Supporting Documents

1. Letter of Support From Kings Isles President Bill Stebins
2. Copy of Testimony By Randy DeFrehn, October 28, 2019 Hearing
3. Telecommunications Act of 1996, Section 704
4. Middle Class Tax Relief and Job Creation Act of 2012, Section 6409 (a) Wireless Facility Siting, National League of Cities
5. T-Mobile Engineering & Operations A2P0217A St. Lucie Trails Wireless Telecommunications Facility Radio Frequency (RF) Engineering Report
6. Examining Invisible Urban Polution and the effect on real estate value in New York City – by William Gati
7. EMF Real Estate Survey Results: "Neighborhood Cell Towers and Antennas – Do They Impact a Property's Desirability?" Electromagnetic Health Blog, March 7, 2014
8. "Wireless Towers and Home Values: An Alternative Valuation Approach Using A Spatial Econometric Analysis". Affuso, Ermanno; Cummings, J. Reid; and Le, Huubinh; On-Line February 18, 2017.
9. U.S. Department of Housing and Urban Development Archives. HUD HOC Reference Guide, "Hazards & Nuisances: Overhead High Voltage Transmission Towers and Lines". Chapter 1 Appraisal & Property Requirements, Pages 1-18f.
10. "2G, 3G, $G LTE Network Shutdown Updates." Digi International; Remmert, Harald, Sr. Director of Technology; June 8, 2021.
11. Florida SB 1944; Utilities and Communications Poles. Signed June 29, 2021.

An open letter to the Port St. Lucie City Council

My name is Bill Stebbins and I am the current President of Kings Isle in SLW. I am writing this letter to express my opinion on the proposed new cell tower in our community. I am not adverse to progress but I don't believe that enhancing revenues for companies is always in the best interests of the local residents. To wit is the fact that, to my understanding, the proposed new tower will be on the doorstep of Country Club Estates, another HOA in SLW. Knowing my fellow residents in Kings Isle I can but imagine their reaction if our community was in the same situation as Country Club Estates. I would think that the City Council chambers would be overflowing with our residents at the meeting to decide whether or not to approve the new tower.
One concern would undoubtedly be what impact would the cell tower have on the property values in CCE? I am not a real estate expert but I cannot fathom that any such effect would be positive.
In recent years the levels of cell capability have continued to grow. We have all seen the stories of the potential harm which might befall individuals near these towers. Like most, I do not have the technical knowledge to make any such assessment but rely on those to provide it for me. It is not difficult to find articles on the internet which are less than positive on this subject.
Unless I am mistaken, I understand that this new tower was previously rejected by the City Council. I would ask the City Council to carefully consider if approving the proposed tower would be in the best interests of the retirees and tax payers of PSL. There would be nothing wrong by reaffirming their previous correct decision.

Respectfully submitted,

Bill Stebbins
President – Kings Isle Community Association

**To the Representatives of the communities of Country Club Estates and the residents they represent:**

The following document was presented to the Port St. Lucie City Council at their meeting held October 28, 2019 when they considered the application to construct a cell tower on the property of St. Lucie Trails Golf Course. Following a presentation by the applicant, comments by the community, and discussion on the motion to approve the application (including an appeal to the applicant to reduce the height of the tower to not greater than the height of the tallest trees, which they rejected), the Council voted unanimously to deny the application.

While the Council's action is final, the owners have a right to seek a judicial appeal. The residents of Fairway Isles, through their HOA, urge the Board of Country Club Estates and those of all of the component communities, to actively oppose any such appeal as construction of a 150-foot cell tower as proposed, would undoubtedly have an adverse impact on the property values in our entire community. Such an impact is not only a hardship for the home owners, failure to take such a position opens those of us who, by virtue of our respective positions as elected representatives to the Boards of our communities, to potential fiduciary liability for failure to take appropriate action to protect such values.

We offer these thoughts, based on the applicable zoning codes, as a basis for the court to uphold the decision by the Council.

Good evening. My name is Randy DeFrehn. My wife Margaret and I are year-round residents of the Fairway Isles community, which is adjacent to the St. Lucie Trails golf course.

Thank you for the opportunity to offer the following concerns and observations we have with respect to the application for a Special Use Exception for the construction of a cell phone tower on the St. Lucie Trails golf course property.

Section 158.255 – Intent

States that "*due to the potentiality for their incompatibility with adjoining land uses,*" Special Use Exception designations "*may be permitted within the zoning district classifications only after affirmative findings that they can be developed at particular locations in a compatible manner.*"

While most of the criteria set forth for your consideration deal with their impact upon properties that are adjacent to the proposed site, which our neighborhood, Fairway Isles is not. Nevertheless, the applicable code stipulates that "*Approval of a special exception shall be granted by the City Council* ***only*** *upon a finding that:*"

In this case the controlling language is cited in Section 158.260. subparagraphs (J) and (K) which state in pertinent part:

(J) *...The proximity or separation and potential impact of the proposed use (including size and height of buildings, ...)* ***on nearby property*** *will be considered in the submittal and analysis of the request. The City may request project design changes, changes to the proposed use to mitigate the impacts upon adjacent properties and the neighborhood....and*

*(K) As an alternative to reducing the scale and/or magnitude of the project as stipulated in criteria (J) above, the City may deny the request for the proposed use if the use is considered incompatible, too intensive or intrusive upon the nearby area and would result in excessive disturbance or nuisance from the use altering the character of the neighborhood.*

The installation of a cell tower with an estimated height of 150' falls squarely in the purview of these specific considerations as its proximity to nearby property – including Fairway Isles, and virtually all of the residents of Country Club Estates – is clearly "incompatible, too intensive (in this case ***and)*** intrusive upon the nearby area and will result in a "nuisance from the use altering the character of the neighborhood."

Not only will such structure tower over the community, detracting from the existing view of the natural surroundings, it will certainly result in a reduction in property values that accompany the current neighborhood, resulting over the long term in a reduction in property tax revenues for the respective jurisdictions. While this structure will undoubtedly result in new revenues, those revenues will accrue only to the owner. We have no objection to the owners maximizing their earnings potential, however, we do object when the result is a depreciation of the character and individual property values of the neighborhood.

It is my understanding that the owners contend that this tower will provide additional safety to the neighborhood by improving cell phone service. In my experience, cell service providers are willing and, in or case, have provided cell service boosters to assist with less than optimal cell service.

In closing, a tower of the type under consideration more appropriately belongs in an area zoned for light industrial use. Barring that, we believe that Council should require clear restrictions on the proposed tower's height not to exceed the height of the tallest trees in the neighborhood to achieve the mandate set forth in subparagraph (J), above, would allow the owners to realize most, if not all, of the revenues this project are expected to produce, without doing irreparable harm to the rest of the community.

Thank you, once again for providing us with the opportunity to introduce our concerns regarding this application for your consideration.

Respectfully Submitted,

Randy G. DeFrehn
403 SW Fairway Landing
Port St. Lucie, Fl 34986

3.

SEC. 704. FACILITIES SITING; RADIO FREQUENCY EMISSION STANDARDS.

(a) NATIONAL WIRELESS TELECOMMUNICATIONS SITING POLICY- Section 332(c) (47 U.S.C. 332(c)) is amended by adding at the end the following new paragraph: `(7) PRESERVATION OF LOCAL ZONING AUTHORITY-

`(A) GENERAL AUTHORITY- Except as provided in this paragraph, nothing in this Act shall limit or affect the authority of a State or local government or instrumentality thereof over decisions regarding the placement, construction, and modification of personal wireless service facilities.

`(B) LIMITATIONS-

`(i) The regulation of the placement, construction, and modification of personal wireless service facilities by any State or local government or instrumentality thereof—

`(I) shall not unreasonably discriminate among providers of functionally equivalent services; and

`(II) shall not prohibit or have the effect of prohibiting the provision of personal wireless services.

`(ii) A State or local government or instrumentality thereof shall act on any request for authorization to place, construct, or modify personal wireless service facilities within a reasonable period of time after the request is duly filed with such government or instrumentality, taking into account the nature and scope of such request.

`(iii) Any decision by a State or local government or instrumentality thereof to deny a request to place, construct, or modify personal wireless service facilities shall be in writing and supported by substantial evidence contained in a written record.

`(iv) No State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the Commission's regulations concerning such emissions.

`(v) Any person adversely affected by any final action or failure to act by a State or local government or any instrumentality thereof that is inconsistent with this subparagraph may, within 30 days after such action or failure to act, commence an action in any court of competent jurisdiction. The court shall hear and decide such action on an expedited basis. Any person adversely affected by an act or failure to act by a State or local government or any instrumentality thereof that is inconsistent with clause (iv) may petition the Commission for relief.

`(C) DEFINITIONS- For purposes of this paragraph—

`(i) the term `personal wireless services' means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services;

`(ii) the term `personal wireless service facilities' means facilities for the provision of personal wireless services; and `(iii) the term `unlicensed wireless service' means the offering of telecommunications services using duly authorized devices which do not require individual licenses, but does not mean the provision of direct-to-home satellite services (as defined in section 303(v)).'. (b) RADIO FREQUENCY EMISSIONS- Within 180 days after the enactment of this Act, the Commission shall complete action in ET Docket 93-62 to prescribe and make effective rules regarding the environmental effects of radio frequency emissions. (c) AVAILABILITY OF PROPERTY- Within 180 days of the enactment of this Act, the President or his designee shall prescribe procedures by which Federal departments and agencies may make available on a fair, reasonable, and nondiscriminatory basis, property, rights-of-way, and easements under their control for the placement of new telecommunications services that are dependent, in whole or in part, upon the utilization of Federal spectrum rights for the transmission or reception of such services. These procedures may establish a presumption that requests for the use of property, rights-of-way, and easements by duly authorized providers should be granted absent unavoidable direct conflict with the department or agency's mission, or the current or planned use of the property, rights-of-way, and easements in question. Reasonable fees may be charged to providers of such telecommunications services for use of property, rights-of-way, and easements. The Commission shall provide technical support to States to encourage them to make property, rights-of-way, and easements under their jurisdiction available for such purposes.

4.

Wireless Facility Siting: Model Chapter Implementing Section 6409(a) and

Wireless Facility Siting: Section 6409(a) Checklist

Section 6409(a) of the Middle Class Tax Relief and Job Creation Act of 2012 mandates that a State or local government approve certain wireless broadband facilities siting requests for modifications and collocations of wireless transmission equipment on an existing tower or base station that does not result in a substantial change to the physical dimensions of such tower or base station. In October 2014, the Federal Communications Commission unanimously approved rules interpreting Section 6409(a).

In an effort to assist jurisdictions with limited resources to comply with the new rules, wireless industry associations PCIA and CTIA affirmatively committed to working with local government associations – the National League of Cities, the National Association of Counties, and the National Association of Telecommunications Officers and Advisors – to: 1) develop a model ordinance and application for reviewing eligible facilities requests under Section 6409(a); 2) distribute wireless siting best practices; 3) create a checklist that local government officials can use to help streamline the review process; and 4) hold webinars regarding the application process.

As we have made clear, neither the model ordinance nor checklist is intended to provide legal advice; we strongly encourage jurisdictions to consult with an attorney on legal matters. Further, neither the model ordinance nor checklist imposes any legal obligation whatsoever on any jurisdiction. These documents are meant only to provide a framework that jurisdictions may voluntary use to determine if their current wireless siting review process complies with the FCC's new rules.

The FCC rules do not require jurisdictions to use or adopt these documents. Some localities may need to revise their existing local laws to the extent that they conflict with the new rules. Some localities with consistent local laws or no laws that regulate wireless deployments may not need to take any legislative action for compliance.

Some may view the model ordinance and checklist as overly broad or too narrow in scope. The presence or absence of any provision or item should not be seen as either an express endorsement or rejection of the provision or item. Again, these documents are not intended to provide legal advice.

Legal or regulatory action challenging the FCC's rules may be taken. In the event any such efforts result in a change in the rules, we will notify our members of such via websites, publications, and all other appropriate means.

Finally, if your jurisdiction has an ordinance or checklist implementing Section 6409(a) and the FCC's rules, please send it to Julia Pulidindi at: Pulidindi@nlc.org. We will make these materials available to our members. In addition, in preparation for the development of *voluntary* wireless broadband facilities siting best practices, we encourage you to share your experiences in dealing with the new rules with us. Tell us what works, what doesn't, and how the process could be made better.

# Wireless Facility Siting: Model Chapter Implementing Section 6409(a)

Note: Use of this model chapter is voluntary. It is meant to provide a framework for those jurisdictions needing assistance in complying with Federal timeframes to act on Eligible Facilities Requests for modifications to existing wireless towers or base stations that do not substantially change the physical dimensions of such towers or base stations. This document is not intended to provide legal guidance; jurisdictions are encouraged to consult an attorney on legal matters.

## I. PURPOSE

This Chapter implements Section 6409(a) of the Middle Class Tax Relief and Job Creation Act of 2012 ("Spectrum Act"),[1] as interpreted by the Federal Communications Commission's ("FCC" or "Commission") Acceleration of Broadband Deployment Report & Order,[2] which requires a state or local government to approve any Eligible Facilities Request for a modification of an existing tower or base station that does not result in a substantial change to the physical dimensions of such tower or base station.

## II. DEFINITIONS[3]

For the purposes of this Chapter, the terms used have the following meanings:[4]

a. *Base Station.* A structure or equipment at a fixed location that enables FCC-licensed or authorized wireless communications between user equipment and a communications network. The term does not encompass a tower as defined herein or any equipment associated with a tower. Base Station includes, without limitation:
   i. Equipment associated with wireless communications services such as private, broadcast, and public safety services, as well as unlicensed wireless services and fixed wireless services such as microwave backhaul.
   ii. Radio transceivers, antennas, coaxial or fiber-optic cable, regular and backup power supplies, and comparable equipment, regardless of technological configuration (including Distributed Antenna Systems ("DAS") and small-cell networks).
   iii. Any structure other than a tower that, at the time the relevant application is filed with [jurisdiction] under this section, supports or houses equipment described in paragraphs (a)(i)-(a)(ii) that has been reviewed and approved

[1] Middle Class Tax Relief and Job Creation Act of 2012, 112 Pub. L. 96, *codified at* 47 U.S.C. 1455.
[2] Acceleration of Broadband Deployment by Improving Wireless Facilities Siting Policies, *Report and Order*, 29 FCC Rcd 12865 (2014) ("2014 Infrastructure Order").
[3] These definitions were adapted from the FCC's own definitions. *See generally* 47 CFR § 1.40001(b). For a discussion of these definitions, see 2014 Infrastructure Order ¶¶ 145-204.
[4] A jurisdiction may wish to incorporate these definitions, which are specific to Section 6409(a), into its wireless facilities ordinance more broadly; alternatively, these can be stand-alone definitions solely for Eligible Facilities Requests under Section 6409(a).

under the applicable zoning or siting process, or under another State or local regulatory review process, even if the structure was not built for the sole or primary purpose of providing that support.

The term does not include any structure that, at the time the relevant application is filed with [jurisdiction] under this section, does not support or house equipment described in (a)(i)-(ii) of this section.

b. *Collocation.* The mounting or installation of transmission equipment on an eligible support structure for the purpose of transmitting and/or receiving radio frequency signals for communications purposes.
c. *Eligible Facilities Request.* Any request for modification of an existing tower or base station that does not substantially change the physical dimensions of such tower or base station, involving:
    i. Collocation of new transmission equipment;
    ii. Removal of transmission equipment; or
    iii. Replacement of transmission equipment.
d. *Eligible support structure.* Any tower or base station as defined in this section, provided that it is existing at the time the relevant application is filed with [jurisdiction] under this section.
e. *Existing.* A constructed tower or base station is existing for purposes of this section if it has been reviewed and approved under the applicable zoning or siting process, or under another State or local regulatory review process, provided that a tower that has not been reviewed and reviewed because it was not in a zoned area when it was built, but was lawfully constructed, is existing for purposes of this section.
f. *Site.* For towers other than towers in the public rights-of-way, the current boundaries of the leased or owned property surrounding the tower and any access or utility easements currently related to the site, and, for other eligible support structures, further restricted t that area in proximity to the structure and to other transmission equipment already deployed on the ground.
g. *Substantial Change.* A modification substantially changes the physical dimensions of an eligible support structure if it meets any of the following criteria:
    i. For towers other than towers in the public rights-of-way, it increases the height of the tower by more than 10% or by the height of one additional antenna array with separation from the nearest existing antenna not to exceed twenty feet, whichever is greater; for other eligible support structures, it increases the height of the structure by more than 10% or more than ten feet, whichever is greater;[5]

[5] Changes in height should be measured from the original support structure in cases where deployments are or will be separated horizontally, such as on buildings' rooftops; in other circumstances, changes in height should be measured from the dimensions of the tower or base station, inclusive of originally approved appurtenances and any modifications that were approved prior to the passage of the Spectrum Act. 47 CFR § 1.40001(b)(7)(i)(A).

ii. For towers other than towers in the public rights-of-way, it involves adding an appurtenance to the body of the tower that would protrude from the edge of the tower more than twenty feet, or more than the width of the Tower structure at the level of the appurtenance, whichever is greater; for other eligible support structures, it involves adding an appurtenance to the body of the structure that would protrude from the edge of the structure by more than six feet;

iii. For any eligible support structure, it involves installation of more than the standard number of new equipment cabinets for the technology involved, but not to exceed four cabinets; or, for towers in the public rights-of-way and base stations, it involves installation of any new equipment cabinets on the ground if there are no pre-existing ground cabinets associated with the structure, or else involves installation of ground cabinets that are more than 10% larger in height or overall volume than any other ground cabinets associated with the structure;

iv. It entails any excavation or deployment outside the current site;

v. It would defeat the concealment elements of the eligible support structure; or

vi. It does not comply with conditions associated with the siting approval of the construction or modification of the eligible support structure or base station equipment, provided however that this limitation does not apply to any modification that is non-compliant only in a manner that would not exceed the thresholds identified in paragraphs (g)(i)-(g)(iv) of this section.[6]

h. *Transmission Equipment.* Equipment that facilitates transmission for any FCC-licensed or authorized wireless communication service, including, but not limited to, radio transceivers, antennas, coaxial or fiber-optic cable, and regular and backup power supply. The term includes equipment associated with wireless communications services including, but not limited to, private, broadcast, and public safety services, as well as unlicensed wireless services and fixed wireless services such as microwave backhaul.

i. *Tower.* Any structure built for the sole or primary purpose of supporting any FCC-licensed or authorized antennas and their associated facilities, including structures that are constructed for wireless communications services including, but not limited to, private, broadcast, and public safety services, as well as unlicensed wireless services and fixed wireless services such as microwave backhaul, and the associated site.

[6] *See* 2014 Infrastructure Order ¶ 200. This section identifies the limited number of prior conditions of site approval that may not be used to determine whether a modification qualifies as a substantial change. *Id.*

## III. APPLICATION REVIEW[7]

a. *Application.* [Jurisdiction] shall prepare and make publicly available an application form which shall be limited to the information necessary for [jurisdiction] to consider whether an application is an Eligible Facilities Request. The application may not require the applicant to demonstrate a need or business case for the proposed modification.

b. *Type of Review.* Upon receipt of an application for an Eligible Facilities Request pursuant to this Chapter, [identify appropriate department– e.g., Public Works, Planning] shall review such application to determine whether the application so qualifies.[8]

c. *Timeframe for Review.* Within 60 days of the date on which an applicant submits an application seeking approval under this Chapter, [jurisdiction] shall approve the application unless it determines that the application is not covered by this Chapter.

d. *Tolling of the Timeframe for Review.* The 60-day review period begins to run when the application is filed, and may be tolled only by mutual agreement by [jurisdiction] and the applicant, or in cases where [jurisdiction's reviewing body] determines that the application is incomplete. The timeframe for review is not tolled by a moratorium on the review of applications.
   i. To toll the timeframe for incompleteness, [jurisdiction] must provide written notice to the applicant within 30 days of receipt of the application, specifically delineating all missing documents or information required in the application.
   ii. The timeframe for review begins running again when the applicant makes a supplemental submission in response to [jurisdiction's] notice of incompleteness.
   iii. Following a supplemental submission, [jurisdiction] will notify the applicant within 10 days that the supplemental submission did not provide the information identified in the original notice delineating missing information. The timeframe is tolled in the case of second or subsequent notices pursuant to the procedures identified in paragraph (d) of this section. Second or subsequent notices of incompleteness may not specify missing documents or information that were not delineated in the original notice of incompleteness.

b. *Interaction with Section 332(c)(7).*[9] If [jurisdiction] determines that the applicant's request is not covered by Section 6409(a) as delineated under this Chapter, the

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[7] This section was adapted from the FCC's rules. *See generally* 47 CFR § 1.40001(c). For a discussion of application review processes, see 2014 Infrastructure Order ¶¶ 205-236.
[8] The jurisdiction may wish to review whether existing processes meet the requirements of the 2014 Infrastructure Order. *See, e.g.,* 47 CFR § 1.40001(c)(1); 2014 Infrastructure Order ¶ 214.
[9] *See* 47 U.S.C. § 332(c)(7); *In re* Petition for Declaratory Ruling to Clarify Provisions of Section 332(c)(7)(B) to Ensure Timely Siting Review and to Preempt Under Section 253 State and Local Ordinances that Classify

presumptively reasonable timeframe under Section 332(c)(7), as prescribed by the FCC's Shot Clock order, will begin to run from the issuance of [jurisdiction's] decision that the application is not a covered request. To the extent such information is necessary, [jurisdiction] may request additional information from the applicant to evaluate the application under Section 332(c)(7)[10], pursuant to the limitations applicable to other Section 332(c)(7) reviews.[11]

c. *Failure to Act.* In the event [jurisdiction] fails to approve or deny a request seeking approval under this Chapter within the timeframe for review (accounting for any tolling), the request shall be deemed granted. The deemed grant does not become effective until the applicant notifies the applicable reviewing authority in writing after the review period has expired (accounting for any tolling) that the application has been deemed granted.

d. *Remedies.* Applicants and [jurisdiction] may bring claims related to Section 6409(a) to any court of competent jurisdiction.

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All Wireless Siting Proposals as Requiring a Variance, *Declaratory Ruling*, 24 FCC Rcd 13994 (2009) ("Shot Clock Ruling"), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-09-99A1_Rcd.pdf.

[10] *See* 2014 Infrastructure Order ¶ 220. For example, an applicant may submit a request for review under Section 6409(a) asserting the modification does not substantially change the physical dimensions of the facility, when in fact the application proposes a substantial change and is therefore not covered under Section 6409(a). *See id.*

[11] *See* 2014 Infrastructure Order ¶¶ 258-260 (prescribing limits on application review and tolling for applications under Section 332(c)(7)).

5.

T · · Mobile ·

Engineering & Operations

# A2P0217A

# St Lucie Trails

# Wireless Telecommunication Facility

## Radio Frequency (RF) Engineering Report

| | |
|---|---|
| Last Updated | 03/18/21 |
| Revision Number | V1.4 |

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## Search Ring Area

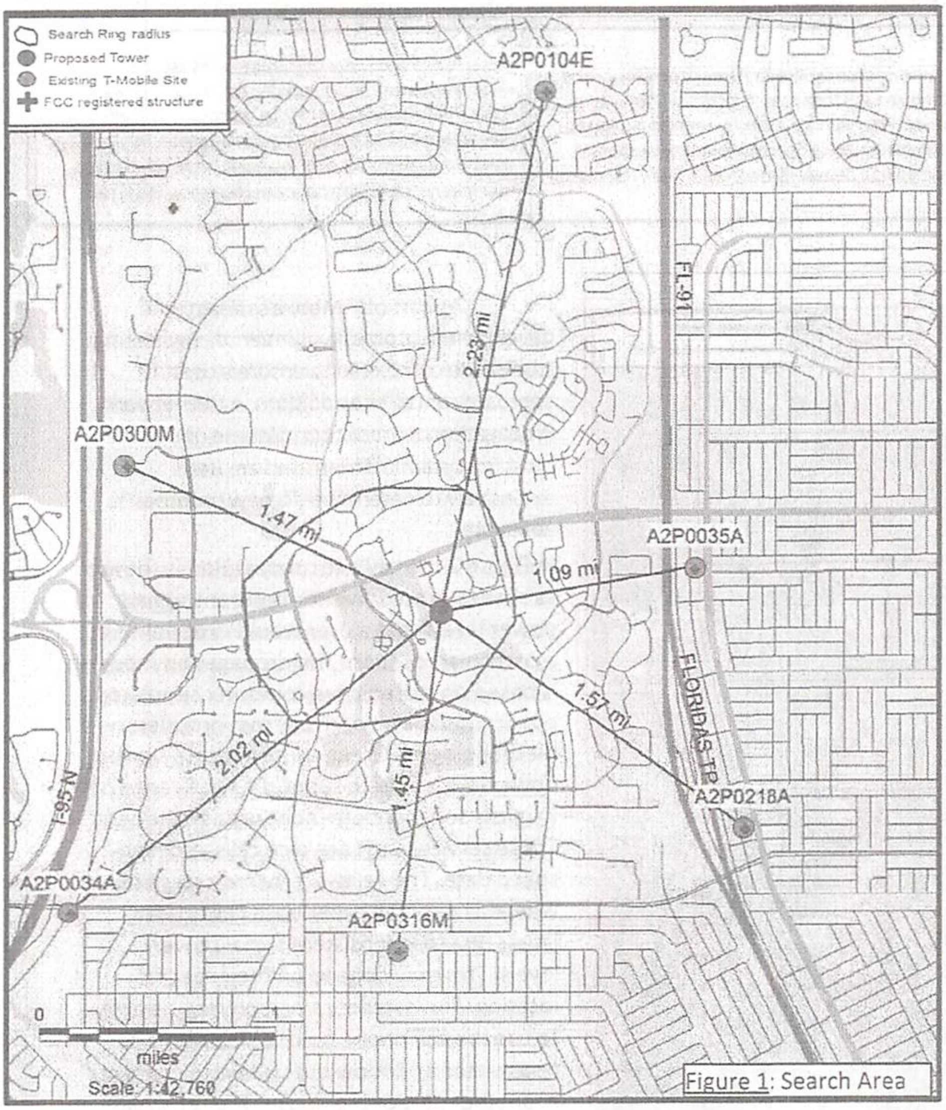



Figure 1: Search Area

As part of T-Mobile's commitment to improve service in the south Florida market a number of "search rings" have been issued to address coverage deficiencies in the cellular network. Each search ring is in an area where service levels are inadequate to provide the necessary cell phone coverage or capacity. Within the search ring existing towers or structures of sufficient height are sought with the goal of deploying radio transceivers and antennas to improve the local area service levels.

Due to the dramatic increase in cell phone traffic and the popularity of wireless data applications over the last few years, significant demands have been placed on network coverage and capacity. One such area in need of improved services is in the area of St Lucie County from approximately NW Peacock Blvd in the north to Crosstown Pkwy in the south and from NW California Blvd in the west to SW/NW Cashmere Blvd in the east. Coverage levels are too low to support the capacity and coverage needs for this part of the network. Users placing calls indoors and especially during network busy hours may experience dropped calls, ineffective network attempts and slow data application speeds. In the worst-case a user may not be able to place a E911 call. There were no towers or structures of sufficient height within the T-Mobile search area that could accommodate the addition of new facility that would provide an adequate coverage improvement. The surrounding facilities have undergone extensive upgrades over the last decade with no appreciable improvement in service levels in the area of concern. Shown above in Figure 1 is the T-Mobile search ring and the proposed location surrounded by existing T-Mobile cellular facilities ("cell sites"). The addition of a new tower of 120' elevation will alleviate the significant service issues in this area.

| TMO ID | Name | Class | Address | City | Antenna Elevation (ft) | Structure Height (ft) | Distance (mi) |
|---|---|---|---|---|---|---|---|
| A2P0035A | Atlantic Coast | Monopole | 601 SW Bitmore Street | Port St Lucie | 150 | 150 | 1.1 |
| A2P0316M | 1033 - 3_33 - Apachee Park Tower S | Flag Pole | 1445 SW Apache Avenue | Port Saint Lucie | 144 | 150 | 1.5 |
| A2P0300M | ALLTEL RESERVE/FPL | Monopole | 417 NW FPL Drive | Port Saint Lucie | 120 | 150 | 1.5 |
| A2P0218A | Crown 813897 Crosstown | Monopole | 1365 SW Biltmore Street | Port Saint Lucie | 145 | 150 | 1.6 |
| A2P0034A | AT&T | Self Support Tower | 2200 SW JULIET AV | Port Saint Lucie | 176 | 300 | 2.0 |
| A2P0104E | Crown 810821 Torino | Flag Pole | 5490-TW NW East Torino Parkway | Port Saint Lucie | 116 | 120 | 2.2 |

## Current Cell Site Coverage and Predicted Improvements

| Good (reliable indoor service) | Average (reliable outdoor service) | below average (poor service) |
|---|---|---|
| Signal power levels able to support a wide range of wireless services both indoors and outdoors. These services include voice calls and high-speed data. | Users may experience call quality issues depending on the signal power levels at their specific location. These issues could include dropped calls, ineffective attempts (blocked calls) or slow data speeds. Service in outdoor locations would be markedly better than indoors in many instances. | A user would encounter call quality issues especially indoors or during network busy hours due to low signal power levels. These issues could include dropped calls, ineffective attempts (blocked calls) and slow data speeds. Service may only be available in outdoor locations. In the worst case a user may not be able to place an emergency (E911) call. |

Existing Coverage

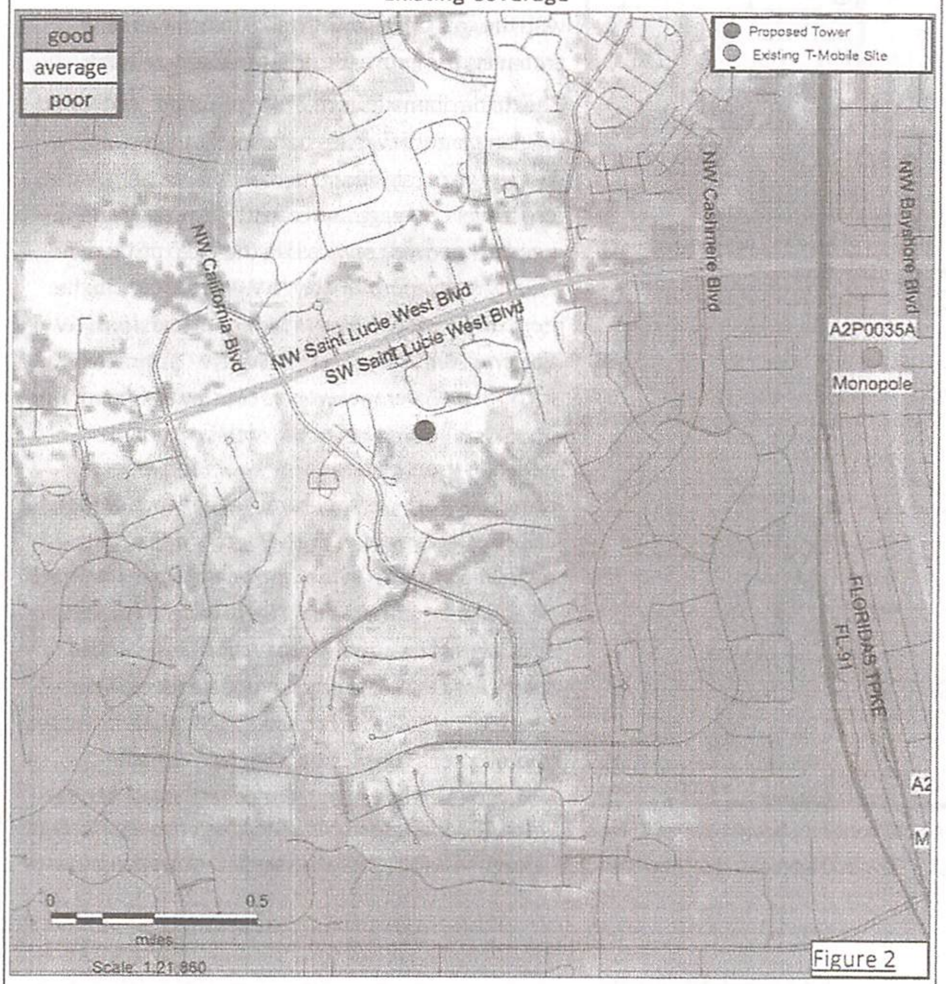



Figure 2

As part of T-Mobile's design and development process a number of engineering studies are completed to ensure a best-fit approach for cell site additions in the network. Propagation or prediction plots are one of the most important of these and are used extensively to determine if a new proposal is adequate.

In Figure 2 the cell site propagation is shown as shades of color which represent signal power levels that a user would experience at a particular location. The propagation model is based on a predictive computer simulator application that is derived from proprietary methodologies. Green areas indicate signal power levels able to support a wide range of wireless services both indoors and outdoors. These services include voice calls and high-speed data. The yellow color indicates areas where a user may experience call quality issues due to inconsistent signal power levels. This may depend on their specific location. For instance, a person may be able to use the cell phone on one side of their house near a window but unable to connect in another part of the house. The red areas represent where a user would encounter call quality issues due to low or unusable signal power levels. This would be especially true indoors or during network busy hours. These issues could include dropped calls, ineffective attempts and slow data speeds. In the worst case a user may not be able to place an emergency (E911) call.

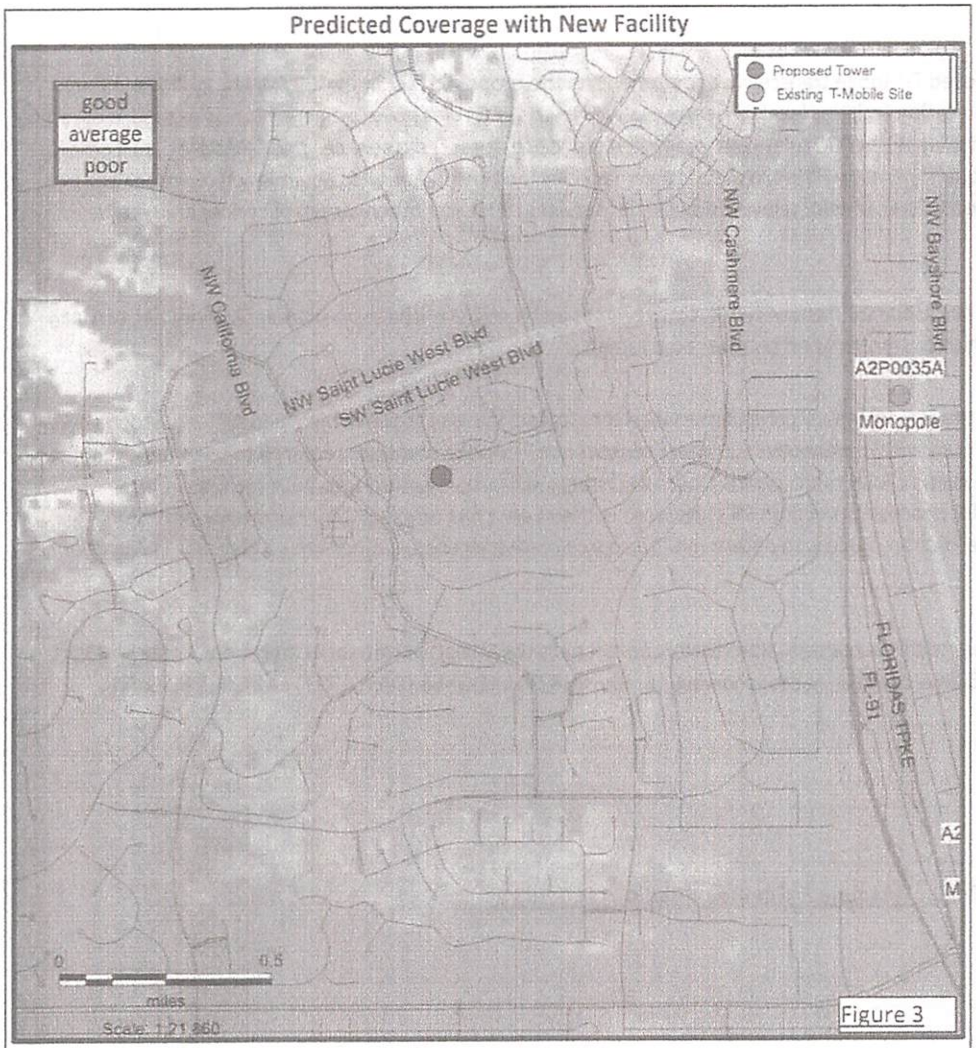


Figure 3

The propagation map shown in Figure 3 depicts the predicted signal power levels for the proposed tower when added to the existing network. As can be seen almost all the residential areas have a minimum of average service levels. This is especially important for users who are transitioning from one geographic area to another due to a more consistent coverage overlay. Users indoors will also benefit tremendously due to the closer proximity to the antenna locations. Areas where below average signal power levels still exist can sometimes be alleviated through network optimization methods after the new site comes online. (These processes are iterative and require a more medium to long term engineering approach)

In summary, T-Mobile has recognized the demand for advanced telecommunication services in these communities. The existing T-Mobile facilities cannot provide these services through upgrade or expansion, due to the distances from the existing tower facilities and cell phone users in this area. Further, no towers or structures of sufficient height were identified in the search ring that could provide the necessary improvements to the network coverage.

These propagation maps graphically demonstrate T-Mobile's business needs based upon existing and predicted customer demands. T-Mobile's goal is to provide reliable wireless service in the areas shown as defined by proprietary QOS (Quality of Service) design parameters.

## Certification Statement of Non-interference

This letter provides information about the proposed T-Mobile transceiving equipment on the proposed facility at 460 SW Utility Drive in Port Saint Lucie, FL and its potential interference with communication facilities located nearby; as well as the FCC rules governing the human exposure to radio frequency energy (OET 65 guidelines). T-Mobile shall comply with all FCC rules regarding interference to other radio services and T-Mobile shall comply with all FCC rules regarding human exposure to radio frequency energy. The proposed tower facilities, and reception and transmission functions will not interfere with the visual and customary transmission or reception of radio, television or similar services as well as other wireless services enjoyed by surrounding properties.

The Federal Communication Commission (FCC) has allocated frequencies exclusively for use by cellular service providers. Each cellular service provider is assigned specific frequencies (channels) on which to transmit and receive radio signals.

Cellular transmitters must be type-accepted by the FCC to ensure compliance with technical standards that limit the frequencies, output power, radio frequency emissions, spurious radio noise and other technical parameters. Cellular licensees like T-Mobile owns are required to use type-accepted equipment. The assignment of frequencies and FCC rules keep cellular radio signals from interfering with or being interfered with by other radio transmissions and provide guidelines outlining the limits for permissible human RF exposure. In the event of a complaint of interference or other concerns about cellular antenna facilities, the FCC has a resolution process to determine the source of interference and whether a facility is in compliance with FCC rules.

In the event of interference or other known issues with the transmission facility contact with the T-Mobile Network Operations Center (NOC) can be established 24 hours a day, 7 days a week 365/366 days per year at the following numbers: (877) 611-5868 (DAY), (877) 611-5868 (NIGHT)

Name Patrick Keane

Title T-Mobile Sr Engineer, Radio Frequency

P Keane

Signature

## Appendix A: Cellular Traffic Increase and Impact on Network Performance

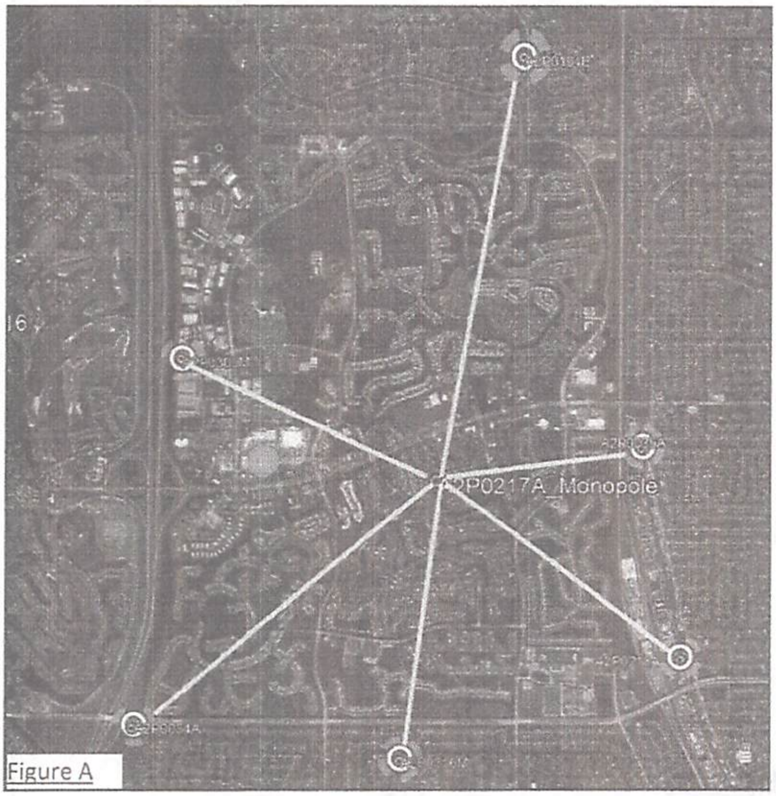


Figure A

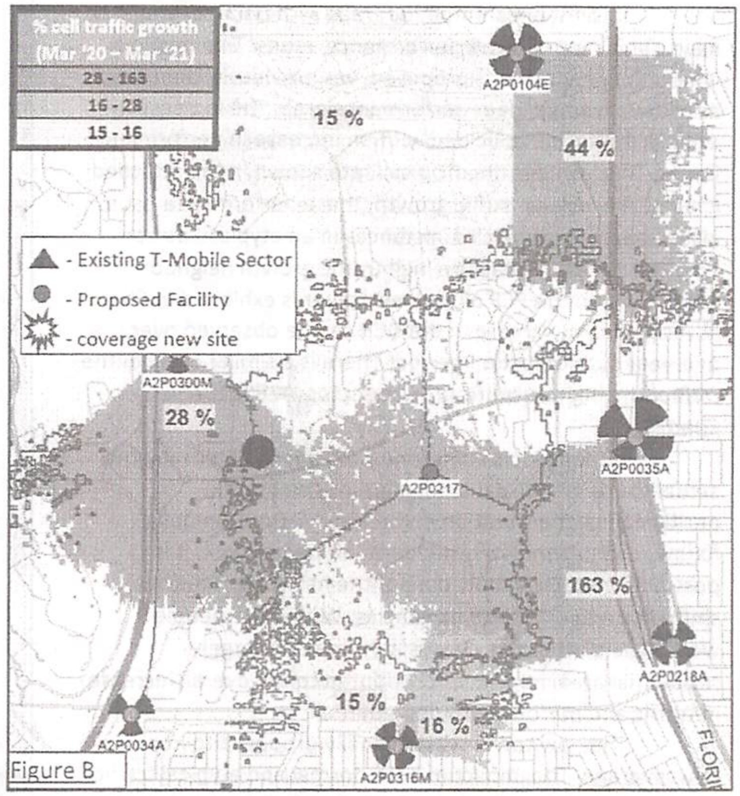


Figure B

Table A

| Site_sector | % cell traffic growth (Mar '20 – Mar '21) | Sector Azimuth (from true north) |
|---|---|---|
| A2P0218A_4 | 163% | 315° |
| A2P0104E_2 | 44% | 120° |
| A2P0300M_2 | 28% | 180° |
| A2P0035A_3 | 28% | 210° |
| A2P0316M_1 | 16% | 60° |
| A2P0104E_3 | 15% | 240° |
| A2P0316M_4 | 15% | 330° |
| A2P0218A_3 | 13% | 255° |

Cellular traffic growth, or the amount of cell phone usage increasing over time is a normal part of cell phone network operations. As more electronic devices connect to the network and new and more applications are utilized, usage generally increases. In some circumstances there may be atypical increases in cellular traffic at the cellular facilities or in a given area. This may include when a new residential development or commercial center is constructed nearby one of the sites. (A site or facility is the location of T-Mobile equipment including a base-station and antennas, usually on a tower or rooftop)

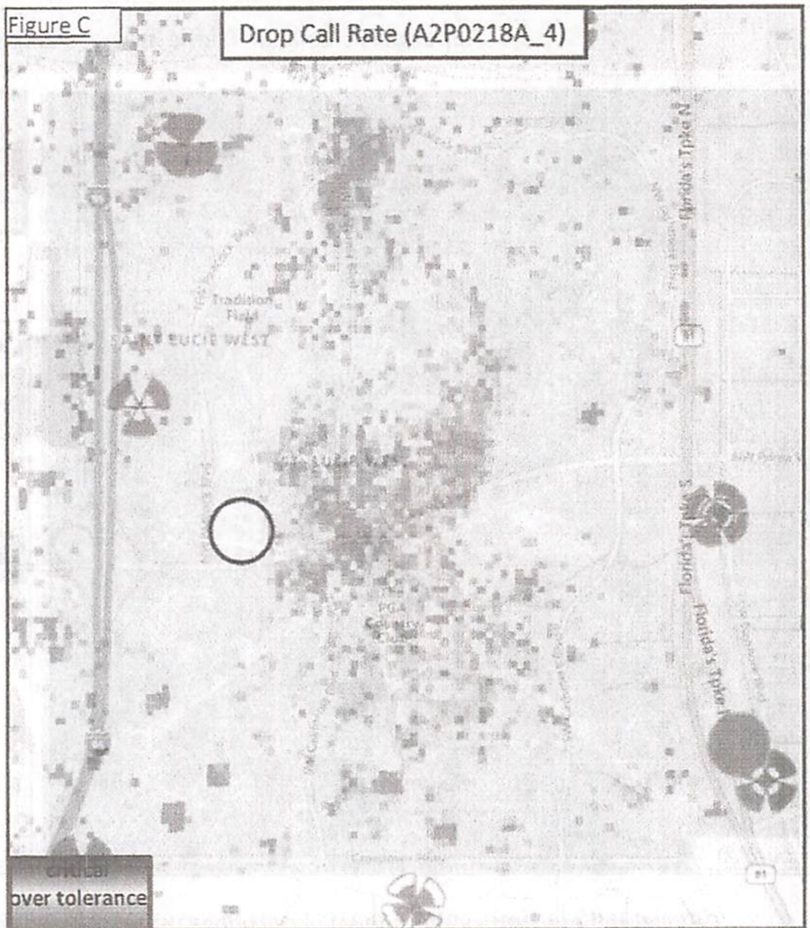
One such area is shown in Figure A with the proposed facility in the center with radials indicating the neighbor or adjacent facilities. (see Search Ring section of this report for more details) The proposed tower is necessary to improve the network coverage. Four of six of the neighbor sites have shown a significant increase in cellular usage over the last year. In particular, the fourth sector of site A2P0218A to the southeast of the proposed tower has seen traffic growth by one-hundred-sixty-three percent. (a sector is an antenna array deployed at a facility that focuses the transmission/reception in a specific direction) In Figure B a map of the proposed tower location and the adjacent sites are displayed. The sectors or directional antenna arrays for each of the existing facilities are indicated by the dark wedges. Overlaid on the proposed tower location is the predicted coverage footprint (PCF) from that site. (blue outline) The PCF of the facilities' sectors with significant cellular traffic growth are color coded with the percentage of that growth over a one-year period. (red/orange/yellow polygons) Note that the PCF from the proposed tower overlaps with the existing PCFs. During network integration the PCF for each tower will be balanced. This is important so the new tower can offload or pick up excessive cellular traffic from its neighbors. The percentage of the sectors' cellular traffic growth over the course of one year and the direction or azimuth of the antenna arrays are shown in Table A.

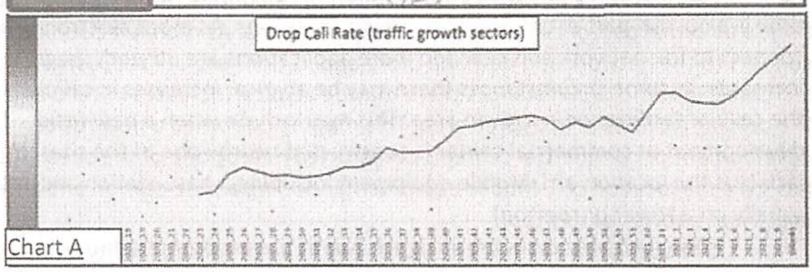
When a facility is serving an area and there is a traffic increase that is above the operational threshold of that facility it can no longer add new users. Devices connected to that facility would experience performance degradation that may include inability to access services, interference, slow speeds and dropped connections. In Figure C, the drop call rate (DCR) indicates that there is significant performance degradation in the areas where the new facility will cover. Users attempting to maintain connections are more likely to have their voice or data session disconnected. The new tower will alleviate these conditions.

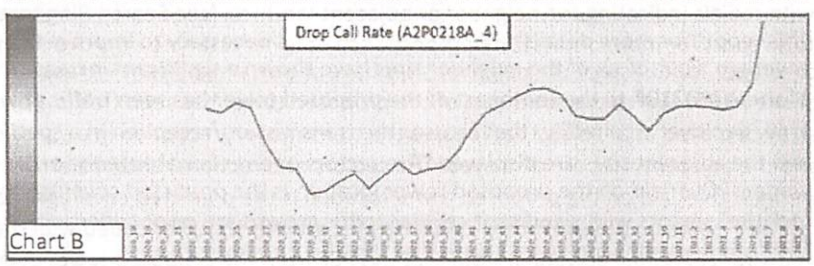
It is not uncommon for areas with poor coverage to have significant network performance issues. The location where the new tower is proposed was previously identified as a low-coverage, poor performance area. The increase in cellular traffic has coincided with an increase in performance issues. This includes the drop call rate shown in the attached charts. Like cellular traffic growth, these performance issues also increase in some circumstances in an atypical fashion. The trend in DCR for all the high traffic growth neighbor sectors within the PCF of the new tower is exhibited in Chart A. A significant increase in the DCR can be observed over the one-year data collection period. There is a similar chart of the DCR of the highest traffic growth sector, A2P0218A_4 in Chart B.

Although it is sometimes difficult to determine the actual cause of unusual or incongruous call traffic performance, the situation in the area in question does follow recent trends in other parts of the network. It is possible if not likely that some of the network traffic has shifted due to COVID-19 exigencies. With more people working and attending classes at home, this largely residential area may have contributed to the overall increase in traffic and performance degradation.

The new tower was originally proposed to improve low coverage. The impact of both normal and atypical traffic increases reinforces the need for a new facility in order to meet T-Mobile's service goals.



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# Examining invisible urban pollution and its effect on real estate value in New York City - by William Gati

September 19, 2017 - Spotlights

William Gati, Architecture Studio

In 1966 New York City a toxic three-day smog descended Thanksgiving weekend, blanketing the city with smoke, haze, carbon monoxide and sulfur dioxide. Those three days became a catalyst in the effort to address urban pollution.

Present-day New York City faces environmental challenges as great, or greater, than those of 1966—and many of them are invisible pollutants that threaten humans, animals and the environment.

**Invisible pollutants and the threats they pose**

Noise pollution: There is a noise complaint in New York City every four minutes. Workplace and environmental noise cause hearing loss, heart disease and suppression of the immune system.

Light pollution: Excessive artificial lighting degrades natural light. Light pollution increases fatigue, headaches, anxiety and stress. It disrupts birds' migratory patterns and life cycles of plants.

EMF: Electromagnetic fields, radio waves and the radiation of wireless technology are real. Scientists know EMF produce harmful effects even at lower levels emitted by appliances and electronic devices.

Air pollution continues to be a problem. The "environmental load" borne by poorer neighborhoods is extreme, but the entire city suffers from air pollution.

Congestion (both human and traffic density), while hardly invisible, contributes to gridlock, road rage and long commutes.

## NYC and the NYC Zoning and Building Code

Ironically, New York City's high population density actually mitigates toxicity. A dense population encourages public transportation, and that has kept New York outside the worst 20 cities in pollution studies. City codes that limit and control traffic have also had an impact.

Yet the city faces challenges. New York State tolerates a higher threshold level for many kinds of contamination than New Jersey and California.

No single lighting code exists in New York City. Light pollution is addressed by a series of state and city agencies and departments.

The city codes do address noise pollution. Midtown Manhattan is demonstrably the noisiest area of the city. By contrast, the quietest neighborhoods (such as the Bronx's Co-op City) are quiet by design. A new noise code adopted in 2007 aims to balance peace and quiet with a city that "never sleeps."

The city's building codes mandate energy efficiency. These cover energy use in new construction, require retrofitting, and address energy reduction targets.

## Effect on Real Estate Values

Invisible urban pollution takes its toll on real estate values. The industry term for this is environmental disamenities. Invisible urban pollution results in very visible reactions from buyers, residential and commercial.

Energy efficiency results in increased home value. Buyers look for homes with "green" features, such as low VOCs and solar power. The city's green building tax credit encourages building green.

Real estate close to railways or factories often show a decrease of 5-7% in market value, while properties close to light rail or green space increase in value. A neighborhood's perceived air pollution can drive down prices, but demonstrating a mere 1% increase in air quality can increase a property's value by up to 10%.

Neighborhoods that make efforts to use outdoor light more effectively report real-time benefits. But people in the neighborhood also report benefits when they sell their property–prospective buyers place value on the neighborhood's efforts. Reduced light pollution is a positive factor for real estate.

Bad sound is "as detrimental to quality of life as bad streetlights or poor sidewalks," according to one urban expert. Noise abatement has been shown to increase property value. Changes as simple as "green roofs" (roofs constructed of materials that can grow plants) soften the urban environment. Efforts to reduce noise pollution ranging from quieting the sources of the noise, to fortifying homes and office buildings against noise, quiet a neighborhood–and increase value.

Understanding EMF values of business and residential locations is relatively new for the real estate industry. Cell phone towers bring extra tax revenue and better reception to a section of the city, but many are skeptical because of potential health risks and the impact on property values. Increasing numbers of people don't want to live near cell towers. In some areas with new towers, property values have decreased by up to 20%.

Burying electrical power lines, redoing existing household wiring and installing radiant barriers in walls can mitigate EMF concerns. Simply being conversant with EMF issues matters, too. Many clients consider such knowledge by the real estate industry a measure of competence, and that builds confidence.

The real estate industry's increased attention to invisible urban pollution can make important changes in residential and commercial environments. Real estate "disamenities" attributable to urban pollution are tangible. With concerted effort, these issues can be tackled. The enhanced quality of both property and life could be dramatic.

**William Gati, AIA, is the president of Architecture Studio, Kew Gardens, N.Y.**

**Tags:**

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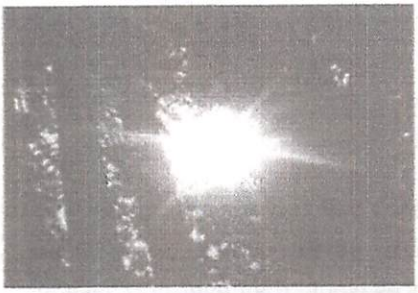

"Our lives begin to end the day we become silent about things that matter."
- Martin Luther King, Jr.

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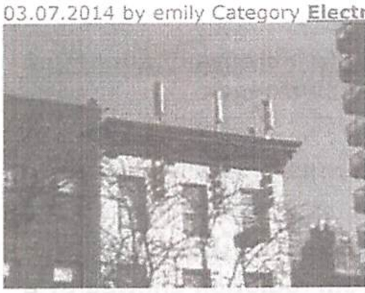
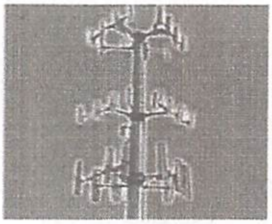
# EMF Real Estate Survey Results: "Neighborhood Cell Towers & Antennas—Do They Impact a Property's Desirability?"

03.07.2014 by emily Category **Electromagnetic Health Blog**



The National Institute for Science, Law and Public Policy's survey **"Neighborhood Cell Towers & Antennas—Do They Impact a Property's Desirability?"** initiated June 2, 2014, has now been completed by 1,000 respondents as of June 28, 2014. The survey, which circulated online through email and social networking sites, in both the U.S. and abroad, sought to determine if nearby cell towers and antennas, or wireless antennas placed on top of or on the side of a building, would impact a home buyer's or renter's interest in a real estate property.



**The overwhelming majority of respondents (94%) reported that cell towers and antennas in a neighborhood or on a building would impact interest in a property and the price they would be willing to pay for it.** And 79% said under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antenna.

- **94% said a nearby cell tower or group of antennas would negatively impact interest in a property or the price they would be willing to pay for it.**
- **94% said a cell tower or group of antennas on top of, or attached to, an apartment building would negatively impact interest in the apartment building or the price they would be willing to pay for it.**
- **95% said they would opt to buy or rent a property that had zero antennas on the building over a comparable property that had several antennas on the building.**
- **79% said under no circumstances would they ever purchase or rent a property within a few blocks of a cell tower or antennas.**
- **88% said that under no circumstances would they ever purchase or rent a property with a cell tower or group of antennas on top of, or attached to, the apartment building.**
- **89% said they were generally concerned about the increasing number of cell towers and antennas in their residential neighborhood.**

The National Institute for Science, Law and Public Policy (NISLAPP) was curious if respondents had previous experience with physical or cognitive effects of wireless radiation, or if their concern about neighborhood antennas was unrelated to personal experience with the radiation. **Of the 1,000 respondents, 57% had previously experienced cognitive effects from radiation emitted by a cell phone, wireless router, portable phone, utility smart meter, or neighborhood antenna or cell tower, and 43% had not experienced cognitive effects. 63% of respondents had previously experienced physical effects from these devices or neighborhood towers and antennas and 37% had not experienced physical effects.**

The majority of respondents provided contact information indicating they would like to receive the results of this survey or news related to the possible connection between neighborhood cell towers and antennas and real estate decisions.

Comments from real estate brokers who completed the NISLAPP survey:

**"I am a real estate broker in NYC. I sold a townhouse that had a cell tower attached. Many potential buyers chose to avoid purchasing the property because of it. There was a long lease."**

**"I own several properties in Santa Fe, NM and believe me, I have taken care not to buy near cell towers. Most of these are rental properties and I think I would have a harder time renting those units... were a cell tower or antenna nearby. Though I have not noticed any negative health effects myself, I know many people are affected. And in addition, these antennas and towers are often extremely ugly–despite the attempt in our town of hiding them as chimneys or fake trees."**

**"We are home owners and real estate investors in Marin County and have been for the last 25 years. We own homes and apartment building here in Marin. We would not think of investing in real estate that would harm our tenants. All our properties are free of smart meters. Thank you for all of your work."**

**"I'm a realtor. I've never had a single complaint about cell phone antennae. Electric poles, on the other hand, are a huge problem for buyers."**

Concern was expressed in the comments section by respondents about potential property valuation declines near antennas and cell towers. While the NISLAPP survey did not evaluate property price declines, a study on this subject by Sandy Bond, PhD of the New Zealand Property Institute, and Past President of the Pacific Rim Real Estate Society (PRRES), **The Impact of Cell Phone Towers on House Prices in Residential Neighborhoods**, was published in *The Appraisal Journal* of the Appraisal Institute in 2006. The Appraisal Institute is the largest global professional organization for appraisers with 91 chapters. The study indicated that **homebuyers would pay from 10%–19% less to over 20% less for a property if it were in close proximity to a cell phone base station.** The 'opinion' survey results were then confirmed by a market sales analysis. **The results of the sales analysis showed prices of properties were reduced by around 21% after a cell phone base station was built in the neighborhood."**

*The Appraisal Journal* study added,

**"Even buyers who believe that there are no adverse health effects from cell phone base stations, knowing that other potential buyers might think the reverse, will probably seek a price discount for a property located near a cell phone base station."**

James S. Turner, Esq., Chairman of the National Institute for Science, Law & Public Policy and Partner, Swankin & Turner in Washington, D.C., says,

**"The recent NISLAPP survey suggests there is now a high level of awareness about potential risks from cell towers and antennas. In addition, the survey indicates respondents believe they have personally experienced cognitive (57%) or physical (63%) effects from radiofrequency radiation from towers, antennas or other radiating devices, such as cell phones, routers, smart meters and other consumer electronics. Almost 90% are concerned about the increasing number of cell towers and antennas generally. A study of real estate sales prices would be beneficial at this time in the Unites States to determine what discounts homebuyers are currently placing on properties near cell towers and antennas."**

Betsy Lehrfeld, Esq., an attorney and Executive Director of NISLAPP, says,

**"The proliferation of this irradiating infrastructure throughout our country would never have occurred in the first place had Section 704 of the Telecommunications Act of 1996 not prohibited state and local governments from regulating the placement of wireless facilities on health or environmental grounds. The federal preemption leaves us in a situation today where Americans are clearly concerned about risks from antennas and towers, some face cognitive and physical health consequences, yet they and their families increasingly have no choice but to endure these exposures, while watching their real property valuations decline."**

The National Institute for Science, Law, and Public Policy (NISLAPP) in Washington, D.C. was founded in 1978 to bridge the gap between scientific uncertainties and the need for laws protecting public health and safety. Its overriding objective is to bring practitioners of science and law together to develop intelligent policy that best serves all interested parties in a given controversy. Its focus is on the points at which these two disciplines converge.

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# Wireless Towers and Home Values: An Alternative Valuation Approach Using a Spatial Econometric Analysis

**Ermanno Affuso**[1] · **J. Reid Cummings**[2] · **Huubinh Le**[3]

Published online: 18 February 2017


**Abstract** This is the first study to use an hedonic spatial autoregressive model to assess the impact of wireless communication towers on the value of residential properties. Using quantile analyses based on minimum distances between sold properties and visible and non-visible towers, we examine the relationship between property values and wireless tower proximity and visibility within various specified radii for homes sold after tower construction. For properties located within 0.72 kilometers of the closest tower, results reveal significant social welfare costs with values declining 2.46% on average, and up to 9.78% for homes within tower visibility range compared to homes outside tower visibility range; in aggregate, properties within the 0.72-kilometer band lose over $24 million dollars.

**JEL Classifications** C5 · K32 · Q51 · R21 · R32 · R38 · R58

**Keywords** Hedonic analysis · Housing value · Land planning · Public planning · Spatial econometrics · Urban externalities · Wireless tower impacts

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In less than 20 years, the number of wireless devices in use[1] in the United States increased 1045%, growing from 340,213 in 1985 to over 355 million in 2014 (CTIA 2015). A growing number of Americans now rely solely on their wireless phones for communication. As of the end of 2014, the Centers for Disease Control and Prevention's National Center for Health Statistics reports that 44% of American households no longer subscribe to landline telephone service; they predict that by the end of 2015, a majority will have severed the cord (Centers for Disease Control and Prevention 2015). U.S. wireless device numbers are truly staggering: 2014 usage comprised 2.45 trillion voice minutes, 4.06 trillion megabytes of data, 1.92 trillion text messages, and 151.99 billion multimedia messages (CTIA 2015). Incredibly, even on the heels of a doubling of wireless data usage from 2012 to 2013, analysts expect data use to surge, growing by more than 650% by 2018 (Cisco 2013). In 2012, wireless industry employment topped 3.8 million people—2.6% of the U.S. workforce (Entner 2012). Analysts predict the industry will create 1.2 million new jobs by 2017 (Pearce et al. 2013). U.S. wireless carriers' capital investment exceeded $33 billion in 2013—a record annual high—and wireless industry experts project an additional $260 billion in new capital investment over the next 10 years (CTIA 2015), adding $2.6 trillion to U.S. gross domestic product (Summers 2010). Perhaps the most surprising, yet at the same time most impressive statistic is that by comparison, the total value of the U.S. wireless industry—currently $196 billion in 2012—exceeds that of agriculture, hotels and lodging, and air transportation (Entner 2012).

Without question, there are many societal benefits offered by the last two decades' myriad advances in wireless technologies. Ease of use and convenience, lower equipment pricing, increasingly competitive rate plans, surges in wireless industry employment, considerable economic multiplier effects from large-scale wireless industry capital investment, and significant realized and projected annual contributions to GDP all work to make the U.S. wireless industry an ever-increasing, important part of our daily lives and our national economy. Yet to date, a largely overlooked societal cost is the potential negative impact on residential property values caused by the exponential proliferation of the number of cell sites[2] necessary to support the wireless industry's rapid growth. In 1985, there were only 900 cell sites in the U.S., but by the end of 2014, the number had increased by 22,778% (CTIA 2015). Of the more than 298,000 cell sites in the U.S., nearly 70% are located on tower structures (Airwave Management, LLC 2013). Amidst intense competition to meet seemingly unceasing demand, providers work continually to improve their wireless service coverage. As they do so, it is logical to expect construction of an increasing number of new wireless towers, located closer and closer together in many urban and suburban areas. As this happens, it is also logical to expect an increasing number of homeowners to question if, and to what extent proximity to a wireless tower affects home values. Those concerned with such questions might also hope that public policy makers will begin asking the same questions, and more importantly, consider the ramifications of the answers as they manage the increasing pressures placed on wireless tower regulatory planning and approval processes.

[1] Wireless devices include special feature phones, smartphones, and tablets.

[2] CTIA defines a cell site as the location of wireless antenna and network communications equipment necessary to provide wireless service in a geographic area (CTIA 2015).

Considering the expected future increases in wireless device users and the cell sites supporting them, this is a critically important question for our time. However, only a few researchers have examined this issue, all yielding somewhat mixed results. In all, the extant literature includes six relevant studies. The first is perceptions-based, offering residents' opinions of how tower proximity influences property values (Bond and Beamish 2005). The second combines a similar perceptions-based component with an hedonic model to estimate sales price impacts (Bond and Wang 2005). The remaining four studies take a strictly empirical approach using hedonic modeling estimations and different types of spatial analysis techniques (Bond 2007a, b; Filippova and Rehm 2011; Locke and Blomquist 2016). Unfortunately, each study suffers from flaws of one sort or another—time invariant issues, inaccurate spatial modeling techniques, or other troublesome variable misspecifications. In essence, the results of these studies are either inconclusive or show only minimal negative price effects due to wireless tower proximity.

In our study though, we use a robust approach for gauging home values relative to tower proximity. Similar to others, our study includes hedonic modeling to capture distinctive property characteristics, yet it is distinctly different from others in two important respects. By performing the analysis within varying radii bands based on quartiles of the distance from the closest wireless tower, we are able to detect potential marginal price gradients of each property across the banded space. More importantly, by conducting a series of robust spatial econometric tests, we are able to identify and use the most unbiased, efficient spatial model that is best suited for the inferential analysis of our research question. The results underscore our concerns that previous studies may potentially suffer from bias due to their failures to address spatial correlation issues typical in hedonic model studies. Two significant reasons contribute to our apprehensions. The first is that Ordinary Least Squares (OLS) estimations are biased and inefficient in the presence of spatial correlations of dependent variables and residuals. The second is that by not accounting for spatial autocorrelation, it is unlikely any hedonic model can correctly disentangle either direct and/or indirect effects of (dis)amenities on housing prices. Research shows the latter is particularly useful when assessing the impact of corrective policy solutions subsequent to market failures (LeSage and Pace 2009). This is important because our research poses potentially significant policy implications, all of which we believe will most likely, yet for substantially different reasons, be of keen interest to governmental and planning officials, wireless tower operators and service providers, neighborhood activist groups, and private property rights' advocates.

In the second section of our paper, we discuss the relevant literature. In the third section, we delineate our data and define our variables. In the fourth section, we develop our hypotheses and methodology. In the fifth section, we present our empirical results, and the final section concludes.

## Literature Review

McDonough (2003) states "...proximity to a wireless tower needs to be considered as a negative amenity that may reduce property valuation" (McDonough 2003, p. 29).

Despite this recognition and the ongoing rapid expansion of the wireless industry, research examining the relationship between wireless tower proximity and home values remains quite limited. Two early studies commissioned by a major wireless service provider look at potential health and visual impacts that wireless towers[3] may have on property values. Bond and Beamish (2005) report that although the studies' results remain secretive, their private review of the results confirms no statistically significant relationships exist. They note, however, that because the studies involve limited sales data, and the underwriter is also a service provider, the question of biased results is potentially concerning.

Some researchers tackle the question using perceptual studies. Bond and Beamish (2005) survey residents in ten Christchurch, New Zealand suburbs—half being study areas (residents living within 300 m of a tower) and half being a control group (residents living more than 1 km from a tower). The authors aim to gauge residents' perceptions about whether and to what extent wireless tower proximity influences property values. Not surprisingly, those living far from a tower express less concern than those living close to one. Distance from a tower largely drove respondents' answers, but in sum, the authors find expectations of more than a 20% price reduction for properties within close tower proximity.

Bond and Wang (2005) combine a perceptual study with an empirical investigation. The perceptual component outcomes are quite similar to those of Bond and Beamish (2005). Their survey's respondents believe that proximity to a wireless tower causes property values to decrease from 10% to more than 20%. The empirical portion of their study includes approximately 4000 home sales spanning from 1986 to 2002 in four different suburbs. The authors' hedonic model includes a dummy variable that captures whether sales occur before or after tower construction. A potential shortcoming of this study could be the authors' choice to measure distances from cell towers not to individual homes, but rather, to a particular street within the study area. Their hedonic models do not account for potential spatial dependence of price and error structure. Their estimations produce mixed results, with negative price effects in two suburbs, a positive price effect in a third, and no significance in the fourth.

Bond (2007a) offers a methodological improvement by calculating exact distances between towers and included properties. Using a dummy variable to capture if a sale occurs before or after tower construction, the author also accounts for sales price time-effects by deflating sales prices to the consumer price index, and includes a time of sale variable in the estimations. Using four of the same suburbs from the earlier work of Bond and Wang (2005), the results show sales price reductions of approximately 15% after tower construction, diminishing as distance from a tower increases. Past 300 m, the negative price effect is negligible. Unfortunately, the results lack consistency, producing a positive price effect in one of the four neighborhoods. This may suggest a possible model misspecification error, or the effect of some other unobservable externality.

Bond (2007b) conducts a similar study using Orange County, Florida wireless tower and sales transaction data. Empirical results indicate a tower's presence yields a statistically significant and negative impact on price. Even so, the author notes the negative price effects are of little consequence.

[3] In their paper, the authors refer to wireless towers as cellular phone base stations.

Filippova and Rehm (2011) investigate tower proximity impacts on property values using property sales data from Auckland, New Zealand. Their final geocoded dataset includes approximately 56,000 sales observations dating from 2005 to 2007, and 521 tower locations. Highly critical of earlier studies' methodologies, the authors emphasize they took care to "ensure that integration dates of nearest cell towers did not occur after the date of sale" (Filippova and Rehm 2011, p. 250). To account for negative impacts that non-residential areas might have on residential area property values (for example, see Bowes and Ihlanfeldt 2001; Grass 1992; Nelson and McCleskey 1990; Mahan et al. 2000), the authors divide their sample into two parts. The first group includes only the 49 towers within residential areas, and all properties within a 500-m radius of existing towers. They also include a dummy variable for tower type, which they describe as lamppost, single monopole, or armed monopole (one with a triangular structure at the top). Generally, their residential area estimations produce no statistical significance. Not surprising, given the extremely close proximity to a tower, the lone exception is for houses located within 100 m of an armed monopole, which suffer a 10.7% price reduction. Estimations for the second group, which includes all towers in the entire study area, yield results similar to those in the first group. As such, the authors conclude that with the exception of a small number of armed monopole towers, wireless tower proximity does not negatively affect sales price.

More recently, Locke and Blomquist (2016) explore the question at hand. They use housing sales (including repeat sales) from 2000 to 2012 occurring in Louisville and Elizabethtown, Kentucky, geocoding each sold property to the street address listed in the sales data. They develop a number of tower location-specific characteristics such as census tract, and distances to major roads, railroads, and military bases. The authors state that, "Holding all else constant, the owner of a communication antenna will attempt to locate the antenna in an area that minimizes the antenna owner's cost" (Locke and Blomquist 2016, p. 134). At first glance, this statement seems obvious, if for no other reason than it makes good business sense. Further thought, however, draws question to the authors' additional statement that, "It appears that communication antennas are in fact located in areas where properties are less valuable" (Locke and Blomquist 2016, p. 134). One might infer from this that carriers strive mainly to construct towers in low-value areas simply to save money. Yet because intuition suggests carriers increase earnings by increasing subscribers, locating towers only in low-valued areas, and hence, providing service coverage only to presumably low-income people does not make good business sense. It seems, therefore, that the authors miss the other side of the coin, which is, in fact, not all towers appear in areas where properties are less valuable, but rather, owners will also construct towers in areas where properties are more valuable in order to fill holes in their service coverage. Indeed, tower location may be a source of endogeneity. However, income, population density, and other unobserved neighborhood characteristics could be instrumental for both homeowners' property and wireless carriers' tower location choices.

Inclusion of spatial considerations in addition to hedonic characteristics in their modeling is a good choice, as it adds robustness to their results. However, as with previous studies, across all model estimations, the authors do not account for potential spatial correlation of price and error structure, finding only slight degrees of price reductions due to tower proximity, again, diminishing with distance.

## Data

To investigate if and to what extent wireless tower proximity impacts home values we combine two datasets. The first includes 23,309 residential property sales occurring in Mobile County, Alabama between 1999 and 2015.[4] We deflate housing prices to a base year of 2014 using the U.S. Bureau of Labor Statistics' Housing Consumer Price Index. The second includes 149 wireless towers located in Mobile County, Alabama.[5] In addition to certain property characteristics, we also include key census tract-level demographic data.[6]

Following Locke and Blomquist (2016), we conduct a visibility analysis of the wireless towers located in the study area. We do so using Viewshed[7] and a 30-m resolution digital elevation map of Mobile County, Alabama.[8] Following Paterson and Boyle (2002), we calculate the visibility for a 360° circle and 1-km radius, including the aboveground tower height, and assume that the average height of an observer's eyes is 1.75 m above the ground at each property's location. Figure 1, Panel A illustrates the spatial distribution of towers, and Fig. 1, Panel B illustrates the Mobile County, Alabama property locations.

At a larger scale, Fig. 2 shows the visibility of towers and properties located in the most urbanized portion of the Mobile County, Alabama.[9] Fig. 2 helps to clarify graphically the idea of the indirect effect of a wireless tower. For example, although some properties lie immediately outside of the border of the visibility range (indicated in the red area), they are contiguous to properties that lie within the border of the visibility range. If there are spatial correlations between property values and tower locations, then we argue that a tower affects both the value of the property location from which the tower is visible, and indirectly, the values of neighboring properties from which the tower is not visible. Additionally, towers that are farther away, but that are still visible from a property, may potentially influence a property's value through a sort of spillover effect carried over across neighboring properties within the tower visibility space.

We compute the minimum distance from each housing unit to the closest wireless tower using the Haversine distance formula, which takes into account the curvature of the Earth. We calculate the distance of housing unit $i$ to the closest wireless tower $j$ as:

[4] Sold properties data draw from the Gulf Coast Multiple Listing Service, Inc., a wholly owned subsidiary of the Mobile Area Association of Realtors, Inc.

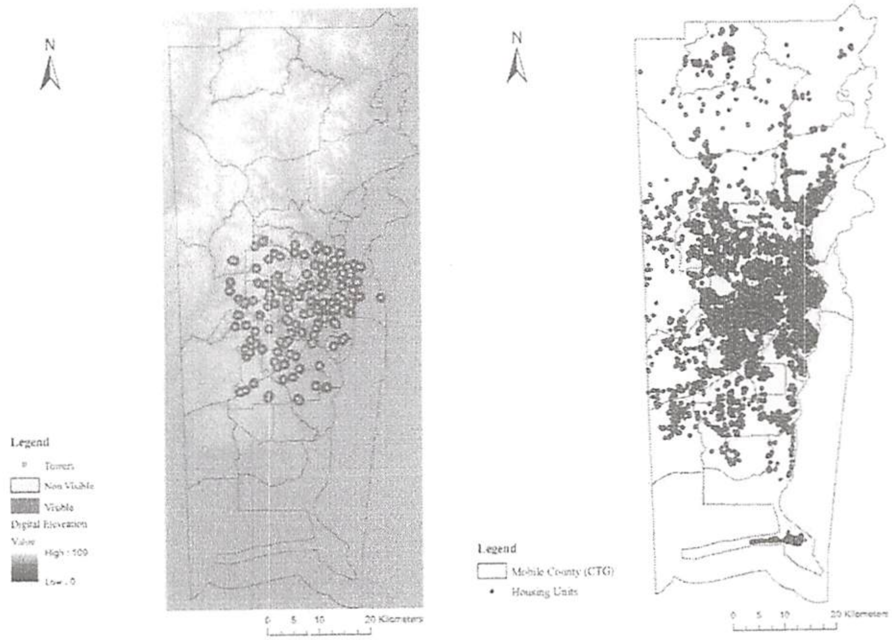
[5] These data draw from the U.S. Federal Communication Commission's Antenna Structure Registration database, available at http://wireless.fcc.gov/antenna/index.htm?job=home.

[6] These data draw from the U.S. Census Bureau, available at http://www.census.gov.

[7] The Viewshed tool is available as part ESRI ArcGIS® software package.

[8] Digital elevation maps draw from publicly available information hosted by the Geospatial Data Gateway of the U.S. Department of Agriculture's Natural Resources Conservation Service.

[9] An anonymous referee observed that every property within a 1 km radius of a tower is also within the towers' viewshed. We believe that this unusual result is consistent with the average height of a wireless tower in our dataset of approximately 60 m, and, more importantly, with the fact that our property sales data draw from a fairly flat coastal geographical area (i.e., the average housing elevation of our sample ≈ 11 m above sea level).




(a) Spatial Distribution of Tower (b) Spatial distribution of properties.

**Fig. 1** Visibility Analysis: smaller scale

$$d_{ij} = min\left\{2r\ arcsin\left[\left(haversine\left(\varphi_j - \varphi_i\right) + cos(\varphi_i)cos\left(\varphi_j\right)haversine\left(\lambda_j - \lambda_i\right)^{0.5}\right]\right\} \quad (1)$$

where $r$ is equal to the Earth's radius of 6371 km, $\varphi$ and $\lambda$ are latitudes and longitudes of property and wireless tower locations expressed in radians. The average minimum distance of a property to a tower is 2.98 km, and we expect a negligible price impact for properties located farther away from a tower than this average. To investigate further the impact of towers on those dwellings that are closer, we conduct a sensitivity analysis using four subsamples based on quartiles of the minimum distance to the closest tower. The first, second, third, and fourth subsamples include houses within radii bands of between 0 to 0.72 km, 0.72 km to 1.13 km, 1.13 km to 1.88 km, and 1.88 km to 41 km of the closest tower, respectively. Table 1 lists and defines all of the variables we use in our analysis and summarizes the statistics for the whole sample of 23,309 properties. Table 2 presents the descriptive statistics of the variables across all four subsamples.

## Methodology

Consistent with the literature, we use an hedonic model to investigate the relationship between property value and wireless tower proximity. Rosen (1974) was the first

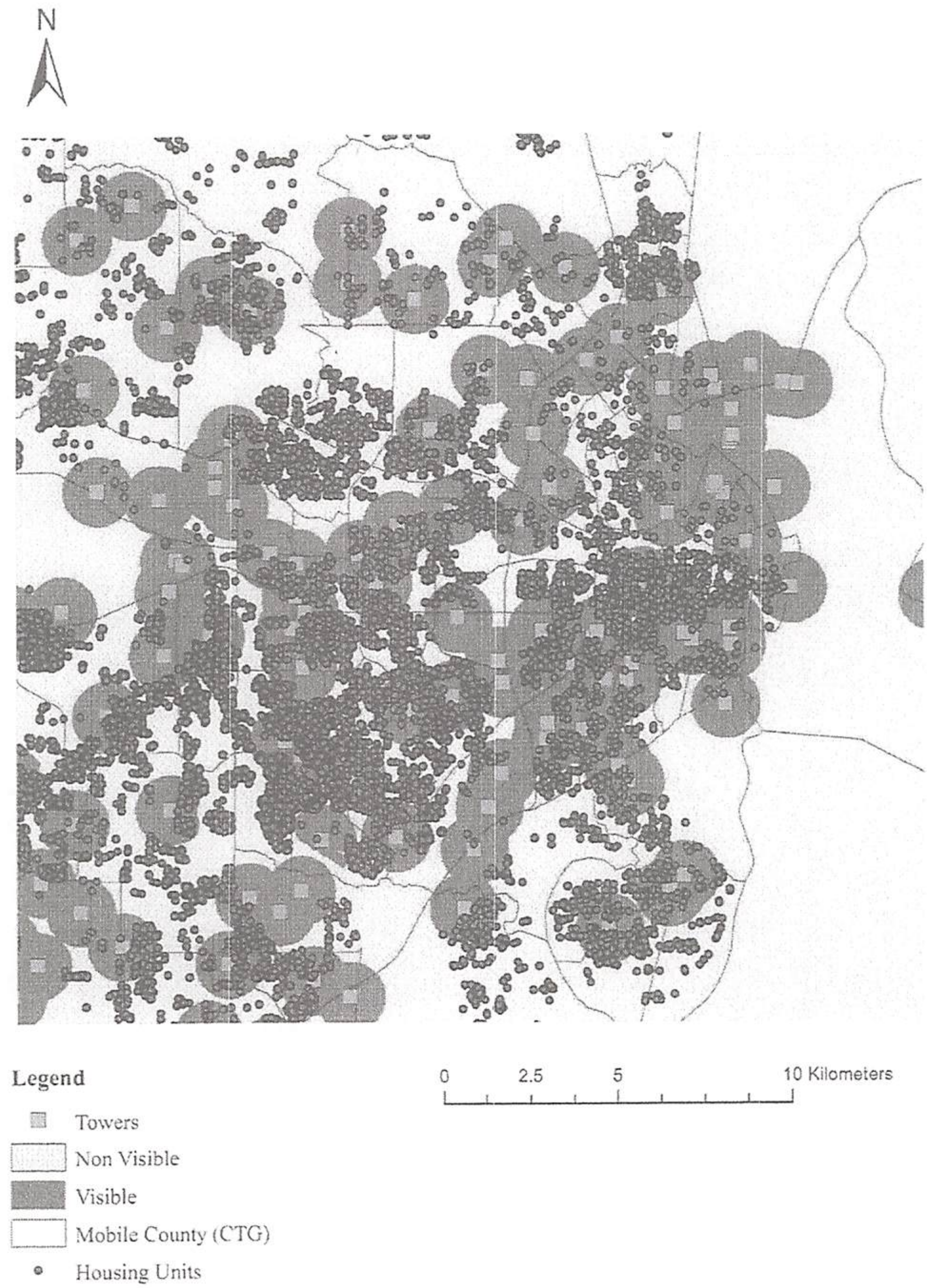



Fig. 2 Visibility Analysis: larger scale

researcher to derive a relationship between the price of a good and its characteristics. His work is widely used in real estate and urban economics research as an indirect method of revealing preferences used to analyze environmental externalities. As such, we assume that the property price is a function of the intrinsic characteristics of the property, neighborhood qualities, demographic characteristics, distance to wireless towers, and a spatial process (essentially, the spatial relationship between objects).

**Table 1** Summary Statistics

| Variable | Definition | Full Sample | |
|---|---|---|---|
| | | Mean | SD |
| Price | inflation adjusted property sales price | 167.592.3 | 124.777.1 |
| Distance | distance between the property and the tower | 2.980 | 5.453 |
| D* | 1 if property sale occurs after tower construction | 16,393 | 69.742 |
| V* | 1 if the tower is visible | 9448 | 74.956 |
| h_tower | height of the tower | 59.148 | 21.050 |
| Age | age of property in years | 23.566 | 19.389 |
| Bedrooms | number of bedrooms in a property | 3.285 | .675 |
| Bathrooms | total number of bathrooms in a property | 2.135 | .671 |
| Onestory* | 1 if number of stories is 1 | 1860 | 41.371 |
| Twostories* | 1 if number of stories is 2 | 2275 | 45.310 |
| Car shelter* | 1 if a property has a car shelter | 15.023 | 73.078 |
| Fireplace* | 1 if a property has a fireplace | 15,080 | 72.965 |
| Fence* | 1 if exterior has a fence | 9375 | 74.862 |
| Deck* | 1 if exterior has a deck | 5377 | 64.317 |
| Pool* | 1 if exterior has a pool | 189 | 13.692 |
| Brick* | 1 if construction is primarily brick | 16.500 | 69.426 |
| Rural* | 1 if population is less than 2500 per census tract | 2644 | 48.416 |
| distCBD | distance to downtown Mobile in kilometers | 17.957 | 8.695 |
| Towers | number of wireless towers per census tract | 4.305 | 5.709 |
| Income | median income per census tract | 66.768.36 | 20.299.91 |
| Black | African-American population per census tract expressed in units | 1070.72 | 812.315 |
| Unemployment | unemployment rate per census tract expressed in percentage points | 9.207 | 5.417 |
| N | number of observations | 23.309 | |

The table above presents the summary statistics for the variables included in the entire dataset; year and zip code dummies are not shown;

*binary variables (assumed to follow the binomial distribution): means and standard deviations for these variables are computed for the binomial distribution

Hence, the econometric model used to examine the potential external impact of a wireless tower on property price takes the following form:

$$\begin{aligned}\ln(Price)_i = {} & \beta_0 + \beta_1 \ln(Distance_i) + \beta_2 D + \beta_3 D\cdot\ln(Distance_i) + \beta_4 V + \beta_5 V\cdot\ln(Distance_i) + \\ & \beta_6 h\_tower_i + \beta_7 V\cdot h\_tower_i + \beta_8 Age_i + \beta_9 Bedrooms_i + \beta_{10}(Bedrooms_i)^2 + \\ & \beta_{11} Bathrooms_i + \beta_{12} Onestory_i + \beta_{13} Twostories_i + \beta_{14} Carshelter_i + \beta_{15} Fireplace_i + \\ & \beta_{16} Fence_i + \beta_{17} Deck_i + \beta_{18} Pool_i + \beta_{19} Brick_i + \beta_{20} Rural_i + \beta_{21} \mathrm{distCBD}_i + \beta_{22} \mathrm{Towers}_i + \\ & \beta_{23} \ln(Income_i) + \beta_{24} \ln(Black_i) + \beta_{25} Unemployment_i + \textstyle\sum_{t=2008}^{2013} \tau_t Year_{ti} + \\ & \textstyle\sum_{j=1}^{31} \delta_j Zipcode_{ji} + \varepsilon_i\end{aligned} \tag{2}$$

where ln(*Price*) is the natural log of the property sales price; ln(*Distance*) is the natural log of the distance between a property and a wireless tower measured in

**Table 2** Summary Statistics for Variables in Each of the Four Subsamples

| | Sample 1[a] (0.00–0.72Km) | | Sample 2[b] (0.72Km – 1.13Km) | | Sample 3[c] (1.13Km – 1.88Km) | | Sample 4[d] (1.88Km – 41Km) | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Price | 163,008.8 | 107,361.6 | 170,634.6 | 133,366.5 | 170,212.1 | 136,985.5 | 166,518.6 | 119,035.9 |
| Distance | 0.497 | 0.156 | 0.920 | 0.116 | 1.425 | 0.202 | 9.080 | 8.295 |
| D* | 4087 | 34.942 | 4256 | 33.874 | 4246 | 33.942 | 3804 | 36.341 |
| V* | 5759 | 8.257 | 3667 | 36.869 | 22 | 4.682 | 0 | 0 |
| h_tower | 53.920 | 20.199 | 53.436 | 19.845 | 56.434 | 19.090 | 72.803 | 18.778 |
| Age | 26.148 | 21.949 | 25.455 | 20.128 | 23.876 | 18.816 | 18.784 | 15.158 |
| Bedrooms | 3.269 | 0.629 | 3.322 | 0.634 | 3.312 | 0.735 | 3.238 | 0.695 |
| Bathrooms | 2.113 | 0.667 | 2.156 | 0.710 | 2.167 | 0.700 | 2.104 | 0.598 |
| Onestory* | 459 | 20.563 | 499 | 21.360 | 528 | 21.912 | 374 | 18.708 |
| Twostories* | 573 | 22.730 | 615 | 23.454 | 642 | 23.901 | 445 | 20.274 |
| Car shelter* | 3832 | 36.227 | 3858 | 36.106 | 3695 | 36.769 | 3638 | 36.968 |
| Fireplace* | 3806 | 36.338 | 4028 | 35.265 | 3910 | 35.866 | 3336 | 37.764 |
| Fence* | 2521 | 37.822 | 2576 | 37.910 | 2380 | 37.522 | 1898 | 35.774 |
| Deck* | 1222 | 31.077 | 1404 | 32.645 | 1369 | 32.363 | 1382 | 32.469 |
| Pool* | 51 | 7.110 | 44 | 6.608 | 47 | 6.828 | 47 | 6.828 |
| Brick* | 3856 | 36.121 | 4142 | 34.608 | 4179 | 34.379 | 4323 | 33.404 |
| Rural* | 787 | 26.091 | 601 | 23.217 | 460 | 20.584 | 796 | 26.216 |
| distCBD | 14.625 | 5.891 | 15.037 | 5.601 | 16.037 | 5.524 | 26.131 | 10.758 |
| Towers | 5.523 | 5.743 | 5.152 | 6.474 | 4.671 | 6.242 | 1.875 | 2.881 |
| Income | 68,790.18 | 23,488.16 | 69,418.33 | 22,687.17 | 67,058.06 | 20,669.78 | 61,806.5 | 10,912.01 |
| Black | 1214.973 | 910.131 | 1139.579 | 801.164 | 1217.888 | 835.001 | 710.429 | 543.371 |
| Unemployment | 9.408 | 6.073 | 8.900 | 5.640 | 8.827 | 5.130 | 9.692 | 4.678 |
| N | 5828 | | 5827 | | 5827 | | 5827 | |

The table above presents the summary statistics for the variables within each of the four subsamples included in the analysis;

*binary variables (assumed to follow the binomial distribution): means and standard deviations for these variables are computed for the binomial distribution

[a] *Sample 1* is a subsample of properties selected within the first quartile of the minimum distance to the closest wireless tower (radius ≤ 0.72Km);

[b] *Sample 2* is a subsample of properties within the second quartile of the minimum distance to the closest wireless tower (0.72Km ≤ *distance* ≤ 1.13Km);

[c] *Sample 3* is a subsample of properties within the third quartile of the minimum distance to the closest wireless tower (1.13Km ≤ *distance* ≤ 1.88Km);

[d] *Sample 4* is a subsample of properties within the fourth quartile of the minimum distance to the closest wireless tower (1.88Km ≤ *distance* ≤ 41Km)

kilometers; *D* is a dummy variable that takes the value of one if the property was purchased after tower construction, and zero otherwise; *V* is a dummy variable that takes the value of one if the closest tower is visible from the property, and zero otherwise; *h_tower* is a continuous variable that measures the height of the closest tower above the ground in meters; *Age* is the age of a property in years; *Bedrooms* is the total number of bedrooms in a property; *Bathrooms* is the total number of bathrooms and/or half-bathrooms in a property; *Onestory* and *Twostories* are binary variables equal to one if the property has one story or two stories above the ground level, respectively; *Carshelter, Fireplace, Fence, Deck, Pool* and *Brick* are dummy variables that take the value of one if a property has a car shelter, a fireplace, a fence around the house, a deck, a pool and/or the exterior construction is made of bricks respectively, and zero otherwise; *Rural* is a binary variable proxy for less dense populated areas that takes value one if the number of inhabitants per census tract is less than 2500, and zero otherwise; *dist*CBD is a continuous variable that measures the distance of each property from the Central Business District of Mobile, Alabama, the largest city in the study area; *Towers* is the number of wireless towers per census tract; ln*(Income)* is the natural log of the median income per census tract; ln*(Black)* is the natural log of the African-American population expressed in units per census tract; and, *Unemployment* is the unemployment rate per census tract expressed in percentage points. As in Jensen et al. (2014), we add the interaction between distance to (dis)amenities and tower visibility (*V*), which we label ln*(Distance)*·*V*. We use *Year*, property sale year dummy variables, to control for the impact of the subprime mortgage crisis. Finally, following Caudill et al. (2014), we include *Zipcode*, a set of dummy variables that attempt to capture additional unobserved neighborhood heterogeneities at a higher resolution than the census tract. Since we are interested in examining the price sensitivity of buyers of homes closest to a wireless tower, we follow Locke and Blomquist (2016) in stating the dependent variable being in logarithmic form. However, we also use the Akaike Information Criterion (AIC) to test several functional forms for hedonic price equations by varying the specification of the variables in the right-hand side of Eq. (2). We do so because by selecting the functional form having the lowest AIC value, we are able to produce a theoretical specification with the least possible information loss.

We calculate the average impact of a wireless tower on housing price by subtracting expected housing values before tower construction from expected housing values after tower construction, using the equation taking the following form:

$$\mathbb{E}\left[e^{Ln\left(\widehat{\text{price}}\right)}|D=1\right]-\mathbb{E}\left[e^{Ln\left(\widehat{\text{price}}\right)}|D=0\right]. \qquad (3)$$

We also calculate the total social welfare impact as:

$$\Delta W=\Sigma_{i=1}^{N}\left[\left(e^{Ln\left(\widehat{\text{price}}\right)_i}|D_i=1\right)-\left(e^{Ln\left(\widehat{\text{price}}\right)_i}|D_i=0\right)\right]. \qquad (4)$$

In addition, to examine the spatial price sensitivity of home buyers—the price elasticity of tower proximity—we partially differentiate Eq. (2) with respect to ln*(Distance)*, using the equation taking the following form:

$$\frac{\partial ln(Price)}{\partial ln(Distance)}=[\beta_1+\beta_3 D+\beta_5 V]\%. \qquad (5)$$

We evaluate Eq. (5) as $D = 0$ and $V = 0$ $(\beta_1)$ for sales occurring before tower construction, and $D = 1$ and $V = 1$ $(\beta_1 + \beta_3 + \beta_5)$ for sales occurring after the visible tower construction. We additionally include $D = 1$ and $V = 0$ $(\beta_1 + \beta_3)$, which accommodates comparison of price sensitivity of buyers of properties from which the closest tower is not visible.

In certain hedonic studies, it is appropriate to perform statistical tests for spatial correlation. This is a consequence of Tobler's first law of geography, which premises the interrelationship of all things, but that closer things are more related than distant things (Tobler 1970). We use spatial correlation tests to account for spatial processes in the dependent variable and estimation residuals. In matrix notation, such a model reads as:

$$\mathbf{y} = \rho\mathbf{W}\mathbf{y} + \mathbf{X}\boldsymbol{\beta} + (\mathbf{I}-\lambda\mathbf{W})^{-1}\mathbf{u} \tag{6}$$

where $\mathbf{y}$ is a n × 1 vector of property prices (previously defined); $\rho$ is a scalar coefficient of spatial correlation; $\mathbf{W}$ is an n x n row, standardized spatial contiguity matrix based on the three closest neighbors as outlined by Caudill et al. (2014); $\mathbf{X}$ is an n × 63 (number of parameters of Eq. 1 including intercept) data matrix with first column vector $\mathbf{1_n}$; $\boldsymbol{\beta}$ is a 63 × 1 vector of parameters; $\mathbf{I}$ is an n x n identity matrix, $\lambda$ is a scalar coefficient of residuals spatial correlation; and, $\mathbf{u}$ is an n × 1 vector of Gaussian innovations.

We estimate the spatial model by maximizing the log-likelihood function (MLL) with respect to the model's parameters, coefficients of spatial correlation ($\rho$ and $\lambda$), and residual standard errors ($\sigma$) using the equation taking the following form:

$$\begin{aligned} LL(\boldsymbol{\beta},\rho,\lambda,\sigma|\mathrm{y}) &= -0.5\,n\ln(\pi) - 0.5\,n\ln(\sigma^2) \\ &+ (\ln|\mathbf{I}-\lambda\mathbf{W}| + \ln|\mathbf{I}-\rho\mathbf{W}|) - [0.5(\sigma^{-2})(\mathbf{u}')(\mathbf{u})] \end{aligned} \tag{7}$$

where $n$ is the sample size, $\mathbf{u} = (\mathbf{I} - \lambda\mathbf{W})^{-1}(\mathbf{I} - \rho\mathbf{W})\mathbf{y} - (\mathbf{I} - \lambda\mathbf{W})^{-1}\mathbf{X}\boldsymbol{\beta}$; and, $\ln|\mathbf{I} - \lambda\mathbf{W}|$ and $\ln|\mathbf{I} - \rho\mathbf{W}|$ are the terms of the log-Jacobian transformation of $\mathbf{u}$ into $\mathbf{y}$. Assuming the same geographic processes for the dependent variable and residuals (same $\mathbf{W}$), the large sample Moran's $I$ test for spatial correlation of the residuals is:

$$Z_I = [I - E(I)]/Var(I)^{0.5} \sim N(0,1) \tag{8}$$

where $I$ is calculated from the residuals of Eq. (2) as $\varepsilon'\mathbf{W}\varepsilon/\ \varepsilon'\varepsilon$. Since this test is asymptotically normal, if $Z_I > 1.96$, with 95% confidence, we reject the null hypothesis that there is no spatial autocorrelation of the residuals.

The econometric models presented in Eqs. (6) and (7) are generic representations of a spatial model which includes both a spatial autoregressive model—model with dependent variable spatially autocorrelated: $\lambda = 0$, and a spatial error model—model with residuals spatially autocorrelated: $\rho = 0$. Following Anselin (1988), in practice, we select only one of the two models. Following the suggestion of Anselin et al. (1996), we use Robust Lagrangian Multiplier (RLM) tests ($H_0$: no spatial autocorrelation) of the residuals, using equations taking the following forms:

$$\mathrm{RLM}_\rho = [\varepsilon'\mathbf{W}\mathbf{y}/\sigma^2 - \varepsilon'\mathbf{W}\varepsilon/\sigma^2]^2 / \{\sigma^2[(\mathbf{W}\mathbf{X}\boldsymbol{\beta})'\mathbf{M}(\mathbf{W}\mathbf{X}\boldsymbol{\beta}) + n\sigma^2] - n\} \tag{9}$$

$$\mathrm{RLM}_\lambda = \left[\varepsilon'\mathbf{W}\varepsilon/\sigma^2 - n\left(\sigma^2\left[(\mathbf{WX}\beta)'\mathbf{M}(\mathbf{WX}\beta) + n\sigma^2\right]\right)^{-1}\varepsilon'\mathbf{W}y/\sigma^2\right]^2 \Big/ n\left[1 - n\left(\sigma^2\left[(\mathbf{WX}\beta)'\mathbf{M}(\mathbf{WX}\beta) + n\sigma^2\right]\right)\right]^{-1} \tag{10}$$

Both Eqs. (9) and (10) follow the $\chi^2$ distribution with one degree of freedom and include $\mathbf{M} = \mathbf{I}\text{-}\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}$ as an idempotent projection matrix. Following Florax and De Graaff (2004), we select the model with the largest RLM statistics.

## Results and Discussion

In this study, we conduct a pseudo-quantile analysis based on quartiles of the distance of each property from the closest tower. We refer to it as a pseudo-quantile analysis because we force the estimation of the conditional mean of the response variable on different values of the distance to the closest tower by subsampling the full data set for the four quartiles of this variable. The idea is to test our research hypothesis for properties located within different distance gradients from wireless towers. We do so by creating four spatial contiguity matrices (one for each sample). In Table 3, we report the results of both the Moran's *I* and RLM tests for spatial correlation across all four samples.

**Table 3** Tests for Spatial Correlation

| Statistic | Sample 1[a] (0.00–0.72Km) Value | Sample 2[b] (0.72Km – 1.13Km) Value | Sample 3[c] (1.13Km – 1.88Km) Value | Sample 4[d] (1.88Km – 41Km) Value |
|---|---|---|---|---|
| Moran's *I* | 0.22 | 0.21 | 0.20 | 0.18 |
| $Z_I$ | 26.43*** | 24.81*** | 24.52*** | 21.53*** |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| $\mathrm{RLM}_\rho$ | 436.83*** | 438.42*** | 490.10*** | 365.60*** |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| $\mathrm{RLM}_\lambda$ | 0.041 | 0.24 | 0.31 | 0.49 |
| | (0.84) | (0.62) | (0.58) | (0.48) |

The table above presents the results of spatial correlation tests for all three samples;

$H_0$ No Spatial Autocorrelation, $Z_I$ follows the standard normal distribution, *RLM,and RLM*$_\lambda$ follow the $\chi^2$ distribution with one degree of freedom

Confidence intervals presented as ***99%; *p*-values in parentheses;

[a] *Sample 1* is a subsample of properties selected within the first quartile of the minimum distance to the closest wireless tower (radius ≤ 0.72Km);

[b] *Sample 2* is a subsample of properties within the second quartile of the minimum distance to the closest wireless tower (0.72Km ≤ *distance* ≤ 1.13Km);

[c] *Sample 3* is a subsample of properties within the third quartile of the minimum distance to the closest wireless tower (1.13Km ≤ *distance* ≤ 1.88Km);

[d] *Sample 4* is a subsample of properties within the fourth quartile of the minimum distance to the closest wireless tower (1.88Km ≤ *distance* ≤ 41Km)

Based on the Moran's *I* test results, with 99% confidence for each sample, we reject the null hypothesis that there is no spatial correlation of the residuals. Based on the results of the RLM test for dependent variable spatial correlation, we reject the null hypothesis of no spatial correlation for each subsample with 99% confidence. In contrast, based on the results of the RLM test for residual spatial correlation, we fail to reject the null hypothesis of no spatial correlation across all subsamples. Consequently, the spatial autoregressive model is the most appropriate econometric tool to conduct our analysis (Florax and De Graaff 2004). In Tables 4 and 5, we report the results of our analysis, comparing the OLS estimates (Table 4) of Eq. (2) to the MLL estimates (Table 5) of Eq. (6) with $\lambda$ restricted to zero as a natural consequence of the Moran's *I* and RLM diagnostic tests discussed above.

Although biased, OLS estimates have good explanatory power across all four samples (the coefficient of determination ranges from 60% to 72%). However, comparison of the lower values of the AIC of the spatial autoregressive models to the corresponding OLS models confirms the hypothesis that the spatial autoregressive models represent the reality with minimum information loss. Therefore, this additional information supports our contention that the spatial autoregressive model is the most appropriate framework for statistical inference in our study.

In general, the spatial autoregressive model estimates have good statistical power and the expected coefficient signs across the four subsamples. Curiously, though, we find that the prices of properties purchased in 2009 after the U.S. financial crisis (compared to the baseline year 2007) are not statistically significant within 1.88 km from the closest tower (across the first three quartiles of the distance to the closest wireless tower). On the other hand, although the coefficients for dwelling age, unemployment rate, and the percentage increase in the African American population per census tract are all statistically significant, none seems to be economically significant in Mobile County. As expected, the numbers of bedrooms and bathrooms, as well as income are important predictors of property value in terms of economic magnitude. However, as in Locke and Blomquist (2016), it appears that the impact of these variables is relative to property location with respect to the towers. For example, an average household would be willing to pay between 7% to 8.5%[10] more than the average price of a property for an additional bedroom across the four samples while the household's willingness to pay for an additional bathroom ranges between 21% to 27% more than the average across the four subsamples. Moreover, commensurate with a 10% increase in median income per census tract, the property price increases range from between 18% to 21% for those properties located beyond 1.88 km from the closest tower (across Samples 2–4). However, it seems that the price of properties located within 0.72 km from the closest tower (Sample 1) is only negligibly sensitive to median income changes.

Turning our analysis to the impact of the wireless tower on the value of residential properties, our first assessment of the spatial autoregressive model estimate of *D* for the properties located within 0.72 km from the closest tower (Sample 1) shows a statistically

[10] There is a quadratic relationship between the logarithm of the property price and the number of bedrooms. We evaluate the semi-elasticities at the mean values of the number of bedrooms as reported in Table 2.

**Table 4** Ordinary Least Squares

| | Sample 1[a] (0.00–0.72Km) | Sample 2[b] (0.72Km – 1.13Km) | Sample 3[c] (1.13Km – 1.88Km) | Sample 4[d] (1.88Km – 41Km) |
|---|---|---|---|---|
| Constant | 9.872*** (16.26) | 6.362*** (12.2) | 6.009*** (15.53) | 6.311*** (11.59) |
| Age | -0.004*** (−12.86) | -0.006*** (−16.64) | -0.007*** (−18.07) | -0.008*** (−21.77) |
| Bedrooms | 0.365*** (7.14) | 0.417*** (9.76) | 0.074*** (6.15) | 0.115*** (9.07) |
| Bedrooms$^2$ | -0.043*** (−5.75) | -0.041*** (−6.99) | -0.002*** (−4.03) | -0.003*** (−5.87) |
| Bathrooms | 0.329*** (31.83) | 0.277*** (30.66) | 0.373*** (37.72) | 0.278*** (26.44) |
| Onestory (0/1) | 0.031* (1.65) | 0.06*** (3.34) | 0.069*** (3.89) | 0.17*** (8.14) |
| Twostories (0/1) | 0.058*** (3.28) | 0.112*** (6.49) | 0.092*** (5.4) | 0.191*** (9.50) |
| Car shelter (0/1) | 0.179*** (17.32) | 0.187*** (17.77) | 0.189*** (18.89) | 0.239*** (23.03) |
| Fireplace (0/1) | 0.203*** (17.87) | 0.184*** (15.52) | 0.158*** (13.74) | 0.179*** (17.01) |
| Fence (0/1) | 0.067*** (6.33) | 0.019* (1.73) | 0.024*** (2.26) | 0.036*** (3.23) |
| Deck (0/1) | 0.092*** (7.03) | 0.065*** (5.02) | 0.075*** (5.96) | 0.093*** (7.15) |
| Pool (0/1) | 0.067 (1.36) | -0.004 (−0.08) | -0.026 (−0.51) | 0.118** (2.20) |
| Brick (0/1) | 0.118*** (10.6) | 0.098*** (8.48) | 0.125*** (11.1) | 0.096*** (7.56) |
| Rural (0/1) | -0.065*** (−3.07) | -0.119*** (−4.93) | -0.066** (−2.25) | 0.216888 (5.35) |
| ln(distCBD) | -0.287*** (−10.06) | -0.103*** (−3.44) | -0.163*** (−4.67) | -0.075 (−1.33) |
| Towers | 0.003*** (2.74) | 0.003*** (3.63) | 0.001 (0.49) | -0.002 (−0.75) |
| ln(Income) | 0.155*** (5.58) | 0.379*** (14.38) | 0.478*** (16.27) | 0.388*** (8.001) |
| ln(Black) | -0.066*** (−6.66) | -0.091*** (−9.41) | -0.065*** (−6.64) | -0.023** (−2.38) |
| Unemployment | -0.011*** (−7.44) | -0.004*** (−2.68) | 0.009*** (5.27) | 0.003*** (1.91) |
| Year 2008 | 0.075*** (3.95) | 0.129*** (6.84) | 0.111*** (5.8) | 0.100*** (5.26) |
| Year 2009 | 0.009 (0.45) | 0.011 (0.54) | 0.036 (1.69) | 0.019 (0.9) |
| Year 2010 | -0.116*** (−5.02) | -0.087*** (−3.57) | -0.118*** (−5.29) | -0.062*** (−3.02) |
| Year 2011 | -0.288*** (−12.54) | -0.297*** (−13.56) | -0.235*** (−10.48) | -0.185*** (−8.4) |
| Year 2012 | -0.346*** (−15.52) | -0.304*** (−13.11) | -0.26*** (−11.13) | -0.21*** (−9.73) |
| Year 2013 | -0.321*** (−14.58) | -0.331*** (−14.89) | -0.307*** (−13.93) | -0.249*** (−11.76) |
| ln(Distance) | -1.257*** (−2.95) | 0.343 (1.41) | 0.055 (0.49) | 0.107*** (3.67) |
| D | -0.191*** (−4.82) | -0.011 (−0.1) | 0.005 (0.05) | 0.044 (1.200) |
| ln(Distance)·D | 0.51*** (5.41) | 0.048 (0.28) | 0.009 (0.07) | -0.031* (−1.72) |
| V | -0.234 (−0.67) | 0.123 (0.74) | -4.314 (−0.54) | NA[e] |
| ln(Distance)·V | 0.829** (1.97) | -0.241 (−0.99) | 5.59 (0.6) | NA[e] |
| H_tower | 0.007 (1.43) | 0.001 (0.62) | 0.001 (1.62) | 0.001*** (3.06) |
| H_tower·V | -0.006 (−1.14) | 0.001** (2.37) | -0.006 (−0.75) | NA[e] |
| Adj. $R^2$ | 0.715 | 0.722 | 0.714 | 0.605 |

Based on the Moran's *I* test results, with 99% confidence for each sample, we reject the null hypothesis that there is no spatial correlation of the residuals. Based on the results of the RLM test for dependent variable spatial correlation, we reject the null hypothesis of no spatial correlation for each subsample with 99% confidence. In contrast, based on the results of the RLM test for residual spatial correlation, we fail to reject the null hypothesis of no spatial correlation across all subsamples. Consequently, the spatial autoregressive model is the most appropriate econometric tool to conduct our analysis (Florax and De Graaff 2004). In Tables 4 and 5, we report the results of our analysis, comparing the OLS estimates (Table 4) of Eq. (2) to the MLL estimates (Table 5) of Eq. (6) with $\lambda$ restricted to zero as a natural consequence of the Moran's *I* and RLM diagnostic tests discussed above.

Although biased, OLS estimates have good explanatory power across all four samples (the coefficient of determination ranges from 60% to 72%). However, comparison of the lower values of the AIC of the spatial autoregressive models to the corresponding OLS models confirms the hypothesis that the spatial autoregressive models represent the reality with minimum information loss. Therefore, this additional information supports our contention that the spatial autoregressive model is the most appropriate framework for statistical inference in our study.

In general, the spatial autoregressive model estimates have good statistical power and the expected coefficient signs across the four subsamples. Curiously, though, we find that the prices of properties purchased in 2009 after the U.S. financial crisis (compared to the baseline year 2007) are not statistically significant within 1.88 km from the closest tower (across the first three quartiles of the distance to the closest wireless tower). On the other hand, although the coefficients for dwelling age, unemployment rate, and the percentage increase in the African American population per census tract are all statistically significant, none seems to be economically significant in Mobile County. As expected, the numbers of bedrooms and bathrooms, as well as income are important predictors of property value in terms of economic magnitude. However, as in Locke and Blomquist (2016), it appears that the impact of these variables is relative to property location with respect to the towers. For example, an average household would be willing to pay between 7% to 8.5%[10] more than the average price of a property for an additional bedroom across the four samples while the household's willingness to pay for an additional bathroom ranges between 21% to 27% more than the average across the four subsamples. Moreover, commensurate with a 10% increase in median income per census tract, the property price increases range from between 18% to 21% for those properties located beyond 1.88 km from the closest tower (across Samples 2–4). However, it seems that the price of properties located within 0.72 km from the closest tower (Sample 1) is only negligibly sensitive to median income changes.

Turning our analysis to the impact of the wireless tower on the value of residential properties, our first assessment of the spatial autoregressive model estimate of *D* for the properties located within 0.72 km from the closest tower (Sample 1) shows a statistically

[10] There is a quadratic relationship between the logarithm of the property price and the number of bedrooms. We evaluate the semi-elasticities at the mean values of the number of bedrooms as reported in Table 2.

Table 4 (continued)

| | Sample 1[a] (0.00–0.72Km) | Sample 2[b] (0.72Km – 1.13Km) | Sample 3[c] (1.13Km – 1.88Km) | Sample 4[d] (1.88Km – 41Km) |
|---|---|---|---|---|
| AIC | 4257 | 4308 | 4157 | 4685 |
| Deg. of Freedom | 5773 | 5774 | 5774 | 5773 |
| Sample Size | 5828 | 5827 | 5827 | 5827 |

The table above presents results of the Ordinary Least Square estimates

*Zipcode* parameter estimates are not reported to save space (available upon request). Ten, twelve, twelve and eight *Zipcode* dummy variables were dropped from the analysis of *Samples 1, 2, 3* and *4*, respectively, because there were not properties within these zipcode areas

Confidence intervals presented as ***99%, **95%, and *90%; t-values in parentheses:

[a] *Sample 1* is a subsample of properties selected within the first quartile of the minimum distance to the closest wireless tower (radius ≤ 0.72Km);

[b] *Sample 2* is a subsample of properties within the second quartile of the minimum distance to the closest wireless tower (0.72Km ≤ *distance* ≤ 1.13Km);

[c] *Sample 3* is a subsample of properties within the third quartile of the minimum distance to the closest wireless tower (1.13Km ≤ *distance* ≤ 1.88Km);

[d] *Sample 4* is a subsample of properties within the fourth quartile of the minimum distance to the closest wireless tower (1.88Km ≤ *distance* ≤ 41Km);

[e] Visibility variable was dropped from the analysis because there were not visible towers in Sample 4

significant, negative correlation between property price and sales occurring after tower construction. The same estimate is statistically equally to zero for those properties located within 0.72 and 1.88 km from the closest tower (Samples 2 and 3). For properties that are far from the visibility range of a tower (Sample 4 includes properties located beyond 1.88 km), the correlation between property price and tower becomes positive and statistically different from zero. *V*, the visibility of the tower, is not statistically significant across the four samples. However, ln(*Distance*)·*V* is statistically significant at the 5% alpha level for properties that are located within 0.72 km from the closest tower (Sample 1). For these properties, we perform a log-likelihood ratio test for the joint significance of *V*, ln(*Distance*)·*V* and *h_tower*·*V*, following the $\chi^2$ distribution with three degrees of freedom equal to the number of restrictions (three estimates simultaneously equal to zero). We reject the null hypothesis that these three estimates are jointly equal to zero (*p*-value =0.071, 90% confidence). Hence, we must include these parameters to model the relationship between housing price and tower proximity for those properties that are closer to the wireless tower (Sample 1). However, the opposite is true for properties located beyond 0.72 km as we fail to reject the null hypothesis when applying the same test to these properties. In addition, the number of wireless towers per census tract (*Towers*) and tower height (*h_tower*) have no significant impact on housing price across the four samples (statistically and economically).

To assess the average social welfare impact of wireless tower proximity on residential property values, we estimate the predicted housing value from sales occurring before and after tower construction using Eq. (3). In Table 6, we report the predicted

**Table 5** Spatial Autoregressive Models

| | Sample 1[a] (0.03Km – 0.72Km) | Sample 2[b] (0.72Km – 1.13Km) | Sample 3[c] (1.13Km – 1.88Km) | Sample 4[d] (1.88Km – 41Km) |
|---|---|---|---|---|
| Constant | 6.404*** (11.417) | 4.315*** (8.984) | 4.109*** (11.697) | 5.304*** (10.467) |
| Age | -0.004*** (−11.15) | -0.005*** (−14.236) | -0.005*** (−14.209) | -0.007*** (−19.002) |
| Bedrooms | 0.358 *** (7.728) | 0.353*** (9.063) | 0.068*** (6.221) | 0.104*** (8.902) |
| Bedrooms$^2$ | -0.044 *** (−6.522) | -0.036*** (−6.755) | -0.002*** (−4.066) | -0.003*** (−5.887) |
| Bathrooms | 0.256*** (26.873) | 0.216*** (25.703) | 0.279*** (29.698) | 0.241*** (24.491) |
| Onestory (0/1) | 0.019 (1.111) | 0.039** (2.38) | 0.042*** (2.591) | 0.133*** (6.847) |
| Twostories (0/1) | 0.043*** (2.673) | 0.077*** (4.884) | 0.063*** (4.125) | 0.155*** (8.296) |
| Car shelter (0/1) | 0.129*** (13.573) | 0.136*** (14.052) | 0.142*** (15.426) | 0.191*** (19.629) |
| Fireplace (0/1) | 0.142*** (13.643) | 0.134*** (12.346) | 0.117*** (11.156) | 0.152*** (15.428) |
| Fence (0/1) | 0.067*** (6.958) | 0.026*** (2.621) | 0.04*** (4.164) | 0.048*** (4.579) |
| Deck (0/1) | 0.08*** (6.74) | 0.059*** (5.035) | 0.081*** (7.096) | 0.084*** (6.965) |
| Pool (0/1) | 0.04 (0.898) | 0.039 (0.807) | 0.003 (0.071) | 0.089** (1.786) |
| Brick (0/1) | 0.078*** (7.743) | 0.076*** (7.249) | 0.101*** (9.888) | 0.085*** (7.262) |
| Rural (0/1) | -0.015 (−0.791) | -0.064*** (−2.908) | -0.042 (−1.598) | 0.153*** (4.063) |
| ln(distCBD) | -0.218*** (−8.416) | -0.089*** (−3.274) | -0.108*** (−3.421) | -0.084 (−1.612) |
| Towers | 0.002*** (2.666) | 0.002** (2.157) | 0.001 (0.313) | -0.001 (−0.583) |
| ln(Income) | 0.09*** (3.557) | 0.207*** (8.428) | 0.274*** (10.083) | 0.179*** (3.908) |
| ln(Black) | -0.04*** (−4.359) | -0.059*** (−6.655) | -0.041*** (−4.66) | -0.02** (−2.165) |
| Unemployment | -0.007*** (−5.249) | -0.003** (−2.204) | 0.006*** (3.715) | 0.001 (0.779) |
| Year 2008 | 0.078*** (4.552) | 0.128*** (7.504) | 0.114*** (6.589) | 0.108*** (6.124) |
| Year 2009 | 0.015 (0.843) | 0.007 (0.374) | 0.031 (1.615) | 0.024** (1.209) |
| Year 2010 | -0.117*** (−5.581) | -0.095*** (−4.276) | -0.12*** (−5.934) | -0.071*** (−3.714) |
| Year 2011 | -0.300*** (−14.474) | -0.304*** (−15.253) | -0.236*** (−11.639) | -0.189*** (−9.255) |
| Year 2012 | -0.340*** (−16.871) | -0.306*** (−14.514) | -0.296*** (−13.986) | -0.228*** (−11.364) |
| Year 2013 | -0.328*** (−16.461) | -0.331*** (−16.388) | -0.322*** (−16.132) | -0.257*** (−13.074) |
| ln(Distance) | -1.167*** (−3.025) | 0.274 (1.232) | 0.059 (0.593) | 0.09*** (3.318) |
| D | -0.12*** (−3.35) | -0.007 (−0.066) | 0.003 (0.031) | 0.06* (1.773) |
| ln(Distance)·D | 0.332*** (3.886) | 0.043 (0.27) | 0.007 (0.062) | -0.039** (−2.298) |
| V | -0.453 (−1.432) | 0.118 (0.782) | -2.747 (−0.377) | NA[e] |
| ln(Distance)·V | 0.872** (2.291) | -0.193 (−0.869) | 3.533 (0.421) | NA[e] |
| H_tower | 0.001 (0.151) | 0.001 (0.436) | 0.001 (1.414) | 0.001* (1.934) |
| H_tower·V | 0.001 (0.02) | 0.001 (1.394) | -0.003 (−0.451) | NA[e] |
| $\rho$ | 0.362*** (31.59) | 0.349*** (30.53) | 0.352*** (32.61) | 0.310*** (26.89) |

**Table 5** (continued)

| | Sample 1[a] (0.03Km – 0.72Km) | Sample 2[b] (0.72Km – 1.13Km) | Sample 3[c] (1.13Km – 1.88Km) | Sample 4[d] (1.88Km – 41Km) |
|---|---|---|---|---|
| $\sigma$ | 0.314*** (33.137) | 0.317*** (32.781) | 0.311*** (33.286) | 0.334*** (31.215) |
| AIC | 3347 | 3457 | 3243 | 4022 |
| Deg. of Freedom | 5571 | 5572 | 5572 | 5571 |
| Sample Size | 5828 | 5827 | 5827 | 5827 |

The table above presents results of the maximum log-likelihood estimations of the spatial autoregressive models

*Zipcode* parameter estimates are not reported to save space (available upon request). Ten, twelve, twelve and eight *Zipcode* dummy variables were dropped from the analysis of *Samples 1, 2, 3* and *4*, respectively, because there were not properties within these zipcode areas

Confidence intervals presented as ***99%, **95%, and *90%: z-values in parentheses;

[a] *Sample 1* is a subsample of properties selected within the first quartile of the minimum distance to the closest wireless tower (radius ≤ 0.72Km);

[b] *Sample 2* is a subsample of properties within the second quartile of the minimum distance to the closest wireless tower (0.72Km ≤ *distance* ≤ 1.13Km);

[c] *Sample 3* is a subsample of properties within the third quartile of the minimum distance to the closest wireless tower (1.13Km ≤ *distance* ≤ 1.88Km);

[d] *Sample 4* is a subsample of properties within the fourth quartile of the minimum distance to the closest wireless tower (1.88Km ≤ *distance* ≤ 41Km);

[e] Visibility variable was dropped from the analysis because there were not visible towers in Sample 4

sales value and t-test results of the sale price means for home sales occurring before and after tower construction.

For properties located within a 0.72-km radius of a wireless tower that are sold after tower construction (Sample 1), it appears there is indeed a tower-related negative price effect. We estimate the social cost tower impact as approximately $4132 (*p*-value =0.014), which corresponds to a *2.65% decrease* in property value. As expected, tower impacts are negligible for the stratum of housing units located beyond 0.72 km. Along the same line, we compute the impact of tower visibility for properties sold after tower construction as $E(exp(\mathbf{X}\beta|\mathbf{D} = 1;V = 1)) - E(exp(\mathbf{X}\beta|\mathbf{D} = 1;V = 0))$. Our calculations, summarized in Table 7, indicate a tower visible to properties within 0.72 km would effectively depreciate property values an average of 9.78%, equating to an average monetary loss of $17,037 (*p*-value =0.00). The impact of tower visibility would be statistically equal to zero for those properties beyond the 0.72 km band. In addition, we use Eq. (4) to gauge the overall social welfare resulting from wireless towers. Computing the sum of the difference between the predicted housing price before and after tower construction across the sample, we find a staggering aggregate value loss of $24.08[11] million dollars.

[11] This figure was calculated using equation (4). Let $\hat{y}_1$ be a column vector (5828 × 1) of predicted housing prices obtained by evaluating exp($\mathbf{X}\beta$) at the average values of all of the price predictors with D = 1 (sold after tower construction) and $\hat{y}_0$ the predicted housing prices counterpart with D = 0 (sold before tower construction). We define the change in welfare of each household *i* within Sample 1, as the element-by-element subtraction $\Delta W_i = \hat{y}_{1i} - \hat{y}_{0i}$. Finally, the aggregate welfare impact was obtained by taking the sum of the elements of the column vector $\Delta W$, i.e., $\sum_{i=1}^{5,828} \Delta W_i = -24,081,385$.

**Table 6** Social Welfare Analysis of Wireless Tower Impact on Home Values

| | Expected Value | | |
|---|---|---|---|
| | Before Tower | After Tower | Impact[a] |
| Sample 1[b] | 155,911 | 151,779 | -4132** |
| | (91,553) | (89,964) | (1681) |
| Sample 2[c] | 161,865 | 164,068 | 2204 |
| | (131,195) | (133,607) | (2453) |
| Sample 3[d] | 162,249 | 163,485 | 1236 |
| | (113,627) | (114,428) | (2113) |
| Sample 4[e] | 159,752 | 161,770 | 2107 |
| | (101,244) | (103,532) | (1897) |

The table above presents the social welfare analysis of wireless tower impacts on home values

*After tower* = $exp.(X\beta)|D = 1$, *Before tower* = $exp.(X\beta)|D = 0$, *Impact* = $exp.(X\beta|D = 1) - exp.(X\beta|D = 0)$

**95% confidence interval; standard deviation in parentheses:

[a] standard error t-test in parentheses; t-test $H_0$: $E[exp(X\beta|D = 1)] = E[exp(X\beta|D = 0)]$;

[b] *Sample 1* is a subsample of properties selected within the first quartile of the minimum distance to the closest wireless tower (radius ≤ 0.72Km – sample size =5828);

[c] *Sample 2* is a subsample of properties within the second quartile of the minimum distance to the closest wireless tower (0.72Km ≤ *distance* ≤ 1.13Km – sample size =5827);

[d] *Sample 3* is a subsample of properties within the third quartile of the minimum distance to the closest wireless tower (1.13Km ≤ *distance* ≤ 1.88Km – sample size =5827);

[e] *Sample 4* is a subsample of properties within the fourth quartile of the minimum distance to the closest wireless tower (1.88Km ≤ *distance* ≤ 41Km – sample size =5827)

Because we find no evidence that towers impact prices of properties located beyond 0.72 km of a tower, we focus our analysis on the price sensitivity of homebuyers of properties located within 0.72 km of a tower. Earlier, we mention one of the main strengths of a spatial econometric analysis is it enables disentanglement of the direct and indirect effects of tower proximity on property values. This is because of a spatially correlated dependent variable—that the change in price of house $i$ with respect to the distance to the closest tower of the neighbor's house $j$ within the same sample is not zero (i.e. $\partial \ln(Price)_i / \partial \ln(Distance)_j \neq 0$ with $i \neq j$).

LeSage and Pace (2009) derive:

$$\left\{\begin{array}{lll} Average\ \ Direct\ \ Impact & = & n^{-1}\, tr\left[(I-\rho\mathbf{W})^{-1} I\beta_k\right] \\ Average\ \ Indirect\ \ Impact & = & n^{-1}\left\{1_n'\left[(I-\rho\mathbf{W})^{-1} I\beta_k\right]1_n - tr\left[(I-\rho\mathbf{W})^{-1} I\beta_k\right]\right\} \\ Average\ \ Total\ \ Impact & = & n^{-1}\, 1_n'\left[(I-\rho\mathbf{W})^{-1} I\beta_k\right] 1_n \end{array}\right\} \tag{11}$$

for each predictor $\beta_k$ with $k = 1,2,..K$. Therefore, we use Eq. (11) to decompose and calculate the average total impact of the wireless tower on property values within Sample 1 as reported in Table 8.

**Table 7** Social Welfare Analysis of Wireless Tower Visibility on Home Values

| | Expected Value | | |
|---|---|---|---|
| | Non-visible Tower | Visible Tower | Impact[a] |
| Sample 1[b] | 174,194 | 157,157 | -17,037*** |
| | (104,007) | (92,447) | (1823) |
| Sample 2[c] | 161,120 | 164,370 | 3251 |
| | (132,276) | (133,740) | (2464) |
| Sample 3[d] | 163,113 | 163,335 | 222 |
| | (114,055) | (114,297) | (2115) |
| Sample 4[e] | 157,454 | NA[f] | NA[f] |
| | (99,875) | (NA)[f] | (NA)[f] |

The table above presents the social welfare analysis of the visibility impact of wireless tower on home values (after tower construction — $D = 1$)

*Visible tower* = $exp.(X\beta|D = 1;V = 1)$, *Non-visible tower* = $exp.(X\beta|D = 1;V = 0)$, *Impact* = $exp.(X\beta|D = 1;V = 1)$ - $exp.(X\beta|D = 1;V = 0)$;

Confidence intervals presented as ***99%; standard deviation in parentheses;

[a] standard error t-test in parentheses; t-test $H_0$: $E[exp(X\beta|D = 1;V = 1)] = E[exp(X\beta|D = 1;V = 0)]$;

[b] *Sample 1* is a subsample of properties selected within the first quartile of the minimum distance to the closest wireless tower (radius ≤ 0.72Km – sample size =5828);

[c] *Sample 2* is a subsample of properties within the second quartile of the minimum distance to the closest wireless tower (0.72Km ≤ *distance* ≤ 1.13Km – sample size =5827);

[d] *Sample 3* is a subsample of properties within the third quartile of the minimum distance to the closest wireless tower (1.13Km ≤ *distance* ≤ 1.88Km – sample size =5827);

[e] *Sample 4* is a subsample of properties within the fourth quartile of the minimum distance to the closest wireless tower (1.88Km ≤ *distance* ≤ 41Km – sample size =5827);

[f] Visibility variable was dropped from the analysis because there were not visible towers in *Sample 4*

We then use Eq. (5) to assess the price sensitivity of buyers with respect to the distance to the closest visible and non-visible towers after their construction. It appears that if the tower is not visible, the property price decreases 8.7% for every 10% increase in distance to the closest tower. The spillover effect on property price due to the depreciation of the neighbor's property—the average indirect effect—is 4.41% of price decrease for every 10% increase in the distance to the closest tower. The total

**Table 8** Decomposition of the Price Sensitivity of Home Buyers to Tower Proximity

| | Average Direct Impact | Average Indirect Impact | Average Total Impact |
|---|---|---|---|
| ln(*Distance*) | -1.213 | -0.616 | -1.828 |
| ln(*Distance*)·*D* | 0.345 | 0.175 | 0.520 |
| ln(*Distance*)·*V* | 0.906 | 0.460 | 1.367 |

The table above presents the results of the sensitivity analysis designed to compare the price sensitivity of buyers of properties from which the closest tower is not visible

*Average Direct Impact* = $\partial \ln(\text{Price})_i/\partial \ln(\text{Distance})_i$, *Average Indirect Impact* = $\partial \ln(\text{Price})_i/\partial \ln(\text{Distance})_j$ with $i \neq j$, *Average Total Impact* = Average Direct Impact + Average Indirect Impact depreciation is 13% for 10% increase in the distance. Therefore, it may well be that non-visible towers are a potential external benefit for properties located within 0.72 km of a tower. Although we cannot affirmatively explain this finding, our sense is it may be due to enhanced wireless coverage resulting in a stronger wireless signal.

It is noteworthy that only 69 of 5828 properties within 0.72 km of the closest tower are outside of the visibility range of a tower. In contrast, however, the 5759 homebuyers purchasing properties within 0.72 km of the closest tower that are within visible range of a tower are not particularly sensitive, on average, to the distance to the visible tower, despite their perceptions of a visible tower as a negative externality. In fact, housing prices appreciate approximately 0.4% for each 10% increase in the distance to the closest visible tower. The average indirect impact of towers on those buyers (price spillover due to neighbor's price movement) is approximately 0.2%. This is to say that buyers of properties located an average of 0.497 km (average minimum distance in Sample 1) to the closest tower are willing to pay a premium of approximately 0.6% of the average housing price for every 10% increase in the average distance from a tower (average total impact). Monetarily, this translates into a value of approximately $962 per 50 linear meters[12] of increase in distance from the closest tower.

One limitation of our study is that we cannot control for potential endogeneity associated with the sale date dummy variable (*D*). Even though homeowners could choose to buy or not to buy a property after tower construction, we have no information as to their motivations for buying. Ideally, a difference-in-differences study restricted to repeat sales of the same property occurring pre- and post-tower construction could potentially mitigate this source of bias. Unfortunately, within the entire sample of 23,309 housing sales there are only 42 repeat sales. A difference-in-differences approach based on a sample of 42 observations would clearly suffer from a micronumerosity problem with negative degrees of freedom (the number of parameters would exceed the sample size), and would, therefore, lack empirical viability.

Notwithstanding the slight potential for bias, our results are clear: consumers perceive visible wireless towers as economic externalities. Aggregate social costs are highly significant relative to those properties within a 0.72 Km radius of a tower. Additionally, we must also point out that our study does not assess intangible social benefits of wireless towers, such as high-speed internet access, emergency communications, and digital forensics enabling national security related wireless communication monitoring, all of which provide invaluable services to consumers, businesses, and institutions.

## Conclusion

Truly, we currently live in the Age of Information. According to the International Communication Union of the United Nations, the number of wireless phone subscriptions totaled over 7 billion worldwide in 2015, with wireless coverage extending to 95% of the world's population (United Nations, International Communication Union 2015). U.S. wireless usage is no less astounding, as evidenced by the 1045% increase in

[12] We calculate a 10% increase in the average minimum distance for houses in *Sample 1* as 0.49 km · 0.1 ≈ 50 m. A 0.59% increase in the average housing price of *Sample 1* is $163,008.8 · 0.0059 ≈ $ 961.80.

wireless devise demand over the last 20 years (CTIA 2015). The future looks promising as well, with expectations that U.S. wireless industry employment will increase more than 31% from 2012 to 2017 (Pearce et al. 2013). Yet, even with the wireless industry poised for continued growth, it is unlikely it will be without consequences. Certainly, there are private benefits associated with the use of wireless service, yet there are costs as well. In this study, we examine one such cost: the impact of wireless towers on home values.

Although previous researchers have examined this issue, our study differs in two aspects. First, we address the econometric problem of spatial dependence that typically flaws hedonic price estimation analysis. We contend our empirical analyses are more efficient than those used in other studies, and as result, our results reveal greater consistency and reliability. Second, rather than rely solely on neighborhood-based property sales data, we test our hypothesis using recent property sales and current wireless tower locational data for an entire metropolitan statistical area,[13] which also happens to be one of the busiest port cities in the United States.[14]

The results of a series of spatial statistical tests developed by Anselin et al. (1996) suggest that a spatial autoregressive model is the most appropriate econometric approach to test our research hypothesis. We conduct a marginal sensitivity analysis for homes within different radii of distances to the closest visible and non-visible wireless towers, basing the distance bands on quartiles of the distance to the wireless tower. Our results reveal wireless tower capitalization only in the value of those properties that are within approximately 0.72 km of a tower. On average, the potential external cost of a wireless tower is approximately $4132 per residential property, which corresponds to a negative price effect of 2.65%. The negative price impact of 9.78% is much more severe for properties within visible range of a tower compared to those not within visible range of a tower. This negative impact vanishes as radii distances exceed 0.72 km. In aggregate, the social welfare cost for the properties in our sample located within 0.72 km amounts to an approximate loss of $24.08 million dollars of value.

U.S. federal law prohibits wireless siting denial if no alternative site is available (FCC 1996; Martin 1997). However, given the apparent social costs associated with negative price effects, local zoning and regulatory authorities should consider granting approvals that include impact-minimizing conditions. For example, wireless tower construction approvals could require development and maintenance of visual or vegetative buffer screening. Concurrently or alternatively, approvals could mandate camouflaging towers to look like trees or flagpoles. Other types of approval conditions could dictate attachment of communication antennae systems to existing structures such as buildings, street light poles, electric utility poles, water towers, billboards, or even sports stadium super-structures. Clearly, society is dependent on wireless communication, and obfuscating efforts to expand or improve coverage makes little sense. Arguably, however, authorities overseeing the process have definitive obligations, perhaps even fiduciary ones, to safeguard the interests and well-being of those whom they serve.

[13] The U.S. Census Bureau list of metropolitan statistical areas ranks Mobile County, Alabama at number 127. Data available at http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

[14] The Port of Mobile is home to the twelfth busiest port in the U.S., and ninth busiest port along the Gulf Coast, ranked by cargo tonnage handled as reported by the U.S. Department of Transportation, available at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_57.html.

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# HUD HOC Reference Guide

## Hazards & Nuisances: Overhead High Voltage Transmission Towers and Lines

**Chapter 1**
**Appraisal & Property Requirements**
**Page 1-18f**

The appraiser must indicate whether the dwelling or related property improvements is located within the easement serving a high-voltage transmission line, radio/TV transmission tower, cell phone tower, microwave relay dish or tower, or satellite dish (radio, TV cable, etc).

1. If the dwelling or related property improvement is located within such an easement, the DE Underwriter must obtain a letter from the owner or operator of the tower indicating that the dwelling and its related property improvements are not located within the tower?s (engineered) fall distance in order to waive this requirement.
2. If the dwelling and related property improvements are located outside the easement, the property is considered eligible and no further action is necessary. The

appraiser, however, is instructed to note and comment on the effect on marketability resulting from the proximity to such site hazards and nuisances.

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- Airports
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- Flood zones and insurance
- Lead based paint
- Radon
- Overhead high voltage transmission towers and lines
- Operating and abandoned oil and gas wells, tanks and pressure lines
- Insulation materials
- Lava zones
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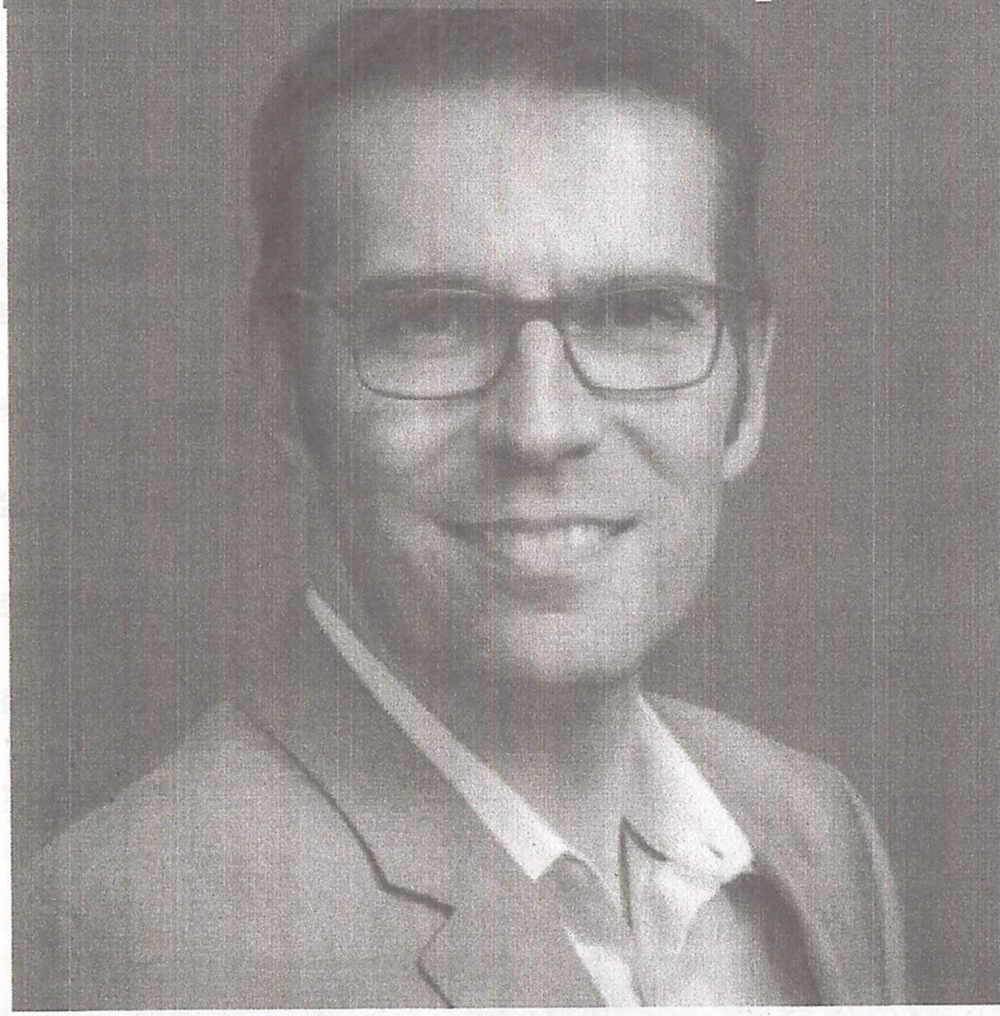
Home / Blog / **2G, 3G, 4G LTE Network Shutdown Updates**

Recorded webinar: 5 Factors to Guide Your Preparation for 5G

# 2G, 3G, 4G LTE Network Shutdown Updates



Harald Remmert, Senior Director of Technology, Digi International
June 08, 2021

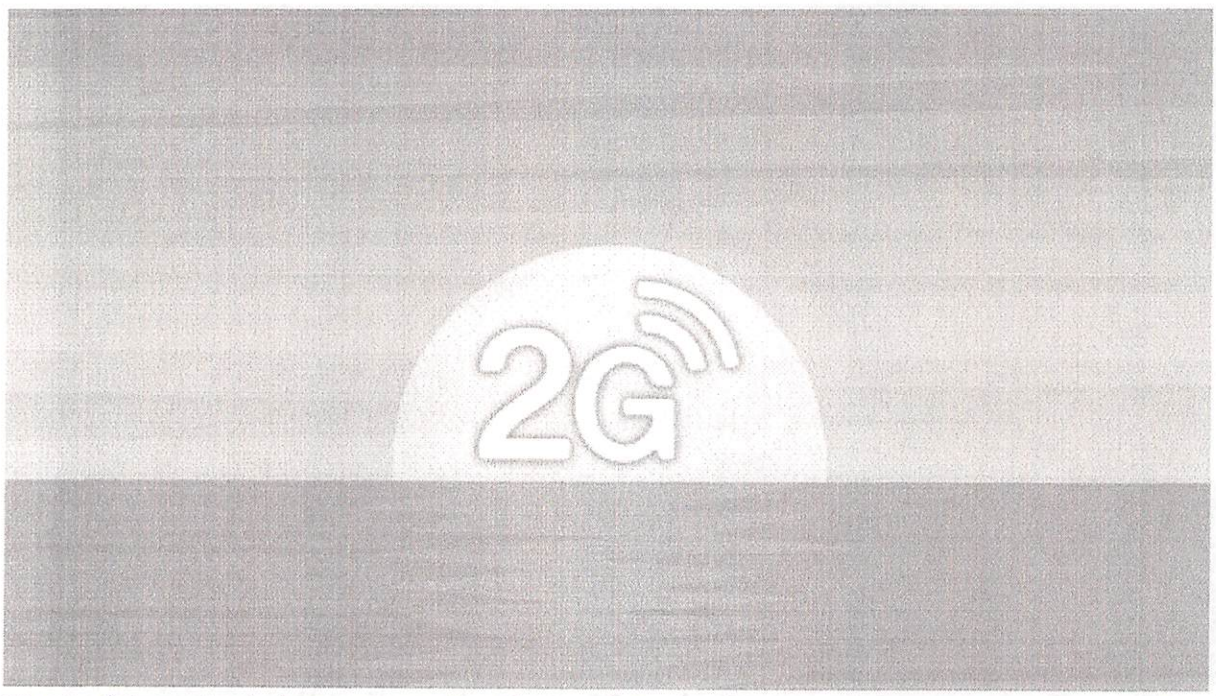
**Get Our White Paper**Learn how to plan your migration to 5G**WATCH VIDEO**

Cellular networks are changing, and 2G and 3G networks are sunsetting. This leads to many concerns and questions from businesses, governments and industries with deployed devices based on older networks. When will 2G go away completely? When will 3G networks sunset? And will 4G LTE networks also be scheduled for shutdown, or is it safe to invest in them now? We will answer each of these questions.

As we shared in the blog post, 4G to 5G: How Long Will 4G LTE Be Available, the main reason for network shutdowns is that the carriers have limited spectrum available for expansion. In order to provide a faster, more responsive network to their customers, they must re-use the spectrum with newer, more efficient cellular technology. Old 2G/3G infrastructure makes way for new networks, and older cellular devices must be retired.

The good news is that 4G LTE will be available for at least a decade to come, and will co-exist with 5G networks. In this post, we'll provide updates on the sunsetting of 2G and 3G networks and the outlook for 4G LTE and 5G networks, to support those who are planning their migration path.

## When Will 2G Shut Down?



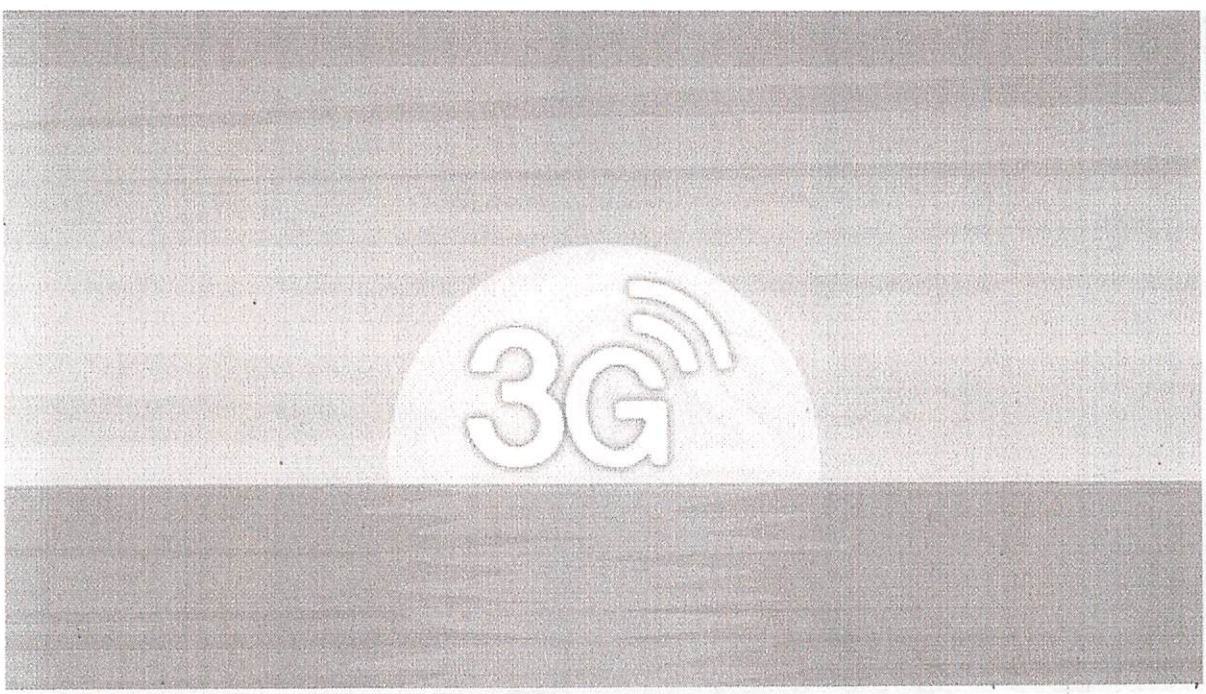

Most of America's largest carriers have already shuttered their 2G service or plan to soon:

- AT&T stopped servicing its 2G network back in 2017.
- Verizon Wireless phased out its 2G CDMA network at the end of 2020.
- Sprint sunsetted their 2G CDMA network in December of 2021.
- T-Mobile plans to sunset their 2G network in December of 2022.

It's important to note that customers will experience restrictions on 2G network usage and disrupted service before the actual sunset date. There are several factors. First, carriers are no longer activating new 2G devices in prepareation for total 2G network shutdown. Devices connected to the network may still function, but support will phase out. Secondly, carriers will re-farm spectrum ahead of the network shutdown, which means that 2G-only devices will no longer work as well in these locations, if at all.

In Canada, Bell shut down their 2G network in June of 2018. Both Telus and Rogers have also stopped supporting 2G devices. In Europe, where active 2G installations continued longer, Vodafone has promised that they won't sunset their 2G service until at least 2025, but they will likely start re-farming spectrum ahead of that date.

## When Will 3G Go Away?




Like 2G, carriers are eager to sunset older 3G networks so that they can repurpose that spectrum to support 4G LTE and 5G. New devices need more speed, and 3G tops out around 3 Mbps. Besides being faster, 4G LTE is also more efficient, as it allows more devices to share the spectrum.

Here are some at-a-glance dates:

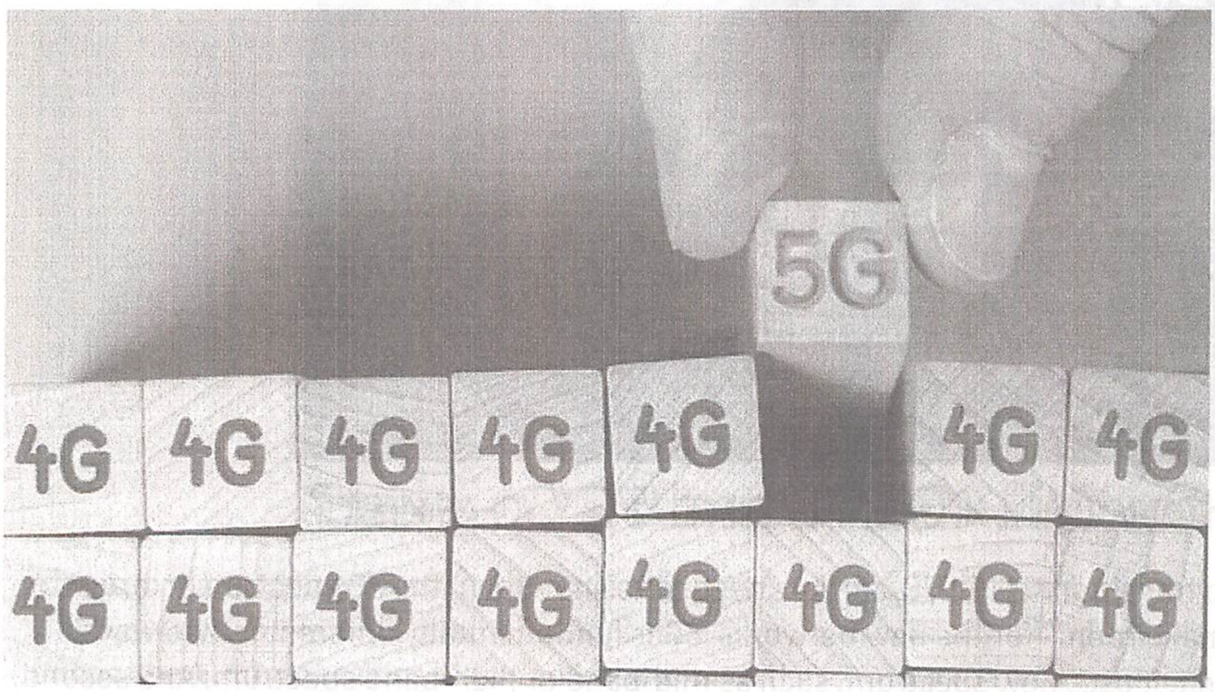
- Verizon will sunset its CDMA network at the end of 2022.

- AT&T has stated they will sunset their 3G network in February of 2022 with the last date for phone activation on the 3G network being already past.
- T-Mobile has stated that they will shutter their 3G networks in April, 2022.
- The last activation date for 3G on the Sprint network was April 2019 and the Sprint 3G network will be shut down in December of 2022.

More information on 3G sunset dates for Canadian and European carriers is available here.

To learn more about the transition from 3G to 4G, see our blog post, How to Ensure a Successful Migration from 2G and 3G to 4G LTE, about how to make that move as smooth as possible. You can find some additional information in the post, How to Stay Ahead of the 3G Network Sunset, which also describes why carriers shut down their 3G service instead of supporting it indefinitely.

# When Will 4G LTE Be Phased Out? (Not for a Long Time!)



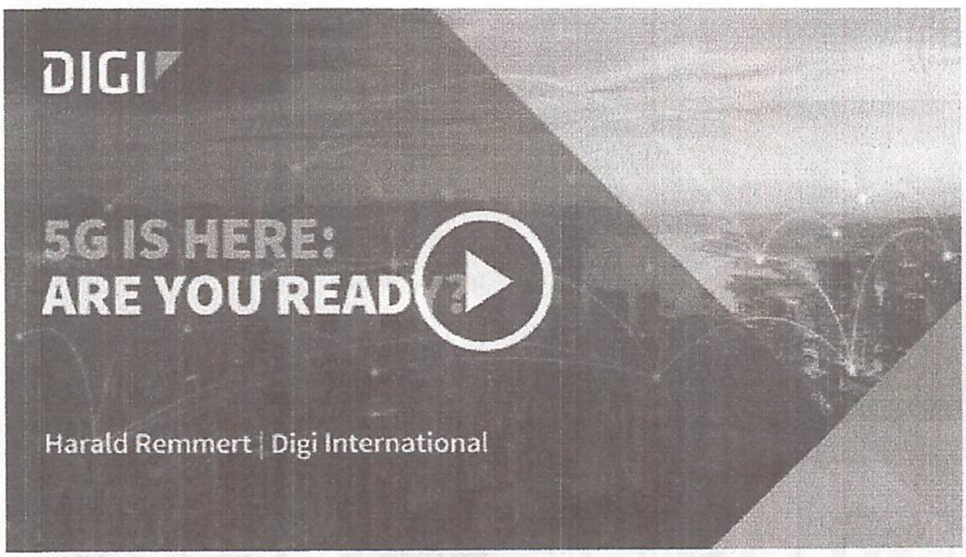

Like anything else, 4G will become obsolete *one day*. However, that day is far enough in the future that IoT deployments today and in the foreseeable future will be deployed on 4G networks. In fact, not only will it be at least a decade or more before 4G has been fully eclipsed by 5G, but 4G LTE is a more cost-effective choice –

and offers plenty of bandwidth – for most IoT applications. 4G LTE, which stands for Long Term Evolution, has a long track ahead.

Meanwhile, 5G is a revolutionary new technology and very exciting, but at this time, it is only advised for early adopters. As with all new technology, testing and full rollout involve some bumps in the road, and important incremental development.

For example, 5G is limited today in terms of coverage, and network infrastructure has to evolve to deliver the 5G vision of "one ubiquitous network for all use cases." Additionally, technologies like 5G mmWave are not ideal in areas with obstructions, such as buildings, dense foliage or rain and snow. Even double-pane glass can block a 5G mmWave signal. In practice, this means that the full 5G rollout will occur over the next 3-5 years and longer, depending on the geographic area.

## Watch our recorded webinar for more thought leadership on 5G




# How Will 4G LTE and 5G Co-exist?

To transition to 4G LTE, carriers needed to shut down the 3G spectrum in order to "make room" for the new networks. 5G is fundamentally different in two ways: First, it uses new spectrum, such as mid-band or high-band spectrum. And second, it can work in conjunction with 4G in existing spectrum, thanks to Dynamic Spectrum Sharing (DSS).

According to CNET, "Dynamic spectrum sharing lets carriers use the same spectrum band for both 4G and 5G. Instead of having different roads for buses and cars, DSS is like having one big highway with separate lanes for buses and cars."

Many next-generation devices like cellular routers will be built with both 4G and 5G radios so that they're capable of connecting to either network. At first, most data will be transmitted via 4G. However, over time as 5G coverage expands, more and more data will be transmitted via 5G. Therefore, to continue with the traffic analogy, 5G will eventually overtake 4G as the bigger lane on the freeway.

## In Summary: Prepare for Change

Within the U.S., it's reasonable to assume that by the end of 2022 there will not be a single major carrier supporting 2G. The same fate awaits 3G. 4G LTE operates under a different scenario, and we can confidently say that 4G will be around for at least another decade. And because 4G LTE has plenty of speed and reasonably low latency for most applications, it is an excellent choice for IoT applications today.

Those guidelines apply to developed countries like the U.S., Canada and Europe, in particular. In less developed countries, 4G LTE will likely remain the standard for several decades to come. Meanwhile, 5G networks will expand and ultimately deliver on their full promise, alongside the continued growth of 4G and the deployment of IoT applications.

Now is the time to plan and take action if you still have 2G/3G device deployments. With 4G LTE, you can continue growing your 4G deployments. If you are an early adopter, 5G may make sense for you soon.

## Support for migration planning

As the world gears up for full deployment of 5G, Digi aims to keep you informed. See our 5G information page, The Journey to 5G, which provides a wealth of information and resources.

Digi is an expert in cellular network planning and migration. Reach out if you need assistance.

*This post was first published in June of 2020, and was updated in June of 2021.*

An act relating to utility and communications poles; amending s. 120.80, F.S.; exempting certain rules adopted by the Public Service Commission from legislative ratification requirements; amending s. 366.02, F.S.; defining terms; amending s. 366.04, F.S.; requiring the commission to regulate and enforce rates, charges, terms, and conditions for pole attachments under certain circumstances; providing requirements for such rules; providing construction; providing situations under which a pole owner may deny access to the owner's pole on a nondiscriminatory basis; requiring the commission to hear and resolve complaints concerning rates, charges, terms, conditions, voluntary agreements, and denial of access relative to pole attachments; requiring the commission to establish cost-based rates, charges, terms, and conditions for pole attachments and apply certain decisions and orders of the Federal Communications Commission; requiring the commission to authorize certain parties to participate as an intervenor in a specified number of administrative proceedings; requiring the commission to adopt rules by a specified date and provide certification to the Federal Communications Commission upon such adoption; requiring the commission to regulate the safety, vegetation management, repair, replacement, maintenance, relocation, emergency response, and storm restoration requirements for poles of communications services providers; providing an exception; requiring the commission to adopt rules, including monetary penalties, by a specified date; authorizing the commission to access the books and records of communications services providers for specified purposes; providing that such information that contains proprietary confidential business information retains its confidential or exempt status when held by the commission; creating s. 366.97, F.S.; requiring pole owners to give advance notice to affected attaching entities of hardening projects; requiring attaching entities to remove pole attachments from redundant poles within a specified timeframe after receipt of electronic or written notice from the pole owner; authorizing a pole owner or its agent to transfer or relocate pole attachments of an attaching entity at the entity's expense under certain circumstances; providing an exception; requiring attaching entities to submit payment within a specified timeframe; authorizing pole owners to seek enforcement of such payment; requiring that the pole owner and its directors, officers, agents, and employees be held harmless under certain circumstances for such actions; authorizing a pole owner to remove and sell or dispose of certain abandoned pole attachments; authorizing the commission to issue orders for the removal or transfer of pole attachments by noncompliant attaching entities upon petition by a pole owner; providing construction; providing a directive to the Division of Law Revision; providing an effective date.

Be It Enacted by the Legislature of the State of Florida:

Section 1. Paragraph (g) is added to subsection (13) of section 120.80, Florida Statutes, to read:

120.80 Exceptions and special requirements; agencies.—

(13) FLORIDA PUBLIC SERVICE COMMISSION.—

(g) Rules adopted by the Florida Public Service Commission to implement ss. 366.04(8) and (9) and 366.97 are not subject to s. 120.541.

Section 2. Subsections (4) through (9) are added to section 366.02, Florida Statutes, to read:

366.02 Definitions.—As used in this chapter:

(4) "Attaching entity" means a person that is a local exchange carrier, a public utility, a communications services provider, a broadband service provider, or a cable television operator that owns or controls pole attachments.

(5) "Communications services provider" means an entity providing communications services as defined in s. 202.11(1).

(6) "Pole" means a pole used for electric distribution service, streetlights, communications services, local exchange services, or cable television services which is owned in whole or in part by a pole owner. The term does not include a pole used solely to support wireless communications service facilities or a pole with no electrical facilities attached.

(7) "Pole attachment" means any attachment by a public utility, local exchange carrier communications services

provider, broadband provider, or cable television operator to a pole, duct, conduit, or right-of-way owned or controlled by a pole owner.

(8) "Pole owner" means a local exchange carrier, a public utility, a communications services provider, or a cable television operator that owns a pole.

(9) "Redundant pole" means a pole owned or controlled by a pole owner which is:

(a) Near or adjacent to a new pole that is intended to replace the old pole from which some or all of the pole attachments have not been removed and transferred to the new pole;

(b) Left standing after the pole owner has relocated its facilities to underground but on which pole attachments of other attaching entities remain; or

(c) Left standing after a pole owner's attachments have been removed from that route or location to accommodate a new route or design for the delivery of service.

Section 3. Subsections (8) and (9) are added to section 366.04, Florida Statutes, to read:

366.04 Jurisdiction of commission.—

(8)(a) The commission shall regulate and enforce rates, charges, terms, and conditions of pole attachments, including the types of attachments regulated under 47 U.S.C. s. 224(a)(4), attachments to streetlight fixtures, attachments to poles owned by a public utility, or attachments to poles owned by a communications services provider, to ensure that such rates, charges, terms, and conditions are just and reasonable. The commission's authority under this subsection includes, but is



CODING: Words ~~stricken~~ are deletions; words underlined are additions.

not limited to, the state regulatory authority referenced in 47 U.S.C. s. 224(c).

(b) In the development of rules pursuant to paragraph (g), the commission shall consider the interests of the subscribers and users of the services offered through such pole attachments, as well as the interests of the consumers of any pole owner providing such attachments.

(c) It is the intent of the Legislature to encourage parties to enter into voluntary pole attachment agreements, and this subsection may not be construed to prevent parties from voluntarily entering into pole attachment agreements without commission approval.

(d) A party's right to nondiscriminatory access to a pole under this subsection is identical to the rights afforded under 47 U.S.C. s. 224(f)(1). A pole owner may deny access to its poles on a nondiscriminatory basis when there is insufficient capacity, for reasons of safety and reliability, and when required by generally applicable engineering purposes. A pole owner's evaluation of capacity, safety, reliability, and engineering requirements must consider relevant construction and reliability standards approved by the commission.

(e) The commission shall hear and resolve complaints concerning rates, charges, terms, conditions, voluntary agreements, or any denial of access relative to pole attachments. Federal Communications Commission precedent is not binding upon the commission in the exercise of its authority under this subsection. When taking action upon such complaints, the commission shall establish just and reasonable cost-based rates, terms, and conditions for pole attachments and shall apply the decisions and orders of the Federal Communications Commission and any appellate court decisions reviewing an order of the Federal Communications Commission regarding pole attachment rates, terms, or conditions in determining just and reasonable pole attachment rates, terms, and conditions unless a pole owner or attaching entity establishes by competent substantial evidence pursuant to proceedings conducted pursuant to ss. 120.569 and 120.57 that an alternative cost-based pole attachment rate is just and reasonable and in the public interest.

(f) In the administration and implementation of this subsection, the commission shall authorize any petitioning pole owner or attaching entity to participate as an intervenor with full party rights under chapter 120 in the first four formal administrative proceedings conducted to determine pole attachment rates under this section. These initial four proceedings are intended to provide commission precedent on the establishment of pole attachment rates by the commission and help guide negotiations toward voluntary pole attachment agreements. After the fourth such formal administrative proceeding is concluded by final order, parties to subsequent pole attachment rate proceedings are limited to the specific pole owner and pole attaching entities involved in and directly affected by the specific pole attachment rate.

(g) The commission shall propose procedural rules to administer and implement this subsection. The rules must be proposed for adoption no later than January 1, 2022, and, upon adoption of such rules, shall provide its certification to the Federal Communications Commission pursuant to 47 U.S.C. s.

224(c)(2).

(9)(a) The commission shall regulate the safety, vegetation management, repair, replacement, maintenance, relocation, emergency response, and storm restoration requirements for poles of communication services providers. This subsection does not apply to a communications services provider that owns no poles.

(b) The commission shall adopt rules to administer and implement this subsection. The rules must be proposed for adoption no later than April 1, 2022, and must address at least the following:

1. Mandatory pole inspections, including repair or replacement; vegetation management requirements for poles owned by providers of communications services; and

2. Monetary penalties to be imposed upon any communications services provider that fails to comply with any such rule of the commission. Monetary penalties imposed by the commission must be consistent with s. 366.095.

(c) The commission may access the books and records of communications services providers to the limited extent necessary to perform its functions and to exercise its authority under subsection (8), this subsection, and s. 366.97(4). Upon request by a communications services provider, any records that are received by the commission under this paragraph which are proprietary confidential business information under s. 364.183 or s. 366.093 shall retain their status as confidential or exempt from disclosure under s. 119.07(1) and s. 24(a), Art. I of the State Constitution.

Section 4. Section 366.97, Florida Statutes, is created to read:

366.97 Redundant poles; transfer of ownership.—

(1) Pole owners shall provide at least 180 calendar days' electronic or written advance notice to affected attaching entities of major hardening projects the purpose of which is to replace poles to ensure the poles meet extreme wind loading requirements. The advance hardening project notice must include:

(a) The scope of the major hardening project, to the extent determined, the locations of the affected poles, the expected start date, and the expected completion date of the major hardening project; and

(b) The date, time, and location of a field meeting for the pole owner and attaching entities to review and discuss the planned major hardening project details, including the types of replacement poles to be used. The field meeting must occur no sooner than 15 calendar days after the date of the notice and no later than 60 calendar days after the notice and, at a minimum, must include sufficient information to enable the attaching entity to locate the affected poles and identify the owner of any facilities attached to the poles.

(2)(a) An attaching entity must remove its pole attachments from a redundant pole within 180 calendar days after receipt of an electronic or a written notice from the pole owner requesting such removal. A pole owner may use a joint use notification software program to accomplish such written or electronic removal notice.

(b) If an attaching entity fails to remove a pole attachment pursuant to paragraph (a), except to the extent excused by an event of force majeure or other good cause as agreed to by the parties or as determined by the commission or its designee within 30 calendar days after the 180 calendar-day period under paragraph (a), the pole owner or its agent may transfer or relocate the pole attachment to the new pole at the noncompliant attaching entity's expense. This subsection does not apply to an electric utility's pole attachments. An attaching entity shall submit payment to the pole owner within 60 days after receipt of the pole owner's invoice for transfer or relocation of the pole attachments. A pole owner may seek to enforce its right to payment under this paragraph in circuit court and, if it prevails, is entitled to prejudgment interest at the prevailing statutory rate and reasonable attorney fees and court costs. Upon receipt by the pole owner of written notice, the attaching entity that fails to comply with this subsection shall indemnify, defend, and hold harmless the pole owner and its directors, officers, agents, and employees from and against all liability, except to the extent of any finding of negligence or willful misconduct, including attorney fees and litigation costs, arising in connection with the transfer of the pole attachment from a redundant pole to a new pole by the pole owner.

(c) If a pole attachment is abandoned by an attaching entity that fails to remove or transfer its attachments in accordance with this section, the pole owner or its agent may remove the pole attachment at the noncompliant attaching entity's expense and may sell or dispose of the pole attachment, except to the extent the attaching entity's noncompliance is excused by an event of force majeure or other good cause as determined by the commission. An attaching entity shall submit payment to the pole owner within 60 days after receipt of the pole owner's invoice. A pole owner may seek to enforce its right to payment under this paragraph in circuit court and, if it prevails, is entitled to prejudgment interest at the prevailing statutory rate and reasonable attorney fees and court costs. Upon receipt by the pole owner of written notice, the noncompliant attaching entity shall indemnify, defend, and hold harmless the pole owner and its directors, officers, agents, and employees from and against all liability, except to the extent of any finding of negligence or willful misconduct, including attorney fees and litigation costs, arising in connection with the removal, transfer, sale, or disposal of the pole attachments from a redundant pole by the pole owner.

(3) Upon petition by a pole owner or an attaching entity, the commission may issue orders enforcing this section which do not expressly relate to circuit court jurisdiction.

(4) This section may not be construed to do any of the following:

(a) Prevent a party at any time from entering into a voluntary agreement authorizing a pole owner to remove an attaching entity's pole attachment. It is the intent of the Legislature to encourage parties to enter into such voluntary agreements without commission approval.

(b) Impair the contract rights of a party to a valid pole attachment agreement in existence before the effective date of this act.

Section 5. The Division of Law Revision is directed to replace the phrase "the effective date of this act" wherever it occurs in this act with the date this act becomes a law.

Section 6. This act shall take effect upon becoming a law.