The Digital Divide;

Addressing Inequities in Internet Access in Northfield, MN
In Partnership with the Healthy Community Initiative and Northfield Public Schools

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Executive Summary

The Covid-19 pandemic forced schools to move classes online, which meant students without adequate Internet access were unable to attend classes or complete assignments. To solve this problem, Northfield Public Schools (NPS) partnered with the HCI, the Healthy Community Initiative, to deliver and maintain hotspots for students, but HCI is curious if hotspots are the best solution to fix the local digital divide. We researched what other communities have done to address their own digital divide, focusing mainly on news articles and broadband project reports. From this we compiled potential solutions for Northfield, and investigated their financial, legal, and technological suitability for Northfield. Three case studies examine the solutions with the most potential. First we examine school-ISP partnerships in Chicago, reducing rates for families. Second, we look at independent networks being built by schools and cities in California. Finally, we see how fixed wireless networks have been used in Lockhart, Texas, to bring residents Internet access. We believe that partnering with a local fixed wireless network to build connections in specific neighborhoods, along with a possible partnership with the school to help families cover costs, would address most of Northfield's connection problems.

Project Overview

The main goal of our project was to support the work of HCI in reducing barriers to Internet access for families in the Northfield and Faribault school districts. Although the immediate need is to provide students with a connection adequate enough for them to participate in their education, the long-term goal goes further. Ultimately, HCI hopes to arrive at a set of solutions that would achieve greater digital equity, giving families full agency over their Internet usage.

In our work, we first sought to establish more concretely the extent of the digital divide in the Northfield School District and then researched what other school districts had done to put together a toolkit of solutions that we feel could be applied in Northfield. One challenge we encountered when exploring the distribution of Internet in the Northfield community was the lack of accurate coverage maps. In response, we decided to create our own maps using the data from HCI's phone surveys with families. With a better sense of the challenges Northfield families faced, we set out to explore ways in which other districts had addressed these problems. In addition, our secondary goal with these solutions was that they not only addressed the needs of families that HCI is currently supporting, but could also be scaled up to support a larger number of students in the future, potentially across a wider area. Lastly, we recognize that broadband and Internet access are issues that many people are working on and that likely the context will change in the coming months and years. Therefore, it is our hope that our toolkit offers a potential direction but also reflects the changing nature of the situation.

Current Situation

Locally, we initially identified three primary challenges facing families within the Northfield and Faribault school districts. These challenges were, broadly, the large number of students in rural areas, specific infrastructural challenges, such as lack of access in apartment buildings and mobile home parks, and financial barriers to access. Currently, HCI is providing some sort of Internet support to 405 students of the 4000 students in the district, translating to roughly 10% of NPS students. This number has increased over the course of our project as the financial strain of paying for Internet plans has increased for many families. In addition, HCI has also begun branching out their support to include families in the Faribault Public Schools (FPS) as well.

Beyond understanding the current situation in Northfield and Rice County, we also felt it was important to establish a general understanding of Internet access and approaches to increasing Internet access on a broader level. Nationally, expanding Internet and broadband coverage has been a growing issue for a number of years, especially with respect to increasing rural broadband. However, although financial support for rural broadband development has increased substantially due to the pandemic, and many areas within Rice County are objectively rural, the town of Northfield itself doesn't meet the classification of "rural," which is defined as less than 20,000 residents by the Minnesota Department of Employment and Economic Development. Because the school district and HCI are operating within the municipality of Northfield and not on a county level, this limits potential funding sources available to our project in future years.

On a state level, Minnesota has a number of legislative restrictions on developing Internet infrastructure. Most importantly, it is illegal for municipalities to develop Internet service systems that compete with existing private Internet service providers (Minn. Stat. Ann. § 429.021). Therefore, although there have been a number of success stories across the country of either municipalities or school districts becoming their own ISP's, this is not a viable option in Northfield. In addition, in order to approve the construction or purchase of an Internet service provider (or the infrastructure), there must be a 65% majority within the municipality council (Minn. Stat. Ann. § 237.19).

Case Studies

As we continued to explore what other districts and communities had achieved, our case selection solidified into a collection of studies that demonstrated economic and technological techniques that could be applied to Northfield and Rice County more generally. While none of the sites exactly match the circumstances in Northfield, across the collection we believe there are useful elements that can be combined into a comprehensive solution that could work for NPS and FPS families.

1. Chicago, IL: Chicago Connected

Project overview:
Chicago Connected is a private-public partnership between the city of Chicago, Chicago Public Schools, ISP's, and a variety of fiscal agents and community organizations. The program directly pays for Internet service for families for up to four years, as well as offering hotspots and extensions to existing hotspots to students in temporary living situations. The program is an example of a larger set of Internet initiatives in which municipalities and school districts partner with ISP's to directly cover the cost, either entirely or partially, of Internet plans for families.

Number of people served: 100,000 students across 60,000 households
ISP's: Comcast and RCN are the primary ISP's involved, the hotspots and hotspot extensions are through a partnership with T-Mobile.
Length of project: Four years
Cost: est. $50 million
Funding model: The project is funded primarily through philanthropic donations, district and city funds, as well as $5 million in CARES Act Funding.

Applications to Northfield & Rice County: Unlike a major infrastructure overhaul, a partnership between the district, the CAC and the city/county to subsidize part or all of the cost of Internet plans for families would be a solution that could be implemented on a shorter timeline or a temporary basis. Given also that a growing number of families are struggling to pay Internet bills, cost subsidies present a fix that could tide households over until a more long-term solution could be implemented.

2. California: School/City independent networks:

Project overview**:**
Many school districts in California had implemented hotspots during the pandemic to give students Internet access. The school districts found the hotspots to be unreliable. Hotspots are expensive in the long run, often don't provide sufficient connections, and are hard to troubleshoot when they break down. Many of the grants that the schools were using to fund

the hotspots will be running out, so they have started looking for new solutions. Multiple school districts and cities are working together to build their own wireless network in their communities, or expand their existing network.

Sites:

A. East Side Community Wifi:

East Side Union High School District has been working with the city of San Jose to bring Internet to students. They have been building a fiber network since 2016, building out to neighborhoods that have a high concentration of students without access. For students in other neighborhoods, they have been giving them hotspots as a temporary solution. They are getting free electricity from PG&E, and have been able to use existing fiber connections at light poles/traffic lights to build into areas without contracting private telecommunications companies.

Number of people served: Over 40,000 residents, with more to come.
Length of project: 5 years so far, more building is expected.
Cost: Not specified
Funding model: Funding from a 2.7 million dollar technology bond ESUHSD passed. Possible help from the E-Rate program.

B. Oakland City Wifi:

The city of Oakland CA has been expanding their city network to accommodate students and families that lack adequate Internet access as part of their Digital Inclusion plan. They have been building fiber, with one central "backbone" of fiber that runs through the city, from which the city can then add more connections to neighborhoods as they get funding and identify resident needs. They plan on also basing Wifi connections around streetlights, as they know they can connect to the city powergrid from these streetlights. The city is planning on adding more hotspots on streetlights to specific low-broadband neighborhoods.

Number of people served: Multiple neighborhoods in Oakland, 75% to 85% of the city may have some form of coverage.
Length of project: Almost a year so far, more building is planned through 2021.
Cost: $7.7 million.
Funding model: CARES Act funding

C. King County:

King County had an existing wireless network, KingsNet. KingsNet was started in 2009, as a 3g WiMax network. They have started switching over to a LTE network in order to increase speed. They used E-Rate funding, a government funded school support program, to build these networks, and supplied families with routers. When E-Rate funding fell out, the Kings County Office of Education elected to keep KingsNet going out using county funding, because it was integral to the lives of the students. They have since expanded to offering routers to other school districts.

Number of people served: No exact number, multiple school districts.
Length of project: Original project 2-3 years. Multiple expansions since.
Cost: Not specified.
Funding Model: Most of the original funding was supplied from the E-Rate program. Charged other schools $10 a month per device, though this may have changed in recent years.

D. West Contra:
West Contra Schools supplied hotspots to students during the pandemic. The hotspots were expensive and unreliable, so many families still lacked Internet access. West Contra saw that their CARES act funding, which allowed them to purchase the hotspots, was going to run out. They would have to pay $900,000 a year to keep the hotspots going. They are currently in a consulting phase to identify test areas, and they are hoping to build fiber networks large enough to cover students in Richmond and San Pablo if the tests go well. They have long term plans to expand this project to other schools and communities if it is successful.

Number of people served:
Project is in progress, they hope to expand to multiple cities if the first building works well. They have sent out hotspots to 5,000 students.
Length of project: Unknown, the project is still being developed.
Cost: Not specified
Funding model: The consulting costs and possibly construction will be done using CARES Act funding.

Applications to Northfield & Rice County:
The collection of California cases demonstrate how a school district-based or city-based Internet service can be a viable solution for areas lacking full, affordable, high-speed Internet coverage. It has a high startup cost, but many schools are using grant money, city funding, and help from public utility companies to alleviate these costs.

KingsNet shows how this solution can work in rural communities, and how this can grow to help other communities in the area. Oakland City Wifi and East Side Community show how to identify trouble areas and how to utilize existing infrastructure, as well as demonstrating how quickly Wifi can be rolled out with proper planning. East Side Community Wifi has been successful for the past five years, showing that this sort of project can be viable. Oakland City Wifi shows how to utilize both hotspots as a short term solution while the long term infrastructure is built.

Again, these projects can be costly, however in Northfield this could be alleviated using CARES Act funding, E-Rate programs, and urban broadband grants from the FCC. Working with the city and expanding upon existing infrastructure rather than building it separately could also help reduce project costs.

However, forming a city-based or district-based Internet service comes with its own unique challenges. The main barrier is legality. Minnesota state laws prohibit municipal networks that compete with local ISPs, and it may require a vote to allow the city to build its own network. This means it is unlikely that the city will be able to build its own network. It is possible the school district could, but the legality is hazy.

The district may have to register and pay for unique frequencies from the FCC to use in the area. In addition, if the Wifi will be free, the funding model has to include maintenance costs. Given that the growing issue for many families is financial barriers to access, this type of solution would require a greater extent of supplemental funding than some of the other solutions. Also, it's important to note that ISPs in the area may push back against this plan, though some may be willing to help out and connect with the new network.

3. Lockhart, TX: Leased Wireless Towers:

Project overview:
The Lockhart independent school district (LISD) in Lockhart, Texas has partnered with Particle Communications, a local ISP, in a 10-year commitment to connect the "last mile" areas in the county. They chose a point-to-point Wifi solution where they would use 3 existing towers from the ISP which would allow them to provide service within an 8 mile radius. The school district would then install more towers around the county. With 7 Wifi towers in the county they would be able to provide Internet coverage county wide. This plan allows the school district of roughly 6,100 students to maximize the number of students and faculty they can offer the Internet to as well as minimizing the amount of infrastructure and overall cost needed to maintain this project through partnerships.

The school district determined that 10Mbps and 5Mbps are speeds that will allow users to do school remotely, but adjustments can be made for reasonable justifications (ie. families with more than one student). Since this Internet is provided by the school district, they have also decided to restrict access to “non-educational sites”. While it is unfortunate that students and families will be limited to what they can access, they will at least be able to fully participate in school whereas they would not have been able to without this project.

The LISD started their project in April 2020 initially planning on having 7 WiFi towers and 500 families connected to LionLink by the end of August 2020. The most recent update on the project was September 2020. In this update they explained that due to some technical difficulties, they were only able to set up 5 Wifi towers and connect 200 families at the end of August. They planned to install the last 2 Wifi towers by the end of October 2020 and continue to connect members of the district to the network.

Number of people served: Initial goal of 500 students with the next goal of 700 more additional homes
Length of project: 4 month for first milestone, still ongoing
Cost:

- Setting up 7 tower + installing routers for up to 500 homes + Internet service for first year = $447,550
- Annual cost for Internet service = $60,000 per year
- Homes beyond 500 initial it would cost the district $22,250 for every 50 homes in the first year
  - Cost of Internet for subsequent years = $6,000 for those additional 50 homes

Funding model:
The project was funded by the school district by cutting back and reallocating their budget and prioritizing this project.

Applications to Northfield & Rice County:
While this is a long term solution and requires some infrastructure, tower installation is faster and cheaper than laying down fiber or cable to individual homes. With many geographical similarities, Northfield also can take advantage of the flat land since fixed wireless work best when direct lines of sight can be made between a tower and a family home. This plan is also scalable, as more towers can be built and set up which will allow access to more families in the area. In terms of cost, this solution is relatively less expensive compared to other broadband expansion plans, costing less than a million dollars.

Recommendations

Short Term:
The short term solutions that may be easiest to implement, especially given the growing number of families experiencing growing financial barriers to adequate Internet access, are hotspot extensions and Internet plan subsidies. T-Mobile's Project 10 Million is one option for hotspot extensions, and based on preliminary phone conversations they're interested in a potential partnership.

Similar to T-Mobile's Project 10 Million, Verizon also has a somewhat similar program called K-12 Education Solutions. Their goal is to improve the digital learning experience by providing Internet access whether it be by providing Internet access or with financial assistance.

Next steps include visiting their websites (T-Mobile Project 10 Million and Verizon Education Solutions) and filling out their contact forms. In terms of forming a subsidized plan option for families, next steps would most likely be conversations with T-Mobile, Verizon, and Northfield Wifi. Examples of language, contract terms and partnership structure can be found in the Chicago Connected Toolkit.

Long Term:
Given the rapidly evolving nature of broadband policy and roll-out at both state and federal levels, it seems likely that our suggestions may not be applicable by the time the project moves to larger infrastructural development. However, given the current situation we believe that in terms of cost, implementation speed and scalability, fixed wireless is the best technological solution. Especially since Northfield Wifi has already started to implement a fixed wireless network, expanding existing infrastructure seems more viable than developing a new network with new technology. In addition, there are specific and concentrated areas that would benefit from improved Internet access, including homes in both Florella's Mobile Home Park and Viking Terrace Mobile Home Park as well as a number of apartment buildings near Jefferson Parkway and the Community Action Center. Fixed wireless provides an efficient solution capable of reaching a number of families with a single installation, and has been explicitly used as an Internet solution to poor access in mobile home parks (see Phoenix Wifi).

Our current map can be found here.

Appendix I: Key Terms & Definitions

Adequate Wifi Access:

There are varying definitions for what speed is adequate enough for users. Zoom's system requirements indicate that it needs at a minimum ~2-3 Mbps for the video connection. The FCC's guidelines indicate that adequate download for students range from 5-25 Mbps, but if there are more users in the household streaming simultaneously, then this would be insufficient. For a household with 3 users streaming simultaneously, you need a minimum of 12-25 Mbps, and above that you need at least 25 Mbps. According to the FCC's broadband map all of Northfield has some Internet service provider (ISPs) that meets these requirements. For the definition used in our maps, see Appendix II.

Municipal Network:

A broadband network owned by public entities, usually local governments, that provides broadband services to residents and public buildings.

Physical Connection vs Wireless:

Physical connection broadband are Internet services that require a direct connection from the ISP to the user via some physical cable. Wireless broadband uses radio frequencies to deliver broadband to a user.

Common types of physical connection broadband:

- DSL
- Cable
- Fiber

Common types of wireless:

- Mobile Wireless
- Fixed Wireless
- Satellite

Broadband Internet that use physical connections (besides DSL) are much faster and reliable compared to wireless options. Unfortunately, the infrastructure that is required to set up a physical connection is extremely expensive. It requires laying down cable lines to each house. Typically ISPs will only install cable and fiber in more densely populated areas in order to maximize their infrastructure usage. Installing these cables in rural and sparsely populated areas is not common and almost never happens because the cost is not worth it to ISPs. Because of this, these areas do not have access to these Internet options.

Wireless broadband options are a more suitable option for rural areas since a lot less infrastructure is needed in order to set up a connection making it a cheaper option. While wireless broadband speeds are increasing due to technological improvements, they still are not as fast or reliable when compared to cable and fiber Internet options.

Digital Subscriber Line (DSL):

Provides Internet access by using the already existing telephone lines installed to homes and businesses. The availability and speed of DSl depends on the distance from a home to the nearest telephone company facility.

- General Transmission Speeds:
  - Ranging from several hundred Kbps to 100Mbps
- Providers in the area:
  - Century Link
  - Frontier

Cable:

Cable providers can use coaxial cables that deliver cable to your tv to also provide broadband. Setup involves connecting a cable wall outlet in a home to the cable modem.

- General Transmission Speeds:
  - Ranging from 50Mbps to 1000Mbps
- Providers in the area:
  - Charter Spectrum
  - Synergy Internet

Fiber:

Fiber involves laying down fiber-optic cables from the ISP to a user's home or business.. Fiber-optic service is fast (typically offers 1000Mbps or more) and reliable. It's also expensive to run to residences and businesses. The average cost for laying a mile of fiber is 27,000$[1], but if you are building in a city, then you also have to account for getting building permits and ripping up and relaying concrete, which will drive up the cost by thousands. There's some fiber in Minnesota, but not a lot, and mostly only in urban areas.

- General Transmission Speeds:
  - 1000 Mbps or more
- Providers in the area:
  - Jaguar Communications
  - MetroNet
  - Lonsdale Telephone COmpany

Wireless

[1] According to the Department of Transportation

Provides Internet access to homes and businesses by using a radio link between the user and radio tower. Wireless broadband can be mobile or fixed. It is commonly used in rural or sparsely populated areas where broadband that uses direct cable connections are unavailable.

- Mobile Wireless is used in our mobile devices, either phone hotspots or actual hotspot devices. These devices connect to ISP towers providing Internet access.
- Fixed Wireless lets users access the Internet from a fixed point. Typically this involves a receiver antenna that has a direct line of sight to a Wifi tower provided by an ISP. The direct line of sight is critical for a fixed wireless connection and things such as trees, hills, and poor weather conditions may affect the connection speeds.
    - General Transmission Speeds:
        - Ranging from 25 Mbps to 50 Mbps
    - Providers in the area:
        - Northfield Wifi
        - Radio Link Internet
        - LTD Broadband

Satellite:

Similar to satellites that orbit the earth that provide telephone and television access, these satellites provide Internet access to receiving antennas. In addition to the service package that was purchased, Internet speeds are affected by weather and line of sight to the satellite as well.

Potentially available pretty much everywhere, but weather is a big problem, as is time-lag as signals have to go up to the satellite and back down.

- General Transmission Speeds:
    - Up to 25 Mbps
- Providers:
    - Viasat
    - HughesNet

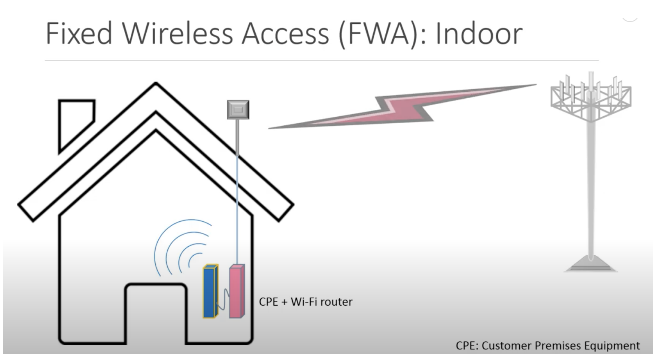
Fixed Wireless (Fixed Wifi):

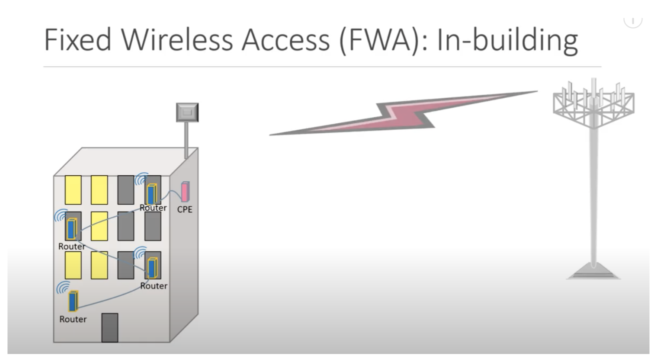
Similar to cell phone towers, fixed Wifi requires some local Wifi tower. It also requires a “direct line of sight” meaning having a clear path from the tower to the receiver antenna without trees or buildings obstructing the airspace. Internet speeds may also be inconsistent due weather such as fog, rain, or snow.

Uses ISM band radio frequency (900 MHz, 1.8GHz, 2.4 GHz and 5GHz)

<u>Fixed Wireless Installation</u>:
Installing fixed wireless for a household is simple. An **antenna** needs to be installed so that there is a **direct line of sight** between the **antenna and the Wifi tower**. Then a **customer premises equipment (CPE)** needs to be installed for the home which is connected to the antenna and a router. When the antenna receives transmission from the Wifi tower, it can then transmit the signal through the router.

In apartments, only one CPE needs to be installed. Routers that are connected to the CPE by ethernet cable can then be installed for each home.





(image from [Beginners: Fixed Wireless Access (FWA)])

<u>Local Providers:</u>
- Northfield Wifi
- Radio Link
- LTD Broadband

Appendix II: Mapping Data & Documentation

Student Data:

The student information comes directly from HCI's master spreadsheet. Our spreadsheet isolated and cross-referenced information about streaming ability and hotspot usage that we then translated into our map layers. For Northfield students, this information included name, address, adequate streaming and hotspot requests. For Faribault students we only included name, address and hotspot requests. We initially also included information about Charter Spectrum coverage, but given their lack of responsiveness we decided to focus solely on Internet adequacy and hotspot usage.

Key Definitions & Special Cases:

- "N. Adequate": Using the information from "Phone Call Responses", we defined "adequate streaming" as both able to access the Internet from a device at home (column F) and able to stream without interruption (column G, noted as "Yes - with no issues").
- "N. Sometimes": These students either explicitly noted "Sometimes" under column G OR there was no response in column G but the student's notes suggested a somewhat present but less than perfect streaming capacity.
- "N. No": These students explicitly noted "No" in column G.
- "N. Unknown": These were students whose names appeared in either "Internet Calling Sign Up" or "Hotspot Spring 2020" but did *not* have a response in "Phone Call Responses".
- "N. Hotspots": these points represent all of the addresses from NPS students that either requested or received a hotspot
- "F. Hotspots": these points represent all of the addresses from Faribault students that either requested or received a hotspot
- Apartment buildings: our software didn't allow multiple values at the same address. For students living in the same apartment complexes or multi-family units as other district families, if there was a range of access levels, we picked the lowest level of access to pin to that address. For example, if two families lived in the same housing unit and one reported streaming without issue and the other reported spotty service, we marked the student with the spotty service at that location.
- Siblings & co-habitants: if more than one student lived at the same address, we used information about access at that address that came up, but listed it all under a single student from that residence. For example, if there was one student listed under "Phone call responses" as not having adequate access to Internet, and another student, *who had the same address, the same guardian and same family ID,* showed

up on the hotspot request form, we noted both the access and the hotspot request under only one of their names (the choice of name was arbitrary).

Mapping MN DEED Awardees:

The BEVCOMM layers included in our map illustrate other areas in southern Minnesota recently awarded funding for broadband initiatives through the MN Department of Employment and Economic Development. A full summary of all recent awardees can be found in the "MN DEED Grant Awardees" folder. The three projects we included in our map are all through partnerships with BEVCOMM (a regional communications company), providing service to a number of communities throughout Le Seur, Rice and Scott counties.

We were unable to find the precise geographic data of the project boundaries beyond the maps included in the grant award notices. Therefore, our layers are an attempt to copy the general outline of those maps.

Mapping the Northfield Wifi Tower:

This layer is based on the updates we received from HCI about the new development of Northfield Wifi's fixed wireless infrastructure on the Faribault water tower. We approximated a maximum coverage radius of 20km based on the general specifications of fixed wireless antenna, however it's important to note that hills, dense trees and sometimes buildings can interfere with the signal and as such the radius would probably not extend as far as our layer suggests.

Maps for HCI vs. Raster for presentation/public view:

- HCI Maps:

These maps are point representations of student data, with one point representing one family. ArcGIS allows for clustering, which can be done using controls on the right, however no other analysis was done on this data

- Raster Maps:

In order to preserve the privacy of students, the maps that were presented to Carleton and are available for presentation to future partners were density rasters than point-value representations. The two rasters we created are for hotspot distribution and students with either inadequate or somewhat adequate Internet access (as stated by the phone survey and sorted on the spreadsheets). For both maps, the cell value is in hotspot (or students w [ ] access) per square mile. However, this value is extended to the area 2 miles in each direction from a point. For example, if there is a single student with a hotspot in a 6 square mile area, the map would display a single 2 mile by 2 mile square, centered on the student's residence. The color of the square would be the shade corresponding to

0.25/sq. Mile, because in that instance there is 1 hotspot distributed over a four square mile area.

Each raster also includes an expansion in the lower right hand corner. For these plots, the density is halved (so hotspot/half square mile) as is the extension value (so 1 square mile squares instead of four square miles). Although the rasters are less precise, they are useful in not only highlighting clusters but also when thinking about potential fixed wireless tower locations, they demonstrate potential sites that are centrally located with respect to many families that need support.