Broadcast Signal Lab

Memorandum

On Clearwire Coverage Issues

To Acton Planning Board
From David Maxson
Re Clearwire Coverage Issues

1. Summary

Clearwire makes two arguments for the height of the proposed tower. One, the 140-foot height is said to be necessary to provide the desired coverage. This is the typical category of argument for a given facility height. Two, Clearwire states that the height is also necessary to obtain a clear line of sight between the Site and Emerson Hospital; this would provide a signal path for a closed circuit *back haul* radio link between wireless facilities at the Site and Emerson Hospital. We address these two questions in separate sections below.

2. Wireless Coverage

Clearwire submitted information regarding its minimum required antenna height at 5-7 Craig Road. Broadcast Signal Lab inquired at each of the two previous meetings regarding the rationale for the signal levels it utilized to represent coverage on its maps. Clearwire responded that it was complicated and declined to give details, instead only generalizing that the represented coverage was similar to a -72 to -74 dBm signal level threshold.

Broadcast Signal Lab, lacking any rationale for the chosen signal level, modeled the Clearwire facilities, existing and proposed, at -80 dBm (a lower signal level) based on the premise that this is a generous signal level for modeling typical wireless communications. Our analysis, submitted in our April 30 report, prompted Clearwire to provide Broadcast Signal Lab with some of the details we needed.

Clearwire states that the baseline signal level (called receiver sensitivity) for WiMAX receivers is -89 dBm. This means that these WiMAX devices are significantly less sensitive than traditional wireless devices on GSM or CDMA technology, which tend to work at signal levels as low as -105 to -113 dBm. Other "margins" are added to the baseline signal level to account for other factors that affect reliable operation. This kind of analysis is called a "link budget." Based on the newly reported receiver sensitivity and link budget assumptions provided by Clearwire, we have revised our signal level modeling from -80 dBm received signal strength to -73 dBm.

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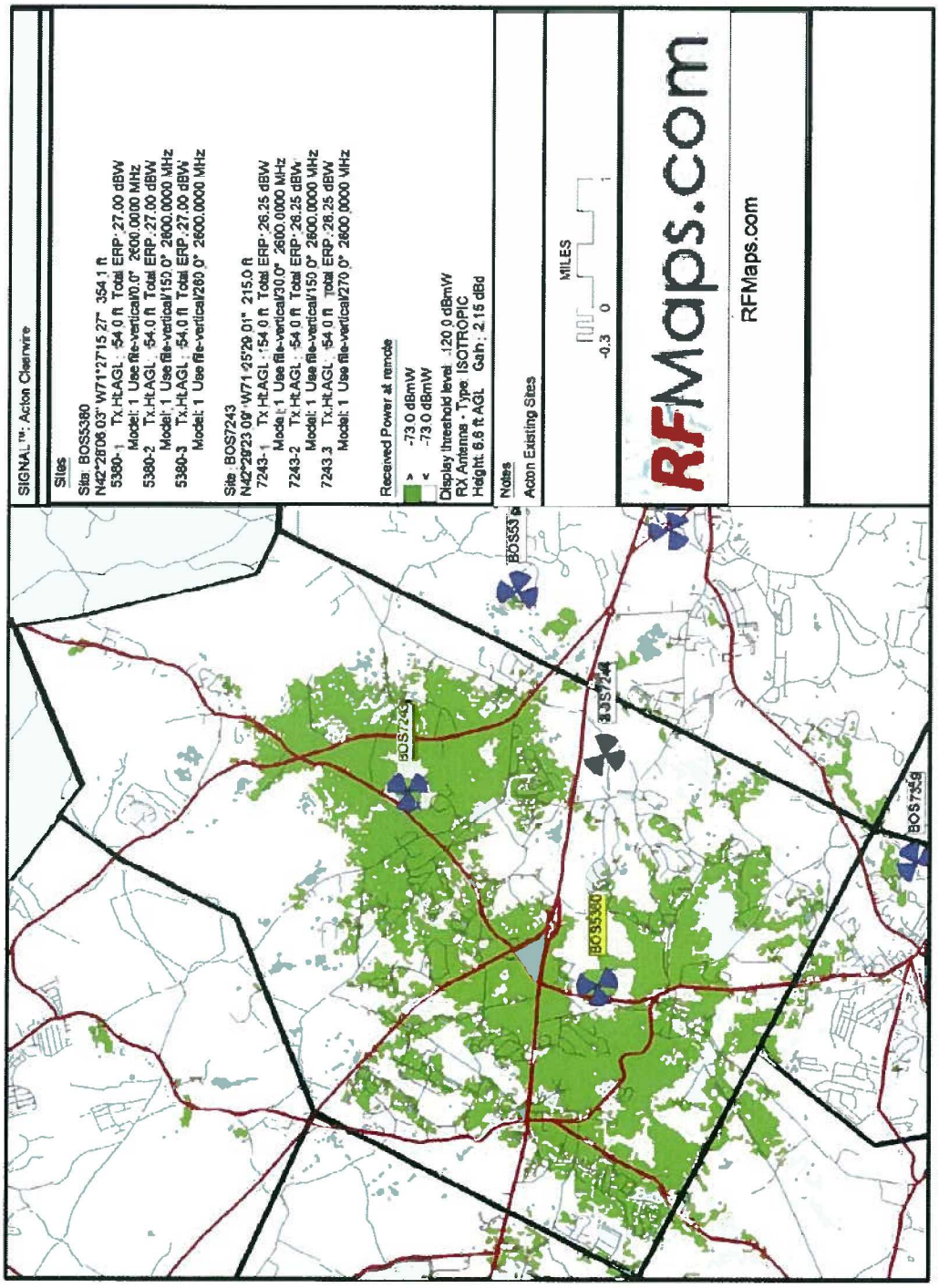
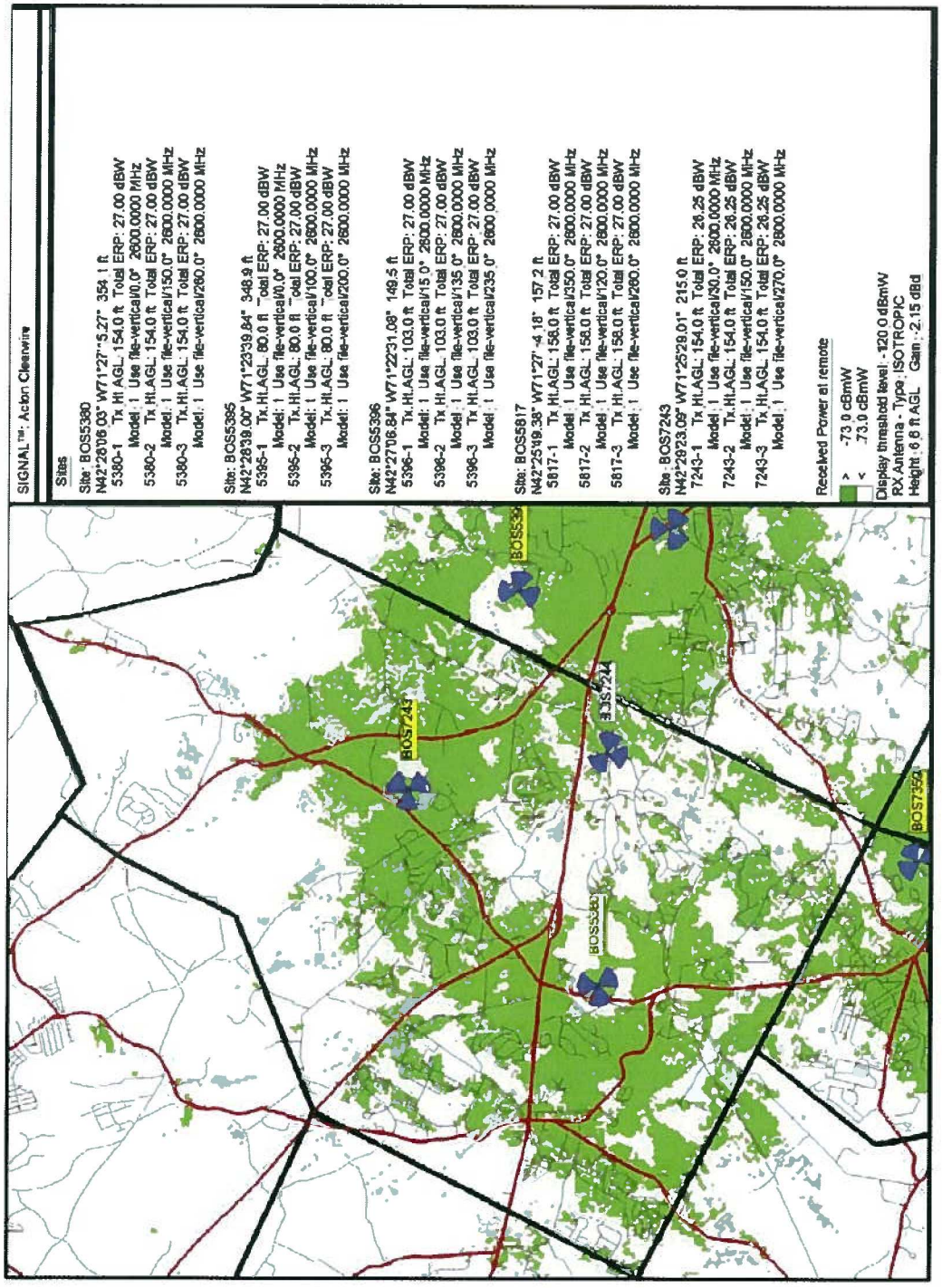
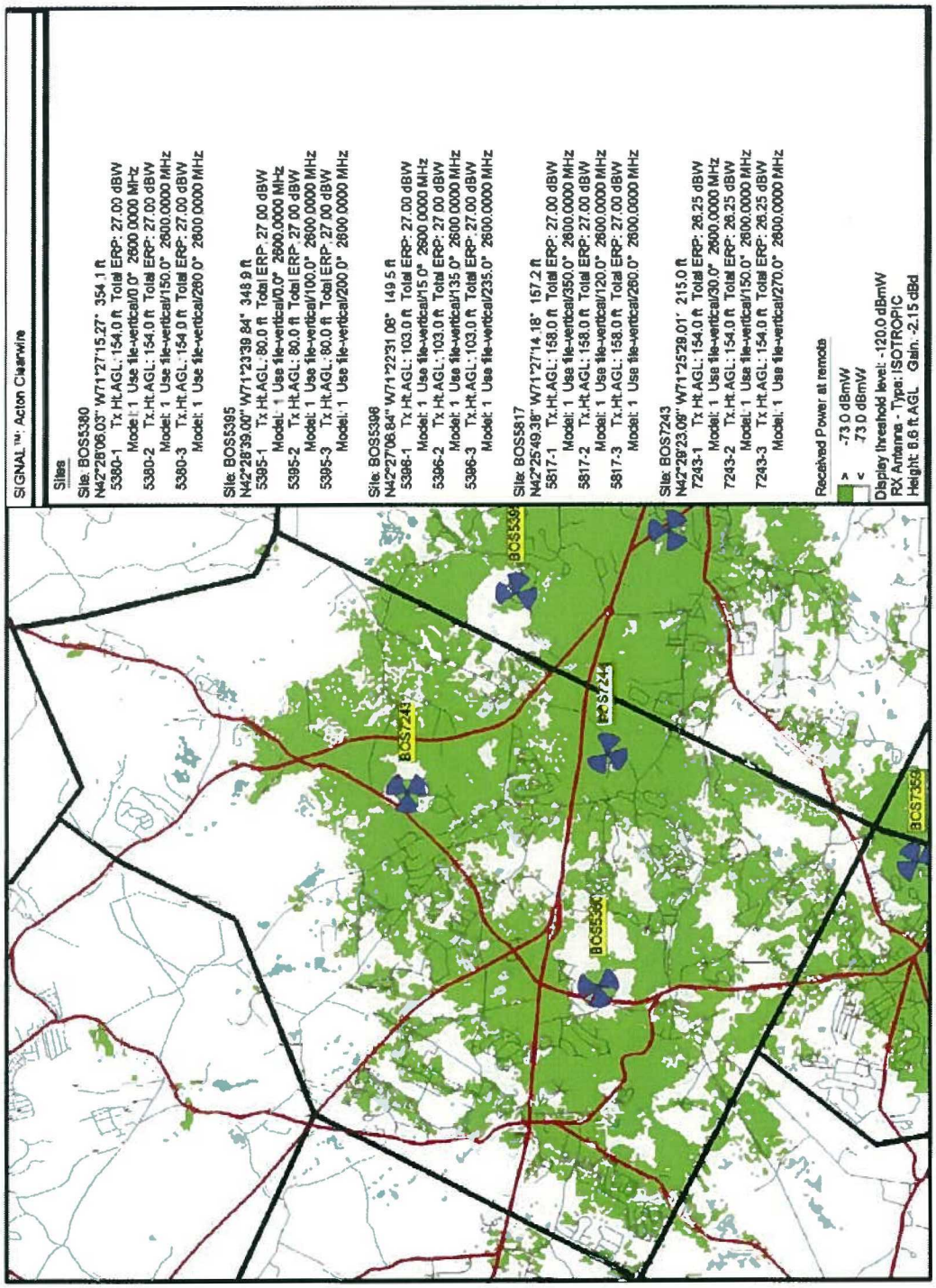
Revised Broadcast Signal Lab coverage plots for Clearwire service are appended below.



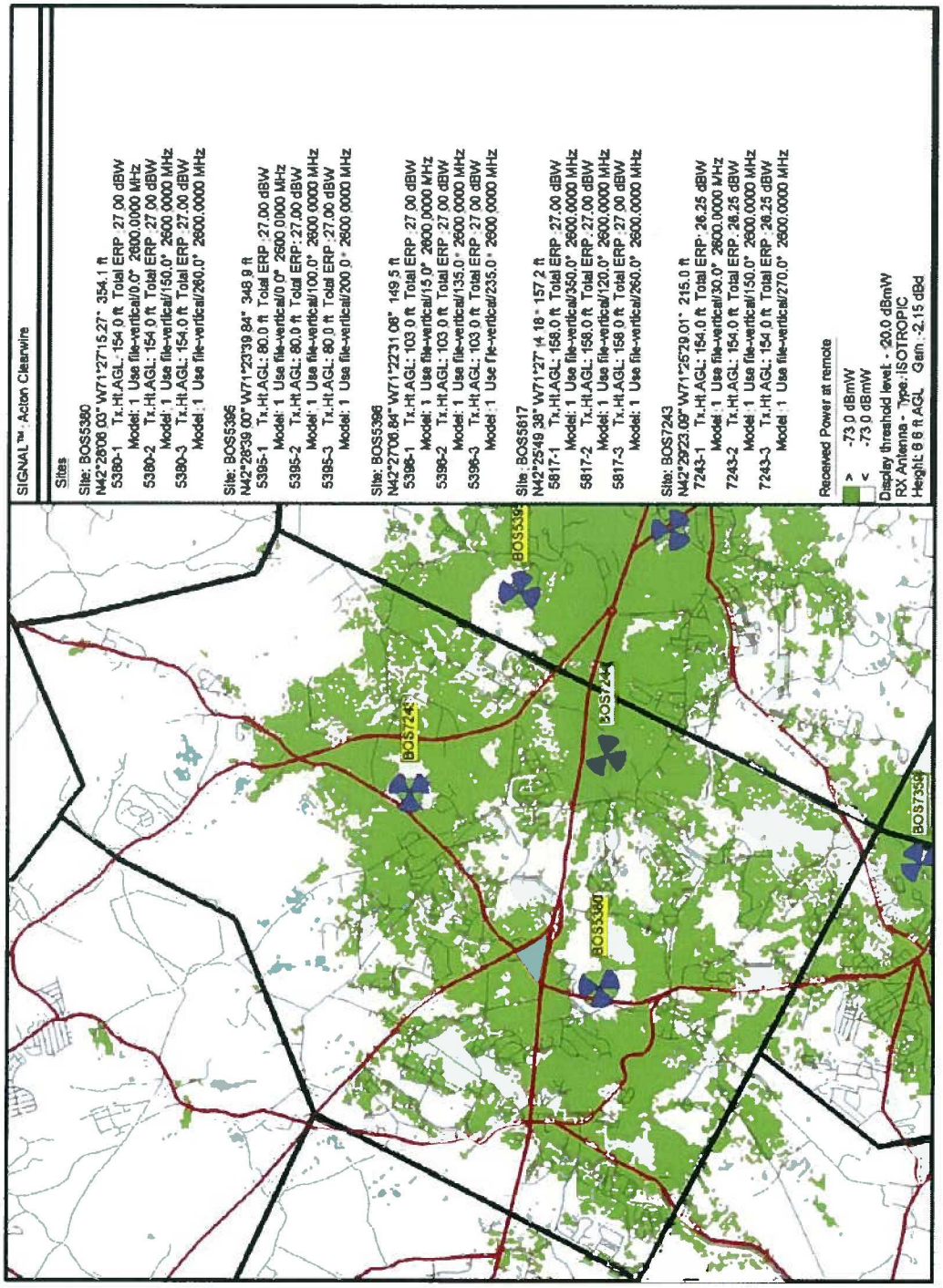
Acton Existing Clearwire Sites



Clearwire Coverage from Wireless Facility Sites in and around Acton



Clearwire Coverage from Existing Sites and Proposed Site ("BOS7244") at 140 ft AGL.



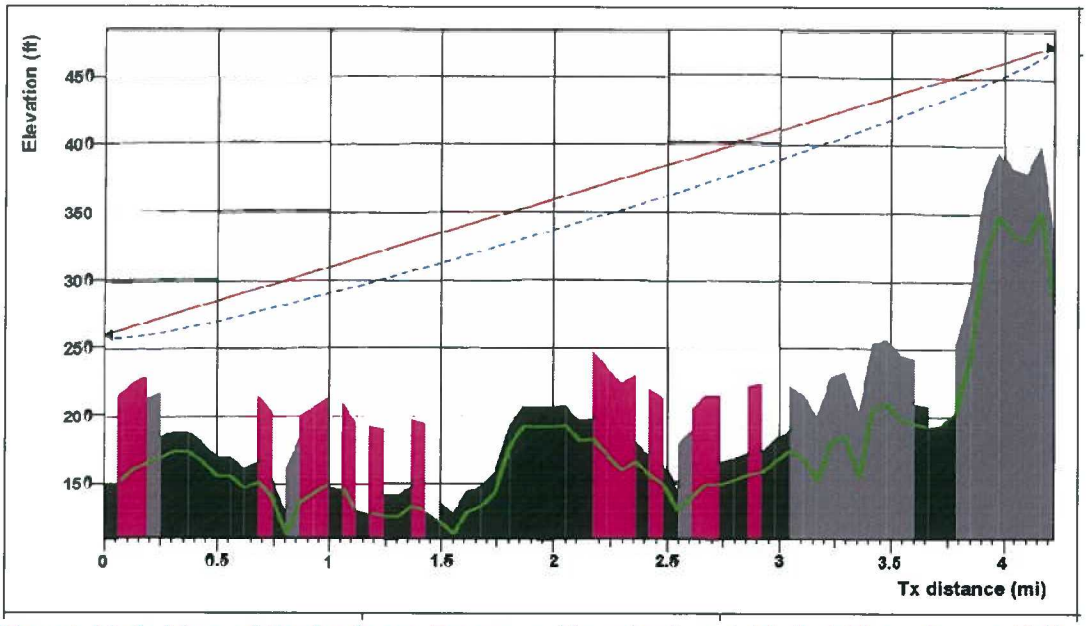
Clearwire Coverage from Existing Sites and Proposed at 100 ft AGL.

3. Back Haul

3.1. Craig Road to Emerson Hospital Line of Sight

Clearwire also explains that it requires the revised proposed height of 140 feet to achieve a line of sight path to Emerson Hospital, where another Clearwire facility exists. This is to support the closed-circuit radio *back* haul link between the two facilities. Clearwire will submit documentation that shows how this 140 ft height achieves the desired line of sight path.

We suggest that it is not necessary to back haul between the proposed Site and Emerson Hospital directly. Both the proposed Site and Emerson Hospital have a line of sight to the tower on Great Hill, as shown by the figures below. These figures are called "path analysis". They show the height of the antennas at each end of the path (red line). They show the intervening terrain (green line). They also approximate the height of buildings and vegetation between the two ends of the path (black, gray, and pink vertical bars). The blue ellipse below the red line indicates a "fresnel zone"[1] around the signal path, which ideally should not intersect with terrain or vegetation.

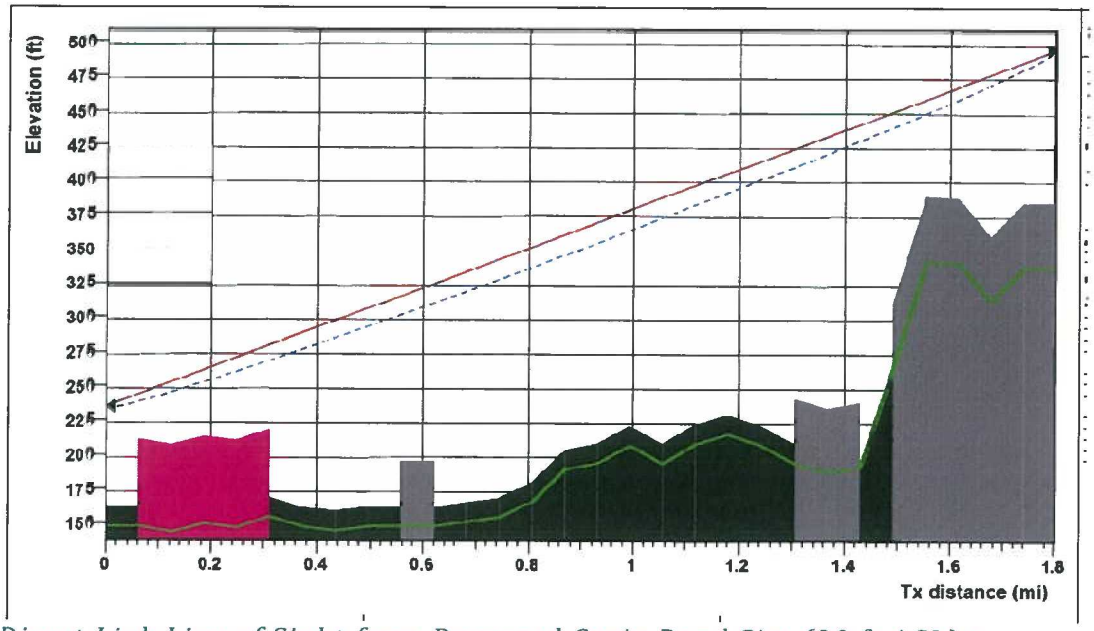


Direct Link Line of Sight from Emerson Hospital at 110 ft AGL to Great Hill 150 ft AGL

(Emerson Hospital height is taken from Broadcast Signal Lab archives – a 1999 application for wireless facilities on Emerson Hospital filed with the Town of Concord)

The line of sight path from the proposed Site to Great Hill is also clear.

[1] We selected a relatively low frequency for the radio link to show a worst case Fresnel zone (2500 MHz). Higher link frequencies will have even narrower Fresnel zones.



Direct Link Line of Sight from Proposed Craig Road Site (90 ft AGL) to Great Hill (150 ft AGL)

The foregoing images illustrate that for a single-link-per-site design, there is no need to provide a direct link from Craig Road to Emerson Hospital, because both sites "see" Great Hill.

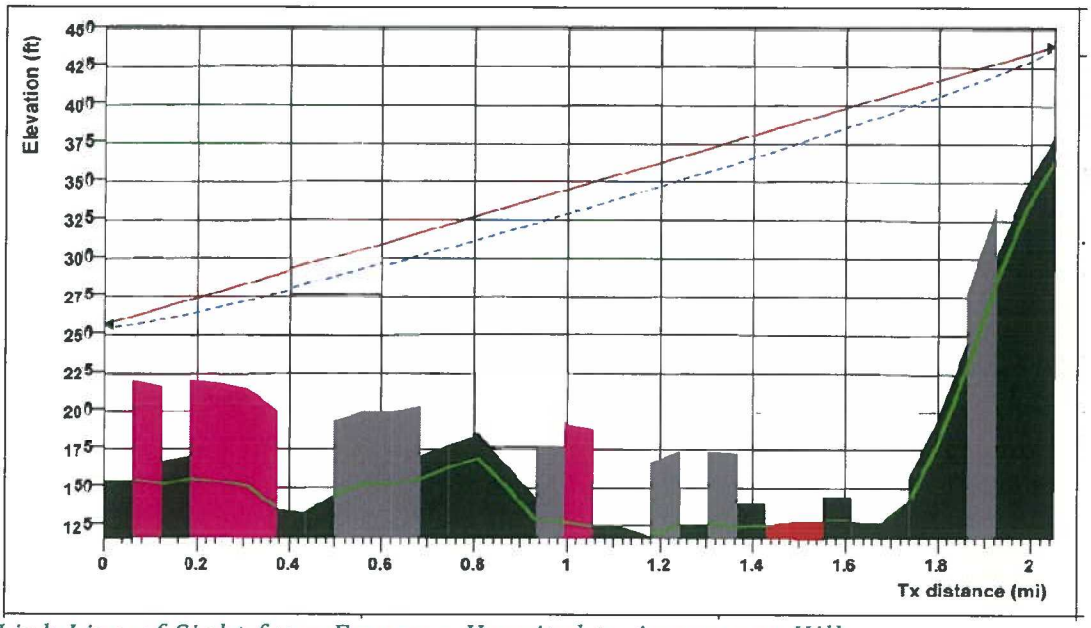
3.2. Ring of Back Hauls

Clearwire explains that their back haul links operate in "rings." This means that if any single link in a ring of interconnected wireless facilities fails, the ring can carry the data in the other direction to reach its destination. The ring that includes Craig Road would hop from Great Hill, to Craig Road, to Emerson Hospital, to some other points, until the ring wraps back around to Great Hill. Each site would have at least two back haul links.

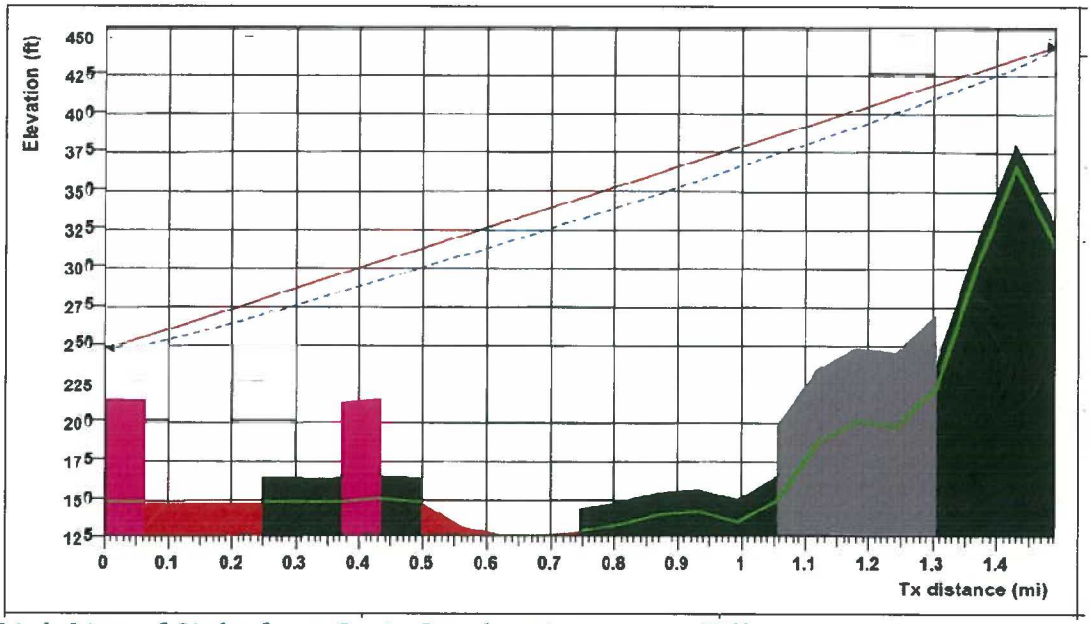
Clearwire cautions that disconnecting the Craig Road to Emerson Hospital link breaks the planned ring.

3.3. Alternative Ring Design

We suggest, *if it is highly desirable to maintain a lower tower height at Craig Road,* there may be a way to modify the ring to address Clearwire's objectives. For instance, a facility at Annursnac Hill can "see" Emerson Hospital, Great Hill and Craig Road at 100 feet. If there is antenna space at Annursnac, there may well be a way to maintain redundancy of links without requiring the proposed Craig Road tower to be 140 feet tall.



Link Line of Sight from Emerson Hospital to Annursnac Hill



Link Line of Sight from Craig Road to Annursnac Hill

3.4. If a Lesser Height is Not a Significant Improvement...

On the other hand, if the Board is inclined to require a new tower to be capable of being extended to greater heights later on, it would only be equitable to start the tower at a height that is optimal for the first carrier (Clearwire), because future increases in tower height will provide later carriers with greater coverage.

3.5. Is Back Haul Antenna Height Protected under the Telecommunications Act re an "effective prohibition of the provision of personal wireless services"?

The back haul objective presents an interesting challenge for the Board to decide. Historically, the provision of wireless service is determined by the ability of a personal wireless service facility to communicate with subscriber devices (from the base station to the mobile unit). Typically, the height of a wireless facility has not been determined by the height necessary to back haul communications to a central point, at least with respect to numerous court cases focused on the provision of wireless coverage to subscribers. If there is any case law that supports protection for the height of back haul antennas as part of the provision of personal wireless services under the Telecommunications Act of 1996, it would be helpful to have it put on the record. The Board might also be inclined to seek advice of counsel on this question.

4 May 2010