STATE OF MINNESOTA
BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

Beverly Jones Heydinger	Chair
Nancy Lange	Commissioner
Dan Lipschultz	Commissioner
Matt Schuerger	Commissioner
John Tuma	Commissioner

In the Matter of the Petition of CenturyLink QC to be Regulated Pursuant to Minn. Stat. § 237.025: Competitive Market Regulation	**Docket No. P-421/AM-16-496**
Repository for "Highly Sensitive Protected Data" subject to Additional Protection in Docket 16-496 (In the Matter of the Petition of CenturyLink QC to be Regulated Pursuant to Minn. Stat. § 237.025: Competitive Market Regulation)	**Docket No. P-421/AM-16-547**

AFFIDAVIT OF ADAM S. NELSON

STATE OF VIRGINIA)
) ss. Fairfax
COUNTY OF FAIRFAX)

I, Adam S. Nelson, being duly sworn, state as follows:

1. I am a Senior Consultant with Federal Engineering. My background includes performance engineering, optimization, and systems design of both public and private wireless communications systems.

2. I also have been involved with the management and maintenance of various municipal wireless networks, specifically in the realm of public safety communications.

3. I have participated in all phases of communications system lifecycle from needs assessment, system recommendations, RFP development, through implementation.

4. I have developed web apps, geo-processing tools, and analysis models for various types of communications systems.

5. My resume is attached as Exhibit 1 to this affidavit.

6. CenturyLink retained Federal Engineering to conduct a study of 32 wire centers in Minnesota to determine the percentage of households in each wire center that have wireless service available. I prepared a study that is attached as Exhibit 2, Assessment of Wireless Voice Coverage in Select CenturyLink Wire Centers in the State of Minnesota.

This concludes my affidavit.

Adam S. Nelson

Subscribed and sworn to before me
this 18th day of November, 2016.

Shawn E Dickerson
Commonwealth of Virginia
Notary Public
Commission No. 7242475
My Commission Expires 7/31/2018

Shawn E. Dickerson
Notary Public

Exhibit 1

ADAM S. NELSON
Senior Consultant

GENERAL BACKGROUND

Mr. Adam Nelson has over 12 years of experience providing consulting services in the fields of public safety, telecommunications, and information technologies. As a member of ***FE's*** Spectrum Center of Excellence, his specialties include radio frequency prediction and analysis, frequency and capacity planning, interference mitigation, LTE system design and analysis, and spectrum-related efforts pertaining to frequency licensing and coordination.

Mr. Nelson's background includes performance engineering, optimization, and systems design of both public and private wireless communications systems. His background also includes the management and maintenance of various municipal wireless networks, specifically in the realm of public safety communications. He has participated in all phases of communications system lifecycle from needs assessment, system recommendations, RFP development, through implementation.

Mr. Nelson has extensive experience with GIS platforms such as ESRI's ArcGIS. Leveraging his GIS expertise, he has developed web apps, geo-processing tools, and analysis models for various types of communications systems.

EDUCATION & TRAINING

- Master's Degree, Geographic Information Systems, The Pennsylvania State University, 2014
- Post-baccalaureate Certificate in Geographic Information Systems, The Pennsylvania State University, 2011
- Bachelor of Science, Information Technology, University of Phoenix, 2003, with honors

AREAS OF EXPERTISE

- RF propagation prediction/ analysis for LMR voice and data
- RF interference assessment and mitigation
- Broadband wireless system design, traffic modeling, and analysis, LTE systems
- System capacity planning
- Frequency planning
- Intermodulation assessment and mitigation
- Network operations and maintenance
- Voice/data communications
- Information technology fundamentals
- Web-based application development
- TCP/IP and networking protocols

PROJECT EXPERIENCE

RF Coverage Prediction, Capacity Analysis, Interference Analysis, and/or Channel Planning for the following projects:

Federal Government Projects

- Department of Homeland Security Office of Emergency Communications (DHS/OEC) Interoperable Communications Technical Assistance Program (ICTAP)
  - Broadband and/or LMR coverage maps created for various technical assistance offerings:
    - California
    - Colorado
    - Connecticut
    - Idaho
    - Indiana
    - Kansas
    - Maine
    - Maryland
    - Massachusetts
    - Michigan
    - New Jersey
    - Nevada
    - Oregon
    - Utah
  - Co-presented Consultation Workshop
    - Connecticut
    - Indiana
    - Iowa
    - Maine
    - Maryland
    - Michigan
    - Missouri
    - Oklahoma
    - South Dakota
    - Tennessee
    - Vermont
    - Virginia
  - Co-presented LTE Technical Workshop
    - Colorado
    - Oregon

Statewide Projects

- State of Arizona LMR Project
- State of Colorado DTRS (Digital Trunked Radio System)
  - Coverage analysis including coverage workshop
- State of Iowa
  - Statewide broadband LTE network
  - Statewide 700 MHz radio system design

- State of Minnesota Allied Radio Matrix for Emergency Response (ARMER)
- State of Oregon
  - Oregon State Radio Project (SRP)
  - Statewide broadband LTE network

Regional Projects

- Arizona Public Service (APS)
  - Coverage analysis
  - Spectrum availability study
  - Voice, data, and telemetry systems analysis
  - Capacity analysis
- Bay Area Regional Interoperable Communications System (BayRICS) Regional Interoperable LMR Project
  - New York City Metropolitan Transit Authority Police Department (MTAPD) 700 MHz Network
  - Multiple simulcast cell design
  - Large frequency licensing effort
- Fauquier, Culpeper, and Rappahannock Counties, Virginia
  - Coverage analysis of existing 800 MHz system and potential P25 system
  - Conducted coverage workshops with stakeholders in each county
- Overlay Regional Interoperability Network (ORION) Hampton Roads region of Virginia
- Omaha Metropolitan Utilities District (OMUD) 800 MHz DMR system design for gas and water utility communications

CERTIFICATIONS & TRAINING

- Simulcast Radio Systems, Motorola Certified Training
- Integrated Voice and Data Systems, Motorola Certified Training
- RAPTR Certified Training
- ATDI Developer Training
- ArcGIS Developer Training

PROFESSIONAL ORGANIZATIONS

- Association of Public Safety Communications Officials

PREVIOUS AFFILIATIONS

- City of Phoenix, Arizona
- Sprint PCS
- BellSouth Mobility
- US West/Qwest Wireless
- Voicestream Wireless

County Projects

- Boone County, Kentucky Microwave Network
- Buncombe County, North Carolina
  - Radio system design alternatives and recommendations
  - Detailed design of transmit/receive sites
  - Channel availability studies
  - Development and submission of FCC licensing documentation per RPC requirements
  - Oversight of vendor design and implementation efforts
- Caroline County, Virginia Land Mobile Radio System Design
- Cortland County, New York interoperable emergency communications system
  - Design, procurement, and implementation
  - Spectrum availability analysis and frequency licensing
- Henry County, Georgia Radio System Consulting
  - Radio coverage analysis
  - Conducted Spectrum and Coverage Workshop
- Isle of Wight County, Virginia System Analysis
  - Analyze mobile and portable coverage of existing VHF countywide system
  - Evaluate potential candidate sites to bolster coverage holes throughout county
  - Coverage workshop with county personnel, demonstrating results of analysis
- King William County, Virginia
  - Analysis of vendor-proposed RF and microwave design
  - Licensing of 700 MHz interoperability channels
- Lewis County, New York System Analysis
  - Analysis of existing public safety network infrastructure and performance
  - System design effort for potential countywide radio system
  - Frequency availability study
- Manitowoc County, Wisconsin Radio System Design Alternatives and Recommendations
  - Coverage and contour analysis
  - Spectrum availability studies for system upgrades
  - Development and submission of FCC licensing documentation
- Pinal County, Arizona System Analysis
  - Analysis of existing radio infrastructure and system performance

- Pitt County, North Carolina VHF System Expansion with Narrowband Migration
- Pittsylvania County, Virginia Radio System Design Alternatives and Recommendations
- Rockbridge County, Virginia Public Safety Mobile Radio Consulting
- San Diego County, California System Analysis
  - Analysis of existing public safety network infrastructure and performance
  - Ongoing design effort for San Diego County and Imperial County radio system design alternatives

Municipal Projects

- New York City Transit/Metropolitan Transit Authority
  - Bus radio system design
- Bowling Green Municipal Utilities
  - Feasibility study for construction of new radio tower
  - Coverage analysis
  - Filed FAA and FCC documentation to facilitate construction in accordance with federal guidelines
- City of Hampton, Virginia Public Safety Mobile Radio System Design
- City of Newport News, Virginia Needs Assessment
  - Develop needs assessment detailing existing system capabilities and future user needs
  - Evaluate and present alternatives for system upgrades
  - Coverage analysis, capacity evaluation, interference analysis
- City of Florence, Arizona Radio Communications Plan
- City of Edmonton, Alberta
  - Analysis of existing communications capabilities
  - Independent review of Project 25 radio system design
  - Coverage, capacity, and interference analysis
- City of Collierville, Tennessee Public Radio System
  - Coverage analysis and spectrum availability study

City of Phoenix, Arizona Network Operation Center (NOC) Manager

- Managed NOC for city's public safety digital communications network
- Served as a contact point for hundreds of users within multiple agencies, performed troubleshooting and monitoring of all system infrastructure, and maintained databases housing all pertinent user profiles and permissions

PROFESSIONAL PROFICIENCIES

Propagation Analysis

- Subject matter expert in radio frequency propagation analysis and GIS mapping
- Versed in many propagation models including:
  - Okamura Hata (National Public Safety Planning Advisory Committee [NPSPAC]-approved)
  - ITU R.P370
  - Deygout diffraction model
  - ITU R.525/526
  - ITU-R 1812-2, as described in TSB-88.2-C
  - Irregular Terrain Model, also known as Longley Rice (NTIA- recommended, NPSPAC-approved)
  - Free Space (NPSPAC-approved)
  - CCIR (NPSPAC-approved)
- Produces clear and concise reports and visual representations of RF coverage analysis that are individually tailored to meet a client's specific requirements
- Effectively employs ***FE's*** RF network analysis tool suite, ***FEPerformancePro™*** in carrying out radio coverage analysis, developing propagation maps, performing radio frequency analysis, and assessing network channel loading
- Fluent in FCC rules for frequency licensing - including contour evaluations, interference analyses, co-channel and adjacent channel conflict studies, and filing requirements.
- Works regularly with Regional Planning Committees who oversee distribution of 700 MHz and 800 MHz frequency allocations to government entities.
- Incorporates current and comprehensive GIS layers such as population distribution, growth projections, political boundaries, and various topological features into RF system design efforts to deliver results tailored to specific client needs

- Develops throughput analysis, site selection, and coverage maps for LTE and other broadband technologies

Noise and Interference Analysis

- Proficient in transmitter noise and power analysis, and receiver sensitivity analysis
- Subject matter expert in interference analysis including co-channel, adjacent channel, and intermodulation studies, as well as simulcast interference analysis and mitigation
- Successfully designed many systems requiring frequency reuse among radio sites, in both simulcast and multicast environments

Spectrum Availability and Licensing

- Proficient in transmitter noise and power analysis, and receiver sensitivity analysis
- Subject matter expert in interference analysis including co-channel, adjacent channel, and intermodulation studies, as well as simulcast interference analysis and mitigation
- Successfully designed many systems requiring frequency reuse among radio sites, in both simulcast and multicast environments
- Worked extensively with local frequency coordinators, FCC personnel, and 700/800 MHz Regional Planning Committees during frequency licensing processes.

Commercial Carrier Expertise

- In-depth understanding of commercial carrier technologies including GSM, CDMA, and TDMA
- Performance engineer for Sprint PCS. Responsibilities included troubleshooting coverage problems, evaluating system performance, and managing site capacity for dynamic load-handling
- Performance engineer for BellSouth Mobility for multistate GSM network in the southeastern U.S. Tasks included cutover of multiple network switch centers from analog to digital operation, troubleshooting transition problems, and optimizing system performance
- RF technician for U.S. West/Qwest Wireless in the Phoenix metropolitan area. Tasks included troubleshooting coverage problems, FCC/FAA frequency coordination, and system optimization
- RF engineer for Voicestream Wireless cellular GSM network in the Phoenix metropolitan area. Tasks included system optimization, coverage troubleshooting, frequency planning, FCC/FAA frequency coordination

Exhibit 2

Assessment of Wireless Voice Coverage in Select CenturyLink Wire Centers in the State of Minnesota

November 18, 2016

Prepared by:

"Unleashing the Power of Technology"
Federal Engineering®

Federal Engineering, Inc.
10600 Arrowhead Dr, Suite 160
Fairfax, VA 22030
703-359-8200

Table of Contents

1. Project Overview

1.1 Background

In October 2016, Qwest Corporation dba CenturyLink QC ("CenturyLink") contracted the services of Federal Engineering, Inc. ("***FE***") to perform an assessment of wireless voice coverage in specific areas of the State of Minnesota ("State"). These specific areas, referred to as "wire centers", are geographic regions where CenturyLink currently has the capability of providing wireline service to customers.

1.2 Goal of the Assessment

The goal of the assessment was to determine the percentages of both population and households in the 32 specific wire centers currently within the coverage area of at least one wireless voice provider. To perform this assessment, ***FE*** obtained technical information about wireless voice providers ("providers") operating within the State, and performed radio frequency (RF) propagation studies to determine where wireless voice coverage should exist, both outdoors and inside residential structures.

The methodologies used, inputs and assumptions, and corresponding results of ***FE***'s assessment are provided in this report.

2. Assessment Inputs

FE obtained a variety of datasets and technical parameters from multiple sources to perform the assessment of wireless voice coverage within the wire centers. This section describes these inputs and their sources.

2.1 Wire Centers

CenturyLink provided ***FE*** with a shapefile (i.e. an electronic location-based dataset) of 32 specific wire centers in the State. These 32 areas, shown in Figure 1, are the focus of the wireless voice coverage assessment.

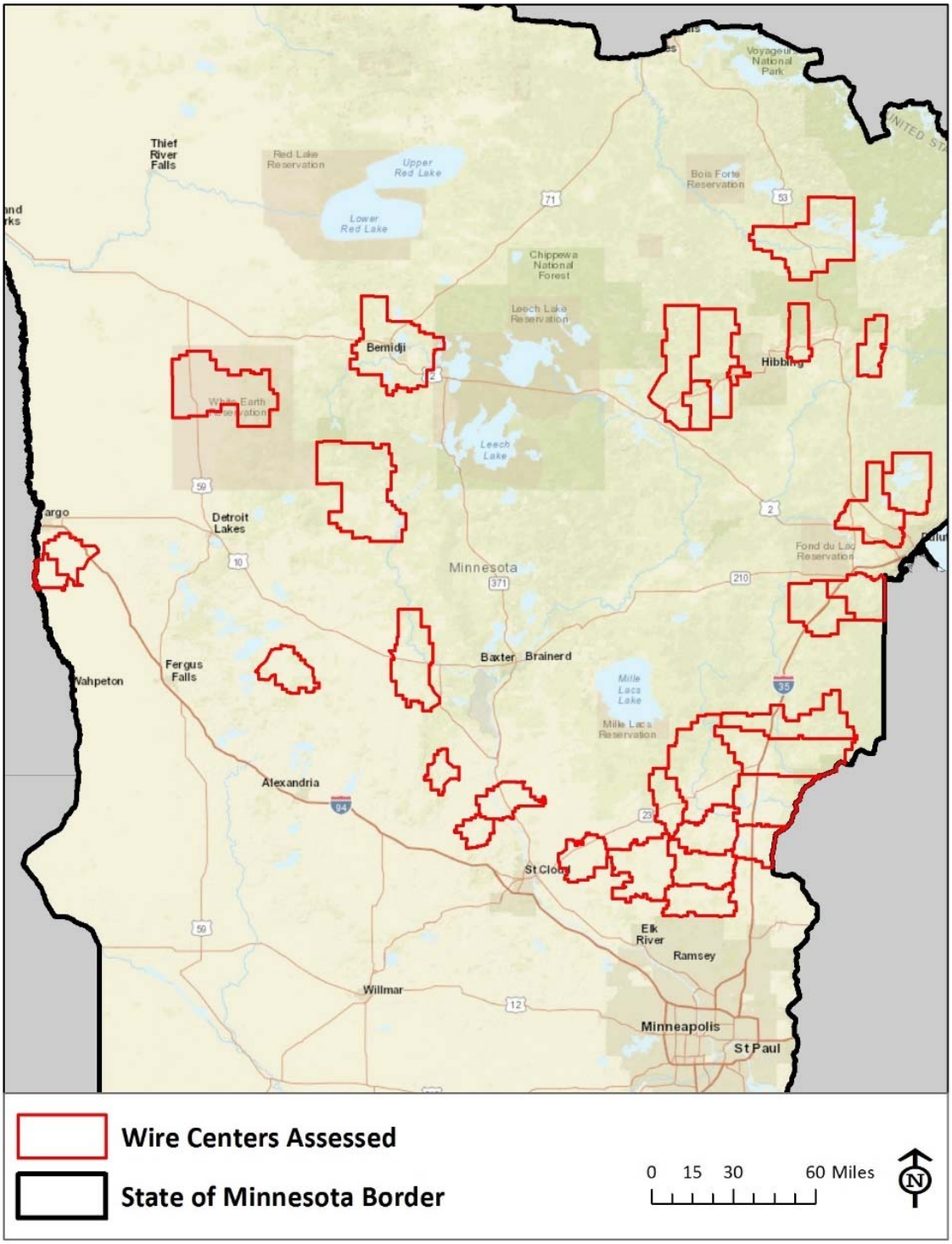

Figure 1 – 32 CenturyLink Wire Centers in Minnesota

2.2 Population and Households

CenturyLink provided ***FE*** with a shapefile containing all United States census blocks that are either partially or entirely within the borders of the 32 wire centers. For each census block, population totals and household totals (from the 2010 census) were encoded into the attribute data for each census block. It is important to note that no specific location information (i.e. geographic coordinates) for either the population or the households was provided in the shapefile, as that information is not published by the US Census Bureau.

2.3 FCC-Licensed Data

FE obtained publicly available information from the Federal Communications Commission (FCC) regarding wireless voice providers operating in the State. In several frequency bands, the FCC grants licenses to commercial providers on an area-wide basis, and does not require that providers report individual transmit locations. The Broadband Personal Communications Service (PCS) (1800/1900 MHz range) and Advanced Wireless Services (AWS) (1700/2100 MHz range) are examples of spectrum for which providers can obtain area-wide licenses from the FCC. Thus, location-specific technical information on individual cell sites in these bands is not available in publicly available federal databases.

In the 800 MHz frequency band, commercial wireless voice providers must submit detailed technical information on individual cell sites and transmitters to the FCC. This information includes geographic coordinates, antenna heights, and power levels for licensed transmitters. In the State of Minnesota, AT&T Mobility ("AT&T") and Verizon Wireless ("VZW") have active FCC licenses to operate cellular systems in the 800 MHz band. Due to the availability of this technical data, which is required to perform RF propagation studies, and the lack of site-specific information in other cellular frequency bands, ***FE*** limited the scope of this assessment to the evaluation of AT&T and VZW's currently-licensed 800 MHz transmitters within the State.

While ***FE*** limited this assessment to an evaluation of 800 MHz licenses, both AT&T and VZW have active licenses in other frequency bands, where technical data on individual cell sites is not publicly available. Table 1 presents a summary of these two providers' FCC licenses and cell sites within the State.

Table 1 – Cellular License Information for AT&T Mobility and Verizon Wireless in the State of Minnesota

Frequency Band Name	Specific Frequency Range (MHz)	AT&T		VZW	
		Licensed in MN?	Number of Cell Sites	Licensed in MN?	Number of Cell Sites
AWS A	1710-1720, 2110-2120	Yes	Not Available	No	N/A
AWS C	1730-1735, 2130-2135	Yes	Not Available	No	N/A
AWS F	1745-1755, 2145-2155	Yes	Not Available	No	N/A
800 MHz Cellular	**824-845, 845-849, 869-890, and 890-894**	**Yes**	**286**	**Yes**	**381**
Lower 700 A	698-704, 728-734	No	N/A	Yes	Not Available
Lower 700 B	704-710, 734-740	Yes	Not Available	Yes	Not Available
PCS A	1850-1865,1930 - 1945	Yes	Not Available	Yes	Not Available
PCS B	1870 -1885,1950 - 1965	Yes	Not Available	Yes	Not Available
PCS C	1895-1910,1975 - 1990	Yes	Not Available	Yes	Not Available
PCS D	1865-1870,1945 - 1950	Yes	Not Available	Yes	Not Available
PCS E	1885-1890,1965 - 1970	Yes	Not Available	Yes	Not Available
PCS F	1890-1895,1970 - 1975	Yes	Not Available	Yes	Not Available
Upper 700 C	746-757, 776-787	No	N/A	Yes	Not Available
WCS C	2315 - 2320	Yes	Not Available	No	N/A
WCS D	2345 - 2350	Yes	Not Available	No	N/A

3. Wireless Voice Coverage Analysis

3.1 RF Propagation Software

FE engineers use ***FEPerformancePro***™, a customized version of ATDI's ICS Telecom network planning software for their RF propagation modeling engine. ICS Telecom is used extensively throughout the communications industry to model wireless networks, perform interference analyses, and frequency planning. The accuracy of the ICS Telecom software has been independently validated by the United States federal government.

FE has also performed thousands of RF prediction studies with ***FEPerformancePro***™, on a multitude of frequency bands, including those in the 800 MHz band. With over a decade of experience with this tool, including calibration of its parameters via real-world drive testing, ***FE*** is confident in the accuracy of its prediction capabilities.

3.2 Coverage Analysis Methodology

Using the technical information and tools described above, ***FE*** ran RF coverage predictions for all 800 MHz licensed transmit locations for both AT&T and VZW. These coverage predictions involve performing highly complex calculations to determine signal strength from the licensed transmitters that may be received by a mobile device. These calculations include the following factors when determining received signal strengths:

- Free space loss
- Signal loss due to terrain (using a high-resolution 30-meter elevation database)
- Signal loss due to environmental clutter (using a high-resolution 30-meter land use/land cover database)
- RF characteristics in the 800 MHz frequency band (e.g. diffraction over obstacles, multipath)

3.3 Outdoor vs. In-building Coverage

When assessing coverage inside buildings, additional signal loss is factored into the RF coverage predictions. For this assessment, ***FE*** assessed the predicted wireless coverage both outdoors and inside residential structures.

There are many variables when assessing coverage inside buildings, such as a customer's location within a structure, the building materials, the number of floors, the size of windows, etc. When performing in-building RF coverage predictions for a large area (as is the case with this assessment), it is practical to choose a specific amount of signal loss (in decibels, or "dB") to apply throughout the entire evaluation area to determine where "in-building" coverage should exist. This value is based on the type of structure being considered, as well as the frequency band being modeled. For the purposes of this assessment, ***FE*** used a value of **10 dB** of signal loss inside a residential structure. This value is consistent with many 800 MHz coverage analyses ***FE*** has performed in the past.

Figure 2 shows an example of the potential difference between outdoor coverage and coverage within residential buildings (which includes the 10 dB of additional signal loss).

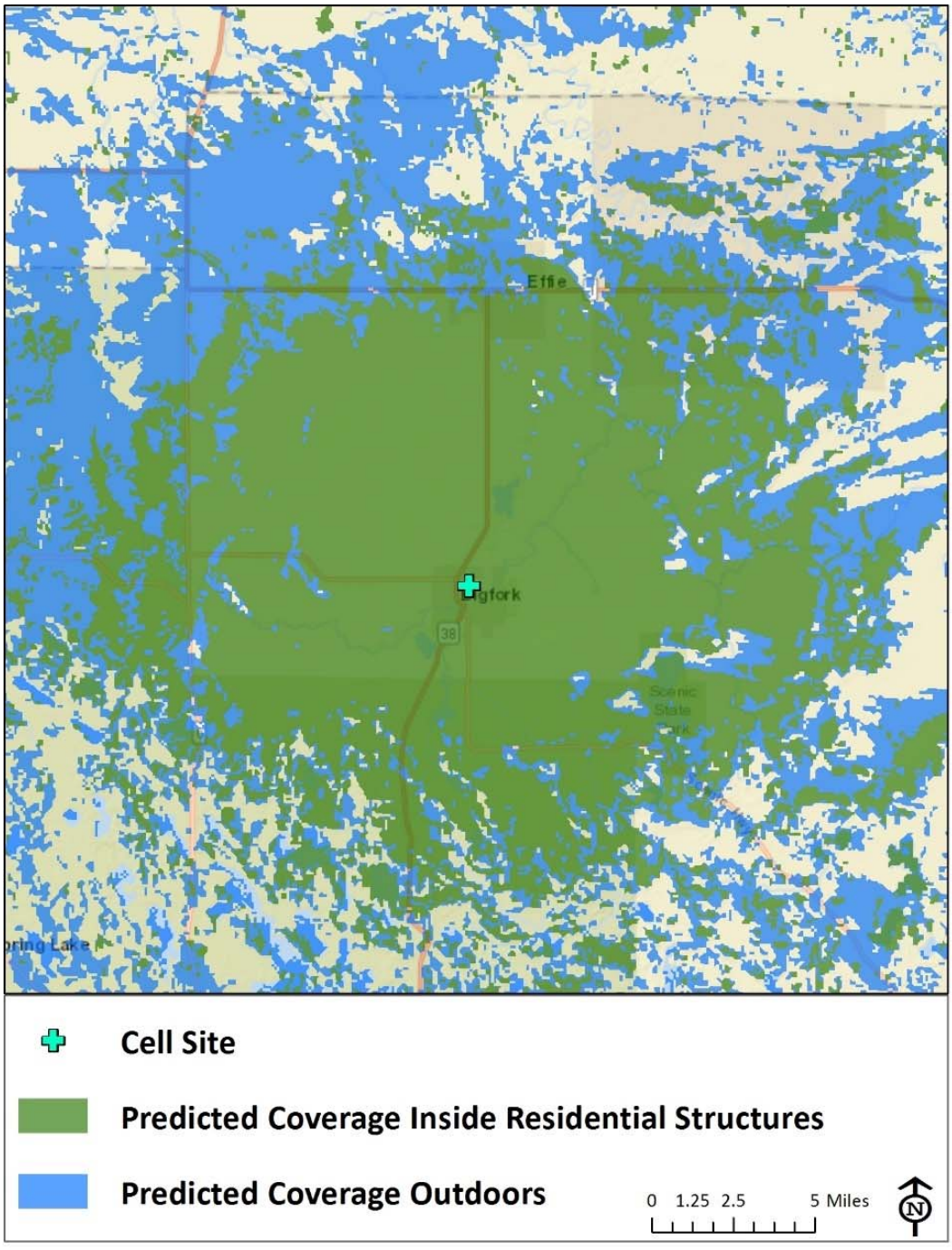

Figure 2 – Example of Potential Difference between Outdoor and In-Building Coverage

3.4 Results of Wireless Voice Coverage Analysis

After performing RF coverage predictions for the 667 locations with licensed 800 MHz cellular transmitters (286 for AT&T, 381 for VZW), ***FE*** created a coverage map (shown as Figure 3) displaying the predicted outdoor and in-building coverage over the 32 CenturyLink wire centers. This map presents a composite coverage footprint of the predicted coverage of both providers.

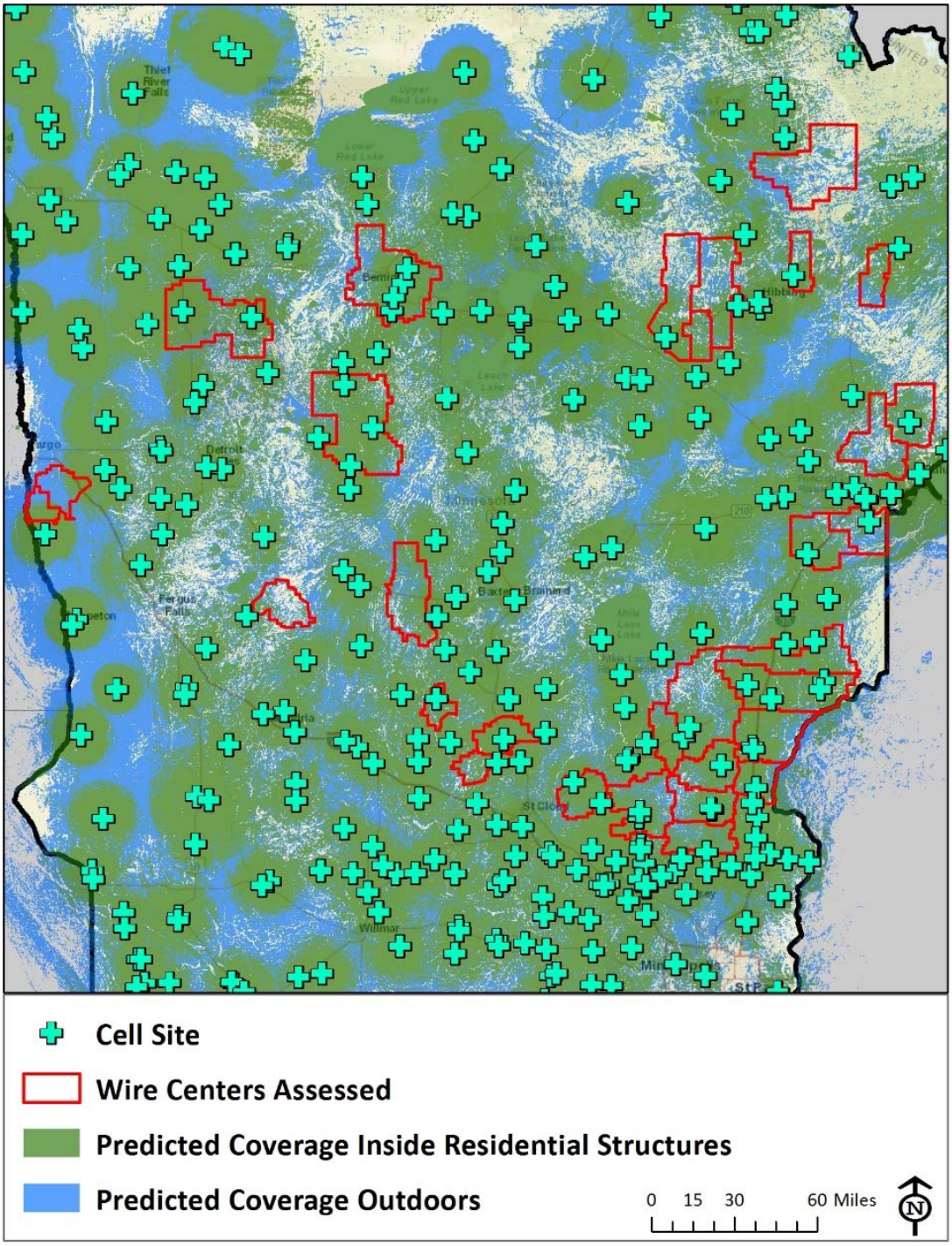

Figure 3 – Predicted Wireless Voice Coverage of AT&T Mobility and Verizon Wireless in the 800 MHz Frequency Band, based on FCC Licenses

4. Population and Household Coverage Analysis

Using the RF coverage predictions, ***FE*** determined the percentage of both population and households covered in the 32 wire centers. This section outlines the methodology used to distribute the initial population/household amounts throughout the wire centers, and presents tabular data detailing the results of the analysis.

4.1 Population and Household Distribution

As stated previously, United States census blocks contain information on population and households, but they do not specify their locations. As an example, Census Block ID# 270017704003097 has a total population of 10 and 9 total households. However, it is not specified where the population and households are located within the census block. When using US census blocks to evaluate the amount of population and/or households that are covered by a wireless coverage footprint, it is necessary to make reasonable assumptions as to their actual locations, as detailed in the following sections.

4.1.1 FCC Methods – Centroid and Actual Area Coverage

The FCC requires wireless voice providers to submit data regarding their coverage footprints throughout the United States on a semi-annual basis. The footprints are submitted by the providers as electronic shapefiles with polygons representing where they provide coverage, and the providers must certify that their shapefiles are accurate. The FCC uses the submitted data to determine the amount of population covered by different technologies, frequency bands, and providers. There are two methods the FCC has identified which they use to perform these evaluations:

- Centroid methodology:
    - If a census block's centroid (geographic center point of the block) is covered by a provider's submitted coverage polygon, then all that block's population and land area is considered 'covered'.
- Actual Area Coverage Methodology:
    - The Actual Area coverage method calculates the actual geographic area percentage of each census block that is covered by the polygons, and

divides the population into ‘covered’ and ‘uncovered’ in direct proportion to the area coverage percentage of that block.

The FCC deemed that the Centroid methodology was susceptible to overstating coverage in certain areas, and has migrated to analyzing broadband/mobile voice coverage using the Actual Area Coverage Methodology.

4.1.2 FE Method – Random Distribution of Points

FE uses Geographic Information Systems (GIS) software to perform a **random distribution of points** technique to distribute population and households throughout each census block. ***FE*** believes this method is superior to the Centroid method, for the same reasons that they deemed that method inaccurate, and provides a degree of variability that the Actual Area Coverage method does not. More specifically, the Actual Area Coverage method assumes that all population is uniformly distributed geographically throughout a given census block, which is not necessarily true. The random point distribution method may come closer to achieving a realistic level of real-world variability.

Figure 4 presents a visual comparison of the Centroid method, the Actual Area Coverage method, and the Random Distribution of Points method.

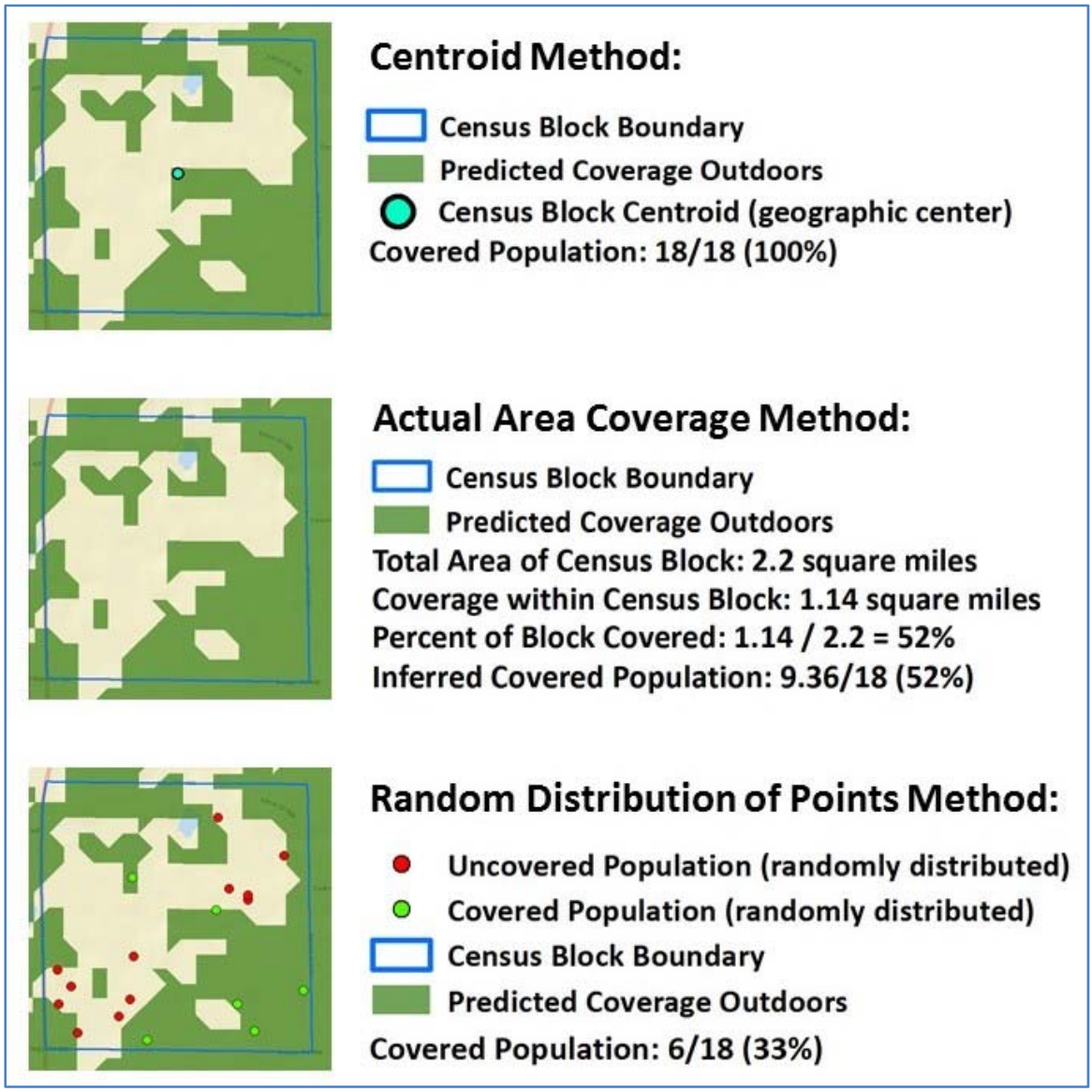

Figure 4 – Comparison of Different Methods of Evaluating Covered Population

While the Random Distribution of Points method will not always represent a conservative estimate of coverage (i.e. fewer covered population than with other methods), the variability inherent in the technique, when applied over the thousands of census blocks considered in this assessment (over 100,000 were supplied by CenturyLink), should create a reasonable, non-inflated result of covered population and households.

4.1.2.1 Comparison of Multiple Random Distribution Studies

CenturyLink provided ***FE*** with a shapefile containing 118,761 census blocks, which in turn contain a population total of 3,811,367 and a household total of 1,516,077. However, some of the provided census blocks were not entirely within the 32 wire centers: they only partially overlapped one or more of the wire centers.

When randomly distributing population and households throughout the partially overlapping census blocks, it may be possible that one pass at the distribution could place most the population outside of a wire center, and another pass could place most of the population inside the wire center. This discrepancy could potentially skew the total amount of population and households within each wire center.

To gauge the severity of the potential discrepancy, ***FE*** performed multiple random distribution passes for population, and assessed how much difference in wire center population existed between the passes. ***FE*** discovered that the wire center population, after performing random point distribution over three passes, deviated by less than one-tenth of one percent. Due to this very small amount of deviation, ***FE*** feels confident that the Random Distribution of Points method should not result in large discrepancies in total population and/or households within the 32 wire centers.

4.1.3 Wire Center Population and Household Totals

FE used the Random Distribution of Points method to assign population and household totals to each of the 32 wire centers considered in this assessment. Table 2 presents a summary of the totals.

Table 2 – Wire Center Population and Household Totals based on Random Point Distribution Method

Wire Center	Total Population	Total Households
BARNUM	3607	1367
BEMIDJI	30637	11861
BIWABIK	2547	1190
BRAHAM	6390	2452
BUHL	1713	745
CAMBRIDGE	16412	6196
CARLTON	4429	1675
COLERAINE	5092	2196
COMSTOCK	338	146
COOK	2394	1028
DULUTH PIKE LAKE	12378	4712
FOLEY	5676	2070
HENNING	2173	895
HINCKLEY	5233	2041
HOLDINGFORD	2392	919
ISANTI	14329	5155
ISLAND LAKE	4309	1699
KEEWATIN	1220	522
MAHNOMEN	3935	1434
MARBLE	1787	690
MORA	12079	4780
NASHWAUK	3216	1409
OGILVIE	2616	960
PARK RAPIDS	10907	4928
PINE CITY	9847	3883
PRINCETON	18476	6849
ROYALTON	3615	1318
RUSH CITY	6177	1980
SABIN	1822	660
SANDSTONE	4363	1334
STAPLES	6028	2379
SWANVILLE	1193	431

4.2 Population and Household Coverage Analysis

FE analyzed the estimated percentage of population and households (distributed throughout the 32 wire centers) covered by AT&T's and VZW's active 800 MHz cellular licenses. Tables 3 and 4 present a summary of the predicted population and households covered, respectively, via AT&T's and VZW's active 800 MHz cellular licenses, within the 32 CenturyLink wire centers.

Table 4 – Percentage of Population Coverage, by Wire Center

Wire Center	Total Population	Outdoor		Inside Residential Structures	
		Covered Population	% of Population Covered	Covered Population	% of Population Covered
BARNUM	3607	3419	94.8%	2733	75.8%
BEMIDJI	30637	30104	98.3%	28142	91.9%
BIWABIK	2547	1829	71.8%	882	34.6%
BRAHAM	6390	6265	98.0%	5588	87.4%
BUHL	1713	1656	96.7%	1583	92.4%
CAMBRIDGE	16412	16049	97.8%	14355	87.5%
CARLTON	4429	4053	91.5%	2904	65.6%
COLERAINE	5092	4662	91.6%	4042	79.4%
COMSTOCK	338	337	99.7%	238	70.4%
COOK	2394	1081	45.2%	190	7.9%
DULUTH PIKE LAKE	12378	9885	79.9%	5501	44.4%
FOLEY	5676	5645	99.5%	5260	92.7%
HENNING	2173	1226	56.4%	432	19.9%
HINCKLEY	5233	5162	98.6%	4897	93.6%
HOLDINGFORD	2392	2117	88.5%	1456	60.9%
ISANTI	14329	13989	97.6%	9922	69.2%
ISLAND LAKE	4309	3868	89.8%	3005	69.7%
KEEWATIN	1220	1220	100.0%	1220	100.0%
MAHNOMEN	3935	3695	93.9%	3222	81.9%
MARBLE	1787	1609	90.0%	1125	63.0%
MORA	12079	11384	94.2%	9176	76.0%
NASHWAUK	3216	2730	84.9%	1923	59.8%
OGILVIE	2616	2598	99.3%	2409	92.1%

Wire Center	Total Population	Outdoor		Inside Residential Structures	
		Covered Population	% of Population Covered	Covered Population	% of Population Covered
PARK RAPIDS	10907	10661	97.7%	9946	91.2%
PINE CITY	9847	9664	98.1%	8953	90.9%
PRINCETON	18476	18180	98.4%	16127	87.3%
ROYALTON	3615	3597	99.5%	3532	97.7%
RUSH CITY	6177	6097	98.7%	5702	92.3%
SABIN	1822	1556	85.4%	388	21.3%
SANDSTONE	4363	4315	98.9%	4092	93.8%
STAPLES	6028	5797	96.2%	3441	57.1%
SWANVILLE	1193	1167	97.8%	1020	85.5%

Table 5 – Percentage of Household Coverage, by Wire Center

Wire Center	Total Households	Outdoor		Inside Residential Structures	
		Covered Households	% of Households Covered	Covered Households	% of Households Covered
BARNUM	1367	1300	95.1%	1007	73.7%
BEMIDJI	11861	11662	98.3%	10918	92.0%
BIWABIK	1190	864	72.6%	433	36.4%
BRAHAM	2452	2423	98.8%	2172	88.6%
BUHL	745	717	96.2%	671	90.1%
CAMBRIDGE	6196	6061	97.8%	5390	87.0%
CARLTON	1675	1540	91.9%	1090	65.1%
COLERAINE	2196	1971	89.8%	1671	76.1%
COMSTOCK	146	146	100.0%	103	70.5%
COOK	1028	451	43.9%	89	8.7%
DULUTH PIKE LAKE	4712	3742	79.4%	2093	44.4%
FOLEY	2070	2056	99.3%	1937	93.6%
HENNING	895	516	57.7%	196	21.9%
HINCKLEY	2041	2026	99.3%	1950	95.5%
HOLDINGFORD	919	800	87.1%	518	56.4%

Wire Center	Total Households	Outdoor		Inside Residential Structures	
		Covered Households	% of Households Covered	Covered Households	% of Households Covered
ISANTI	5155	5043	97.8%	3519	68.3%
ISLAND LAKE	1699	1557	91.6%	1246	73.3%
KEEWATIN	522	522	100.0%	522	100.0%
MAHNOMEN	1434	1351	94.2%	1226	85.5%
MARBLE	690	625	90.6%	435	63.0%
MORA	4780	4491	94.0%	3586	75.0%
NASHWAUK	1409	1213	86.1%	884	62.7%
OGILVIE	960	953	99.3%	887	92.4%
PARK RAPIDS	4928	4815	97.7%	4418	89.7%
PINE CITY	3883	3785	97.5%	3491	89.9%
PRINCETON	6849	6730	98.3%	5944	86.8%
ROYALTON	1318	1307	99.2%	1284	97.4%
RUSH CITY	1980	1941	98.0%	1791	90.5%
SABIN	660	585	88.6%	157	23.8%
SANDSTONE	1334	1295	97.1%	1180	88.5%
STAPLES	2379	2273	95.5%	1304	54.8%
SWANVILLE	431	424	98.4%	379	87.9%

4.3 Additional Coverage Analysis Considerations

4.3.1 Additional Licenses - AT&T and Verizon

The coverage predictions included in this assessment for two commercial wireless voice providers, are limited to technical information obtained from FCC licenses in the 800 MHz frequency band. As previously stated, these two providers (AT&T Mobility and Verizon Wireless) also have FCC licenses in additional frequency bands (e.g. AWS, Lower/Upper 700 MHz), where additional wireless voice coverage is possible. The licenses in these additional bands do not specify exact geographic locations or technical parameters of cell sites, therefore, ***FE*** cannot provide coverage predictions for these carriers in these bands. These licenses do specify the Cellular Market Area (CMA) in which the provider is licensed to operate.

For example, AT&T Mobility has an active license (FCC call sign WQGA897) to operate within the Koochiching CMA in the AWS A Channel Block (1710-1755 / 2110-2115 MHz). Several CenturyLink wire centers fall within the Koochiching CMA, including the Nashwauk Wire Center, predicted in this assessment to have 59.8% population coverage in the 800 MHz cellular band. If AT&T has built out its AWS licenses within this CMA (to supplement its 800 MHz voice coverage), there may be higher levels of wireless voice coverage within this wire center. Correspondingly, higher coverage levels may also exist in other wire centers that were predicted in this assessment to have less than 60% household/population coverage.

4.3.2 Additional Licenses - Other Providers

Other wireless service providers are also licensed to operate in Minnesota on several non-800 MHz frequency bands. These providers include other national carriers such as T-Mobile® and the Sprint®, who each have area-wide licenses (i.e. no exact locations of cell sites) in other bands, such as AWS and PCS. These carriers may also provide wireless voice coverage to population and/or households beyond those that are predicted to be covered under the licenses evaluated in this assessment.

For example, one area where this could occur is in the Wilkin, MN CMA, which contains the Henning CenturyLink wire center. In the Wilkin CMA, Sprint is licensed to operate in the PCS A and PCS G channel blocks. Similarly, T-Mobile is licensed to operate in the PCS B channel block in this CMA. This assessment showed that the 800 MHz cellular licenses provided coverage to 19.9% of the Henning wire center's population. However, the existence of Sprint and T-Mobile's PCS band licenses in this CMA indicates that there may be additional wireless voice coverage beyond what is predicted in this assessment.

4.4 Conservative Modeling Techniques

As stated in § 3.2 *Coverage Analysis Methodology*, ***FE***'s RF propagation modeling software incorporates additional signal losses based on the type of environmental clutter classification (e.g. forest land, residential, agricultural) of each point considered in the analysis. For example, a point considered to be "forest land" has an additional 25 dB of signal loss incorporated into the calculations, which simulates the amount of signal loss expected when attempting to use a wireless device in a forested area.

FE uses environmental loss values based on recommendations made by the Telecommunications Industry Association (TIA) in Telecommunications Systems Bulletin(TSB) 88-D, which outlines recommendations for modeling wireless

communication systems coverage. In many cases, the recommended amounts of signal loss described in TSB-88-D present the “worst-case” situation (i.e. the highest amount of likely signal loss), which helps to ensure that modeled coverage does not exceed the real-world performance of the system.

The recommendations and loss characteristics in TSB-88-D may be more restrictive than those used by commercial wireless voice providers when modeling their coverage, and in turn when designing their systems. Therefore, it is possible that ***FE***’s coverage model represents a more conservative estimate than that used by commercial wireless carriers, and that the real-world coverage from these 800 MHz cellular systems may be greater than predicted in this assessment.

5. Conclusion

FE concludes that the 800 MHz cellular coverage of AT&T Mobility and Verizon Wireless is predicted to cover 60% or more of the **total population** within 25 of the 32 CenturyLink wire centers inside residential structures, and 30 of the 32 CenturyLink wire centers outdoors. Similarly, the coverage is predicted to cover 60% or more of the **total households** within 25 of the 32 CenturyLink wire centers inside residential structures, and 30 of the 32 CenturyLink wire centers outdoors. Also, additional population/household coverage in these wire centers is also possible, based on the points discussed in § 4 of this assessment.