CITY OF SOMERVILLE, MASSACHUSETTS
ZONING BOARD OF APPEALS
JOSEPH A. CURTATONE, MAYOR

MEMBERS
HERBERT F. FOSTER, JR., CHAIRMAN
ORSOLA SUSAN FONTANO, *CLERK*
RICHARD ROSSETTI
T. F. SCOTT DARLING, III, ESQ.
DANIELLE FILLIS
ELAINE SEVERINO (ALT.)

Case #: 2007-65
Site: 88 Beacon Street
Date of Decision: July 9, 2008
Decision: Petition Approved with Conditions
Date Filed with City Clerk: July 10, 2008

ZBA DECISION

Applicant Name: Nextel Communications of the Mid-Atlantic, Inc.
Applicant Address: 9 Crosby Drive, Bedford MA 01730
Property Owner Name: 88 Beacon Street Realty, Inc.
Property Owner Address: 59 Union Square, Somerville, MA 02143
Agent Name: Heather Castagnaro
Alderman: Maryann Heuston

Legal Notice: Applicant Nextel Communications of the Mid-Atlantic, Inc. & Owner 88 Beacon Street Realty, Inc. seek a special permit under SZO §7.11.15.3 to install a wireless communications facility on the roof of 88 Beacon Street, Somerville. Pursuant to an Order of the Superior Court, dated October 23, 2007, the Zoning Board of Appeals will conduct a *de novo* hearing on the request. See, Kramer v. Ercolini et al., Superior Court C.A. No. MICV03-2174.

Zoning District/Ward: Residence C (RC) zone. Ward 2.
Zoning Approval Sought: Special Permit under SZO §7.11.15.3
Dates Public Hearing: 2/6, 2/20, 3/5, 3/19, 4/2, 4/16, 5/7, 5/21, 6/4, 6/18, & 7/9/08
Date of Decision: July 9, 2008
Vote: N/A

Appeal #ZBA2007-65 was opened before the Zoning Board of Appeals at Somerville City Hall on February 6, 2008. Notice of the Public Hearing was given to persons affected and was published and posted, all as required by M.G.L. c. 40A, sec. 11 and the Somerville Zoning Ordinance. After public hearings and deliberation, the Zoning Board of Appeals took a vote.

DESCRIPTION:

1. Subject Property: The subject property, an 11,080 s.f. lot, contains a brick condominium building, six stories in height, with an elevator penthouse located on the roof. According to the Assessor's records, there are 32 one and two bedroom units in the building. The building is located on Beacon Street, very close to the Cambridge border, in a Residence C (RC) zoning district.

CITY HALL ● 93 HIGHLAND AVENUE ● SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 ● FAX: (617) 625-0722
WWW.SOMERVILLEMA.GOV

Proposal: The Applicant seeks special permit approval for a wireless communications facility on the roof of the subject site. This facility would be comprised of two freestanding structures: a false penthouse containing an array of four antennas, and a separate equipment shelter housing radios, batteries, and other equipment, on the outside of which would be mounted two separate arrays of four antennas each. These structures would be designed as false penthouses and screened by a fiberglass materials designed to match the building's brick façade. The penthouse on the north/street-facing corner (housing only four antennas) would measure 15' x 6' x 6'. The penthouse on the north/rear-facing corner containing the internal equipment shelter and the external shielded antennas would measure 20' x 11.5'. Coaxial cables connecting the equipment room with the antennas would be contained in a cable tray mounted nearly flush with the roof. These trays would not be visible from the street level.

As shown on plans, the equipment shelter would not meet the maximum height and required setbacks from the roof edge on the right-hand side. SZO §14.3.2 limits equipment to 10' in height and §14.3.4 requires at least a 10' setback of equipment from a roof's edge (as well as a setback equivalent to the structure's height, so that the equipment sits behind a 45-degree plane extending from the cornice).

The actual setback from the roof's edge on the right-hand side falls just short of the 10' requirement, being shown as 9.7'. While in itself this might be *de minimis*, it appears that other dimensional standards are violated. The equipment shelter's height appears to be greater than 10', resulting in violations of both the height limit and the 45-degree plane setback. While height is indicated in the submission, plans do provide the elevation of the shelter and the roof; the difference in these indicates that the structure is 12.5' in height.

Noncompliance with this requirement can only be permitted via a variance.

2. Nature of Application: A special permit is required by the Table of Uses, §7.11.15.3 of the Zoning Ordinance, for any proposed wireless communications facilities within an RC zoning district. The information supplied by the Applicant complies with the requirements of the SZO.

3. Surrounding Neighborhood: The building is located very close to the Cambridge border near Harvard Square. There are various retail and restaurant uses located along Beacon Street. However, the majority of the area consists of residential uses of various types, including two-family dwellings as well as multi-unit apartment buildings. There are also several Harvard University buildings close to the site on the Cambridge side of the border.

4. Parking: According to the Division of Traffic & Parking, the on-street parking situation in this area of Beacon Street is limited. There are 31 off-street parking spaces currently existing, although approximately 45 would now be required for the 32 units in the building; this difference creates a legally non-conforming situation.

In addition to being nonconforming with current standards, the site appears to be in violation of its original permits, which would have required 32 parking spaces for the 32 units. One of these required spaces currently houses two garbage dumpsters. In addition, while no plan of the parking survives from the original permits, the plan submitted with the present application indicates that the dimensions of these spaces are also nonconforming. While any prior nonconformity in parking—quantity or dimension—would be protected, any increase in the nonconformity would require a Special Permit under SZO §4.5.

The Applicant has submitted a study by transportation consultants, Traffic Solutions, LLC, which asserts that relocation of the equipment shelter into the parking lot would either reduce the dimensions of at least one existing space or displace at least one parking space, increasing the nonconformity. While it is unclear to Planning Staff that this outcome is inevitable, it may nevertheless be appropriate to require relief for parking in order to reduce the impacts of the current proposal. Since the site appears to be in noncompliance with the permits under which it was developed, such relief may be in order anyway.

5. Impacts on Abutting Properties: The installation has been designed to minimize the visual obtrusiveness of the facilities. By sheathing the antennas and the equipment room in material that mimics the brick façade, the additional equipment appears similar to a penthouse such as already exists on the roof of the structure. As viewed from the street, this sheathing, combined with the setbacks of the facilities and the height of the building, reduces the visual impact. However, concerns have been

CITY HALL ● 93 HIGHLAND AVENUE ● SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 ● FAX: (617) 625-0722
WWW.SOMERVILLEMA.GOV

raised about the visual impacts to abutters in a neighboring nine-story residential building, whose southerly views could be significantly impacted.

Site visits to abutting properties demonstrate significant visual and acoustic impacts from antennas and especially the equipment shelter to abutting properties. These facilities are at eye-level with neighboring properties and, as they span much of the depth of the building, they block much of the adjoining property owners' views. Furthermore, the air conditioning units required to cool the equipment shelter run intermittently on a 24-hour basis, generating noticeable noise impacts, even when windows are closed. However, if the facilities were to be accommodated elsewhere than on the roof, it is difficult to imagine such impacts. Façade-mounting the antennas would present some additional visual impacts from Beacon Street, but to a far lesser degree than the requested configuration.

GENERAL FINDINGS

Based on the Applicant's submission, site visits, staff reports, peer review reports, and public testimony, the Board makes the following findings, in addition to the required findings under §7.11.15.3:

1. The visual and acoustic impacts of the equipment shelter and antennas, if located on the roof of 88 Beacon Street, are significant to abutters.

2. There is insufficient evidence that the proposed configuration of the facility is uniquely qualified to the meet the Applicant's need.

3. The equipment shelter may be relocated away from the roof, dramatically reducing the impacts on abutting properties, without harming signal quality. This is an appropriate solution, even if parking relief is required. Alternatively, the facility could be located in the building's interior.

4. There is insufficient evidence that antennas must be roof-mounted in order to function properly. With appropriate sheathing or other aesthetic interventions, wall-mounting these antennas would eliminate significant negative visual impacts to immediate abutters, while only modestly impacting street-level views.

FINDINGS FOR SPECIAL PERMIT (SZO §7.11.15.3)

1) Compliance with Standards: *With relocation of facilities away from the roof and appropriate screening*, the Board finds that this proposal is in compliance with the standards and criteria of SZO §14.5 for wireless communications facilities, which must be considered prior to granting a special permit:

a. Height of proposed facility: The facility is one of the highest along this section of Beacon Street, minimizing the visual impact to lower structures and to the street. However, there is a taller structure immediately northwest, whose views would be impacted.

b. Proximity to residential structures and zoning districts: The proposed facility would be on a residential building in a Residence C zoning district. Areas immediately surrounding the property are primarily residential, with one-, two- and three- family dwellings. Beacon Street has a number of commercial uses, while Inman Square and the intersection of Washington and Beacon Streets are nearby commercial nodes.

c. Nature of uses on adjacent and nearby properties: As described above, the predominant land use immediately surrounding the site is residential, although there are many commercial uses along Beacon Street near the property.

Surrounding topography and prominence of proposed facility: The height of the building gives the facility a great degree of obscurity from the ground level in the surrounding area. As proposed by the Applicant, facilities would be less visually prominent as viewed from the street but extremely visually prominent as viewed from neighboring properties.

CITY HALL ● 93 HIGHLAND AVENUE ● SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 ● FAX: (617) 625-0722
WWW.SOMERVILLEMA.GOV

As conditioned by the Board, one array of antennas would be somewhat more visually prominent as viewed from the street but would be far less prominent as viewed from abutting properties; the equipment shelter would not be visible from either vantage.

d. Surrounding tree cover and foliage: Due to the height of the installation, tree cover would not be effective for shielding the facility.

e. Design of tower & reduction of visual obtrusiveness: The placement of the facility, rather than its design, will have the most impact on its visual obtrusiveness. Removal of the equipment shelter from the roof would significantly reduce the visual impact. Façade-mounting antennas will somewhat increase their visibility to the public, while dramatically reducing their visual impact to immediate abutters. Design of their screening materials can reduce this impact to the public view.

f. Location of tower and suitable alternative sites: The Applicant represents that no other existing buildings located in the immediate area met their requirements. A map and short explanation of rejected sites has been submitted and includes: 120 Beacon Street (at southeast corner of Beacon and Washington Streets—deemed too low, too little capacity), 94 Beacon Street (residential property to the north—deemed too tall, too much interference), 1575 Cambridge Street (southwest of site—deemed too far, too little coverage), 1493 Cambridge Street (south of site—deemed too far, too much overlapping coverage, too tall, too much interference).

The peer review consultant has found that, while 88 Beacon Street may be the best location for the facility under the present circumstances, relocation of antennas from the roof to the façade is an "attractive" option.

g. Proposed Ingress and Egress: Access to and from the equipment is through a roof-hatch from an interior hallway.

h. Distance from existing facilities: The Applicant has listed existing locations as 1 Brattle Street, 1950 Massachusetts Avenue, and 139 Hampshire Street in Cambridge; and proposed locations at 100 Concord Avenue and 25 Eighth Street in Cambridge.

i. Availability of suitable existing facilities (demonstration of need): The Applicant has submitted maps of existing and proposed coverage (with and without the facility on the subject property) demonstrating a gap in coverage without the proposed facilities.

2) Consistency with Purposes: *With relocation of facilities away from the roof and appropriate screening,* this proposal is consistent with the purpose of the S.Z.O, specifically to "to facilitate the adequate provision of …other public requirements; to …increase the amenities of the municipality" (SZO §1.2). Additionally, the Staff finds that this proposal is consistent with the purpose of Wireless Communications facilities, as outlined in §14.1 of the S.Z.O, specifically to "enhance the ability of the providers of telecommunications services to provide such services to the community quickly, effectively, and efficiently; encourage users of…antennas to configure them in ways that minimize the adverse visual impact of the…antennas through careful design, siting…and innovative camouflaging techniques."

3) Site and Area Compatibility: *With relocation of facilities away from the roof and appropriate screening,* the facility would be designed in a manner that is reasonably compatible with both the existing features of the site and the characteristics of the built and non-built surrounding area and land uses. Noise impacts are not specifically addressed in the required findings but can be significant when large equipment shelters require several air conditioners. Due to the residential surroundings of the subject property, the Applicant should show how noise impacts from any part of the facility would be mitigated, as part of the building permit application.

CITY HALL ● 93 HIGHLAND AVENUE ● SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 ● FAX: (617) 625-0722
WWW.SOMERVILLEMA.GOV

DECISION:

With relocation of facilities away from the roof as conditioned below, the Board found that the proposed use as a wireless communications facility is consistent with the purposes of the S.Z.O. and would not be detrimental to the surrounding neighborhood.

Present and sitting were Members Herbert Foster, O. Susan Fontano, Richard Rossetti, Danielle Fillis, and Scott Darling. Upon making the above findings, Susan Fontano made a motion to approve the request for a special permit. Scott Darling seconded the motion. Wherefore the Zoning Board of Appeals voted (5-0) to **APPROVE** the request. In addition the following conditions were attached:

Special Permit to Install a Wireless Communications Facility (S.Z.O §7.11.15.3)

<table>
<tr><th>#</th><th>Condition</th><th>Timeframe for Compliance</th><th>Verified (initial)</th><th>Notes</th></tr>
<tr><td>1</td><td>Approval is based on applications materials and plans as modified in conditions 2 and 3.
<table><tr><th>Date</th><th>Submission</th></tr><tr><td>12/11/02 Plan Date</td><td>“Final Construction Drawing" as modified by conditions 2 & 3, showing antennas and equipment shelter removed from the roof.</td></tr></table>Any changes to the approved site plan and elevations, other than de minimis changes or changes required by the conditions below, must receive ZBA approval.</td><td>Building Permit/ Perpetual</td><td>ISD/Plng</td><td></td></tr>
<tr><td>2</td><td>The equipment shelter shall be relocated from the roof. If this results in reduced parking space dimensions, a special permit will be required for the expansion of the nonconforming parking situation. Proof of noise mitigation will also be required.</td><td>BP</td><td>ISD/Plng</td><td></td></tr>
<tr><td>3</td><td>The antennas shall be removed from the roof (most likely, façade-mounted) and screened. Prior to installation, the material and location shall be approved by Planning Staff.</td><td>Building Permit</td><td>Plng</td><td></td></tr>
<tr><td>4</td><td>Any antenna that is not operated continuously for a period of twelve (12) months shall be considered abandoned, and the owner of such antenna shall remove the same within ninety (90) days of notice from the City of Somerville informing the owner of such abandonment;</td><td>Perpetual</td><td>ISD</td><td></td></tr>
<tr><td>5</td><td>Any construction enclosure for electrical equipment will require detection devices and that the Bureau will require a site plan to determine Fire Department access to the site.</td><td>CO</td><td>Fire Prev.</td><td></td></tr>
<tr><td>6</td><td>Compliance with Noise Control Ordinance. Prior to the issuance of a Certificate of Use and Occupancy Permit for the installation of the wireless telecommunications facility, the Applicant shall submit to the Inspectional Services Department, with a copy to the Zoning Board of Appeals, a sound level measurement certified as accurate by a professional acoustician and shall perform such sound level measurements six months after issuance of the certificate of occupancy, with subsequent sound level measurements annually on or before the anniversary date of the original six month measurement to document</td><td>Perpetual</td><td>ISD</td><td></td></tr>
</table>

#	Condition	Timeframe for Compliance	Verified (initial)	Notes
	that all of the Applicant's installed equipment complies and continues to comply with the decibel level standards established by the City of Somerville, Noise Control Ordinance. The Applicant shall provide the results of such measurements and certify that the facility complies with the decibel level standards established by the City of Somerville, Noise Control Ordinance, with a copy to the Zoning Board of Appeals.			
7	*Compliance with Federal Communications Commission Guidelines for Human Exposure to Electromagnetic Fields.* To ensure compliance with the standards established by the Federal Communications Commission Office of Engineering and Technology ("FCC") in OET Bulletin 65 as adopted by Massachusetts Department of Public Health under 105 CMR 122.021, the Applicant shall perform measurements, within two (2) months of the date that the Applicant's wireless telecommunications facility commences operation and at intervals of twelve (12) months thereafter, to establish that the Applicant's wireless telecommunications facility complies and continues to comply with the FCC guidelines and applicable state regulations for human exposure to radio frequency electromagnetic fields for human exposure to radio frequency electromagnetic fields. The Applicant shall provide the results of such measurements with certification of compliance to the City of Somerville, Health Department, with a copy to the Zoning Board of Appeals.	Perpetual	BOH	
8	The Applicant must comply with the conditions of this permit within 90 days of the end of the appeal period.	90 days after appeal period expires	ISD	
9	The Applicant shall contact Planning Staff at least five working days in advance of a request for a final sign-off on the building permit to ensure the proposal was constructed in accordance with the plans and information submitted and the conditions attached to this approval.	Final Building Permit Signoff	Plng. / ISD	

CITY HALL ● 93 HIGHLAND AVENUE ● SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 ● FAX: (617) 625-0722
WWW.SOMERVILLEMA.GOV

Attest, by the Zoning Board of Appeals:

Herbert Foster, *Chairman*
Orsola Susan Fontano, *Clerk*
Richard Rossetti
T.F. Scott Darling, III, Esq.
Danielle Fillis

Attest, by the Director of the Planning Division of OSPCD:

_____
Madeleine Masters

Copies of this decision are filed in the Somerville City Clerk's office.
Copies of all plans referred to in this decision and a detailed record of the SPGA proceedings are filed in the Somerville Planning Dept.

CLERK'S CERTIFICATE

Any appeal of this decision must be filed within twenty days after the date this notice is filed in the Office of the City Clerk, and must be filed in accordance with M.G.L. c. 40A, sec. 17 and SZO sec. 3.2.10.

In accordance with M.G.L. c. 40 A, sec. 11, no variance shall take effect until a copy of the decision bearing the certification of the City Clerk that twenty days have elapsed after the decision has been filed in the Office of the City Clerk and no appeal has been filed, or that if such appeal has been filed, that it has been dismissed or denied, is recorded in the Middlesex County Registry of Deeds and indexed in the grantor index under the name of the owner of record or is recorded and noted on the owner's certificate of title.

Also in accordance with M.G.L. c. 40 A, sec. 11, a special permit shall not take effect until a copy of the decision bearing the certification of the City Clerk that twenty days have elapsed after the decision has been filed in the Office of the City Clerk and either that no appeal has been filed or the appeal has been filed within such time, is recorded in the Middlesex County Registry of Deeds and indexed in the grantor index under the name of the owner of record or is recorded and noted on the owner's certificate of title. The person exercising rights under a duly appealed Special Permit does so at risk that a court will reverse the permit and that any construction performed under the permit may be ordered undone.

The owner or applicant shall pay the fee for recording or registering. Furthermore, a permit from the Division of Inspectional Services shall be required in order to proceed with any project favorably decided upon by this decision, and upon request, the Applicant shall present evidence to the Building Official that this decision is properly recorded.

This is a true and correct copy of the decision filed on _____ in the Office of the City Clerk, and twenty days have elapsed, and
FOR VARIANCE(S) WITHIN
_____ there have been no appeals filed in the Office of the City Clerk, or
_____ any appeals that were filed have been finally dismissed or denied.
FOR SPECIAL PERMIT(S) WITHIN
_____ there have been no appeals filed in the Office of the City Clerk, or
_____ there has been an appeal filed.

Signed_____ City Clerk Date_____

CITY HALL ● 93 HIGHLAND AVENUE ● SOMERVILLE, MASSACHUSETTS 02143
(617) 625-6600 EXT. 2500 ● FAX: (617) 625-0722
WWW.SOMERVILLEMA.GOV

TECHNICAL MEMORANDUM

To: City of Somerville, Zoning Board of Appeals

From: Andrew G. Klein, Ph.D., peer review consultant

Date: July 9, 2008

Subject: Technical findings relating to Nextel antenna at 88 Beacon St

---

As a peer review consultant for the City of Somerville, I was asked to investigate four technical aspects relating to Nextel's cellular antenna on the rooftop of 88 Beacon St. Each of these four questions are addressed in the following sections. The information used in making the technical evaluations contained in this memorandum came from a variety of sources, including:

- Technical documentation submitted by Nextel to the ZBA.
- Nextel's recorded testimony before the ZBA (including meetings on 2/6/2008, 3/4/2008, and 4/16/2008).
- Telephone conversation with Nextel's RF engineer (Mr. Joe Sutherland).
- Written answers and technical data from Mr. Sutherland on a host of technical inquiries I conducted through email (all contained in the Appendix).
- Observations made during a site visit to 88 Beacon St.
- Knowledge of the fundamentals of radio signal propagation.

As mentioned previously to the ZBA, the models used by Nextel are proprietary. Consequently, it is not possible for an independent peer review consultant to recreate or verify coverage maps. As such, any consultant must rely on data that comes exclusively from Nextel, who themselves have a bias for a particular outcome. The consultant, then, is left to apply the fundamentals of radio signal propagation to interpret their data, attempt to verify the veracity of their claims, or identify possible inconsistencies in the presented data.

1 Is the rooftop of 88 Beacon St the *best* location?

If Nextel's network were being built from scratch, 88 Beacon St would likely not be the best location. From a signal propagation perspective, for example, 94 Beacon St has some clear advantages over 88 Beacon St: the lack of nearby trees, and the lack of a large building obstruction. However, Nextel's network has existed for several years, as has the antenna at 88 Beacon St. In building out a cellular network, the location of one antenna affects the preferred location and planning of other nearby antennas. Thus, changing the location of an existing antenna that is part of a network that has been built up over several years has a ripple effect that may require redesign or adjustment of other antennas in the network.

Conclusion: Nextel's claim that the 88 Beacon St rooftop is the *best* location for the antenna *does* seem valid.

2 Is the rooftop of 88 Beacon St the *only* suitable location?

The broad statements made by Nextel regarding frequency reuse and interference with adjacent cells are true claims that apply to cellular network planning in general. Furthermore, as mentioned above, changes to an existing antenna will have a ripple effect that will impact other antennas in the network. However, Nextel's claim that it is impossible to find an alternate location (or configuration) that provides an acceptable balance of coverage and frequency reuse while minimizing interference does seem unconvincing. In particular, I have the following doubts:

- Other than the proprietary coverage maps, Nextel has not provided convincing evidence or data as to *why* the coverage is insufficient at the considered alternate locations.
- I remain unconvinced that Nextel has attempted to optimize the various antenna parameters that affect coverage. They have largely chosen the parameters (e.g. azimuth and tilt) to be identical for all candidate sites, which may not be the best choice. While there may be little room to adjust the precise location and height of an antenna, there are a variety of parameters that can be tuned for a particular scenario, including
  - effective radiated power (ERP)
  - choice of antenna (and consequently its beam pattern)
  - azimuth
  - downtilt

  These parameters allow for a certain amount of flexibility in antenna placement; I find it difficult to believe that there is not an alternate location or configuration that permits acceptable coverage when these paremeters have been appropriately optimized.
- I find it curious that the coverage maps vary so significantly for each candidate site compared to the coverage for 88 Beacon St rooftop. As the relative terrain features and clutter would seem to differ very little over such small distances, and since the azimuth and tilt were chosen to be the same for all rooftop-mounted sites, it would seem that the coverage should be quite similar for the candidate alternate locations.
- The most plausible explanation given for the coverage difference between the various locations is the fact that alternate locations (for example, 1575 Cambridge St) are several hundred feet away from 88 Beacon St, and thus introduce a geographical shift of the coverage. It is hard to believe, even in a dense urban network, that the system cannot tolerate a translation of several hundered feet through appropriate optimization of antenna parameters.
- In at least one case – that of 94 Beacon St (rooftop) – the provided coverage maps seem to contradict the fundamentals of radio signal propagation. Nextel claims that the increased height of 94 Beacon St results simultaneously in *decreased* local coverage, but *increased* interference with adjacent cells. This raises questions about the methodology used in the generation of the coverage maps.

Conclusion: The above doubts, plus the fact that the relative local terrain and clutter seem fairly consistent throughout the desired coverage area (including alternate locations) leads me to find the claim that "88 Beacon St rooftop is the *only* suitable location" to be dubious.

3 What other locations might be suitable?

Having surveyed the area, it does indeed seem that all possible alternate sites in the area have been considered previously, namely:

- 88 Beacon St (facade)
- 94 Beacon St (rooftop)
- 94 Beacon St (facade)
- 120 Beacon St
- 1493 Cambridge St
- 1575 Cambrdige St
- 10 Webster St
- 15 Warren St
- 59 Union Sq

I was not able to identify any additional locations which would be appropriate, largely due to the lack of nearby structures of sufficient height.

Due to the use of proprietary models and the vast quantity of variables involved (e.g. neighboring sites, capacity, network density, etc) it is impossible to state with certainty which, if any, of these alternate locations would provide suitable coverage for Nextel's network. Nevertheless, as noted above, it seems quite dubious that *none* of these alternate sites or configurations would provide an acceptable level of coverage, and it seems plausible that, with careful optimization of network parameters, several alternate sites ought to provide an acceptable signal.

The 120 Beacon St and the two Cambridge St locations do seem to be an attractive alternative, as they offer a building of similar height to that of 88 Beacon St. The most noteworthy difference between these locations and the original 88 Beacon St is that fact that the locations are several hundred feet away, and thus modifications would need to be made to the antenna parameters to compensate for the geographical shift. If the network cannot easily accomodate having the antenna moved several hundered feet, then 88 Beacon St (facade mounted) may be the best possible alternate. The option of facade mounting would seem to have the following differences:

- Antenna heights would be 6-8 feet lower. The height used by Nextel to generate their coverage maps for facade-mounting was *14 feet lower* than the height used for the rooftop coverage map; thus, the coverage shown in their coverage map for the facade-mounted scenario is likely to be pessimistic.

- The azimuth would have to be changed, according to Nextel, since the desired azimuth cannot be obtained due to the building geometry. Perhaps alternate antenna mounting hardware could be investigated in order to obtain desired azimuth.

- The clutter due to trees might increase; however, there are already trees at the height of the antenna in the current configuration.

- Obstruction due to 94 Beacon St could arguably improve, as facade mounting may permit the antenna to be moved such that a larger geographical area is unobstructed by 94 Beacon St.

Conclusion: If the network cannot easily accomodate having the antenna moved several hundered feet (for example, due to optimization of antenna/network parameters), then 88 Beacon St (facade) may be the best possible alternate. If the reduced height of 88 Beacon St (facade) cannot easily be accommodated, then either 120 Beacon St or one of the Cambridge St locations would likely be the best alternate.

4 Is it technically feasible to move the equipment shelter to the parking garage?

Indeed, Mr. Sutherland of Nextel has claimed that "a shelter in the lot would not require excessive cable runs".

Conclusion: Moving the equipment shelter from the roof to the parking lot *does* seem feasible from a technical perspective.

5 Summary of Findings

While 88 Beacon St is probably the *best* location from a network-wide perspective given Nextel's current build-out, it seems dubious that there is not another nearby location or configuration that would lead to acceptable coverage. As outlined above, facade-mounting at 88 Beacon St seems like an attractive alternative. If the reduced height of 88 Beacon St (facade) cannot easily be accommodated, then I suggest narrowing the scope of the candidate locations to the following, as they are structures having height similar to 88 Beacon St:

- 120 Beacon St
- 1493 Cambridge St
- 1575 Cambrdige St

Moving the equipment shelter from the roof to the parking lot is a very attractive option from a technical perspective (though, of course, there are other concerns such as the availability of space in the parking lot). Since this is technically feasible, and since the shelter imposes the largest visual impact, it is highly recommended that the equipment shelter be moved to the garage if the antenna remains at 88 Beacon St.

Appendix: Mr. Sutherland's Written Responses to Technical Inquiries

Question:*As we discussed, when modeling the coverage of an antenna in the network, there are a variety of parameters that need to be set for a given antenna. These parameters include, but are not limited to: antenna height, radiation pattern of antenna (and other characteristics of the particular chosen antenna, such as gain, beam width, etc), azimuth, ERP, tilt, and orientation. Could you please provide the input parameter values used in the generation of the coverage maps for 88 Beacon St, as well as the nine sites considered in the March 4, 2008 letter from Steve Grill? Those additional 9 sites are:*

a. *15 Warren St*

b. *59 Union Sq*

c. *10 Webster St*

d. *120 Beacon St*

e. *1493 Cambridge St*

f. *1575 Cambridge St*

g. *88 Beacon St (facade)*

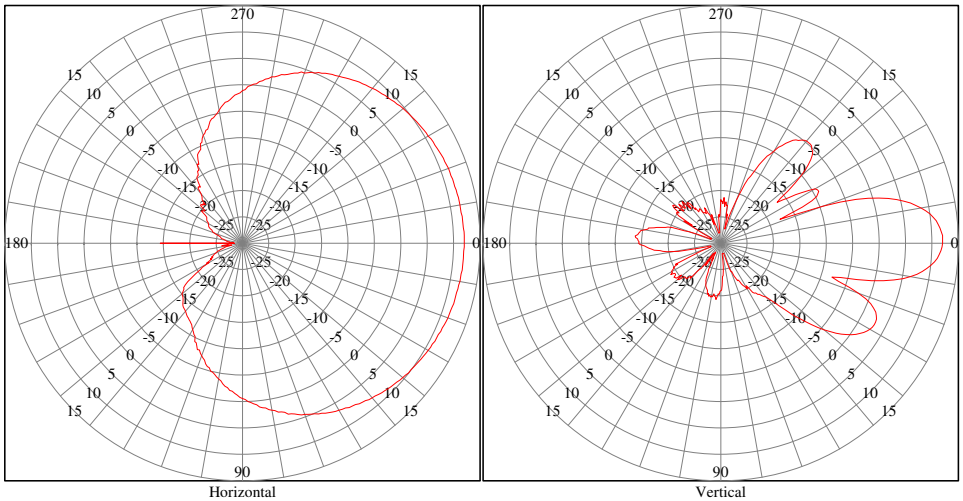
h. *94 Beacon St (facade)*

i. *94 Beacon St (rooftop)*

Answer:

Candidate Site	Antenna	Azimuth (deg)	ERP (Watts)	Height (ft)	DownTilt (deg)
15WarrenSt - TX 1	DB844H90E-XY	330	50	67	6
15WarrenSt - TX 2	DB844H90E-XY	120	50	67	0
15WarrenSt - TX 3	DB844H90E-XY	220	50	67	1
59Union - TX 1	DB844H90E-XY	330	50	67	6
59Union - TX 2	DB844H90E-XY	120	50	67	0
59Union - TX 3	DB844H90E-XY	220	50	67	1
10Webster - TX 1	DB844H90E-XY	330	50	62	6
10Webster - TX 2	DB844H90E-XY	120	50	62	0
10Webster - TX 3	DB844H90E-XY	220	50	62	1
120Beacon - TX 1	DB844H90E-XY	330	50	50	6
120Beacon - TX 2	DB844H90E-XY	120	50	50	0
120Beacon - TX 3	DB844H90E-XY	220	50	50	1
1493Cambridge - TX 1	DB844H90E-XY	330	50	60	6
1493Cambridge - TX 2	DB844H90E-XY	120	50	60	0
1493Cambridge - TX 3	DB844H90E-XY	220	50	60	1
1575Cambridge - TX 1	DB844H90E-XY	330	50	65	6
1575Cambridge - TX 2	DB844H90E-XY	120	50	65	0
1575Cambridge - TX 3	DB844H90E-XY	220	50	65	1
Rooftop88 - TX 1	DB844H90E-XY	330	50	60	6
Rooftop88 - TX 2	DB844H90E-XY	120	50	67	0
Rooftop88 - TX 3	DB844H90E-XY	220	50	67	1
Facade88 - TX 1	DB844H90E-XY	18	50	53	6
Facade88 - TX 2	DB844H90E-XY	80	50	53	0
Facade88 - TX 3	DB844H90E-XY	220	50	53	1
Facade94Beacon - TX 1	DB844H90E-XY	18	50	53	6
Facade94Beacon - TX 2	DB844H90E-XY	80	50	53	0
Facade94Beacon - TX 3	DB844H90E-XY	220	50	53	1
94Beacon - TX 1	DB844H90E-XY	330	50	109	8
94Beacon - TX 2	DB844H90E-XY	120	50	109	8
94Beacon - TX 3	DB844H90E-XY	220	50	109	8

Notes: 15 Warren is an 11 story building; did not test at rooftop, assumed a possible faade mount. For the 88 and 94 Beacon St facade options, cannot get desired azimuth due to building orientation. Antenna gain pattern:



Horizontal Vertical

Manufacturer:	Decibel Products		
Model:	DB844H90E-XY		
Description:	Panel Antenna		
File Name:	DB844H90E-XY_806H_0dg_VerticalPol.APF		
Length:	4.00		
Minimum Gain:	-28.00	Maximum Gain:	12.00
Mechanical Tilt:	0	Beam width (H, V):	90, 15
Horizontal Elevation:	0	Vertical Azimuth:	0

Question: *Do you have any intuition as to why the coverage is insufficient to the east/west/etc for each of these various locations (a. through i. above)? Is it terrain? Clutter? Chosen orientation of antenna?*

Answer: It is a combination of all of the above as well as distance from the intended coverage. We rely heavily on our tuned prediction models that take all these factors into consideration.

Question: *I understand that the larger height of the 94 Beacon St (rooftop) location could conceivably introduce more interference than 88 Beacon St. However, it is not clear to me what aspects of your model would cause the coverage to be worse than 88 Beacon St. Do you have any intuition as to why this is so?*

Answer: In order to reduce the potential for interference due to increased height, the down tilt was increased. This distorts the antenna pattern and can decrease or increase the gain in any given direction from the boresight of the antenna. It should also be noted that the landlord at 94 Beacon has indicated that he does not want any additional telecommunications equipment on the property. This site is no longer an option.

Question: *I would assume that you have a variety of antenna choices from various manufacturers with a variety of radiation patterns. Have you considered alternate antennas with alternate beam pattens that might extend coverage to the east/west/north/south to compensate for the lack of acceptable coverage in a particular direction?*

Answer: In order to achieve more gain from an antenna, additional elements within the antenna are required. This in turn increases the length of the antenna further reducing mounting options and creating a greater visual impact. Also a higher gain antenna will have a more narrow beam-width reducing coverage on the side lobes.

Question: *Can you describe the clutter database in more detail that is used in your model? In particular, how much detail can you control? Is it simply a matter of labeling the geographical area under study as being rural, suburban, urban, dense urban (i.e. one of perhaps 5 or so choices), which manifests itself as a coefficient or exponent in the model, and covers the whole geographical area? Or are the physical buildings in the area contained in the clutter database?*

Answer: Our clutter data contains twelve different classes at a 30 meter resolution. We can define average clutter height sites on a per site or geographic basis and individually set passthrough adjustment factors for each class to further tune our models. Individual buildings are not stamped into the clutter database.

Question: *In our telephone discussion, you stated that the interference map is generated by indicating an interference "pixel" on the map wherever the power of the interference is within 20 dB of the desired user (i.e. the COI). Larger interference levels could certainly be accommodated with more advanced techniques such as intercell interference cancellation techniques. Am I correct to assume, then, that Nextel does not employ such techniques, and anything less than 20 dB COI prohibits reliable communication?*

Answer: That is correct the Motoral iDEN equipment used by Nextel does not employ such techniques and the 20dB C/I is specified by Motorola.

Question: *Depending on the details of the propagation model employed, it would seem that there is a tradeoff between antenna height and ERP. That is, the 2-D "coverage" for a given ERP and antenna height ought to be equivalently attainable with increased height and decreased ERP. Is this true in the modified Lee model employed by Nextel?*

Answer: By increasing the height, you increase the number of areas further away from the cell site that will have an unobstructed path, this will increase the interference potential. At the same time the local area around the site will still have a similar obstructed path, reducing the ERP will only further reduce the local coverage while gaining minimal reduction in interference.

Question: *After digesting your previous response, I had a few more follow-up questions. I am still quite perplexed as to what aspect of Nextel's propagation model would cause the coverages between the various locations to vary so widely. From our previous discussions, you have suggested that the only differences between the various candidate locations are:*

- *clutter*
- *terrain*
- *height*
- *azimuth (which is only different for the 2 facade-mounted options)*
- *down tilt (which is only different for the 94 Beacon St rooftop)*

Due to the proximity of the locations considered, I would not expect difference in the relative terrain and clutter to be significant enough to play a major role in the causing such large variations in coverage for the considered alternate locations.

Besides those listed above, are there any other parameters which differ for each of the candidate locations that could cause such different coverage for each location?

Answer: Distance from the intended coverage area is one. Considering a mature cellular system in an urban setting where the distances between cell sites typically are 3/4 , 1/2 mile or less, 500 ft can greatly affect coverage. 1575 and 1430 Cambridge Street are 600 and 800 feet away from 88 Beacon respectively. The sites located in the Union Square area are all over 2500 feet away from 88 Beacon. These distances combined with the additional pass through loss due to the clutter can easily account for the decreased coverage. This is why we rely on our tuned models for candidate analysis.

In addition to the changes in coverage due to the different locations, other factors need to be considered when choosing a cell site location. We need to consider the locations of our existing neighboring sites. The amount of overlapping coverage with neighboring sites, and again I need to stress our frequency reuse issues, due to the obligations under the re-banding order issued by the FCC we will loss approximately 30% of our channels. This will require an increase in the number of times channels are used within the network making the need to reduce interference throughout the network even greater. There is very little room to move sites.

Question: *For each candidate location, have you attempted to perform any optimization of these various parameters? Is it possible that the chosen parameters are poor choices for their specific locations?*

Answer: As mentioned above, neighboring sites need to be taken into account when determining the cell site configuration. Changing the antenna orientation moving the main lobe to try and increase the signal strength in one area will generally take coverage from another. Due to the existing sites and planned sites within the network the configurations have been chosen to minimize interference and maximize channel reuse.

Question: *You mentioned that the 94 Beacon St rooftop location had increased downtilt to minimize interference to adjacent cells. When the interference map was generated for 94 Beacon St, did it include the increased downtilt? If so, do you have any intuition as to why 94 Beacon St rooftop could have both* **reduced** *coverage but* **increased** *interference?*

Answer: Yes the interference maps were generated with the tilt included. This was done to show that even with down-tilting, the increased height at 94 Beacon still allows the signal to pass over terrain features increasing the amount of interference. This greatly reduces the ability to reuse frequencies within our system. The lower antenna center line at 88 Beacon allows us to take advantage of natural terrain features to contain the radio signal and increase our spectrum efficiency allowing greater channel reuse.

The decrease in local coverage around the site can easily be attributed to changes in the direction of the gain pattern due to the down-tilting. Down-tilting tends to bring in the side lobes resulting in a smaller coverage footprint close to the site.

Question: *In generating the coverage maps, how is "coverage" defined? Is there a received power threshold which must be exceeded in order for a "pixel" to be drawn at a particular location? If so, what is that power threshold (in dBm)? And is that the received power at the mobile (downlink), or at the base station (uplink)?*

Answer: The coverage maps show where the downlink received signal strength will be strong enough for in-build use for a mobile user. Signal strength of -71 dBm is considered a strong enough signal for the mobile user within a building. In the maps provided the bins show where the signal is -71 dBm or better.

Question: *In the table of parameters you provide in your last email, should I interpret the heights to be feet above sea level? Thus, the rooftop of 94 Beacon St (listed at 109) is 49 feet above 88 Beacon St (listed at 60)?*

Answer: The heights given are the antenna center line referenced to ground level.

Question: *The ZBA has mentioned the possibility of moving the equipment shelter, but keeping the antennas in there current location. I understand that the equipment shelter can only be so far away from the antennas, but would like to understand a little better what these limits are.*

Presumably the longest tolerable distance (cable length) between the antenna and the equipment shelter depends on the power margin. Thus, one would expect that an antenna meant to cover a larger area would have stricter limits on cable length than an antenna meant to cover a smaller area. What does Nextel believe is the maximum tolerable cable length between antenna and equipment shelter for the 88 Beacon St location (and similarly sized coverage regions)?

Answer: It should be noted that the placement of the shelter on the roof is due to the current limited number of parking spaces at 88 Beacon Street. That being said, we generally we try to keep the loss due to transmission lines below 2 dB, using the 1 5/8 cable below works out to about 320 feet.

Question: *What is the type of cable (manufacturer & part number) used between the antenna and equipment shelter? What is the loss per foot?*

Answer: We typically use coaxial cable manufactured by Andrew Corporation or Commscope. Commscope recently acquired Andrew and their product specifications can be found here.

http://awapps.commscope.com/catalog/product.aspx?id=269

We commonly use the follow sizes listed below with their associated loss per 100ft

- CR-1070-PE - 7/8" cable, loss is approximately 1.04 db per 100 feet
- CR-1480-PE - 1 1/4" cable, loss is approximately 0.78 db per 100 feet
- CR-1873-PE - 1 1/2" cable, loss is approximately 0.63 db per 100 feet

Question: *Is there anything particular to the iDEN system that would preclude the use of an amplifier or repeater to extend the permissible distance between the antenna and equipment shelter?*

Answer: (Steve Grill first responded with "I'll let Joe answer, but I don't think a shelter in the lot would require a line amplifier for the cable run.") That is correct. A shelter in the lot would not require excessive cable runs. Typically we do not use an amplifier to increase the uplink signal. Amplifiers tend to increase non desired signals as well as the desired signal. This raises the system noise floor and affects the system performance.