.

3.6   Astound coverage, service offers, and pricing

Astound (formerly RCN), the smaller video and broadband provider in Boston, shared that its Boston subscriber base has fallen by more than half in recent years due to the aggressive competitive presence of Verizon Fios and Starry and aggressive marketing by incumbent Comcast Xfinity. Figure 8 below, shows Astound's service territory according to federal Form 477 data.

Astound is an Open Video System (OVS) in Boston with an operating agreement that is similar to a cable license. Astound also operates systems in 18 nearby towns, as well as in New York City, Chicago, Washington D.C., and Pennsylvania communities.

Stonepeak Infrastructure Partners recently acquired Astound Broadband, the sixth largest U.S. cable-TV provider, for $3.6 billion. Astound, which was owned by Boston-based private-equity firm TPG and cable-management company Patriot Media Management, is the operator of RCN Telecom Services LLC, Grande Communications, Wave Broadband and enTouch Systems.[31]

The Astound transfer is largely a procedural matter, in that Boston is less than 3 percent of Astound's customer base. Nonetheless, the City has the opportunity to confirm commitments that are unique to Boston within the transfer.

Astound's presence in Boston—offering cable TV, high-speed internet and telephone services—has provided residents with a limited competitive choice for cable, internet and telephone services in their service areas. Under existing Boston license terms, Astound has supported PEG access cable channels, and provided fiber to the City's network.

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[31] Miriam Gottfried, "Stonepeak Infrastructure to Buy Cable Provider Astound Broadband," *The Wall Street Journal*, November 1, 2020, https://www.wsj.com/articles/stonepeak-infrastructure-to-buy-cable-provider-astound-broadband-11604266329.

Figure 8: Astound service territory in Boston
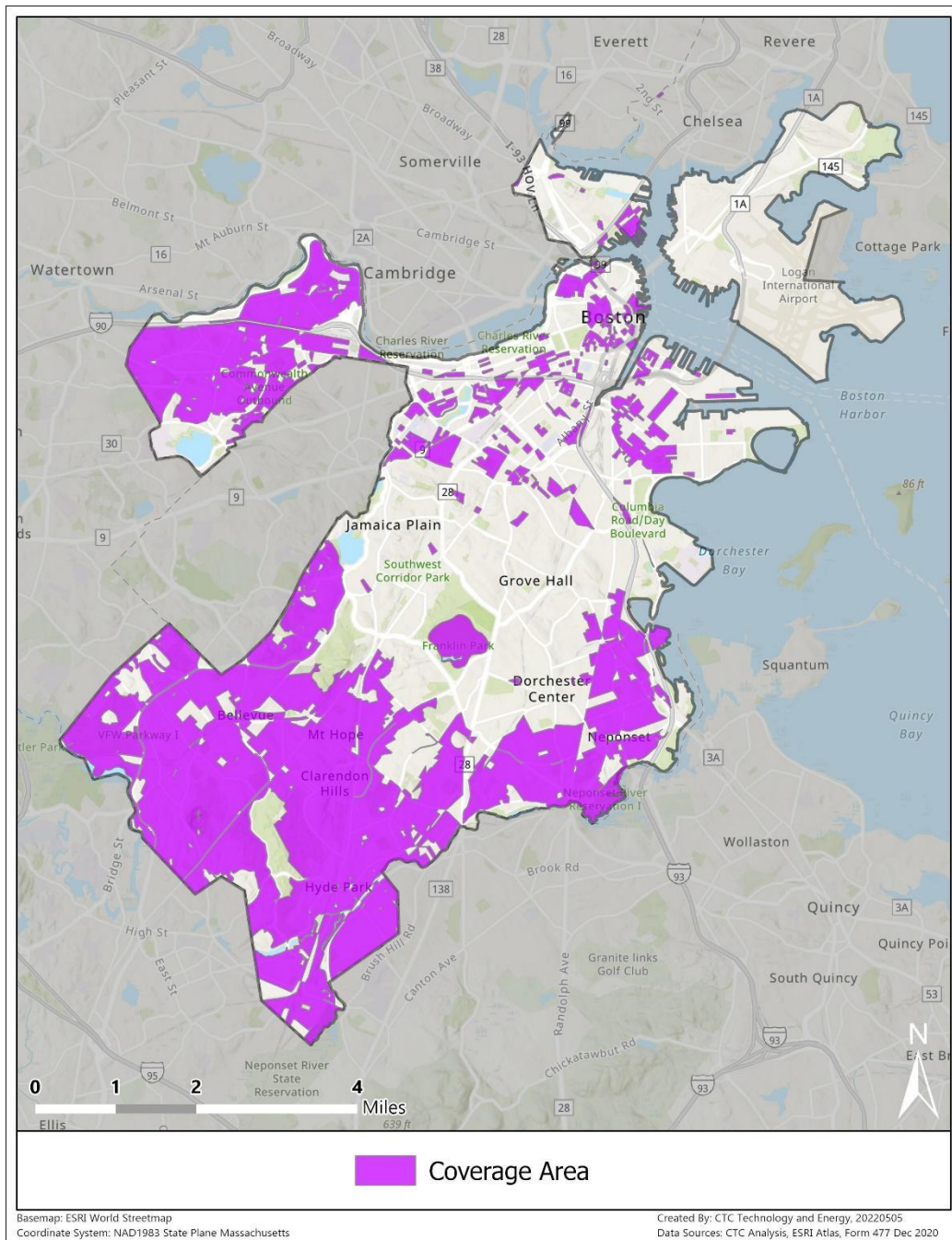
The company offers three main plans as shown in Table 8. Unlike the other providers included in this report we have chosen to list both the promotional and non-promotional pricing for Astound. The reason for this is the large difference in price between their discounted rate and their non-promotional rate. Astound customers who sign up for their plans are offered the promotional rate for the first year of service however, after this first year their rates will increase by close to

$100 a month. Since this price increase is so steep, we felt it was important to capture both their promotional and non-promotional pricing to provide a complete picture of their service offerings in the Boston area.

Table 8: Astound service plans

Service	Advertised Download/Upload Speeds	Monthly Price (promotional)	Monthly Price (non-promotional)	Notes
RCN Internet First	50/4	$9.95	$9.95	Plan only available to eligible individuals
RCN Internet	300/20	$25.99	$143.99	Price does not include $12/month for equipment rental or $79.95 installation fee.
RCN Internet	600/20	$35.99	$148.99	Price does not include $12/month for equipment rental or $79.95 installation fee.
RCN Internet	940/20	$45.99	$153.99	Price does not include $12/month for equipment rental or $79.95 installation fee.

3.6.1   Astound's Internet First program for qualifying households

In addition to the plans mentioned above Astound offers a low-cost plan called Internet First to certain qualified customers. Eligible low-income customers pay $9.95 per month for a wired internet connection with up to 50 Mbps downloads speeds and 4 Mbps upload speeds[32].

Eligibility for this program is based on a household's participation in certain federal and state aid programs[33]. The list of eligible programs can be found below:

- Medicaid,
- Public housing assistance,
- Unemployment benefits,
- Supplemental Nutrition Assistance Program (SNAP),
- Temporary Assistance for Needy Families (TANF),

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[32] Astound, "Internet First terms and conditions", https://www.internetfirst.com/terms-conditions/ (Accessed June 2022)

[33] Astound, "Internet First terms and conditions", https://www.internetfirst.com/terms-conditions/ (Accessed June 2022)

- Supplemental Security Income,
- Low Income Home Energy Assistance Program (LIHEAP),
- Women, Infants, and Children program (WIC),
- The National Free and Reduced School Lunch Program/Head start,
- VA pension,
- Or any tribal assistance program.

Any interested individual will need to apply online through Internet First's online portal to participate in this program[34].

While this program offers broadband service at an affordable price point there are some important caveats. Any customer of the Internet First program cannot have received service from Astound within the past 60 days of their application to the program[35]. This makes it difficult for people who were already paying for Astound service to switch to the more affordable Internet First plan (for example, if job loss means a customer now qualifies for the lower-cost service).

The second is that Internet First customers are required to reapply for the program every year. The application process for the Internet First program is fairly burdensome and could deter eligible individuals from continuing to participate in the program. In addition to making customers reapply each year, RCN will also raise an Internet First customers rate by up to $10/month each year[36]. Since the promotional price of their cheapest internet plan is $25.99, this price increase creates little incentive for an Internet First customer to continue participating in the program after a year.

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[34] Astound, "Internet First terms and conditions", https://www.internetfirst.com/terms-conditions/ (Accessed June 2022)

[35] Astound, "Internet First terms and conditions", https://www.internetfirst.com/terms-conditions/ (Accessed June 2022)

[36] Astound, "Internet First terms and conditions", https://www.internetfirst.com/terms-conditions/ (Accessed June 2022)

4   Crown Castle has greatly expanded to serve multiple needs

Crown Castle (Crown) is a real estate investment trust and provider of shared communications infrastructure with a network of over 40,000 cell towers and nearly 80,000 route miles of fiber across the United States. Crown, over the past seven years, acquired fiber assets from Sunesys and Lightower giving the company a large fiber footprint throughout the City of Boston.

The City of Boston currently leases fiber from Crown for BoNet to connect about 170 public institutions in the City for up to 30 years. This leased dark fiber supports internet and wide area network connectivity to Boston public schools, Boston Police Department and Fire Department locations, and housing managed by the Boston Housing Authority. See Section 2.6 for further detail on how Boston uses this leased fiber to support digital equity initiatives in the city.

As a neutral-host infrastructure provider, Crown continually upgrades its fiber backhaul network in Boston to support mobile carrier LTE densification and 5G services. At the time Crown Castle provided information to CTC in April of 2022, the provider had approximately 1,525 small wireless facility and tower sites operational in the Boston Metropolitan Statistical Area. This backhaul network and sites support mobile carriers' ability to provide Boston residents (who are within range) access to higher LTE and 5G speeds.

5 Mobile wireless coverage, service levels, and pricing

While the FCC and others have repeatedly identified that mobile service is an inadequate substitute for fixed broadband services,[37] an estimated 15 percent of U.S. adults continue to rely on their smartphones as the only source of home broadband connectivity.[38] Smartphone dependency is more common among young adults and low-income households; nationwide, Pew found that 28 percent of adults between 18 and 29, and 27 percent of households with incomes of less than $30,000, have mobile data services but not home fixed broadband services.[39]

These smartphone-only adults often have difficulty performing tasks that were designed primarily for more robust computing devices, such as most online education, telehealth, government services, and job application portals. Tasks like creating a resume are often daunting on a laptop but become nearly impossible on a small screen with only a touchscreen interface. The FCC notes that other common uses, such as the streaming of "large quantities of high-definition video content" and use of smart home technologies like smart lights or home security cameras, require fixed broadband connections.[40]

Most modern smartphones can be used as wireless hotspots to connect other computing devices to the internet, and mobile providers now offer "fixed wireless" services with devices dedicated to being hotspots, but this "tethered" connectivity is limited by several factors. Tethered computers can only send and receive information as quickly as the hotspot and network support, primarily limited by the dimensioning of the mobile network's network (i.e., the network design defining the number of access points in a given area providing certain speeds) and the number of users on the same access point at a given time. Many mobile networks are dimensioned to support 5/1 Mbps, and while 5/1 Mbps service is widely available throughout Boston,[41] faster services are less widespread.

The mobile smartphone device's service agreement may also restrict broadband speed significantly, often after reaching a monthly data use limit. Verizon's "Unlimited" plan provides 15 gigabytes (GB) per month of mobile hotspot data, after which it reduces the speed of the connected computing device to 0.6 Mbps.[42] Other mobile providers may require additional add-ons or a subscription to higher tier plans. For example, AT&T's service agreement prohibits mobile phones from being used to tether other computing devices to the internet unless they

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[37] E.g., 2020 Broadband Deployment Report, para 11.

[38] Andrew Perrin, "Mobile Technology and Home Broadband 2021," Pew Research Center, June 3, 2021, https://www.pewresearch.org/internet/2021/06/03/mobile-technology-and-home-broadband-2021/.

[39] Ibid.

[40] 2020 Broadband Deployment Report, para 12.

[41] See "Mobile LTE Coverage Map," FCC, https://www.fcc.gov/BroadbandData/MobileMaps/mobile-map, accessed April 25, 2022.

[42] "The Verizon Plan Unlimited FAQs," Verizon, accessed April 25, 2022.

subscribe to specific service plans that offer tethering.[43] AT&T subscribers on lower tier plans that activate their smartphone's tethering feature are automatically enrolled in their additional "DataPro 5GB" monthly service and are charged an additional fee of $10 per 1 GB beyond the first 5 GB offered monthly by this service.[44]

Dedicated mobile hotspots with more generous monthly data plans are available as well but tend to offer a lower performance speed than fixed broadband providers' lowest performance options. The FCC notes that mobile wireless providers have been making these offerings an "increasingly-attractive alternative to fixed services" with more competitive pricing,[45] yet a review of the current range of mobile wireless technologies will identify that these mobile hotspots remain a complement, and not a full replacement to widespread fixed broadband availability.

The primary three mobile service providers, Verizon, AT&T, and T-Mobile, each offer at least 5/1 Mbps service throughout nearly all of Boston.[46] However, their higher performance service tiers are not commonly available, and the performance characteristics of these mobile providers' networks not clearly displayed on their coverage maps. Each provider's map shows the availability of its 5G and 4G LTE networks differently, and their names for the services do not adequately distinguish between technologies that offer widely different data transmission speeds. For example, Figure 9 demonstrates that while AT&T is claiming some form of 5G is available throughout Boston, it simply does not distinguish between the various 5G technologies on its map.[47] 5G technologies offer speeds of anywhere between 40 Mbps and 1 Gbps, and consumers cannot know their service speeds for certain until they try to use them.

This vagueness has resulted in substantial confusion about whether current 5G deployments can replace wireline broadband technologies. Verizon is now marketing at-home fixed wireless services over these networks as well, while the others imply similar uses of their hotspots. As a result, the performance characteristics of 5G technologies must be identified to sort through the hype and understand their potential impact on the fixed broadband market.

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[43] "AT&T Consumer Service Agreement," AT&T, https://www.att.com/legal/terms.consumerServiceAgreement.html#whatAreTheIntendedPurposesOfDataServ, (accessed April 25, 2022).

[44] "Create Your Own Hotspot," AT&T, https://www.att.com/plans/tethering/, (accessed April 25, 2022).

[45] 2020 Broadband Deployment Report, para 11.

[46] See "Mobile LTE Coverage Map," FCC, https://www.fcc.gov/BroadbandData/MobileMaps/mobile-map, accessed April 25, 2022.

[47] https://www.att.com/maps/wireless-coverage.html. AT&T notes that "Actual coverage may vary. Coverage isn't guaranteed and is subject to change without notice".

Figure 9: AT&T's mobile service coverage area map[48]
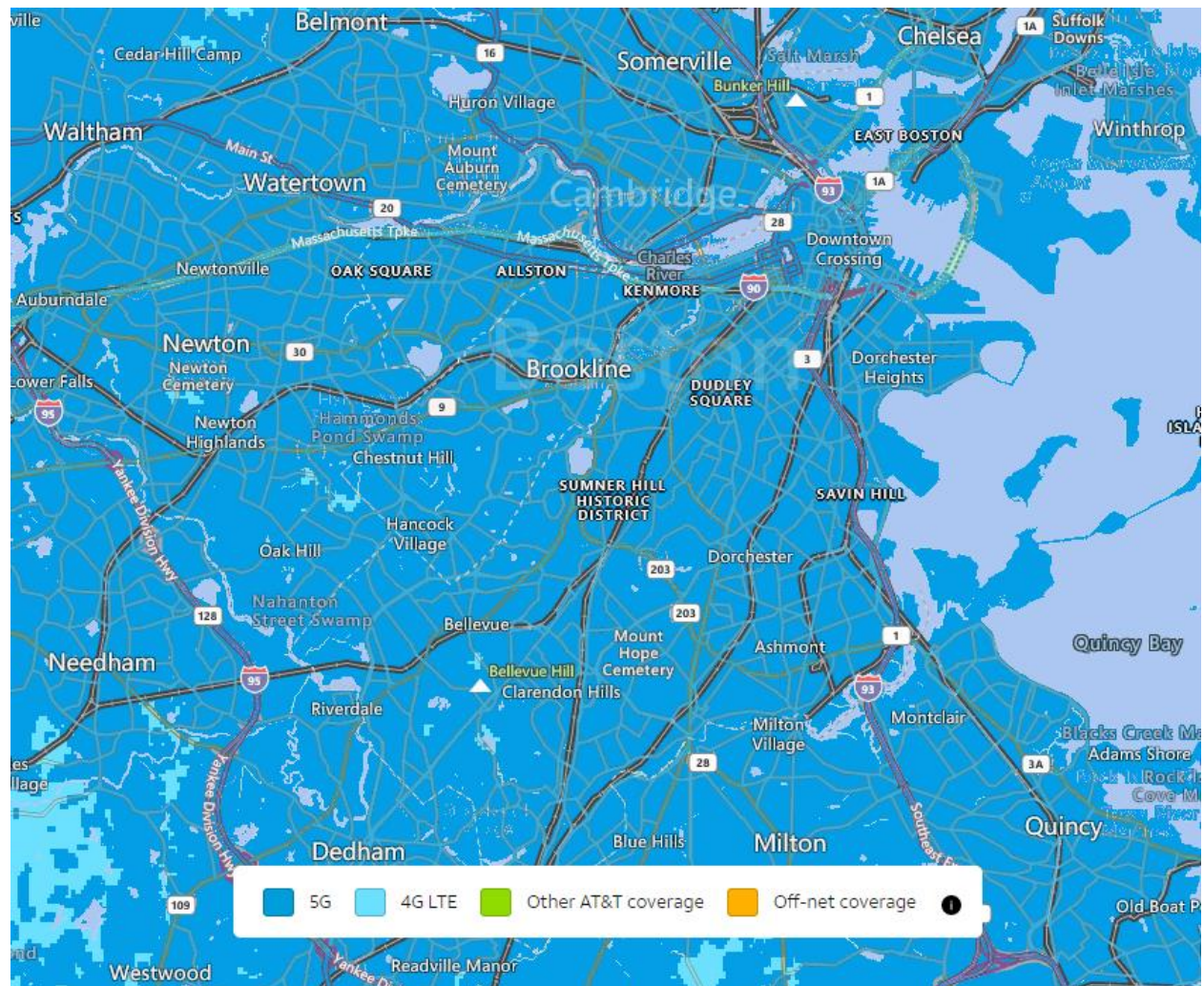
Millimeter Wave 5G: Mobile providers have been quick to claim that their 5G networks will be capable of speeds of up to 1 Gbps,[49] but industry reports and press have regularly challenged these claims.[50] This highest level of performance is only possible using one of the three different

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[48] "Wireless Coverage," AT&T, https://www.att.com/maps/wireless-coverage.html, (accessed May 2, 2022).

[49] E.g., 5G Speed: How Fast is 5G?," Verizon, August 3, 2020, https://www.verizon.com/about/our-company/5g/5g-speed-how-fast-is-5g; T-Mobile Dominates in New 5G Studies and Advances 5G with Carrier Aggregation," T-Mobile, January 18, 2022, https://www.t-mobile.com/news/network/t-mobile-dominates-in-new-5g-studies-and-advances-5g-with-carrier-aggregation; Igal Elbaz, "BREAKING NEWS: AT&T 5G Network First in the U.S. to Surpass 1 Gigabit Wireless Speeds," AT&T, Technology Blog, March 29, 2019, https://about.att.com/innovationblog/2019/03/1_gigabit_wireless_speeds.html.

[50] E.g., Geoffrey A. Fowler, "The 5G Lie: The Network of the Future is Still Slow," *The Washington Post*, September 8, 2020, https://www.washingtonpost.com/technology/2020/09/08/5g-speed/; "United States' Mobile and Fixed

radio spectrum frequency ranges composing mobile providers' 5G networks. High-band, millimeter wave (MMW) frequencies can offer data transfer speeds of at least 1 Gbps in ideal conditions but "cannot travel far, cannot travel well through buildings, and tend to be absorbed by trees and rain."[51] As a result, using this portion of the spectrum effectively requires that MMW-capable small cell transmitters be placed on every city block. This high-speed portion of the 5G spectrum then is more useful in very dense environments, such as stadiums and commercial districts.[52]

With such targeted, block-by-block deployments required to use the full potential of 5G, some policy analysts have noted that 5G networks could exacerbate the digital divide, rather than helping to close it.[53] Worse, MMW's inability to penetrate walls and windows has necessitated that home uses of the technology consider using antennas outside of buildings to bring the signal inside[54] or develop even more outlandish solutions, like special MMW-friendly window glass.[55] In this way, MMW deployments may increasingly resemble the fixed wireless offerings of companies like Starry, requiring that mobile service providers develop a dense network of MMW transmitters and receiver antennas outside dwellings to offer real fixed broadband services to residences.

Low- and Mid-Band 5G: In contrast with MMW spectrum, the low- and mid-band frequencies used in 5G networks offer propagation and transmission characteristics more closely resembling existing 4G LTE systems.[56] These low- and mid-band 5G have improved mobile broadband network performance noticeably. Ookla's first quarter 2022 speed testing found that T-Mobile, Verizon, and AT&T's 5G networks produced median download speeds of 191, 107, and 68 Mbps, respectively.[57] These recent 5G performance metrics are significantly faster than average 4G LTE

Broadband Internet Speeds," Ookla, https://www.speedtest.net/global-index/united-states#market-analysis, accessed April 26, 2022.

[51] Congressional Research Service, "Fifth-Generation (5G) Telecommunications Technologies: Issues for Congress," p. 15, January 30, 201, ("CRS 5G Report").

[52] 5G small cell transmitters have an estimated range limit of 2 km but require substantially closer proximity to the end user to send signals around obstacles and provide reliability. CRS 5G Report, p. 20.

[53] E.g., Zack Quaintance, "Does 5G Have the Potential to Make the Digital Divide Worse?," *Government Technology*, January 31, 2020, https://www.govtech.com/network/does-5g-have-the-potential-to-make-the-digital-divide-worse.html; Ari Breland, "Experts Worry 5G Could Widen Digital Divide in Cities," *The Hill*, September 30, 2018, https://thehill.com/policy/technology/409047-experts-worry-5g-could-widen-digital-divide/?rl=1.

[54] "T-Mobile High Speed 5G Internet Gateway (Nokia 5G21) External Antenna Guide," Waveform, April 25, 2022, https://www.waveform.com/a/b/guides/hotspots/t-mobile-5g-gateway.

[55] Dan Jones, "DoCoMo Claims It Can Smash the 5G Glass Barrier," *Light Reading*, January 17, 2020, https://www.lightreading.com/mobile/5g/docomo-claims-it-can-smash-the-5g-glass-barrier/d/d-id/756914.

[56] Low-band refers to the portion of the radio wave spectrum with frequencies below 1 GHz, while the mid-band refers to the portion of the spectrum between 1 GHz and 6 GHz. CRS 5G Report, pp. 15-16.

[57] "United States' Mobile and Fixed Broadband Internet Speeds," Ookla, https://www.speedtest.net/global-index/united-states#market-analysis, accessed April 26, 2022. OpenSignal's January 2022 results were less impressive, finding that T-Mobile, Verizon, and AT&T produced average download speeds of 150, 56, and 49 Mbps,

speeds a little over a year ago, which tended to offer media speeds of between 32 and 55 Mbps,[58] but nonetheless fall well short of both 5G maximum performance claims and fixed broadband service providers' higher service tiers. These speeds also enable subscribers' monthly data limits to be met more quickly, highlighting the role that monthly mobile data caps play in hindering mobile broadband services' ultimate impact.

Figure 10: T-Mobile's mobile service coverage area map
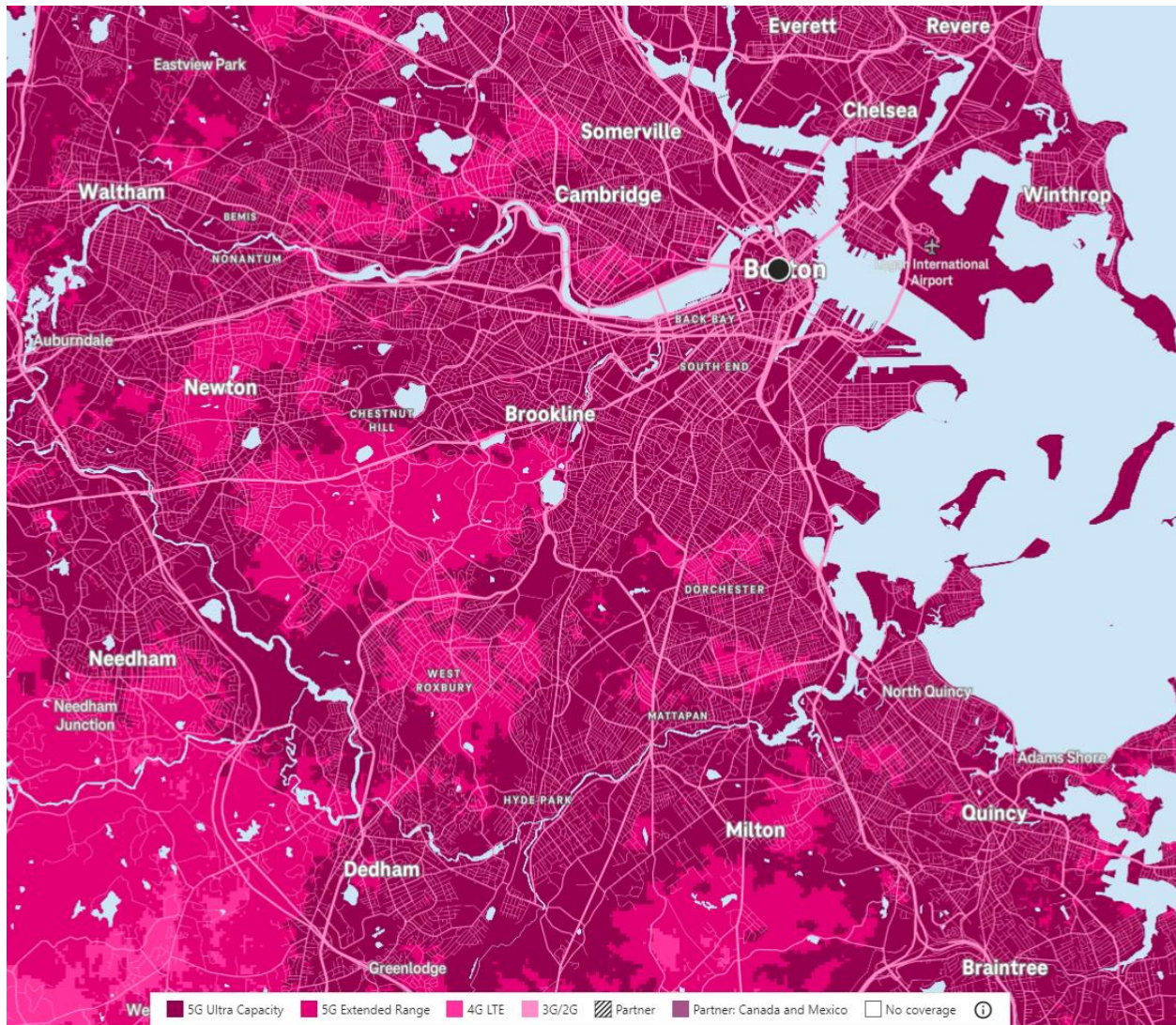
Unfortunately, the major mobile providers' maps do not distinguish between 5G high-band MMW coverage and the low- and mid-band 5G service availability primarily offered by the

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respectively. Francesco Rizzato, "5G Experience Report January 2022," OpenSignal, https://www.opensignal.com/reports/2022/01/usa/mobile-network-experience-5g, accessed April 26, 2022.
[58] See *Tom's Guide*, June 1, 2021.

carriers. T-Mobile Map's fine print explains that MMW 5G is not depicted,[59] begging the question about what technologies and speeds are offered by its "5G Ultra Capacity" service areas (above, in Figure 10). As shown in Figure 11 below, Verizon's 5G map omits any mention of this technology and instead explains its "5G Ultra Wideband" service as offering speeds that are "up to 10x as fast as its median Verizon 4G LTE speeds,[60] which tended to be between 35 and 55 Mbps.[61] This offering then does not identify or guarantee access to MMW speeds.

Figure 11: Verizon's mobile service coverage area map[62]

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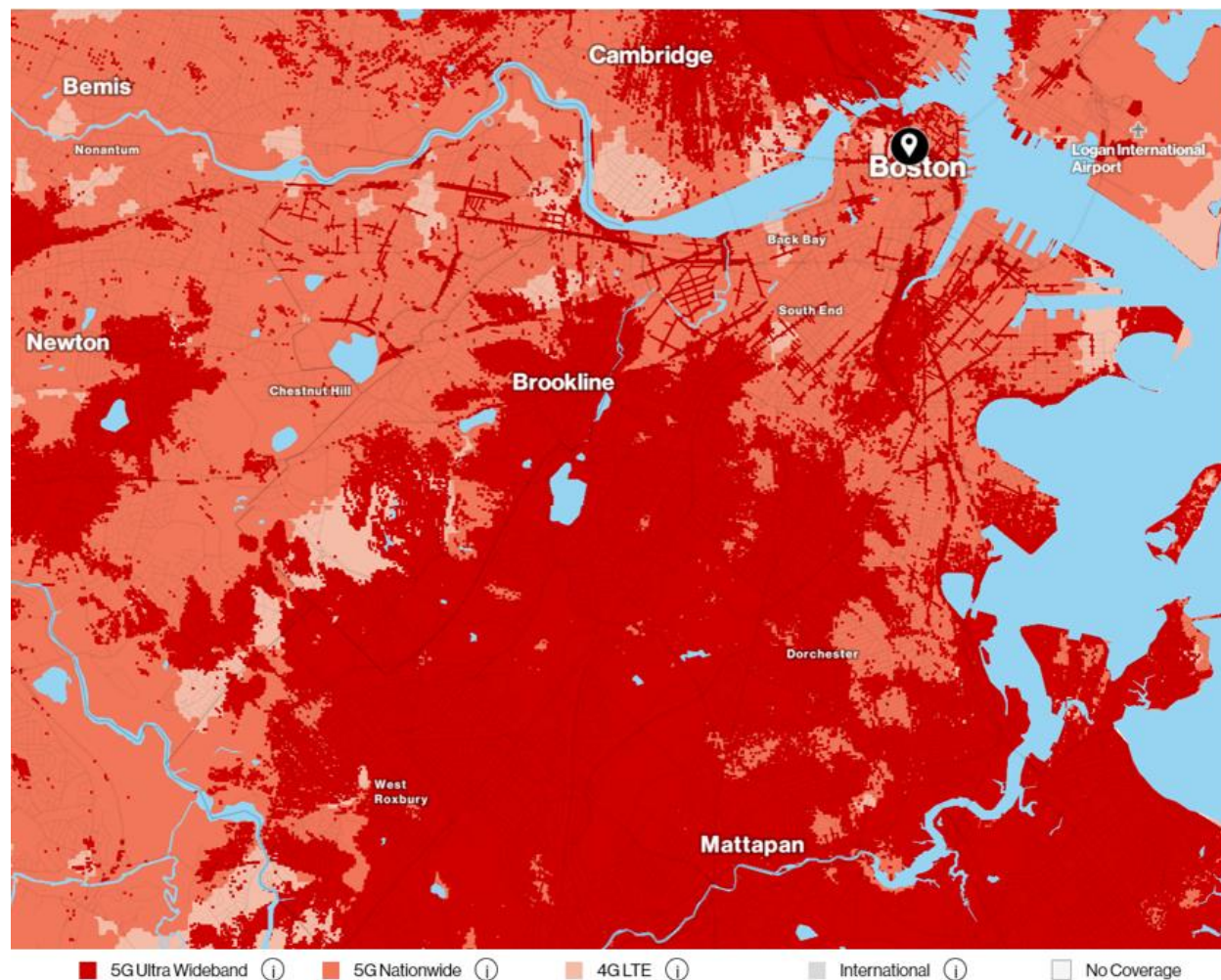
[59] "5G & 4G Coverage Map," T-Mobile, https://www.t-mobile.com/coverage/coverage-map, (accessed May 2, 2022).

[60] "Coverage Map," Verizon, https://www.verizon.com/coverage-map/, (accessed May 2, 2022).

[61] Recent 4G-only testing is no longer provided publicly by Ookla, but other sources and earlier 4G-only speed tests placed the carrier's speeds in this range. E.g.," 5G is Faster than 4G, but How Much Faster Depends on Which Carrier's Network You're on," *Tom's Guide*, June 1, 2021, https://www.tomsguide.com/features/5g-vs-4g.

[62] "Verizon Coverage Map," Verizon, https://www.verizon.com/coverage-map/, (accessed May 2, 2022).

Verizon's "5G Ultra Wideband" does establish the coverage area for the higher service tiers of home fixed broadband service, however. Table 9 shows the prices of these services. 4G LTE home services are the only option in areas beyond the "Ultra Wideband" service area and are claimed to provide downloads of between 25 and 50 Mbps and uploads of between 3 and 4 Mbps, without monthly data restrictions. At $60 per month, this option is unlikely to compete favorably with other fixed broadband service providers. "Ultra Wideband" zones can receive services with downloads of at least 50 Mbps that may be substantially faster in many cases, but their non-promotional pricing still is substantially higher than fixed wireless alternatives like Starry. However, their bundled prices may be appealing to households that otherwise might have been mobile-only.

Table 9: Verizon Wireless fixed broadband service plans

Wireless Home Service Plans	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Monthly Bundled Price with 5G Phone	Notes
LTE Home	4G LTE (25/4 to 50/4 Mbps)	$60	$25	No data cap
5G Home	5G Ultra Wideband	$60	$25	No data cap
5G Home Plus	5G Ultra Wideband	$80	$35	No data cap

For those bundling their services with 5G phone subscriptions, the carriers' wireless hotspot programs are also becoming more appealing to consumers that may have been mobile only. However, low monthly data limits make them a poor alternative for most families that may have considered a second hotspot device alongside the smartphone to provide kids with their own connection. After the monthly data allocation has been used up, the service is throttled to a speed that is inadequate for nearly all modern uses, or subscribers are asked to purchase more data at high costs per GB. Access to 5G speeds is also dependent upon the purchase of a 5G-compatible hotspot, which can be as costly as many smartphones.

Table 10: Major mobile carriers' wireless hotspot service plans

Carrier	Standalone Hotspot Service	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Monthly Bundled Price with 5G Phone	Notes
Verizon	Essential	5G	Not available	$20	15 GB of hotspot use, then throttled to 0.6

Carrier	Standalone Hotspot Service	Advertised Download/Upload Speeds	Monthly Price (non-promotional)	Monthly Bundled Price with 5G Phone	Notes
					Mbps if on 5G or lower network
Verizon	Plus	5G Ultra Wideband	Not available	$40	50 GB of hotspot use, then throttled to 0.6 Mbps if on 5G or lower network
Verizon	Pro	5G Ultra Wideband	$90	$60	100 GB of hotspot use, then throttled to 0.6 Mbps if on 5G or lower network
Verizon	Premium	5G Ultra Wideband	$110	$80	150 GB of hotspot access, then throttled to 0.6 Mbps if on 5G or lower network
AT&T	DataConnect 25GB	5G	$50	N/A	After first 25 GB, $10 per additional 2 GB used per month
AT&T	DataConnect 40GB	5G	$75	N/A	After first 40 GB, $10 per additional 2 GB used per month
T-Mobile	Data Plan	5G	$10	N/A	After 2 GB, purchase data at $20 for 5 GB, $30 for 10GB, or $50 for 50 GB

The mobile service providers' smartphone service offerings have increasingly identified the role these devices play as wireless hotspots as well, with most premium plans offering more data than many of the dedicated hotspot service plans identified above. Similar to the problems with relying on hotspots for home services, all but the most expensive options have monthly data limits of between 1 and 12 percent of the average household's monthly data use.[63] Once the data cap is reached, transfers slow to speeds that hinder most uses.

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[63] "Broadband Insights Report – 3Q2021," OpenVault, p. 3, https://openvault.com/wp-content/uploads/2021/11/OVBI_3Q21_Report.pdf.

Some of these plans also offer additional performance to subscribers in better 5G coverage areas, encouraging consumers to upgrade their services to actually take advantage of the full speed benefits of 5G "Ultra Wideband," in Verizon's case, or allowing faster service speeds after the data cap is reached if the subscriber is in the right area. AT&T's low-cost plans actually do not offer 5G access, requiring that users spend at least $60 per month to gain access to these new frequencies. Video streaming is also generally throttled, with 1080P and 4K resolutions only available to the most expensive plans on the better parts of the carriers' 5G networks. Table 11 shows the primary mobile service options.

Table 11: Primary mobile service offerings from three carriers

Carrier	Phone Service	Network Technology	Monthly Price* (non-promotional)	Notes
AT&T	5 GB Monthly (Prepaid)	4G LTE	$30	After first 5 GB, speed limited to 0.128 Mbps; Video limited to 480p; unlimited talk and text.
AT&T	8 GB Monthly (Prepaid)	4G LTE	$50	After first 8 GB, speed limited to 0.128 Mbps; Video limited to 480p; unlimited talk and text. Cost is $25/month + $300 upfront for 12 months
AT&T	Unlimited (Prepaid)	5G	$65	Unstated device data limit, subject to AT&T throttling network practices; video limited to 1.5 Mbps; unlimited talk and text; hotspot limit not stated.
AT&T	AT&T 4G	4G LTE	$50	After first 4 GB, $10 per 1 GB used per month; video limited to 1.5 Mbps; unlimited talk and text; unclear whether use as hotspot will trigger auto-enrollment into higher plan; ineligible for phone promotions.
AT&T	Unlimited Starter	5G	$60	3 GB monthly hotspot limit; unstated device data limit, subject to AT&T throttling practices; video limited to 1.5 Mbps; unlimited talk and text
AT&T	Unlimited Extra	5G	$65	15 GB monthly hotspot limit; 50 GB device data, subject to AT&T throttling network practices; video limited to 1.5 Mbps; unlimited talk and text
AT&T	Unlimited Elite	5G	$75	40 GB monthly hotspot limit; unlimited device data, subject to AT&T throttling network practices; video limited to 1.5 Mbps; unlimited talk and text
Verizon	5GB (Prepaid)	5G	$40	After first 5 GB, speed limited to "2G speeds"; Video limited to 480p; unlimited talk and text
Verizon	15GB (Prepaid)	5G	$50	After first 15 GB, speed limited to "2G speeds"; Video limited to 480p; unlimited talk and text
Verizon	Unlimited (Prepaid)	5G	$65	After first 10 GB, speed limited to 0.6 Mbps; Video limited to 480p; unlimited talk and text

Carrier	Phone Service	Network Technology	Monthly Price* (non-promotional)	Notes
Verizon	Unlimited Plus (Prepaid)	5G "Ultra Wideband"	$75	When in "Ultra Wideband area": video display up to 4K; no data limit. When not in "Ultra Wideband area": after first 10 GB, speed limited to 0.6 Mbps; Video limited to 480p; unlimited talk and text
Verizon	5G Start	5G	$80	Data is throttled depending on network demand; unlimited talk and text
Verizon	5G Play More	5G "Ultra Wideband"	$90	50 GB of device use, then throttled to network demand; 25 GB of hotspot use, then throttled to 0.6 Mbps if on 5G network; unlimited talk and text
Verizon	5G Do More	5G "Ultra Wideband"	$90	50 GB of device use, then throttled to network demand; 25 GB of hotspot use, then throttled to 0.6 Mbps if on 5G; unlimited talk and text
Verizon	5G Get More	5G "Ultra Wideband"	$100	Unlimited device use; 50 GB of hotspot use, then throttled to 0.6 Mbps if on 5G or lower network; unlimited talk and text
T-Mobile	10GB (Prepaid)	Unclear	$40	10 GB of device and hotspot use, then 5 GB add-ons available for $5/month; unlimited talk and text
T-Mobile	Unlimited (Prepaid)	Unclear	$50	50 GB of device use, then throttled to network demand; unlimited 3G-speed-limited hotspot use; video limited to 480p; unlimited talk and text
T-Mobile	Unlimited Plus (Prepaid)	Unclear	$60	50 GB of device use, then throttled to demand; 10 GB of hotspot use on 4G LTE, then 3G-speed-limited; video limited to 480p; unlimited talk and text
T-Mobile	Base Essentials	5G	$45	20 GB of device use, then throttled to demand; unlimited 3G-speed-limited hotspot use; video typically limited to 480p; unlimited talk and text
T-Mobile	Essentials	5G	$65	50 GB of device use, then throttled to demand; unlimited 3G-speed-limited hotspot use; video typically limited to 480p; unlimited talk and text
T-Mobile	Magenta	5G	$75	100 GB of device use, then throttled to demand; 5 GB of hotspot use, then throttled to 3G-speed; unlimited talk and text
T-Mobile	Magenta MAX	5G	$90	Unlimited device use, then throttled to demand; 40 GB of hotspot use, then throttled to 3G-speed; unlimited talk and text

*AT&T fees include $1.50 "Regulatory Cost Recovery Fee, $1.99 Administrative Fee, and others per mobile line.[64] T-Mobile: Monthly Regulatory Programs (RPF) & Telco Recovery Fee (TRF) totaling $3.49 per voice line ($0.50 for RPF & $2.99 for TRF); taxes/fees approx. 4 percent to 38 percent of bill.

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[64] "AT&T Wireless Coverage Map," AT&T, https://www.att.com/maps/wireless-coverage.html, (accessed May 2, 2022). AT&T notes that "Actual coverage may vary. Coverage isn't guaranteed and is subject to change without notice".

6   Alignment of demographic patterns and broadband subscriptions

While Boston does not have many significant gaps in network investment, there are still some potential issues—especially affordability—which may limit internet access.

6.1   Identification of broadband service affordability issues

The U.S. Census Bureau collects data on a variety of topics in its American Community Survey. We overlaid demographic data from the survey about broadband adoption. Figure 12 shows areas in Boston where relatively higher percentages of the population do not have a home broadband internet subscription, according to 2016-2020 American Community Survey estimates, the most recent federal data offering this level of detail.[65]

While this data does not reflect Boston's efforts to address digital equity from the beginning of the pandemic to May of 2022, it highlights areas most in need of additional efforts. The Census data also does not indicate whether a lack of subscription is by choice, affordability obstacles, or other reasons, but additional device availability and income information will help to sort through these adoption issues.

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[65] The Census Bureau's American Community Survey's 5-year estimates are period estimates, with the data reported on a rolling basis. The data for the five years are combined, weighted, and processed as a whole dataset to take advantage of the larger number of responses. The 5-year estimate can equate to the midpoint of this time series in certain specific cases, but this characterization is less accurate when conditions change drastically during the sample period, as was the case with the COVID-19 Pandemic and the ACS 2016 to 2020 estimates. CTC included this data to be understood as reasonable, best available estimates, given the constraints to further data collection and ACS's widespread use as the standard dataset informing policymakers' decisions. However, it should be noted that the most current available ACS data does not reflect Boston's efforts to address digital equity from the beginning of the pandemic to May of 2022.

Figure 12: Percentage of households without a broadband subscription that is cable, fiber, or DSL
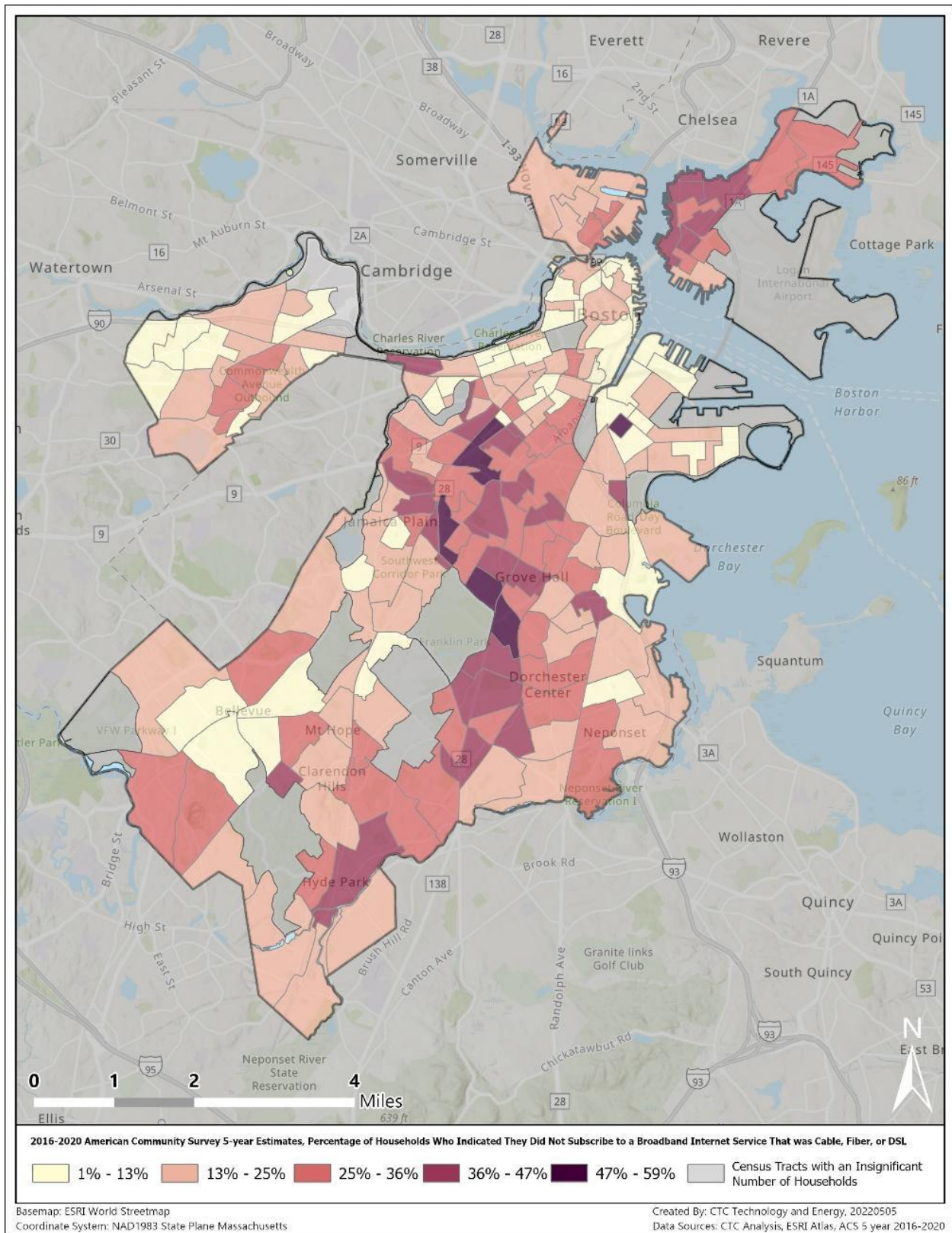
Figure 13 illustrates computer ownership in Boston according to the ACS survey data.

Figure 13: Percentage of households without a computer
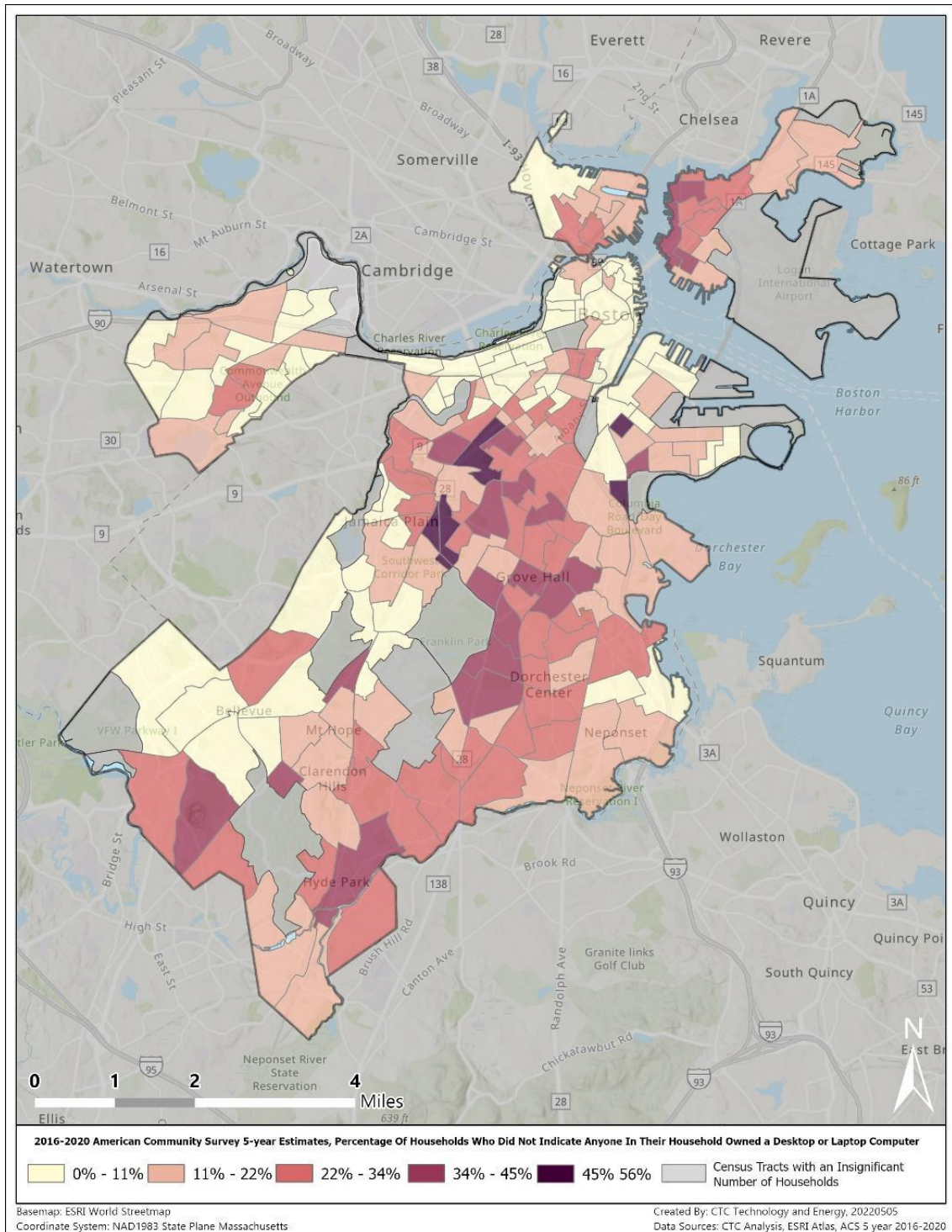
The populations with the lowest levels of internet subscriptions and computer ownership tend to be concentrated in the lower-income neighborhoods of the City. Figure 14 shows poverty levels in Boston.

Figure 14: Percentage of households under the poverty level
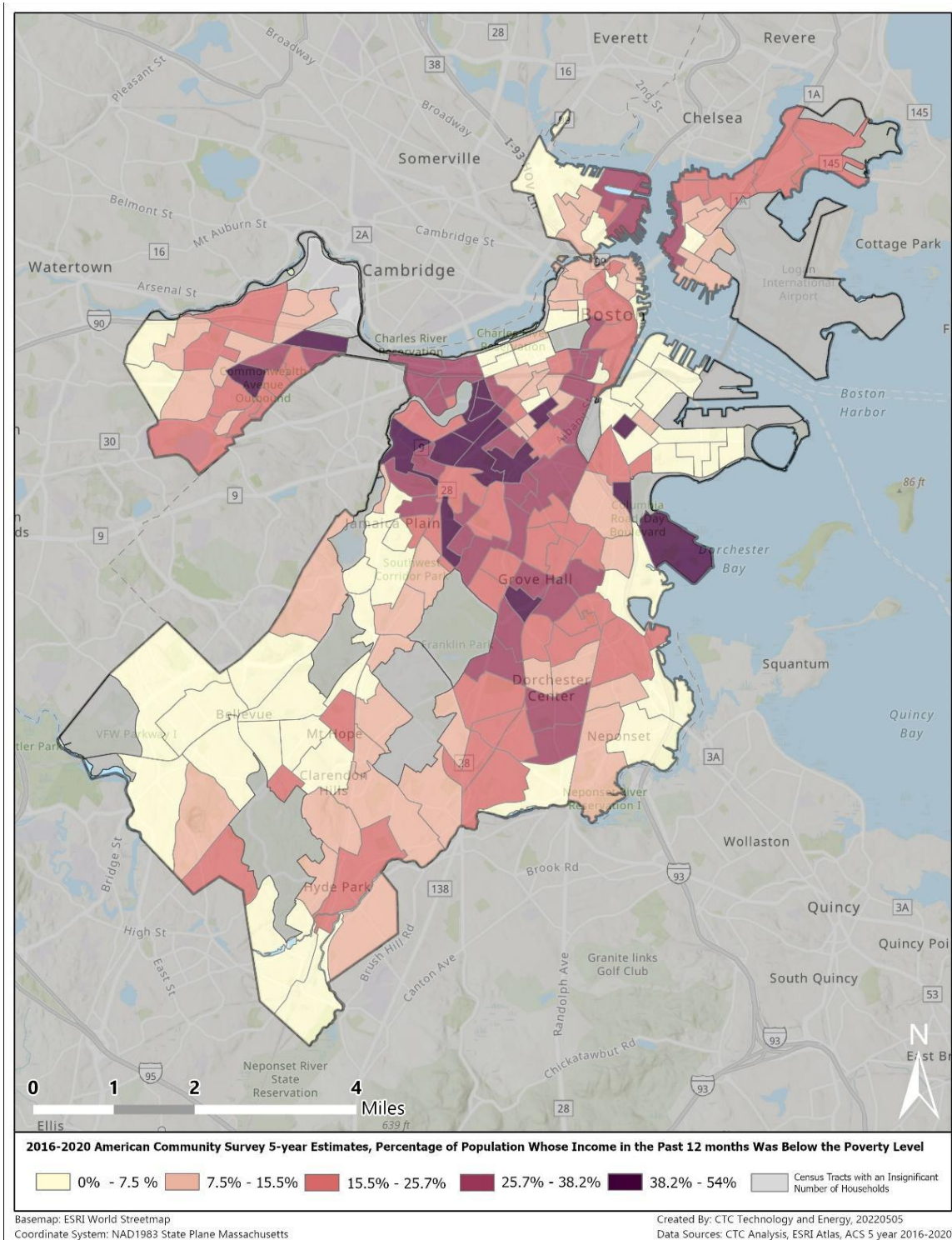
6.2   Affordable Connectivity Program participation rate in Boston

In addition to our comparison of investment and demographic patterns, CTC also analyzed and determined the rate of participation in the FCC's Affordable Connectivity Program (ACP) for Boston.

The FCC officially launched the ACP, a $14.2 billion program enacted under the bipartisan Infrastructure Investment and Jobs Act (IIJA), on January 1, 2022. The ACP provides a long-term investment in broadband affordability and ensures households can access high-speed internet services that are essential for participation in virtual education, telehealth, work and more. The transition from the EBB program to ACP is now underway.

While the ACP only began on January 1, 2022, the program replaced the Emergency Broadband Benefit (EBB) Program, which had been operating since May 2021. The EBB program provided support for broadband services and certain devices to help low-income households stay connected during the COVID-19 pandemic, thanks to the federal Emergency Broadband Connectivity Fund, a $3.2 billion subsidy to help Americans afford internet service during the pandemic.

The ACP is a needs-based internet subsidy program that will provide a subsidy of $30 per month toward a participant's internet bill.[66] A household is eligible if a single member of the household meets one of the following criteria:[67]

- Has an income that is at or below 200 percent of the federal poverty guidelines;

- Participates in certain assistance programs, such as SNAP, Medicaid, Federal Public Housing Assistance, SSI, WIC, or Lifeline;

- Participates in Tribal specific programs, such as Bureau of Indian Affairs General Assistance, Tribal TANF, or Food Distribution Program on Indian Reservations;

- Is approved to receive benefits under the free and reduced-price school lunch program or the school breakfast program, including through the USDA Community Eligibility Provision in the 2019-2020, 2020-2021, or 2021-2022 school year;

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[66] "Affordable Connectivity Fund," FCC, https://www.fcc.gov/acp (accessed February 2022).
[67] "Affordable Connectivity Fund," FCC, https://www.fcc.gov/acp (accessed February 2022).

- Received a Federal Pell Grant during the current award year; or

- Meets the eligibility criteria for a participating provider's existing low-income program.

As of August 1, 2022, Boston had 29,192 households participating in the ACP.[68] CTC estimates that approximately 86,000 Boston households may be eligible based on income alone, with other eligibility criteria likely expanding the program's potential reach.[69] A significant number of residents of Boston may be able to still take advantage of this federal aid program (though some may already be covered by other low-cost programs or do not wish to obtain internet service). By increasing awareness of this program and/or running programs to help residents sign up for this program, the City could potentially help eliminate some of its broadband affordability and access concerns.

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[68] "Affordable Connectivity Program Enrollments and Claims Tracker," FCC, https://www.usac.org/about/affordable-connectivity-program/acp-enrollment-and-claims-tracker/#enrollment-by-state (accessed May 2022).

[69] To estimate the proportion of households in Boston who are eligible to participate in the ACP by their annual household income alone, CTC: (1) Established an income threshold for households below the 200% poverty line by using the US Department of Health and Human Services' "HHS Poverty Guidelines for 2022" (https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines) to identify the poverty line that would apply to the average Boston household size presented by ACS 2016-2020 estimates, (2) Estimated the cumulative proportion of households in Boston earning at or below the adjusted 200% poverty threshold from the estimated income distribution for the city as presented by ACS 2016-2020 estimates, then (3) Gathered the count of ACP-participating households as of August 1, 2022, in the zip codes that fell within the city's boundaries as reported by the Universal Service Administration Company (USAC), the independent non-profit charged by the FCC to administer ACP and other programs supported by the FCC's Universal Service Fund (USF). We added the ACP enrollment for the following zip codes: 02108, 02109, 02110, 02111, 02113, 02114, 02115, 02116, 02118, 02119, 02120, 02121, 02122, 02124, 02125, 02126, 02127, 02128, 02129, 02130, 02131, 02132, 02134, 02135, 02136, 02199, 02210, and 02215.

PROGRESS ON DIGITAL EQUITY: A REVIEW OF PROGRAMS AND GAPS IN. BOSTON

1 Summary of task report

1.1 Overview

The City of Boston's efforts to improve broadband access and achieve greater digital equity—that is, affordability of broadband, access to devices, and adequate skills—span decades. The City has worked to expand its fiber and wireless infrastructure and bring in Verizon Fios as a competitive overbuilder. Comcast's low-cost Internet Essentials program, described in the Task 1 report, was first launched in Boston a decade ago. And Tech Goes Home, a nonprofit that is a key provider of skills training and devices, also got its start in the City. In recent years the City of Boston has expanded its focus on addressing unaffordability of available services, unequal access to computers, and gaps in computer skills in part by launching a Digital Equity Fund with $35,000 in 2018 and expanding it in later years. The Covid pandemic highlighted the criticality of broadband and enormous gaps still faced by many residents and led to vast efforts by the Boston Public Schools and Boston Public library, among others, to provide tens of thousands of laptops and mobile connectivity devices to residents.

But gaps may still exist. Based on the U.S. Census Bureau's American Community Survey's (ACS) 2016-2020 estimates, as many as 35,000 households do not have an internet subscription (though as noted above, whether they do this by choice or because of affordability is not captured by the survey).[70] Gaps in computer ownership are also evident in the ACS survey and were articulated by stakeholders. And now new federal programs—coupled with fast-growing City programmatic efforts—have set the stage to a significant acceleration of efforts to close these gaps, particularly with respect to facilitating new broadband subscriptions by leveraging the new $30 monthly subsidy available under the Affordable Connectivity Program (ACP).

This Task report details the history and progress with respect to digital equity programming in the City of Boston, estimates gaps, compares Boston across several metrics to three other cities in these areas, and provides recommendations.

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[70] The Census Bureau's American Community Survey's 5-year estimates are period estimates, with the data reported on a rolling basis. The data for the five years are combined, weighted, and processed as a whole dataset to take advantage of the larger number of responses. The 5-year estimate can equate to the midpoint of this time series in certain specific cases, but this characterization is less accurate when conditions change drastically during the sample period, as was the case with the COVID-19 Pandemic and the ACS 2016 to 2020 estimates. CTC included this data to be understood as reasonable estimates given the constraints to further data collection and ACS's widespread use as the standard dataset informing policymakers' decisions. However, it should be noted that the standard ACS methodology cannot fully represent Boston's efforts to address digital equity from the beginning of the pandemic to May of 2022.

1.2 Study methodology and data collection

CTC conducted research to identify, quantify, and characterize the progress of Boston's digital equity initiatives. Among other tasks, CTC:

- Engaged with the City and ISPs to document programmatic initiatives and conducted research to analyze the breadth of programs and resources available to Boston residents with respect to broadband subscriptions, devices, and skills. (See Section 2).

- Engaged with City stakeholders—including top officials at the Boston Public Library, Boston Public Schools, Boston Housing Authority, Age Strong Commission and other entities—to document progress and characterize remaining gaps. (See Section 4).

- Developed benchmarking metrics to provide a comparison of Boston's digital equity gaps and initiatives to those in San Francisco, Philadelphia, and the District of Columbia. (See Section 5).

- Developed a set of recommendations based on the data. The emergence of a new $30 per month ACP service subsidy is already leading to a shift of City emphasis toward focusing more on outreach and recruitment of households into this program and somewhat less on funding efforts like hotspots and Chromebooks for households and related training efforts. CTC concurs that the top priority at this juncture is to devote the City's energies to maximize enrollment in the ACP while also encouraging coordination among City entities and engaging with relevant state officials to jointly plan for new programmatic efforts as new federal monies become available. (See Section 0).

2 Digital equity initiatives in Boston have expanded significantly in the past five years

Over the last five years, digital equity initiatives in Boston have expanded significantly, particularly during the Covid-19 pandemic. The City launched a Digital Equity Fund through a $1 million Verizon grant to provide support to community-based organizations that help Boston residents with device, skills, and affordability challenges.

The first funding cycle in fiscal year 2018 provided $35,000 to the Castle Square Tenants Organization to fund its work with local students. That budget swelled to $100,000 the following year, split between three recipients: La Alianza Hispana, Mujeres Unidas Avanzando, and South End Technology Center. By 2021 it was increased to $478,900 to 19 Boston nonprofit

More details about the Digital Equity Fund can be found at the following links
Digital Equity Fund website
Review committee presentation
FAQ document
Scoring rubric

organizations; $150,000 of that additional funding came from the City's Age Strong Commission and additional support from the City budget.

Grants from the Digital Equity Fund are evaluated and awarded based on reviews by an internal Boston review committee and an outside Digital Equity Fund Council.[71]

The City also created the role of Digital Equity Advocate in 2015 within the Broadband & Cable office of DoIT. This advocacy and outreach role has been instrumental in providing coordinated programmatic support to departments as they integrate digital equity initiatives into their work with the residents of Boston.

Anne Schwieger led this role from 2015-2020 and presently serves as a member of the Strategic Initiatives Team in the Office of Mayor Michelle Wu. Peter Favorito recently assumed this role. Together with Mike Lynch, the City's director of broadband and cable, they work across city agencies and with the consultation of the City's Equity and Inclusion Cabinet to help shape policy designed to realize the promise of the current federal funding landscape to enable low-income households across the City to access affordable internet service and close device and skills gaps. Boston's larger service agencies, in particular the Boston Housing Authority, Boston Public Schools, Age Strong Commission, Boston Public Health Commission and the Boston Public Library,

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[71] Digital Equity Fund Council members from 2016 through 2021 include Alessandra Brown, Director of Community Engagement and Corporate Social Responsibility, Athena Global Advisors; Colin Rhinesmith, Founder and Director, Digital Equity Research Center at Metropolitan New York Library Council (previously Assistant Professor, School of Library and Information Science, Simmons University); Trinh Nguyen, Director, Workforce Development; and Sasha Costanza-Chock, Associate Professor of Civic Media, MIT.

have been strong partners in this work, as well as constituent service advocacy agencies such as the Mayor's Office for Immigrant Advancement (MOIA).[72]

Annually, the National Association of Telecommunications Officers and Advisors (NATOA), a professional organization, recognizes exceptional leadership in government for serving as champions of local interests and needs with Community Broadband & Digital Equity Awards. Last year, NATOA awarded their (2021) Digital Equity Project of the Year to the City of Boston for its Digital Equity and Digital Inclusion Programs during and after COVID19, recognizing the extraordinary local efforts to bring the benefits of technology to Boston's communities. NATOA cited Boston's Broadband Digital Equity & Inclusion efforts to:

- Improve access to affordable and reliable high-speed internet for households and businesses,

- Expand the availability of high-speed internet in public places, and

- Facilitate ease of access to up-to-date digital tools; and,

- Work to protect Net Neutrality rules that ensure a fair and open Internet.

The City invested over $15 million in resources during the pandemic to strengthen the City's internet network and connectivity; distribute online devices to residents and families in need; and, to support digital training and skills development through a network of dedicated non-profits.

Since the adoption of recent federal funding laws (ARPA, IIJA) aimed at addressing digital equity and inclusion (DE&I), Boston has pivoted its effort to identify the opportunities to secure and address DE&I issues with these new and significant funding opportunities.

Some of this recent federal funding is already having a large impact. For example, through the Emergency Connectivity Fund (ECF), which was signed into law last year as part of the larger American Rescue Plan Act, Boston invested more than $12 million to further bring digital equity and inclusion to Boston public housing residents, library users, and school-age families. Of this amount, $10 million funded a continuation of Chromebook, hotspot, and Internet Essentials voucher programs at the Boston Public Schools and $2.2 million went to similar efforts at the Boston Housing Authority.

The City has also been a long-time primary funder of Tech Goes Home, which provides training and free laptops to low-income residents, including recent immigrants. The City provided

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[72] Mark Racine, CIO at Boston Public Schools, Lydia Agro, community relations at BHA, Commissioner Emily Shea, Age Strong, Yusufi S. Vali, Director, Mayor's Office for Immigrant Advancement, Kurt Mansperger, former CTO at the BPL.

$500,000 annually to TGH starting in 2012; in 2016, the City increased this amount to $1 million annually, and in 2022, the City granted TGH an additional $2 million in American Rescue Plan Act (ARPA) funding. TGH reports that 11,561 Bostonians have graduated from a TGH program in the past three years. In this same timeframe, TGH distributed 8,186 devices.

Boston's overall approach to the digital inclusion has had four elements:

- As described in the previous section, foster competition to provide choice to residents, households, and businesses—resulting in Verizon Fios now offering competition citywide and Starry competing in some areas.

- As described in the previous section, demand comprehensive deployment of wireline and wireless providers in all Boston's neighborhoods. Comcast serves 98 percent of the City and FiOS will eventually reach those levels. The City has also facilitated the expansion of mobile services in part by expand by facilitating fiber and other infrastructure deployments.

- Through City agencies and City-funded nonprofits, provide the digital tools (Chromebooks, notebooks, hotspots, subsidies) to help residents connect and engage online, especially during the pandemic.

- Increase funding during the pandemic to help residents learn and acquire the digital skills to effectively use broadband and computers

Specific efforts include:

- Launching a Digital Equity Fund for non-profits and CBOs, as noted above;

- Launching and expanding Boston's Wicked Free Wi-Fi open air access network;

- Strengthening the City's network (called BoNet), providing connectivity to community centers, Wicked Free Wi-Fi, and City buildings;

- Distributing devices to residents and families in need;

- Supporting digital training and skills development through a network of non-profits;

- Adding $2 million in ARPA funding to TGH in this year's budget

The following subsections summarize efforts made by key Boston city departments, the Boston Housing Authority, and community organizations.

2.1 Digital Equity Fund supports a variety of initiatives through investing in community-based organizations

As noted above, the City's Digital Equity Fund provides support to community-based organizations that help Boston residents to digitally connect and participate in educational, economic, and civic opportunities. Launched in October 2017, the fund is supported by three Boston departments: DoIT; the Age Strong Commission; and the Equity and Inclusion Cabinet. A summary of the program and award amounts provided through the Digital Equity Fund are shown below in Table 12.

Table 12: Dollars allotted through Digital Equity Fund by year

Fiscal Year	Number of programs funded	Total Award Amount
2018	1	$35,000
2019	3	$100,000
2022	19	$478,900

In 2020 and 2021, digital equity initiatives were funded through the Boston Resiliency Fund.

Through these efforts, community-based and non-profit organizations have accelerated digital literacy and engagement throughout the City. The 23 entities that received funding from the Digital Equity Fund are shown below in Table 13.

Table 13: The 23 entities supported by the Digital Equity Fund since 2018

Organization/Program Name	Fiscal Year	Initiative goal	Target Population	Grant Dollars Funded
Castle Square Tenants' Organization	2018	Creating a technology audio/visual college course	Local high school students	$35,000
La Alianza Hispana	2019	Leveraging partnerships by providing social, educational, and health services, and technology resources	Boston's Latino community	$100,000 for all three programs
Mujeres Unidas Avanzado	2019	Providing technology resources	Latinas from a disadvantaged background, including low-income and formerly incarcerated	
South End Technology Center	2019	Facilitating the use of technology in a variety of	Residents of organization who are	

Organization/Program Name	Fiscal Year	Initiative goal	Target Population	Grant Dollars Funded
		ways	at an increased risk of joblessness	
Allston Brighton Community Development Corporation	2022	Offering bilingual in-person technology education courses and devices	Older Bostonians in the organization's affordable rental portfolio	$6,586
Boston Center for Independent Living	2022	Providing 150 of the organization's residents with technology, including hotspots	Persons with disabilities at four of the organization's locations	$28,000
Boston Higher Education Resource Center	2022	Increasing access to devices and training	High school and college English Language Learner (ELL) students	$25,000
Boston Project Ministries	2022	Implementing a user-centered tool to help people connect to digital platforms	Older Bostonians	$7,250
Castle Square Tenants' Organization (CSTO)	2022	Building digital skills among the organization's residents	Older Bostonians who are residents of the organization	$16,164
Central Boston Elder Services	2022	Providing tablets, training, internet access, and ongoing user-support	Low-income, elderly residents of the organization	$35,000
Center for Community Health Education Research and Service	2022	Improving self-management of diabetes by increasing self-efficacy with technology	Older African-American/Black and Latinx (AA/BL) adults	$35,000
Codman Square Neighborhood Development Corporation	2022	Expanding existing workforce training programs	Organization residents and surrounding community members	$35,000
East Boston Community Council	2022	Providing internet services at home, internet training, and devices	ELL students	$35,000
Ethos	2022	Improving social interaction with innovation in information delivery and technology access	Older Bostonians	$10,000
Found in Translation	2022	Providing equipment and technology literacy training to better participate in the interpreting profession	Students and alumni of the program	$30,354
Harvard Street Neighborhood	2022	Facilitate telehealth access	Residents of the	$35,000

Organization/Program Name	Fiscal Year	Initiative goal	Target Population	Grant Dollars Funded
Health Center		through equipment and training	organization	
Mothers for Justice and Equality	2022	Providing 200 Chromebooks and monthly unlimited Wi-Fi access cards	Residents of three communities in Boston	$33,246
Neighborhood of Affordable Housing	2022	Distributing technology equipment and internet access	Families in the East Boston community	$28,000
Prince Hall Community Corporation	2022	Implementing a 15-hour training program, and distributing devices and internet access assistance	Older Bostonians	$35,000
St. Mark Community Education Program	2022	Recruiting and training 20 multilingual volunteers to offer at least 30 free digital skills courses in different languages	Workers who are unemployed or underemployed	$26,400
Victory Programs	2022	Enhancing existing mobile prevention team and providing internet access	Clients of the organization	$24,000
X-Cel Education	2022	Providing basic to intermediate computer skill trainings	Older Bostonians	$5,000
Zumix	2022	Providing media training	Boston's youth	$35,000

2.2 Boston Public Schools provides Chromebooks to all students and means for free internet access

Boston Public Schools (BPS) plays a critical role in helping students to become and stay connected to reliable high-speed internet by providing Chromebooks, hotspots, and Internet Essentials vouchers to families with students in the school system. The district serves more than 46,000 students in 125 schools, representing approximately 74 percent of school-age children who live in Boston. During the COVID-19 pandemic, BPS provided approximately 60,000 Chromebooks, one to every student the school system serves, an effort called the Access for All Initiative. (This figure includes more devices than students because 10 to 15 percent of these devices have been broken or lost.)

The school system also provided approximately 7,000 hotspots and 3,000 vouchers for Comcast's Internet Essentials program to ensure families with students had sufficient connectivity for remote learning. These Internet Essentials vouchers provide households with internet service

with the monthly subscription fee paid for by BPS. The City recognizes that the public school system will need long-term funding to support these Chromebook, hotspot, and voucher programs. In February 2022, Mayor Wu and Senator Markey announced that, of $12 million in digital equity investment, BPS will receive nearly $10 million in continuing support for these programs.

2.3 Boston Public Library provides device-lending and digital literacy programs for patrons

The Boston Public Library (BPL) is comprised of the central library in Copley Square and 25 branches across the neighborhoods of Boston, serving nearly 4 million visitors per year and millions more online, demonstrating how digital equity, access and inclusion are central to the BPL's mission. The programs and resources available at all locations include expanding Wi-Fi and computer access and device lending programs as described below. In addition to in-person resources, the library offers a multitude of digital resources (e.g., bpl.org/stream-and-download/ and bpl.org/online-resources/). Resources include:

- **Overdrive and Libby** (bpl.overdrive.com): More than 100,000 eBooks, audiobooks, and magazines.

- **Flipster** (bit.ly/BPLflipster): Current magazine issues readable on a computer, tablet, or smartphone.

- **Hoopla** (hoopladigital.com): Stream or download movies, TV shows, music, eBooks, and comics to mobile devices or smart TVs, with no waiting lists. Borrow up to 10 items per calendar month.

- **Kanopy** (boston.kanopy.com): More than 30,000 movies and documentaries available to stream with no waiting lists. Watch online, via the app, or on a smart TV. Borrow up to 6 items per calendar month.

- **New York Times** (bit.ly/BPLNYT): Check out a 3-day library pass to access the current issue of the New York Times online or via their app. You must create a free nytimes.com account or connect the pass to your existing one.

- **PressReader** (bit.ly/BPLpressreader): Full-color reproductions of thousands of U.S. and international newspapers and magazines, available via web or app.

- **Wall Street Journal** (bit.ly/BPLwallstreetjournal): Check out a 3-day library pass to access the current issue of the Wall Street Journal online or via their app. You must create a free wsj.com account or connect the pass to your existing one.

2.3.1   Outdoor Wi-Fi

The BPL has expanded its Wi-Fi to provide a stronger signal outside fourteen branches, giving patrons free internet access on BPL property. The rollout of the external wireless access points began in September 2020 amid the pandemic and prioritized neighborhoods having lower at-home broadband adoption[73] household income, and where outdoor seating was available. The branches include Brighton, Codman Square, Connolly, East Boston, Egleston Square, Grove Hall, Honan-Allston, Hyde Park, Lower Mills, Mattapan, Parker Hill, Roxbury, South End, and West Roxbury.

Funding for this initiative was supported by the Boston Public Library Fund.

2.3.2   Outdoor improvements enhance use of Wi-Fi outside libraries

To use the outdoor Wi-Fi to its full potential, the BPL made improvements to outdoor areas. Through partnership with other city departments (MONUM, Environment) and organizations (Culture House, Sasaki), the BPL was able to improve outdoor areas to add color, shade, and seating, from picnic tables to misting tents. These improvements have helped facilitate patrons' digital needs and also acted as dynamic spaces to promote city resources like Rental Relief Office Hours, Summer Eats pickups, and more. Branches included Brighton, Codman Square, East Boston, Egleston Square, Grove Hall, Hyde Park, Mattapan, and Roxbury.

In some locations, like Egleston and Codman Square, the libraries sit on the street, where outdoor work cafes serve as much needed shade and a welcoming entrance into the library for passersby. At other locations, like Mattapan and Brighton, dedicated patio areas off the parking lots have huge potential to become permanently shaded cafe areas — only a few weeks after installation the library reported that outdoor Wi-Fi usage doubled at the Brighton location as people responded to more comfortable seating and shade.

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[73] Per 2018 American Community Survey Data: http://arcg.is/1znzbW1

2.3.3 Short-Term Device Lending

The BPL has offered <u>hotspots</u> for about five years and had 225 devices circulating at the time the library system provided data to CTC. These help bridge the digital divide by providing free, reliable internet access that patrons can take to any location. The lending period is for three weeks.

In early 2021, the BPL expanded its short-term device lending offering to include 75 Chromebook Home <u>Connectivity Kits</u> (expanded to 150 units in 2022). The kits include a Chromebook, a Wi-Fi hotspot, a mouse, chargers, a quick start guide, and a BPL bag for transportation. The Boston Public Library loans Chromebook Home Connectivity Kits for 3 weeks. While the BPL continues to offer <u>public computer access</u> at all library locations, Connectivity Kits extend this service into patrons' homes and neighborhoods, on a schedule that works for them. The BPL hopes these kits will help Bostonians job hunt, learn new skills, or simply connect with friends and family. Patrons can place a hold and check out a hotspot or Connectivity Kit by calling 617.536.5400 or by visiting <u>bpl.org/hotspot</u> or <u>bpl.org/chromebook</u>.

Note: This section was adapted from <u>*https://www.bpl.org/news/boston-public-library-launches-new-initiatives-to-bridge-the-digital-divide/*</u>

2.3.4 Long-Term Device Lending

This program was initially rolled out in December 2021 through the use of the Emergency Connectivity Fund (ECF) and in close partnership with the Boston Housing Authority (BHA) and the Mayor's Office of New Urban Mechanics (MONUM). The program was designed to reach adult patrons who have unmet digital connectivity needs for devices not just for a few weeks, but for an indefinite amount of time. Partnerships were leveraged to target key demographics that may or may not be aware of the Boston Public Library's resources. Physical mailings were sent to approximately 9,000 BHA residents to inform them about the program.

Through the program, patrons can request an LTE-enabled home Wi-Fi router and/or a Chromebook. Devices are sent directly to patrons of the Boston Public Library under a long-term loan agreement where they will be able to continue loaning the devices until it is no longer needed or its value is determined to be zero – at which point the lending period will end and the patron will not need to return the device.

The intention is to reach those most in need through leveraging the following partnerships to target some key demographics. The initial partnership with BHA was prioritized and then expanded to other departments:

- Elderly and disabled in Section 8 housing (Boston Housing Authority),
- Unemployed (Office of Workforce Development),
- Homeless people and those at risk (Office of Housing Stability),
- Returning citizens (Office of Returning Citizens),
- Immigrants (Immigrant and Family Services Institute – Boston, Office of Immigrant Advancement – Boston, US Immigration Office – Malden)
- Veterans (Office of Veteran Affairs),
- Small Businesses (Office of Economic Development)

2.3.5 Community Hotspots

A total of 200 hotspots were provided via American Rescue Plan Act (ARPA) funding through the Massachusetts Board of Library Commissioners (MBLC). Rather than supplementing its existing lending program the BPL partnered with MONUM to prioritize third spaces and community-based organizations to reach residents. The hotspots have been distributed to more than 15 community organizations and city departments. Our partners have used these hotspots to empower youth organizers in the field, provide connection to public housing residents, connect farmers' market and food pantry clients with easy access to SNAP and recipes online, make telehealth a reality for our most vulnerable neighbors, offer digital English classes available for Afghan refugees, and much more.

2.3.6 Community Learning

The BPL also offers classes, workshops, and info sessions on a wide range of topics, including computer and digital skills training. Library staff are available for one-on-one technology assistance on a drop-in basis during regular branch hours or by appointment. For more in-depth computer training, patrons can also register for the Tech Goes Home program, which strives to ensure that all residents of the City of Boston are equipped with the tools, training, and access to support 21st-century skill development. Participants in the program receive 15 hours of digital skills training and receive a free Chromebook laptop at the end of the course.

2.4 Boston Housing Authority assists its residents in connecting to subsidized connectivity and training programs

The Boston Housing Authority (BHA) is a public agency governed separately from the City that owns or oversees more than 12,600 housing units and currently supports device distribution programs and computer skills trainings in partnership with other organizations including the BPL and Tech Goes Home. As noted below, the BHA is also developing free Wi-Fi in common areas at BHA sites.

As noted above, of the $12 million investment the City of Boston is making, $2.2 million went to BPL to support a BPL's long-term lending program under which Chromebooks and hotspots will be distributed to BHA residents. BHA is coordinating with BPL by reaching out to public housing tenants, which include potentially vulnerable residents like seniors, disabled residents, limited English proficiency residents, and veterans. BHA staff also hold regular "coffee hours" where residents can get help signing up for this program. As of April of 2022, the BHA had received 920 device requests and had distributed approximately 500 mobile connectivity devices, which provide service from T-Mobile.

BHA is also hiring one or more digital navigators to provide enrollment support. This $12 million funding will build on $2 million in American Rescue Plan Act (ARPA) funds allocated by Mayor Wu and the Boston City Council. By June of 2022, the BHA will have completed the process of re-wiring 17 BHA sites to provide free Wi-Fi in communal areas supported through a $1 million grant from this allocation. BHA has also purchased new computers and desk furniture for community rooms, task force offices, and computer rooms and has purchased and started distributing 400 Chromebooks and tablets to residents who do not currently have a device.

BHA also partners with Tech Goes Home and other organizations to provide computer literacy classes to residents. In addition to four TGH trainers providing digital skills courses at BHA sites, BHA has a number of other partners assisting with digital skills training such as the Center for Community Health Education Research and Service which provided computer literacy and telehealth training to seniors and disabled residents at two BHA sites: Doris Bunte and MLK Towers. Additionally, Central Boston Elder Services (CBES) ran a 10-week program to provide 100 Boston seniors with digital skills training at the Holgate, Washington Manor, Frederick Douglass, and Hampton House sites. Other partners include Boston Senior Home Care, Little Brothers and Friends of the Elderly. BHA works with these and potential new partners to provide on-site digital literacy trainings at as many of its sites as possible on an ongoing and rotating basis.

In terms of connectivity, the Starry Connect program—from the fixed wireless provider Starry— began as a pilot project in 2018 as a partnership between Starry and the BHA. Starry partnered with the Boston Housing Authority to provide free community-area Wi-Fi access at Ausonia, a 100-unit senior living community in the North End. Starry deployed access points through each

of the community's common areas and on hallways of each of the floors. Starry also donated five computers for a designated computer lab for Ausonia residents.

2.5 Boston's Age Strong Commission advocates for digital equity in Boston's aging population

Boston's Age Strong Commission (the Commission) is a City department that supports and advocates for Boston residents aged 55+ through a range of programmatic initiatives, grantmaking, and resource distribution. The Commission focuses on digital literacy and access. In 2017, the Commission released its Age-Friendly Action Plan, a report with initiatives and actions. One focus area was to improve the senior population's access to digital communications throughout the City. The Commission has advocated for the aging population's ability to connect to broadband, including as a generous partner of the City's Digital Equity Fund; in FY21, the Commission supported the fund with an estimated $320,000.

2.6 BoNet provides connectivity for the City's municipal facilities and public spaces

The Boston Optical Network is the fiber network the City of Boston. The City of Boston fiber network for municipal use, (BoNet) was initially developed utilizing dark fiber infrastructure owned by Comcast, Astound—and now Verizon—and contractually provisioned to the City through cable license agreements. The City of Boston's cable licenses incorporate elements of a city-managed fiber optic network riding on the dark fiber of cable providers and additional city-built fiber assets.

The City of Boston has two multi-year initiatives underway to expand the City's fiber network (BoNet) from the 134 locations received in 2008 under the Comcast cable license agreement to reach 352 locations: 127 locations under the Verizon agreement and 145 locations over two years with Crown Castle Fiber under a $10 million 20-year IRU agreement. (Core redundancies account for multiple connections.)

These locations include all City libraries, schools, police and fire stations, community centers and municipal service locations totaling 432 fiber connections to 352 sites providing City services plus external public safety locations. Several locations have two or more connections to provide additional network redundancy and connectivity for critical locations such as core locations and police and fire stations. These will have fiber connections from different providers.

The City-owned fiber network eliminates leased-line expenses while increasing the speed and capacity of city online services. Boston DoIT pursued the franchise dark fiber and planned the network as an alternative to leased lines for data and video traffic between various city locations.

As of September 2022, of the 352 locations the City had 98 percent (347) "live" on BoNet.

BoNet began operating in 2008 and provides middle mile connectivity to support many digital equity-related initiatives across the City. BoNet connects Boston Public Schools, Boston Public Libraries, city facilities like public safety buildings such as police and fire stations, affordable housing sites, community centers, and Wicked Free Wi-Fi's outdoor network.

The City of Boston actively invests in maintaining and expanding BoNet given the network's crucial role in supporting institutions across the City. In 2014, the City commissioned a technical review of BoNet given the continued growth in traffic on the network and increasing demand and opportunity to connect new sites and services. The report concluded that BoNet was technically and operationally sound.

In April of 2017, the City, with Council approval, released a Request for Proposal (RFP) to solicit bids from private providers to expand BoNet through a $10 million investment in the network's fiber backbone and infrastructure. The project provided broadband services to Boston Public Schools, public housing and more than 145 City buildings while strengthening public safety communications by connecting the remaining 73 schools with City fiber, as well as all BHA-owned family and elderly (mixed) housing developments and other sites for public safety and transportation services.

The City continues efforts to ensure BoNet is highly capable of supporting digital equity efforts and city operations to the fullest extent possible. Network improvements are continuing. The City is in the process of updating the BoNet Core System to upgrade the network's legacy dense wave division multiplexing (DWDM) equipment.

It should be noted that, under the current Indefeasible-Rights-of-Use (IRU) in place between the City of Boston and Crown Castle, this network capacity cannot be leased to any third party or used for any non-municipal commercial activities. Likewise, the portions of the BoNet network the City acquired from Verizon, Comcast, and Astound Broadband (RCN) through IRUs or similar licensure agreements are also limited in this way.

2.7   Community Broadband Deployment: Urban Edge CDC

The Metropolitan Area Planning Council (MAPC) has been engaged over the past year with Urban Edge, a community development corporation, on a planning study regarding digital access along the Columbus Avenue corridor. Urban Edge serves the communities of Roxbury and Jamaica Plain bordered by Jackson and Egleston Square and owns close to 2,000 affordable housing units in the Columbus Avenue area.

Together, they are developing a plan to ensure more residents and business owners in the area have high speed and reliable access to the internet, as well as exploring potential workforce or skills-based training opportunities that could further leverage any efforts to improve internet connections in the area.

The City recognizes the potential for wireless rooftop community broadband deployments such as this one being contemplated by Urban Edge as replicable in other under-served neighborhoods across the City.

2.8   Wicked Free Wi-Fi increases connectivity for residents through public spaces

Wicked Free Wi-Fi (WFW) is a free, public Wi-Fi system the City of Boston operates to provide outdoor connectivity for residents—and is a service enabled by BoNet. DoIT launched WFW Boston's Public Wireless Network in 2014 with more than 170 access points, initially in the Grove Hall area as an effort to close the digital divide. The City expanded WFW in 2016 in more of Boston's public buildings, schools, and neighborhood business district locations reachable by the City's fiber network. As of April 2022, the City was in the process of planning to expand Wicked Free Wi-Fi's coverage area through Boston's 20 neighborhood Main Street nonprofit programs with an additional 130 access points.

Now that City has completed fiber expansions through Verizon and Crown Castle fiber, the City is ready to deploy even more access points and anticipates spending $1 million on between 30 and 50 buildings, predominantly community centers, for inside wiring and rooftop access points to further expand the reach of the free Wi-Fi network.

2.9   Boston Resiliency Fund started during Covid-19 provided funding for remote learning efforts

During the height of the COVID-19 public health emergency, the City temporarily shifted to funding digital equity programs through the Boston Resiliency Fund, a temporary fund the City created to coordinate and expedited funding for essential services to Boston residents whose health and well-being were most immediately impacted by COVID-19. The Fund was active in 2020 through 2021 and focused on securing food, supporting public health efforts, and other basic needs, in addition to supporting technology for remote learning.

Overall, $34.5 million was raised for Covid-19 relief efforts, supporting 377 nonprofits and over 250,000 Boston families. Of this, the City spent $4 million on Chromebooks and hotspots for Boston Public Schools students for remote learning.

2.10 Tech Goes Home is a successful example of collaboration between City and community-based organizations

Tech Goes Home (TGH) is a nonprofit founded in Boston in 2000 to provide computers, internet access, and skills training to students, adults, and seniors through partnerships with other community organizations. Upon completion of 15 hours of TGH curriculum and training, learners earn a new Chromebook and 12 months of free internet service. Tech Goes Home offers targeted computer training courses specific to adults, small businesses, families with school-aged children, and early childhood programs.

TGH reports that 11,561 Bostonians have graduated from a Tech Goes Home program in the past three years. In this same timeframe, TGH distributed 8,186 devices.

Tech Goes Home serves marginalized communities in Boston and beyond, with an emphasis on those with low-incomes, immigrants, families, and older adults.

As of April 2022, Tech Goes Home has offered training programs with more than 400 community-serving organizations across Boston.

3 Efforts underway by internet service providers (ISP) to expand access are pivotal in addressing gaps

Providers can often serve as active partners in collaboration with communities to further digital equity goals. This section summarizes the low-cost programs and other efforts offered by the ISPs operating in Boston.

3.1 Comcast

Comcast's efforts to address digital equity include offering reduced-price internet service (Internet Essentials) to qualifying low-income residents, providing devices and Wi-Fi to Boston residents in coordination with many Boston nonprofits, and providing financial support to Boston nonprofits. Comcast also participates in the ACP subsidy program.

Comcast first piloted a reduced-price internet service offering in 2010 for Boston residents in collaboration with the City government. The success of this pilot led to the creation of Comcast Internet Essentials in 2011. As part of this study, Comcast shared that 27,000 Boston residents had enrolled in the program; the company did not provide current active enrollment numbers. Comcast provides an Internet Essentials help line in English and Spanish. The online application is available in seven languages and printed material is available in 15 languages.

Comcast also partnered with local Boston organizations to provide free Wi-Fi to community spaces. At the time Comcast provided data to CTC, the provider was operating 33 of these free community Wi-Fi spaces (known as "Lift Zones") in the City.

Comcast also worked with local organizations to distribute laptops to Bostonians in need in partnership with Tech Goes Home and Boston Public Schools. In August of 2021, Comcast donated 500 laptops to seniors in Boston who completed Tech Goes Home's digital training course, in addition to a $25,000 grant to TGH to support the organization connecting more seniors in Greater Boston with devices, computer skills training, and Internet Essentials sign-ups. In December of 2021, Comcast also donated 500 laptops via the Parent University Program run by Boston Public Schools. Comcast also donated $722,000 to the Boston Digital Equity Fund in 2021.

In the second quarter of 2020, Comcast and the City of Boston worked with the Commonwealth to amend the state blanket procurement contract to allow cities, towns, and schools in Massachusetts to bulk purchase Internet Essentials. Many community-serving organizations in Boston such as Tech Goes Home and Boston Public Schools have entered into such agreements with Comcast to provide Bostonians in need with an internet connection free of charge.

3.2   Verizon/Smart Cities

Verizon has contributed more than $6 million in funding and support for digital equity efforts in Boston, including $2.5 million in in-kind contributions to the City in the form of Smart City support during COVID for hotspots and tablets to BPS households, seniors in public housing and others in need of digital connectivity.

In 2016, the City of Boston announced a partnership with Verizon to carry out a pilot project to provide traffic condition monitoring supported by network infrastructure the provider was already installing in Boston. This was an in-kind contribution to the City that Verizon agreed to as the company was upgrading its local 4G LTE network and expanding Fios internet and cable service to all neighborhoods in Boston. This pilot project also included Verizon's contribution of $100,000 to the City, which was used to support a mobile hotspot lending program at BPL.

This pilot led to an expanded partnership between Boston and Verizon. In 2018, Verizon and the City signed a 10-year agreement where Verizon committed to expanding its wireless small cell network to boost network speed and capacity to lay the foundation of improved services in the City while continuing to collaborate with Boston on intelligent surveillance, intelligent city lighting, traffic condition monitoring, and other smart city applications. As part of this agreement, and as noted above, Verizon also committed to contributing $1 million to the Boston Digital Equity Fund. Additionally, in response to the pandemic, approximately $2.5 million of the $4.7 million committed to funding these smart city applications was reallocated to fund hotspots and data plans to support Boston Public School students.

3.3   Starry Connect

Starry is a fixed wireless provider (ISP) that began operating in recent years in Boston. As noted above, in its Starry Connect program, Starry partnered with the Boston Housing Authority to provide free community-area Wi-Fi access at Ausonia, a 100-unit senior living community in the North End. Starry deployed access points to each of the community's common areas and on hallways of each of the floors. Starry also donated five computers for a designated computer lab for Ausonia residents. Starry offers "Starry Connect" to subsidized or affordable housing.[74]

3.4   NetBlazr

In 2017, NetBlazr team has also attempted to provide solutions by partnering with the Madison Park Development Corporation, owner-operators of the Haynes House, an affordable, multifamily housing complex with 130 units to provide two years of free internet service and all

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[74] Eligible housing sites include ones where 90%+ units are subsidized by federal, state or local funding; where the community is 100% owned by a public housing authority or other government entity; where 100% of all units are either subsidized by federal, state or local funding and/or are income limited (income thresholds), so as to qualify as regulated affordable or workforce housing in the local municipality; or where 90%+ units are rent-controlled, rent-stabilized or participate in another State or City mandated affordable housing preservation program.

the necessary equipment thanks to a donation from Korea Telecom, which was demonstrating technology that can deliver high speed internet over aging copper infrastructure.

4   Stakeholder engagement and characterization of gaps

CTC interviewed leaders at the Boston Public Library, Boston Public Schools, Boston Housing Authority, Age Strong Commission, Mayor's Office for Immigrant Advancement, Tech Goes Home, and Boston Neighborhood Network. The following common themes emerged:

- Significant progress has been made, but the scale of the need for programs of all kinds remains large, with ACP enrollment support emerging as a top need.

- Residents have difficulty signing up for the ACP, Internet Essentials, and Lifeline. These challenges include confusion over the process, issues getting the required documents together, language and accessibility barriers, and mistrust and hesitancy based on past interactions with broadband providers.

- CBOs are among the most effective conduits for digital equity initiatives because they have established relationships in the community. This is particularly significant for residents who have limited English ability and those who are older. However, many organizations are constrained by time, staff, and available funds.

- Outreach materials and programs must be offered in multiple languages, and the Mayor's Office for Immigrant Advancement also stressed that these materials be culturally appropriate.

- Although online versions of classes and enrollment support services are useful, older adults often need digital skills trainings or reduced-price internet program sign-ups to be offered in person.

- Different personal situations require different connectivity solutions, with mobile hotspots often being the best solution for people having an unstable home situation. This was relayed by Mark Racine of BPS, members of the Mayor's Office for Immigrant Advancement, and Dan Noyes of Tech Goes Home. Dan Noyes said that in his experience, people are 50 times more likely to take free hotspots from Tech Goes Home than they are to take a free Comcast Internet Essentials subscription.

Below are further characterizations of progress and gaps provided by the stakeholders. Their statements and characterizations have been condensed for clarity.

4.1   Boston Public Library: Keith Gillette, Chief Technology Officer and Kurt Mansperger, Former Chief Technology Officer

Boston Public Library (BPL) serves nearly 4 million visitors per year and, as described in the previous section, offers a variety of initiatives including device-lending programs and outdoor Wi-Fi spaces to advance digital equity across the City. These efforts have been crucial in reducing the digital divide, especially among immigrants and older adults. Providing residents with devices, digital literacy resources, and access options work effectively together to address the gaps that prevent equitable connectivity. Partnerships like the BPL's Long-Term Device Lending program in conjunction with the BHA and the Mayor's Office of New Urban Mechanics (MONUM), provide multi-agency collaboration to successfully distribute resources to populations in need.

Some residents face challenges in signing up for the Comcast Internet Essentials program, often due to language barriers, skill level, and accessibility. Those with little technical skill may need in-person sign-ups, for example, to get successfully connected. Vouchers for internet service for Section 8 housing, as opposed to individual enrollments in Internet Essentials or ACP, could be helpful in increasing connectivity among public housing residents. Limited funding can prevent organizations from comprehensive data collection to identify gaps.

4.2   Boston Public Schools - Mark Racine, Chief Information Officer

Boston Public Schools (BPS) serves more than 46,000 Boston students in 125 schools and has played a crucial role in keeping them connected to reliable high-speed internet and devices. Over the course of the pandemic, all students were served through the distribution of nearly 60,000 Chromebooks, 10,000 hotspots, and 3,000 vouchers for Comcast Internet Essentials. Racine relayed the success of getting and keeping students connected through the collaborative efforts of stakeholders within the school district.

Racine identified four areas that the school district found to be barriers to internet access for families: a complex application process for ACP or Internet Essentials; the complexity of setting up routers; troubleshooting Wi-Fi; and cultural accessibility.

Families sometimes struggle to understand how to apply for service through Comcast or Verizon, despite both companies having adjusted their application process. Teachers and principals often directly engage in the enrollment process by being present on the phone with the ISP, helping families to understand their options and fill out the application during both installation and troubleshooting. BPS found that families were often being sold higher, more expensive packages, or being convinced to add other unnecessary services. Even when provided with vouchers, some families reported that they were told the voucher wouldn't cover their needs and they needed to purchase a more expensive package.

Further, not all families understood how modems and wireless routers work, which created downtime when a family experienced an internet outage. Students sometimes have issues connecting to their router or understanding how Wi-Fi works, which caused simple technical issues to result in long periods of downtime. Racine can recall multiple times when families thought they had no internet access when in fact they needed to reboot the router or had forgotten the password. When compared with other utilities, there are many more opportunities for user error when it comes to broadband. Lastly, ISPs do not always offer language support for all of the languages spoken in the Boston Public Schools (beyond English and Spanish), which also requires school staff to assist with the installation process. In addition to language support, some families were apprehensive about providing personal information during the application process due to undocumented status or other issues.

4.3   Boston Housing Authority - Lydia Agro, Chief of Staff and Media & Engagement and Joel Wool, Chief of Procurement

The Boston Housing Authority (BHA) has supported the City in its digital equity efforts through the purchase and distribution of laptops and tablets, expansion of free Wi-Fi in community spaces, and offering information about ACP with the use of CARES Act funding allocated to the BHA. During the beginning of the pandemic, the BHA conducted a survey of residents and found that about a quarter of BHA residents were not connected to broadband, particularly residents who were elderly or of limited English proficiency. The BHA has continued to work to reduce these gaps and explore opportunities to support connectivity, digital literacy, and equipment.

Agro and Wool relayed that residents of public housing properties typically do not enjoy the benefits of competition for in-unit service. BHA residents have reported that the cost of service and devices are primary barriers to access. BHA's survey suggested Spanish-speaking residents have fewer subscriptions to internet service than English-speaking residents. Even when subsidized programs are offered, these residents may require additional outreach.

Agro and Wool stressed the importance of supporting enrollment in the ACP and that community-serving organizations will need additional financial support to do so. Agro stated that enrollment support is most effective for seniors when in-person and should be offered in multiple languages for those with limited English ability. They said residents who prequalify due to public housing residency should have "one-click" access to sign-up.

Agro and Wool relayed that during the height of the pandemic, many had multiple communications needs at home for work and school and that service quality was a question, but they lacked data on service quality. Consumer advocates also suggest residents' monthly costs may be higher than necessary due to upselling. Agro and Wool additionally relayed that for more comprehensive data collection efforts on public housing residents' internet access, BHA would need additional partnerships or resources.

4.4   Mayor's Office for Immigrant Advancement - Agnes Chang, Chief of Staff, Natalia Espinosa Tokuhama, Economic Integration Specialist, and Yusufi S. Vali, Director

The Mayor's Office for Immigrant Advancement (MOIA) advocates and promotes the well-being of immigrants through economic, civic, social, and cultural opportunities. MOIA was created in 1998 originally as the Mayor's Office of New Bostonians and since has supported immigrants through promoting resources, services, and programming. Through partnership and advocacy, MOIA has supported digital equity initiatives and acted collaboratively with other agencies.

MOIA has found that key barriers exist in accessibility, affordability, and skills, limiting immigrants' digital access and, consequently, their employment opportunities. The City should prioritize digital skill-building strategies that incorporate employer and employee feedback. To ensure that immigrant workers can adopt digital skills, MOIA recommended partnering and funding digital skills training with English language learning programs while also providing childcare and other forms of support for employees engaging in training, such as offering employer-paid training and accommodating time and commuting needs required by the training.

Additionally, Chang, Espinosa Tokuhama, and Vali all relayed that immigrant communities face various challenges in gaining digital access. Every step is complicated—from obtaining a device, obtaining a reliable internet connection, to obtaining cost-reducing benefits that require a social security number and high English skills for application completion. Some are also reluctant to provide residency information to federal programs, whether it be due to documented status or having a fluid living situation. Even as those who are undocumented or newly arrived try to gain access without benefits, they may lack the financial or credit history to obtain devices and internet subscriptions.

The stakeholders suggested that wider outreach and networking services for immigrants are necessary. What's needed are programs that prioritize immigrant communities' unique needs. This can include, for example, administering programs that offer multilingual online courses, free hotspots, free cellular devices with strong and reliable data plans, or broadband plans that don't require difficult sign-ups or residency information. It is crucial that trainings, materials, and outreach are in peoples' native language, and is culturally appropriate.

MOIA emphasized that the City should further support non-profit organizations that serve immigrants, as these organizations have a relationship of trust already built with communities that is fundamental in delivering ACP outreach, skills programs, and other digital equity initiatives. Partnering with organizations like Tech Goes Home is instrumental in broadening access. Many immigrant households are large families sharing a single device. Quantifying devices per family size is necessary for ensuring these families are adequately served.

4.5   Age Strong Commission – Alison Freeman, Director - Area Agency on Aging, Emily Shea, Commissioner, and Melissa Carlson, Deputy Commissioner

The Age Strong Commission is a department of the City of Boston that serves senior residents through various programs and community-based initiatives. The Commission has been instrumental in its advocacy for digital equity for the City's aging population, including as a co-partner of the Digital Equity Fund along with the Department of Innovation & Technology and the Equity & Inclusion Cabinet.

The Age-Strong Commission conducted a survey of providers and human service agencies including aging services organizations, faith based communities, immigrant serving organizations, neighborhood associations, and senior housing providers. Age-Strong heard back from a cross section of 90 of these organizations, together serving thousands of older adults, learning that:

- In general, access to computers or tablets, the internet, and training is a major issue for older adults.

- 30 percent of the organizations surveyed said that only 10 percent of the older adults they were connected to had access to a computer or tablet; and

- 39 percent of organizations said that between 25 percent and 50 percent of older adults had such access.

Freeman, Shea, and Carlson emphasized that digital equity gaps remain among older adults in Boston for three primary reasons: (1) lack of understanding and skills to use technology, (2) lack of broadband connection, and (3) lack of devices. The first of the three presents the largest barrier. CBOs play a leading role in connecting Boston's older population by identifying individuals who are not connected and organizing opportunities for training. Older adults have shared that learning looks different depending on the individual, and training that is too advanced can be a deterrent. Skills trainings of varied levels—and in a variety of languages—helps keep older residents engaged.

To reach older residents, the Commission relayed that advertisements at medical offices, banks, and houses of worship can be important, especially for the socially isolated. It also can help to leverage family connections, like communicating to adult children about programs for their elderly parents. Some partners have found ongoing end-user support after formal instruction to be a crucial part of supporting older residents. You need to communicate in many different ways –in writing, digitally, and orally. You need to communicate in many languages. And you need to communicate where older people go: medical offices, houses of worship, hairdressers and barber shops, grocery stores, senior centers, community centers, direct mail, and newspapers. This is a very diverse audience receiving information in different ways, and communication needs to be diverse in order to meet the needs.

4.6   Tech Goes Home - Dan Noyes, Co-CEO

Tech Goes Home (TGH) is an organization founded in Boston in 2000 to provide computers, internet access, and skills training to students, adults, and seniors through partnerships with community organizations. Dan Noyes, who has been involved with the organization since 2002, highlighted the importance of the City providing funding to community organizations to facilitate Affordable Connectivity Program (ACP) outreach and enrollment support. Noyes said that hotspots should remain an option for securing connectivity, given that the people TGH serves are 50 times more likely to choose hotspots than free broadband subscriptions.

Digital inequity denies thousands of people in Boston and millions across the country the opportunity to succeed, perpetuating inequalities in educational, economic, and health outcomes, Noyes said. Advancing digital equity requires increasing access to digital devices like computers and tablets, stable and reliable internet access, and culturally responsive digital skills training. Efforts to advance digital equity must be grounded in community and focused on actualizing power in communities that have been most marginalized for decades – often low-income communities and communities of color that have been and continue to be excluded from accessing critical resources and opportunities, including healthcare, education, and jobs Policymakers and other stakeholders must develop solutions in partnership with these communities and work with local organizations to develop, implement, and sustain digital equity efforts.

Noyes said that effectively addressing digital inequity requires tackling the systemic injustices that perpetuate digital exclusion, including systemic and structural racism and economic inequality. Intentional policy changes at the local, state, and federal level, and increased investment to expand effective, community-centered solutions are essential to advancing digital equity efforts that reflect the interconnectedness of systemic challenges.

Noyes stressed that digital equity efforts will only be effective if they deliver what historically marginalized communities need and include the input of community representatives. He also explained that through his work at TGH, he's learned that immigrant populations require more resource-intensive and targeted outreach. These communities not only tend to live in lower-income neighborhoods, but due to language barriers, they often aren't aware of the resources that are available to them. This means that the city of Boston should invest in targeted advertising and work with trusted community partners to increase ACP enrollment and raise awareness about available computer skills courses among this demographic. Noyes gave the following recommendations for any City grant programs designed to support ACP outreach and sign-up activities:

- Require grantees to demonstrate trust and/or active connections with the community

- Require grantees to show how they will direct people to sign up for devices and skills programs, as needed so that participants can use the internet once they're enrolled in ACP

- Require grantees to report data on the number of people who were able to sign up, while keeping reporting requirements efficient so as not to waste time and resources. (CTC recommends the City aggregate this data to have a clear picture across all organizations' efforts.)

Noyes recommended the City focus on fund digital equity initiatives and empower community organizations that are doing the work to experiment with approaches to find the most effective methods.

4.7   Boston Neighborhood Network – Justin Petty, President of Board of Directors

Justin Petty, president of BNN's Board of Directors, described a large need for computers, connectivity, and digital skills training among Boston residents. Justin Petty serves multiple roles in the Roxbury community, chairing the broadcast media technology program at Roxbury Community College and volunteering as the digital equity advocate for Prince Hall Masonic Grand Lodge in Grove Hall.

Boston Neighborhood Network (BNN) is a community media center and nonprofit founded in 1983 that acts as a public forum for all Boston residents, nonprofit and community-based organizations, and governmental and educational institutions. BNN's mission is to provide Bostonians with affordable training and access to emerging media technologies and the skills to use those technologies for the benefit of the community.

The most significant gap Bostonians face is affordability; the single most significant effort the City could undertake would be helping residents sign up for the ACP, including through in-person multilingual enrollment support. Through the senior computer skills training program he oversees through the Prince Hall Masonic Temple, he relayed that senior participants were effectively reached through local news advertisements, email, the radio, Facebook and Instagram posts, or by word-of-mouth. Hard-to-reach populations can be incentivized to participate in digital skills training programs with the promise of getting a device if they complete a course. He recommended that future programs use this approach.

5   Benchmarking Boston's progress

To understand how Boston's efforts to address digital equity compare to those of other cities, CTC consulted publicly available data to gather information on ACP participation, household computer ownership, broadband subscription status, and the address-level analysis of the availability of download speeds of 1 Gbps for Boston and three other cities: Philadelphia, San Francisco, and Washington, DC.

The proportion of Boston households with a computer, internet subscription, and with access to internet download speeds of 1 Gbps are similar to those in the other cities. Boston stands above Philadelphia on household computer ownership and slightly behind San Francisco and Washington DC. The cities rank similarly in terms of households with a broadband internet subscription, with percentages showing more Boston households with a computer than in Philadelphia and Washington, DC, and less than San Francisco in this area. The percentage of residential addresses capable of receiving download speeds 1 Gbps, drawn from the FCC's Form 477 data, shows near-ubiquitous access across all four cities.

With respect to ACP participation relative to the potential eligibility, Boston households may not be adopting the new program to the extent seen by households in other cities. However, this comparison does not take into consideration the fact that during the pandemic, the Boston departments of DoIT and BPS acquired and distributed connectivity resources to more than 13,000 Boston households, including at least 3,500 Internet Essentials subscriptions and approximately 10,000 wireless hotspots over the last two years. Presumably, this COVID-related distribution of wireless and wireless broadband and devices reduced the demand for ACP enrollments among eligible populations, and in an indeterminate number, some households may be choosing not to subscribe to broadband.

A summary of our findings can be found below in Table 14 and reflect numbers as of May 2022 for all of the cities.

Table 14: Quantitative comparison of Boston, Philadelphia, San Francisco, and Washington, D.C. [75]

Quantitative Metric	Boston	Philadelphia	San Francisco	Washington, D.C.
Estimated proportion of ACP-participating households as a percentage of households at or below 200% of the federal poverty threshold [76, 77]	29%	44%	32%	56%
Households with a desktop or laptop, percent, 2016-2020 ACS [78]	80.6%	70.9%	86.3%	81.6%
Proportion of households with a subscription to an internet service, percent, 2016-2020 ACS [79]	87.1%	80.5%	89.5%	85.6%

[75] The Census Bureau's American Community Survey's 5-year estimates are period estimates, with the data reported on a rolling basis. The data for the five years are combined, weighted and processed as a whole dataset to take advantage of the larger number of responses. The 5-year estimate can equate to the midpoint of this time series in certain specific cases, but this characterization is less accurate when conditions change drastically during the sample period, as was the case with the COVID-19 Pandemic and the ACS 2016 to 2020 estimates. CTC included this data to be understood as reasonable estimates given the constraints to further data collection and ACS's widespread use as the standard dataset informing policymakers' decisions. However, it should be noted that the standard ACS methodology cannot fully represent each city's efforts to address digital equity from the beginning of the pandemic to May of 2022.

[76] To estimate the proportion of households in Boston who are eligible to participate in the ACP by their annual household income alone, CTC: (1) Established an income threshold for households below the 200% poverty line by using the US Department of Health and Human Services' "HHS Poverty Guidelines for 2022" (https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines) to identify the poverty line that would apply to the average Boston household size presented by ACS 2016-2020 estimates, (2) Estimated the cumulative proportion of households in Boston earning at or below the adjusted 200% poverty threshold from the estimated income distribution for the city as presented by ACS 2016-2020 estimates, then (3) Gathered the count of ACP-participating households as of May 1, 2022, in the zip codes that fell within the city's boundaries as reported by the Universal Service Administration Company (USAC), the independent non-profit charged by the FCC to administer ACP and other programs supported by the FCC's Universal Service Fund (USF). (To calculate the ACP enrollment for Boston as of May 1, 2022, we added the ACP enrollment for the following zip codes: 02108, 02109, 02110, 02111, 02113, 02114, 02115, 02116, 02118, 02119, 02120, 02121, 02122, 02124, 02125, 02126, 02127, 02128, 02129, 02130, 02131, 02132, 02134, 02135, 02136, 02199, 02210, and 02215.) The final proportions presented in row 1 of Table 15 is the ratio of ACP-participating households from Step 3 over the total households earning at or below the adjusted 200% poverty threshold from Step 2.

[77] It is critical to note that income is only one criterion used to determine a household's eligibility for the ACP program. Households may also eligible if they participate in a variety of federal assistance programs, meet the eligibility criteria for a provider's existing low-income internet program, or meet additional criteria. Conversely, households who are otherwise eligible may already have their internet needs met through Comcast's Internet Essentials or similar programs, hotspots distributed by school systems, or through other means. The data presented in Table 15, row 1 should be viewed as high-level estimates.

[78] Census Reporter, Table B28001 – for Boston, Philadelphia, San Francisco, and Washington, DC. Accessed May 2022.

[79] The households included in these proportions exclude respondents who indicated they have home internet without paying a monthly subscription, such as when the respondent's city or town provides free internet to residents. Only households who selected the response "Broadband (high speed) internet service like cable, fiber optic, or DSL" after already indicating they pay for a monthly internet subscription were included in proportions given in Table 15. However, it should be noted that the question as presented in the ACS survey did not define a minimum speed threshold for "broadband" service and grouped DSL service, which may not deliver performance

CTC also contacted City officials in Philadelphia, San Francisco, and Washington, DC, to gather information on whether the City had digital equity plans, strategies for maximizing ACP enrollment, and resources like staff and funding each locality has committed to digital equity efforts. Responses from the City representatives have been recorded below in Table 15.

Table 15: Qualitative comparison of Boston, Philadelphia, San Francisco, and Washington, D.C.

Qualitative Metric	Boston	Philadelphia	San Francisco	Washington, D.C.
Does the locality have a digital equity plan in place?	Yes	Yes	Yes	No
Is there a digital equity plan in place, and funding to execute the strategy with collaboration across local agencies?	Yes	Yes	Yes	No
Does the locality have an officer tasked with addressing digital equity concerns in the target area?	Yes	Yes	Yes	No

necessary to meet the FCC's current definition of "broadband," alongside other technologies that always do so. Therefore, the data may be an overestimate of the proportion of households with a broadband internet subscription if using the FCC's minimum 25/3 Mbps broadband service standard.

6   Recommendations

The strategic recommendations presented here are informed by data developed during the course of this study.

6.1   Accelerate enrollment efforts in the Affordable Connectivity Program

As many as 35,000 Boston households are not subscribed to any internet service based on 2016-2020 ACS data; the figure includes respondents who said they had a wired residential and/or a mobile connection.[80, 81] The FCC's Affordable Connectivity Program (ACP) prioritizes the internet for eligible low-income households, a critical part of Boston's population that continues to remain disconnected. Enrollment programs like the ACP ensure affordable, reliable internet options for residents and prove to be pivotal in increasing access. To this end, we applaud and endorse the City's efforts at accelerating enrollment efforts in the Affordable Connectivity Program.

6.2   Build coordination among various agencies in the City to further increase impact

Achieving broadband connectivity for all residents in a community requires a coordinated, multi-pronged approach. The Digital Equity Fund has proven as a successful collaboration between the Department of Innovation and Technology, the Age Strong Commission, and the Equity & Inclusion Cabinet. Additionally, the Boston Public Library has partnered with the Boston Housing Authority to distribute devices to patrons, and the Boston Public Schools has made strong efforts to provide 10,000 hotspots to students for school use.

Furthering collaboration between entities on a larger scale will make it possible to efficiently streamline and address areas of need and will align with ACP enrollment support efforts underway by CBOs. For example, the same student households receiving hotspots might also benefit from ACP enrollments. We recommend that the City establish a coalition establish a bi-monthly meeting with these stakeholders to provide updates and synthesize efforts. Additionally, the agencies can synthesize more areas for collaboration and impact. This coalition should also establish a central data repository with standardized metrics applicable to all digital equity programs in Boston so that impact over time can be monitored effectively.

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[80] This estimate was calculated by excluding from the total number of Boston households the portion of those households who selected the response "Broadband (high speed) internet service like cable, fiber optic, or DSL" on the ACS survey after already indicating they pay for a monthly internet subscription.

[81] The Census Bureau's American Community Survey's 5-year estimates are period estimates, with the data reported on a rolling basis. The data for the five years are combined, weighted, and processed as a whole dataset to take advantage of the larger number of responses. The 5-year estimate can equate to the midpoint of this time series in certain specific cases, but this characterization is less accurate when conditions change drastically during the sample period, as was the case with the COVID-19 Pandemic and the ACS 2016 to 2020 estimates. CTC included this data to be understood as reasonable estimates given the constraints to further data collection and ACS's widespread use as the standard dataset informing policymakers' decisions. However, it should be noted that the standard ACS methodology cannot fully represent Boston's efforts to address digital equity from the beginning of the pandemic to May of 2022.

6.3   Build coordination with the Commonwealth of Massachusetts

As new federal funding is granted to the state, the bulk of these funds will go to the Commonwealth of Massachusetts and then be distributed to local municipalities or specific programs. The Massachusetts Broadband Institute will be the Commonwealth's lead agency. The Commonwealth created the MBI as a division of the MassTech Collaborative when signing the Broadband Act into law in August 2008. The Massachusetts Broadband Institute at MassTech Collaborative has already launched several digital equity programs through the "Partnerships for Recovery" efforts over the last six months.

The $1 trillion Infrastructure Investment and Jobs Act (IIJA)—including $65 billion in broadband funding for extensive deployment and digital equity initiatives—was signed into law on November 15, 2021. The following programs were established by the Digital Equity Act of 2021 and will be administered by NTIA to address digital equity specifically:

1.   State Digital Equity Planning Grant Program ($60 million)

2.   State Digital Equity Capacity Grant Program ($1.44 billion)

3.   Digital Equity Competitive Grant Program ($1.25 billion)

States apply directly for the Digital Equity Planning program. While applications will not be available until October of 2022, the Act sets out significant prerequisites for the states to apply for this funding that mean some states will be begin getting public input on digital equity throughout the year. These plans then serve as the framework for each state's digital equity projects that can be funded through the State Digital Equity Capacity Grant Program. The State Digital Equity Capacity Grant funding will be distributed in annual grants to each state over five years "to implement digital equity projects and support the implementation of digital equity plans."[82] States are directed to use this money to establish programs to fund both statewide and local digital equity efforts.

NTIA funds will offer Boston no funding for citywide municipal broadband, but the City may be able to take advantage of the Digital Equity Act Programs given the funding is intended to address digital equity challenges in urban and suburban areas in addition to rural ones. NTIA has stated that these programs aim "to promote the meaningful adoption and use of broadband services across the targeted populations in the Act, including low-income households, aging populations,

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[82] BroadbandUSA, "NTIA's Role in Implementing the Broadband Provisions of the 2021 Infrastructure Investment and Jobs Act," NTIA, https://broadbandusa.ntia.doc.gov/news/latest-news/ntias-role-implementing-broadband-provisions-2021-infrastructure-investment-and (accessed November 17, 2021).

incarcerated individuals, veterans, individuals with disabilities, individuals with a language barrier, racial and ethnic minorities, and rural inhabitants."[83]

Funding will be distributed to localities through a plan developed by the state, which is why Boston has already connected directly with the state's Broadband Office (Massachusetts Broadband Institute) to communicate the City's digital equity concerns and funding priorities. We recommend the Commonwealth, and the City of Boston should continue this direct line of communication as the Commonwealth develops policies and proceedings for distributing new dollars. Additionally, if Boston could coordinate with local CBOs and other urban jurisdictions with similar digital equity concerns and develop a list of common priorities and recommendations, demonstrating this level of collaboration may increase chances the issues and recommendations will be included in the Commonwealth's broadband plan. For example, federal funding could be applied to a new iteration of the Digital Equity Fund, allowing the City to expand the fund size and total number of awardees. Among other efforts, this funding can be used to get CBOs to promote and enroll residents in the ACP.

6.4 Promote participation in existing device subsidy programs to free up City resources for other digital equity efforts

There is a great need for the City to allocate resources that can support all digital equity-specific needs, ranging from devices and internet services to digital skills programs. Devices, while an integral part of the digital equity framework, should be de-emphasized so that city resources can be put towards other efforts like funding for CBOs to support ACP outreach. The city has many existing device subsidy programs at its disposal and should make new device programming less of a focus.

Existing device subsidy programs include:

- The Universal Services Administration Corporation's Emergency Connectivity Fund efforts by schools and libraries through the $12 million granted to Boston's schools and libraries.[84]

- ACP includes funding for a subsidy of up to $100 for a "connected device," such as a laptop, desktop, or tablet computer[85]

- Comcast's Internet Essentials provides an option for a $149 laptop

In the current moment, these other programs are sufficient for the City's needs. With ACP, the City will be able to help residents receive devices through the program for the next five to seven

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[83] "Grants," NTIA, https://ntia.gov/category/grants (accessed November 17, 2021).
[84] https://www.boston.gov/news/over-12-million-invested-digital-equity-and-inclusion
[85] ACP Final Rules at paras. 92-118.

years. To this end, the City should spend strategically on promoting enrollment support for these existing programs to increase both devices and efficient resource allocation.

6.5 Continue to foster relationships with CBOs to further impact on the ground

The city has an exceptional track record of working with CBOs to engage within the City's wide range of communities. Programs funded through the Digital Equity Fund and partnerships like Tech Goes Home and Boston Neighborhood Network Media, champion collaboration, and success in community-based work. Given this track record, we recommend continuing to develop this framework. We recommend that the City continue to invest in this work and to work with CBOs to formulate strategies for further improvement to the process.

6.6 Build more comprehensive reporting requirements for City-funded programs to measure digital equity efforts over time

The City has captured the importance of reaching certain demographics and focuses through the Digital Equity Fund. To further and quantify this impact, we recommend that a portion of future funds go to supporting thorough, comprehensive data collection.

Establish demonstrated metrics for CBOs to follow and report on within a six, 12, and 18-month period. The grant opportunities the City administers should require grantees to report measures of success, the project timeline and milestones, financial reports on funding remaining and report and schedule of all active grants and funds, a hallmark of a well-thought-out grantmaking system.

The reporting requirements the City uses for awards made under the Digital Equity Fund we recommend to further use. Each awardee should report program success in the form of metrics developed by the City and articulated in grant agreements; have standard reporting requirement sets for the program types; and use the standard data collection types for more thorough analysis of the program's success, supported by the data allowing this apples-to-apples comparison.

HIGH-LEVEL ESTIMATE OF CITYWIDE FIBER-TO-THE-PREMISES COSTS

1. Summary of task report

CTC developed a conceptual, high-level FTTP outside plant network design and cost model for all of Boston that is aligned with industry best practices and would be able to support a variety of electronic architecture options and business plans.[86]

The FTTP model will cost an estimated $721.6 million for the backbone and distribution plant and be capable of serving 399,864 passings in the city of Boston, or $1,800 per passing.

The cost for the distribution network electronics, subscriber drops, and CPE will vary based on the take-rate. These network elements are estimated to cost from $103.3 million – $239.8 million, depending on the take-rate of the network.

In total, the overall cost of the network is estimated to be $824.9 million – $961.4 million, or $3,430 – $6,880 per subscriber.

These costs are outlined in Table 16, Table 17, and Table 18.

Table 16: Summary of estimated backbone and distribution plant cost

Fixed Costs	
Backbone and distribution plant	$721,600,000
Number of passings	399,864
Cost per subscriber	$1,800

Table 17: Summary of estimated distribution network electronics, subscriber drop, and CPE costs

Fixed Costs			
Take-rate	30%	50%	70%
Number of subscribers[87]	119,959	199,932	279,905
FTTP distribution network electronics	$25,300,000	$41,500,000	$57,700,000
Subscriber drop costs	$21,750,000	$36,250,000	$50,750,000
Customer premises equipment	$56,250,000	$93,750,000	$131,300,000
Total cost	**$103,300,000**	**$171,500,000**	**$239,750,000**

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[86] This is a stand-alone citywide FTTP network that does not use any portion of the City of Boston's Network (BoNet). BoNet is a network built on borrowed, leased, or licensed fiber from a collection of providers. Each use agreement stipulates a 'Municipal Use' discussion which is described in all four (Comcast, RCN & Verizon licenses and the Crown Fiber lease) as the use of assets under an Indefeasible-Right-of Use type of agreement limited to municipal use, not non-municipal or commercial use.

[87]

Table 18: Summary of estimated total implementation costs

Fixed Costs			
Take-rate	30%	50%	70%
Total implementation cost	**$824,900,000**	**$893,100,000**	**$961,350,000**
Cost per subscriber	**$6,880**	**$4,470**	**$3,430**

The network is estimated to take between 6 and 8 years to complete[88], depending on crew availability and supply chain. With the influx of federal funding for broadband, broadband deployment resources will be in high demand over the next several years.

1.1 Objectives and key attributes

This model would provide the City with cost-effective and flexible infrastructure—optimized for long-term use. The key design criteria for the network include:

- **Providing service to the entire City, with capacity for future growth**

- **Providing resilient and survivable service** – backbone routes interconnecting 12 separate network hubs are strategically placed to minimize the length of lateral runs, creating improved resiliency at each edge site and providing physical redundancy for backbone services

The recommended architecture is a hierarchical data network that would provide scalability and flexibility, both in terms of initial network deployment and ability to accommodate the increased demands of future applications and technologies. The central characteristics of this hierarchical FTTP data network include:

- **Capacity** – ability to consistently provide efficient transport for subscriber data at advertised speeds, even at peak times

- **Availability** – high levels of reliability and resiliency; the ability to quickly detect faults

- **Scalability** – ability to grow in terms of physical service area and increased data capacity, and to integrate newer technologies without new construction

This architecture offers scalability to meet long-term needs. It is consistent with best practices for either a standard or an open-access network model to provide customers with the option of multiple network service providers. This design would support the current industry standard

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[88] This estimate is based on the high-level design created for this cost analysis and our understanding of the market. A more detailed study would provide more accurate deployment timeframes and how the deployment might be phased.

Gigabit Passive Optical Network (GPON) technology, as well as emerging 10 Gbps XGS-PON and NG-PON2 standards. It could also provide the option of direct Active Ethernet (AE) services on a limited basis, such as for business customers, using spare fiber capacity built into the designs.

1.1 Assumptions and criteria

The cost of building an FTTP network will depend in large part on what percentage of the network infrastructure is built on aerial poles as opposed to inside underground conduit. Based on our analysis, we assume the FTTP design would employ 86 percent aerial fiber and 14 percent underground fiber uniformly throughout the City.

In addition, the network design and cost estimates assume the network will:

- Use existing publicly owned land or City-owned buildings as network hub sites; the cost estimate includes the facility costs with adequate environmental systems and backup power generators.

- Use manufacturer-terminated fiber tap enclosures within the public right-of-way or easements, providing watertight fiber connectors for customer service drop cables, and eliminating the need for service installers to perform splices in the field. This is an industry-standard approach to reducing both customer activation times and the potential for damage to distribution cables and splices.

- Serve all passings within the City. The network design treats each unit in an MDU as a separate passing.

The network design was defined based on the following criteria:

- Underground conduit and fiber will be installed in the public right-of-way or in an easement on the side of the road.

- The aerial fiber design will make use of existing poles where possible.

- Backbone fiber sizes will range from 144- to 288-count cables; extended lateral fiber sizes will utilize 864-count cables; and short lateral and drop fiber will contain 12 strands.

- The network will target up to 288 passings per secondary distribution point, each served from a fiber distribution cabinet (FDC) containing optical splitters.

- Distribution plant will terminate at multi-port subscriber tap terminals (i.e., "taps") in underground handholes, each serving no more than 12 homes.

- Access conduit will be placed in drop access handholes placed at the edge of the parcel for each serviceable passing (one handhole per one or two passings).

- Underground vault spacing will be no more than 750 feet along distribution routes.

- The hubs will be constructed to support network electronics with backup power generation, redundant cooling systems, robust physical security, and inert gas fire-suppression systems. For the network design, existing City-owned locations, such as fire-stations, were considered for the hub sites.

- Where possible, the distribution plant network routes will avoid crossing major roadways, railways, and waterways.

- Each unit in an MDU was considered as an individual passing.

- In the aerial design, we assume that the builder is able to obtain an attachment agreement from the pole owners.

- Based on analysis from the City, we assumed a $200/ft restoration fee would be required for 1/3 of the network's underground deployment.

- We assumed the network would be built utilizing union labor. The cost estimate utilizes estimated union labor costs provided by the City.

We reviewed GIS and Google Street View data to sample pole conditions and estimate the percentage of poles requiring make-ready in segments of the FTTP network. We extrapolated the data to estimate make-ready costs and determine the percentage of the network routes that can utilize aerial infrastructure.

We estimated 44 percent of the network had a small number of poles requiring make-ready or replacement, 54 percent of the network had a moderate number of poles requiring make-ready and some replacement, and 2 percent of the network had poles requiring a large amount of make-ready.

As not all potential subscribers on the network will opt to use service, we present the costs at three different assumed take-rates—that is, we assumed different percentages of the total passings of the network will choose to use the service. This quantity affects the costs of the network electronics needed to serve the network and the costs for deploying drops to subscribers on the network. This will present a range of potential costs based on how many potential passings choose to subscribe to the network.

1.2   Conceptual design

Figure 15, below, shows the conceptual architecture for the physical plant in the FTTP network. A hub will feed primary distribution conduit through distribution vaults located throughout the City. Some distribution vaults will be designated as equipment vaults, which contains splitters to feed secondary distribution conduit to tap access handholes located near residents. Each tap access handhole will then connect to drop access handholes located on the edge of the parcel

but still within the City's right-of-way. By installing infrastructure all the way to the edge of each premises parcel, costs are reduced for future installation to a subscriber.

Figure 15: Conceptual design for the FTTP network
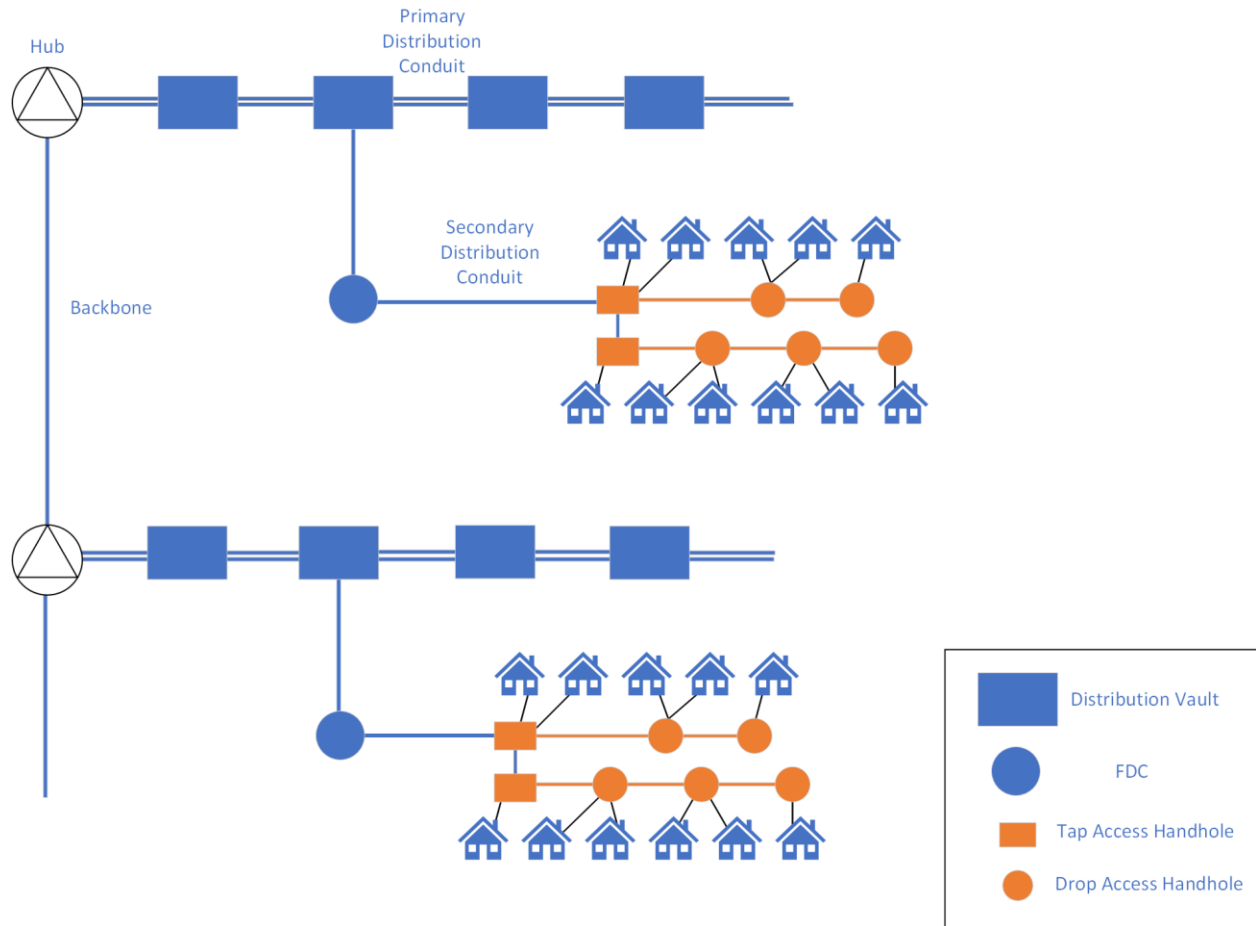

Figure 16, below, shows the logical representation of the FTTP network architecture we recommend based on the conceptual outside plant design above. This representation illustrates the primary functional components in the FTTP network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

Figure 16: High-level FTTP architecture and components
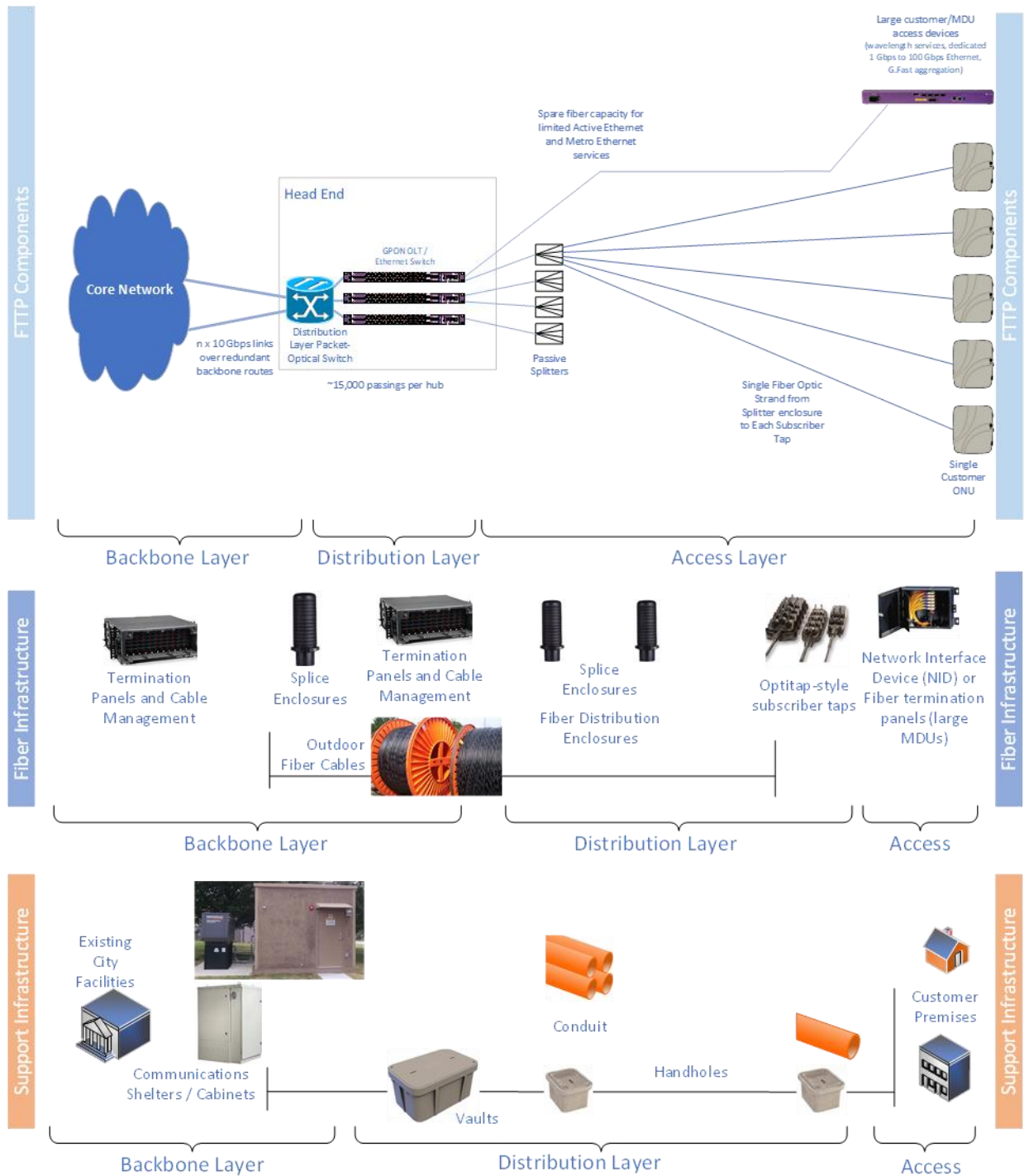
1.3 Network design

The design (as illustrated below in Figure 17) shows the backbone routes and overall distribution network of the FTTP model. Figure 18 displays an example of the deployment of FDCs throughout

a neighborhood while Figure 19 show how these FDCs connect to taps located at the edge of parcels.
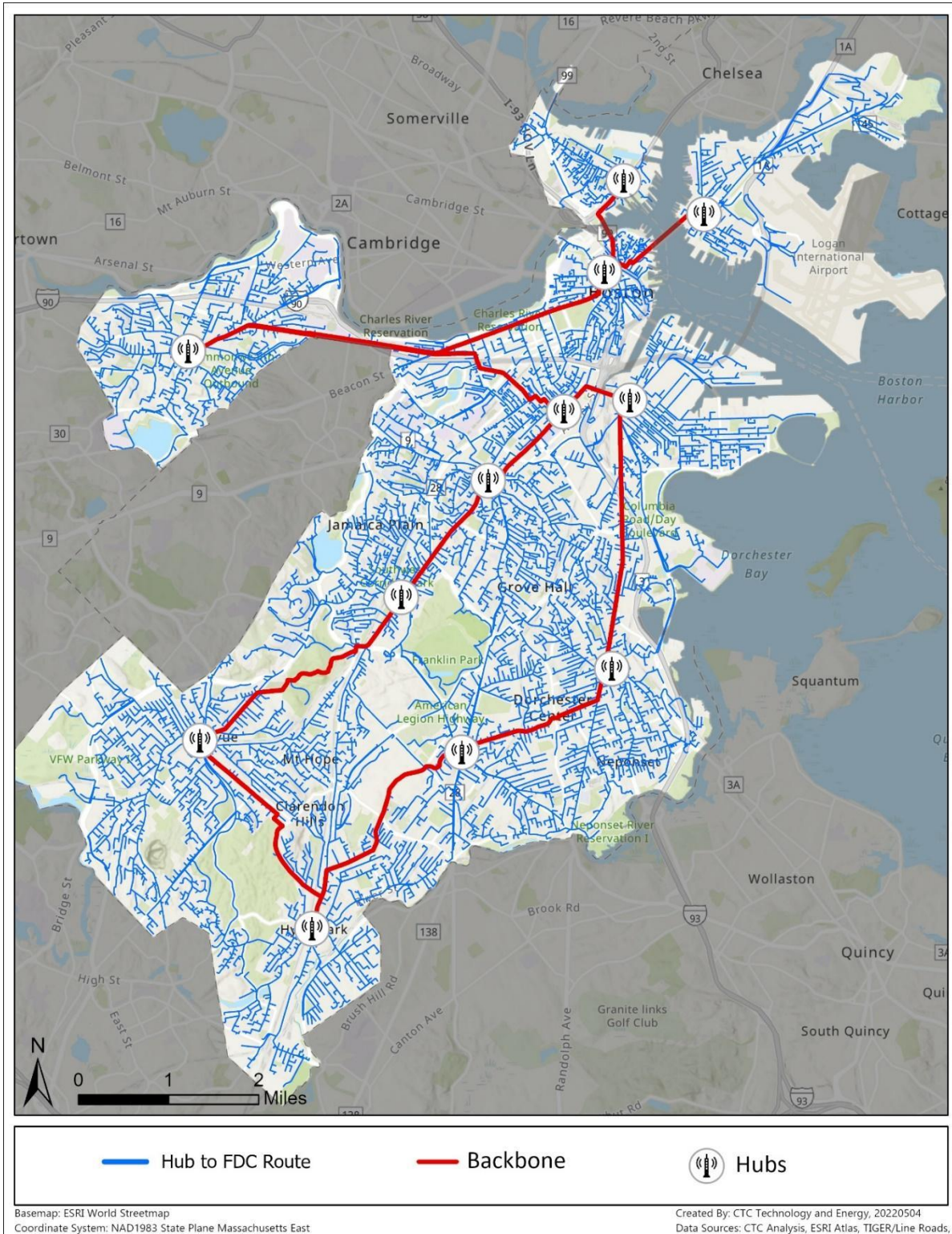
Figure 17: FTTP design complete map

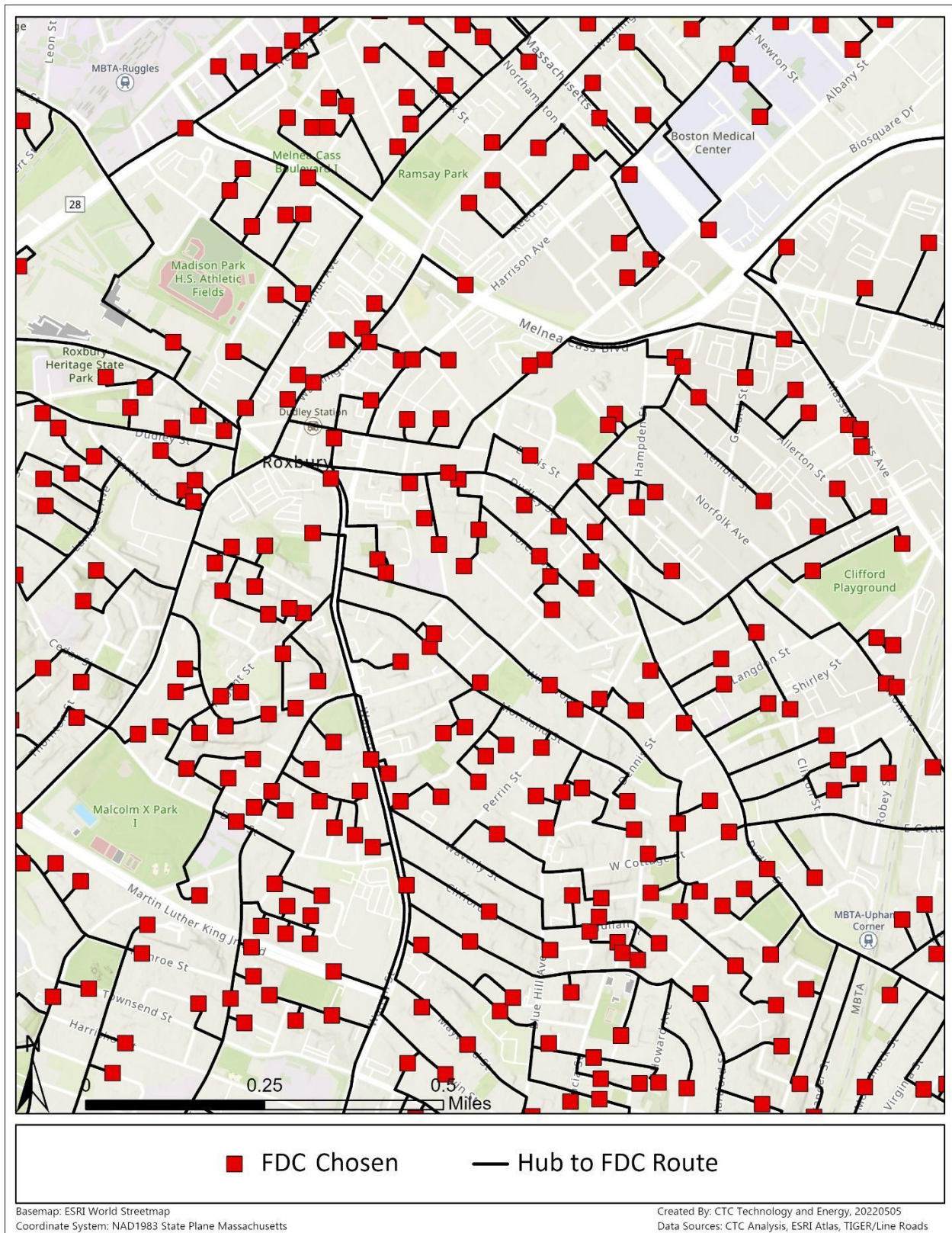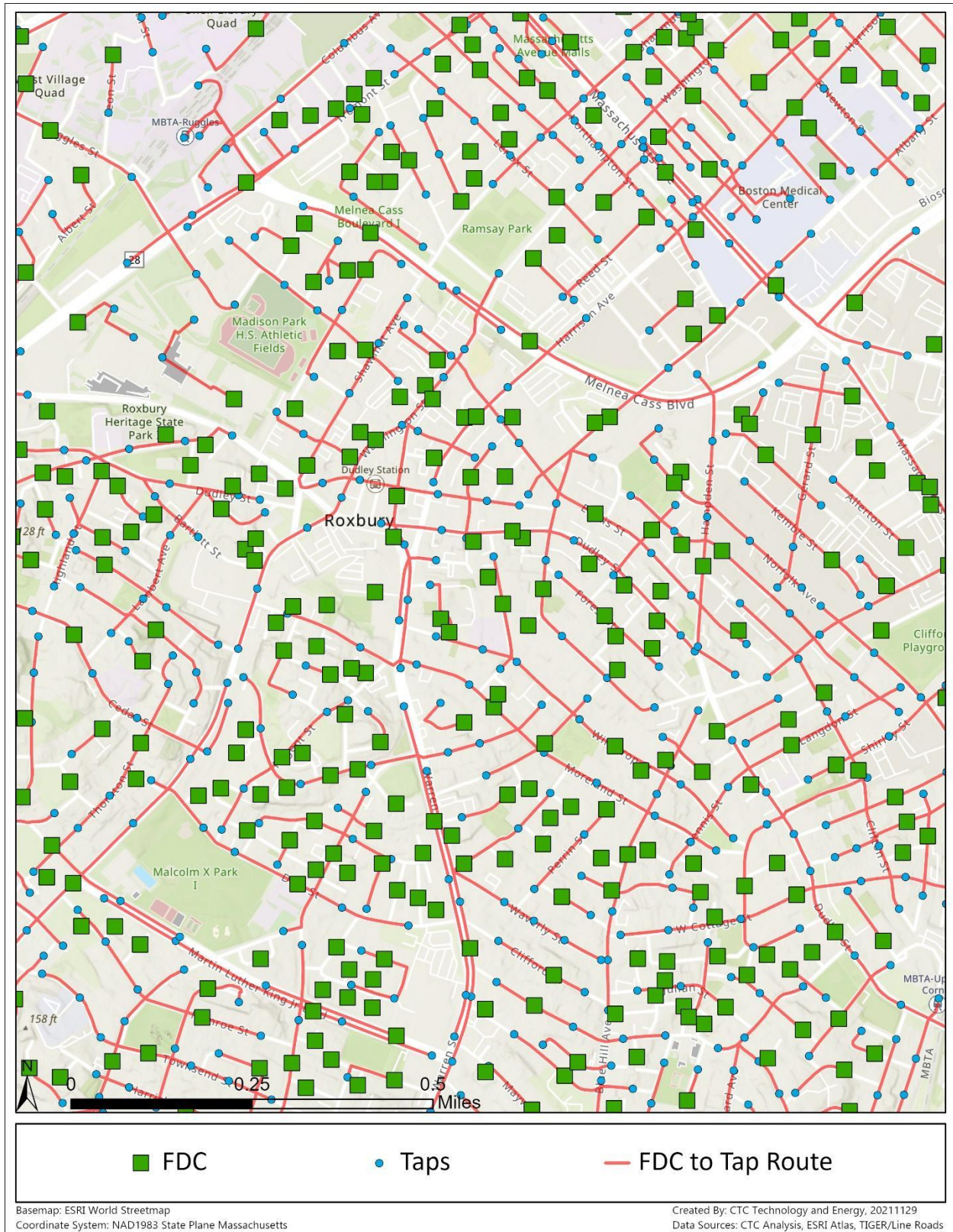Figure 18: FTTP primary distribution network example

Figure 19: FTTP secondary distribution primary example

2. Capital costs for a citywide FTTP network

2.1 Cost elements

The cost for the backbone and distribution plant includes the following elements:

- **Project management** – encompasses overall project and contract management, including oversight of the construction and engineering contractor(s), equipment suppliers, and right-of-way agreements; we assumed a 3-person project management team for three years.

- **Engineering and as-builts** – includes system-level architecture planning, preliminary designs, and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials.

- **Conduit and vault infrastructure** – consists of all labor and materials related to underground communications conduit construction, including conduit placement, vault/handhole installation, and surface restoration; includes all work area protection and traffic control measures inherent to roadway construction activities.

- **Utility pole make-ready** – consists of the labor needed for preparing poles for the addition of new aerial cabling. This includes moving existing cables to make room for new cables or replacing poles if the existing pole is at maximum capacity.

- **Fiber optic cables and components** – consists of the material and labor costs specific to the installation of fiber optic cables, taps, splice enclosures, and other related components, irrespective of the cable pathway (underground conduit or aerial placement).

- **Fiber splicing, testing, and documentation** – includes all labor related to splicing of outdoor fiber optic cables.

- **Hub site facilities and systems –** consists of the material and labor costs of placing head end and active hub site shelters and enclosures; related hub systems (backup power generation, cooling systems, etc.); and terminating backbone fiber cables within the head end and active hub site.

- **Post-Covid market demand contingency –** accounts for price increases on material due to supply chain interruptions during the pandemic. This contingency is not applied to the project management and engineering and as-builts categories since they do not incorporate construction material.

The estimated total cost for distribution electronics is listed separately. We also provide the estimated cost for subscriber drops. This represents the cost for material and labor for installing aerial or underground infrastructure across a subscriber's property. These costs are provided at multiple take-rates to provide a range of possible costs based on the number of subscribers using the network.

2.2 Cost estimate

The backbone and distribution plant are estimated to cost $721.6 million, or $1,800 per passing, including a 20 percent contingency cost on construction material. These costs are itemized below in Table 19. Note that the costs have been rounded.

Table 19: Estimated backbone and distribution plant cost

Fixed Costs	
Project management	$2,750,000
Engineering and as-builts	$10,900,000
Conduit and vault infrastructure	$313,950,000
Materials	*$11,450,000*
Labor	*$302,500,000*
Aerial strand	$44,900,000
Materials	*$2,450,000*
Labor	*$42,450,000*
Utility pole make-ready	$30,400,000
Fiber optic cables and components	$142,900,000
Materials	*$74,350,000*
Labor	*$68,550,000*
Fiber splicing, testing, and documentation	$54,800,000
Head end facilities and systems	$3,000,000
Backbone and distribution plan total cost	$603,600,000
Post-Covid market demand contingency on construction material (20%)	$118,000,000
Backbone and distribution plant total cost with contingency	**$721,600,000**
Number of passings	399,864
Cost per passing	**$1,800**

Table 20 presents the estimated costs for the FTTP distribution network electronics, subscriber drop costs, and CPE. As not all addresses will choose to sign up for service, we have provided a range of potential costs by estimating at 30 percent, 50 percent, and 70 percent take-rates. The total costs for electronics, subscriber drops, and CPEs are estimated to range from $103.3 million to $239.8 million.

Table 20: Estimated distribution network electronics, subscriber drop, and CPE costs

Fixed Costs			
Take-rate	30%	50%	70%
Number of subscribers[89]	119,959	199,932	279,905
FTTP distribution network electronics	$25,300,000	$41,500,000	$57,700,000
Subscriber drop costs	$21,750,000	$36,250,000	$50,750,000
Customer premises equipment	$56,250,000	$93,750,000	$131,300,000
Total cost	$103,300,000	$171,500,000	$239,750,000

Table 21 presents the estimated total implementation costs at each take-rate. The total implementations costs are estimated to range from $824.9 million to 961.4 million, or $3,430 to $6,880 per subscriber.

Table 21: Estimated total implementation costs

Fixed Costs			
Take-rate	30%	50%	70%
Total implementation costs	$824,900,000	$893,100,000	$961,350,000
Cost per subscriber	$6,880	$4,470	$3,430

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[89] At a 60 percent take-rate and inclusive of single-family homes and MDUs.

Appendix A: Timeline of federal advocacy and outreach on broadband and digital equity and inclusion by the City of Boston (2020-2022)

The City of Boston supplied this narrative.

August 22, 2022: The National Digital Inclusion Alliance (NDIA) named the City of Boston a "Digital Inclusion Trailblazer" for its continued work in moving its community towards digital equity by promoting digital literacy and broadband access for underserved residents.

June 30, 2022: Peter Favorito, the City's Digital Equity Advocate, was a keynote speaker at the Public Service Network's "Government Innovation Massachusetts" event. Peter spoke about the "Evolution of Digital Equity in Boston" and emphasized the continued focus on bridging the digital divide not just in Boston, but across the country as well.

May 2, 2022: Mayor Michelle Wu wrote to the Honorable Gina M. Raimondo, Secretary, U.S. Department of Commerce and Alan Davidson, Administrator of the National Telecommunications and Information Administration to advocate for Boston and other cities for support through the Infrastructure Investment and Jobs Act of 2021 (IIJA) Broadband Grants.

April 28, 2022: Gerard Lederer, the City's outside counsel on federal telecom, hosted a cities' call with NTIA staff (and former Chattanooga Mayor Andrew Berke for Boston, Chicago, USCM and others to push for favorable consideration of cities and affordable broadband support.

April 28, 2022: CompTIA PTI Local Government CIO and Tech Leader Summit on Thursday, IT at the Table: Managing Expectations for Federal Funding. Facilitated by Mike Lynch Boston Dept. of Innovation & Technology - Broadband & Digital Equity and featuring panelists: Laurel Caldwell, ITS Director, Latah County, Idaho (& Public Technology Institute (PTI) CGCIO); Julia Pulidinidi, Broadband Program Specialist, Office of Internet Connectivity and Growth, NTIA - U.S. Department of Commerce. The Infrastructure Investment and Jobs Act is designed to help local governments improve broadband access and digital inclusion for our communities. A review of the latest on how funding initiatives are progressing and tips for partnering with others in the organization to ensure that effective plans, strategies and goals are in place for when the funding starts to reach local governments. See https://connect.comptia.org/events/view/comptia-pti-2022-cio-tech-leader-summit

April 20, 2022: NLC - What City Leaders Should Know about the FCC's Affordable Connectivity Program. Presenters include Eduard Bartholme, Associate Bureau Chief, Consumer and Governmental Affairs Bureau, FCC; Olivia Wein, Attorney, National Consumer Law Center, Mike Lynch, Director, Broadband and Cable, City of Boston DoIT; Trinity Thorpe-Lubneuski, Executive Director, Internet Essentials, Comcast. The FCC's Affordable Connectivity Program, created by

the 2021 Bipartisan Infrastructure Law, is a new subsidy program that will help your residents get connected, and the leaders of your city, town or village can work to ensure that your community is getting as much value from the program as possible. See https://www.nlc.org/events/digital-equity-2022-webinar-series/

April 19, 2022: Fiber Broadband Association's Regional Fiber Connect 2022: "Broadband Funding & The Fiber Infrastructure Playbook" moderated by Gary Bolton, FBA President & CEO; presenters Joanne Hovis, CTC Technology & Energy President and Mike Lynch, Mike Lynch Boston Dept. of Innovation & Technology Broadband & Cable Director, DoIT.

April 15, 2022: Boston, Chicago, and Washington, D.C., with Montgomery County, Maryland, and the Texas Coalition of Cities for Utility Issues ("Local Governments") file Reply Comments to the FCC in the Affordable Connectivity Program (ACP) and Emergency Broadband Benefit Program proceeding advocating partnership and support for cities in outreach to ACP eligible parties. The filing underscores local governments' belief that the current definition of a high-cost area should remain as defined under universal service definitions, and how such a definition is not inconsistent with that employed in the IIJA.

April 1, 2022: ACM-Northeast Regional Annual Conference: Diversity, Equity & Inclusion: Building diverse boards & a more welcoming culture. Moderated by Bonnie Bastien and discussion by Audrey Duncan and Glenn Williams, BNN Media General Manager.

March 24, 2022: Boston, the Texas Coalition for Utility Issues ("TCCFUI") and the National Association of Telecommunications Officers and Advisors ("NATOA") file Reply Comments in the FCC's Empowering Broadband Consumers Through Transparency, CG Docket No. 22-2 proceeding to ensure that broadband labels provide consumer meaningful insights, including (1) the addition of minor modifications accounting for meaningful content, such as the Affordable Connectivity Program, (2) a machine-readable, standardized format; (3) display location requirements on an ISP's website, consumers' monthly bills; and (4) a requirement that includes options for viewing the broadband labels in multiple languages and in a manner that is accessible to persons with disabilities.

March 8, 2022: Boston participated in the USCM's "IIJA Implementation Series: Ensuring Cities Benefit from New Federal Broadband Investment, Engaging the U.S. Department of Commerce and States to Secure this Outcome," part of the Conference's 2022 Infrastructure Investment and Jobs Act Implementation Webinar Series, this March 8 webinar focused on how new federal broadband investment programs can expand services and facilities for unserved and underserved city residents. https://www.usmayors.org/programs/mayors-and-business-leaders-center-for-compassionate-and-equitable-cities/uscm-meeting-videos-on-compassion-and-equity/

Feb. 16, 2022: The FCC adopted a [Report and Order and Declaratory Ruling](#) aimed at providing competitive choice of communications services for those living and working in multiple tenant environments (MTEs). The Order includes three actions:

- Adopts new rules prohibiting providers from entering into certain types of revenue sharing agreements that are used to evade our existing rules.

- Adopts new rules requiring providers to disclose the existence of exclusive marketing arrangements in simple, easy-to-understand language.

- Clarifies that existing Commission rules regarding cable inside wiring prohibit so-called "sale-and-leaseback" arrangements which effectively deny access to alternative providers.

Feb. 3, 2022: Boston joined the U. S. Conference of Mayors (USCM) and other local governments including Chicago and Washington, D.C. in submitting comments on the IIJA Implementation Docket No. NTIA-2021-0002 to the National Telecommunications and Information Administration (NTIA) about "Bringing Reliable, Affordable, High Speed Broadband to All Americans" to advocate for "Use Affordability" as a metric to identify those areas, and require state plans to support historically disadvantaged communities, noting if NTIA or any state defines unserved as only places lacking 25/3 Mbps speeds, "at least five of the permitted uses would be rendered meaningless." The coalition further advocated that NTIA mandate municipal consultation at every phase and not undercut state and local authority or property rights. The local governments' comments notes that the "NTIA can best meet the needs of unserved, underserved and historically excluded communities in urban America by mandating local government consultation in state broadband plans and implementation."

Feb. 2, 2022: National Association of Telecommunications Officers and Advisors (NATOA) shares local governments' concerns and interests with NTIA on several of the grant programs of the IIJA during a NATOA-only listening session. Boston joined the jurisdictions of Chicago, IL; Washington, DC; and Montgomery County, MD; as well as the Texas Coalition of Cities for Utilities Issues and the USCM, in jointly filing comments as "Local Governments," along with NATOA, in response to NTIA's Notice and Request for Comment.

Jan. 26, 2022: Boston invests over $12 million to meet the challenge of Digital Equity and Inclusion, announces Mayor Michelle Wu and Senator Ed Markey to meet the challenge of Digital Equity and Inclusion for Boston public housing residents, library users and school-age families. The Boston Public Library has received $2.1M in Emergency Connectivity Funding from to acquire and distribute Chromebooks and Home Router Wi-Fi access for 3,000 Library patrons in public housing. The Boston Public Schools will receive nearly $10 million for Chromebooks and

connectivity for 20,000 Boston schools' families. This deployment will address additional needs following BPS initial distribution of 55,000 Chromebooks and 8,000 hotspots/home routers.

Jan. 7, 2022: Treasury releases Final Interim Rules for the Coronavirus State Fiscal Recovery Fund and the Coronavirus Local Fiscal Recovery Fund established under the American Rescue Plan Act. https://home.treasury.gov/system/files/136/SLFRF-Final-Rule.pdf Boston's had filed with Los Angeles, Chicago, Portland, Montgomery County, MD, and both the Texas Coalition of Cities for Utilities Issues and the U.S. Conference of Mayors challenging Treasury's bar on the use of ARPA funding for network investments in the presence of a 25/3 providers (i.e., all of Boston.)

Dec. 28, 2021: Boston joins with Chicago, IL, Los Angeles, CA, Montgomery County, MD, Washington, DC, and the Texas Coalition of Cities for Utility Issues ("Local Governments") to restate appreciation to the 117th Congress and President Biden for making possible the continuation of a broadband affordability subsidy through the Affordable Connectivity Program (ACP) and to identify the three primary roles local government sought in the federal broadband affordability program: (1) providers of broadband services either directly or indirectly through the purchase and distribution of free or sponsored subscriptions and devices; (2) leaders in raising awareness and coordinating resources; and (3) consumer watchdogs.

Dec. 8, 2021: Boston, MA, Montgomery County, MD, Washington, DC and TCCFUI file Comments celebrating the continuation of the Emergency Broadband Benefits (EBB) program, the nation's largest digital broadband inclusion program, with the standing up of the Affordable Connection Program (ACP). Local Governments offer a cautionary note about the programmatic changes resulting in some disruptions in the lives of those who can least afford such interruptions and concern over a transition from EBB to ACP taking place in the middle of the school year and at the onset of another possible wave of Covid.

Nov. 19, 2021: Boston, MA; Portland, OR; and Ontario, CA ("Cities") submit Reply Comments in the FCC proceeding, Improving Competitive Broadband Access To Multiple Tenant Environments (GN Docket No. 17-142), to document that local governments such as Cities have a clear and compelling interest in promoting broadband availability, affordability, and competition in their communities, and demonstrating that each has undertaken an array of pro-competitive, pro-consumer efforts to support all of their citizens have access to competitive broadband services, not just those that live in single family homes. The Commenters recognize that affordable broadband has guided the Infrastructure Investment and Jobs Act in making sure that it is available to residents of multi-tenanted environments (MTE's.)

June 2021: The City participated in an effort with Chicago, IL, Los Angeles, CA, Washington, DC, the National Association of Telecommunications Officers and Advisors (NATOA) and the US Conference of Mayors (USCM) to persuade the U. S. Treasury Department that: Qualified

Broadband projects under Sections 603(c)(1)(A)-(C) are not barred by the presence of 25/3 service; Treasury incorporate an affordability factor in the determination of whether an American is unserved or underserved. And, in the alternative, make clear that a local government may rely upon its own determination on affordability to determine whether a resident is unserved or underserved. (See the attached letter from local governments, as well as a, Filing in support from NATOA citing the comments of the City of Boston, et al.—"seek assurances from Treasury that a qualified project under Sections 603(c)(1)(A)-(C) is not barred by the presence of 25/3 service.") (Treasury had released updated FAQs on the use of Coronavirus State and Local Fiscal Recovery Funds (CSLFRF) authorized in the American Rescue Plan Act (ARPA) in response to comments filed by the USCM and several city and county governments, who asked the Treasury to clarify that its interim final rule for the $350 billion state and local fiscal recovery funds appropriated by the ARPA "permits investments of the Funds for the broadest array of broadband services and network elements to alleviate the economic damages suffered by individuals, businesses and institutions from the COVID-19 pandemic." These changes in the rules around the availability test of 25 Mbps download by 3 Mbps open the door to use of ARPA-CSLFRF in Boston for efforts to expand network and community broadband through the upcoming Verizon PROW City fiber project and, possibly, the BHA's network deployment projects. The path is further complicated by our various agreements with Verizon and Comcast, but it's certainly worth continuing to pursue.

June 15, 2021: Boston participates in comments of the Cities of Los Angeles, CA; Chicago, IL; Portland, OR; Washington, D.C.; Montgomery County, MD, and the Texas Coalition of Cities For Utility Issues, to Treasury Secretary Janet Yellin seeking assurances from Treasury that a qualified project under Sections 603(c)(1)(A)-(C) is not barred by the presence of 25/3 service; and a call for Treasury to incorporate an affordability factor in the determination of whether an American is unserved or underserved.

May 10, 2021: eNATOA webinar, "How to Understand and Close the Digital Divide in Your Community." Moderator: by Mike Lynch, and presenters Samantha Graham, Institute for Emerging Issues at NC State; Elisabeth Perez, Director, City of Portland, OR, and Dev Khoslaa, Head, Private Wireless Business Development, Nokia The presentations shown during the webinar can be downloaded here. An archive recording can be found here: https://register.gotowebinar.com/recording/6008100285454810124

May 7, 2021: BNN Media on BNN News: Mike Lynch, Director of Boston's Office of Broadband and Cable, explains the Emergency Broadband Benefit being made available to households in need starting May 12, 2021. Segment link: https://www.youtube.com/watch?v=9FqrrwbZWJ4

April 19, 2021: Ex Parte call with FCC Commissioner's staff regarding the proceeding, Establishing Emergency Connectivity Fund to Close the Homework Gap, WC Docket No. 21-93. Boston joined

Los Angeles, CA, Chicago, IL, Washington, DC, Montgomery County, MD, Dallas TX, Philadelphia, PA and local government associations, National Association of Telecommunications Officers and Advisors, National League of Cities and the United States Conference of Mayors following comments filed in the matter to address cities' efforts address broadband and digital literacy; use of ECF funds to preserve the greatest possible flexibility include construction and training; concerns for residents with multiple users (students, etc.) in a household to establish upload speeds to meet their needs; use Library ECF funding based on community served, not the square footage of the building; eligibility requirement of smart phones; and, promoting availability of service by providers.

April 5, 2021: Boston joined Portland, OR, Los Angeles, CA, Chicago, IL, Washington, DC, Montgomery County, MD, and the Texas Coalition of Cities for Utilities Issues in Comments on the Emergency Connectivity Fund for Educational Connections and Devices to Address the Homework Gap During the Pandemic, WC Docket No. 21-93. The coalition urges that entities beyond schools and libraries should be made eligible, as we have stood up connectivity programs, including providing equipment, in response to connectivity needs of eligible individuals and families during the pandemic.

February 23, 2021: Counsel to the cities of Los Angeles, CA; Portland, OR; Chicago, IL; Boston, MA; Washington, D.C., and Montgomery County, MD as well as the Texas Coalition of Cities for Utility Issues discusses with Commissioners' staff and the Deputy Bureau Chief, Wireline Competition Bureau the Emergency Broadband Benefit Program (EBB) and the need to protect sponsored programs such as those described in ECF Assistance filing.

February 16, 2021: Boston City Councilor At Large Michelle Wu files comments in Emergency Broadband Benefit Program, Public Notice, WCB Docket No. 20-445 (Jan. 4, 2021) to support "the swift and broad implementation of the Emergency Broadband Benefit Program." Then-Councilor Wu notes, "We know that today bridging the digital divide requires not only a broadband solution but access to computing devices and digital skills training as well. … A just and equitable recovery demands a fully connected Boston. This means building on, or re-imagining, every aspect of our City's functions, from speeding up and smoothing out the rollout of widespread telehealth, to installing free WiFi along bus routes and subway stops for community members who currently depend upon smartphones for their Internet access."

Feb. 2, 2021: Public Technologies Institute/COMPTIA - Members-Only Tech Talk Forum on Digital Equity work and federal telecom issues looks at Issues surrounding broadband infrastructure and the lack of public access to the Internet have been magnified over the past 10 months as local governments have had to come up with creative new programs to facilitate Internet connectivity throughout their communities. Mike Lynch, Director, Broadband & Cable, City of Boston, MA and Mitsuko Herrera, ultraMontgomery Director with Montgomery County, Maryland share how the

county has leveraged federal COVID-19 funding to install outdoor public Wi-Fi at public library locations.

Feb. 8, 2021: eNATOA "Federal Communications Policy in 2021 and Beyond: What to Expect from the Administration and New FCC Leadership." Webinar moderated by Donna Richardson, Cable Administrator, Howard County, MD. Speakers include Nancy Werner, General Counsel, NATOA; Mike Lynch, Director, Broadband & Cable, City of Boston, MA and Gerry Lederer, Partner, Best Best & Krieger LLP.

Jan. 25, 2021: Boston joined Portland, OR, Los Angeles, CA, Chicago, IL, and the Texas Coalition of Cities for Utilities Issues in Comments to offer support, insights and pledge of assistance to the FCC in implementing the emergency Connectivity Fund program offering insights based upon local partnerships to address the digital divide in our communities including that money is not the only obstacle to connecting the unconnected and partnering is the only way to succeed.

Dec. 23, 2020: NATOA – Biden FCC Agency Review – Local Government Meeting with President-Elect Biden's Agency Review Team members John Williams, Team Lead, U.S. House of Representatives, Committee on the Judiciary

Mignon Clyburn, former FCC Commissioner; Smitty Smith, DLA Piper; Paul de Sa, a partner with Quadra Partners; and Christiana Ho to discuss a number of FCC-related issues, including Digital Equity & Inclusion; Expanding E-Rate (outside of schools, inside public housing, Wi-Fi in community); Push for the wireless industry (and neutral hosts) to work on equity; and 5G as an equity issue. NATOA leadership including Nancy Werner, general counsel; Brian Roberts (San Francisco), president; Mike Lynch, (Boston DoIT), past president and Joanne Hovis, past president.

June 4, 2020: CompyTIA/PTI Webinar - Stretching the Limits: Broadband Capacity and Availability in a Crisis, a PTI Webinar Series is presented by CompTIA's Public Technology Institute (PTI) in association with the National Governors Association (NGA), the National League of Cities (NLC) and NASCIO. Speakers include Mike Culp, Director of Information Technology, Albemarle County, Virginia; Mitsuko Herrera, ultraMontgomery Director, Dept. of Technology Services Office of Broadband Programs, Montgomery County, Maryland; Mike Lynch, Broadband & Cable, Department of Innovation and Technology, City of Boston, Massachusetts; and, Angelina Panettieri, Legislative Manager, Information Technology and Communications - Federal Advocacy, National League of Cities discussing widespread and mandated telework because of the COVID-19 crisis challenging broadband availability and capacity around the country. As a result, from supporting rural access to broadband networks to concerns over the safety of home internet connections, local governments are dealing with a myriad of telecom issues.