

**From:** [Christian Sepulveda](#)  
**To:** [Al Royse](#); [Christine Krolik](#); [Larry May](#); [Marie Chuang](#); [Sophie Cole](#); [Christopher Diaz](#); [Ann Ritzma](#)  
**Subject:** Comments on Cellular Service in Hillsborough  
**Date:** Saturday, March 6, 2021 8:37:30 AM  
**Attachments:** [Cellular Services and Hillsborough-c1.pdf](#)

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**CAUTION - EXTERNAL SENDER.**

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Hello all,

I recently had the opportunity to talk with Al Royce. Al was mostly in "listening mode" and heard my perspective on cellular. Given Brown Act concerns, Al suggested I submit some of my thoughts in writing to the town council. While there are more items that I'd be happy to discuss, I've tried to focus on a few key areas in the attached document.

There are a two main points

- a) I think you can get good coverage with 8-15 towers, limited to 35ft antennas, and 150ft+ from homes
- b) I suggest the town pursue, with a cellular consultancy, drafting a town-centric cellular deployment plan

I expand on these points in the document, but (b) is timely. I noticed the town, at Monday's meeting, will explore engaging a third party facilitator for help on cellular needs. I appreciate the quagmire cellular has become in Hillsborough, but I think such money is better spent on a cellular plan. A plan provides a concrete proposal for residents, particularly the different "factions", to review and react to.

I feel much of the debates have been too abstract -- focussed on very broad issues like "we need cellular" to simple assertions like "keep towers away from homes". I believe both sets of concerns are satisfiable and a concrete plan might make progress easier.

I've deliberately focussed on core concerns, deferring some complex details that may need to be addressed. But given the heated disagreements, I suggest starting with top priorities and establishing shared requirements, then expand to the next layer of issues.

I will also note my background, as I have fairly deep technical knowledge about cellular. I am the VP Engineering for Bastille Networks and we make both hardware and software for wireless security, with an emphasis on cellular. I hold several patents related to cellular (and wireless), follow the industry and ever evolving technology, both in its design and implementations.

Finally, I am willing to help try to move cellular service discussions forward in Hillsborough. I realize there are sometimes constraints on these discussions, but I am happy to engage in public or private dialogues.

Thanks,

Chris

P.S. I've attempted my own draft of cellular deployment plans, which is how I've come up with the 8-15 number of towers and 150ft setbacks. We could review my strawman ideas. I believe they are "directionally correct", but they should be explored with a cellular consultancy who has tools I simply don't have access to. (I have not included my hypothetical map in the attached doc.)

And fwiw, I thought the street light style tower the WCAC proposed last year was pretty good.

# Cellular Service and Hillsborough

Christian Sepulveda

*Note: This document contains a mix of my opinions and technical facts. I work with wireless technology and have considerable expertise with cellular technology. But my opinions and assumptions should be discussed. The goal of this document is to share a perspective and invite a discussion regarding cellular service in Hillsborough.*

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Hillsborough can have reliable, quality cellular service with approximately 8-15 new towers. These towers can be 35ft tall (in most, if not all cases). They can be at least 150 feet away from homes. We can preserve the beauty of Hillsborough and emerge from the quagmire of the cellular service debate that has strained our town for years.

I am making some assumptions. They are:

- Cellular data services would reliably work at speeds from 10 Mbps to 70 Mbps
  - High speed 5G, i.e. over 300 Mbps, would not be supported, but “regular” 5G would
- Multiple carriers would “share” the towers, i.e. single antenna sites would provide the antenna and equipment housing for multiple cellular service carriers (technically feasible, but requires cooperation)

## Cellular Service Goals

Furthermore, the following goals are assumed:

- Reliable calls in most of Hillsborough (over 90%), both indoors and outdoors
- Data services for Internet browsing and app usage
  - Possible backup for home Internet outage
  - Not a home Internet replacement
- Reliable emergency call services (though details of backup power require discussion)

## Some Comments on 5G

There are several variations of 5G and the standards are still being debated and revised. The 3GPP is the standards body for cellular and current specifications and proposals can be found at <https://www.3gpp.org/specifications/releases>.

While 5G standards are evolving (and there aren't “pure” 5G rollouts yet), here are a few items of note for Hillsborough

- 5G (non mm wave) tower requirements are the same as 4G. A carrier can upgrade to 5G with software (firmware) updates and/or hardware updates, but a 4G site can be used as a 5G site
- High speed 5G, i.e. 5G mm (millimeter wave) will be challenging, if not impossible, to ever work reliably in Hillsborough

5G mm wave requires line of sight between the antenna and the receiving device to achieve high speed. Even under ideal conditions, a 5G mm wave deployment would require many towers (possibly hundreds).

However, 5G mm wave is very sensitive. In RF parlance, it attenuates, which means a 5G signal suffers degradation with only minimal interference. Foliage, buildings and even fog, will attenuate a 5G signal. Cellular systems are robust and dynamically adjust for varying conditions. So a 5G tower and phone would renegotiate their connection and automatically “downgrade” to a slower speed.

While a 5G mm wave could provide good service, it would probably operate at lower speeds, without any improved reliability. Also, it would be expensive and intrusive and it probably would not deliver any better service than 15 towers might.

## Key Considerations for Cellular Coverage

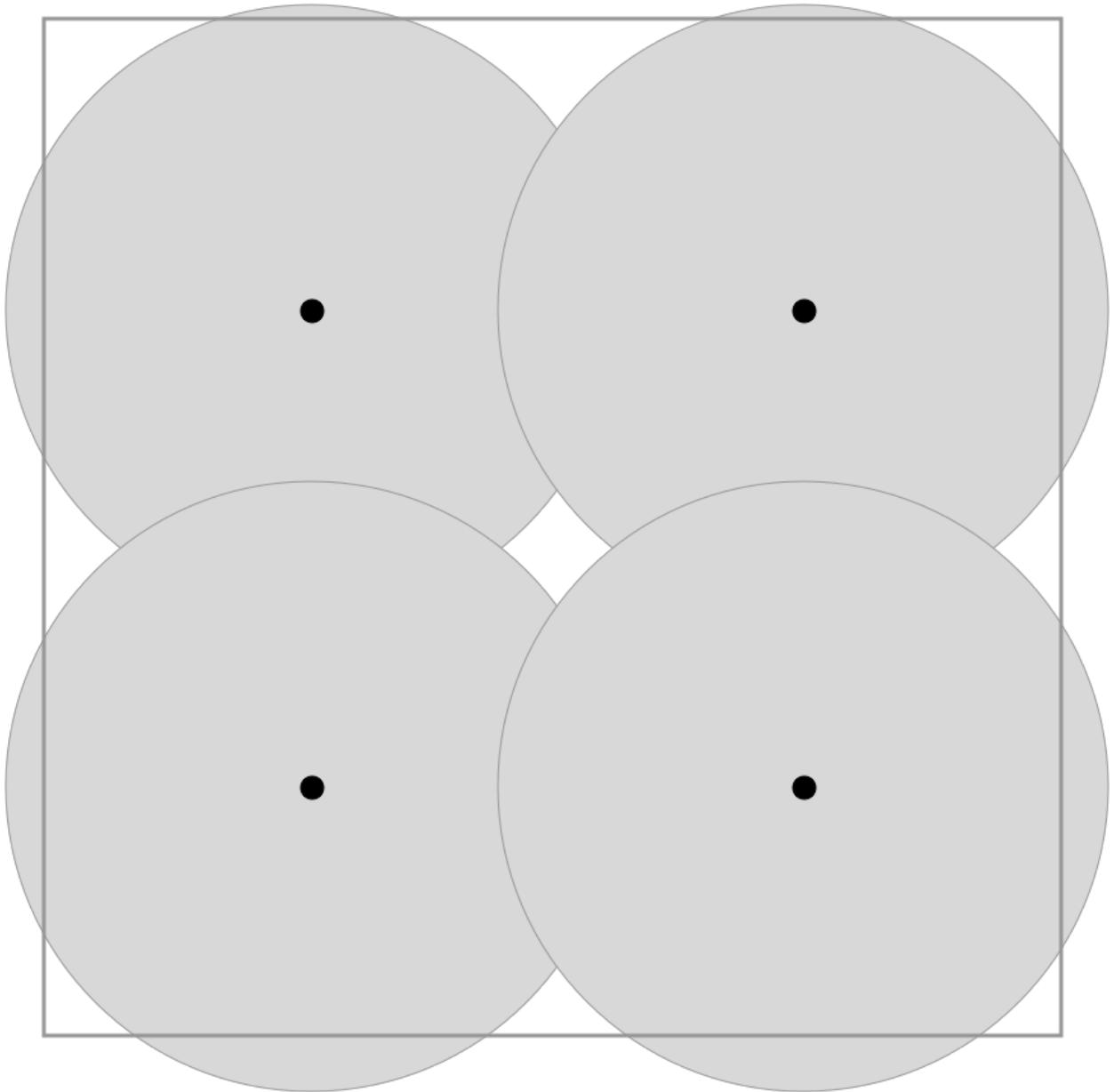
Cellular Service can be compared to a series of lighthouses, distributed in an area. Each casts a “light” (i.e. cellular service) over an area and the lattice of towers provide coverage to Hillsborough overall.

The coverage of a tower is primarily determined by

- Antenna height
- Antenna type (omnidirectional or directional)
  - Directional antennas are like spotlights, focussed on one area
  - Omnidirectional antennas are like light bulbs, casting light in all directions
  - Towers can deploy a hybrid of antennas, including multiple directional antennas to provide a larger coverage area
- Surrounding topology

While there are other factors, such as power levels, the aforementioned 3 characteristics largely determine coverage.

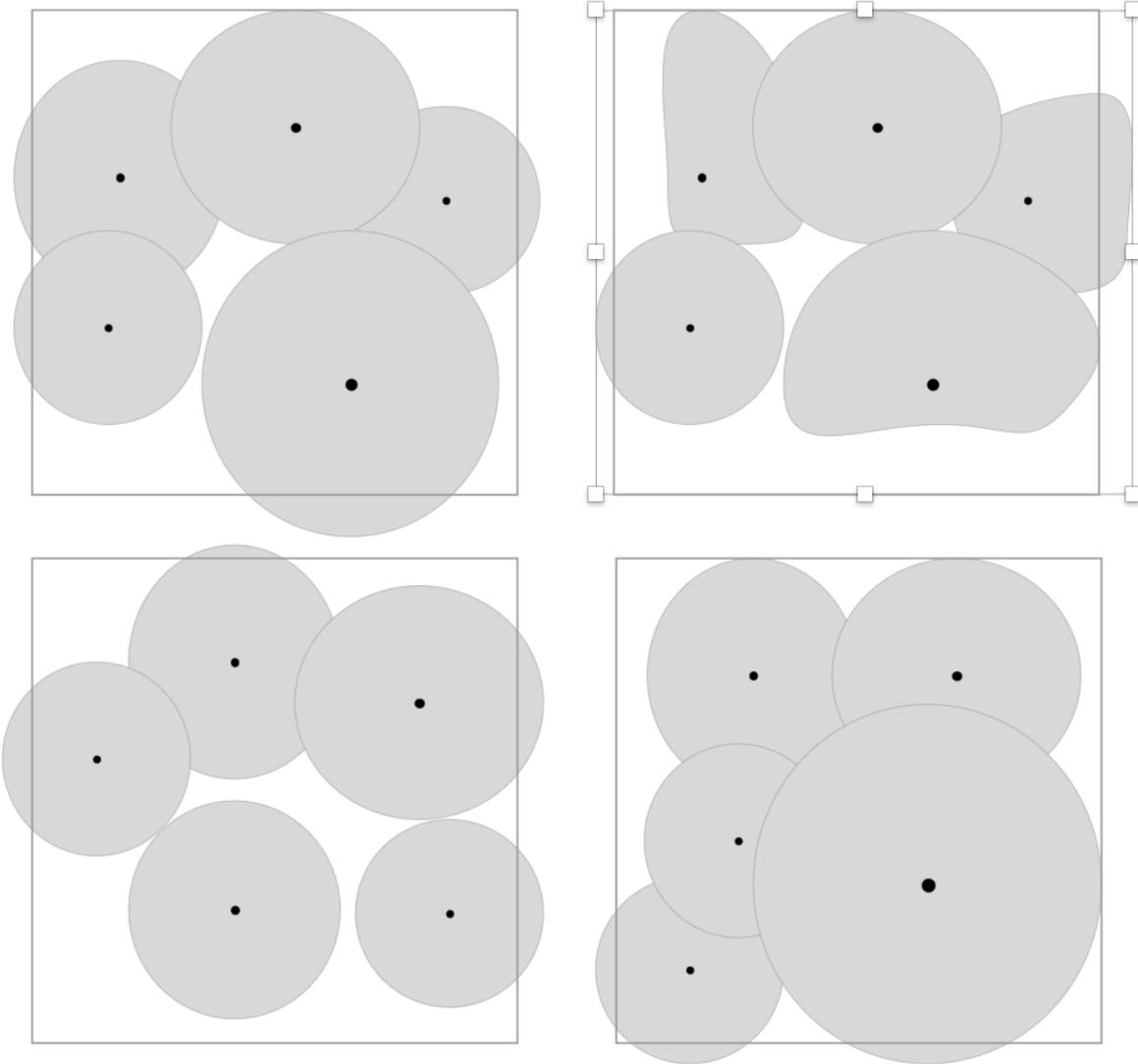
Consider a very simple example: omnidirectional antennas in a flat area.



In such an area, you might only need a few symmetric towers to provide coverage.  
(Note: in flat conditions, cellular towers can reach phones 20 miles, or more, away)

But topology and different antenna types can result in uneven coverage “cones”.

Conceptually, a cellular deployment can be compared to a set of sliding tiles; shift the tiles to achieve your coverage goals, but note that as the tiles shift in position, they may change in size.



## Cellular Application Process

Ideally, I'd suggest all tower applications contain a common set of required elements, ideally deferring to town preferences, such as tower height and form, distance from homes, etc.

Notably, all tower applications should contain

- existing cellular service coverage maps and
- hypothetical coverage maps, based on the addition of the tower

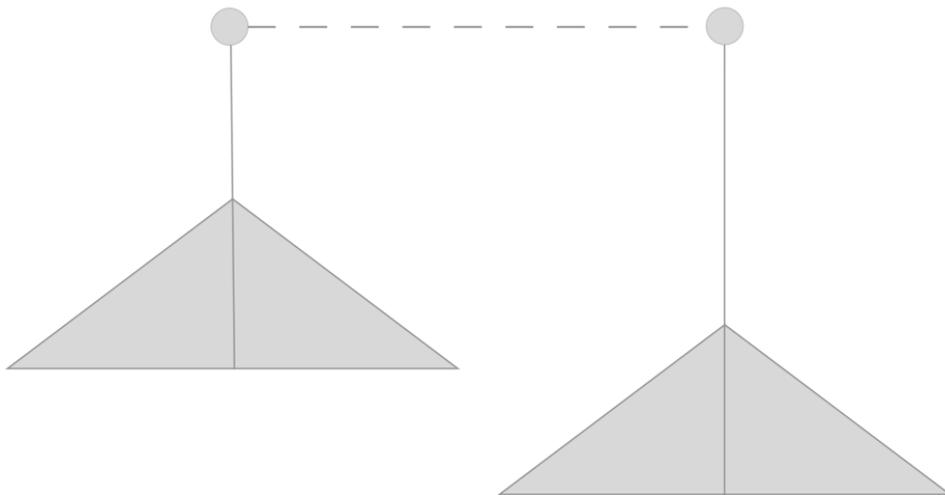
Without such coverage maps, it is hard to determine the benefit of the new tower application and resulting tradeoffs, such as sacrifices of the beauty of Hillsborough.

I've reviewed the Crown Castle applications (the 12+) and the two most recent AT&T applications. The Crown Castle applications do not contain coverage maps (or, at least, I did not find them). I've attempted, via very simple modeling, to plot the resulting coverage of the proposed applications and I can't understand the choices. There seems to be redundancy in some areas (4-5 towers where 1 might be sufficient) and then gaping holes in other areas of the town.

In the AT&T applications, one tower was 90ft and another was 145ft. But they provided a "prime" coverage radius of only 1500-2000 ft. While I suspect the topology of Hillsborough limited their coverage, I also suspect a much shorter tower in each location, such as 40 ft, might result in the same coverage.

I struggled for a possible reason for the large towers and then I considered the following hypothesis. The larger towers are not for cellular coverage, but to allow wireless data backhaul (to the AT&T network).

Wireless backhaul (tower to AT&T network communication) eliminates the need for traditional wired backhaul expenses, saving the carrier money, but at the expense of Hillsborough skyline. These would need to be the highest structures in Hillsborough. (As a note, wireless backhaul can be unreliable, especially in rain.)



(shaded area is the "cone" of coverage, but the antenna height is for antenna-to-antenna or antenna-to-network transmissions)

These comments are speculative. But I include them to highlight the importance of coverage maps. In the AT&T applications, for example, I would have liked to have had alternate propagation maps that showed results for lower tower heights.

## Suggestions for Path Forward

- Draft short list (approximately 3-7 items) of primary constraints, such as tower height, setback, tower form, total tower count, etc.
- If possible, generate list of possible tower sites
  - Larger public parcels
  - Survey residents to determine who welcomes a tower closer to their home
  - ...
- Engage a cellular consultancy to draft a deployment design draft, with cellular propagation maps
  - Accounts for topology of Hillsborough
  - Explores different tower heights
  - Try to minimize the number of towers, maximize distance from homes, etc.

I've attempted to build such a plan, with "napkin math" plots. But I lack access to the standard software that is used to develop such propagation maps.

Are 8-15 towers what is needed? 20? Only 4? Antenna height? These are important issues for Hillsborough and a cellular deployment plan would establish a baseline of possibilities for the town, based on the town's perspective, requirements and priorities.

Such a plan may not be actionable, as there are practical constraints that depend on factors that only the cellular carriers have, such as the power requirements of their equipment, their backhaul network wiring and that network's capacity, etc. But it should be technically feasible, even without the noted carrier proprietary details, to build a viable plan.

A viable plan would demonstrate a reasonable cellular solution exists. It might minimize the needless debates and circular arguments, emphasizing concrete possibilities and tangible options.