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April 3, 2017

TOWN of NASSAU Planning Board
ATTN: Sam Critton, Chairman
29 Church Street
PO Box 587
Nassau NY 12123

RE: Telecommunications Facility RF Site Review
Cellco Partnership d/b/a Verizon Wireless
Route 66 – Tax Map No. 181.-1-24.11

Dear Mr. Critton,

This preliminary report discusses the radio-frequency (RF) aspects of the proposed Cellco Partnership d/b/a Verizon Wireless (Applicant) project in the Town of Nassau. Subsequent reports, if needed, will address any remaining questions or issues that arise during public hearings at the request of the town. Appendix A is attached to this report as a summary my professional qualifications to render opinions regarding the application. Additional background information related to technical matters is included in Appendix B and following.

The following materials form the basis for this report:

1. Site Plan Application dated September 30, 2016
2. Visual Resource Evaluation dated January 17, 2017
3. Noise Comparison Letter dated January 9, 2017
4. Additional RF Materials and Exhibits dated February 14, 2017 regarding tower height justification and alternate site analysis.
5. Additional Materials and Exhibits dated February 28, 2017

Summary of Findings

1. The RF coverage levels upon which the proposed site is designed are reasonable values and comport with levels used by Applicant in other sites throughout this region.
2. Using the stated RF coverage thresholds for in-building and in-vehicle coverage, applicant has demonstrated need for RF coverage from a base station facility in the general area of the proposed project site.

3. The proposed height appears reasonable and is probably at or close to the minimum height for the proposed site based upon coverage objectives and predicted RF propagation results. In particular, RF propagation plots for the proposed coverage and coverage at a reduced height show reduction in performance near the edges of the proposed cell primarily due to terrain shadowing effects. That reduction shows that the proposed coverage is not excessive and that reduction in height will produce some shadowing and propagation degradation.
4. Applicant's narratives mention the use of twelve (12) antennas at the proposed site. It is noted that the site plan elevation drawing indicates that quantities of antennas are to be determined.
5. Applicant analyzed alternate scenarios that include a new tower site (County Tower) and hypothetical extension of existing tower heights. In both cases, these scenarios fail to provide adequate coverage to the target area.
6. Applicant also analyzed the effect of the proposed site ACL on the ability to fill coverage gaps in other parts of the Town of Nassau. Even when extending the proposed tower height to unreasonable ACL, the proposed site would still not fill coverage gaps in eh southern part of town. Note that increasing the height of the proposed antennas would cause increasing interference to the surrounding neighbor cells.
7. The town's tower overlay districts are located in the southern part of town and are approximately 3.5 miles away from the center of the target coverage area. Extrapolating the alternate site analysis discussed above, and given the distance to the northern edge of the proposed target coverage area, a tower located in the tower overlay districts cannot provide Applicant adequate RF coverage or appropriate capacity relief for existing sites.
8. The proposed site is tower-mounted with antennas more than 10 m above ground. Therefore, the site is categorically excluded under FCC regulations from mandatory human exposure analysis.
9. Although the proposed site is categorically excluded from mandatory human exposure analysis, Applicant has provided an analysis that concludes the site is operating within general population exposure limits.
10. A "Visual Resource Evaluation" (VRE) is included in the materials submitted to the board on January 26, 2017. General commentary on photo simulations is included below. The VRE materials and noise evaluation were reviewed by the town's engineer.
11. If the proposed site is ultimately approved it, like the existing neighbor sites currently in operation, will serve as a fixed area of coverage to which future neighbor sites must connect.
12. Wireless networks consist of individual cells that function as a whole. Approval of any one particular site should consider the future need for additional neighbor sites and the locations of those sites. A new tower in a more controversial area

may be required to address the remaining coverage gaps, extend the coverage area, and properly connect the proposed site into the larger network.

13. The proposed RF coverage shows that several coverage gap areas will remain in the area, as previously noted by the board. Those gaps that remain after a proposed site is active imply the possibility that Applicant may decide to address those areas as part of their overall wireless network. Additional tower height and the new fire department tower will not fill those gaps. At this time, the board should understand the potential need to serve remaining gap areas and how approval of the proposed site will influence the placement and height of future sites.

The information in this report concerns the RF engineering issues related to the proposed project to assist the board in weighing the alternatives and planning for the future of the community. Engineering design choices may also implicate aesthetic and legal issues. However, this report must not be relied upon for any legal advice or direction. Legal advice about action on these issues must be obtained from the board's counsel. The remainder of this report addresses the details that support the findings above, as well as supporting background information that may be useful to the board to help explain some of the engineering constraints and aesthetic analysis.

Site Details

Applicant proposes a new 120' monopole supporting twelve (12) panel antennas located at 116' antenna center line (ACL), associated cabling and ground equipment mounted on a 11.5' x 16' platform within a 100' x 100' leased compound. The antenna count is noted in Applicant's narrative, but the elevation plan indicates "quantity to be determined."

Site Justification

Subject to confirmation by the board's legal counsel, in New York an Area Variances, Special Use Permits and Use Variances for a proposed telecommunication facility is normally based upon an applicant showing that (1) its new construction "is a public necessity in that it is required to render safe and adequate service"; and (2) "there are compelling reasons, economic or otherwise, which make it more feasible" to build a new facility than to use an alternative site.[1] Area-wide RF coverage gaps tend to show necessity. Feasibility generally relates to whether the proposed facility addresses the coverage need, avoids unacceptable performance degradation, and avoids unreasonable community aesthetic impact. Considering the need to provide wireless service and the impact on the community, the proposed site should represent the most balanced and reasonable solution among all alternatives. Determination of reasonableness might also involve an analysis of whether a proposed site creates unacceptable precedents for or constraints upon the locations of other future sites in the area needed to provide additional area coverage (SEQRA segmentation) where Applicant's future build-out

[1] *Cellular Tel. Co. v. Rosenberg*, 82 N.Y.2d 364, 371-371 (1993).

plans are apparent. Additional considerations can include whether the proposed structure can accommodate additional antenna arrays and the potential limitations for effective co-location at heights lower than that proposed by Applicant.

Telecommunication facilities fall into two categories based upon the status of the service provider's technology. The status must be determined by the municipality's legal counsel. Some facilities are deemed to be covered by the Telecommunications Act of 1996, 47 USC §332(c)(7), which limits some aspects of local zoning authority. Other facilities are deemed not included or their status is unclear because of the nature of the service provider's technology or lack of precedential decisions at the FCC or within the courts. Determination of the actual status of any particular applicant requires advice from legal counsel and is beyond the scope of this report. This report will proceed on the assumption that 47 USC §332(c)(7) local zoning limitations apply and will, therefore, focus upon the areas of review permitted under those limitations. A subsequent contrary determination by the municipality will affect the application of the law to the facts and engineering opinions presented in this report, and such determination may open other areas of inquiry.

Subject to confirmation by the board's legal counsel, the federal Telecommunications Act of 1996 (Act) in 47 USC §332(c)(7) limits certain aspects of local zoning authority regarding wireless telecommunication services providers. Beyond the few explicit limitations, "…nothing [else] 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."[2] The main limitations imposed by the Act require that local regulation of "the placement, construction, and modification of personal wireless service facilities . . . (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."[3] The Act also states that "[n]o 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."[4] Otherwise, the Act leaves substantial and familiar local zoning authority in place balanced by the familiar conditions that local zoning decisions must be timely, based upon substantial evidence, and documented for potential judicial review.[5]

Public Necessity

Wireless service providers, such as Applicant, establish the radio-frequency (RF) coverage level necessary for what they unilaterally define as reliable service[6] consistent

[2] 47 U.S.C. §332(c)(7)(A).
[3] 47 U.S.C. §332(c)(7)(B)(i).
[4] 47 U.S.C. §332(c)(7)(B)(iv).
[5] This balance is discussed at length in *Sprint v Willoth* 176 F.3d 630 (2nd Cir 1999).
[6] Service that is "safe and adequate" is part of the New York utility standard as described in *Cellular Tel. Co. v. Rosenberg*, 82 N.Y.2d 364, 371 (1993). The meaning of "safe and adequate" is defined by each

with their business model. The business model involves a trade-off between the quality of service experienced by a subscriber and the cost of network deployment and operation. Several factors determine the level of subscriber service. Two important factors for base station site selection are the wireless RF signal level and the system capacity. The choice of minimum wireless RF signal level directly affects service reliability. The design specification for system capacity limits the number of simultaneous subscribers that can use the proposed facility.

Applicant's mobile wireless subscribers are often located inside buildings or vehicles that are screened by foliage from direct view of a base station. Foliage, buildings and vehicles are obstacles to radio wave penetration. In order to provide "safe and adequate" service, the wireless RF signal must travel over the terrain in the coverage area, penetrate obstacles that block a direct path to the subscriber, and then arrive with sufficient signal level to achieve the desired level of service. Wireless telecommunication systems must operate simultaneously in both directions between the base station facility and the subscriber's mobile equipment. Therefore, the return signal from the subscriber's mobile or stationary equipment must also overcome the signal losses due to terrain and other obstacles. Generally, when a high level of service reliability or high user capacity are needed, network base stations must be placed closer together to provide both high RF signal levels and increased network user capacity over a smaller area. In less populated areas where user capacity is not an issue, the base stations can be spaced at greater distances where the separation is generally limited by path loss caused by terrain features, buildings, and other obstacles. For RF coverage considerations from a particular base station, the wireless service provider's choice of minimum RF signal level limits the extent of cell coverage. If the RF signal level requirement is high, then the acceptable coverage area is generally small. When a service provider adopts lower but acceptable reliability and uses a lower RF signal threshold for their network design, a single base station will cover more area at the reduced level.

Design engineers for wireless service providers use an RF link budget to quantify the RF signal level required for "safe and adequate" wireless network operation. The RF link budget ultimately establishes the maximum permitted path loss from base station to mobile. The RF link budget includes all relevant system design assumptions including measures of dropped connections related to signal strength and ultimately quantifies maximum permissible path loss. Path loss, or signal attenuation during propagation, is the reduction in RF signal as it travels from the base station to the subscriber's mobile device and, likewise, from the mobile device back to the base station. If the path loss is too high, then the received signal will be below the established minimum RF signal level threshold. When the received signal is below threshold, unreliable operation (i.e. dropped connections or reduced data transmission speed) may result.

After establishing the minimum RF signal threshold level the design engineer can analyze the area RF coverage path loss encountered from a proposed base station. The path loss analysis predicts the actual coverage area. Applicant Verizon Wireless uses

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service provider in terms of the required signal level to limit the probability of a dropped connection to some maximum value.

-105 dBm[7] Reference Signal Received Power (RSRP) for operation of their LTE technology in the 700 MHz band as the minimum signal level for adequate service in this region.

Wireless system engineers use an RF propagation plot for area coverage analysis and prediction. An RF propagation plot shows predicted area signal power levels with respect to the minimum signal threshold for site performance analysis in units of dBm. Visually, an RF propagation plot maps the area surrounding a proposed base station using various colors to represent locations where the RF coverage levels meet or exceed the minimum RF signal levels as stated in dBm. By the absence of color, an RF propagation plot will also show locations where the base station cannot provide the minimum signal levels. These areas (called coverage "gaps") are a graphic measure of whether a particular site achieves RF design coverage levels for the given location and height. A gap could be only slightly below threshold or it might represent a deep lack of coverage. A designer usually anticipates slight gaps surrounding a cell because of difficult area terrain and clutter. When gaps are deep and located along critical roadways or near relatively high population areas, one can anticipate unreliable wireless service. A particular site may fail as a suitable location because of such gap areas.

In support of the application, Applicant has provided a series of RF propagation plots that show existing RF coverage and how the proposed site fills the coverage need relative to provision of wireless service to their subscribers.[8] Exhibit 1 in the RF narrative shows that the area surrounding the Hoag Corners site lacks reliable RF coverage in the 700 MHz LTE band where many areas in the immediate area are covered at less than the required -105 dBm RSRP level. Existing overage plots for other bands are not included in the application materials.

The presence of RF coverage gaps predicted by the RF propagation plot for existing coverage and, when applicable, the actual and predicted trends toward maximum capacity tend to demonstrate need. Whether these gaps can be addressed by the proposed site or a less intrusive alternate site when balanced between the technical performance and aesthetic advantages serves to justify the proposed site.

Feasibility - Addressing the Need and Balancing of Impact

A service provider makes decisions to provide wireless RF coverage based on the location and travel habits of their subscriber base. Base stations are limited to coverage areas surrounding the site since they must be able to communicate with the low-power wireless subscriber device. Therefore, to achieve maximum effect, a base station facility generally should be placed near the center of the target coverage area when zoning, land use, and aesthetic considerations allow. After the location of a proposed base station is established, the terrain features and other "scatter" obstacles of the target area must be

[7] The unit "dBm" is decibels above 1 milliwatt and is calculated from the power level (in watts) as dBm=20Log(power/0.001); a milliwatt is 0.001 watts. Values that are less negative represent stronger signal levels.

[8] See "RF Justification and Site Selection Analysis, Sept. 26, 2016" exhibit contained in the September 30, 2016, submission materials.

analyzed to determine how effectively the base station can cover the target area. In addition to area coverage, wireless service providers attempt to position their base station sites to achieve continuous coverage from one cell to the next with few intervening coverage gaps. Even if the area of the proposed project is relatively flat, it may still contain foliage and obstacles that can produce shadowing and absorption of the RF radio waves. Shadowing and scatter cause the jagged pattern shown on the RF propagation prediction plots. RF coverage becomes more uncertain at lower antenna heights because local obstacles in the area through which the signal must propagate are not individually modeled in the computer simulation.

The significance of visual impact from the tower and antennas and the significance of that impact to nearby residents and visitors are appropriate matters for the board to consider. The board may also wish to consider the prospects for possible future co-location on the proposed site. While considering the local impact, consider that any nearby alternate site location would require at least the same antenna height because the proposed site is nearly central to the existing gap area. Generally, base stations at the center of a coverage gap area result in the shortest antenna height requirement. When a base station must cover a gap from a non-central location, the height must usually increase to overcome terrain shadowing to provide comparable levels of RF coverage and maintain adequate connectivity to the adjacent neighbor cells. In the alternative, area coverage might be achieved from a non-central location by multiple shorter sites. Use of multiple sites increases the cost to cover the target area.

In the present case, the proposed Hoag Corners site is located in a central gap area where it has a good vantage point to project the radio signal inside the terrain valleys to fill in existing coverage gap areas between it and the neighbor sites.

Reasonableness of the Proposed Project

Approval of a base station facility usually requires review for use and area variances and/or site plan approval that considers similar concerns common to use and area variances. The review is governed by standards applicable to an applicant's status as a utility, broadcaster, telecommunication services provider or other category. Board decisions must not be arbitrary or capricious. Therefore an applicant should provide objective evidence of their need and, when weighing alternatives, objective evidence regarding the strengths and weaknesses of the alternative sites. The board then weighs that evidence to determine whether the site is reasonable and properly balances the interests of the community and the applicant.

Where an applicant is also classified as a public utility, a less restrictive standard for area and use variances may apply. Subject to confirmation by the board's legal counsel, a provider of wireless telecommunication services like Applicant is considered a public utility in New York.[9] As a public utility, there may also be legal constraints on the whether a municipality can impose restrictions on Applicant that unreasonably increase project costs. Unreasonable costs may accrue when mandated co-location or use

[9] Cellular Tel. Co. v. Rosenberg, 82 N.Y.2d 364 (1993)

of sub-optimum sites causes the need for additional base stations to fill the existing coverage gap. Under some limited circumstances the need for multiple sites may also increases technical complexity beyond what might be considered reasonable. If the board determines that the proposed site as proposed cannot be approved, the alternatives for Applicant would include options that could increase network costs or decrease potential coverage area. These options include:

(1) modification of the proposed site to conform to zoning and visual impact requirements,
(2) identification of nearby sites that collectively meet both the RF coverage objectives and zoning and/or aesthetic requirements,
(3) construction of an alternate site that meets aesthetic and zoning requirements and provides some coverage even if it does not completely provide coverage to the gap area, or
(4) abandonment of the project.

The range of options is not particularly limited by the technology and engineering issues. However, the choice of a specific option could implicate the previously mentioned legal and land control issues. The legal implications are beyond the scope of the present report and, if necessary, should be discussed with the board's counsel. If one or more of these options are deemed viable by the board, a more focused analysis on the specific option(s) can be provided in a supplemental report.

The proposed site plan and zoning analysis, if applicable, for any particular site usually considers the nature of the proposed site in the context of the surrounding area and the nature of other alternate sites that can provide adequate, even if not identical, RF coverage. The analysis also balances the impact of a new facility with the benefits derived from with availability of wireless services. The characteristics of the area in which the site is proposed, the proximity and visibility of the site to nearby residences, and accessibility of the site generally weigh into the analysis. In some circumstances, other considerations may include whether a particular site exceeds Federal Communications Commission (FCC) human exposure limits and whether it is necessary to illuminate the tower for aircraft safety even if not required by Federal Aviation Administration (FAA) requirements.

Sometimes the objectionable aesthetics of a tower can be partially mitigated by use of stealth structures to blend into the area. Stealth structures tend to limit the co-location opportunities for future wireless service providers because the structures are usually customized for reduction of aesthetic impact. Generally, the design of stealth structures attempts to minimize height and cross-section. Minimization of height and cross section usually reduces the mechanical load-bearing ability of the structure compared to other support technologies such as a monopole or lattice tower. The reduced cross-section limits the ability to host additional antenna arrays within the structure's envelope. However, where a stealth structure is appropriate to achieve the desired aesthetic goals the trade-off between future co-location and acceptable appearance are appropriate.

The proposed Hoag Corners site is 120' tall. Although there are occasional situations where it might be applicable, stealth technologies are generally not appropriate where the site would be much taller than the local tree canopy. This leads to the question of whether the proposed site could function adequately at lower ACL. ACL reduction is generally not a go/no-go proposition since the radio signal propagation will degrade gradually as the antennas get closer to the surrounding tree canopy, terrain and obstacles. The question of minimum height was addressed by Applicant in their February 14, 2017, supplemental materials Exhibit Supp1 through Exhibit Supp6. Supp1 shows proposed coverage at 120' (116'ACL) while Supp2 shows the coverage 20' below. As one would expect, the coverage in areas near the edge of the cell are compromised. When the levels of RF coverage are less than the target threshold (-105 dBm RSRP here), a subscriber's ability to use the LTE network reliably may be impacted.

In addition to ACL height reduction, Applicant analyzed best-case scenarios for placing equipment at the Tsatsawassa Lake Fire House, the County Tower site, or on existing neighbor sites with higher ACL (250') at those sites. Applicant analyzed the fire house site at 200' (the maximum height to generally avoid mandatory FAA marking and lighting). Supp5 shows coverage from the proposed Hoag Corners site with coverage from the County Tower site. The County Tower site at 200' ACL provides no coverage to the target coverage area. When the existing neighbor tower sites are analyzed at 250' ACL, as shown in Exhibit Supp6, very sparse coverage is obtained in the target area. The conclusion from these scenarios is that neither the fire house site or extended height at the existing tower sites will achieve Applicant's coverage objectives. Distance between the target area and the undulating terrain in the coverage area are the primary reasons for the failure of each alternative scenario.

The board also asked Applicant to analyze how, if at all, the proposed site could be used to provide coverage in the southern part of the town. Exhibit Supp4 shows RF coverage for ACL of 195.' For ACL of 195', coverage expands toward existing neighbor sites as well as providing some additional coverage to the south, However, the coverage to the south does not extend completely into the gap areas north of US-20. If Applicant decides to provide expanded LTE coverage to those areas, a new site further to the south and east of the existing Nassau site will be required. Even if coverage to the southern part of the town was achieved, the expansion of signal into the areas already covered by neighbor sites would cause interference to those existing cells. Interference into existing cells caused by excessive overlap of coverage areas is undesirable for robust network operation.

The Town of Nassau Communications Facility Law §6.10-5 permits towers in the Tower I and Tower II overlay districts. If adequate coverage/capacity cannot be achieved " … consistent with federal regulations, the Planning Board may determine that a major wireless communications facility may be permitted as a special permit use in another zoning district in accordance with the provisions …" of that law. In this case, the overlay districts are approximately 3.5 miles to the south of the proposed coverage area. The fire house site, located in the most southern area of the town, analyzed by Applicant and discussed above fails to provide coverage to the proposed target coverage area. A site

located in the more northern area of the Tower Overlay District would fail to provide adequate RF coverage to the target area and, where RF coverage might be provided, would fail to provide a balanced capacity off-load from the existing sites to the north. Therefore, it is our opinion that a tower in either of the Tower Overlay Districts would fail to provide adequate coverage and capacity to the proposed target area.

Additional Considerations

FAA Marking and Lighting

The applicant is proposing a tower that does not exceed 200'. Generally, all towers in excess of 200' require FAA marking and lighting. In the present proposal, Applicant's documentation includes a "TOWAIR Determination of Results" in the 9/30/2016 materials. The note on the document indicates it is purely advisory, and not conclusive as to its findings.

Future Co-location

Many municipalities specify that, as a condition of approval, a tower must be designed to accommodate several additional wireless service providers. Generally a wireless service provider designs a cell for an antenna centerline that provides the required coverage but is not so high as to cause interference and excessive overlap to their own adjacent neighbor cells. Since each service provider builds their network to achieve their own reliability and service design requirements, the coverage maps for two wireless service providers can be remarkably different even for those operating in the same frequency band. Future build-out plans are closely guarded secrets based on proprietary customer demographics and technology deployment, so it is usually challenging to know what a given service provider will require in the years ahead and how those requirements will translate to co-location opportunities. Given the uncertainties, there are two views on the matter of co-location each having advantages and disadvantages.

First, some municipalities take the position that it is better to concentrate the co-locations at one site rather than conduct hearings for multiple shorter towers. Under this approach, the current tenant and each future service provider with an area coverage gap will ideally locate on the proposed tower. If co-location is agreeable to a service provider, it will force an approximately similar coverage grid to that of the existing carriers. In some cases the similar grid pattern can increase the likelihood that future neighbor tower sites will be required in a location that may be more controversial or in places where it may be undesirable to stack multiple service providers on the same tower. The concentration of a large number of service providers on the same tower can result in a visual impact that far exceeds that of the original tower as proposed even if the height remains unchanged.

Second, some municipalities prefer multiple shorter towers since the lower height may make them more easily buffered by foliage and/or facilitate stealth structures. Stealth structures include structures designed to look like clock towers, church steeples, building facades, or trees. Stealth tree structures are generally effective when antenna centerline and tower height are within 15' of the existing tree canopy, so this generally precludes future co-location without additional height. When the tower height dramatically exceeds the existing tree canopy the advantages of a stealth tree are arguably diminished. Stealth structures are generally more expensive to implement and exhibit some structural limitations for future co-locations. An additional advantage to the multiple-shorter-site approach using more traditional tower structures is that it does provide co-location for capacity expansion when multiple shorter towers are already in place. As more wireless subscribers join the network, the need increases for smaller cells where each cell can handle approximately the same number of calls and will then relieve the burden of the additional subscribers on existing cells. This affect will be more likely in suburban or urban settings, but may occur in rural installations where population is concentrated in a specific sector and demand starts to reach capacity.

There are many variables that affect successful co-location. There is no guarantee that any future service provider will be interested in co-location at a specific site since their RF coverage requirements may be remarkably different than the service provider that proposed the tower in the first place. Given the advantages and disadvantages, some municipalities handle it with a compromise solution.

A compromise between multiple short towers and consolidation of service providers on a single tower is to build a proposed tower to the minimum required height as currently required but design the tower foundation and lower superstructure to accommodate a future height increase if so justified by a future co-location application. Increases in height can generally be in 20' increments on a tower designed for expansion. Future expansion in height, unlike the mere addition of antennas to an existing tower, is arguably a *substantial change* and, if so, would likely fall outside of the Middle Class Tax Relief and Jobs Creation Act of 2012 (PL 112-96, February 22, 2012, 126 Stat 156) which includes Sec. 6409: Wireless facilities deployment. That law limits municipal review of an *eligible facility request* under specific circumstances. This matter and the implications for future site review of a tower designed for expansion should be discussed in more detail with the board's attorney if needed.

Non-Ionizing Electromagnetic Radiation (NIER) Exposure Compliance

Wireless facilities like the one proposed by the applicant are generally found to comply with FCC Office of Engineering and Technology (OET) Bulletin 65. Bulletin 65 sets maximum permissible human exposure levels for Non-Ionizing Electromagnetic Radiation (NIER). When transmission antennas are installed in or near occupied areas of a building, it raises concern regarding occupants of the building and maintenance personnel who may need to access the rooftop. Thresholds for subjecting a wireless transmission facility to a more thorough emission analysis have been established by the

FCC. These thresholds and the techniques for NIER evaluation are discussed in the Federal Communication Commission Office of Engineering and Technology Bulletin 65 (FCC OET Bulletin 65)[10]. Table 2[11] in FCC OET Bulletin 65 excludes

- *building-mounted* cellular sites ("cellular" sites are those described in 47 CFR 22 Subpart H) where the power transmitted from all channels is less than 1000 W ERP (1640 W EIRP) and
- *tower-mounted* sites that are more than 10m (32.8') from ground and, if not, where the power transmitted from all channels is less than 1000 W ERP (1640 W EIRP).

Applicant provided an analysis by Millennium Engineering of Non-ionizing Electromagnetic Radiation from the proposed site. The report is included in the 9/30/2016 application materials. The report concludes that the site will comply with FCC RF safety guidelines. While not technically an issue for this application since health effects are not to be considered when a proposed site will operate within FCC limits, Appendix B provides a summary and some additional background information for the board regarding NIER.

SEQRA Segmentation

Like the more familiar subdivision and phased housing development project, an RF wireless network functions as a whole. In order to avoid inadvertent impact segmentation, it may be appropriate that the design for Applicant's future neighbor sites required to address remaining RF coverage gaps and capacity needs within the jurisdiction be considered during the current site plan review. The lack of coverage that will exist after the proposed site is operational may indicate a need for future facilities in those areas to improve or expand Applicant's wireless network coverage in the area. It is recommended that Applicant discuss the entire proposed network build-out in the jurisdiction since approval of any single site, such as the proposed facility, creates a fixed area of RF coverage to which other neighbor sites must connect. Additional sites in the area may need to be located in other zoning-controversial locations in order for the applicant to properly meet their coverage objectives and connect to the currently proposed and existing sites. In the worst case, approval of the proposed site could force one or more future neighbor sites to require a tower in an area where such a structure may be even more controversial than the proposed location.

The overall area coverage map shows the existing network neighbor sites and can be used by the town to identify coverage gap locations where controversial zoning may be required for future sites. While Applicant is currently before the board, the board may choose to ask Applicant to estimate the height and location of structures needed to fill the remaining gaps within and near the town's jurisdictional boundaries. This information could then assist the town in planning efforts and allow evaluation of whether the

[10] See http://ftp.fcc.gov/oet/info/documents/bulletins/
[11] FCC OET Bulletin 65, p69.

presently proposed site will later unduly restrict municipal planning goals or otherwise conflict with the comprehensive plan.

Distributed Antenna Systems

The board may already be aware of other approaches to deliver wireless communications that could avoid tall towers in a given area. For example, on one extreme certain cellular-type systems can be implemented using low-Earth orbit satellites. On the other extreme, very small pico-cell systems can allow subscribers to connect to their own home or office network using technology similar to a cordless phone. Each approach has its advantages and disadvantages. One such system that fits between satellite systems and pico-cells is called a Distributed Antenna System (DAS). DAS systems are presented here for completeness because this issue can arise in zoning hearings for new towers.

DAS systems are designed and deployed by companies such as NextG Networks[12], ExteNet Systems[13], and others who install and then lease use of the DAS to wireless service providers. Essentially a DAS involves an array of antennas mounted on existing telephone poles or shorter towers/structures that are otherwise unsuitable for a base station facility. The antennas and associated transceivers, sometimes called "nodes", are interconnected by fiber optic links. The cellular/PCS signals are converted at each node to optical signals which can then be routed to a hub site and converted back into the signals useable by a specific service provider.

Some wireless service providers use DAS technology to service tunnels, airport terminals and dense buildings where either signal penetration limitations or lack of ability to construct a tower would stop wireless services. When above-ground utilities exist in an area, a DAS may have the distinct advantage of allowing wireless services from short sites that would tend to alleviate certain aspects of aesthetic concern over tall towers. Unfortunately, the multiplicity of antenna sites, the interconnection of the nodes and the lack of contingency power tend to limit their practical use to very dense areas or areas that are not serviceable by other means. Examples of DAS limitations include:

- need for numerous closely-spaced above-ground utility poles or light stanchions in the service area
- potential lack of of E-911 location technology to allow emergency responders to know a more precise location of an outdoor emergency call (an in-building DAS would not present such a problem since it is localized to the building in question),
- the regulatory constraints and deployment/operating costs to negotiate outdoor pole attachments and ground equipment locations,
- the potential fragility of the fiber optic inter-node links that are usually more extensive and more exposed to falling trees or ice as in a conventional wireless base station topology, and
- lack of reliable/durable/cost-effective remote power at each node.

[12] See http://www.nextgnetworks.net/
[13] See http://www.extenetsystems.com/

These limitations present significant potential reductions in performance and reliability that should be carefully weighed. Further, since the systems are deployed and operated by a third party the cost to use the system may be excessive. The limitations are real, but in situations where it is not feasible to approve a tower that provides the necessary RF coverage Applicant seeks, a DAS to supplement their network or one that replaces the proposed tower is a possible approach. If necessary, the board's prerogative in this matter should be thoroughly discussed with the board's counsel because it is subject to all the legal limitations associated with the Telecommunications Act and Applicant's legal standing as a public utility in New York.

For an example of where a DAS is currently operational and where new nodes are being installed, Lower Merion Twp in Pennsylvania has a twelve-node operational DAS.[14] The system is reported to be operational and, in the spring of 2009, there were zoning proposals before the municipality to increase the number of nodes in the system. Please refer to the township web site for the most up-to-date information. As of September, 2009, the City of Mount Vernon planning board had a joint application from ExteNet, a DAS system provider, and Metro PCS, a wireless service provider, for a special use permit for the installation of a DAS consisting of fiber optic cable and telecommunications equipment placed on utility pole structures located within the corridor of the public right of way throughout the city. Previously, the City of Yonkers granted pole attachment rights to ExteNet within that jurisdiction. A July 15, 2009 article that briefly discusses the use of the ExteNet DAS by MetroPCS is available online[15]. A more detailed news report dated March 31, 2009, is available from Reuters at their web site[16].

Photo Simulation of Proposed Tower

Photographic simulation is one assessment technique offered by project sponsors to assess the visual impact of a proposed tower or tower modifications. The physical laws that govern propagation of radio waves at the frequencies used by wireless service providers requires elevation of the base station antennas are above the surrounding buildings, trees and natural terrain to facilitate reliable reception. Photo simulations of the elevated structures provide a two-dimensional photograph of a specific vantage point scene that shows the existing view and the same view with a superimposed likeness of the proposed tower or tower modification. This provides a pre-build "before" and "after" photograph to assist in assessing the potential visual impact. Photo simulations, like any assessment tool, have advantages and limitations. A "Visual Resource Evaluation" is included in the materials submitted to the board dated January 26, 2017.

Photo simulation of a new tower structure is produced using a brightly-colored balloon tethered at the height of the proposed tower on a day when weather will allow observation of the balloon from a distance. Since the goal is to hold the balloon at a

[14] See http://www.lowermerion.org/index.aspx?recordid=558&page=50 or search the base URL for "DAS" and "NextG" for multiple documents, including the January 22, 2009, press release.
[15] See http://www.govtech.com/gt/articles/702090 (available as of September 7, 2009)
[16] See http://www.reuters.com/article/pressRelease/idUS254010+31-Mar-2009+BW20090331

height representing the proposed tower, the wind velocity on the day of observation must be low. After the balloon is positioned, a photographer moves around the area to capture photographs of the balloon from critical vantage points. Later, the photographs are modified by stripping out the balloon and replacing it with an photo image of a tower like the one that is proposed. The tower image is properly scaled and post-processed into the photograph. This composite photograph that shows the expected scene that will result if the tower is constructed.

When viewing a tower scene, one's attention is generally drawn to visual discontinuities or abnormalities that result from a disruption of the horizon. As we walk around our own neighborhood we mentally process the foreground and background objects based on our previous experiences of size and proportion. When one views a visual discontinuity scene in-person, the viewer is usually able to mentally process the near-field "clutter" using three-dimensional visual clues and remove them from the scene to get an accurate proportional assessment of the situation. Two-dimensional photographs lack the three-dimensional clues we use to get a proper proportional assessment, so a viewer supplements their assessment by inferring the proportionality information. Generally that process provides a good appraisal of the visual impact provided care is taken when producing the photo simulations to avoid unintentional false clues.

False clues are often foreground clutter that appears to minimize the visual discontinuity of a proposed tower or tower modification. Objects such as telephone poles, trees, utility wires, and roadway signage in the foreground are a few of the possible clutter items that require a two-dimensional viewer to take special care in assessing visual discontinuities produced by a proposed tower or tower modification. Reasonable care should be taken to avoid photo simulations that include unnecessary items in the foreground because they can sometimes mask the assessment of the tower or tower modifications. Most of us have seen humorous photographs of friends holding their hands out in such a way as to make it appear an object in the background is resting on their hands in the foreground. This effect is possible when proportionality clues are misinterpreted by the viewer. An example is shown below.

1. Two examples of false visual clues in two-dimensional photographs.

In the first example, one eventually discerns that the person is located in the foreground and the Gateway Arch in St. Louis is some distance in the background – but for most viewers it takes a few seconds to make that connection. Unless one knows the proportion of the arch, it would be easy to draw the false conclusion that the arch is fairly minimal in size.

2. Gateway Arch in St. Louis with minimal foreground objects

In the second example, the visual perspective is an arguably "accurate" depiction of the scene of view. Some viewers would conclude that the tower, although a dramatic visual continuity on the horizon, is in proportion to the surrounding scene. If that photograph had been produced with a perspective that excluded the building and foreground trees, the true visual discontinuity would be more apparent. In a worst-case example of photo simulations gone bad, a photograph showed a large tree in the foreground with the caption "Proposed tower buffered by existing vegetation" when, in fact, had the photograph been taken from a position only ten feet either side of the tree, the balloon would have been clearly visible from that street view. However, with careful scene selection and minimal editing, photo simulations can provide a good assessment of visual impact.

Conclusion

The information in this report concerns the RF engineering issues related to the proposed project to assist the board in weighing the alternatives and planning for the future of the community. Engineering design choices implicate aesthetic and legal issues as well. However, this report must not be relied upon for any legal advice or direction. Legal advice about action on these issues must be obtained from the board's counsel.

Thank you for the opportunity to assist the Town of Nassau. Please feel free to call if there are additional questions or other concerns at this time.

Sincerely,

William P Johnson
Consultant

Appendix A: Summary of Qualifications
Appendix B: Human Exposure to NIER

Appendix A: Summary of Qualifications

I, William P. Johnson, certify that I:

1. am a full-time member of the faculty of Rochester Institute of Technology (RIT) and have been so since 1989;

2. currently serve as program director for the graduate program in Telecommunications Engineering Technology at RIT;

3. have been employed since 1972 in the radio-frequency (RF) and microwave industry holding positions prior to 1989 such as design engineer, staff engineer, and VP Engineering;

4. am actively involved in RF/microwave consulting;

5. hold graduate degrees in both electrical engineering and law;

6. am qualified to analyze radio-frequency design and performance documentation relevant to the justification of minimum radio antenna height and tower locations;

7. am qualified to comment upon alternate site analysis, aesthetic characteristics, and visual impact effects relevant to telecommunication towers by virtue of extensive involvement since 1997 in telecommunications site plan and New York SEQRA reviews and administrative agency and court litigation;

8. have consulted for well over over 50 municipalities and private organizations since 1997 in the area of broadcast and telecommunication facility tower review;

9. have a reputation in both the industry and among clients for being qualified and having the necessary relevant technical expertise needed to provide telecommunication facility tower review;

10. am the author of the technology content for the New York Department of State Land Use Technical Series publication *Planning and Design Manual for the Review of Applications for Wireless Telecommunications Facilities* (2001) (available at http://www.dos.state.ny.us/lgss/localgovt.html);

11. provided expert services and subsequent engineering testimony on behalf of defendant Town of Ontario, NY, during successful litigation defense in *Sprint v Willoth*, 996 F.Supp. 253 (WDNY 1998) and during petitioner Sprint's appeal in *Sprint v Willoth*, 176 F.3d 630 (2nd Cir. 1999).

Signed: 

William P. Johnson
Consultant

Appendix B: Human Exposure to Non-Ionizing Electromagnetic Radiation (NIER)

Federal law preempts local zoning authorities from considering environmental effects of and human exposure to cellular/PCS RF emissions as long as the proposed base station complies with Federal Communications Commission (FCC) emission standards.[17] Nonetheless, the matter is sometimes of concern to residents, municipal staff and board members. In response to those concerns, the following information is offered for your consideration.

The FCC is required by the National Environmental Policy Act of 1969 to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment.[18] Toward this end, a substantial effort has been made by the FCC and other agencies to provide information to both the public and the wireless/broadcast industries. Guidelines and information relevant to Non-Ionizing Electromagnetic Radiation (NIER) health and safety assessment are published by the Federal Communications Commission Office of Engineering and Technology (FCC-OET).[19] FCC-OET and the Federal Drug Administration (FDA) jointly maintain an internet web site that provides basic information to consumers regarding cell phone health effects.[20] FCC-OET also publishes detailed technical information for the industry that recommends calculations and field measurement methodology to demonstrate compliance with the NIER exposure guidelines.[21] At the international level, the World Health Organization (WHO) provides on-going research and summary information regarding a wide range of RF emissions including emissions from cell phones and base stations.[22]

In light of the information available, Congress and the FCC decided in the 1990s to exclude cellular/PCS and other base stations from mandatory NIER analysis when those sites meet certain emission and height requirements. In a recent study that spanned 13 counties and included 13,000 cell phone users, the World Health Organization (WHO) International Agency for Research on Cancer (IARC) Interphone Study Group published the results of a 13-country study in the International Journal of Epidemiology on May 17, 2010.[23] According to the World Health Organization in June, 2011, "[a] large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use."[24]

Commenting on the Interphone study, Dr. Christopher Wild, IARC's director, said that "[a]n increased risk of brain cancer is not established from the data from Interphone.

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[17] 47 USC §332(c)(7)(B)(iv).
[18] See National Environmental Policy Act of 1969, 42 U.S.C. Section 4321, et seq.
[19] http://www.fcc.gov/oet/rfsafety/
[20] http://www.fda.gov/cellphones/
[21] http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf and updates.
[22] http://www.who.int/peh-emf/en/
[23] Elisabeth Cardis et. al., *International Journal of Epidemiology* (2010;1–20) (Oxford University Press on behalf of the International Epidemiological Association) (May 17, 2010).
[24] "Electromagnetic fields and public health: mobile phones ", Fact Sheet No. 193 (updated June, 2011) http://www.who.int/mediacentre/factsheets/fs193/en/.

However, observations at the highest level of cumulative call time and the changing patterns of mobile phone use since the period studied by Interphone, particularly in young people, mean that further investigation of mobile phone use and brain cancer risk is merited."[25]

Beyond the potential damage to tissue caused by exposure to high-intensity NIER fields, some individuals report symptoms they attribute to low level NIER exposure. One hypothesis is that symptoms are correlated with physiological changes. Measurable physiological changes include metrics such as heart rate, blood pressure, and skin conductance. A three-year study performed at the University of Essex, UK, published in July, 2007, failed to find a correlation between low-level NIER exposure and such physiological changes.[26] In the study, the number of symptoms reported during the double-blind portion of the experiments was not related to the actual presence of low-level NIER.[27] This result is in agreement with earlier more limited studies.

On the arguably more conservative side, a report released on August 25, 2009[28] by International EMF Collaborative entitled "Cellphones and Brain Tumors: 15 Reasons for Concern, Science, Spin and the Truth Behind Interphone" includes, according to the report, endorsement by Ronald B. Herberman, MD, University of Pittsburgh Cancer Institute. While serving as director, Dr. Herberman had previously urged his staff[29] and the general population to recognize and understand that, while research has not proved conclusively one way or the other and given the uncertainty about the ultimate long-term safety of wireless radio signals, there are precautions that one can take. The report urges a skeptical individual and public policy approach to NIER exposure and encourages the on-going study of radio emissions and health concerns. The report urges prudent defensive actions to protect one's self and to move public policy toward a conservative approach to NIER exposure.

A report of partial findings from the National Toxicology Program (NTP) released on May 26, 2016, presents initial data regarding development of tumors during a multi-year study of lab rats[30]. The study exposed lab rats to high levels of whole-body electromagnetic radiation (CDMA and GSM modulation formats) for 9 hours a day over a two-year period. The level of exposure was chosen to avoid thermal issues beyond that which the animal could self-regulate body temperature.[31] While this level is far more than exposure regulated by the FCC, the higher level was used to allow study of the impact on the animal's organs other than just the brain. After release of the initial report,

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[25] CNET News at http://news.cnet.com/8301-27083_3-20005235-247.html (May 18, 2010).
[26] Stacy Eltiti et. al. "Does short-term exposure to mobile phone base station signals increase symptoms in individuals who report sensitivity to electromagnetic fields? A double-blind randomised provocation study" (Environmental Health Perspectives, 7/25/2007) (University of Essex, UK) available at http://www.ehponline.org. The study is also available at http://www.essex.ac.uk/psychology/EHS/eltiti%20et%20al%20BEMS%20ON-LINE%20PUBLICATION.pdf
[27] *Ibid*.
[28] See http://www.radiationresearch.org/pdfs/15reasons.asp
[29] See http://www.post-gazette.com/downloads/20080722upci_cellphone_memo.pdf
[30] See http://biorxiv.org/content/early/2016/05/26/055699
[31] A 1-degree body temperature rise.

a press briefing was held to allow reporters to ask questions about the incomplete study data and results[32]. The audio and transcript may be a useful way for the general public to hear answers to some of the complex issues raised by release of the initial report. Researcher Dr. John Bucher, when asked by a reporter for the "take away" from the initial report for the general public said:

> So this is a study that is looking at the plausibility, biological plausibility of carcinogenic effect due to cell phone radiation. The direct translation of these findings to the way humans are using cell telephones is not currently completely worked out and that's part of the evaluation that's going forward. This may have relevance, it may have no relevance.[33]

As of June, 2016, the NTP study has not yet been peer reviewed to establish independent credibility, but the researchers felt it was important enough to disseminate the information so that others could start looking at the results prior to completion of the normal peer-review process. We anticipate full results, recommendations and application to understanding the effects of human exposure, if at all, after 2017.

Without meaning to minimize concerns on the part of any individual on this matter, the scientific information to date as a whole seems to favor a conclusion that neither the biological effects of tissue heating nor symptoms allegedly due to low-level NIER are likely caused by a base station facility that complies with FCC guidelines. If anything, the use of a hand-held mobile device held to one's head or in proximity to the body are more of a concern since the mobile device transmits radio signals while communicating with a base station. While it is possible to prove scientifically that something is "unsafe" (i.e. identifiable and repeatable conditions that lead to the undesired result) it is logically impossible to prove that something is "safe" by performing any number of tests that are limited in scope and time. While it is undisputed that someday a peer-reviewed study and subsequent validation experiments *may* show that low-level NIER is problematic for a class of human population, such evidence does not currently appear to exist. The lack of such evidence tends to lend credibility to the assertion that low-level NIER from base station facilities may not be dangerous. Naturally, a person who experiences any health-related symptoms should consult with a heath care professional – not an RF engineer.

[32] Audio and transcript available at http://www.niehs.nih.gov/news/newsroom/releases/2016/may27/
[33] See transcript of press briefing available at http://www.niehs.nih.gov/news/newsroom/releases/2016/may27/ Page 24 of 36.