Appendix A

ANNUAL REPORT

The Effect of Cell Towers on Birds and Bats at Rock Creek Park, Washington, D.C.

SUBMITTED TO

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26 February 2007

Abstract

This report details the first year of a three-year study on the potential effects of two existing telecommunication towers on migratory birds and bats in Rock Creek Park, Washington, D.C. The impact of tall towers (≥200 ft [61 m]) with obstruction lighting and guy wires on these species has been well documented, but shorter, monopole tower designs remain largely uninvestigated. The towers in Rock Creek Park are of this shorter, monopole design and lack obstruction lighting and guy wires. Mortality surveys were conducted on a daily basis during spring and fall migration periods, and weekly surveys were conducted during the summer. Preliminary results suggest that short, unlit, unguyed towers do not pose a significant threat to migratory birds and bats in this area.

Introduction

Migratory birds must navigate across a landscape dominated by man-made structures as they move between wintering and breeding grounds and back again each year. Collision deaths associated with such structures have been documented in the United States since the late 1800's (Avery 1979), and efforts continue to quantify the magnitude of these losses today. A conservative estimate for avian fatalities due to communication towers ranges from 4-5 million per year (Erickson et al. 2005), but a more realistic estimate could range from 40-50 million tower kills per year (Manville 2001).

Beginning in the 1950's, and extending through the 60's and 70's, several investigators began conducting detailed studies of bird kills at individual communication towers. As the field began to widen, it soon became evident that several factors were involved including tower characteristics such as height, the presence of guy lines, and lighting scheme, as well as weather conditions, bird behavior at towers, and peak migration periods for nocturnal migrants. Insights into the mechanisms by which birds are killed at communication towers are now being used to make recommendations to curb the number of birds killed at these structures, as well as to develop monitoring guidelines to assist in on-going research.

Tower Height

Most studies concerning the impact of telecommunication towers on migratory birds have focused almost exclusively on tall towers (Weir 1976, Avery et al. 1978, Avery et al. 1980, Trapp 1998, Derby et al. 2002, Johnson et al. 2000). In a 29-year period, approximately 44,007 birds were killed at a 204 m television tower in northern Leon County, Florida (Crawford and Engstrom 2001). This study was able to isolate tower height from all other factors by examining the same tower at three different heights. The tower was lengthened from its original 204 m height (1956-1959) to 308 m (1960-1963) and then shortened again to 94 m (1999). No significant difference was found between the numbers of birds killed when the tower was 204 m versus 308 m. When the number of bird kills in October 1999 and October 2000 at 94 m (no scavenger control) were compared with the 13 years of data from Octobers 1968-1973 and 1977-1983 (no scavenger control), the number of bird kills was lowered by a factor of 32 compared to when the tower was 308 m (Crawford and Engstrom 2001). Likewise, a west central

Wisconsin TV tower at its original 500 m height produced no recorded casualties, but when it was replaced with a 1000 m tower in 1957, 121,560 birds were killed over a 38-year period (Kemper 1996). In general, as tower height increases, so does its potential as a hazard to migrating birds.

Tower Lighting, Guy Lines, and Bird Behavior at Towers

Along with tower height itself, mortality is influenced by the infrastructure associated with tall towers: the stabilizing guy lines and the Federal Aviation Administration (FAA) lighting scheme. The placement of guy lines and the distance they extend from the tower has been shown to affect bird mortality (Avery et al. 1977). The 366 m Omega tower, stabilized by three sets of five guy lines anchored at 122 m, 213 m, and 297 m from the tower, was searched for carcasses with special attention directed toward the area directly under the guy lines. Overall, losses on overcast nights were concentrated near the tower, whereas losses on non-overcast nights were more evenly distributed. When comparing seasonal losses, the numbers of losses in spring were generally less than the fall losses closer to the tower, but exceeded fall losses farther out on both overcast and non-overcast nights. On overcast nights, large numbers of fall migrants are aloft and congregate around the tower, colliding with the structure itself, the guy lines, and other birds (Avery et al. 1977). Spring migrants tended to be aloft when winds were favorable for migration regardless of cloud cover; so much of the mortality took place on clear nights. On such nights, the birds seemed to avoid the tower itself, but sizeable losses still occurred via collision with outlying guy lines and transmitting cables (Avery et al. 1977).

Another killing potential of guy lines is their placement from tower to ground. In many tower constructions, the guy lines terminate at a common point some distance away from the base of the tower. This was the situation at a Nashville, Tennessee, site where a lower tower (247 ft [75 m]) and a higher tower (940 ft [287 m]) were compared. The largest numbers of casualties were found near and beyond two groups of guy cables which the migrants meet before reaching the high tower or the set of cables extending south as they fly from the north in the fall (Laskey 1960). Bierly (1968) suggested that the greater the angle of the wire from the vertical tower, the greater the amount of exposed wire at higher elevations and the greater the probability of tower casualties; therefore, an alternate construction is the connection of each individual cable to the ground at expanding intervals. Regardless, the presence of guy lines in any form is highly dangerous to migrants. There have been no studies published documenting bird kills at unguyed communication towers (Kerlinger 2004).

The lighting scheme interacts with guy line presence to compound the danger to nocturnally migrating birds. The FAA considers any tower 200 ft (61 m) or higher as a potential aviation hazard (Harden 2002), and as tower height increases so does the amount of obstruction lighting. The FAA requests three flashing red lights and four to six steady-burning red sidelights on communication towers 351-700 ft (107-213 m) tall, and five to seven flashing red lights and nine to twelve steady-burning red sidelights on towers 1,000-1,400 ft (305-427 m) tall (Kerlinger 2004). Tower lighting colors (red/white lights, ultraviolet, or specific wavelengths) and the duration of light (strobes, flashing lights, or steady lights) both affect the attraction of birds (Beason 2000), and attracted birds are reluctant to leave the lighted area. Migrants respond to lights by following a circular flight pattern, flying through the tower framework to the edge of the lighted area, only to double-back toward the light and inevitably strike the guy lines (Graber 1968, Larkin 2000). Furthermore, the proportion of birds showing curved, circling, or hovering behavior is significantly higher in response to red lights than to white strobe lights (Gauthreaux 2000). However, the strobe effect may be more important than the color of the light itself. The longer the "off" phase between the flashes, the less likely birds are attracted to the lighting (Manville 2000).

Weather and Migration Periods

The majority of bird-tower kill studies specifically address the interaction of inclement weather conditions during the spring/fall migration periods with the hazardous tower characteristics discussed above. For instance, fall losses occur primarily under overcast skies associated with the passage of cold fronts; spring losses are characterized by smaller, more evenly distributed kills throughout the season (Avery et al. 1977). In central Illinois, 5,465 birds were collected on 13 dates between 2 September and 12 November 1972 on mornings following nights with reduced visibility from fog/precipitation, or with low cloud cover, or both. Interestingly, over 93% of all birds killed occurred on three nights in September and one night in October, following the passage of cold fronts with low ceilings of ≤550 m and reduced visibility of <8 km (Seets and Bohlen 1977). At an east-central Illinois tower, birds were killed on nights with 80-100% cloud cover, a ceiling of 400-1,600 ft (122-488 m), and obscured visibility (Brewer and Ellis 1958).

Although the number of birds killed by towers peaks during the migration months, the fall season tends to be the most deadly. In some instances, the fall migration period has been recorded to be ten times greater in mortality than the spring (Brewer and Ellis 1958). In the north Florida television tower study, about 20% of the total number of birds killed was during a two-month period in the spring and 65% occurred during a two-month period in the fall (Engstrom 2000). Of the 121,560 birds killed at a west central Wisconsin tower between 1957 and 1995, the compacted spring season (~75 days from April to June) produced more than 20 days with over 100 kills, while the extended fall season (mid-July to mid-November) produced much greater losses including "mega-kills" of up to 12,000 birds on a single night (Kemper 1996).

Southern New Mexico does not typically experience low visibility and fog conditions (Ginter and Desmond 2004) and, therefore, towers in this part of the country may not produce large bird kill events. Avian mortality investigated at six radio towers along the Rio Grande corridor in southern New Mexico, ranging in height from 265 m to 805 m and including guy lines and night lighting, produced only six specimens from 1 August-30 October 2001: four migrant passerines, one partial-carcass of a migrant passerine, and one migrant raptor (Ginter and Desmond 2004). Although this site was only monitored for a single fall season and other factors may have been involved resulting in so few carcasses retrieved, it is possible that more studies of bird casualties at communication towers in the southwestern United States could conclusively identify weather as the single most important factor in bird kills at towers.

Rock Creek Park Project

The current project concerning the effects of cell towers on birds and bats at Rock Creek Park, Washington, D.C., is one of the few studies to examine the effect of unlit (no obstruction lighting present, although one tower has a mounted light associated with the tennis facility), unguyed "short towers" (<200 ft [61 m]) on avian mortality. The insufficient Environmental Assessment (EA) filed by the National Park Service, resulting in the right-of-way permit for Bell Atlantic Mobile, Inc. (now Verizon Wireless) to construct the cell phone towers, was based on the misconception that short towers do not pose a threat to migratory birds. On 2 July 2002, the court ruled that the National Park Service must develop and adopt a program to monitor the impact of the existing telecommunications facilities on migratory birds. The University of Maryland Center for Environmental Science, Appalachian Laboratory, was contracted to conduct a three-year study, with each year consisting of a spring and fall assessment that coincides with bird and bat migrations and an abbreviated summer assessment. This report describes the results for the 2006 season.

Methods

To determine the number of birds killed as a result of collision with the Rock Creek Park cell towers, the areas surrounding the towers were searched for carcasses from 24 May-15 November 2006. The tower adjacent to the tennis courts (TC tower) is 100 ft (30 m) in height (Figure 1) and is located within a row of light posts that illuminate the outdoor tennis courts. No FAA obstruction lighting is present on this tower, but a light has been mounted on the pole at the same height as the light posts. The TC tower is also near to a grassy picnic area with clumps of tall deciduous trees (e.g., *Fagus grandifolia, Quercus alba, Carya* sp., *Liriodendron tulipifera*) and shorter shrubby vegetation (e.g., *Smilax* sp., *Ampelopsis brevipedunculata, Lonicera* sp., *Toxicodendron radicans*), and various saplings. There is also a large paved parking lot and a larger tennis arena that fall within the search area of this particular tower. Many of the lights at the larger arena are significantly taller than the TC tower (Figure 2). The tower at the maintenance yard (MY tower) is 130 ft (40 m) in height (Figure 3) and is located on the sloping edge of a deciduous forest, consisting of oaks (*Quercus* sp.) and some of the same species noted near the TC tower. Scattered areas of undergrowth (e.g., *Polygonum cuspidatum, Vitus* sp., *Parthenocissus quinquefolia*, *Wisteria* sp., *Rubus phoenicolasius*) are also present. The park maintenance yard, as well as park offices, equipment, and a large paved parking lot, are prominent features at this site. Both towers lack obstruction lighting and are unguyed.

A double sampling approach was used for this study involving both ground and net sampling, as suggested by Manville (2002). Net sampling, similar to the method of Avery et al. (1978) and Avery and Beason (2000), allows for adjustment of the ground sampling estimates by correcting for carcass removal by scavengers and searcher efficiency bias based on the relative ratio of the number of carcasses found per unit area using the two sampling methods.

Ground Sampling

The search grids for each tower consisted of 21 N-S transect lines 100 m in length centered on the tower, forming a 100 m × 100 m square (prior to 2 June, the grid was 50 m × 50 m). Each transect was 5 m apart, yielding a 2.5 m search width on either side. Avery et al. (1978) found 63% of all the carcasses at their study site within 300 ft (91 m) of the 1,210 ft (369 m) guyed tower. Based on the relationship between the distance that a carcass is found from the tower and the tower height, we expected to find most carcasses in our study within 40 ft (12 m) of the towers, e.g., 1,210 ft/300 ft (369 m/91 m) is equivalent to 130 ft/33 ft (40 m/10 m). Ground searches were conducted daily at each tower site from 24 May- 15 November 2006, except for a one-month summer period (15 June-15 July) when searches were performed once per week. The entire ground area within the grid was searched as well as any rooftops falling inside the search area.

Notes: Due to the Mason-Legg/U.S. Open Tennis Tournament held near the TC tower from 29 July-6 August, as well as the week preceding and following, ground searches were more or less restricted to the southern half of the grid. From 17 September 2005 until mid-May 2006, a tennis bubble dome was in place over the tennis courts near the TC tower (see Figure 1).

Net Sampling

In addition to the daily ground searches, two 25 ft × 25 ft (7.62 m × 7.62 m) nylon nets were also erected at each tower site in order to catch any birds that might collide with the towers. The two nets were placed as close to the tower as possible, adjusting for the terrain and vegetation cover at each site. Due to a delay in delivery by the manufacturer, we were only able to monitor the nets during the fall migration period in 2006 (15 July-15 November). The two nets at the MY tower went up on 12 July, and the first net at the TC tower went up on 14 July and the second net on 8 September.

Data Collection

Carcass searches began at dawn (30 minutes before sunrise) in all seasons. Searches were conducted daily from 24 May to 15 June for the spring migration, and from 15 July to 15 November for the fall migration. During the summer season, 15 June-15 July, searches were conducted once per week. We tried to select nights with low ceiling height (cloud cover) and poor visibility for our weekly summertime searches whenever possible.

Each day that a tower was examined, beginning and ending time of each search, time spent searching, time since last search, and weather data were recorded. Weather data were recorded at the beginning of the search, for the previous night, and for the last 24 hours (including temperature, wind direction/speed, cloud cover %, ceiling height, barometric pressure, relative humidity, precipitation, and front activity). Current temperature, wind, cloud cover, and relative humidity were all recorded at the time of the search using a Kestrel (WeatherEssentials, Chandler, AZ) hand-held weather meter, while all other weather variables were taken from KDCA weather station at Reagan National Airport. All bird carcasses discovered during the searches were collected, numbered, and placed in the freezer, and the species, date, exact location, distance from tower, perpendicular distance from nearest transect, body condition, probable cause of death, and any evidence of scavenging were recorded. Live birds observed in the area were also noted on datasheets.

Statistics

In order to determine whether the bird casualties found during this study were likely due to collision with the tower, the mean distance of the carcasses from the towers was compared to the mean distance expected by chance using a Monte Carlo simulation. The null hypothesis for this test is that carcasses discovered during daily searches are incidental and so are randomly distributed throughout the search area. The alternate hypothesis is that carcasses are due to tower collision deaths and therefore are distributed closer to the tower than expected by chance. In the future, this test will be refined to accommodate searcher efficacy (i.e., high/low visibility) and missing parts of the search space (i.e., inaccessible parts of grid).

Results

Between 24 May and 15 November 2006, transect searches produced a total of three dead birds, one partial carcass (wing), and five feather spots beneath the cell towers at Rock Creek Park during 151 daily searches and 432.5 search hours (Table 1). Net searches were also conducted from 15 July to 15 November 2006, during 124 search days. No birds were collected from the nets. No bat carcasses were found on the transect searches or in the nets during the 2006 season of the study. All fatalities occurred between 1 June and 25 July 2006, except for one feather spot found on 27 October 2006. Interestingly, virtually all mortalities at the Rock Creek Park towers occurred during the summer months, unlike most other studies where fall is the deadliest season. Furthermore, none of the birds or bird remains found were Neotropical migrants, despite their presence in the area (Table 2).

TC Tower

A total of 163 search hours were spent at the TC tower. The highest number of casualties took place at this site, with three feather spots, one partial carcass, and one complete carcass being collected. The feather spots were identified as a gray catbird (*Dumetella carolinensis*) on 8 June, an American robin (*Turdus migratorius*) on 7 July, and a northern cardinal (*Cardinalis cardinalis*) on 25 July, found at 46 m, 47 m, and 28.5 m from the tower, respectively. The partial carcass found on 1 June, 4.7 m from the tower, consisted of a wing fragment possibly from a house sparrow (*Passer domesticus*). All of the feather spots appeared to have been the result of predation rather than scavenging, but this assessment has yet to be verified. The wing fragment, however, did appear to belong to a scavenged carcass, whether it was originally from predation or a tower kill is unknown, although it was not produced from a recent kill based on its condition. The complete carcass was a juvenile house sparrow (*Passer domesticus*) found 42.5 m from the tower on June 15. This bird appeared to have died from exposure and was found on the sidewalk just outside the fence surrounding the tennis courts. None of the casualties suffered at this site were significantly closer to the tower than would be expected by chance (*P* (feather piles) = 0.499, *P* (feather piles + partial carcass) = 0.290, *P* (complete carcass) = 0.50, *P* (all carcass types) = 0.320) and, therefore, were unlikely to have been killed by striking the tower.

MY Tower

This site suffered slightly fewer casualties than did the TC site. A total of two feather spots and two complete carcasses were retrieved. The two feather spots were identified as rufous-sided towhees (*Pipilo erythrophthalmus)* on 17 July and 27 October 2006, and were located 62 m and 10 m away from the tower, respectively. Both feather spots appeared to be the result of predation, possibly by hawks. The two complete carcasses were both juvenile American robins (*Turdus migratorius*) found on 17 July and 24 July, located 1.36 m and 53 m from the tower, respectively. The robin found directly under the tower at 1.36 m is the only casualty that may have resulted from actually colliding with the tower. The other robin, found farther away, likely collided with the NPS office building next to which it was collected. None of the casualties suffered at this site were significantly closer to the tower than would be expected by chance (*P* (feather piles) = 0.448, *P* (complete carcass) = 0.258, *P* (all carcass types) = 0.351) and, therefore, were unlikely to have been killed by striking the tower.

Discussion

Telecommunication towers are a hazard to nocturnally migrating birds, especially those which are >200 ft (61 m) in height, guyed, and lighted. The spring and fall migration periods produce the most losses, and the birds most impacted are Neotropical migrants. While each of these factors presents their own dangers, it is their interaction that produces large, spectacular kills. The “worst case” scenario develops when nocturnally migrating birds are aloft on nights with low visibility and cloud cover associated with passing cold fronts, in the vicinity of a tall communication tower. Their celestial cues obstructed, the birds hone in on the lights of the tower and gravitate toward it. Once inside the halo of the tower’s light, the birds are reluctant to leave it and inevitably some will strike the guy lines or the tower itself.

The effect of short (≤200 ft [61 m]) towers remains largely uninvestigated, along with the interactions between guy lines, weather, and lighting of these shorter towers. However, the preliminary data from this study suggest that the short monopole tower construction is not obstructive to migratory birds in this location. Overall, only three carcasses were collected during the study and six partial carcass/feather spots. With the exception of one bird at the MY site (juvenile American robin), all fatalities appeared to be unconnected to the towers. The TC tower which occurs within a string of lights for the tennis court, and even has lights mounted on it, failed to show any differences with the MY tower. However, there is night security lighting in the maintenance yard itself, near the MY tower.

Although this study had a truncated spring season (24 May-15 June vs. 15 April-15 June), it is unlikely that this resulted in the retrieval of significantly fewer carcasses, because the fall months tend to be the deadliest in other studies. This study did have a complete fall season (15 July-15 November), during which only a single feather pile was found (27 October). Searcher efficiency is presumed to have been high, as no birds were found in the nets, suggesting that there was minimal scavenging bias.

It may not be appropriate, however, to generalize the results of this study across all short towers at this time. It is possible that some location effects are involved, and that the same towers in a different location (e.g., on a ridge top or near wetlands) might actually produce some kills. For instance, the height at which migrating birds in ROCR fly has not been documented, and therefore may be different from the height migrants fly elsewhere. Most passerine nocturnal migrants fly <1,000 m (Able 1973), but migration height can vary anywhere from <500 m to 3,000 m (Harper 1958, Tedd and Lack 1958, Graber and Cochran 1959, Hassler et al. 1963, Griffin 1973). Furthermore, it is possible that the interaction between the towers and weather conditions were just not right to produce kills during the 2006 season, and continued monitoring might reveal that fatalities do indeed occur.

Acknowledgments

We would like to thank ROCR personnel, Ken Ferebee, Bill Yeaman, Geoff Clark, and Joe Kish, for their help with mortality surveys, erecting and taking down of nets, clearing vegetation, and a multitude of other tasks. We would also like to recognize Brad Dickey for his help with mortality surveys and statistical analysis. We thank the National Park Service for their support in funding this project.

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Table 1. Avian casualties recorded at cell towers in Rock Creek Park, Washington, D.C., from 24 May-15 November 2006.

Common name	Scientific name	Family	Date	Distance (m) from tower	Type
House sparrow?	*Passer domesticus*	Passeridae	June 1	4.7	Partial
Gray catbird?	*Dumetella carolinensis*	Paridae	June 8	46	Feather spot
House sparrow	*Passer domesticus*	Passeridae	June 15	42.5	Complete
American robin?	*Turdus migratorius*	Muscicapidae sub. Turdinae	July 7	47	Feather spot
Rufous-sided towhee	*Pipilo erythrophthalmus*	Emberizidae Sub. Emberizinae	July 17	62	Feather spot
American robin	*Turdus migratorius*	Muscicapidae sub. Turdinae	July 17	1.36	Complete
American robin	*Turdus migratorius*	Muscicapidae sub. Turdinae	July 24	53	Complete
Northern cardinal	*Cardinalis cardinalis*	Emberizidae sub. Cardinalinae	July 25	28.5	Feather spot

Common name	Scientific name	Family	Date	Distance (m) from tower	Type
Rufous-sided towhee	*Pipilo erythrophthalmus*	Emberizidae sub. Emberizinae	October 27	10	Feather spot

Table 2. Live birds observed[1] and/or heard during carcass searches at Rock Creek Park, Washington, D.C., from 24 May-15 November 2006.

Common name	Scientific name	Family	No. observations[2]
American crow	*Corvus brachyrhyncos*	Corvidae	91
American goldfinch	*Carduelis tristis*	Fringillidae	5
American redstart	*Setophaga ruticilla*	Emberizidae, sub. Parulinae	2
American robin	*Turdus migratorius*	Muscicapidae, sub. Turdinae	124
Black-and-white warbler	*Mniotilta varia*	Emberizidae, sub. Parulinae	1
Black-throated Green warbler	*Dendroica caerulescens*	Emberizidae, sub. Parulinae	1
Blue jay	*Cyanocitta cristata*	Corvidae	68
Blue-gray gnatcatcher	*Piloptila caerulea*	Muscicapidae, sub. Sylviinae	1
Brown creeper	*Certhia americana*	Certhiidae	3
Brown thrasher	*Toxostoma rufrum*	Mimidae	40
Brown-headed cowbird	*Molothrus ater*	Emberizidae, sub. Icterinae	14
Canada goose	*Branta canadensis*	Anatidae	5
Carolina chickadee	*Parus carolinensis*	Paridae	21

Common name	Scientific name	Family	No. observations[2]
Carolina wren	*Thryothorus ludovivicanus*	Troglodytidae	112
Cedar waxwing	*Bombycilla cedrorum*	Bombycillidae	1
Common grackle	*Quiscalis quiscula*	Emberizidae, sub. Icterinae	33
Common yellowthroat	*Geothlypis trichas*	Emberizidae, sub. Parulinae	8
Downy woodpecker	*Picoides pubescens*	Picidae	16
Eastern phoebe	*Sayornis phoebe*	Tyrannidae	3
Eastern wood-peewee	*Contopus virens*	Tyrannidae	2
European starling	*Sturnus vulgaris*	Sturnidae	82
Fish crow	*Corvus ossifragus*	Corvidae	2
Golden-crowned kinglet	*Regulus satrapa*	Muscicapidae, sub. Sylviinae	1
Gray catbird	*Dumetella carolinensis*	Mimidae	116
Hairy woodpecker	*Picoides villosus*	Picidae	4
Hermit thrush	*Catharus guttatus*	Muscicapidae, sub. Turdinae	4
House finch	*Carpodacus mexicanus*	Fringillidae	5
House sparrow	*Passer domesticus*	Passeridae	84

Common name	Scientific name	Family	No. observations[2]
House wren	*Troglodytes aedon*	Troglodytidae	5
Mourning dove	*Zenaida macroura*	Columbidae	43
Northern cardinal	*Cardinalis cardinalis*	Emberizidae, sub. Cardinalinae	113
Northern mockingbird	*Mimus polyglottos*	Mimidae	23
Ovenbird	*Seiurus aurocapillus*	Emberizidae, sub. Parulinae	5
Pileated woodpecker	*Dryocopus pileatus*	Picidae	6
Red-bellied woodpecker	*Melanerpes carolinus*	Picidae	32
Red-tailed hawk	*Buteo jamaicensis*	Accipitridae	1
Ruby-crowned kinglet	*Regulus calendula*	Muscicapidae, sub. Sylviinae	13
Rufous-sided towhee	*Pipilio erythrophthalmus*	Emberizidae, sub. Emberizinae	74
Scarlet tanager	*Piranga rubra*	Emberizidae, sub. Thraupinae	3
Slate-colored junco	*Juncus hyemalis*	Emberizidae, sub. Emberizinae	19
Song sparrow	*Melospiza melodia*	Emberizidae, sub. Emberizinae	9
Tufted titmouse	*Parus bicolor*	Paridae	60
Turkey vulture	*Cathartes aura*	Cathartidae	1

Common name	Scientific name	Family	No. observations[2]
White-breasted nuthatch	*Sitta carolinensis*	Sittidae	51
White-throated sparrow	*Zonotrichia albicollis*	Emberizidae, sub. Emberizinae	25
Winter wren	*Troglodytes troglodytes*	Troglodytidae	3
Wood thrush	*Hylocichla mustelina*	Muscicapidae, sub. Turdinae	17
Yellow-shafted flicker	*Colaptes auratus*	Picidae	19

[1] Live birds observed is not an exhaustive list and is limited to those birds identifiable by the searcher.
[2] Number of observations refers to the number of days a particular species was observed within 151 search days.

Figure 1. Tennis court (TC) tower located in Rock Creek Park, Washington, D.C., on 29 April 2006. Note the lights low on the tower and the white bubble dome over the tennis courts in the background.

Figure 2. TC tower located north of the tennis facility in Rock Creek Park, Washington, D.C., on 29 April 2006. The black arrow indicates the position of the tower. Note that several lights surrounding the tennis arena are taller in comparison to the TC tower.

Figure 3. Maintenance yard (MY) tower located in Rock Creek Park, Washington, D.C., on 29 April 2006.

Appendix B

Rock Creek Park

Telecommunication Facilities EA

Alternative Siting Analysis

February 20, 2002

Prepared for the National Park Service, U.S. Department of the Interior

by

The Louis Berger Group, Inc.

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INTRODUCTION

The five scenarios considered under alternative C in the alternatives section of the environmental assessment were established through the completion of a comprehensive engineering analysis. An independent wireless telecommunications consulting firm was contracted to assess the siting possibilities for two telecommunications facilities in and/or around Rock Creek Park. The engineering analysis consisted of:

(1) Identification and confirmation of the coverage gap originally established by Verizon Wireless through:

   a. Identifying the coverage gap that Verizon Wireless would sustain if the two facilities in the park were not functioning, but the remainder of the Verizon Wireless network was operational.

   b. Evaluating the topography, land cover, and existing structures in the identified coverage gap to determine the best location for one or two telecommunications facilities to address the coverage gap for Verizon Wireless customers.

(2) Assessing potential alternative sites including:

   a. Evaluation of moving the antennas currently located in Rock Creek Park to existing structures (telecommunications towers and other antennas, building structures, etc) outside of the park to determine if relocation could fully meet existing Verizon Wireless coverage;

   b. Constructing new monopoles at locations outside of the park to determine if this relocation could fully meet existing Verizon Wireless coverage; and

   c. Considering locations or a combination of locations both inside and outside of the park that could fully or partially meet existing Verizon Wireless coverage.

(3) Considering alterative technologies including

   a. Identifying possible alternative technologies and assessing their ability to satisfy the Verizon Wireless coverage gap, taking into account factors such as the terrain of the area and the extent of the coverage gap.

   b. Identifying possible combinations of technologies and assessing their ability to satisfy the Verizon Wireless coverage gap.

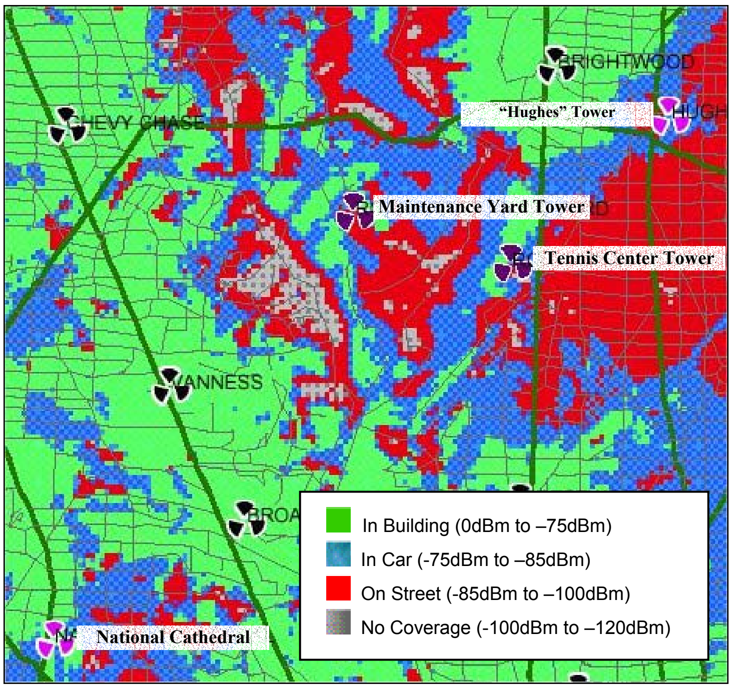
IDENTIFICATION AND CONFIRMATION OF THE VERIZON WIRELESS COVERAGE GAP

Identification and confirmation of the coverage gap originally established by Verizon Wireless was completed through an independent engineering analysis conducted in January 2003 for the two telecommunications facilities at Rock Creek Park. This was accomplished through the completion of drive tests, propagation studies, and coverage simulations on the two existing telecommunications facilities sites with in Rock Creek Park. The analysis assumed:

The coverage necessary had to equal the existing coverage maintained by the two telecommunications facilities in Rock Creek Park, specifically along the road network within the park (Military Road, Beach Drive, Broad Branch Road, Ross Drive, Glover Road, and Ridge Road).

The minimum signal level required for adequate cell phone coverage is -85dBm (in car) in an urban area. This level is designated by the Federal Communications Commission and is the minimum level required to achieve the standards for Enhanced 911 (E911).

Using the methodology and assumptions outlined above, the engineering assessment determined that removal of the existing towers would result in coverage problems for Verizon Wireless in the following areas (see Appendix E Figure 1):



APPENDIX E FIGURE 1. COVERAGE SIMULATION - CELLULAR COVERAGE WITHOUT THE TWO PARK SITES

Very weak coverage along Beach Drive

Very weak coverage along Military Road

Very weak coverage along Broad Branch Road

Very weak coverage north of Military Road, between Oregon Avenue and Beach Drive

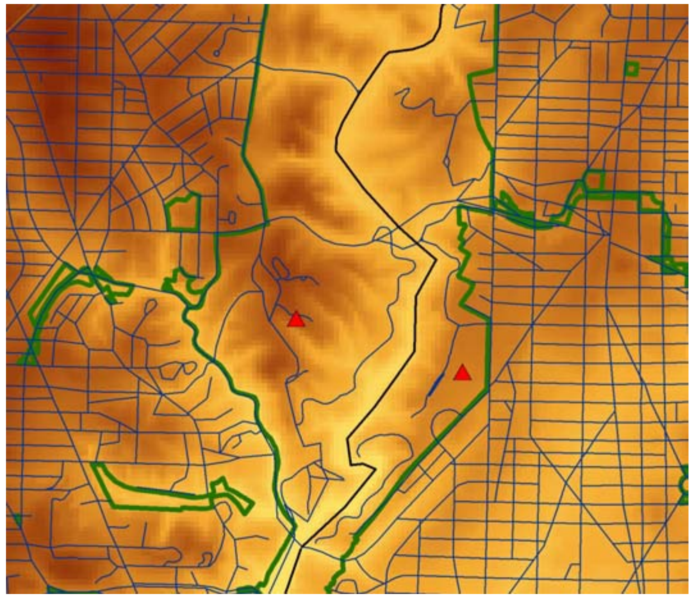
Very weak coverage along Ross Drive, south of Military Road

Very weak coverage between Ridge Road and Beach Drive south of Military Road

Significant areas along Military Road, Beach Drive, Ross Drive, and Broad Branch Road would not reach the necessary signal strength to meet those required for Enhance 911 (E-911) access. In order to address such a coverage gap, towers must be located within the identified gap to be effective.

EVALUATION OF TOPOGRAPHY, LAND COVER, AND EXISTING STRUCTURES

The topography of Rock Creek Park is varied and can best be described as rolling. As seen in Figure , 1, the dark shading represents areas of higher elevations, such as the area located around the existing maintenance yard telecommunications facility site. The gradual change of color leading up to this site represents a ridge that runs through Rock Creek Park in a north/south direction. The lighter area between the two existing telecommunications facilities sites represents the Rock Creek valley. Verizon Wireless currently has a network of towers around the park along Connecticut Avenue and 16th Street (see Appendix E Figure 2). Because the ridge on the west side of the park, the signal from the towers on Connecticut Avenue is unable to reach into the park. Similarly, the signal from the antennas on 16th Street are unable to reach Rock Creek valley because the signal is projected from the tower in a straight line and does not follow the topography of the valley, thus the signal passes over the valley.



APPENDIX E FIGURE 2. TOPOGRAPHY IN AND AROUND ROCK CREEK PARK

The rolling topography of Rock Creek Park, including its ridges and valleys, makes the siting of telecommunications facilities difficult and dependent on the terrain. The topography of this geographical region is very hilly, and important roads cut through hills and valleys. Such terrain is very difficult to provide with the necessary and required signal levels for successful call completions and good call quality, as well as to meet the minimal signal level required for urban coverage. Best practices of radio frequency engineering require cell sites in such situations to be placed as close as possible to terrain depressions. This allows the signal generated by the cell site to reach the deep valley floors. It is along the valleys of the park that some of its important roads are laid out. Covering the roads and valleys of the park then take on an added importance given the amount of vehicular traffic that uses the roads on a daily basis.

ASSESSMENT OF POTENTIAL ALTERNATIVE SITES

After determining the need for the two telecommunications facilities, an evaluation of alternative sites was conducted to evaluate the feasibility of relocating the both towers outside of Rock Creek Park and replacing them with a single tower, while maintaining the coverage and capacity objectives of Verizon Wireless. The alternative sites analysis reviewed two types of potential locations: existing structures on which the Verizon Wireless antennas could be placed and alternative sites requiring the construction of new monopoles.

A. Existing Structures

A national structures database was queried to locate existing structures within the area on which to potentially relocate the tower antennas. Buildings, water towers and tanks, existing towers, chimneys, etc. were assessed as potential sites. Coverage simulation models were run to for the three most promising sites using existing structures. These simulations assume that both of the telecommunications facilities within the park would be replaced by one telecommunications facility outside of the park (see appendix C):

Coverage simulation of a cell site at the National Cathedral;

Coverage simulation of a cell site on the “Hughes Tower” (Peabody Street between Georgia Avenue and 9th Street); and

Coverage simulation of a cell site located at St. Johns College High School on the existing flag pole, co-locating on an existing cellular telecommunications tower.

The National Cathedral site is located approximately 2.5 miles southwest of Military Road. Due to tree cover and topography, a reliable wireless signal cannot be achieved in the identified coverage gap. A coverage simulation plot modeled the site, assuming an antenna mounted on the cathedral at 120 feet. The signal from this site would not reach Rock Creek Park and, therefore, would not meet the Verizon Wireless coverage and capacity objectives.

APPENDIX E FIGURE 3. HUGHES TOWER AS SEEN FROM THE ROCK CREEK PARK TENNIS CENTER

The "Hughes Tower," located on Peabody Street between 9th Street and Georgia Avenue, has adequate height and ground elevation; however, again, an antenna siting in this location would not reach Rock Creek Park due to tree cover and terrain (see Appendix E Figure 3). The coverage simulation plot modeled the coverage from the site with antennas mounted at 150 feet on the Hughes Tower. The signal from this site would not reach the park and would also create interference for other Verizon Wireless sites; therefore, the site would not meet the Verizon Wireless coverage and capacity objectives.

The St. Johns College High School site existing cell tower designed as a flag pole does not have the necessary ground elevation to qualify as a good cell site for the coverage gap. The coverage analysis showed that this site does not have enough height to overcome the hilly terrain and trees to the south. The site does expand the coverage area on and to the north of Military Road but provides no coverage to those areas of the park located south of Military Road (see Appendix E Figure 4).

APPENDIX E FIGURE 4. FLAG POLE TOWER AT ST. JOHNS COLLEGE HIGH SCHOOL

B. Assessment of new monopole sites

Having determined the identified gap in coverage exists and no existing structures could be used to achieve full (the level of coverage Verizon Wireless currently possesses) coverage, four additional siting scenarios were run, relocating the two Rock Creek Park monopole facilities to a single facility outside of the park boundary.

Four sites were selected based on acceptable ground elevation. Other parameters, such as zoning, potential site leasing costs, existing land uses, were not considered; the analysis was conducted solely to determine if the same coverage could be achieved with the towers located outside of the park boundary at a single facility. The simulations were run for a full-scale cell site with antennas mounted at 130 feet, simulating the existing maintenance yard tower. Coverage simulation models were run on each of the following sites:

Coverage simulation with a cell site located at Military Road and Jocelyn Street

Coverage simulation with a cell site located at 16th Street and Military Road

Coverage simulation with a cell site located at 16th Street and Kennedy Street

Coverage simulation with a cell site located at 16th Street and Allison Street

None of the four sites alone provided the same level of coverage currently achieved by the two existing towers within Rock Creek Park.

SITE COMBINATION ALTERNATIVES

Based on the coverage simulations run for the three existing structures and the four alternative new sites, the following five siting scenarios were developed for analysis:

Scenario 1. Tennis center tower remains in place; maintenance yard tower is relocated to site at Military Road and Jocelyn Street.

Scenario 2. Tennis center tower remains in place; maintenance yard tower is relocated to site at St. Johns College High School.

Scenario 3. Tennis center tower is relocated to church site located at the corner of 16th Street and Kennedy Street; maintenance yard tower is relocated to site at St. Johns College High School.

Scenario 4. Tennis center tower is relocated to church site located at the corner of 16th Street and Kennedy Street; maintenance yard tower is relocated to site at Military Road and Jocelyn Street.

Scenario 5. Tennis center tower is relocated to church site located at the corner of 16th Street and Kennedy Street; maintenance yard tower remains in place.

Four sites—the National Cathedral, Hughes Tower, 16th Street and Military Road, and 16th Street and Allison Street—were removed from further analysis after determining that they would compromise existing coverage beyond an acceptable level as it related to spatial coverage of the -85 dBm signal necessary to maintain E-911 access as regulated by the Federal Communications Commission (see Alternatives Considered but Not Carried Forward map).

Various combinations of the three remaining sites, as well as the two existing sites within the park, were used to create the five scenarios stated above. The selected scenarios do not provide the same level of coverage as the existing towers; however, some cellular capability is still available within the park boundaries along the major roadways (see Table 1). The study area has approximately four miles of roadway.

ALTERNATIVE TECHNOLOGIES

Research on applicable technologies took into account the area currently lacking coverage for Verizon Wireless customers, topography, forest cover, and land availability. Depending on the coverage needs and the type of area requiring coverage as well as the projected capacity requirements, various alternative coverage methods can be utilized. The independent engineering analysis studied three alternative technologies that could potentially be used in Rock Creek Park: microcells, repeaters, and satellite technology (see appendix D).

APPENDIX E TABLE 1. CELLULAR COVERAGE ALONG MAJOR ROADWAYS WITHIN ROCK CREEK PARK STUDY AREA

	Miles w/o Cellular Coverage	Miles w/ Cellular Coverage	% Miles w/o Cellular Coverage
All Verizon Sites (including tennis center and maintenance yard) (EXISTING)	0.53	3.46	13
Tennis center, flag pole, other Verizon Sites	1.20	2.79	30
Tennis center, Military Road & Jocelyn Street, and other Verizon sites	1.13	2.86	28
Maintenance yard, 16th & Kennedy Street, and other Verizon sites	1.36	2.63	34
Flag pole, 16th & Kennedy Street, and other Verizon sites	1.90	2.09	48
Military Road & Jocelyn Street, 16th and Kennedy Street, and other Verizon sites	2.03	1.96	51

These alternative technologies were qualitatively assessed as an alternative to the existing telecommunication facilities (see Appendix E Table 2. Alternative Technologies Analysis) and as a potential alternative to replace one or both of the existing telecommunication facilities.

APPENDIX E TABLE 2. ALTERNATIVE TECHNOLOGIES ANALYSIS

	Microcells	Repeater	Satellite
Geographic Area Covered	Small area such as a mall, subway station, or sports complex.	Buildings, tunnels or difficult terrain, usually used to extend the range of base station signals.	Remote areas such as deserts, heavy forests, and high seas – areas where no landline or cell phone service is available.
Application in Rock Creek Park	Microcells would be required every 300 yards. Approximately 30 would be needed to cover roadways and would provide only limited coverage.	Multiple towers would be required in the park. The number of towers would depend on location, height, and availability of a donor site.	Not applicable, technology is not available for Verizon Wireless.
Assessment	Numerous cells would be necessary to provide limited coverage. Topography of the park, dense vegetation, and meandering trails and roadways limit effectiveness.	Small poles would not be high enough to allow the repeater to receive a strong enough signal. Many tall poles would be needed.	This technology is capacity-limited, expensive, and does not provide for FCC E911 requirements. Verizon Wireless does not currently operate a satellite phone system.

There are also coverage enhancer systems that can reduce the number of necessary towers by one third to one half depending on the terrain. These would not be feasible technology in Rock Creek Park due to rolling topography.

Microcells

All technologies require a base station. Base stations consist of antennas installed on supporting structures or mounted on buildings connected by feeder cables to transmitters and receivers. Networks are comprised of three sizes of base stations (Scottish Executive 2001), macrocells, microcells, and picocells. Macrocell base stations provide the main coverage infrastructure and are meant to service a large geographic area, antennas for macrocells are usually mounted on ground based masts, rooftops, or other existing structures above signal obstacles; however, they may be within a building. Microcells are used to infill and improve the main network, especially where call volume is high. The antennas are small boxes the size of burglar alarms mounted at street level typically on the external walls of existing structures. They have a range of a few hundred meters. Microcell base stations are suitable for transmitting signals to pedestrians but are less suited to fast moving traffic. Picocell base stations have even smaller antennas and are generally sited inside buildings such as airports, railway stations, and shopping centers.

Microcells, are limited in power and often used to cover a limited geographical area, such as a mall, subway station, or sports complex. Microcells do not have the same height and power requirements as macrocells, but a larger number of microcells are needed to provide widespread coverage. Microcells do not have to be located on high towers; they can be installed in church steeples, on rooftops, and even inside offices where they would not be noticed. They can be attached to utility poles and lamp posts with cables running down to equipment located in underground shelters.

In an area such as Rock Creek Park, a microcell would be necessary approximately every 300 yards to provide reliable coverage. Within Rock Creek Park, the use of microcells would require erecting small poles approximately every 300 yards with the required antennas mounted on them and ensuring overground and/or underground connections necessary for power and T1. Based on a qualitative assessment, approximately 30 microcell sites would be necessary to cover the roadways of Rock Creek Park. The resulting coverage from such microcells would not provide the same extent of cellular coverage that the existing towers currently provide. Areas of the park such as bike trails and other areas accessible to the general public, where cell phone coverage is also needed, and where coverage is currently available for Verizon Wireless would not be provided using microcell technology. In order to provide cover for the study area at –85dBm, the minimum signal level required for the in-car coverage determined necessary for Enhanced 911 capabilities, additional microcell sites would be necessary beyond the 30 estimated for coverage of main roadways in the park. This estimate is dependent on factors, such as power output from the microcell, pole height, and location. The topography of the park, dense vegetation, and meandering nature of the trails and roadways raise additional concerns for the use of microcells.

Implementation of alternative technologies in combination with towers located outside of the park was considered. In general, alternative technologies were eliminated from further consideration due to the excessive construction requirements and/or equipment requirements that would be necessary to address the identified coverage gap. Microcell technology, in combination with the existing towers, would require a microcell approximately every 30 feet along each of the roadways to fill the coverage gap. Microcells do not provide sufficient in car coverage, nor would they provide coverage on the trails. Furthermore, microcell technology is designed for limited use in a small space such as a subway station or sports complex, and would not be an appropriate technology for Rock Creek Park. Even if microcells were feasible, the existing towers would still be necessary to achieve the same level of coverage.

Repeaters

A repeater is a device that receives a radio signal, amplifies it, and re-transmits it in a new direction. Repeaters are often used in wireless networks to extend the range of base station signals, thereby expanding coverage more economically than by building additional base stations. Repeaters typically are used for buildings, tunnels, or difficult terrain (CTIA 2002a).

A repeater can be considered a cell site that does not need a telephone line, and is usually used to extend the coverage of particular cell site to a specific area. Similar to a cell tower, an outdoor repeater also needs sufficient ground elevation and height above ground level in order to provide reliable coverage to the area it is required to serve. The ground equipment for a repeater site is very small when compared with that of a tower site; however, the structure is the same. A repeater site needs antennas, cables, and a donor antenna (usually a dish) to allow the reception of signal from a neighboring site at good strength.

To achieve the same coverage in the park with a repeater solution, Verizon Wireless would have to construct multiple towers in the park. The number of towers would depend on location, height, and the availability of a donor site. A solution with repeaters mounted on small poles would not be feasible in most areas of the park, since short poles would not be high enough to allow the repeater to receive sufficient signal strength from a qualified Verizon Wireless donor site and to relay it to its intended coverage area. For this reason, repeaters would not work in combination with either one of the existing telecommunications towers.

Implementation of alternative technologies in combination with towers located outside of the park was considered. In general, alternative technologies were eliminated from further consideration due to the excessive construction requirements and/or equipment requirements that would be necessary to address the identified coverage gap. Repeaters, in combination with the existing towers, would require numerous tall towers because the repeater must be located in the line of sight from the donor tower. Furthermore, repeaters bring up a capacity issue because the donor tower must be able to accommodate all of the calls in the area in addition to the calls directed to the donor tower from the repeater.

Satellites

Satellite service serves as a complement to wireless and landline phone coverage in remote areas of the globe, such as, deserts, heavy forests, and high seas, where no landline or cell phone service is available.

Verizon Wireless does not currently operate a satellite phone service. It is a very sophisticated, capacity-limited, and expensive technology. Currently there are very few providers of such service. Satellite phone service is reserved for nautical navigation, military operations, and activities in remote areas. Additionally, current available technology for satellite communications does not provide for the Federal Communications Commission E-911 requirements. For these same reasons, satellite technology in conjunction with the existing towers would not be a feasible alternative.

CONCLUSIONS

Rock Creek Park presents a unique set of circumstances for providing cellular coverage in the area due to limited available sites in a heavily populated urban area and the steep, undulating topography of Rock Creek Park.

Based on park visits, drive testing, and extensive propagation analyses, it is clear that Verizon Wireless would not possess the same level of service in the park with any other site when compared to the two existing sites within Rock Creek Park. Each of the existing tower sites is located such that they provide cell coverage to specific valleys and roadways within the park. While the tennis center tower provides reliable coverage along Beach Drive, just south of Military Road, the maintenance yard tower improves Verizon Wireless coverage on Military Road, Broad Branch Road, Ross Drive, and Glover Road. These two cellular telecommunication facilities provide cellular coverage to large sections of the park and its roadways that are not covered adequately without these two sites. In addition, the maintenance yard and the tennis center are the only accessible sites in the park that have acceptable ground elevation.

As discussed above, the alternatives to these two sites were located too far away geographically to provide coverage in the park or were unable to provide the same level of coverage that Verizon Wireless currently enjoys to various sections of the park and its roadways. Alternative methods of providing coverage in the park were also examined. All of the three methods considered – microcells, repeaters and satellites – each pose unique challenges to placement within Rock Creek Park. While microcells and/or repeaters would require scores of microcells and/or repeaters to be placed strategically throughout the park on towers/poles, the coverage obtained from them would not be comparable to that provided by the two existing tower sites. A satellite solution may be able to cover the park, but it would require building earth stations with high dish antennas and it would not be able to support E-911 location functionality.

In conclusion, the two telecommunications facility sites, as currently located, are the best suited for Verizon Wireless coverage in the park and along the major roads of the park.

Evaluation of Coverage and Alternative Sites for the Two Verizon Wireless Towers Located in Rock Creek Park, Washington, DC

Prepared for

City	**Rock Creek Park, Washington, DC**
Site Names	***Tennis Center and Maintenance Yard***
Structure Type	***Monopole Tower***
Report Date	***February 20, 2003***

PREFACE

This report has been commissioned by The Louis Berger Group, Inc. to provide an analysis of the necessity for two Verizon Wireless telecommunications towers located in Rock Creek Park, Washington, DC. Based on inputs provided by Verizon Wireless, Wireless Facilities, Inc. (WFI), a wireless telecommunications consulting firm, independently conducted a drive test for each telecommunication tower, completed propagation studies, and modeled coverage simulations on the towers. In addition, coverage simulations were conducted on multiple location scenarios outside of the Rock Creek Park boundary.

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1. INTRODUCTION

Wireless Facilities, Inc. (WFI) was commissioned by the National Park Service through the Louis Berger Group, Inc. to provide an independent analysis of Verizon Wireless cellular telecommunications coverage needs in the Rock Creek Park area. WFI was contracted to investigate the potential for and location of alternative sites that would provide Verizon Wireless the coverage objectives it currently meets with two cellular telecommunications towers in operation within Rock Creek Park. The coverage area identified by Verizon Wireless constitutes the study area of this report. The area is heavily wooded with steep terrain; the tree cover, foliage, and topography present obstacles to the easy propagation of radio waves. Providing reliable cell phone coverage to such an area is a challenge to cell phone carriers.

To perform a systematic analysis of the radio frequency (RF) and cellular engineering requirements of the identified coverage area in Rock Creek Park, extensive visits to the area were made and information was gathered regarding the terrain, road network, and general coverage objectives. First a study of the existing RF coverage of the area, as provided by the two existing towers was undertaken. To ensure the validity and accuracy of the propagation models and analysis thereof, continuous wave drive testing was performed using the two existing towers as test sites. Based on measurement data collected during drive testing and existing cell site parameters provided by Verizon Wireless, WFI modeled the Verizon Wireless cellular network in and around the coverage area in the park and exhaustively analyzed its overall coverage needs, as well as the individual coverage provided by the two towers. Section 3 of this report discusses and presents an analysis of the existing sites and the existing coverage.

This report considered existing structures outside of the park as potential sites for co-location of the existing towers and sites without existing structures. Propagation studies were performed on alternative locations and various combinations of sites both inside and outside the park to see if an acceptable level of coverage in the Rock Creek Park area could be obtained (a) without the two Rock Creek Park sites, (b) with both of the sites, (c) with each site individually, (d) with individual sites other than the two towers, and (e) a combination of existing sites and an alternative site. The following coverage scenarios are presented herein:

- Coverage simulation of Verizon Wireless network without the two sites
- Coverage simulation of Verizon Wireless network with the two sites
- Coverage simulation of Verizon Wireless network with the tennis center tower only
- Coverage simulation of Verizon Wireless network with the maintenance yard tower only
- Coverage simulation with a cell site located at the National Cathedral
- Coverage simulation with a cell site located on the Hughes Tower located on Peabody Street, between Georgia Avenue and 9th Street
- Coverage simulation with a cell site located at St. Johns College High School
- Coverage simulation with four alternative cell site locations selected to the east and the west of the park

In each of the simulations and propagation studies undertaken, analyses of the park coverage were completed by considering the coverage obtained by each of the sites in combination with the surrounding Verizon Wireless sites in the Rock Creek Park vicinity. As warranted, specific combinations of sites were analyzed together. Figure 1 indicates the location of the existing Verizon Wireless sites (black) and that of the alternative sites considered above (shown in pink).

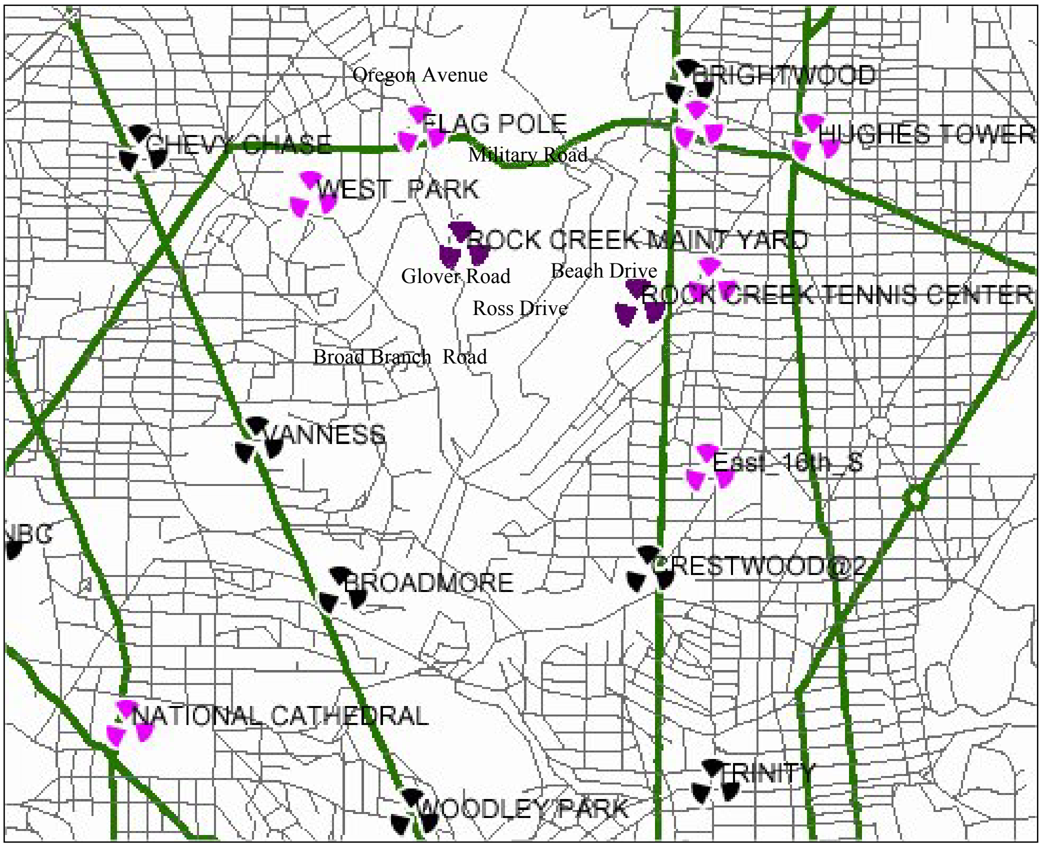

Figure 1: Existing Verizon Wireless Sites and Alternative Sites Considered

■ Alternative sites considered

■ Existing Verizon Wireless facilities within Rock Creek Park

■ Existing Verizon Wireless facilities outside of Rock Creek Park

2. PROCESS

2.1 Drive Test

The drive test data collection was conducted Friday, January 10, 2003 under clear and dry conditions. This usually takes place before a cell site is built and helps determine whether the site will meet the intended coverage objectives. An antenna connected to a RF signal transmitter was attached to the top of each monopole (on the lightning rod) and set to transmit at a frequency provided by Verizon Wireless. Using a RF signal receiver, WFI drove the roads in and around the park collecting the received signal level data. Since all the RF parameters (amplitude, height, antenna gain, and frequency) were matched to Verizon Wireless system parameters, the results of the drive test provide an indication of Verizon Wireless coverage in the Rock Creek Park area.

2.2 Coverage Simulations

The coverage simulations were generated using a prediction tool that simulates the level of coverage provided by a cell site. This tool uses terrain data files, land classification information, signal propagation models, as well as cell site RF parameters to simulate cellular coverage on a map. In addition, data collected during the drive test is used to fine-tune the signal propagation model and increase the level of accuracy. Since the drive test occurred during the winter months, leaves and foliage did not affect the drive testing. Appropriate signal attenuation attributable to tree cover and other vegetation was factored in the signal propagation model. This additional decrease accounts for signal attenuation from leaves and foliage as would be the case during spring and summer seasons.

2.3 Signal Level

To depict drive test results and for the coverage plots provided herein, four colors are used to represent different signal level classes:

- Green: In Building Coverage (0dBm to –75dBm)
- Blue: In Car Coverage (-75dBm to –85dBm)
- Red: On Street Coverage (-85dBm to –100dBm)
- Grey: Insufficient Coverage (-100dBm to –120dBm)

The minimum signal level required in the industry for cell phone coverage is -85dBm (in car) in urban areas. This requirement is the typical signal strength necessary for cell users sitting in their cars in an urban area to successfully complete a phone call, specifically an E-911 call. Signal strength less than -85dBm (red and grey) is not acceptable coverage under the parameters of this study.

2.4. Coverage Simulations for Alternate Site Location

In addition to the study of the two existing Verizon Wireless Rock Creek Park sites, alternative locations were assessed as potential Verizon Wireless cellular sites in lieu of the two Rock Creek sites.

In considering potential alternative sites, care was taken to maintain the basic requirements of a wireless CDMA cellular system, as used by Verizon Wireless. While the immediate objectives of the alternative site(s) are obviously clear – that of obtaining appropriate coverage in the park – RF and cellular engineering requirements of capacity and interference also affect the selection of a cellular site. Hence, while considering the many different existing structures as potential sites, all appropriate RF and cellular engineer criteria were considered in addition to the coverage requirements of the Rock Creek Park area.

Additionally, just as the two Rock Creek sites are an integral part of an overall cellular network, so will be any alternative sites. This implies that while each site has specific requirements that it needs to fulfill, it also has to meet the overall requirements of the network. The various attributes of a site (location, height, antenna type etc.) will govern the coverage and capacity it provides, but these same attributes will also affect the network by influencing the capacity and coverage of the surrounding sites. Hence in selecting any alternative site as a potential candidate for analysis, care was taken to select those that would meet the overall system requirements.

Cell sites in urban areas are often limited in height due to capacity limitations. Cell sites with antennas higher than 100 feet are very rare in urban areas. While Rock Creek Park presents a very heavy terrain and a profusion of trees, it is located in the middle of a very heavily populated urban area. Also, passing through the park are roads that are very well-traveled and these need to be addressed in the capacity.

Given the foliage of the park, the signal from a cell site with antennas mounted at 100 feet placed in the park will not be sufficient to penetrate through the trees. In heavy foliage areas, wireless carriers need to place their cell site at about 40 to 60 feet above the tree line. However, if a site were to be higher than required, its coverage would interfere with that of the surrounding sites. Also, capacity provisioning of the surrounding sites would be affected.

Hence an appropriate candidate for analysis as an alternate site would have to be in the vicinity of 130 feet. The exact height would be determined based on the location. For that reason, the simulation of coverage from alternative cell sites was conducted with antennas mounted at 130 feet.

3. SITE LOCATION STUDY

3.1. Verizon Wireless Coverage without the Rock Creek Park Towers

The following coverage simulation plot shows Verizon Wireless coverage in the Rock Creek Park area without the two sites located in the park (Figure 2). It is possible to locate the following Verizon Wireless coverage problems:

- very weak coverage along Beach Drive;
- very weak coverage on Military Road;
- very weak coverage along Broad Branch Road;
- very weak coverage north of Military Road, between Oregon Avenue and Beach Drive;
- very weak coverage along Ross Drive, south of Military Road; and
- very weak coverage between Ridge Road and Beach Drive south of Military Road.

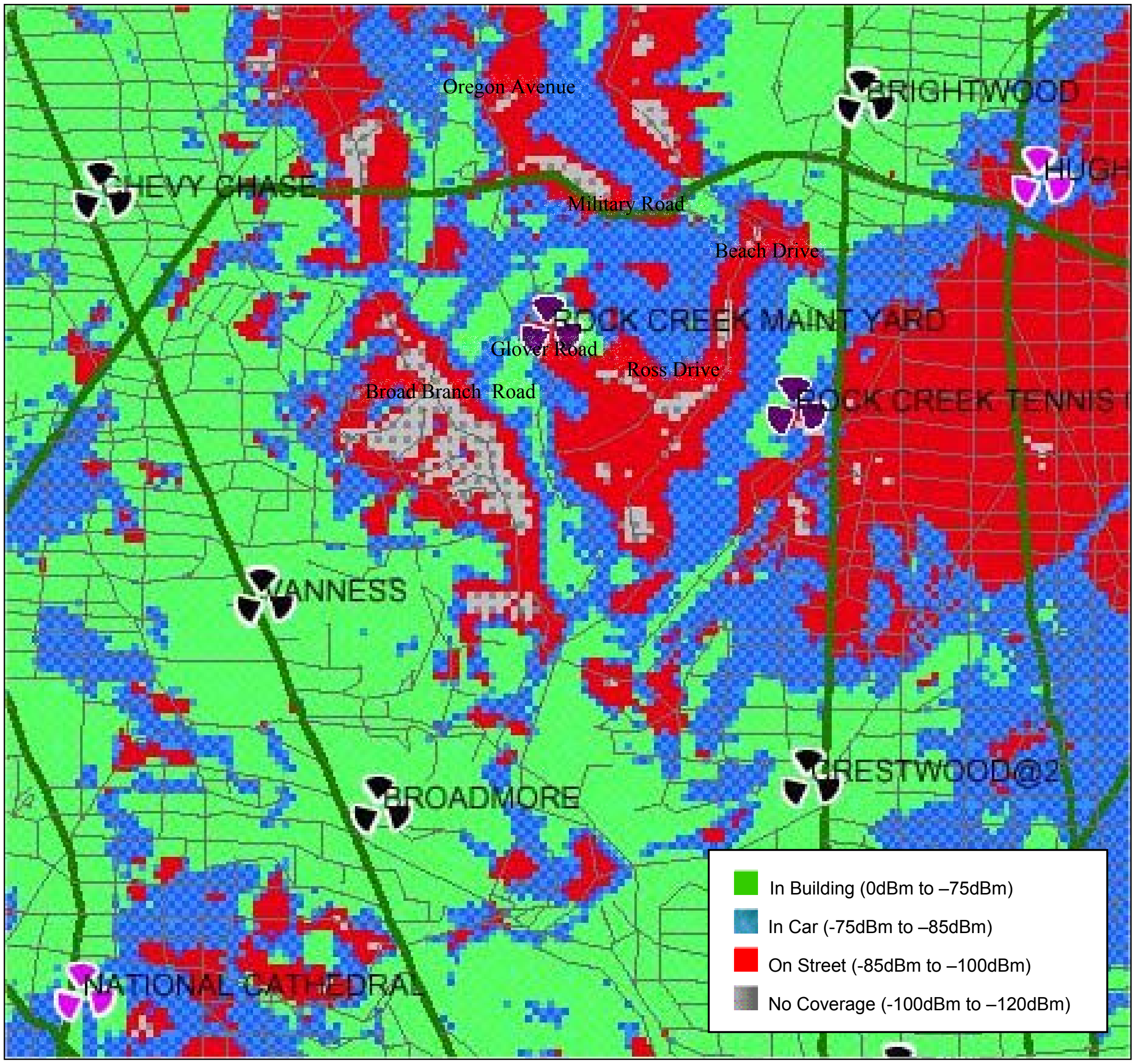

Figure 2: Coverage Simulation – Verizon Wireless Network without the Two Park Sites

In addition to good received signal strength, the CDMA technology (used by Verizon Wireless) requires that a stable and consistent cell site "server" be available for the cell phone. This is called the "best server." Figure 3 below shows that, without the two towers, the signal from several remote Verizon Wireless sites is received at a very low level in the park. Consequently, there is not a dominant server (best server) in many areas of the park. Without a best server, as indicated in Figure 3 by the lack of clear breaks between each separate tower (indicated by color), dropped cell phone calls and cell phone call origination failures are more prevalent. The best way to avoid this situation in a particular area is to have a strong dominant server able to significantly rise above other weak servers, thus allowing successful cell phone call originations and good cell phone call quality.

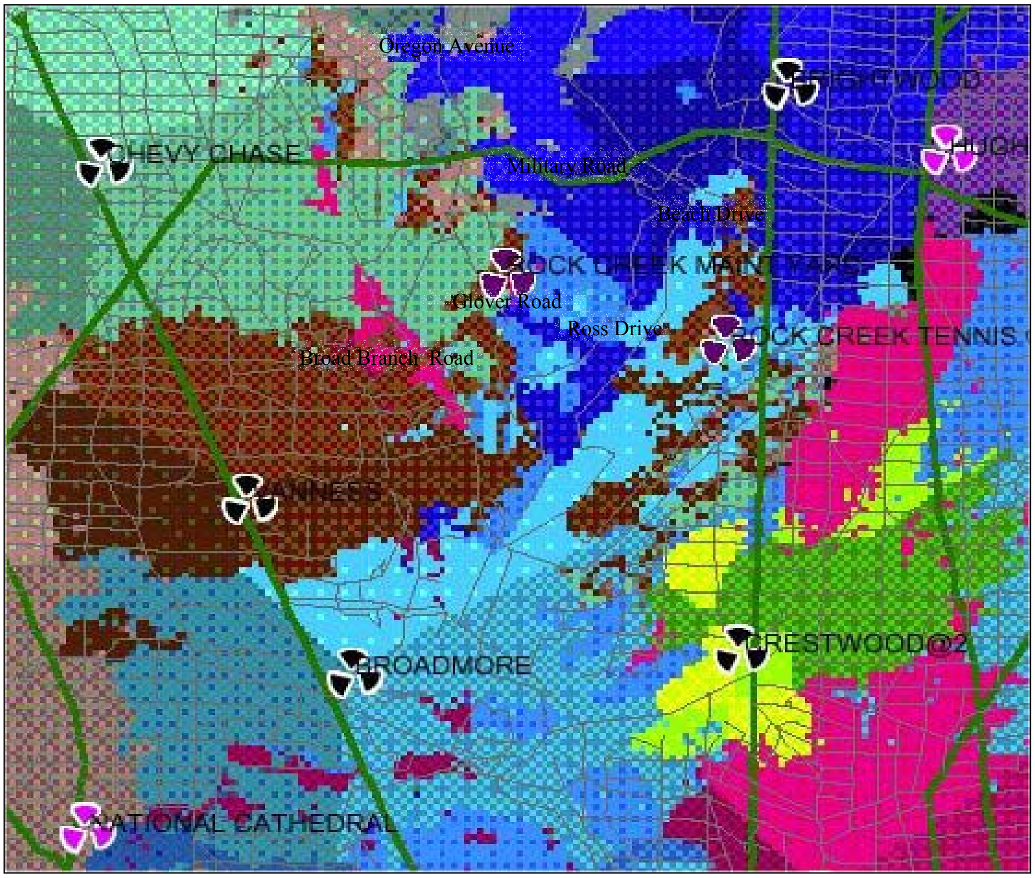

Figure 3: Best Server Plot – Without the Two Towers

3.2. The Tennis Center Site

3.2.1. Drive Test

A drive test was conducted for the tennis center site at a height of approximately 102 feet. Figure 4 indicates that the tennis center site provides excellent coverage to the east of 16th Street, but most importantly provides coverage on Beach Drive, south of Military Road. This area, which sits in one of the Rock Creek Park's valleys, is difficult to cover. The best way to cover this type of geographical area is to place a cell site as close as possible to the valley. The farther the site is from the cliff's edge, the higher the site will have to be in order to be able to cover the valley. The drive test data shown in Figure 4 does not account for foliage, as the drive test was conducted during the winter season.

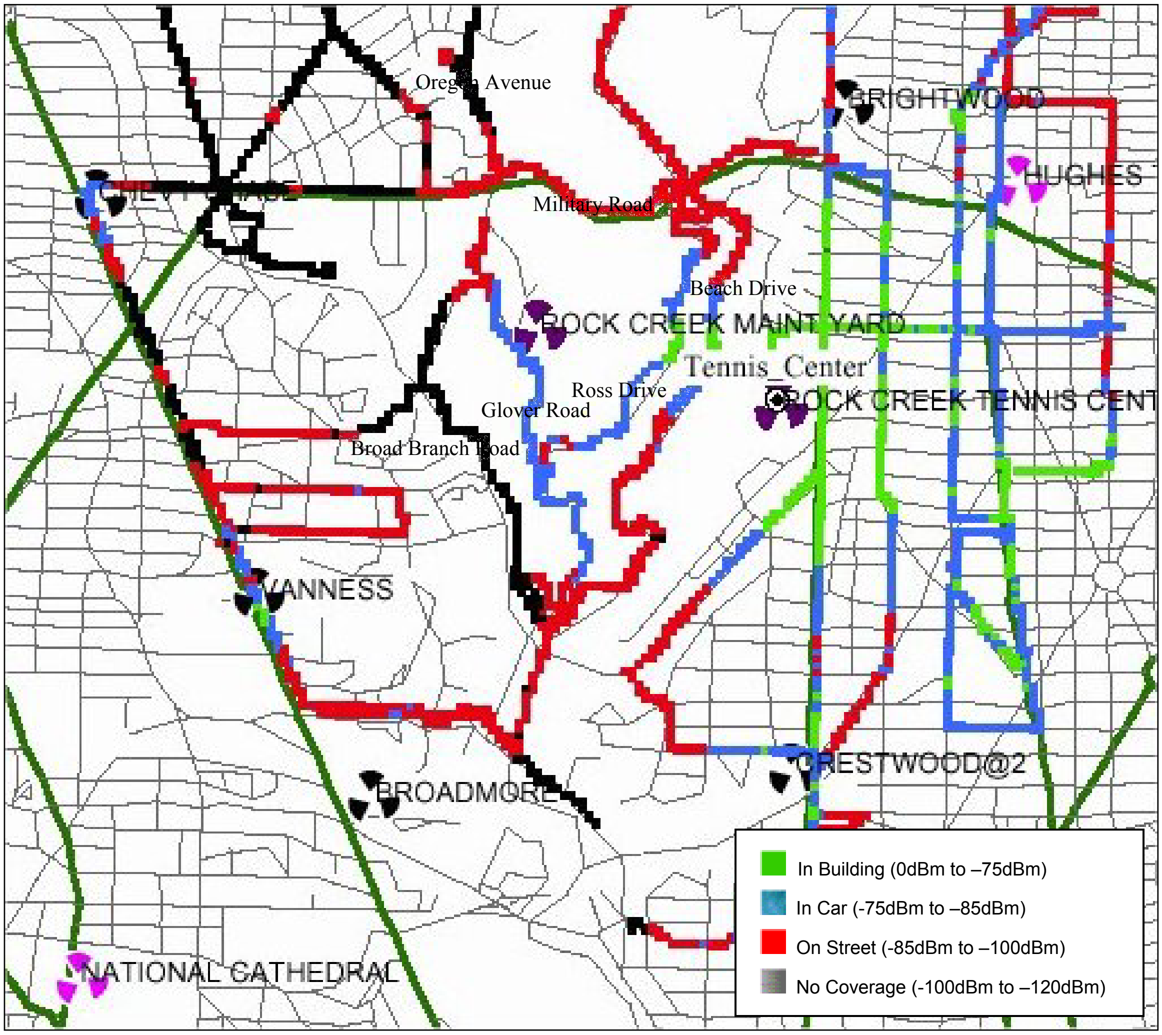

Figure 4: Drive Test Results – Tennis Center Site

3.2.2. Coverage Simulation

After the drive test, the data collected was used to model and simulate the tennis center tower's coverage. The coverage from the simulation is very close to that of the drive test, and shows that the tennis center tower, being the closest site to Beach Drive provides sufficient coverage to the area (Figures 5 and 6). Additionally, Ross Drive and Glover Road are also provided good coverage from the tennis center tower, unlike Military Road.

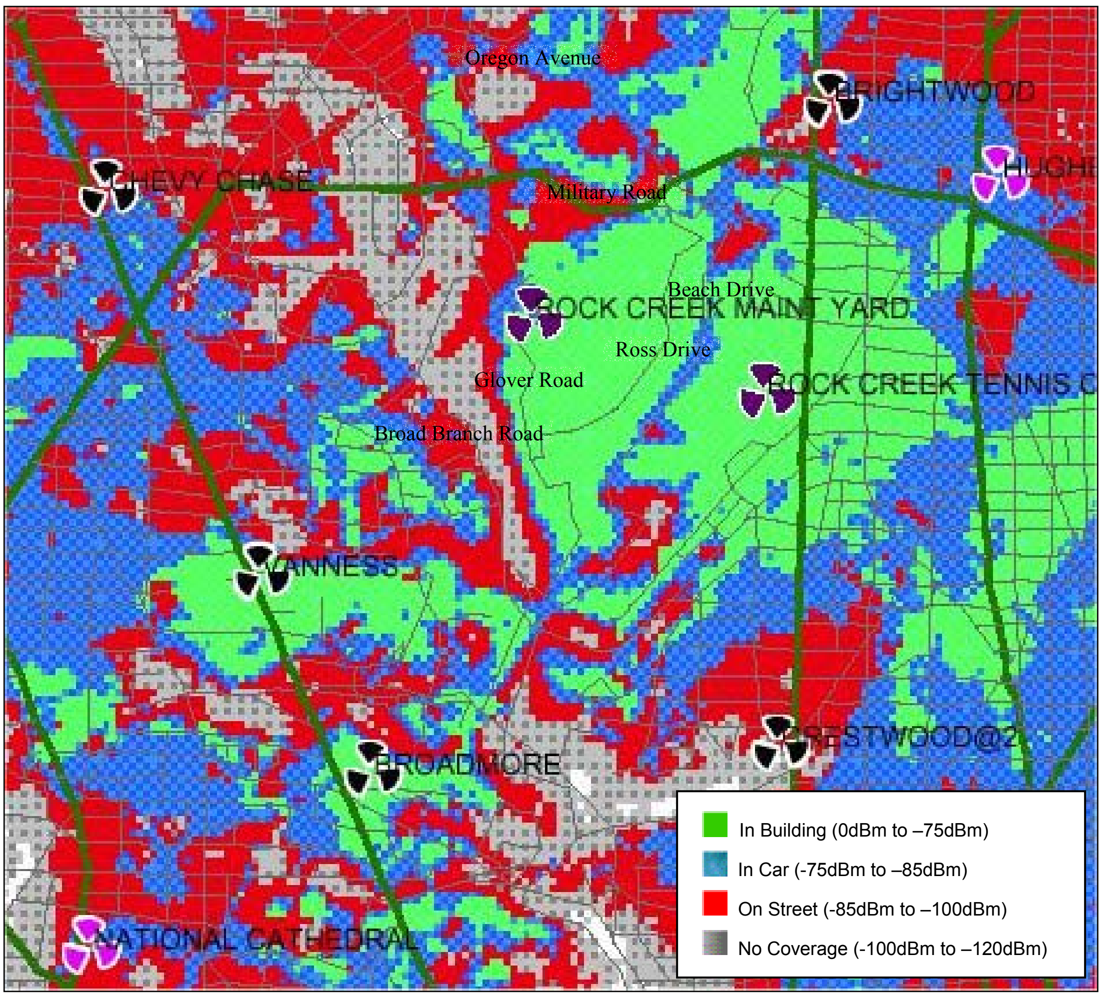

Figure 5: Coverage Simulation – Tennis Center Site

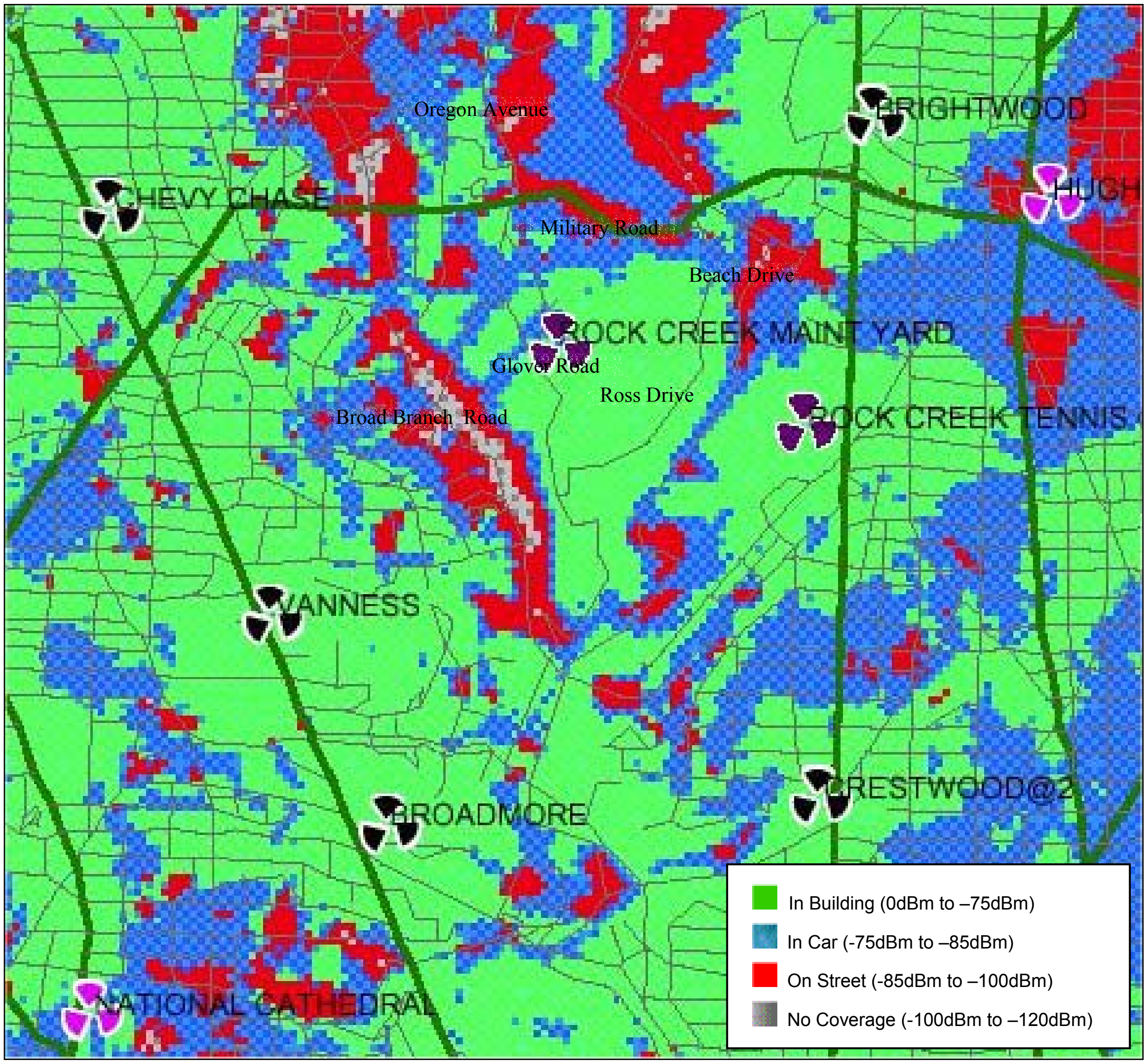

Figure 6: Coverage Simulation – Tennis Center Site and Other Verizon Wireless Sites (Maintenance Yard Site not included in the simulation)

3.3. The Maintenance Yard Site

3.3.1 Drive Test

A drive test was conducted for the maintenance yard tower at a height of approximately 134 feet. Since the data collected outside the park from the tennis center tower had already provided general signal propagation characteristics of the area outside the park, we decided to collect the drive test data from the maintenance yard tower only on the roadways located in the park.

The maintenance yard tower improves Verizon Wireless coverage along Ross Drive, Military Road, and part of Broad Branch Road, but not along Beach Drive, just south of Military Road. This can be explained by the fact that the dip in the terrain and the tree cover prohibit the signal from the maintenance yard tower from reaching the Beach Drive valley, which is the deepest valley in the area. The drive test data shown in Figure 7 does not account for foliage, as the drive test was conducted during the winter season.

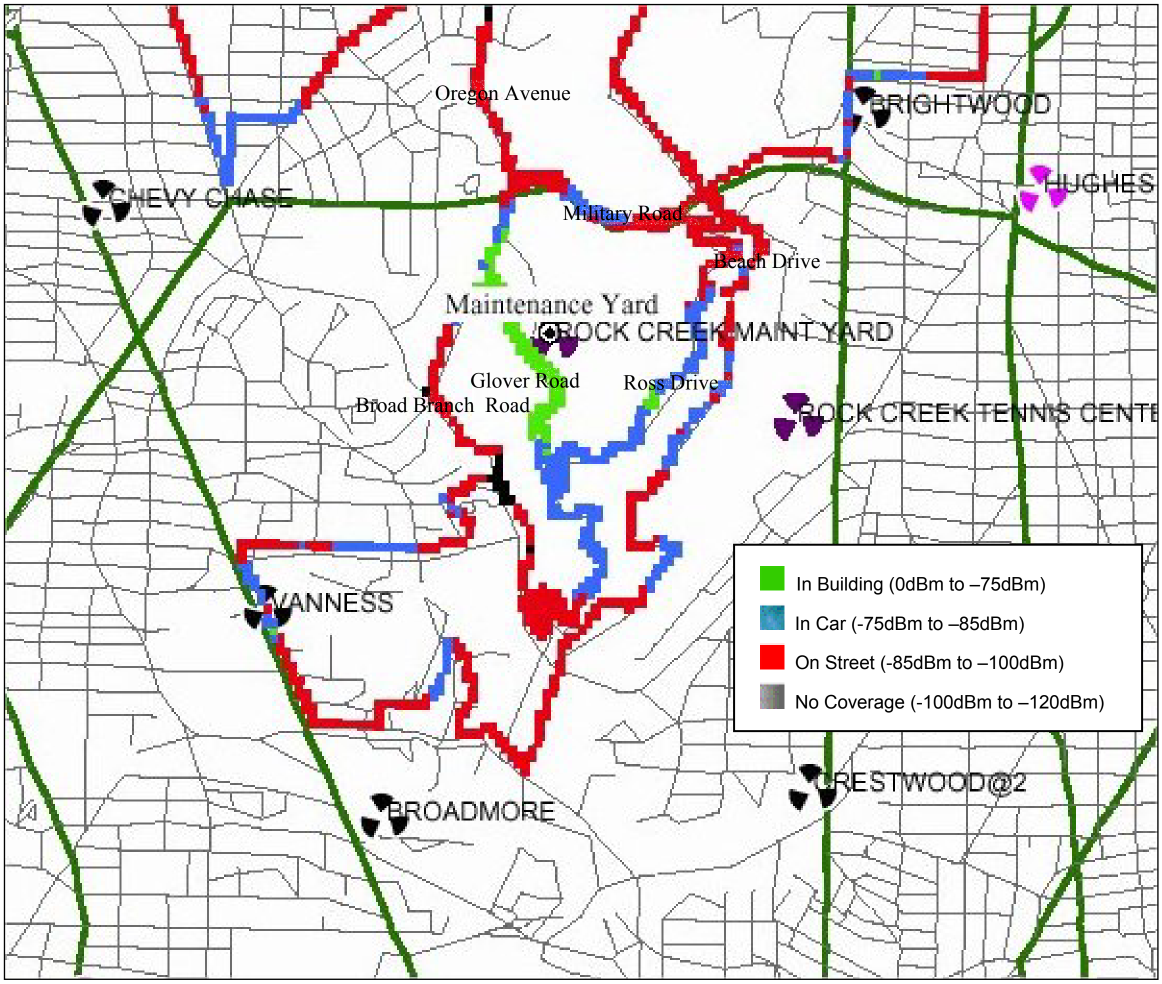

Figure 7: Drive Test Result – Maintenance Yard Site

3.3.1 Coverage Simulation

The data collected during the maintenance yard tower drive test was used to model and simulate the site's coverage. The simulations indicate that the maintenance yard tower provides good coverage to Military Road, Ross Drive, and Ridge Road (Figures 8 and 9). Also, the site provides acceptable coverage to the north part of Beach Drive and Broad Branch.

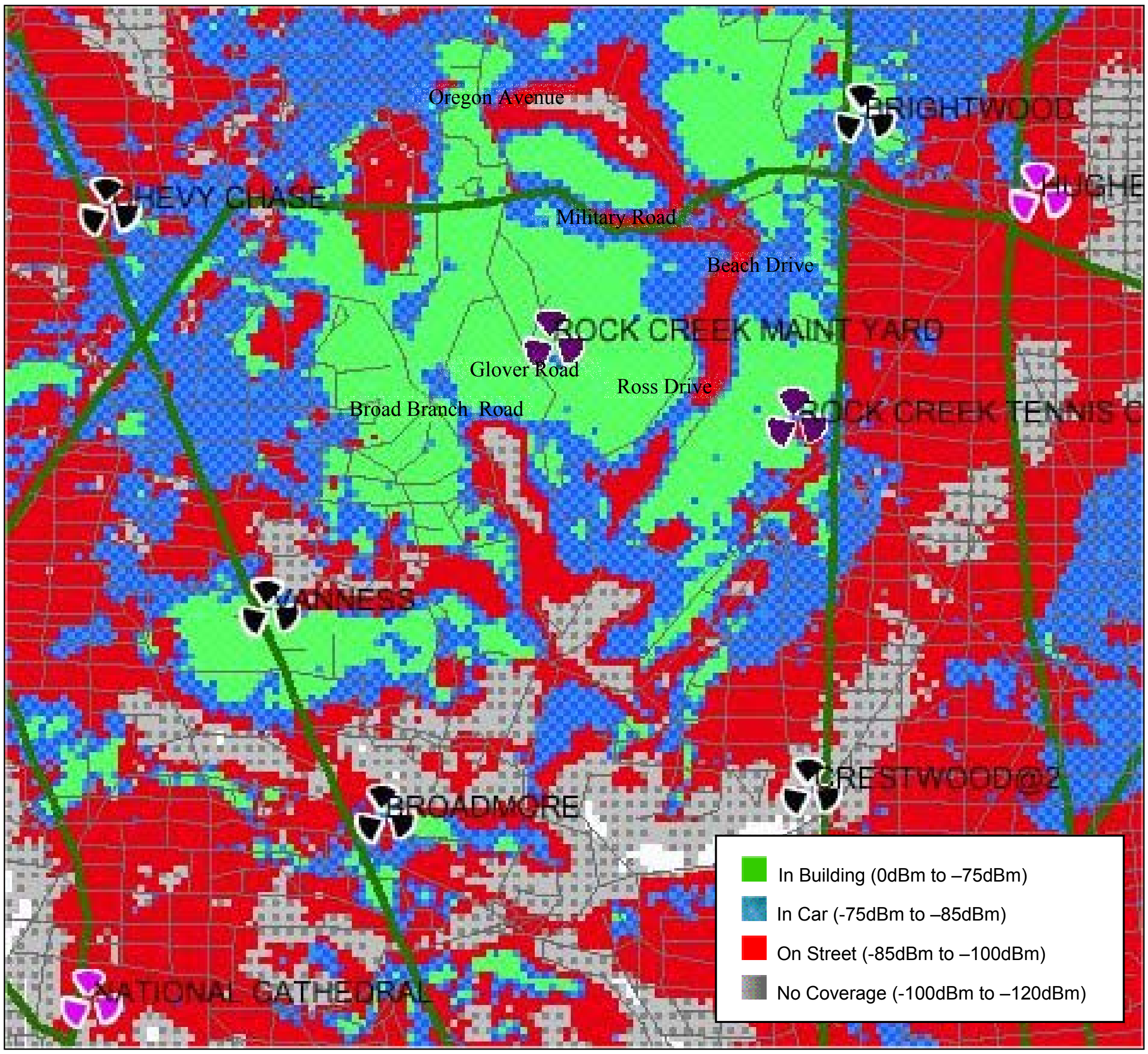

Figure 8: Coverage Simulation – Maintenance Yard Site

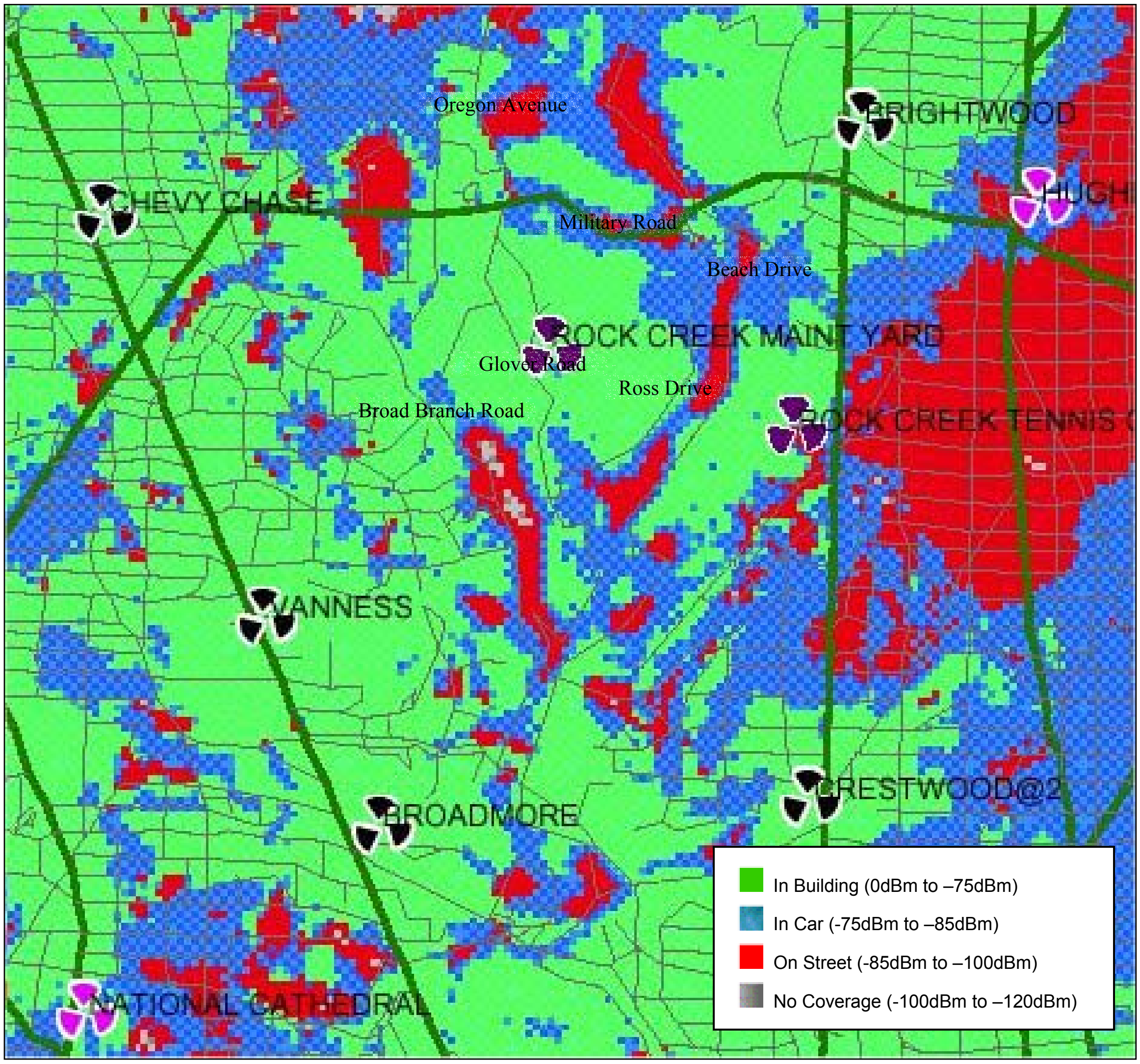

Figure 9: Coverage Simulation – Maintenance Yard Site and Other Verizon Wireless Sites (Tennis Center Site not included in the simulation)

3.4. Verizon Wireless Coverage with the Two Rock Creek Park Sites

Figures 10 and 11 show that by combining the two sites, Verizon Wireless has significantly improved its coverage in the park. As a result, the amount of green and blue areas – areas with acceptable coverage for a CDMA cellular system in urban areas – has significantly improved. Beach Drive, Ross Drive, Military Road, and Ridge Road are all under good coverage while Broad Branch has acceptable coverage.

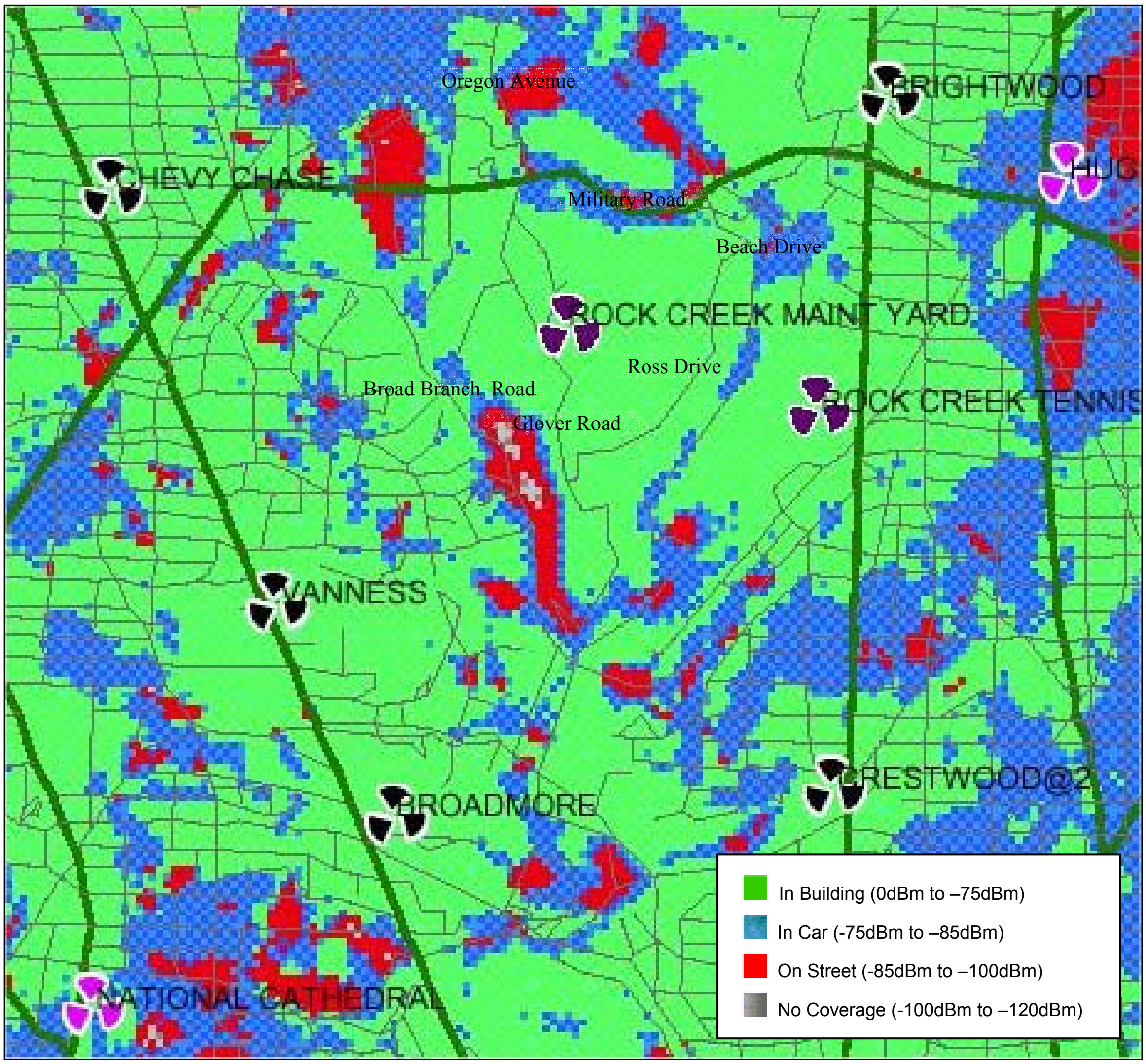

Figure 10: Coverage Simulation – All Verizon Wireless Sites in the Park Area

Figure 11 shows clearly that there will be less confusion as to what site is the best server in most areas of the park with the two Rock Creek Park sites operating. In most places, the dominant server is consistent and strong. This would lead to mobile phone being able to find and “lock” in on sites, leading to fewer drop calls and call origination failures. The best server plot also points to the fact that RF interference in the park is much reduced due to the presence of a strong dominant server.

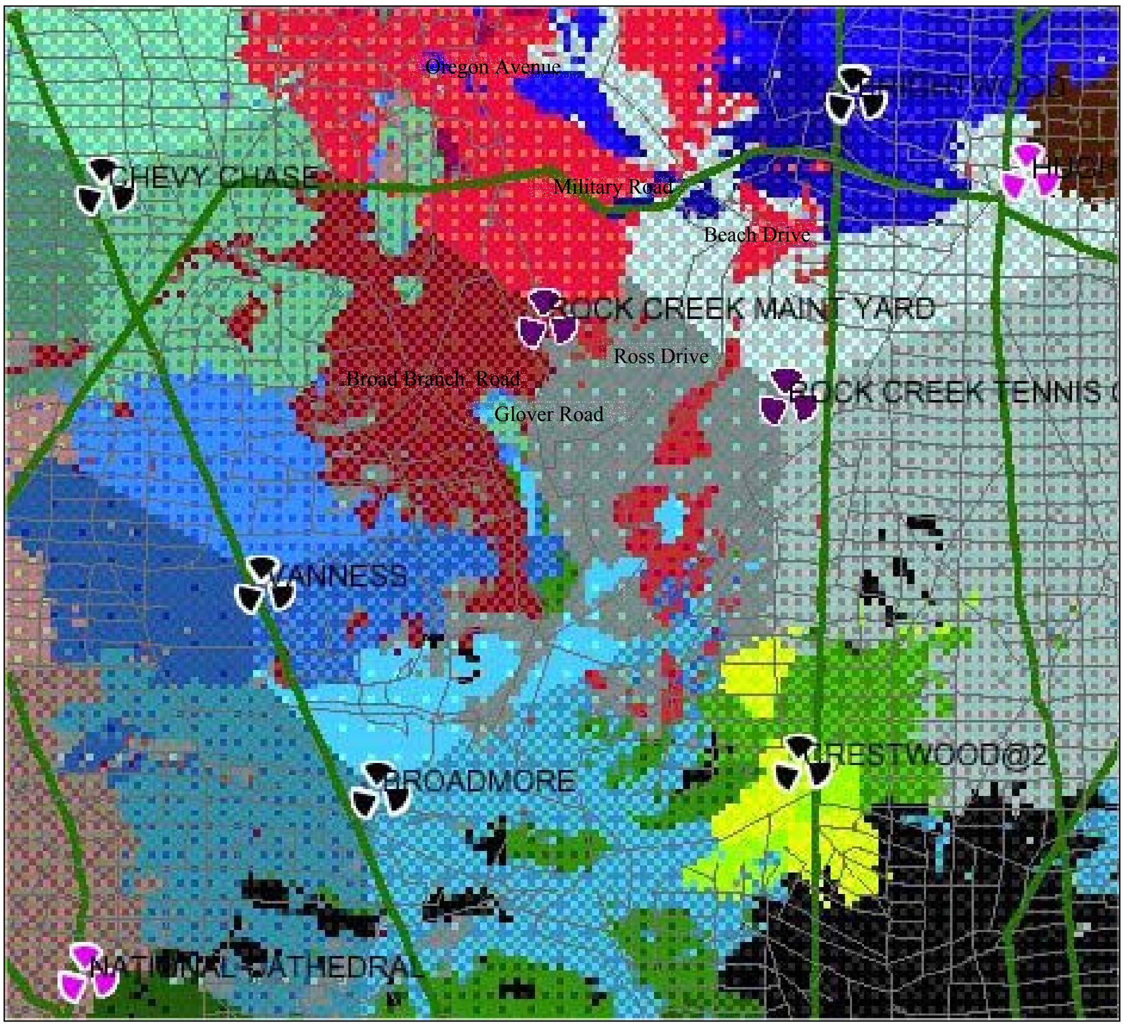

Figure 11: Best Server Plot – All Verizon Wireless Sites in the Park Area

4. ALTERNATIVE SITES

During WFI's study of the Rock Creek Park area, we visited the park and its surrounding area several times and queried our National Structure Database to locate any other existing structure that would allow Verizon Wireless to achieve adequate coverage in the park area without using the two towers. We looked for buildings, water towers and tanks, existing towers, chimneys, etc., that would be able to meet the various RF engineering and cellular engineering requirements as discussed in section 2.4 of this report. We identified the following alternative sites:

- The Hughes Tower
- The Washington National Cathedral
- St. Johns College High School
- Site at Military Road and Jocelyn Street
- Site at 16th Street and Military Road
- Site at 16^{th} Street and Kennedy Street
- Site at 16^{th} Street and Allison Street

4.1 The Hughes Tower

The Hughes Tower, located on Peabody Street between 9th Street and Georgia Avenue, has enough height and ground elevation to achieve adequate coverage; however, that tower is located too far away from the area needing coverage, and the tree cover and changes in the terrain would prohibit any wireless phone antenna mounted on the tower to reach Rock Creek Park's deep valley floors. Figures 12 and 13 model the coverage from a full-blown cell site with antennas mounted at 150 feet on the Hughes Tower. It shows that the signal not only would skip the park's valley, but also would create interference to other Verizon Wireless sites.

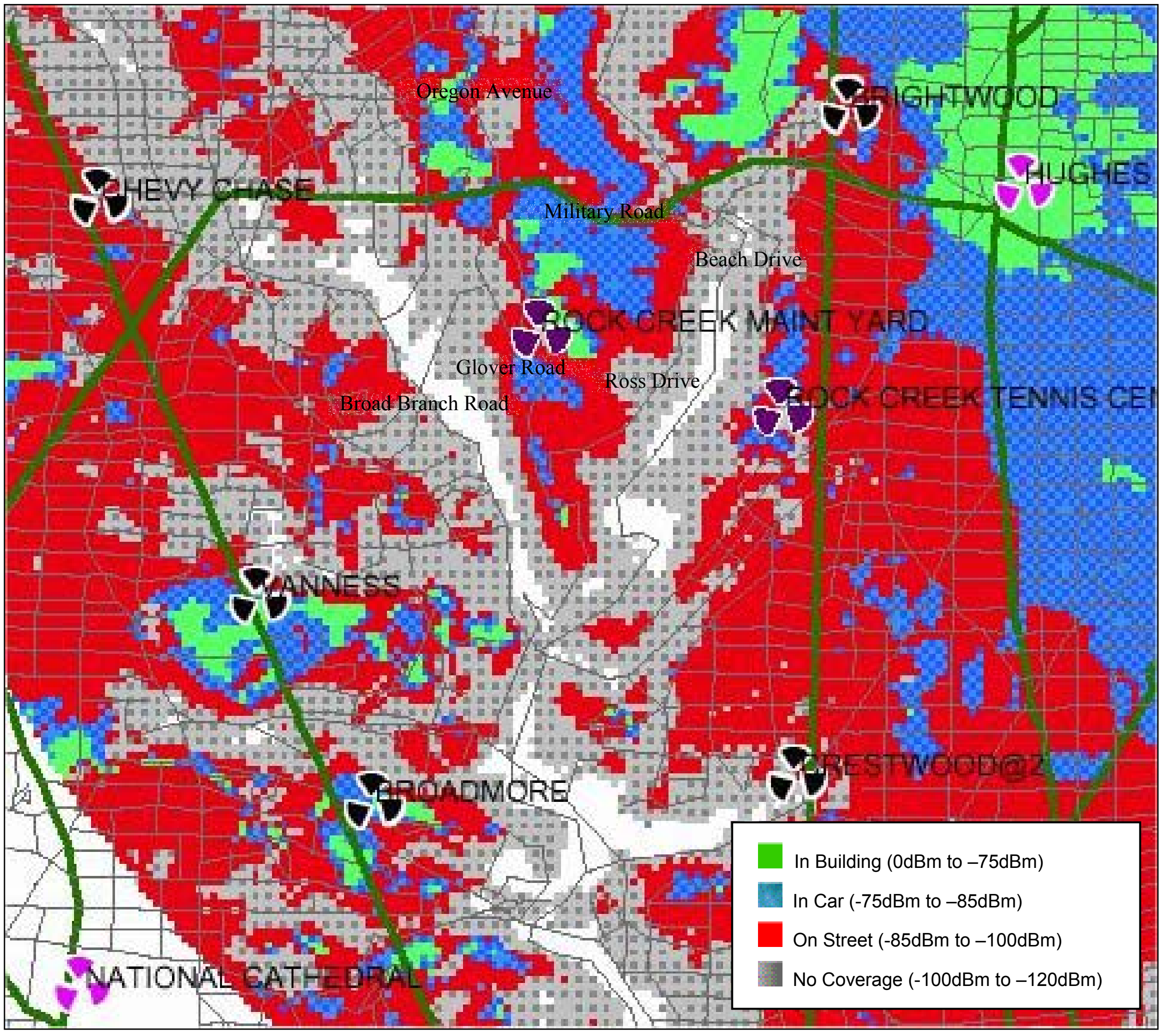

Figure 12: Coverage Simulation – The Hughes Tower Site Only

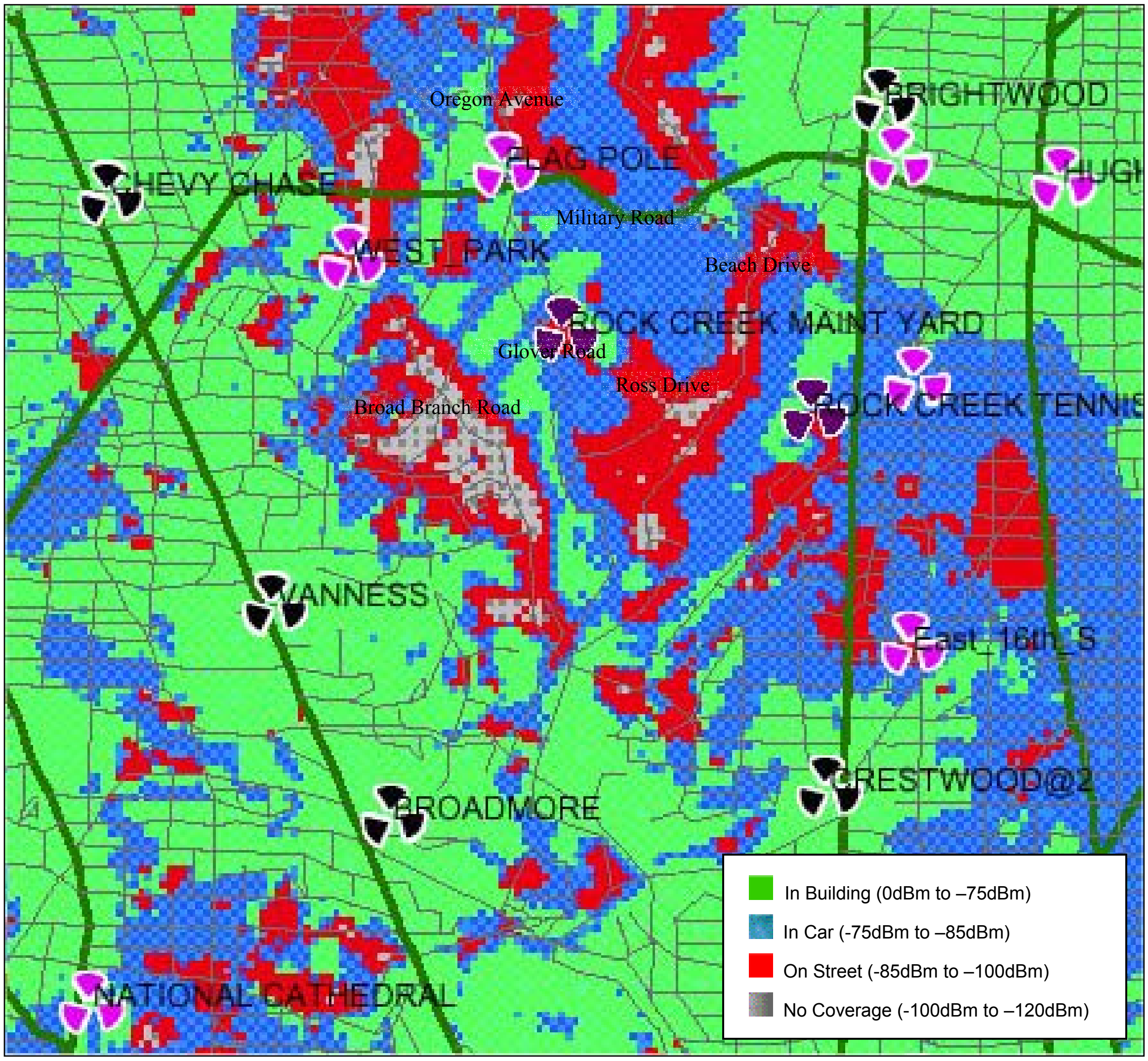

Figure 13: Coverage Simulation – The Hughes Tower with Other Verizon Wireless Sites

4.2 The Washington National Cathedral

The Washington National Cathedral site is located at approximately 2.5 miles southwest of Military Road. A reliable wireless signal cannot be carried from that location into the Rock Creek Park areas needing coverage, because of the tree cover and the steep terrain. Figures 14 and 15 model the coverage from a full-blown cell site with antennas mounted at 120 feet on the National Cathedral. This site would not cover the Rock Creek Park area.

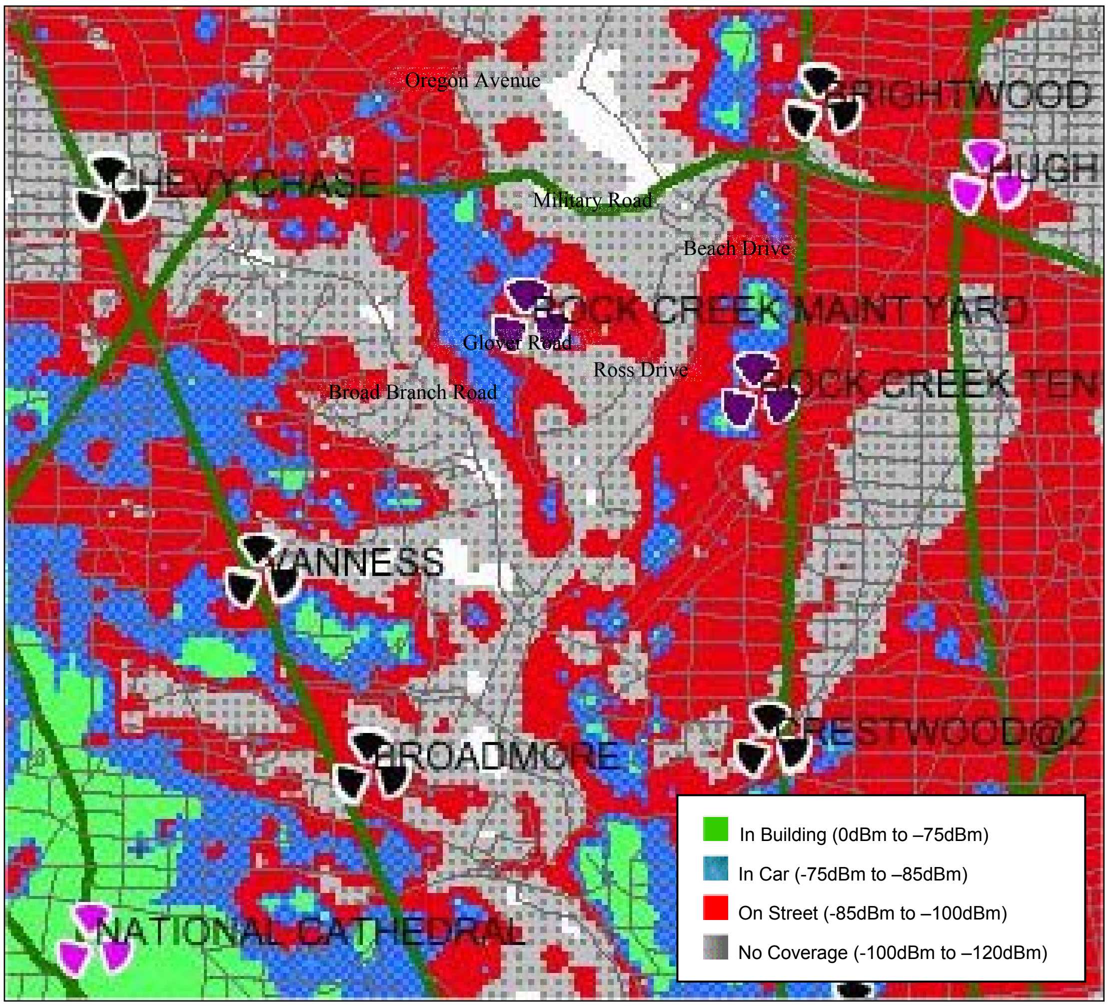

Figure 14: Coverage Simulation – The Washington National Cathedral Site Only

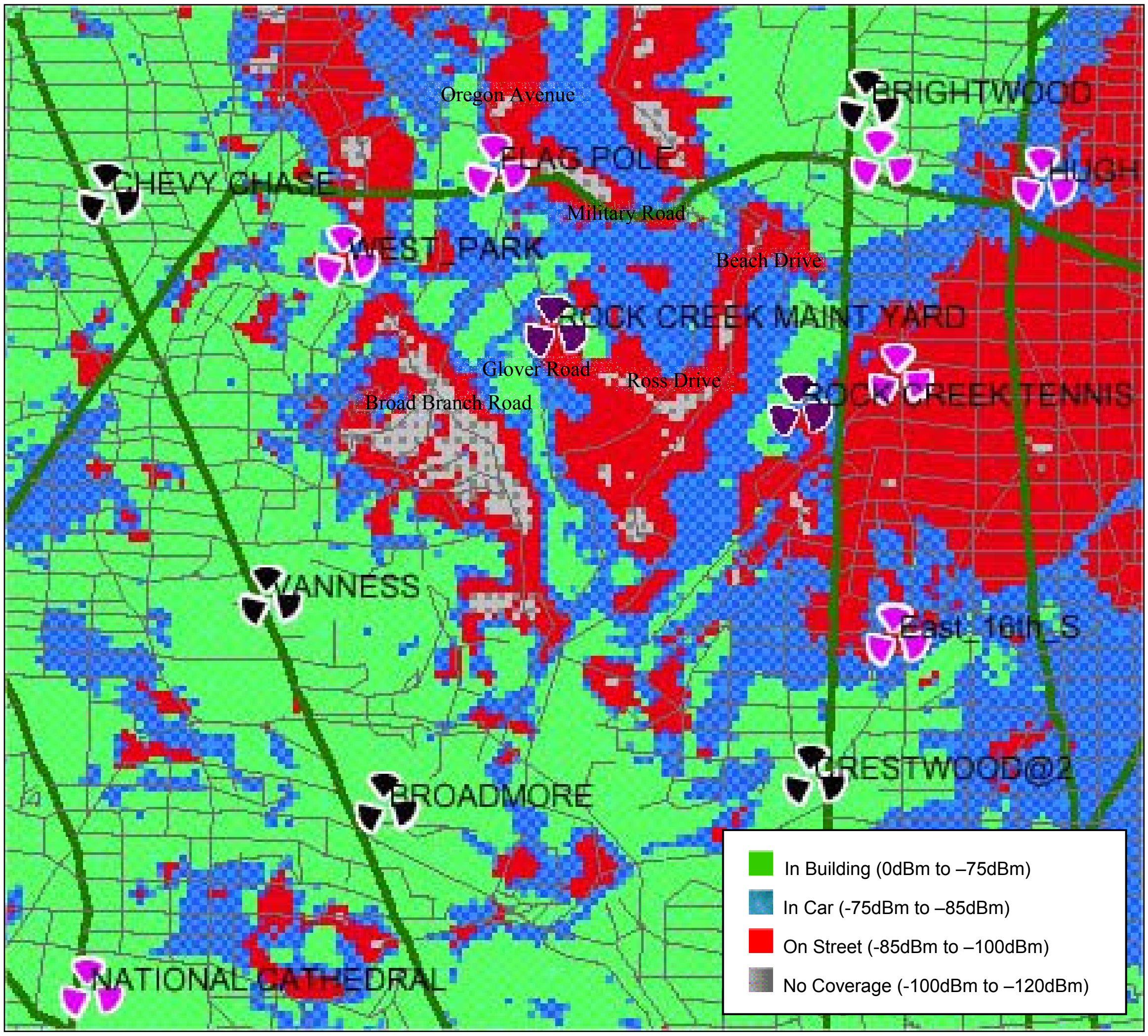

Figure 15: Coverage Simulation – The Washington National Cathedral with Other Verizon Wireless Sites

4.3. St. Johns College High School

At St. Johns College High School, a flag pole near Military Road and Oregon Avenue was evaluated as a potential site. Unlike the previous two sites, the flag pole is located closer to the park area. This site, though better located, does not have the ground elevation necessary to qualify as a good cell site. As a result of this, it is not capable of covering the area near Beach Drive. Monopoles were evaluated at varying heights between 130 and 240 feet. Figures 16 and 17 illustrate that this site does not have sufficient height to overcome the hilly terrain and trees to its south. This site expands Verizon Wireless coverage on Military Road and to the area north of Military Road but provides no coverage at all to the park area located south of Military Road.

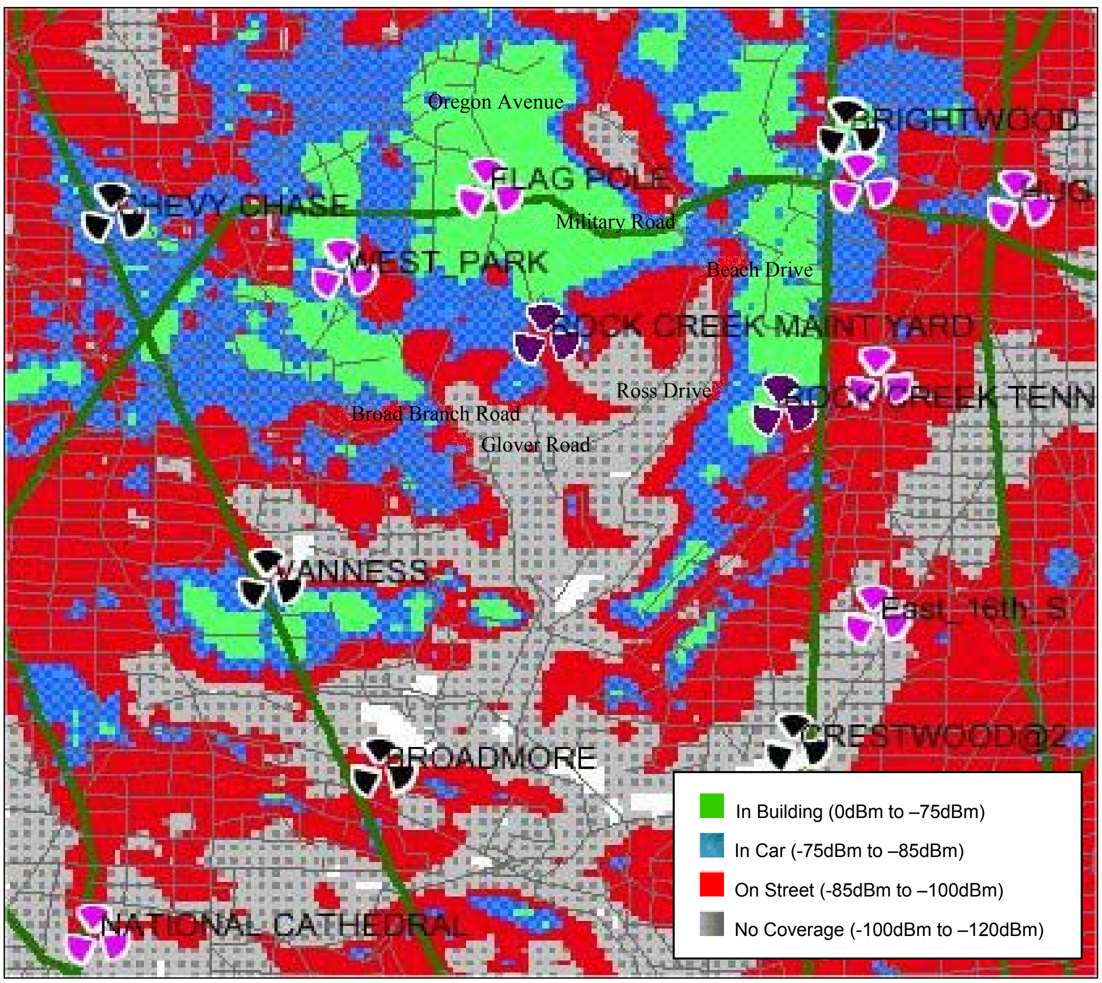

Figure 16: Coverage Simulation – St. Johns College High School Site Only

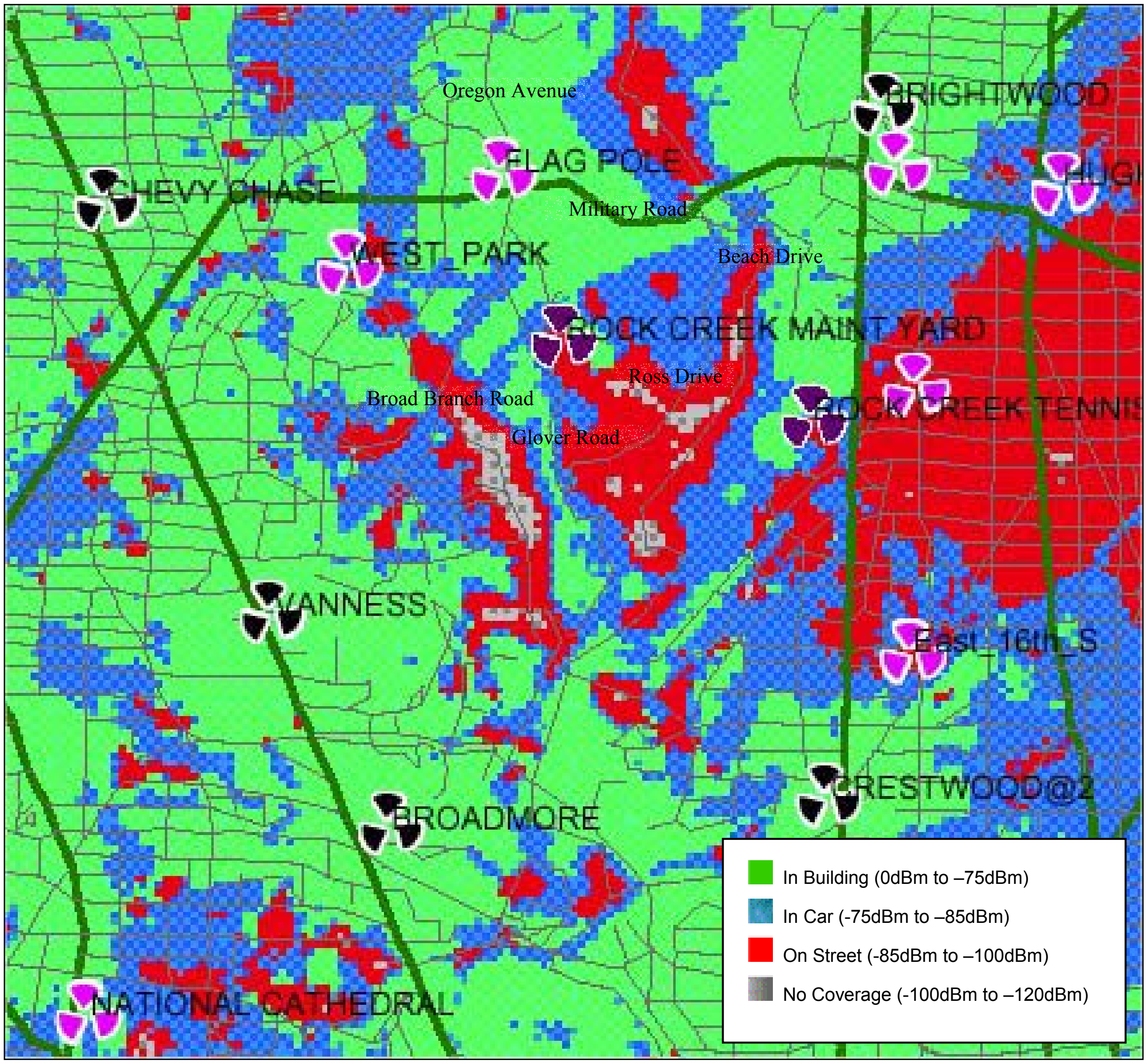

Figure 17: Coverage Simulation – St. Johns College High School with Other Verizon Wireless Sites

4.4 Other Sites

In addition to the above-mentioned sites, WFI was able to identify four sites with acceptable ground elevation just outside the park. One of these sites is located to the west of the park, and the three remaining are to the east of the park. To determine whether these sites could help Verizon Wireless achieve adequate coverage in the park, WFI ran coverage simulations and created propagation models for these sites. The simulations were created for a full-blown cell site with antennas mounted at 130 feet. The resulting coverage simulation plots show that none of the four sites are able to cover the valley floors of the park (Figures 18-25). Since the critical roads in the park–Beach Drive and Broad Branch Road–are located along the valleys, these roads would essentially be without coverage from these alternative sites, which also interfere with other Verizon Wireless sites. Based on these results, WFI concluded that if a cell site were placed in these locations to the east or to the west of the park, coverage in the park would not meet the coverage area currently provided by the two existing towers in Rock Creek Park.

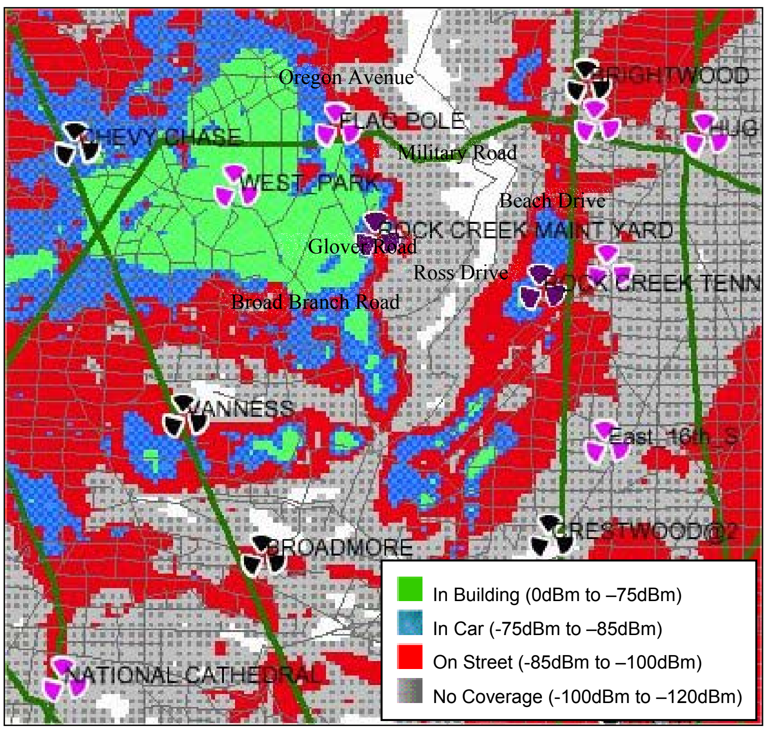

Figure 18: Coverage Simulation – Military Road and Jocelyn Street Site Only

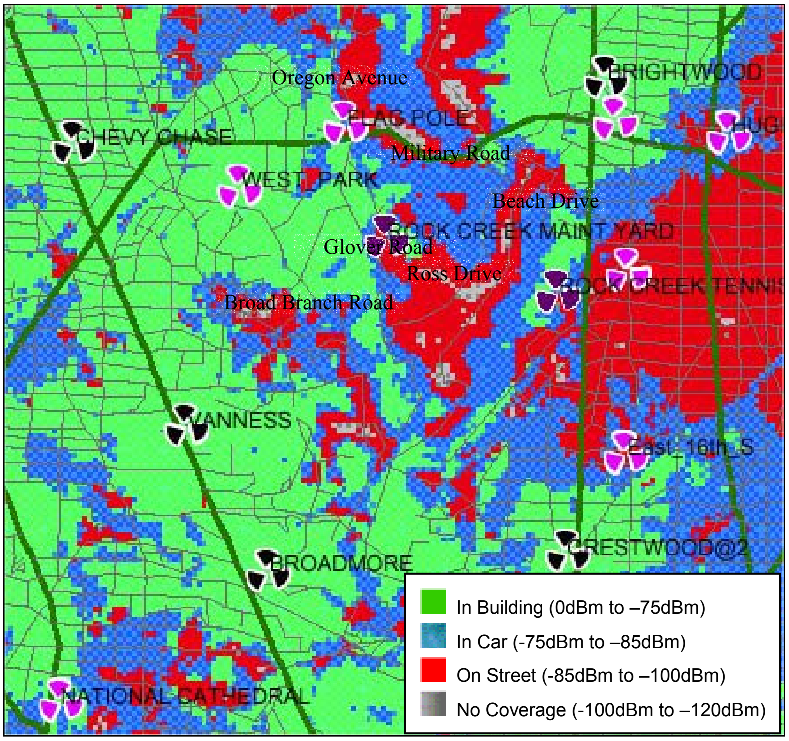

Figure 19: Coverage Simulation – Military Road and Jocelyn Street with Other Verizon Wireless Sites

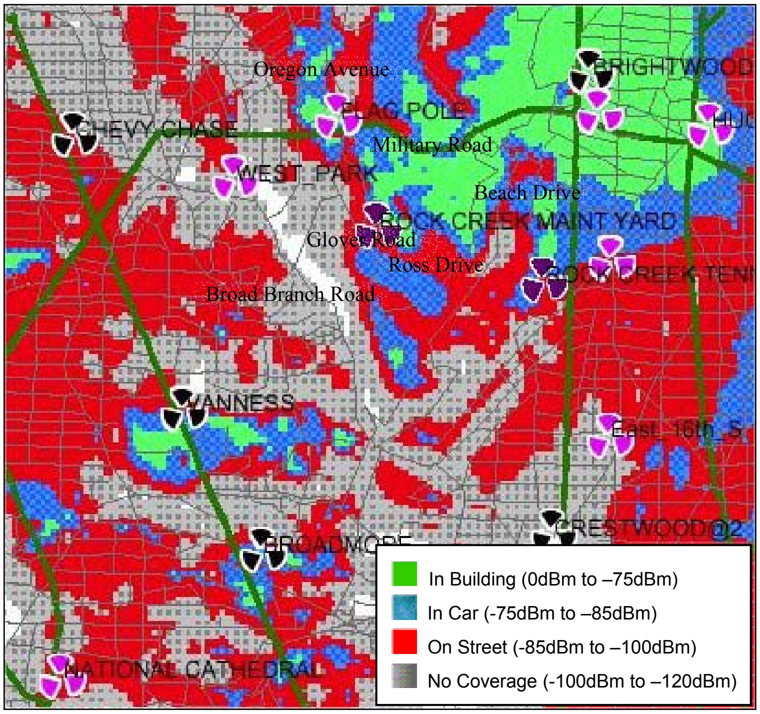

Figure 20: Coverage Simulation –16th Street and Military Road Site Only

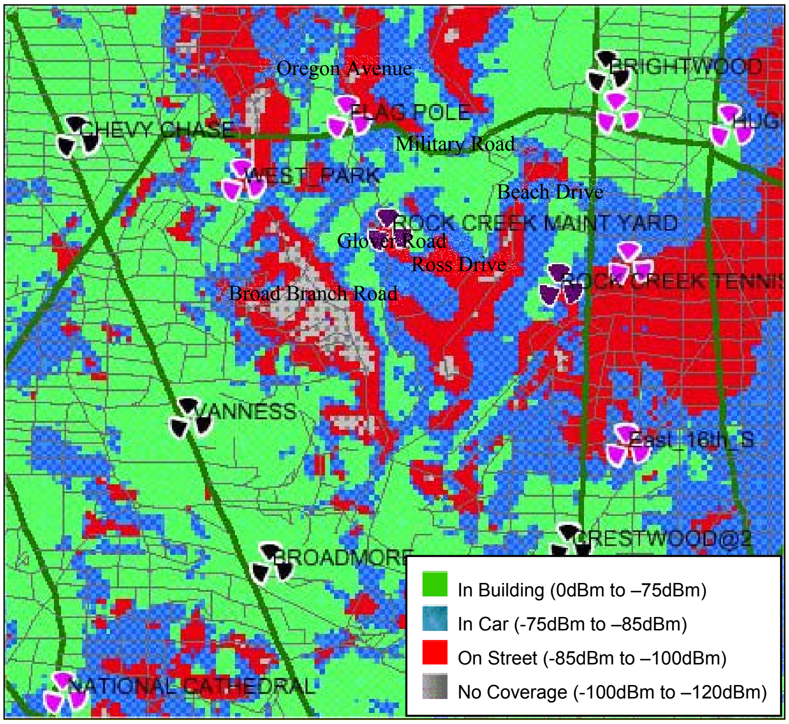

Figure 21: Coverage Simulation –16th Street and Military Road with Other Verizon Wireless Sites

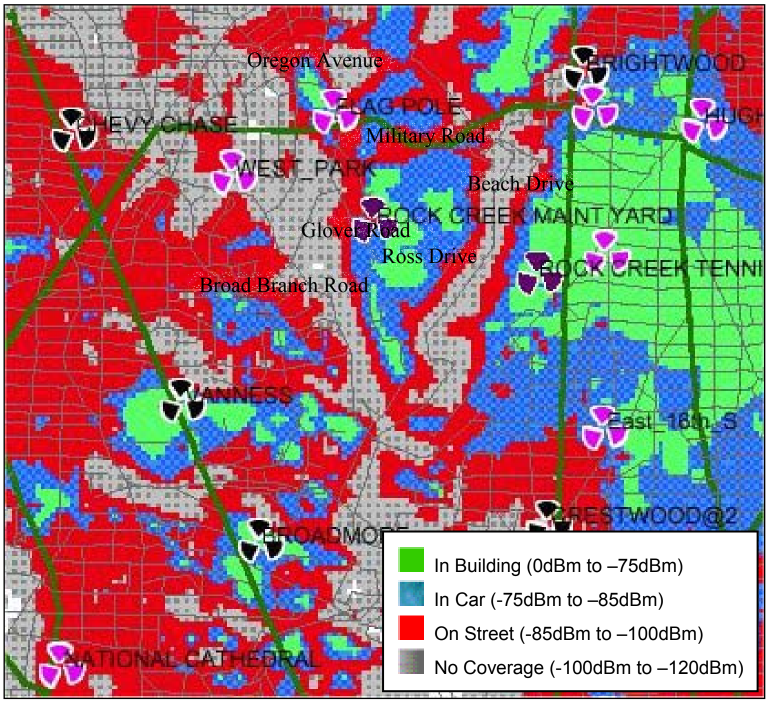

Figure 22: Coverage Simulation –16th Street and Kennedy Street Site Only

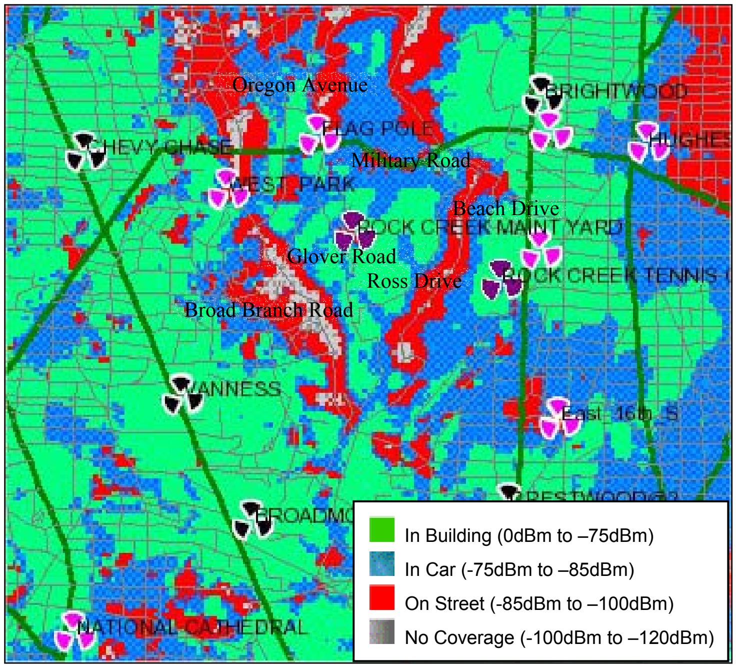

Figure 23: Coverage Simulation – 16th Street and Kennedy Street with Other Verizon Wireless Sites

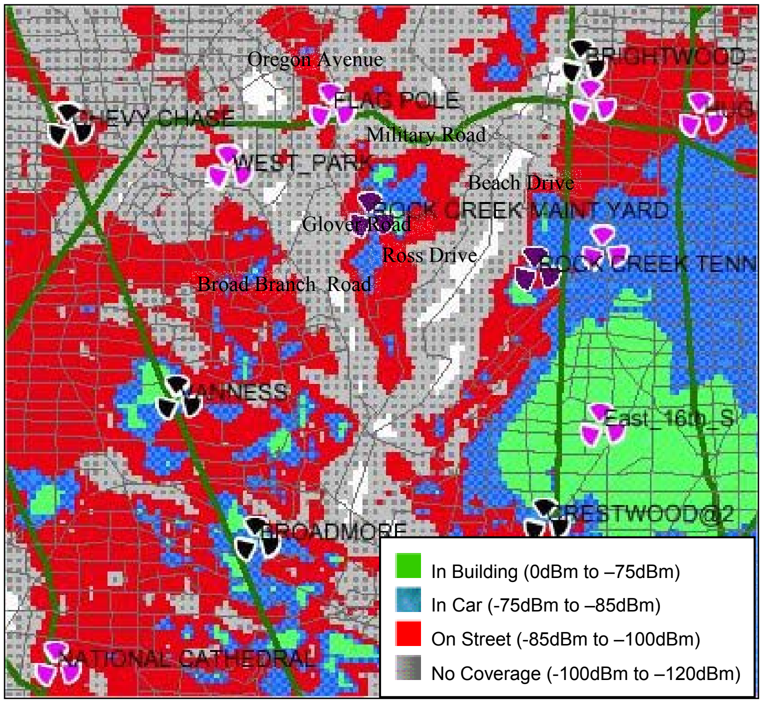

Figure 24: Coverage Simulation –16th Street and Allison Street Site Only

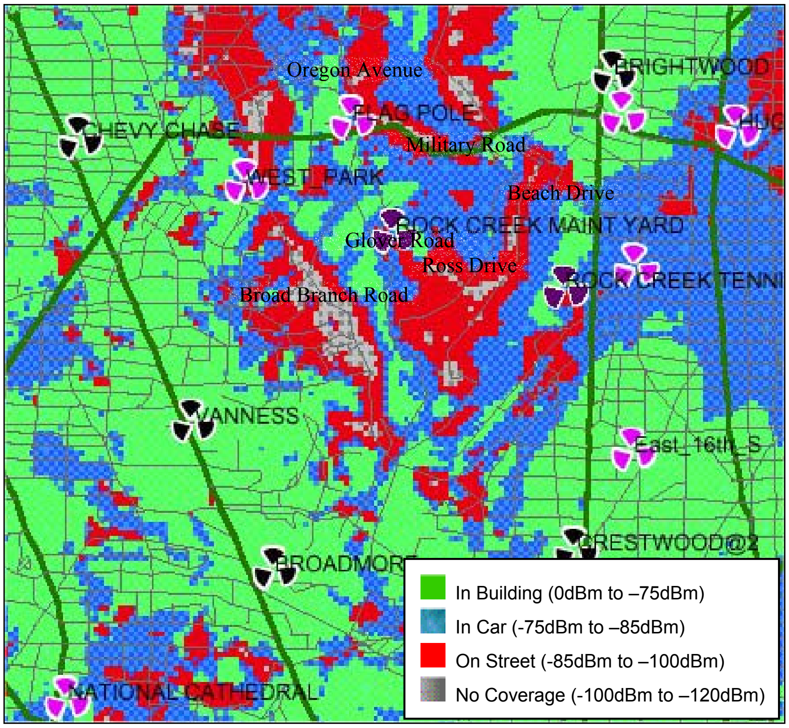

Figure 25: Coverage Simulation – 16th Street and Allison Street with Other Verizon Wireless Sites

4.5. Combinations of a Site inside the Park with a Site outside the Park

Combinations of a site inside the park with a site outside the park were also considered. Because of distance constraints, the only feasible sites for such a combination are: St. Johns College High School, Military Road and Jocelyn Street, and 16th Street and Kennedy Street. We performed coverage simulations created propagation models on these combinations.

4.5.1 Combination of the Tennis Center and St. Johns College High School

Figure 26 shows the coverage that would result from the combination of the tennis center tower, the St. Johns College High School site, and Verizon Wireless sites around the park area. It shows that such a combination would not be able to provide coverage on Broad Branch Road. This combination of sites also would weaken the coverage on the southern tip of Beach Drive.

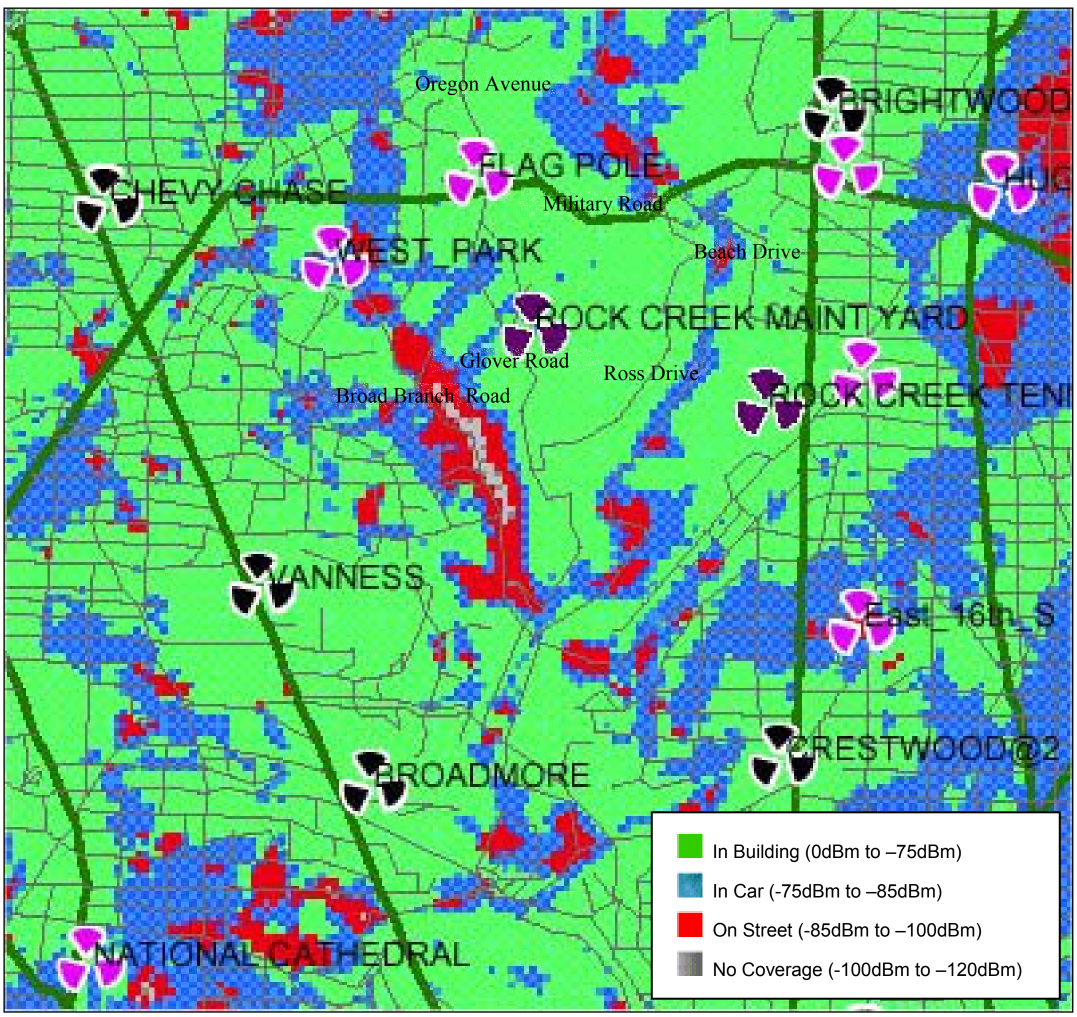

Figure 26: Coverage Simulation – Tennis Center, St. Johns College High School, and Other Verizon Wireless Sites (Maintenance Yard Site is Turned Off)

4.5.2 Combination of the Tennis Center Site and Military Road and Jocelyn Street Site

Figure 27 shows the coverage that would result from the combination of the tennis center tower, Military Road and Jocelyn Street site, and Verizon Wireless sites around the park area. It shows that such a combination would weaken the coverage on Beach Drive and would open a coverage hole on Military Road.

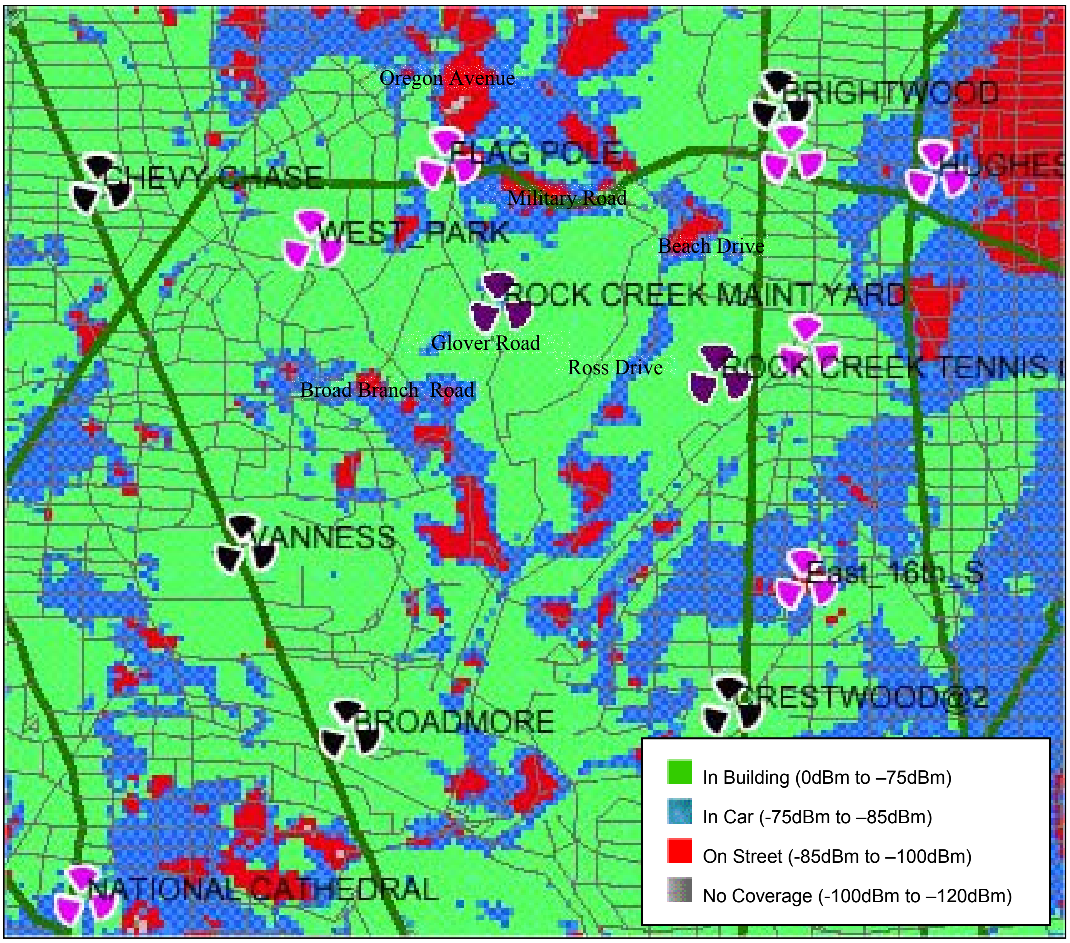

Figure 27: Coverage Simulation – Tennis Center Site, Military Road and Jocelyn Street Site, and Other Verizon Wireless Sites (Maintenance Yard Site is Turned Off)

4.5.3 Combination of the Maintenance Yard Site with the 16th Street and Kennedy Street Site

Figure 28 shows the coverage that would result from the combination of the maintenance yard tower, the 16th Street and Kennedy Street site, and Verizon Wireless sites around the park area. It shows that such a combination would seriously weaken the current coverage on Beach Drive.

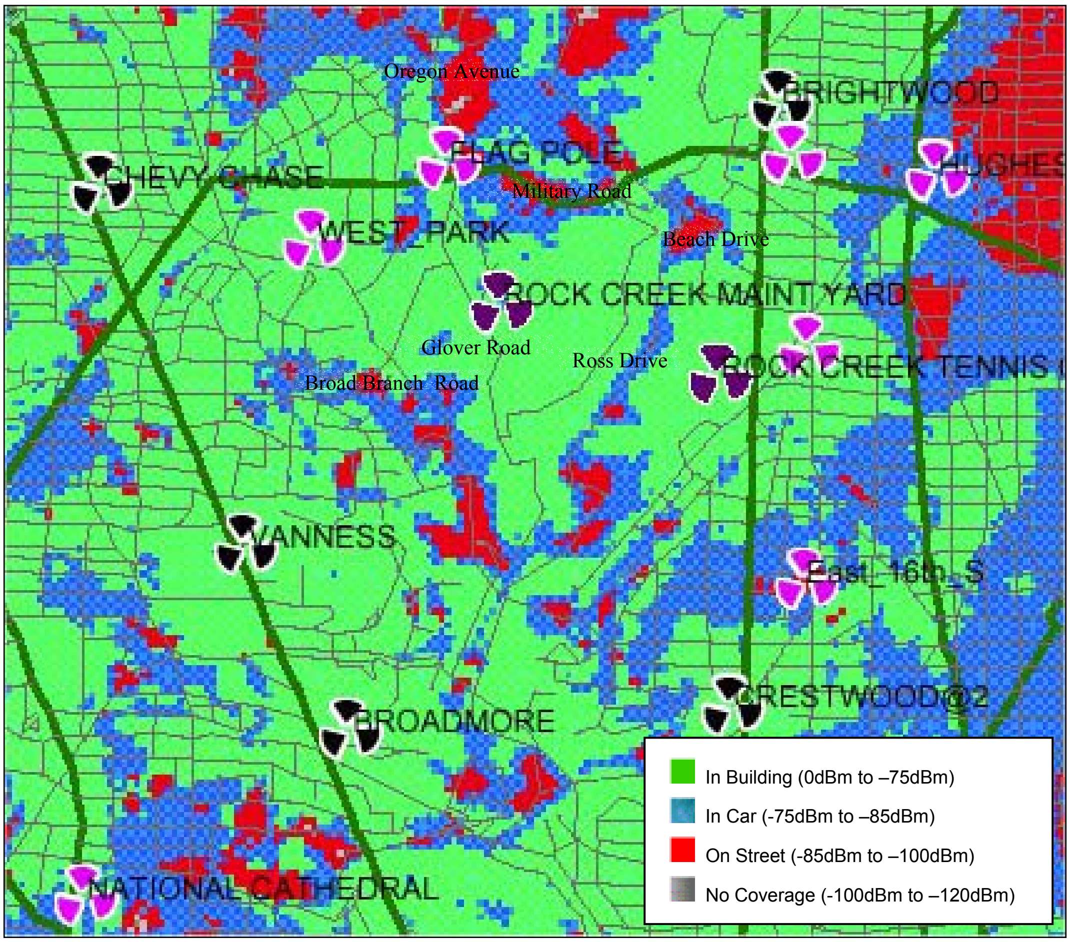

Figure 28: Coverage Simulation – Maintenance Yard Site, the 16th Street and Kennedy Street Site, and Other Verizon Wireless Sites
(Tennis Center Site is Turned Off)

5. ALTERNATIVE METHODS FOR COVERAGE

Since RF coverage of a given area can be accomplished by various means in addition to deploying cell sites, our study analyzed these alternative methods as well. Depending on the coverage needs and the type of area that needs to be covered as well as the projected capacity requirements, various alternative coverage methods maybe utilized. Following is a discussion on the use of (a) microcells, (b) repeaters, and (c) satellites to potentially cover the Rock Creek Park area.

5.1. Microcells

Microcells, which can be considered small sites, are very limited in power and are used to cover a limited geographical area, such as a malls, subway and train stations, and sports complexes.

Because of the heavy terrain and the twisting roads passing through Rock Creek Park, a microcell will be needed at very close intervals – approximately about every 300 yards – to provide reliable coverage. A coverage solution with microcells for Rock Creek Park implies building small poles every 300 yards or so, with the required antennas mounted on them and making the overground/underground connections necessary for electrical power and T1 communication with the rest of the wireless network. Based on a preliminary study, we estimate that about 30 microcell sites will be necessary to cover the various roadways of the park. The resulting coverage from such microcells will not fully cover the park, unlike the two full-blown cell sites that cover the park in addition to the roadways. The microcell coverage will not cover areas of the park, such as bike trails and other areas accessible to the general public, where cell phone coverage is also needed and where coverage is currently available. To cover the entire park with microcells at –85dBm, many more microcell sites would be needed in addition to the approximately 30 microcells needed for providing coverage to the main roadways. This estimate depends upon various factors, such as power output from the microcell, exact height(s) of the antennas location(s), etc.

5.2. Repeaters

A repeater can be considered a small cell site that is usually used to extend the coverage of particular full-blown cell site to a specific area. Similar to a full-blown cell site, an outdoor repeater also needs sufficient ground elevation and height above ground level to provide reliable coverage to the area it needs to serve. The ground equipment for an outdoor repeater site is very small when compared with that of a full-blown site; however, the overhead structure is similar to that of a full-blown cell site. An outdoor repeater site needs antennas, cables and a donor antenna (usually a dish antenna) to allow the reception of RF signal from a neighbor site.

To achieve the adequate coverage in the park with a repeater solution, Verizon Wireless would have to use multiple outdoor repeaters. Each repeater would have to be mounted on some kind of a structure like a tower within the park. The number of outdoor repeaters and their towers would depend on towers' location, antenna height, and the availability and location of a donor site. A solution with repeaters mounted on short poles will not be feasible in most areas of the park, since short poles would not be high enough to allow the repeater to receive sufficient signal strength from a qualified Verizon Wireless donor site and to relay it to its intended coverage area.

5.3. Satellite Phone Service

Satellite phone service is meant to serve as a complement to wireless and landline phone coverage in areas such as remote areas of the globe, deserts, heavy forests, and high seas, where no landline or cell phone service is available.

Verizon Wireless does not currently operate a satellite phone service. Satellite telecommunication is a very sophisticated, capacity-limited, and expensive technology. Currently there are very few providers of such a service in the world; Satellite phone service is reserved for nautical navigation, military operations and activities in remote areas of the globe. For Verizon Wireless to provide satellite service in the park, they would have to not only commission satellites to be placed in Earth orbit, but also create extensive "Ground Stations" with huge dish antennas, for communicating with the satellite. Additionally, currently available technology for satellite communications does not provide for the FCC E-911 requirements.

6. CONCLUSIONS

Rock Creek Park presents a unique set of circumstances for providing RF and cellular coverage in the area. First, the park is located in a heavily populated urban area. Due to site availability and zoning restrictions, this urban location regulates the potential height of cell towers. Tall towers naturally tend to cover a larger radius of coverage and hence in urban areas, due to higher population densities, tall tower sites often reach capacity limits. Additionally, tall towers tend to create interference with neighboring towers and create an RF environment that is problematic to a cellular network. Interference in a CDMA network, like that of Verizon Wireless, is manifested in the absence of a specific dominant server, but with the presence of many weak servers. This results in a high number of dropped calls and problems in initiating and receiving cell phone calls.

The second criterion to be considered is the steep, undulating topography of Rock Creek Park. As discussed, the topography of this geographical region is very hilly, and important roads cut through hills and valleys. Such terrain is very difficult to provide with the necessary and required signal levels for successful call completions and good call quality, as well as to meet the minimal signal level required for urban coverage. Best practices of radio frequency engineering require cell sites in such situations to be placed as close as possible to terrain depressions. This allows the signal generated by the cell site to reach the deep valley floors. It is along the valleys of the park that some of its important roads are laid out. Covering the roads and valleys of the park then take on an added importance given the amount of vehicular traffic that uses the roads on a daily basis.

Based on park visits, drive testing, and extensive RF propagation analyses, it is clear that Verizon Wireless would not possess the same level of service in the park with any other site. Each of the existing tower sites is located such that they provide cell coverage to specific valleys and roadways within the park. While the tennis center tower provides reliable coverage along Beach Drive, just south of Military Road, the maintenance yard tower improves Verizon Wireless coverage on Military Road, Broad Branch Road, Ross Drive, and Glover Road. These two cellular telecommunication towers provide cellular coverage to large sections of the park and its roadways that are not covered adequately without these two sites. In addition, the maintenance yard and the tennis center are the only accessible sites in the park that have acceptable ground elevation.

Alternatives to these two sites were also studied and analyzed. As discussed in the narrative above, sites like the Hughes Tower and the National Cathedral are too far away geographically to provide coverage in the park. Even sites closer to the park – such as the site at 16th Street and Kennedy Street, St. Johns College High School, or the area west of the park off Military Road and Jocelyn Street – are unable to provide the same level of coverage that Verizon Wireless currently enjoys to various sections of the park and its roadways. The terrain of the park – with hills and valleys – requires that potential site be placed very close to the valleys and the roadways to ensure that sufficient RF signal reaches the roadways. Additionally, the small hill northwest of the Nature Center effectively impedes signals from any prospective site west of the park. Sites like the flag pole at St. Johns College High School and off of Military Road and Jocelyn Street are not as effective as the existing towers since these sites are blocked by terrain and are unable to effectively cover park areas along Beach Drive. Making these sites taller is not a viable option due to cellular and RF engineering reasons discussed above (tall sites cause interference). Sites along the eastern side of the park also were found to fall short of the requirements, as they were not able to provide the same level of service to large sections of the park.

Alternative methods of providing coverage in the park were also examined. All of the three methods considered – microcells, repeaters and satellites – each pose unique challenges to placement within Rock Creek Park. While microcells and/or repeaters would require scores of microcells and/or repeaters to be placed strategically throughout the park on towers/poles, the coverage obtained from them would not be comparable to that provided by the two existing tower sites. A satellite solution may be able to cover the park, but it would require building earth stations with high dish antennas and it would not be able to support E-911 location functionality.

In conclusion, the two sites, as currently located, are the best suited for Verizon Wireless coverage in the park and along the major roads of the park.

Appendix C

Appendix C

Avian Species Identified During Breeding Bird Surveys as Potential Breeding Species

TABLE 1. AVIAN SPECIES IDENTIFIED DURING BREEDING BIRD SURVEYS AS POTENTIAL BREEDING SPECIES

Species	1993	1994	1995	1996	1997	1998*	2001	2002
Mallard				✓			✓	
Cooper’s Hawk				✓		✓		
Red-shouldered Hawk								✓
Red-tailed Hawk				✓			✓	✓
American Woodcock			✓	✓				
Rock Dove			✓					
Mourning Dove	✓	✓	✓	✓	✓	✓	✓	✓
Yellow-billed Cuckoo		✓	✓	✓				
Eastern Screech Owl	✓							
Chimney Swift							✓	
Red-bellied Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓
Northern Flicker	✓	✓	✓	✓	✓	✓	✓	✓
Downy Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓
Hairy Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓
Pileated Woodpecker	✓	✓	✓	✓	✓	✓	✓	✓
Eastern Wood-Pewee	✓	✓	✓	✓	✓	✓	✓	✓
Eastern Phoebe	✓	✓	✓	✓	✓	✓	✓	✓
Acadian Flycatcher	✓	✓	✓	✓	✓	✓	✓	✓
Great Crested Flycatcher	✓	✓	✓	✓	✓	✓	✓	✓
Eastern Kingbird			✓	✓				
Red-eyed Vireo	✓	✓	✓	✓	✓	✓	✓	✓
Yellow-throated Vireo	✓			✓		✓	✓	✓
Blue Jay	✓	✓	✓	✓	✓	✓	✓	✓
American Crow	✓	✓	✓	✓	✓	✓	✓	✓
Tufted Titmouse	✓	✓	✓	✓	✓	✓	✓	✓
Carolina Chickadee	✓	✓	✓	✓	✓	✓	✓	
White-breasted Nuthatch	✓	✓	✓	✓	✓	✓	✓	✓
Carolina Wren	✓	✓	✓	✓	✓	✓	✓	✓
Blue-gray Gnatcatcher	✓	✓	✓	✓	✓	✓	✓	✓
Veery	✓	✓	✓	✓	✓	✓	✓	✓
Wood Thrush	✓	✓	✓	✓	✓	✓	✓	✓
American Robin	✓	✓	✓	✓	✓	✓	✓	✓
Gray Catbird	✓	✓		✓	✓	✓	✓	✓
Northern Mockingbird			✓					
Brown Thrasher	✓							
European Starling		✓			✓		✓	✓
Northern Parula						✓		
Black-and-white Warbler				✓	✓		✓	✓
Yellow-throated Warbler				✓		✓		
Hooded Warbler	✓	✓	✓	✓				
Worm-eating Warbler	✓							
Ovenbird	✓	✓	✓	✓	✓	✓	✓	✓
Louisiana Waterthrush				✓	✓		✓	
Common Yellowthroat			✓	✓	✓			✓
Yellow-breasted Chat					✓			
American Redstart	✓			✓				
Summer Tanager				✓				
Scarlet Tanager	✓	✓	✓	✓		✓	✓	✓
Eastern Towhee	✓	✓	✓	✓	✓	✓	✓	✓
Northern Cardinal	✓	✓	✓	✓	✓	✓	✓	✓

Species	1993	1994	1995	1996	1997	1998*	2001	2002
Indigo Bunting			✓		✓		✓	
Song Sparrow				✓	✓		✓	✓
Common Grackle	✓	✓				✓	✓	✓
Brown-headed Cowbird	✓	✓	✓	✓	✓	✓	✓	✓
House Finch		✓	✓		✓	✓		
House Sparrow				✓				

Data for 1999 and 2000 was not available within the time constraints of the EA preparation

TABLE 2. WASHINGTON DC AUDUBON CHRISTMAS BIRD COUNT ROCK CREEK PARK - 1980–2002 ANNUAL AVERAGE

Species	Carter Barron	Nature Center	Species	Carter Barron	Nature Center
Mallard	2.2	5.0	Winter Wren	0.1	0.6
Wood Duck	0.2	0.8	Brown Creeper	0.3	1.4
Barred Owl	—	0.0	Northern Mockingbird	3.2	2.6
Great Horned Owl	0.0	0.3	Mourning Dove	3.6	12.3
Eastern Screech Owl	0.4	0.8	Rock Dove	25.2	4.0
American Crow	18.5	38.0	European Starling	33.5	21.3
Fish Crow	0.4	0.3	Ovenbird	—	0.1
Herring Gull	0.3	—	House Sparrow	22.7	15.4
Ring-billed Gull	40.7	11.5	Eastern Towhee	0.0	1.0
American Kestrel	—	0.0	White-throated Sparrow	10.7	21.9
Belted Kingfisher	0.2	0.2	Song Sparrow	1.7	8.0
Red-shouldered Hawk	0.0	0.1	Dark-eyed Junco	11.7	16.1
Red-tailed Hawk	0.4	0.7	Purple Finch	0.0	0.4
Sharp-shinned Hawk	0.2	0.2	House Finch	5.5	19.3
Cooper's Hawk	0.1	—	American Goldfinch	4.4	5.4
Turkey Vulture	0.1	0.4	Northern Cardinal	8.2	16.0
Black Vulture	0.0	0.0	Evening Grosbeak	—	0.1
Northern Flicker	0.2	1.3	Field Sparrow	—	0.2
Red-bellied Woodpecker	4.9	9.6	American Tree Sparrow	—	0.0
Downy Woodpecker	3.9	8.7	Fox Sparrow	—	0.0
Hairy Woodpecker	0.5	1.0	Brown-headed Cowbird	—	0.0
Pileated Woodpecker	0.8	2.3	Red-winged Blackbird	—-	1.9
Yellow-bellied Sapsucker	0.3	0.7	Common Grackle	0.1	28.0
White-breasted Nuthatch	6.0	11.9	Blue Jay	2.1	3.2
Red-breasted Nuthatch	0.0	0.3	Cedar Waxwing	1.3	3.5
Golden-crowned Kinglet	0.6	3.6	American Robin	3.3	2.6
Ruby-crowned Kinglet	0.5	0.1	Hermit Thrush	—	0.0
Tufted Titmouse	13.3	30.7	Gull spp.	0.4	0.1
Carolina Chickadee	12.5	43.0	Kinglet spp.	0.3	—
Carolina Wren	4.1	8.8			
Total Individuals:	**247.0**	**366.2**			
Total Species:	**21.2**	**27.3**			

Appendix D

Appendix D

Air Quality Applicability Analysis

FEBRUARY 2003

AIR QUALITY APPLICABILITY ANALYSIS

This air quality applicability analysis was conducted to identify potential increases or decreases in criteria air pollutant emissions associated with the alternatives that consider construction and operation of two telecommunications facilities at sites both inside and outside of Rock Creek Park in Washington, DC. Since all of the alternatives for the construction and operation of the telecommunications facilities will occur within the U.S. Environmental Protection Agency (EPA) designated ozone non-attainment area, it is subject to the federal conformity requirements. The purpose of the analysis is to further determine the applicability of the Federal General Conformity Rule established in 40 CFR, Part 93 entitled: *Determining Conformity of Federal Actions to State or Federal Implementation Plans* to the action.

The federal conformity rules were established to ensure that federal activities do not hamper local efforts to control air pollution. In particular, Section 176(c) of the *Clean Air Act* prohibits federal agencies, departments or instrumentalities from engaging in, supporting, licensing, or approving any action, in an area that is in non-attainment of the National Ambient Air Quality Standards, which does not conform to an approved state or federal implementation plan. Therefore, the agency must determine whether or not the project would interfere with the clean air goals in the *State Implementation Plan* (SIP).

PROJECT DESCRIPTION

The purpose of and need for federal action is to meet the conditions of the court in *Audubon Naturalist Society of the Central Atlantic States, Inc. v. NPS and Bell Atlantic Mobile, Inc.* and the National Park Service requirements for environmental analysis under NEPA and *Director's Order #12*.

The following alternatives were considered in this analysis:

> Alternative A (No-Action Alternative) — Telecommunications facilities remain at Rock Creek Park as permitted in 1999
>
> Alternative B — Telecommunications facilities remain at Rock Creek Park with additional mitigation applied to protect park resources and values (Preferred Alternative)
>
> Alternative C — One or both Verizon Wireless facilities would be relocated to alternative locations outside Rock Creek Park (Environmentally Preferred Alternative)

METEOROLOGY/CLIMATE

Temperature is a parameter used in calculations of emissions for air quality applicability. Temperature data from the Reagan National Airport in Washington, DC represents the meteorological conditions for the study area. Summers are warm and humid and winters are cold, but not severe. Summertime temperatures are usually in the upper 80°F and the winter dips to just below 32°F. Average temperature is 64°F.

CURRENT AMBIENT AIR QUALITY CONDITIONS

The EPA has designated the Washington, DC Metropolitan area, which includes the District of Columbia and Rock Creek Park, as in severe non-attainment for the National Ambient Air Quality Standards pollutant ozone. This can be attributed primarily to mobile sources.

AIR QUALITY REGULATORY REQUIREMENTS

The EPA defines ambient air in 40 CFR Part 50 as “that portion of the atmosphere, external to buildings, to which the general public has access.” In compliance with the *1970 Clean Air Act* and the 1977 and 1990 *Clean Air Act* Amendments, the EPA has promulgated National Ambient Air Quality Standards. The National Ambient Air Quality Standards were enacted for the protection of the public health and welfare, allowing for an adequate margin of safety. To date, the EPA has issued National Ambient Air Quality Standards for six criteria pollutants: carbon monoxide (CO), sulfur dioxide (SO), particles with a diameter less than or equal to a nominal 10 micrometers (PM_{10}), ozone (O_3), nitrogen dioxide (NO), and lead (Pb). Areas that do not meet National Ambient Air Quality Standards are called non-attainment areas. The EPA classified the Metropolitan Washington, DC area, including the area of the telecommunications facilities sites in and around Rock Creek Park, as in severe non-attainment for ozone. The National Ambient Air Quality Standards for ozone is presented in Table 1.

To regulate the emission levels resulting from a project, federal actions located in non-attainment areas are required to demonstrate compliance with the general conformity guidelines established in 40 CFR Part 93 *Determining Conformity of Federal Actions to State or Federal Implementation Plans* (the Rule). The study area is located within a severe ozone non-attainment area; therefore, a General Conformity Rule applicability analysis is warranted.

Section 93.153 of the Rule sets applicability requirements for projects subject to the Rule through establishment of *de minimis* levels for annual criteria pollutant emissions. These *de minimis* levels are set according to criteria pollutant non-attainment area designations. Projects below the *de minimis* levels are not subject to the Rule. Those at or above the levels are required to perform a conformity analysis as established in the Rule. The *de minimis* levels apply to direct and indirect sources of emissions that can occur during the construction and operational (including maintenance) phases of the action.

Direct emissions are those caused by, or initiated by the federal action that occur at the same time and place as the action. Indirect emissions are those caused by the action, but which occur later in time and/or at a distance removed from the action itself, yet are reasonably foreseeable and the federal agency responsible for the action can maintain control as part of the actions program responsibility. To determine the applicability of the Rule to this action, emissions must be estimated for the ozone precursor pollutants nitrogen oxides (NO_x) and volatile organic compounds (VOC). Annual emissions for these compounds were estimated for the two telecommunications facilities to determine if emission levels would be below or above the *de minimis* levels established in the Rule. The *de minimis* for severe ozone areas is 25 tons per year (TPY) for each ozone precursor pollutant.

TABLE 1: AMBIENT AIR QUALITY STANDARDS FOR OZONE

Pollutant (Ozone (O_3))*	Federal Standard (ppm)	District of Columbia Standard (ppm)
1-Hour Average	0.12	0.12
8-Hour Average	0.08	0.08

* Federal primary and secondary standards for this pollutant are identical.
ppm= parts per million.
Source: EPA.

In addition to evaluation of air emissions against *de minimis* levels, emissions are also evaluated for regional impact. A federal action that does not exceed the threshold emission rates of criteria pollutants may still be subject to a general conformity determination if the direct and indirect emissions from the action exceed 10% of the total emissions inventory for a particular criteria pollutant in a non-attainment or maintenance area. If the emissions exceed this 10% threshold, the federal action is considered to have a regional impact, and thus, the general conformity rules apply.

CONFORMITY APPLICABILITY ANALYSIS

The project construction- and operations-related General Conformity analysis needs to be performed for the proposed telecommunications facilities within the study area for all alternatives evaluated. Since both alternative A and alternative B evaluate the two telecommunications facilities as they currently exist, it is assumed that the air quality applicability analysis for these two alternatives would be similar. This conformity analysis and air emissions evaluation will follow the criteria regulated in *40 CFR Parts 6, 51, and 93, Determining Conformity of General Federal Actions to State or Federal Implementation Plans; Final Rule* (November 30, 1993).

CONSTRUCTION PHASE EMISSIONS

Construction emissions would result from the operation of heavy equipment, the commuter vehicle traffic of the construction crew, and the painting of building surfaces. The project would utilize a mix of heavy equipment for the construction of the telecommunications towers and equipment buildings.

Emissions from Heavy Equipment

Annual emissions were calculated for various types of diesel construction vehicles using EPA's document *Exhaust Emission Factors for Nonroad Engine Modeling—Compression-Ignition* (Report No. NR-009A, 1998). Truck emission levels were calculated using *MOBILE6* for an average temperature of 64°F. The total annual emissions, in tons per year, were determined for each vehicle based on the number of vehicles used and the number of operating hours per year. For sites inside the park, it was assumed that construction of the two telecommunications facilities occurred simultaneously in 2000 and become operational at the same time. It was also assumed that under all of the alternatives, the construction activities for each facility would last for approximately 3 months (90 days) utilizing a 40-hour work week. Construction personnel were assumed to travel an average 60 miles per day over the 3 months. Emissions factors used for construction vehicles are shown in Table 2.

TABLE 2: EMISSIONS FACTORS FOR CONSTRUCTION VEHICLES

Construction Vehicle Type	NO_x	VOC
Backhoe	1.806	0.342
Concrete Truck	3.688	0.442
Crane	1.844	0.209
Tractor Trailer	1.806	0.342
Drill Rig	4.161	0.348
Pick-up Truck	1.557*	2.651*
Delivery Truck (heavy duty) (Dump Truck)	18.569*	0.812*

* Units are in grams/mile/vehicle.

Calculations for Construction Emissions – Alternative A and Alternative B

Construction emissions for the existing two telecommunications facilities in Rock Creek Park under alternative A and alternative B would be identical. Using the emissions factors in Table 2, annual construction emissions were calculated for the two telecommunications facilities. Using the assumptions described above, the annual emissions in tons per year of NO_x and VOC for construction emissions were calculated for each vehicle type using the appropriate equations displayed in Table 3.

Table 4 summarizes total annual emissions for the heavy equipment used during construction of the two new telecommunications facilities for alternative A and alternative B, based upon hours of usage.

Calculations for Construction Emissions – Alternative C

Alternative C utilizes the same mix of construction equipment as alternative A and alternative B. However, alternative C differs in that under three of the scenarios (scenario 1, 2, and 5) the potential for one existing telecommunications facility in the park to be dismantled and relocated outside of the park exists and under two of the scenarios (scenario 3 and scenario 4), the potential for both existing telecommunications facilities in the park to be dismantled and relocated outside of the park exists. All of these scenarios would require that the construction equipment be used for a greater length of time for the relocation of the existing facilities. In order to calculate the peak level of emissions, this analysis assumed that both towers would be dismantled and relocated. Using the emissions factors in Table 2, annual construction emissions were calculated for the dismantling and relocation of the two telecommunications facilities to locations outside the park. Using the assumptions described above, the annual emissions in tons per year of NO_x and VOC for construction emissions were calculated for each vehicle type using the appropriate equations displayed in Table 3.

TABLE 3: EQUATIONS FOR CONSTRUCTION EMISSIONS CALCULATIONS

Emission Source	Equation	Sample Calculation
Heavy Equipment Emissions, On-Site Activities	(# of vehicle type) (Emission factor) (Total # of days in operation) (percent usage) (hours/day) (1 ton/2000 lbs) = Tons of air emissions	(2 cranes) (1.844 lbs/hr/vehicle) (5 days in operation) (100% usage) (8 hours/day) (1 ton/2000 lbs) = 0.07 Tons of NO_x emissions
Construction Crew, Commuting	(# of vehicles) (#miles/day) (#days) (emissions factor grams/mile) (1 lb/453.59 grams) (1 ton/2000 lb) = Tons of Vehicle Emissions	(20 vehicles) (60 miles/day) (60 days) (1.277 grams/mile/vehicle) (1 lb/453.59 grams) (1 ton/2000 lb) = 0.10 Tons NO_x of Vehicle Emissions

**TABLE 4: TOTAL EMISSIONS FROM ON-SITE CONSTRUCTION ACTIVITY–
ALTERNATIVE A AND ALTERNATIVE B**

			Total Emissions (tons)	
Construction Vehicle Type	Number of Vehicles	Length of Operation (days)	NO_x	VOC
Backhoe	2	5	0.07	0.01
Concrete Truck	2	5	0.15	0.02
Crane	2	5	0.07	0.01
Tractor Trailer	2	5	0.07	0.01
Drill Rig	2	5	0.17	0.01
Pick-up truck	2	60	0.0124	0.0210
Delivery Truck (Heavy Duty)	2	30	0.07	0.00
Total Emissions			**0.62**	**0.09**

Table 5 summarizes total annual emissions for the heavy equipment used during the dismantling of the existing towers and construction of the new telecommunications facilities at locations outside of the park under alternative C, based upon hours of usage.

EMISSIONS FROM CONSTRUCTION CREW WORKERS

Emissions from construction personnel traffic were calculated using the *EPA's MOBILE6.* It was assumed that 10 construction workers would be required at each site for construction and 10 at each site for dismantling the exiting towers, if applicable. Construction activities at both sites were assumed to occur simultaneously, during a 90-day period under all three alternatives.

Calculations for Emissions from Construction Crew Workers – Alternative A and Alternative B

It is assumed that there will be an average of 10 workers at each tower site over 3 months, or 60 working days. It is assumed that the average number of workers (20 total) will drive approximately 30 miles each day, each way, for a total of 60 miles driven each day by each worker. Based on *MOBILE6,* the emission factor for NO_x is 1.227 grams/mile/vehicle and VOC is 2.190 grams/mile/vehicle for the average fleet in DC. It was found that the total emissions associated with the commuter vehicles from the construction crew are approximately 0.10 tons of NO_x and 0.17 tons of VOC under alternative a and alternative b.

Calculations for Emissions from Construction Crew Workers – Alternative C

It is assumed that there will be an average of 10 workers at each tower site for dismantling the existing towers and 10 workers at each tower site for constructing the new towers over 3 months, or 60 working days. It is assumed that the average number of workers (40 total) will drive approximately 30 miles each day, each way, for a total of 60 miles driven each day by each worker. Based on *MOBILE6,* the emission factor for NO_x is 1.227 grams/mile/vehicle and VOC is 2.190 grams/mile/vehicle for the average fleet in DC. It was found that the total emissions associated with the commuter vehicles from the construction crew are approximately 0.20 tons of NO_x and 0.35 tons of VOC under alternative C.

TABLE 5: TOTAL EMISSIONS FROM ON-SITE CONSTRUCTION ACTIVITY – ALTERNATIVE C

			Total Emissions (tons)	
Construction Vehicle Type	Number of Vehicles	Length of Operation (days)	NO_x	VOC
Backhoe	4	5	0.14	0.03
Concrete Truck	2	5	0.15	0.02
Crane	4	5	0.15	0.02
Tractor Trailer	4	5	0.14	0.03
Drill Rig	2	5	0.17	0.01
Pick-up truck	4	60	0.0247	0.0421
Delivery Truck (Heavy Duty)	2	30	0.07	0.00
Total Emissions			**0.85**	**0.15**

EMISSIONS FROM PAINTING ACTIVITIES

When calculating VOC emissions from painting, it was assumed that water-based latex paint would be used with a VOC content of three pounds per gallon, and one-gallon of paint covers approximately 300 square feet. It was also assumed that the monopoles would come pre-painted from the factory and the only on-site painting required would be for the two equipment buildings. Three coats of paint will be applied (one primer and two finish) to approximately 760 square feet of interior surfaces for each building, for a total of 2,280 square feet of painting for each maintenance shed.

Calculations for Emissions from Painting Activities – Alternative A and Alternative B

Under these alternatives, a total of two maintenance sheds would be constructed. Each maintenance shed would have 2,280 square feet of area painted for a total of 4,560 square feet painted. Based on these assumptions approximately 16 gallons of paint are needed. Painting of the maintenance sheds will create approximate VOC emissions of 0.02 tons.

Calculations for Emissions from Painting Activities – Alternative C

Under alternative C, a total of two maintenance sheds would be constructed. Each maintenance shed would have 2,280 square feet of area painted for a total of 4,560 square feet painted. Based on these assumptions approximately 16 gallons of paint are needed. Painting of the maintenance sheds will create approximate VOC emissions of 0.02 tons.

SUMMARY OF CONSTRUCTION EMISSIONS

After emissions analysis was performed for all aspects of construction, the totals were added to determine the combined construction emissions under all of the alternatives evaluated. Table 6 displays a summary of the findings compared to the *de minimis* values for alternative A and alternative B. Table 7 displays a summary of the findings compared to the *de minimis* values for alternative C.

OPERATIONAL EMISSIONS

Emissions from operation of the two telecommunications facilities under all of the alternatives evaluated would include emissions from daily activities including operation of the emergency generator and traffic from maintenance vehicles. Operational emissions would be the identical under all three alternatives.

TABLE 6: TOTAL EMISSIONS FROM CONSTRUCTION RELATED ACTIVITIES – ALTERNATIVE A AND ALTERNATIVE B

Construction Activity	Total Emissions (tons per year)		*De minimis* Values (tons per year)	
	NO_x	VOC	NO_x	VOC
Use of Heavy Equipment	0.62	0.09	25	25
Construction Crew Workers	0.10	0.17		
Painting	NA	0.02		
Total Emissions from Construction	**0.72**	**0.29**		

TABLE 7: TOTAL EMISSIONS FROM CONSTRUCTION RELATED ACTIVITIES – ALTERNATIVE C

Construction Activity	Total Annual Emissions (tons per year)		*De minimis* Values (tons per year)	
	NO_x	VOC	NO_x	VOC
Use of Heavy Equipment	0.85	0.15	25	25
Construction Crew Workers	0.20	0.35		
Painting	NA	0.02		
Total Emissions from Construction	**1.06**	**0.52**		

EMERGENCY POWER EMISSIONS – ALTERNATIVE A, ALTERNATIVE B, AND ALTERNATIVE C

In calculating emissions from emergency power emissions it was assumed that the two telecommunications facilities would each use a 30 kilowatt emergency generator that operates on natural gas. It is also assumed that the emergency generator would be run for testing approximately one hour a week. The calculation for emissions assumes approximately 70 hours a year of run time to account for weekly testing and potential use of the emergency generator in case of a power failure. Using EPA's *AP-42 Fifth Edition, Compilation of Air Pollutant Emission Factors Volume I, Chapter 1: Stationary Sources, Supplement D (1998)* the emissions for both NO_x and VOC were determined for the emergency generator. For the purposes of calculating NO_x emissions, the emergency generator falls in the category of small, uncontrolled boilers. It was found that the NO_x emissions from small, uncontrolled boilers are approximately 100 $lb/10^6$ standard cubic feet of natural gas, and for VOCs the emissions rate was found to be 5.5 $lb/10^6$ standard cubic feet of natural gas. Using the above stated emission factors and natural gas demand, the emissions of NO_x and VOC were calculated to be 0.02 TPY and 0.0011 TPY respectively.

VEHICLE EMISSIONS FROM MAINTENANCE VEHICLES – ALTERNATIVE A, ALTERNATIVE B, AND ALTERNATIVE C

Vehicle emissions from maintenance vehicles are based on the *MOBILE6* air modeling program, estimating the emissions per vehicle per mile traveled. The *MOBILE6* modeling program takes into account the vehicle age and vehicle type to create average emission factors to be used in an overall analysis. The following assumptions were used in the analysis: the annual average temperature is 64°F and construction would occur during a 3 month time period. It is also assumed that maintenance vehicles would be included in the category of pick-up trucks. Based on these assumptions, the emissions factors for NO_x and VOC, in average vehicles are described in Table 8. Using these emission factors, the annual emissions in tons per year of NO_x and VOC for commuter emissions were calculated using the appropriate equations displayed in Table 9.

TABLE 8: EMISSION FACTORS FOR COMMUTER VEHICLES

Pollutant	Emissions Factor (grams/mile/vehicle)
NO_x	1.557
VOC	2.651

TABLE 9: EQUATIONS FOR OPERATIONS EMISSIONS CALCULATIONS

Emission Source	Equation	Sample Calculation
Operations, Maintenance Vehicles	(# of vehicles) (# of trips/day) (#miles/trip) (#days/year)= #miles/year (#miles/year) (emissions factor grams/mile) (1 lb/453.59 grams) (1 ton/2000 lb) = tons of vehicle VOC emissions	(2 vehicles) (2 trips/day) (30 miles/trip) (24 days/year) = 2,880 miles/year (2.651 g/mile/vehicle) (1 lb/453.59 grams) (1 ton/2000 lbs) = 0.01 tons of VOC

It was estimated that each site would be visited by maintenance vehicles at least once a month. Routine preventative maintenance would also occur on a quarterly basis. For the purposes of this analysis, it was assumed that maintenance vehicles would visit each site approximately twice a month. Based on these assumptions, the daily vehicle emissions are shown in Table 10.

SUMMARY OF OPERATION EMISSIONS – ALTERNATIVE A, ALTERNATIVE B, AND ALTERNATIVE C

Operational emissions, as shown in the sections above, include emissions from emergency generators and maintenance vehicle traffic. Table 11 combines all operational emissions and compares them to the *de minimis* values for all alternatives evaluated.

REGIONAL IMPACT

Air emissions were also evaluated to determine regional impact. The *Phase II Plan for the Washington Metropolitan Nonattainment* (MWCOG 2000) sets forth 2005 projections for daily target levels using control measures of 354.9 tons per day of VOC and 418.2 tons per day of NO_x for the Washington Metropolitan ozone non-attainment. Under all of the alternatives evaluated, the increase in annual emissions from the construction and operation activities would not make up 10% or more of the available regional emission inventory for VOC or NO_x and would not have a regional impact.

CUMULATIVE IMPACTS

An air quality applicability analysis was performed to determine the cumulative impacts under each alternative, with impacts under alternative A and alternative B being similar. Cumulative impacts assume that the remaining five wireless providers in the Washington, DC area would have a need to fill coverage gaps similar to those of Verizon Wireless.

CUMULATIVE IMPACTS UNDER ALTERNATIVE A AND ALTERNATIVE B

Under alternative A and alternative B, it is assumed that at each site within the park, two providers will co-locate on the Verizon Wireless tower, each requiring their own equipment building. It is also assumed that the remaining three provides would require construction of a new tower on which all three would co-locate, along with a equipment building for each provider. The result would be one additional tower and five additional equipment buildings being constructed at each site within the park.

TABLE 10: EMISSIONS FROM DAILY VEHICLE TRAFFIC

Total Emissions (tons)	
NO_x	VOC
0.005	0.01

TABLE 11: TOTAL EMISSIONS FROM OPERATION ACTIVITIES – ALTERNATIVE A, ALTERNATIVE B, AND ALTERNATIVE C

	Total Annual Emissions (tons per year)		*De minimis* Values (tons per year)	
Operational Activity	NO_x	VOC	NO_x	VOC
Emergency Generator	0.02	0.0011	25	25
Maintenance Vehicle Traffic	0.005	0.01		
Total Emissions from Operation	**0.02**	**0.01**		

Since it is unknown when the additional facilities would be built, it was assumed that all five providers would build their facilities in the same year and same 90-day period, while the two existing telecommunications facilities remain in operation. This assumption was made because emissions from the construction phase are higher than those from operations phase and this represents the highest level of air emissions possible from cumulative impacts under alternative a and alternative b. Under alternative b, air emissions from construction and operation of additional towers would not occur during the development of the telecommunications facilities plan. Table 12 represents the emission levels from the simultaneous construction of one telecommunications tower and five maintenance sheds at each of the two sites and the operation of the two existing towers under alternative a and alternative b.

CUMULATIVE IMPACTS UNDER ALTERNATIVE C

Cumulative impacts under alternative C (table 13) would allow for other providers to locate facilities at those sites remaining within the park, including two providers co-locating on the existing Verizon Wireless tower and the remaining three providers co-locating on a newly constructed tower. Under all of the scenarios, this analysis assumes that sites located outside of the park would not have co-location of other carriers. Three of the five scenarios (scenarios 1, 2, and 5) relocate one of the two towers that currently exist in Rock Creek Park. Under these scenarios, five additional carriers would locate at one tower site that would remain in the park; each requiring its own equipment building. At the one site in the park, two carriers would co-locate on the existing Verizon Wireless tower and the remaining three carriers would co-locate on a new tower at each site. Each building is assumed to have an emergency generator resulting in a total of 6 generators operating within the park once all the towers and associated structures are completed. It was assumed that all five carriers would build their facilities in the same year and same 90-day period, while the one existing tower in the park remains in operation. This assumption was made because emissions from the construction phase are higher than those from the operations phase, representing the highest level of air emissions. The emission levels were determined assuming the simultaneous construction of five new telecommunications facilities at one site within the park (one additional tower and five equipment buildings). No new co-locations or facilities would occur at sites outside the park.

TABLE 12: SUMMARY OF ANNUAL EMISSIONS AND COMPARISON TO DE MINIMIS VALUES – CUMULATIVE IMPACTS UNDER ALTERNATIVE A AND ALTERNATIVE B

Activity	Construction Emissions (tons)		Operation Emissions (tons)		Peak Year Emissions (Operation + Construction) – (tons)	
	NO_x	VOC	NO_x	VOC	NO_x	VOC
Heavy Equipment (construction of 2 towers and 10 maintenance sheds)	10.69	1.67	—	—	10.71	1.59
Construction Crew Commuters	0.51	0.87	—	—	0.51	0.87
Painting 10 maintenance sheds	NA	0.11	—	—	NA	0.11
Emergency Generator for 2 existing towers	—	—	0.02	0.0011	0.02	0.0011
Maintenance Traffic for 2 existing towers	—	—	0.005	0.01	0.00	0.01
Totals	**11.19**	**2.65**	**0.02**	**0.01**	**11.21**	**2.67**

TABLE 13: SUMMARY OF ANNUAL EMISSIONS AND COMPARISON TO DE MINIMIS VALUES – CUMULATIVE IMPACTS UNDER ALTERNATIVE C

Activity	Construction Emissions (tons)		Operation and Maintenance Emissions (tons)		Peak Year Emissions (Operation/Maintenance + Construction) - (tons)	
	NO_x	VOC	NO_x	VOC	NO_x	VOC
Heavy equipment (construction of 1 tower and 5 equipment buildings at the site within the park)	5.34	0.83			5.35	0.79
Construction crew commuters	0.25	0.43			0.25	0.43
Painting 5 equipment buildings	NA	0.06			NA	0.06
Emergency generator for 1 existing tower			0.01	0.00055	0.01	0.00055
Maintenance traffic for 1 existing tower			0.002	0.004	0.002	0.004
Totals	**5.60**	**1.33**	**0.012**	**0.005**	**5.61**	**1.34**

OVERALL RESULTS

Tables 14 through 17 summarize the total emissions associated with the construction and operation of the two telecommunications facilities in Rock Creek Park in and/or around Washington, DC under all of the alternatives evaluated. Construction related emissions will be temporary and only occur during the 3 month development period. Operations emissions will occur throughout the life of the towers. When compared to the *de minimis* values for this non-attainment area of 25 TPY for both NO_x and VOC, the emissions associated with construction and operation of two telecommunications facilities fall below the *de minimis* values under all alternatives evaluated, including the cumulative impacts of all alternatives. As a result the two telecommunications facilities are not subject to the General Conformity Rule requirements under all of the alternatives evaluated.

TABLE 14: TOTAL EMISSIONS FROM IMPLEMENTATION OF THE ALTERNATIVE A AND ALTERNATIVE B

Activity	Construction Emissions (tons)		Operation Emissions (tons)	
	NO_x	VOC	NO_x	VOC
Heavy Equipment (tower construction)	0.62	0.09		
Construction Crew Commuters	0.10	0.17		
Painting	NA	0.02		
Emergency Generator			0.02	0.0011
Daily Commuter Traffic			0.005	0.01
Totals	**0.72**	**0.29**	**0.02**	**0.01**

TABLE 15: TOTAL EMISSIONS FROM IMPLEMENTATION OF ALTERNATIVE C

Activity	Construction Emissions (tons)		Operation Emissions (tons)	
	NO_x	VOC	NO_x	VOC
Heavy Equipment (tower construction)	0.85	0.15		
Construction Crew Commuters	0.20	0.35		
Painting	NA	0.02		
Emergency Generator			0.02	0.0011
Daily Commuter Traffic			0.005	0.01
Totals	**1.05**	**0.52**	**0.02**	**0.01**

TABLE 16: TOTAL EMISSIONS FROM CUMULATIVE IMPACTS UNDER ALTERNATIVE A AND ALTERNATIVE B

Activity	Construction Emissions (tons)		Operation Emissions (tons)		Peak Year Emissions (Operation + Construction) - (tons)	
	NO_x	VOC	NO_x	VOC	NO_x	VOC
Heavy Equipment (construction of 2 towers and 10 equipment buildings)	10.69	1.67	—	—	10.71	1.59
Construction Crew Commuters	0.51	0.87	—	—	0.51	0.87
Painting 10 maintenance sheds	NA	0.11	—	—	NA	0.11
Emergency Generator for 2 existing towers	—	—	0.02	0.0011	0.02	0.0011
Maintenance Traffic for 2 existing towers	—	—	0.005	0.01	0.00	0.01
Totals	11.19	2.65	0.02	0.01	11.21	2.67

TABLE 17: TOTAL EMISSIONS FROM CUMULATIVE IMPACTS UNDER ALTERNATIVE C

Activity	Construction Emissions (tons)		Operation and Maintenance Emissions (tons)		Peak Year Emissions (Operation/Maintenance + Construction) (tons)	
	NO_x	VOC	NO_x	VOC	NO_x	VOC
Heavy equipment (construction of 1 tower and 5 equipment buildings at each existing tower sites within the park)	5.34	0.83			5.35	0.79
Construction crew commuters	0.25	0.43			0.25	0.43
Painting 5 equipment buildings	NA	0.06			NA	0.06
Emergency generator for 1 existing tower			0.01	0.00055	0.01	0.00055
Maintenance traffic for 1 existing tower			0.002	0.004	0.002	0.004
Totals	**5.60**	**1.33**	**0.012**	**0.005**	**5.61**	**1.34**

APPENDIX D REFERENCES

U.S. Environmental Protection Agency

n.d. National Primary and Secondary Ambient Air Quality Standards. 40 CFR Part 50.

n.d. Conformity to State or Federal Implementation Plans of Transportation Plans, Programs, and Projects Developed, Funded or Approved under Title 23 U.S.C. or the *Federal Transit Act*. 40 CFR Part 51, Subpart T.

n.d. Designation of Areas for Air Quality Planning Purposes, Subpart C: Section 107 Attainment Status Designations. 40 CFR Part 81.

1998a Compilation of Air Pollutant Emission Factors, Volume I, Chapter 1 Supplement D: Stationary Sources, AP-42, 5th edition.

1998b Exhaust Emission Factors for Nonroad Engine Modeling-Compression-Ignition, Report No. NR-009A. February 13, 1998, revised June 15, 1998.

1997 MOBILE6 Emission Factor Model, for Trucks year 2000 Vehicle Emissions.

Metropolitan Washington Council of Governments

2000 State Implementation Plan (SIP) Revision, Phase II Attainment Plan for the Washington DC-MD-VA Nonattainment Area. February 3.