The Prostate Health Center

HAND DELIVERED

June 1, 2015

Ms. Martha Frisone, Assistant Chief
Jane Rhoe-Jones, Project Analyst
Certificate of Need Section
Division of Health Service Regulation
NC Department of Health and Human Services
809 Ruggles Drive
Raleigh, North Carolina 27603

Re: Comments on Application for a Certificate of Need for a Linear Accelerator relocation to Hillsborough, Orange County, Health Service Area IV; CON Project ID Number J-011035-15, University of North Carolina Hospitals, Hillsborough Campus.

Dear Ms. Frisone and Ms. Rhoe-Jones:

On behalf of Parkway Urology, LLC, thank you for the opportunity to comment on the above referenced application from University of North Carolina Hospitals at Chapel Hill (UNC Hospitals) to relocate its Siemens Artiste linear accelerator to a medical office building "co-located with the medical oncology services offered on the Hillsborough campus." The project offers a change in scope to Project ID J-8330-09. The latter project involves relocation of beds from its main campus at 101 Manning Drive to the Hillsborough Campus.

The proposed project, involves an expenditure of $2,839,864 to move a six-year old linear accelerator (CON Project ID# J-7841-07) to a site that will be operational in 2017, when that linear accelerator will be eight years old. Siemens appears to have discontinued production of this model in 2011, prompting us to question if repair and replacement parts will be available. (See chart in Attachment A).

The application raises other questions as well. It notes that a new linear accelerator procured under Policy AC-3 is to become operational in mid-2015. That project received Agency approval five years ago (J-8611-10) and was presented as urgently needed to meet teaching and accreditation requirements. Yet the applicant repeatedly delayed implementation.

The current application notes that two simulators located in the North Carolina Cancer Hospital provide patient simulation for all six linear accelerators (page 22). It notes that UNC Hospitals does not plan to increase the number of simulators. If UNC Hospitals transfers the Artiste to Hillsborough, patients treated on that accelerator will be required to go to Chapel Hill for the initial and for all adjustment simulations. With the state standard at one simulator per two linear accelerators, [1]the application fails to explain why a standard of one to three simulators offers better quality care. Proposed simulation for the denied Holly Springs linear accelerator is not clear. If done at UNC Hospitals, the ratio would be one to 3.5.

Given the applicant's history with regard to linear accelerators, one of long delayed implementation that results in changes in equipment, the absence of plans to replace and upgrade the Artiste equipment and the high ratio of linear accelerators to simulators, The Agency should be concerned about the true intent of the project. The application does not quantify the need of the proposed served population at the new location. Will the applicant later propose to "replace" this equipment or to relocate it elsewhere? Utilization forecast indicate that, by Year 3, the project itself will not operate at full utilization as defined by the 2015 State Medical Facilities Plan. Is this current CON application just a strategy to park excess capacity in Hillsborough when the AC-3 accelerator comes on line?

Close examination of capital cost estimates for the current project shows notable oversights. The project description depicts an addition to an existing building. However,it fails to include relocation or calibration costs, as well as any software needed to manage remote connection to the simulator at the Cancer Hospital.

The application justifies the project as needed to serve the aging population of central and northern Orange County. Yet, according to State Demographer forecasts, the whole county will add only 8,300 people in the next five years and only 5,200 of these will be over age 65, which the application indicates is the primary population in need. That population of 149,000 people will have direct access to six linear accelerators, about six times the recommended state average of one per 120,000 people[2].

We recognize that the State's Certificate of Need (CON) award for the proposed linear accelerator will be based upon the State's CON health planning objectives, as outlined in the following statutes: G.S. 131E-175(6), G.S. 131E-178 and GS-131E-183. Among other things, these mention the costly risk of excess capacity and the importance of justifying need of the population for the service proposed. Comments in this letter do not intend to be comprehensive. Rather they highlight areas in which the application fails to conform to either the spirit, or the letter, of the statute. Specifically, we request that DHSR Planning and CON Section carefully consider the extent to which the Hillsborough project application:

- Proves a need for linear accelerator services the proposed population,
- Is inconsistent about the proposed population to be served. Is it the 40,000 to 45,000 residents of the four townships in north and central Orange County, or is it some other group?
- Represents a complete service,

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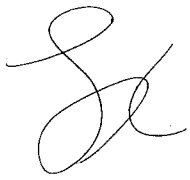
[1] Special Rules 10 NCAC.1900.
[2] 2015 State Medical Facilities Plan, Chapter 9, page 128

- Fully represents all of the costs associated with the project, and
- Is consistent with the basic principles of the 2015 State Medical Facilities Plan: cost, quality and access.

Attachments to this letter include detailed written comments organized in the context of applicable statutory criteria, as well as supporting data and materials to the written comments.

We believe these issues are significant enough to warrant a public hearing; we request you hold one. Thank you for your serious consideration of these comments.

Sincerely,



Kevin Khoudary, MD
President
Parkway Urology, LLC

Attachments

ATTACHMENTS

Attachment A

Statutory Review Criteria: Written Comments

COMPLIANCE WITH CON REVIEW CRITERIA

1. **The proposed project shall be consistent with applicable policies and need determinations in the State Medical Facilities Plan, the need determination of which constitutes a determinative limitation on the provision of any health service, health service facility, health service facility beds, dialysis stations, ambulatory surgery operating rooms, or home health offices that may be approved.**

Although not a response to need determinations in the 2015 State Medical Facilities Plan (SMFP), the project is not consistent with the determination that Service Area 14 has excess linear accelerator capacity. The Division of Health Service Regulation, Healthcare Planning and Certificate of Need Section (Agency) considered this a critical factor in its determination to deny Project ID No.O-103266-14, an application to relocate unused Adult Care beds in New Hanover County. Service Area 14 has five operational linear accelerators. In Section IV, the application shows that it will soon have six. On page 135, the 2015 SMFP shows an excess of 0.1 linear accelerators before the sixth comes on line. By the logic applied in New Hanover, this project is non-conforming to this criterion.

3. **The applicant shall identify the population to be served by the proposed project, and shall demonstrate the need that this population has for the services proposed, and the extent to which all residents of the area, and, in particular, low income persons, racial and ethnic minorities, women, handicapped persons, the elderly, and other underserved groups are likely to have access to the services proposed.**

The application fails to conform to this criterion. The applicant does not attempt to define the difference in population to be served by the relocated equipment and population served by other linear accelerators on the Chapel Hill campus. It does not distinguish or quantify the need that population to be served by the relocated equipment has for the service. The application is internally inconsistent. It first argues that the relocation will create a new group of users (page 46, reference to Dr. Marks' study of breast cancer patients, and page 52). It then goes on to contradict that statement by suggesting that the treatments and ESTV's at Hillsborough will be transfers from growth of the linear accelerator services located on the main campus in the NC Cancer Hospital. The application's forecast for patient origin for the Hillsborough location (page 63) is identical to the patient origin for the linear accelerators on the main campus in 2014. Together, these inconsistencies imply the applicant lacks confidence of significant need in the north and central Orange County townships.

The application makes a broad claim based on one study in Exhibit 17, which asserts that the number of cancer patients receiving radiation therapy during their initial treatment course will increase **22 percent over 10 years ending** in **2020**. Based on that, it proposes that total treatments on the seven linear accelerators at UNC Hospitals will increase from 27,501 in FY 2017 to 35,625 in FY 2020, **an increase of 29 percent in three years not ten years.**

According to the application, the source of the steep forecast increase at UNC is the addition of one linear accelerator dedicated to research that was delayed for five years, and the relocation of old equipment a distance of 12 miles. It does not acknowledge a 2014 study published in the North Carolina Medical Journal that shows the five-mile impact of distance on radiation therapy use applies to urban areas (Attachment D). The proposed move is from an urban to a rural area.

The application contains no quantified discussion of the population at or near the proposed new

location, and no discussion of cancer incidence in this population. However, an unknown factor produces 4,598 treatments in Hillsborough in FY 2020. The application provides no methodology for these calculations. With no special procedures and the high proportion of field checks required for this older equipment, these "CPT code treatments" would translate to fewer ESTV's than treatments in the third year. For example, if 20 percent were field checks, the weighted average would be 0.9 ESTV's per treatment (0.2 * 0.5 plus 0.8 * 1.0); and 4,598 treatments times 0.9 would be 4,138 ESTV's. Even with a weight of one ESTV per treatment, the proposed count in the third year is far short of the benchmark 6,750 ESTV's used to justify need for a new linear accelerator in the Agency's special rules (10NCAC 14C.1903). As a relocation, the project may be exempt from special rules, but the applicant has not demonstrated need for this project.

The applicant also fails to demonstrate a rationale for retaining all five of the linear accelerators it proposes to retain UNC. The discussion of need is prior history and one study indicating that use of radiation therapy services will increase. With confusing patient origin, it is unclear which patients will go where.

3a. **In the case of a reduction or elimination of a service, including the relocation of a facility or a service, the applicant shall demonstrate that the needs of the population presently served will be met adequately by the proposed relocation or by alternative arrangements, and the effect of the reduction, elimination or relocation of the service on the ability of low income persons, racial and ethnic minorities, women, handicapped persons, and other underserved groups and the elderly to obtain needed health care.**

The project does not conform to this criterion. The application proposes to relocate a piece of equipment that serves the 10 million plus people in entire state of North Carolina and other countries to a site focused on the 140,000 people in Orange County (page 46). It makes the ingenuous argument that increases in total ESTV's in Orange County are correlated with growth in the Orange County population (page 46), further suggesting that the project will increase local access. However, the proposed change will not change any of the critical components of access:

- total number of linear accelerators,
- county of location,
- price of procedures provided, or
- distance from the proposed service population by more than 18 minutes.

Moreover, the applicant argues a need for the project, in order to serve the growing population of persons over 65 in Orange County; however, it fails to note that between 2015 and Project Year 03, that population will increase by only 5,200 people. At a rate of 497 new cases per 100,000 persons[1], this would mean an increase of 26 cases (5200 / 100,000 * 497 = 25.8). Using the American Cancer Society ratio of 50 percent of cancer patients getting radiation and 29 treatments per case, this would require 375 linear accelerator treatments, including treatments for persons over 100 years old.

[1] NC Cancer Statistics http://www.schs.state.nc.us/schs/gis/atlas/PDFs/Cancer_All0711.pdf

Forecast Orange County Population Over 65 –

Year/ Age Group	65-74	75-84	85-99	100+	Total
2015	10,946	4,455	1,813	21	17,235
2020	14,251	6,063	2,098	39	22,451
Increase	3,305	1,608	285	18	5,216

Source: NCOSBM, May 30, 2015

Clearly, the argument that there is great need in Orange County, or more specifically northern and central Orange County, is ingenuous. The population is only 40,000 to 45,000. The following data show distribution of township populations during the 2010 Census.

Township Populations, Orange County, NC 2010

North and Central		
Cedar Grove	5,222	
Little River	3,458	
Cheeks	9,313	
Hillsboro	13,809	
Eno	7,501	
Total		*39,303*
South		
Chapel Hill	87,971	
Bingham	6,527	
Total		*94,498*
Total Orange County		**133,801**

Source: American Community Survey, See Attachment C

By using percentages in its need argument, the application masks the relatively small size of the target population. Acknowledging this, the application shows no change in patient origin when the proposed linear accelerator becomes operational (Section III.5(c) page 63).

The application does not demonstrate the absence of an effect on low income and underserved persons. In fact, it moves a linear accelerator to a location that is remote from public transportation.

Many UNC Cancer Hospital patients are inpatients. The application contains no discussion of the impact on inpatients.

5. **Financial and operational projections for the project shall demonstrate the availability of funds for capital and operating needs as well as the immediate and long-term financial feasibility of the proposal, based upon reasonable projections of the costs of and charges for providing health services by the person proposing the service.**

The application fails to conform to this criterion. It is missing significant capital costs including relocation and recalibration costs and the software links needed to communicate with the remote simulator. Moving a piece of equipment like this has significant cost. The application proposes no start up and lists no moving costs. Funds proposed for the project include no contingency and are limited to the amount listed in Section VIII.1.

The application contains no methodology or assumptions to support the 10 and 15 percent annual growth factors that drive the utilization projections. The factors are not referenced in Section III.1(b) as suggested in the application. They just appear in the financial pro formas.

8. **The applicant shall demonstrate that the provider of the proposed services will make available, or otherwise make arrangements for, the provision of the necessary ancillary and support services. The applicant shall also demonstrate that the proposed service will be coordinated with the existing health care system.**

Capital costs include only construction. It includes no cost for software to link remote simulation with the relocated linear accelerator is a critical flaw. Similarly critical are the missing fees for recalibration of the relocated equipment, or new accreditation fees for the new site.

18a. **The applicant shall demonstrate the expected effects of the proposed services on competition in the proposed service area, including how any enhanced competition will have a positive impact upon the cost effectiveness, quality, and access to the services proposed; and in the case of applications for services where competition between providers will not have a favorable impact on cost effectiveness, quality, and access to the services proposed, the applicant shall demonstrate that its application is for the service for which competition will not have a favorable impact.**

The application does not conform to this criterion.

Competition

The proposed project will maintain the UNC Hospitals monopoly on linear accelerator services in Orange County. On page 41, the application acknowledges that UNC Hospitals is the only provider of radiation oncology in Linear Accelerator Service Area 14.

Cost Effectiveness

Costs associated with transfer of an eight-year old piece of equipment that is no longer manufactured, and was produced by a company that is no longer producing linear accelerators (Attachment B), to serve a current "repatriated" population that, according to Google maps, is 18 minutes away, are not justified. The need justification on page 41 mentions 2,400 patient visits to a hematology/ oncology office in Hillsborough. This too, is misleading. A single chemotherapy patient could have 30 to 100 visits in a year. The application carefully avoids mention of the number of radiation oncology patients who currently reside in the Hillsboro area or get treatment at that oncology office.

Costs to the patient will be the same as at the main campus, because the service will be 'provider-based.' Evidence of cost-effectiveness of this project is inadequate, at best.

Quality

Why a system that has the annual earnings of UNC Hospitals would push old equipment on a more rural community is not clear.

Access

Spending almost $3 million that will easily go to overrun conditions to move 18 miles is hardly an argument in favor of access. Financial access will not change (page 90).

Attachment B

Support Article and Comparison Chart:

Siemens Linear Accelerator

AuntMinnie.com

Siemens explains rationale for linac exit

By Cynthia E. Keen, AuntMinnie.com staff writer

December 23, 2011 -- Facing a choice of whether to chase the market leaders of linear accelerators whose recent acquisitions have made them stronger, or expand a radiation oncology portfolio with entry-level products, Siemens Healthcare chose the latter, and talked with *AuntMinnie.com* about its decision to exit the sector.

After notifying all of its radiation oncology customers throughout the world that it was planning to stop manufacturing its Artiste, Oncor, and Primus linear accelerator systems as of January 1, 2012, Siemens stated in a November press release that it would be repositioning its radiation oncology business segment and would not rule out "rightsizing" with linear accelerators. However, it did not announce an exit from the linear accelerator business until earlier this week, leaving the market to its key competitors: Accuray, Elekta, and Varian Medical Systems.

Siemens head of public and media relations Matthias Kraemer, PhD, said that the company had been analyzing market changes based on unstable and recessionary conditions in mature healthcare markets for about a year and a half. In view of cost pressures in the U.S. and increasingly in Europe, Siemens had been planning to invest in both the development of new innovations for radiation oncology and expand its radiation oncology portfolio with entry-level products.

But major changes in the market were occurring, and what they represented made Siemens reassess its strategic plans, Kraemer said. Accuray announced that it would purchase TomoTherapy for $277 million, completing the deal in June. That month oncology firm Elekta announced that it would purchase radiation therapy firm Nucletron for $522.1 million. This acquisition was completed in September. And in September, radiation therapy vendor Varian announced it would purchase electromagnetic localization technology developer Calypso Medical Technologies, a deal completed in November.

"We are strong in the radiation oncology market with our imaging equipment, therapy planning, and after-treatment care, but we were not the top leader of the linac business segment," Kraemer said. "It is a corporate objective to be No. 1 or No. 2 in each market segments."

This strategy was made public with Siemens' announcement in early November of Agenda 2013, a global initiative to enhance innovation, build on its greatest strengths, and become more competitive. "In addition to development of a program to improve the cost position in the

diagnostics division, Agenda 2013 includes measures targeting innovation, regional presence, competitiveness, and human resource development over two years," Kraemer said.

The program also included a reallocation of investments and resources to focus on the areas of greatest future development. "It makes sense to develop lower-cost products in radiation oncology for increasingly cost-sensitive mature markets, specifically Europe and North America, and also to target these products to countries like China and India that are rapidly expanding their healthcare systems," Kraemer said.

He emphasized that Siemens is protecting the investment made by its customers in its linac systems. A major software upgrade is scheduled for spring 2012, and customers will be fully supported with technical assistance and maintenance.

Approximately 400 employees in Germany and a much smaller number of employees in the rest of the world will be impacted. Kraemer said that it was the express goal of Siemens to avoid job terminations for operational reasons, and that efforts would be made to transfer affected employees to other positions within the Healthcare division or other company divisions.

Last Updated hh 12/23/2011 11:54:38 AM

Forum Comments

Post your comment ...

RADIOLOGY ONCOLOGY SYSTEMS

Siemens Linear Accelerator Comparison Chart*

Models	Artiste	Oncor (Impression, Expression,& Avante Garde)	Primus K	Primus M
Year(s) Manufactured	2009-2011	2004-2011	1998-2005	1998-2005
Power Source	Klystron	Klystron, Magnetron	Klystron	Magnetron
Photon Energy Configuration	6&10/15/18	6&10/15/18	6&10/15/18	6MV
Electron Energies	Yes	Yes	Yes	Yes
Multi-Leaf Collimator (MLC)**	160 MLC	58; 82; 160 MLC (optional)	58 MLC	58 MLC
Portal Imager (EPID)**	Optivue (Amorphous Silicon)	Optivue (Amorphous Silicon)	BeamView, Optivue (optional)	BeamView, Optivue (optional)
Treatment Delivery	3D, IMRT, VMAT, SRS	3D, IMRT, VMAT, SRS	3D, IMRT, SRS (optional)	3D, IMRT, SRS (optional)
KV Imaging for IGRT**	K-Vision	N/A	N/A	N/A
CBCT	M-Vision, In room CT (optional)	M-Vision	N/A	N/A
Stereotactic Radiosurgery**	Cones or MLC Based	Cones or MLC Based	Cones or MLC Based	Cones or MLC Based
Treatment Couch	TXT	ZXT or TXT	ZXT	ZXT
Demand/Resale Value***	$$$	$$	$	$

*Data shown here may not be accurate and is based on equipment seen in the secondary market. See manufacturers for exact data

**Similar devices are manufactured by vendors other than the linear accelerator manufacturer

***Five $$$$$ indicate that the resale demand for like systems is high, and used equipment will therefore command a higher price

Few dollar signs indicate that the resale demand is lower, and prices for used equipment is lower. One $ indicates very little, if any, value currently exists.

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Please enable Javascript in your browser's settings for advanced site-functionality,
or continue browsing the site if you would prefer to continue without Javascript enabled.

Please call us at (858) 454-8100 or e-mail to: info@oncologysystems.com

Attachment C

Orange County Population Data

Planning & Inspections Department
About Us
Application Forms
Building Inspections
Boards & Committees
Calendars
Census/Demographics
Comprehensive Land Use
Current Interest Projects
Documents
Engineering
Erosion Control
Fees
Floodplain Information
Orange Public Transportation
Ordinances
Planning GIS Maps
Small Area Plans
Transportation Planning
Zoning and Subdivision
Contact Planning & Inspections
Ask an Inspector

Home » Departments » Planning and Inspections » Census/Demographics

Orange County, NC Population, Demographics, and Population Projections

Email me page updates

July 1, 2013 Population Estimate: 139,694*

Census 2010 Population:

Bingham Township	**6,527**
Cedar Grove Township	**5,222**
Chapel Hill Township	**87,971**
Town of Carrboro	19,582
Town of Chapel Hill	54,397
Unincorporated	13,992
Cheeks Township	**9,313**
City of Mebane	1,793
Unincorporated	7,520
Eno Township	**7,501**
Hillsborough Township	**13,809**
Town of Hillsborough	6,087
Unincorporated	7,722
Little River Township	**3,458**
TOTAL	**133,801**

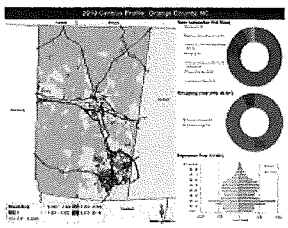
SOURCE: Census Bureau 2010 Census

** Note: 2013 estimate calculated by North Carolina's Office of State Budget & Management*

Census 2010 Profiles

(Population, Race, Housing and Households)

- Orange County
- Cedar Grove Twp
- Little River Twp
- Cheeks Twp
- Hillsborough Twp
- Eno Twp
- Bingham Twp
- Chapel Hill Twp



Census 2010 Maps

« May 2015 ›

S M T W T F
26 27 28 29 30 1
3 4 5 6 7 8
0 11 12 13 14 15
7 18 19 20 21 22
24 25 26 27 28 29
1 2 3 4 5

Wed, Jun 3rd, 2015
Planning Board Meeting

Mon, Jun 8th, 2015
Board of Adjustment Meeting

Wed, Jun 17th, 2015
Orange Unified Transportation Board (OUTBoard) Meeting

MORE ›

Population Density by Census Block
Percent Hispanic or Latino by Census Block
Population Change 2000-2010 by Township
Housing Density by Census Block
Total Housing Unit Change 2000-2010 by Township
Vacant Housing Unit Change 2000-2010 by Township

American Community Survey 5 Year Estimates

The Census Bureau collects American Community Survey data from a sample of the population in the United States and Puerto Rico--rather than from the whole population. All ACS data are survey estimates. To help you interpret the reliability of the estimate, the Census Bureau publishes a margin of error (MOE) for every ACS estimate.

American Community Survey 1-, 3-, and 5-year estimates are period estimates, which means they represent the characteristics of the population and housing over a specific data collection period. Data are combined to produce 12 months, 36 months or 60 months of data. These are called 1-year, 3-year and 5-year data.

ACS 5 Year Profiles (School Enrollment, Education Attainment, Travel Time, Means of Transportation, and Income)

Orange County	2010	2011	2012	2013
Cedar Grove Twp	2010	2011	2012	2013
Little River Twp	2010	2011	2012	2013
Cheeks Twp	2010	2011	2012	2013
Hillsborough Twp	2010	2011	2012	2013
Bingham Twp	2010	2011	2012	2013
Eno Twp	2010	2011	2012	2013
Chapel Hill Twp	2010	2011	2012	2013

Census 2000

View our Census 2000 site

Population Projections

The methodology used to prepare the population projections below were approved by the Board of County Commissioners as part of the Orange County 2030 Comprehensive Plan.

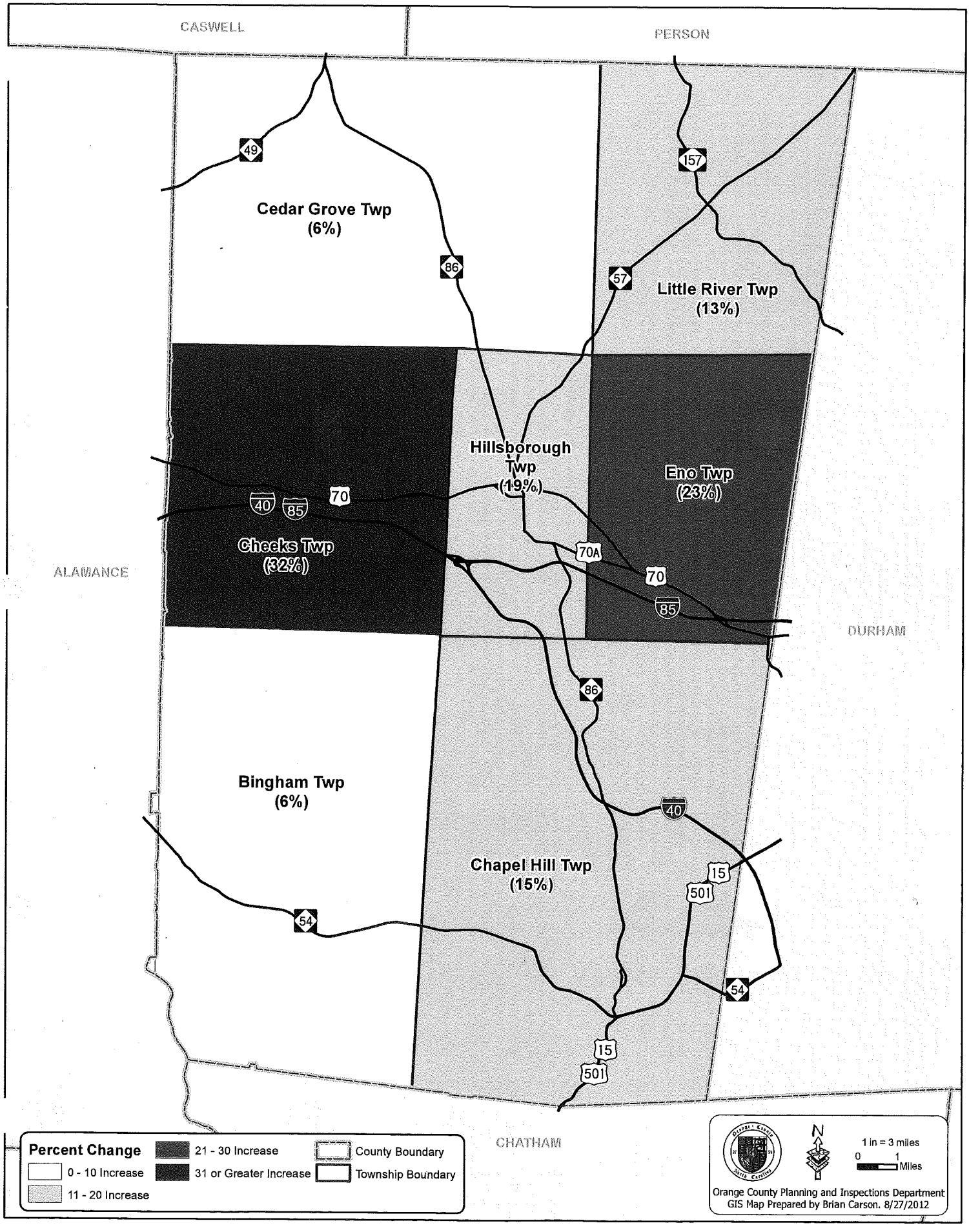
Based on 2010 Census:

2010-2050 Exponential Projection
2010-2050 Linear Projection

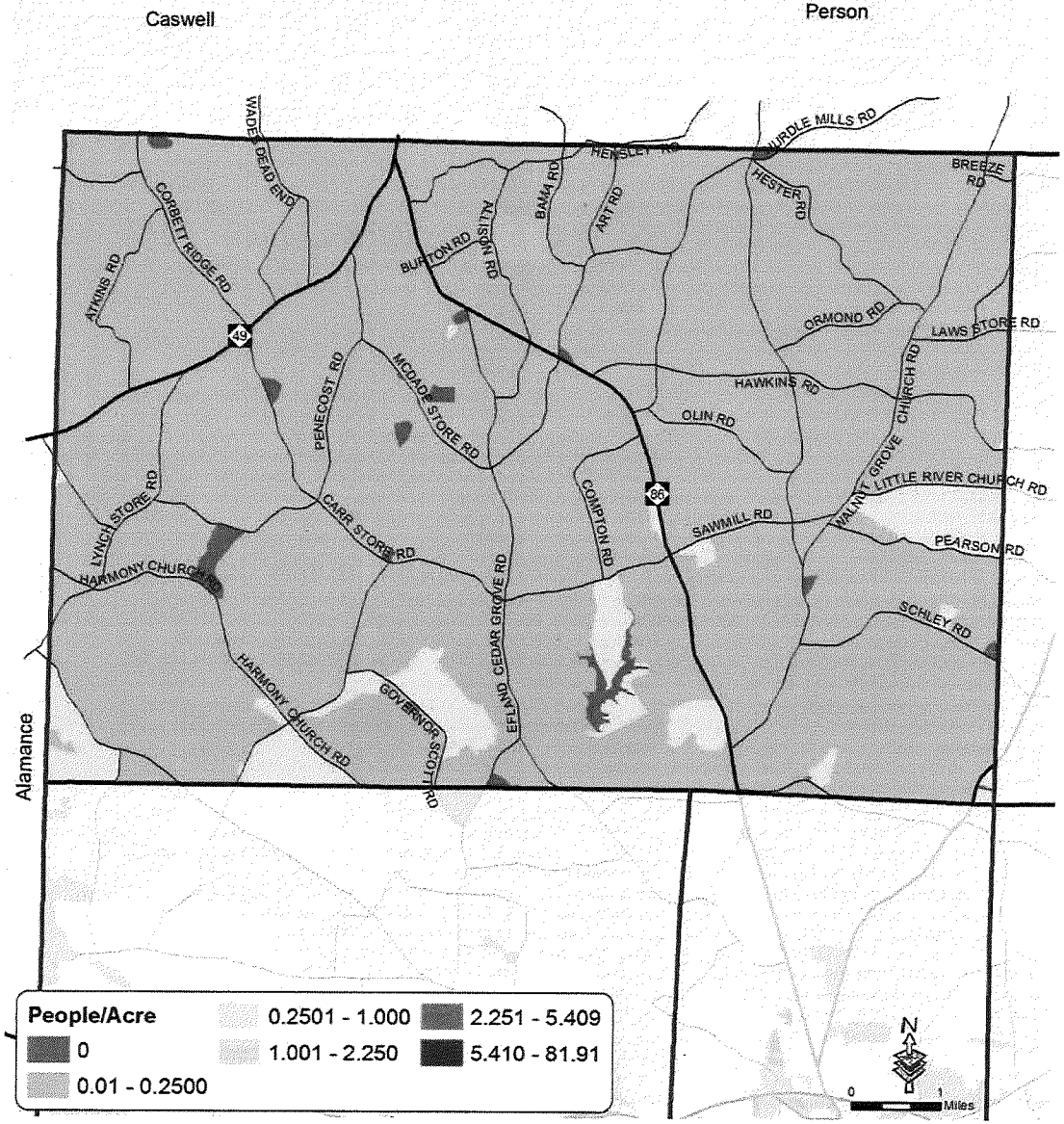
Based on 2000 Census:

2000-2030 Exponential Projection
2000-2030 Linear Projection

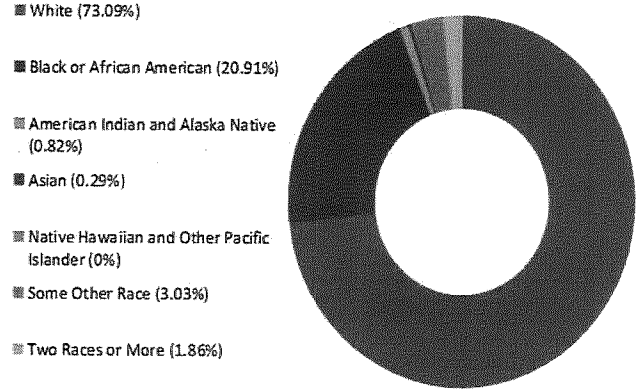
Population Change 2000-2010 by Township



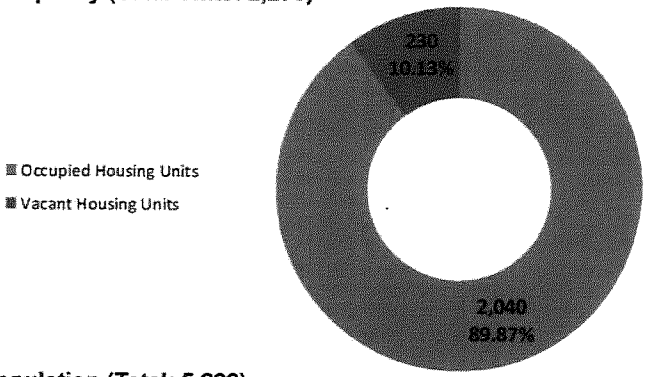
2010 Census Profile: Cedar Grove Township, NC



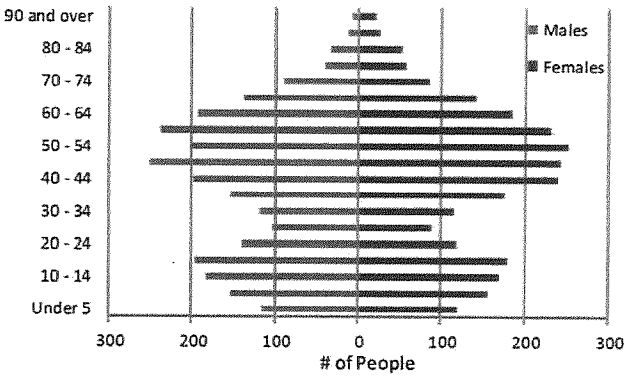
Race Composition (One Race)



Occupancy (Total Units: 2,270)



Population (Total: 5,222)



Population Characteristics - Census 2010, Summary File 1 (Cedar Grove Township)

HIGHLIGHTS	2000	2010	% Change
Total Population	4,930	5,222	5.9
Males	2,451	2,568	4.8
Females	2,479	2,654	7.1
Population Under 18	1,238	1,148	-7.3
Population Under 5	290	235	-19.0
Population 5-17	948	913	-3.7
Population 65 & Over	477	704	47.6
Median Age			
Total	38.2	43.6	14.1
Males	38.1	43.0	12.9
Females	38.2	44.2	15.7
Race			
One Race	4,864	5,125	5.4
White	3,511	3,817	8.7
Black or African American	1,183	1,092	-7.7
American Indian and Alaska Native	35	43	22.9
Asian	8	15	87.5
Native Hawaiian and Other Pacific Islander	0	0	
Some Other Race	127	158	24.4
Two or More Races	66	97	47.0
Hispanic or Latino Origin			
Hispanic or Latino	183	316	72.7
Not Hispanic or Latino	4,747	4,906	3.3

Source: U.S. Census Bureau Census 2000 & 2010

RACE & ETHNICITY	Number	% of
Race		
One Race	5,125	98.1
White	3,817	73.1
Black or African American	1,092	20.9
American Indian and Alaska Native	43	0.8
Asian	15	0.3
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	158	3.0
Hispanic or Latino Origin		
Hispanic or Latino	316	6.1
Not Hispanic or Latino	4,906	93.9
Hispanic or Latino and Race		
Hispanic or Latino	316	6.1
White	114	2.2
Black or African American	8	0.2
American Indian and Alaska Native	18	0.3
Asian	0	0.0
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	151	2.9
Two or More Races	25	0.5
Not Hispanic or Latino	4,906	93.9
White	3,703	70.9
Black or African American	1,084	20.8
American Indian and Alaska Native	25	0.5
Asian	15	0.3
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	7	0.1
Two or More Races	72	1.4

SEX BY AGE	Total Population		Male		Female	
	Number	% of	Number	% of	Number	% of
Under 5	235	4.5	115	4.5	120	4.5
5 - 9	309	5.9	153	6.0	156	5.9
10 - 14	353	6.8	183	7.1	170	6.4
15 - 17	251	4.8	132	5.1	119	4.5
18 - 19	126	2.4	65	2.5	61	2.3
20	55	1.1	20	0.8	35	1.3
21	51	1.0	29	1.1	22	0.8
22 - 24	153	2.9	91	3.5	62	2.3
25 - 29	192	3.7	104	4.0	88	3.3
30 - 34	233	4.5	118	4.6	115	4.3
35 - 39	330	6.3	153	6.0	177	6.7
40 - 44	437	8.4	198	7.7	239	9.0
45 - 49	493	9.4	251	9.8	242	9.1
50 - 54	454	8.7	202	7.9	252	9.5
55 - 59	469	9.0	238	9.3	231	8.7
60 - 61	162	3.1	86	3.3	76	2.9
62 - 64	215	4.1	107	4.2	108	4.1
65 - 66	119	2.3	62	2.4	57	2.1
67 - 69	160	3.1	76	3.0	84	3.2
70 - 74	176	3.4	91	3.5	85	3.2
75 - 79	97	1.9	40	1.6	57	2.1
80 - 84	86	1.6	34	1.3	52	2.0
85 +	66	1.3	20	0.8	46	1.7
Total	5,222	100.0	2,568	100.0	2,654	100.0

Household Characteristics - Census 2010, Summary File 1 (Cedar Grove Township)

HIGHLIGHTS	2000	2010	% Change
Total Households	1,870	2,040	9.09
Total Population	4,930	5,222	5.92
In Households	4,925	5,216	5.91
Family Households	4,378	4,592	4.89
Nonfamily Households	547	624	14.08
In Group Quarters	5	6	20.00
Institutionalized	0	0	
Noninstitutionalized	5	6	20.00
Households with People			
Under 18 Years	1,238	1,148	-7.27
65 + Years	477	704	47.59
Average Household Size	2.63	2.56	-2.66
Average Family Size	3.01	2.93	-2.66

Source: U.S. Census Bureau Census 2000 & 2010

HOUSEHOLD TYPE BY HOUSEHOLD SIZE

	Total		Family Households		Nonfamily Households	
	Number	% of	Number	% of	Number	% of
1-Person Hhld	0	0.0	x	x		0.0
2-Person Hhld	1,125	55.1	708	46.4	417	81.1
3-Person Hhld	440	21.6	355	23.3	85	16.5
4-Person Hhld	300	14.7	289	18.9	11	2.1
5-Person Hhld	114	5.6	113	7.4	1	0.2
6-Person Hhld	44	2.2	44	2.9	0	0.0
7 + -Person Hhld	17	0.8	17	1.1	0	0.0
Total	2,040	100.0	1,526	100.0	514	100.0

GROUP QUARTERS POPULATION BY TYPE

	Number	%
Total Population in Group Quarters	6	100.0
Institutionalized Population	0	0.0
Correctional Facilities for Adults	0	0.0
Juvenile Facilities	0	0.0
Nursing Facilities/Skilled-nursing Facilities	0	0.0
Other Institutional Facilities	0	0.0
Noninstitutionalized Population	6	100.0
College/University Student Housing	0	0.0
Military Quarters	0	0.0
Other Noninstitutional Facilities	6	100.0

FAMILY TYPE BY PRESENCE AND AGE OF OWN CHILDREN

	Number	%
Total Families	1,526	100.0
With Own Children Under 18 Years	589	38.6
Husband-Wife Family	1,174	76.9
With Own Children Under 18 Years	430	28.2
Male Household, No Wife Present	104	6.8
With Own Children Under 18 Years	45	2.9
Female Household, no Husband Present	248	16.3
With Own Children Under 18 Years	114	7.5

Housing Characteristics - Census 2010, Summary File 1 (Cedar Grove Township)

HIGHLIGHTS	2000	2010	% Change
Housing Units	2,082	2,270	9.03
Occupied Housing Units	1,870	2,040	9.09
Owner Occupied	1,549	1,683	8.65
Renter Occupied	321	357	11.21
Average Household Size	2.63	2.56	-2.66
Owner Occupied	2.67	2.56	-4.12
Renter Occupied	2.48	2.52	1.61
Vacant Housing Units	212	230	8.49

Source: U.S. Census Bureau Census 2000 & 2010

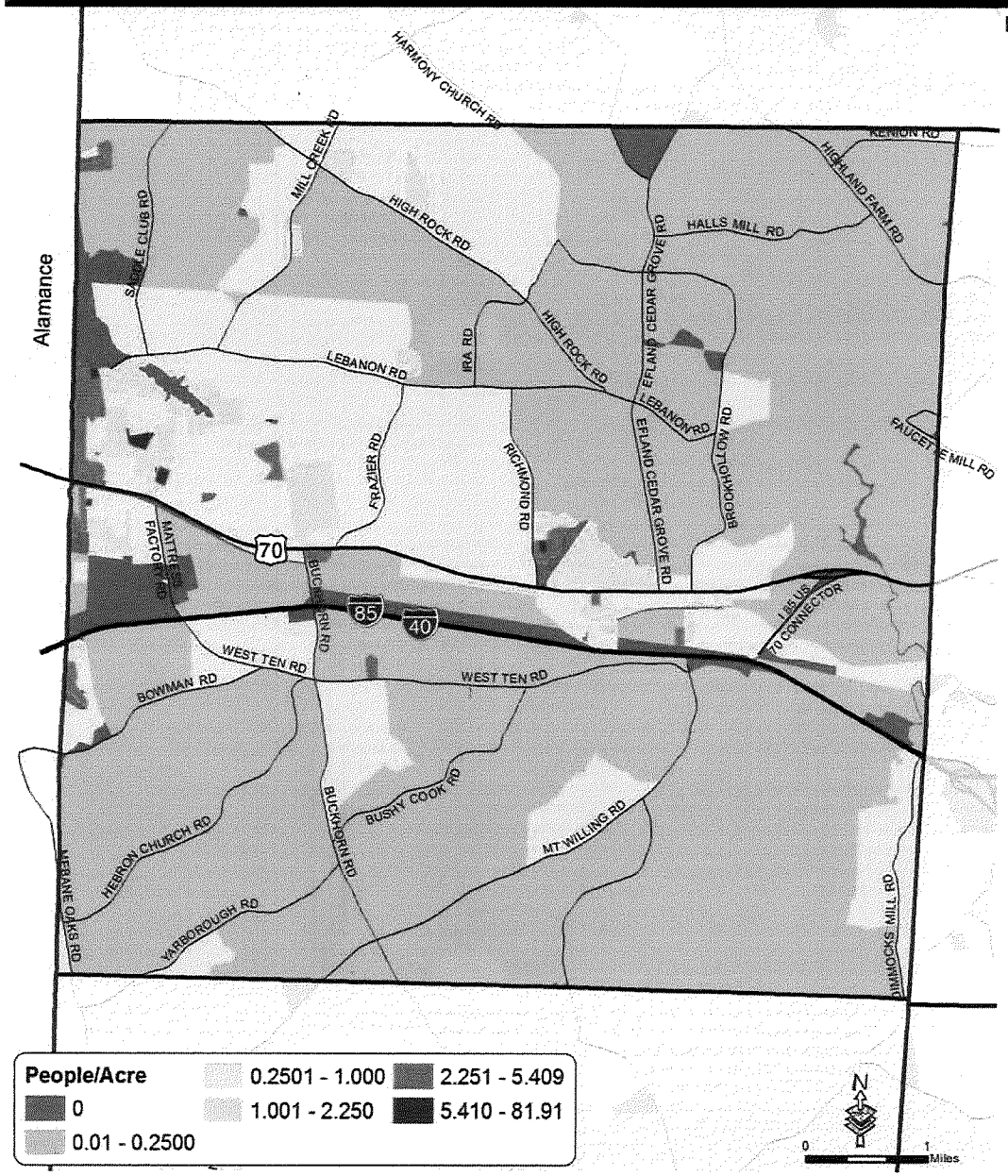
VACANCY STATUS

	Number	%
Total	230	100.00
For Rent	35	15.22
Rented, Not Occupied	0	0.00
For Sale Only	29	12.61
Sold, Not Occupied	10	4.35
For Seasonal, Recreational, or Occasional Use	22	9.57
For Migrant Workers	6	2.61
All other Vacants	128	55.65

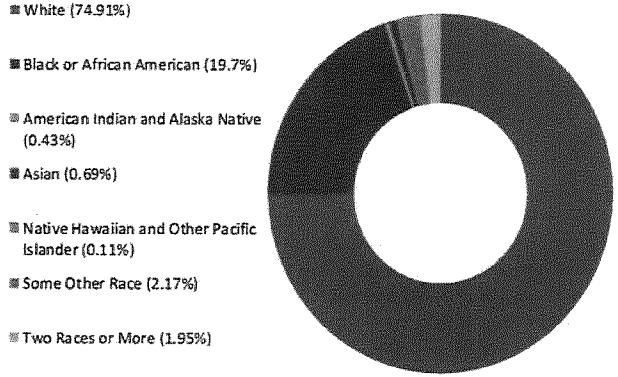
TENURE

	Number	%
Total	2,040	100.00
Owner Occupied	1,683	82.50
Owned with a Mortgage or a Load	1,212	59.41
Owned free and Clear	471	23.09
Renter Occupied	357	17.50

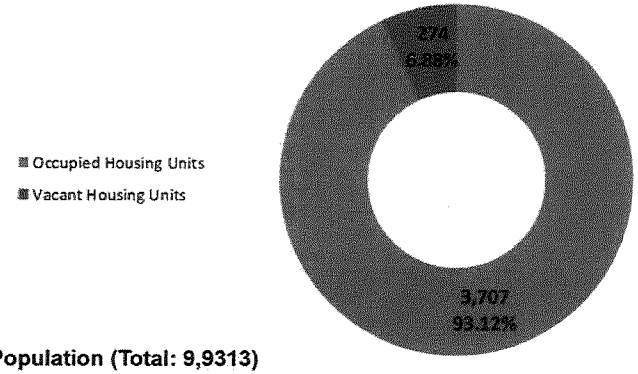
2010 Census Profile: Cheeks Township, NC



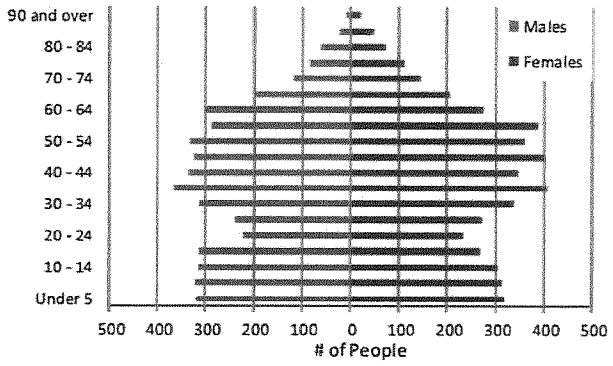
Race Composition (One Race)



Occupancy (Total Units: 3,981)



Population (Total: 9,9313)



Population Characteristics - Census 2010, Summary File 1 (Cheeks Township)

HIGHLIGHTS	2000	2010	% Change
Total Population	7,064	9,313	31.8
Males	3,450	4,484	30.0
Females	3,614	4,829	33.6
Population Under 18	1,797	2,262	25.9
Population Under 5	495	638	28.9
Population 5-17	1,302	1,624	24.7
Population 65 & Over	761	1,096	44.0
Median Age			
Total	36.4	38.8	6.6
Males	35.7	38.0	6.4
Females	37.1	39.6	6.7
Race			
One Race	6,990	9,131	30.6
White	5,318	6,976	31.2
Black or African American	1,482	1,839	24.1
American Indian and Alaska Native	25	40	60.0
Asian	19	64	236.8
Native Hawaiian and Other Pacific Islander	2	10	400.0
Some Other Race	144	202	40.3
Two or More Races	74	182	145.9
Hispanic or Latino Origin			
Hispanic or Latino	325	581	78.8
Not Hispanic or Latino	6,739	8,732	29.6

Source: U.S. Census Bureau Census 2000 & 2010

RACE & ETHNICITY	Number	% of
Race		
One Race	9,131	98.0
White	6,976	74.9
Black or African American	1,839	19.7
American Indian and Alaska Native	40	0.4
Asian	64	0.7
Native Hawaiian and Other Pacific Islander	10	0.1
Some Other Race	202	2.2
Hispanic or Latino Origin		
Hispanic or Latino	581	6.2
Not Hispanic or Latino	8,732	93.8
Hispanic or Latino and Race		
Hispanic or Latino	581	6.2
White	320	3.4
Black or African American	14	0.2
American Indian and Alaska Native	20	0.2
Asian	0	0.0
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	184	2.0
Two or More Races	43	0.5
Not Hispanic or Latino	8,732	93.8
White	6,656	71.5
Black or African American	1,825	19.6
American Indian and Alaska Native	20	0.2
Asian	64	0.7
Native Hawaiian and Other Pacific Islander	10	0.1
Some Other Race	18	0.2
Two or More Races	139	1.5

SEX BY AGE	Total Population		Male		Female	
	Number	% of	Number	% of	Number	% of
Under 5	638	6.9	319	7.1	319	6.6
5 - 9	635	6.8	322	7.2	313	6.5
10 - 14	619	6.6	314	7.0	305	6.3
15 - 17	370	4.0	189	4.2	181	3.7
18 - 19	213	2.3	124	2.8	89	1.8
20	84	0.9	43	1.0	41	0.8
21	74	0.8	33	0.7	41	0.8
22 - 24	297	3.2	145	3.2	152	3.1
25 - 29	511	5.5	239	5.3	272	5.6
30 - 34	652	7.0	314	7.0	338	7.0
35 - 39	771	8.3	365	8.1	406	8.4
40 - 44	682	7.3	336	7.5	346	7.2
45 - 49	726	7.8	325	7.2	401	8.3
50 - 54	691	7.4	332	7.4	359	7.4
55 - 59	677	7.3	289	6.4	388	8.0
60 - 61	234	2.5	118	2.6	116	2.4
62 - 64	343	3.7	185	4.1	158	3.3
65 - 66	183	2.0	87	1.9	96	2.0
67 - 69	220	2.4	111	2.5	109	2.3
70 - 74	261	2.8	116	2.6	145	3.0
75 - 79	196	2.1	83	1.9	113	2.3
80 - 84	134	1.4	62	1.4	72	1.5
85 +	102	1.1	33	0.7	69	1.4
Total	9,313	100.0	4,484	100.0	4,829	100.0

Household Characteristics - Census 2010, Summary File 1 (Cheeks Township)

HIGHLIGHTS	2000	2010	% Change
Total Households	2,742	3,707	35.19
Total Population	7,064	9,313	31.84
In Households	7,064	9,305	31.72
Family Households	6,212	8,041	29.44
Nonfamily Households	852	1,264	48.36
In Group Quarters	0	8	
Institutionalized	0	0	
Noninstitutionalized	0	8	
Households with People			
Under 18 Years	1,797	1,272	-29.22
65 + Years	761	810	6.44
Average Household Size	2.58	2.51	-2.71
Average Family Size	2.97	2.97	0.00

Source: U.S. Census Bureau Census 2000 & 2010

HOUSEHOLD TYPE BY HOUSEHOLD SIZE

	Total		Family Households		Nonfamily Households	
	Number	% of	Number	% of	Number	% of
1-Person Hhld	886	23.9	x	x	886	83.3
2-Person Hhld	1,351	36.4	1,190	45.0	161	15.1
3-Person Hhld	667	18.0	657	24.8	10	0.9
4-Person Hhld	495	13.4	490	18.5	5	0.5
5-Person Hhld	187	5.0	187	7.1	0	0.0
6-Person Hhld	72	1.9	71	2.7	1	0.1
7 + -Person Hhld	49	1.3	49	1.9	0	0.0
Total	3,707	100.0	2,644	100.0	1,063	100.0

GROUP QUARTERS POPULATION BY TYPE

	Number	%
Total Population in Group Quarters	8	100.0
Institutionalized Population	0	
Correctional Facilities for Adults	0	
Juvenile Facilities	0	
Nursing Facilities/Skilled-nursing Facilities	0	
Other Institutional Facilities	0	
Noninstitutionalized Population	8	100.0
College/University Student Housing	0	
Military Quarters	0	
Other Noninstitutional Facilities	8	100.0

FAMILY TYPE BY PRESENCE AND AGE OF OWN CHILDREN

	Number	%
Total Families	2,644	100.0
With Own Children Under 18 Years	1,136	43.0
Husband-Wife Family	1,976	74.7
With Own Children Under 18 Years	773	29.2
Male Household, No Wife Present	159	6.0
With Own Children Under 18 Years	83	3.1
Female Household, no Husband Present	509	19.3
With Own Children Under 18 Years	280	10.6

Housing Characteristics - Census 2010, Summary File 1 (Cheeks Township)

HIGHLIGHTS	2000	2010	% Change
Housing Units	2,930	3,981	35.87
Occupied Housing Units	2,742	3,707	35.19
Owner Occupied	2,322	2,973	28.04
Renter Occupied	420	734	74.76
Average Household Size	2.58	2.51	-2.71
Owner Occupied	2.56	2.55	-0.39
Renter Occupied	2.67	2.35	-11.99
Vacant Housing Units	188	274	45.74

Source: U.S. Census Bureau Census 2000 & 2010

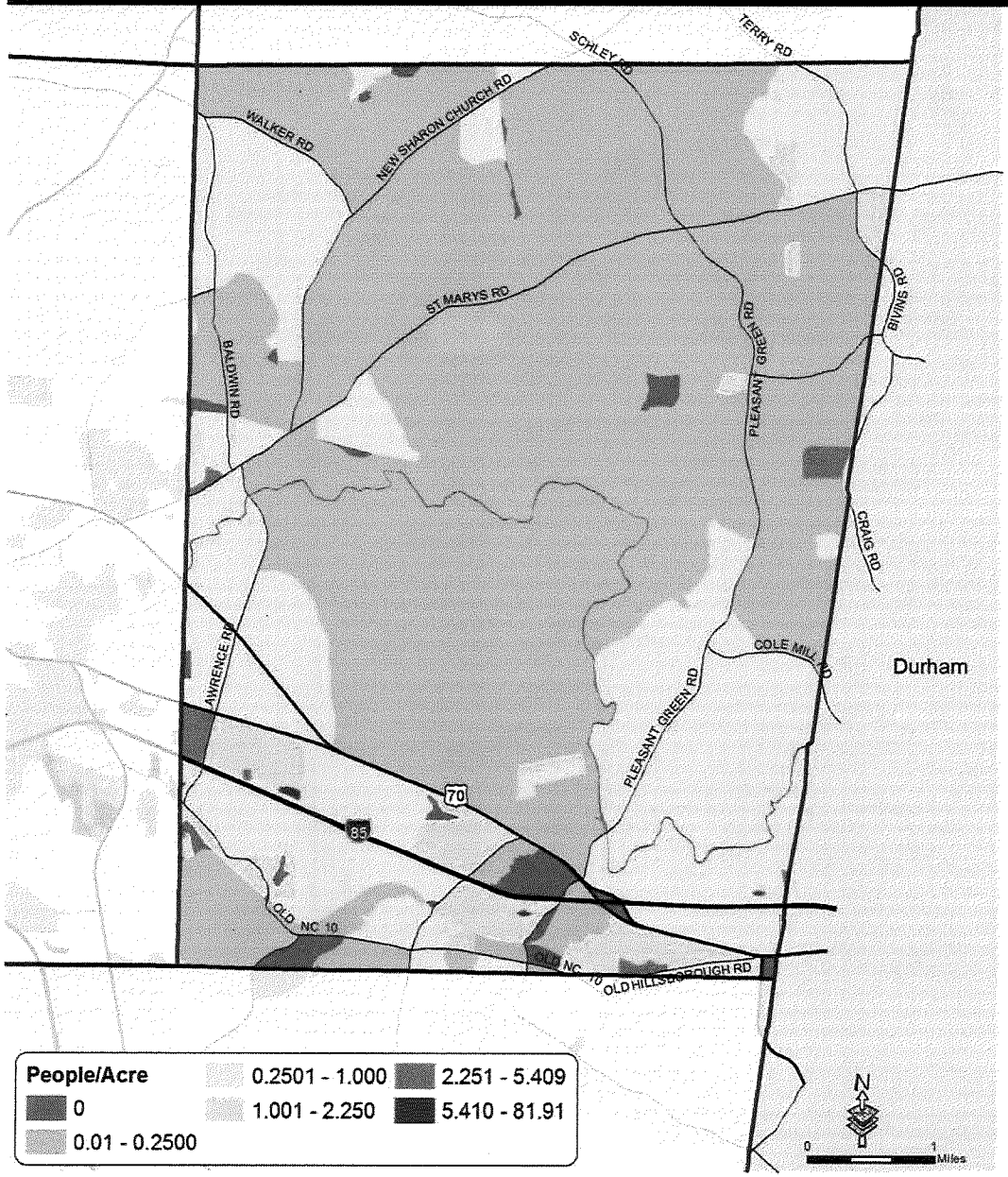
VACANCY STATUS

	Number	%
Total	274	100.00
For Rent	45	16.42
Rented, Not Occupied	4	1.46
For Sale Only	68	24.82
Sold, Not Occupied	15	5.47
For Seasonal, Recreational, or Occasional Use	21	7.66
For Migrant Workers	1	0.36
All other Vacants	120	43.80

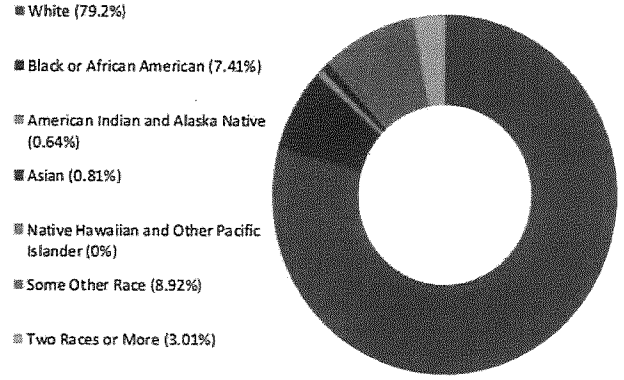
TENURE

	Number	%
Total	3,707	100.00
Owner Occupied	2,973	80.20
Owned with a Mortgage or a Load	2,244	60.53
Owned free and Clear	729	19.67
Renter Occupied	734	19.80

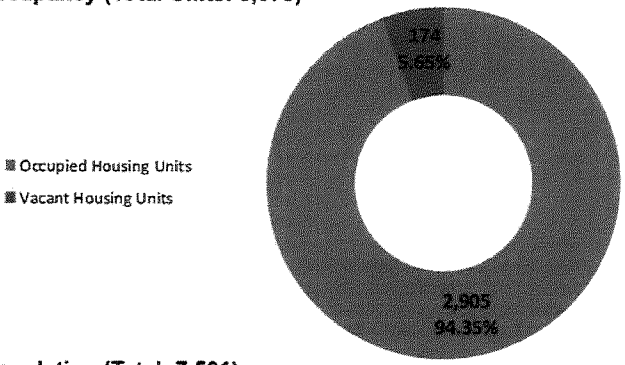
2010 Census Profile: Eno Township, NC



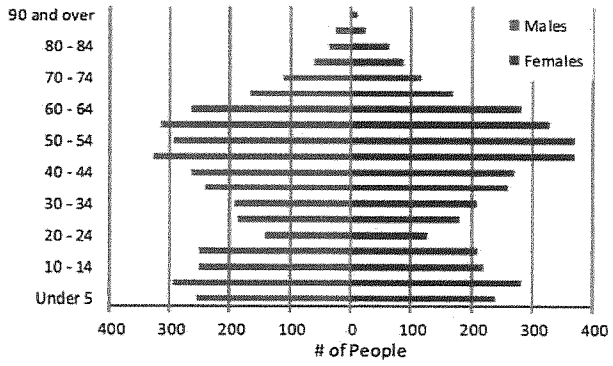
Race Composition (One Race)



Occupancy (Total Units: 3,079)



Population (Total: 7,501)



Population Characteristics - Census 2010, Summary File 1 (Eno Township)

HIGHLIGHTS	2000	2010	% Change
Total Population	6,092	7,501	23.1
Males	3,040	3,683	21.2
Females	3,052	3,818	25.1
Population Under 18	1,479	1,871	26.5
Population Under 5	361	496	37.4
Population 5-17	1,118	1,375	23.0
Population 65 & Over	563	874	55.2
Median Age			
Total	39	41.9	7.4
Males	37.6	40.5	7.7
Females	40	43.2	8.0
Race			
One Race	6,016	7,275	20.9
White	5,344	5,941	11.2
Black or African American	549	556	1.3
American Indian and Alaska Native	22	48	118.2
Asian	50	61	22.0
Native Hawaiian and Other Pacific Islander	0	0	
Some Other Race	51	669	1211.8
Two or More Races	76	226	197.4
Hispanic or Latino Origin			
Hispanic or Latino	139	1,054	658.3
Not Hispanic or Latino	5,953	6,447	8.3

Source: U.S. Census Bureau Census 2000 & 2010

RACE & ETHNICITY	Number	% of
Race		
One Race	7,275	97.0
White	5,941	79.2
Black or African American	556	7.4
American Indian and Alaska Native	48	0.6
Asian	61	0.8
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	669	8.9
Hispanic or Latino Origin		
Hispanic or Latino	1,054	14.1
Not Hispanic or Latino	6,447	85.9
Hispanic or Latino and Race		
Hispanic or Latino	1,054	14.1
White	290	3.9
Black or African American	15	0.2
American Indian and Alaska Native	26	0.3
Asian	1	0.0
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	652	8.7
Two or More Races	70	0.9
Not Hispanic or Latino	6,447	85.9
White	5,651	75.3
Black or African American	541	7.2
American Indian and Alaska Native	22	0.3
Asian	60	0.8
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	17	0.2
Two or More Races	156	2.1

SEX BY AGE	Total Population		Male		Female	
	Number	% of	Number	% of	Number	% of
Under 5	496	6.6	256	7.0	240	6.3
5 - 9	577	7.7	295	8.0	282	7.4
10 - 14	473	6.3	254	6.9	219	5.7
15 - 17	328	4.4	182	4.9	146	3.8
18 - 19	130	1.7	65	1.8	65	1.7
20	58	0.8	32	0.9	26	0.7
21	54	0.7	31	0.8	23	0.6
22 - 24	158	2.1	79	2.1	79	2.1
25 - 29	367	4.9	187	5.1	180	4.7
30 - 34	401	5.3	193	5.2	208	5.4
35 - 39	501	6.7	241	6.5	260	6.8
40 - 44	535	7.1	264	7.2	271	7.1
45 - 49	697	9.3	328	8.9	369	9.7
50 - 54	663	8.8	294	8.0	369	9.7
55 - 59	644	8.6	315	8.6	329	8.6
60 - 61	227	3.0	101	2.7	126	3.3
62 - 64	318	4.2	162	4.4	156	4.1
65 - 66	146	1.9	77	2.1	69	1.8
67 - 69	189	2.5	89	2.4	100	2.6
70 - 74	228	3.0	111	3.0	117	3.1
75 - 79	148	2.0	61	1.7	87	2.3
80 - 84	99	1.3	37	1.0	62	1.6
85 +	64	0.9	29	0.8	35	0.9
Total	7,501	100.0	3,683	100.0	3,818	100.0

Household Characteristics - Census 2010, Summary File 1 (Eno Township)

HIGHLIGHTS	2000	2010	% Change
Total Households	2,449	2,905	18.62
Total Population	6,092	7,501	23.13
In Households	6,088	7,501	23.21
Family Households	5,271	6,593	25.08
Nonfamily Households	817	908	11.14
In Group Quarters	4	0	-100.00
Institutionalized	4	0	-100.00
Noninstitutionalized	0	0	
Households with People			
Under 18 Years	904	1,033	14.27
65 + Years	420	649	54.52
Average Household Size	2.49	2.58	3.61
Average Family Size	2.89	2.99	3.46

Source: U.S. Census Bureau Census 2000 & 2010

HOUSEHOLD TYPE BY HOUSEHOLD SIZE

	Total		Family Households		Nonfamily Households	
	Number	% of	Number	% of	Number	% of
1-Person Hhld	613	21.1	x	x	613	81.8
2-Person Hhld	1,073	36.9	952	44.2	121	16.2
3-Person Hhld	516	17.8	509	23.6	7	0.9
4-Person Hhld	463	15.9	455	21.1	8	1.1
5-Person Hhld	152	5.2	152	7.1	0	0.0
6-Person Hhld	52	1.8	52	2.4	0	0.0
7 + -Person Hhld	36	1.2	36	1.7	0	0.0
Total	2,905	100.0	2,156	100.0	749	100.0

GROUP QUARTERS POPULATION BY TYPE

	Number	%
Total Population in Group Quarters	0	
Institutionalized Population	0	
Correctional Facilities for Adults	0	
Juvenile Facilities	0	
Nursing Facilities/Skilled-nursing Facilities	0	
Other Institutional Facilities	0	
Noninstitutionalized Population	0	
College/University Student Housing	0	
Military Quarters	0	
Other Noninstitutional Facilities	0	

FAMILY TYPE BY PRESENCE AND AGE OF OWN CHILDREN

	Number	%
Total Families	2,156	100.0
With Own Children Under 18 Years	1,401	65.0
Husband-Wife Family	1,728	80.1
With Own Children Under 18 Years	1,169	54.2
Male Household, No Wife Present	125	5.8
With Own Children Under 18 Years	71	3.3
Female Household, no Husband Present	303	14.1
With Own Children Under 18 Years	161	7.5

Housing Characteristics - Census 2010, Summary File 1 (Eno Township)

HIGHLIGHTS	2000	2010	% Change
Housing Units	2,609	3,079	18.01
Occupied Housing Units	2,449	2,905	18.62
Owner Occupied	2,059	2,434	18.21
Renter Occupied	390	471	20.77
Average Household Size	2.49	2.58	3.61
Owner Occupied	2.51	2.53	0.80
Renter Occupied	2.35	2.85	21.28
Vacant Housing Units	160	174	8.75

Source: U.S. Census Bureau Census 2000 & 2010

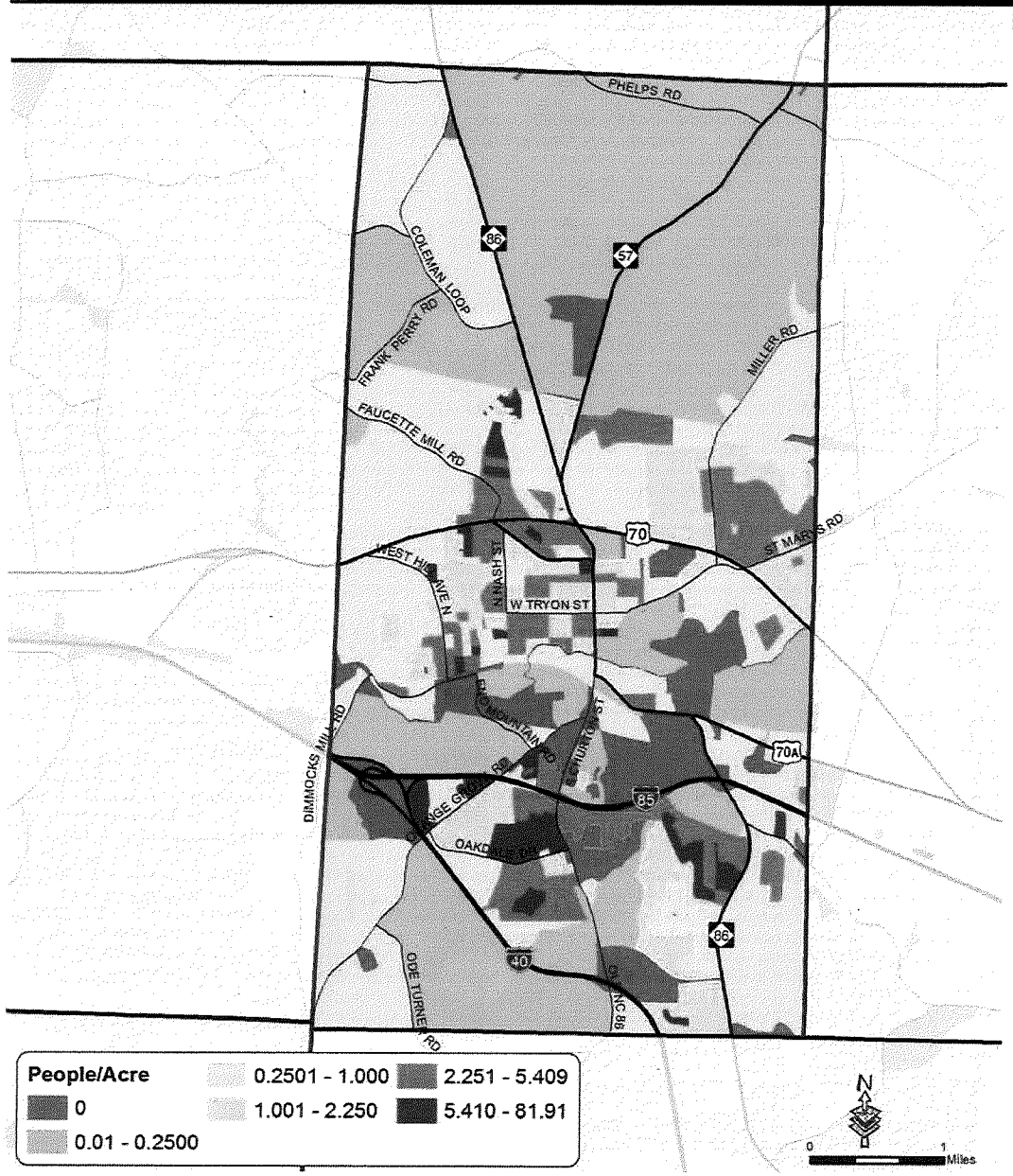
VACANCY STATUS

	Number	%
Total	174	100.00
For Rent	45	25.86
Rented, Not Occupied	3	1.72
For Sale Only	28	16.09
Sold, Not Occupied	1	0.57
For Seasonal, Recreational, or Occasional Use	15	8.62
For Migrant Workers	0	0.00
All other Vacants	82	47.13

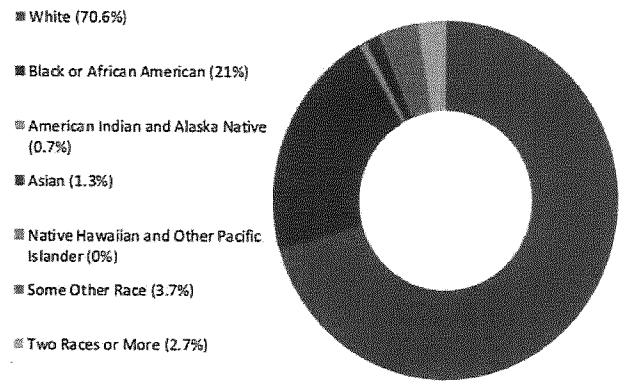
TENURE

	Number	%
Total	2,905	100.00
Owner Occupied	2,434	83.79
Owned with a Mortgage or a Load	1,677	57.73
Owned free and Clear	757	26.06
Renter Occupied	471	16.21

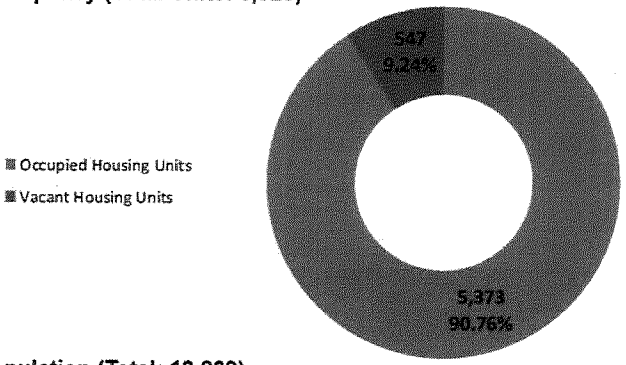
2010 Census Profile: Hillsborough Township, NC



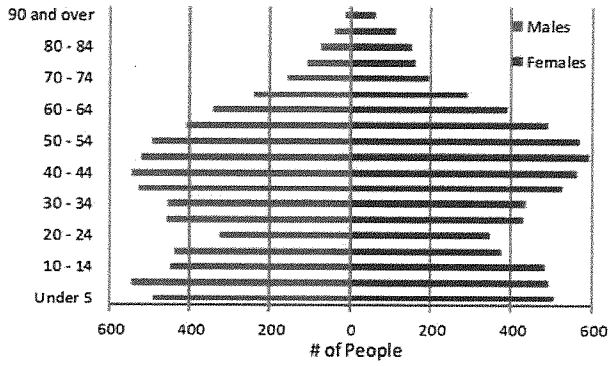
Race Composition (One Race)



Occupancy (Total Units: 5,920)



Population (Total: 13,809)



Population Characteristics - Census 2010, Summary File 1 (Hillsborough Township)

HIGHLIGHTS	2000	2010	% Change
Total Population	11,639	13,809	18.6
Males	5,613	6,622	18.0
Females	6,026	7,187	19.3
Population Under 18	2,939	3,501	19.1
Population Under 5	752	997	32.6
Population 5-17	2,187	2,504	14.5
Population 65 & Over	1,341	1,605	19.7
Median Age			
Total	35.7	38.3	7.3
Males	34	36.4	7.1
Females	37.6	39.9	6.1
Race			
One Race	11,411	13,439	17.8
White	8,119	9,747	20.1
Black or African American	2,999	2,896	-3.4
American Indian and Alaska Native	53	97	83.0
Asian	51	183	258.8
Native Hawaiian and Other Pacific Islander	1	3	200.0
Some Other Race	188	513	172.9
Two or More Races	228	370	62.3
Hispanic or Latino Origin			
Hispanic or Latino	405	1,155	185.2
Not Hispanic or Latino	11,234	12,654	12.6

Source: U.S. Census Bureau Census 2000 & 2010

RACE & ETHNICITY	Number	% of
Race		
One Race	13,439	97.3
White	9,747	70.6
Black or African American	2,896	21.0
American Indian and Alaska Native	97	0.7
Asian	183	1.3
Native Hawaiian and Other Pacific Islander	3	0.0
Some Other Race	513	3.7
Hispanic or Latino Origin		
Hispanic or Latino	1,155	8.4
Not Hispanic or Latino	12,654	91.6
Hispanic or Latino and Race		
Hispanic or Latino	1,155	8.4
White	499	3.6
Black or African American	29	0.2
American Indian and Alaska Native	38	0.3
Asian	0	0.0
Native Hawaiian and Other Pacific Islander	1	0.0
Some Other Race	489	3.5
Two or More Races	99	0.7
Not Hispanic or Latino	12,654	91.6
White	9,248	67.0
Black or African American	2,867	20.8
American Indian and Alaska Native	59	0.4
Asian	183	1.3
Native Hawaiian and Other Pacific Islander	2	0.0
Some Other Race	24	0.2
Two or More Races	271	2.0

SEX BY AGE	Total Population		Male		Female	
	Number	% of	Number	% of	Number	% of
Under 5	997	7.2	490	7.4	507	7.1
5 - 9	1,037	7.5	544	8.2	493	6.9
10 - 14	931	6.7	448	6.8	483	6.7
15 - 17	536	3.9	279	4.2	257	3.6
18 - 19	280	2.0	160	2.4	120	1.7
20	141	1.0	70	1.1	71	1.0
21	113	0.8	61	0.9	52	0.7
22 - 24	419	3.0	194	2.9	225	3.1
25 - 29	888	6.4	457	6.9	431	6.0
30 - 34	893	6.5	455	6.9	438	6.1
35 - 39	1,055	7.6	528	8.0	527	7.3
40 - 44	1,108	8.0	544	8.2	564	7.8
45 - 49	1,113	8.1	519	7.8	594	8.3
50 - 54	1,061	7.7	493	7.4	568	7.9
55 - 59	900	6.5	409	6.2	491	6.8
60 - 61	293	2.1	144	2.2	149	2.1
62 - 64	439	3.2	196	3.0	243	3.4
65 - 66	229	1.7	103	1.6	126	1.8
67 - 69	303	2.2	137	2.1	166	2.3
70 - 74	353	2.6	157	2.4	196	2.7
75 - 79	270	2.0	108	1.6	162	2.3
80 - 84	223	1.6	72	1.1	151	2.1
85 +	227	1.6	54	0.8	173	2.4
Total	13,809	100.0	6,622	100.0	7,187	100.0

Household Characteristics - Census 2010, Summary File 1 (Hillsborough Township)

HIGHLIGHTS	2000	2010	% Change
Total Households	4,514	5,373	19.03
Total Population	11,639	13,809	18.64
In Households	11,215	13,331	18.87
Family Households	9,516	11,186	17.55
Nonfamily Households	1,699	2,145	26.25
In Group Quarters	424	478	12.74
Institutionalized	397	467	17.63
Noninstitutionalized	27	11	-59.26
Households with People			
Under 18 Years	1,702	3,498	105.52
65 + Years	965	1,508	56.27
Average Household Size	2.48	2.48	0.00
Average Family Size	2.96	30.3	923.65

Source: U.S. Census Bureau Census 2000 & 2010

HOUSEHOLD TYPE BY HOUSEHOLD SIZE

	Total		Family Households		Nonfamily Households	
	Number	% of	Number	% of	Number	% of
1-Person Hhld	1,489	27.7	x	x	1,489	83.2
2-Person Hhld	1,756	32.7	1,490	41.6	266	14.9
3-Person Hhld	912	17.0	887	24.8	25	1.4
4-Person Hhld	747	13.9	741	20.7	6	0.3
5-Person Hhld	305	5.7	302	8.4	3	0.2
6-Person Hhld	103	1.9	103	2.9	0	0.0
7 + -Person Hhld	61	1.1	60	1.7	1	0.1
Total	5,373	100.0	3,583	100.0	1,790	100.0

GROUP QUARTERS POPULATION BY TYPE

	Number	%
Total Population in Group Quarters	478	100.0
Institutionalized Population	467	97.7
Correctional Facilities for Adults	365	76.4
Juvenile Facilities	2	0.4
Nursing Facilities/Skilled-nursing Facilities	94	19.7
Other Institutional Facilities	6	1.3
Noninstitutionalized Population	11	2.3
College/University Student Housing	0	0.0
Military Quarters	0	0.0
Other Noninstitutional Facilities	11	2.3

FAMILY TYPE BY PRESENCE AND AGE OF OWN CHILDREN

	Number	%
Total Families	3,583	100.0
With Own Children Under 18 Years	1,750	48.8
Husband-Wife Family	2,483	69.3
With Own Children Under 18 Years	1,169	32.6
Male Household, No Wife Present	242	6.8
With Own Children Under 18 Years	107	3.0
Female Household, no Husband Present	858	23.9
With Own Children Under 18 Years	474	13.2

Housing Characteristics - Census 2010, Summary File 1 (Hillsborough Township)

HIGHLIGHTS	2000	2010	% Change
Housing Units	4,909	5,920	20.59
Occupied Housing Units	4,514	5,373	19.03
Owner Occupied	3,100	3,588	15.74
Renter Occupied	1,414	1,785	26.24
Average Household Size	2.48	2.48	0.00
Owner Occupied	2.52	2.59	2.78
Renter Occupied	2.41	2.26	-6.22
Vacant Housing Units	395	547	38.48

Source: U.S. Census Bureau Census 2000 & 2010

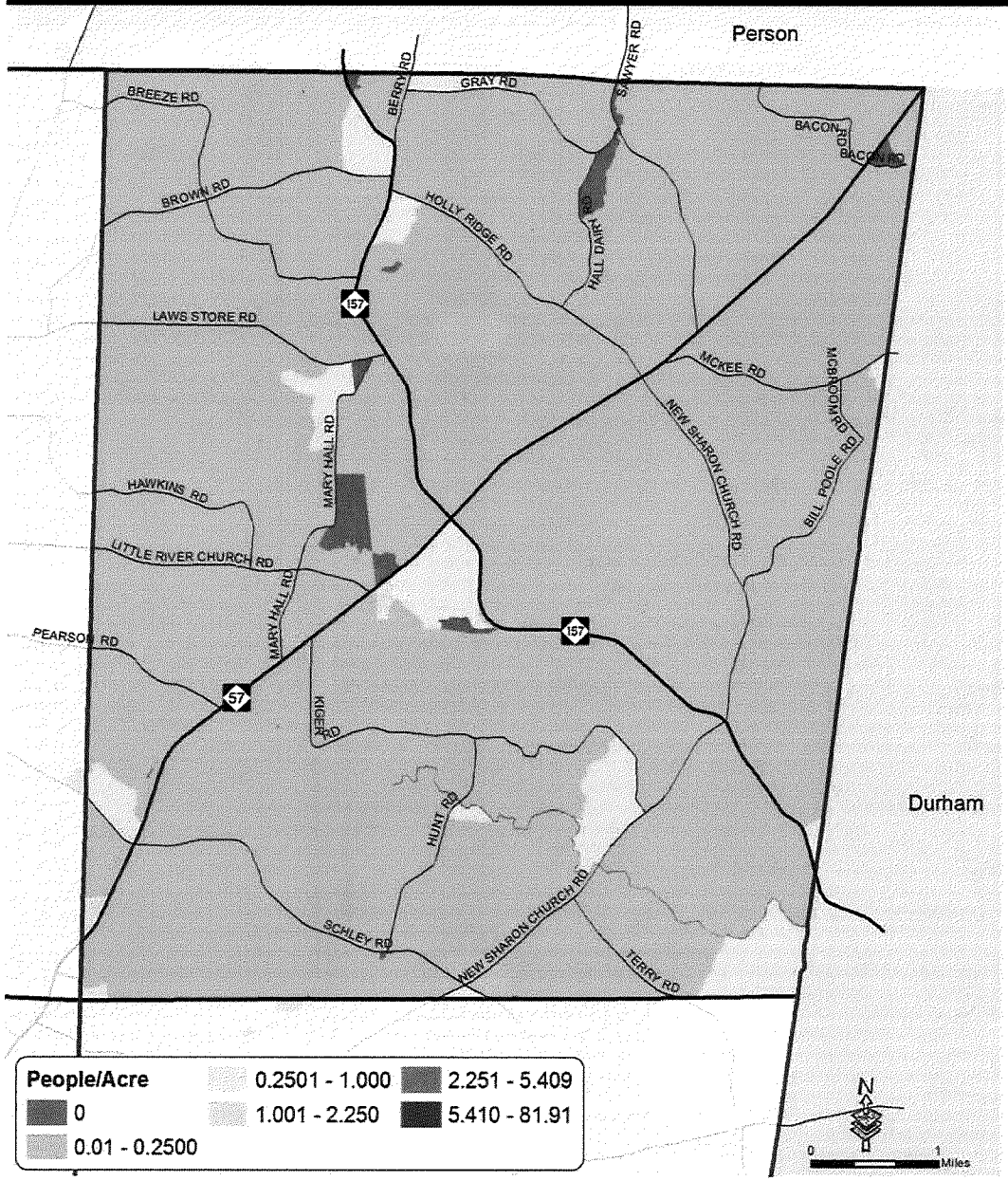
VACANCY STATUS

	Number	%
Total	547	100.00
For Rent	231	42.23
Rented, Not Occupied	11	2.01
For Sale Only	79	14.44
Sold, Not Occupied	9	1.65
For Seasonal, Recreational, or Occasional Use	35	6.40
For Migrant Workers	0	0.00
All other Vacants	182	33.27

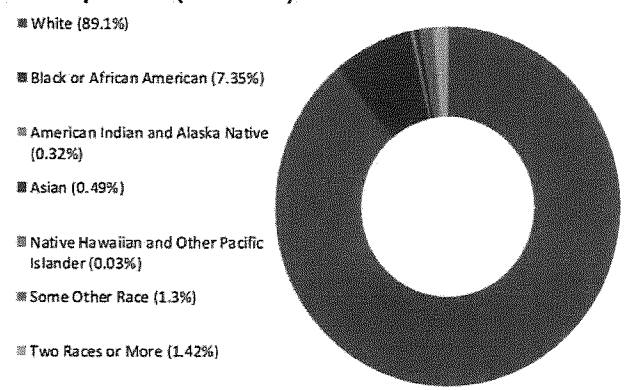
TENURE

	Number	%
Total	5,373	100.00
Owner Occupied	3,588	66.78
Owned with a Mortgage or a Load	2,636	49.06
Owned free and Clear	952	17.72
Renter Occupied	1,785	33.22

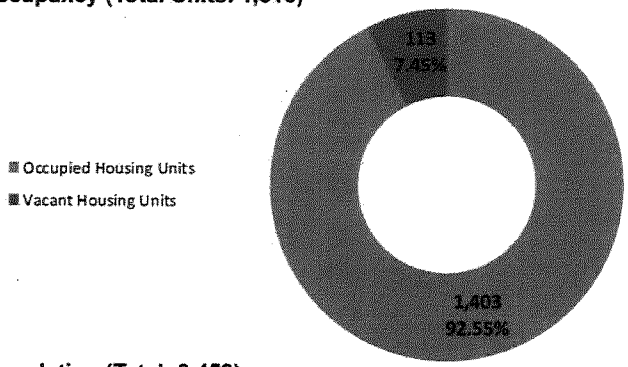
2010 Census Profile: Little River Township, NC



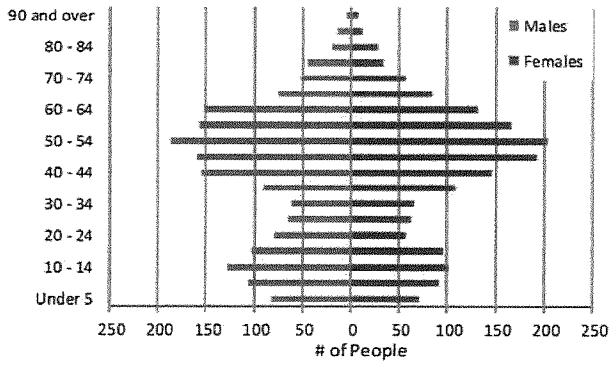
Race Composition (One Race)



Occupancy (Total Units: 1,516)



Population (Total: 3,458)



Population Characteristics - Census 2010, Summary File 1 (Little River Township)

HIGHLIGHTS	2000	2010	% Change
Total Population	3,047	3,458	13.5
Males	1,503	1,737	15.6
Females	1,544	1,721	11.5
Population Under 18	745	723	-3.0
Population Under 5	174	153	-12.1
Population 5-17	571	570	-0.2
Population 65 & Over	275	435	58.2
Median Age			
Total	38.9	46.0	18.3
Males	38.7	45.0	16.3
Females	39.1	46.7	19.4
Race			
One Race	3,021	3,409	12.8
White	2,702	3,081	14.0
Black or African American	267	254	-4.9
American Indian and Alaska Native	7	11	57.1
Asian	14	17	21.4
Native Hawaiian and Other Pacific Islander	0	1	#DIV/0!
Some Other Race	31	45	45.2
Two or More Races	26	49	88.5
Hispanic or Latino Origin			
Hispanic or Latino	44	91	106.8
Not Hispanic or Latino	3,003	3,367	12.1

Source: U.S. Census Bureau Census 2000 & 2010

RACE & ETHNICITY	Number	% of
Race		
One Race	3,409	98.6
White	3,081	89.1
Black or African American	254	7.3
American Indian and Alaska Native	11	0.3
Asian	17	0.5
Native Hawaiian and Other Pacific Islander	1	0.0
Some Other Race	45	1.3
Hispanic or Latino Origin		
Hispanic or Latino	91	2.6
Not Hispanic or Latino	3,367	97.4
Hispanic or Latino and Race		
Hispanic or Latino	91	2.6
White	38	1.1
Black or African American	0	0.0
American Indian and Alaska Native	6	0.2
Asian	0	0.0
Native Hawaiian and Other Pacific Islander	1	0.0
Some Other Race	33	1.0
Two or More Races	13	0.4
Not Hispanic or Latino	3,367	97.4
White	3,043	88.0
Black or African American	254	7.3
American Indian and Alaska Native	5	0.1
Asian	17	0.5
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	12	0.3
Two or More Races	36	1.0

SEX BY AGE	Total Population		Male		Female	
	Number	% of	Number	% of	Number	% of
Under 5	153	4.4	82	4.7	71	4.1
5 - 9	197	5.7	105	6.0	92	5.3
10 - 14	230	6.7	128	7.4	102	5.9
15 - 17	143	4.1	71	4.1	72	4.2
18 - 19	56	1.6	32	1.8	24	1.4
20	32	0.9	19	1.1	13	0.8
21	22	0.6	16	0.9	6	0.3
22 - 24	83	2.4	44	2.5	39	2.3
25 - 29	129	3.7	66	3.8	63	3.7
30 - 34	128	3.7	62	3.6	66	3.8
35 - 39	198	5.7	90	5.2	108	6.3
40 - 44	301	8.7	155	8.9	146	8.5
45 - 49	352	10.2	159	9.2	193	11.2
50 - 54	391	11.3	187	10.8	204	11.9
55 - 59	324	9.4	157	9.0	167	9.7
60 - 61	108	3.1	61	3.5	47	2.7
62 - 64	176	5.1	91	5.2	85	4.9
65 - 66	66	1.9	33	1.9	33	1.9
67 - 69	93	2.7	42	2.4	51	3.0
70 - 74	109	3.2	52	3.0	57	3.3
75 - 79	79	2.3	45	2.6	34	2.0
80 - 84	49	1.4	20	1.2	29	1.7
85 +	39	1.1	20	1.2	19	1.1
Total	3,458	100.0	1,737	100.0	1,721	100.0

Household Characteristics - Census 2010, Summary File 1 (Little River Township)

HIGHLIGHTS	2000	2010	% Change
Total Households	1,166	1,403	20.33
Total Population	3,047	3,458	13.49
In Households	3,047	3,458	13.49
Family Households	2,740	2,988	9.05
Nonfamily Households	307	470	53.09
In Group Quarters	0	0	
Institutionalized	0	0	
Noninstitutionalized	0	0	
Households with People			
Under 18 Years	446	433	-2.91
65 + Years	198	318	60.61
Average Household Size	2.61	2.46	-5.75
Average Family Size	2.94	2.87	-2.38

Source: U.S. Census Bureau Census 2000 & 2010

HOUSEHOLD TYPE BY HOUSEHOLD SIZE

	Total		Family Households		Nonfamily Households	
	Number	% of	Number	% of	Number	% of
1-Person Hhld	299	21.3	x	x	299	79.5
2-Person Hhld	566	40.3	502	48.9	64	17.0
3-Person Hhld	247	17.6	237	23.1	10	2.7
4-Person Hhld	212	15.1	210	20.4	2	0.5
5-Person Hhld	56	4.0	55	5.4	1	0.3
6-Person Hhld	13	0.9	13	1.3	0	0.0
7 + -Person Hhld	10	0.7	10	1.0	0	0.0
Total	1,403	100.0	1,027	100.0	376	100.0

GROUP QUARTERS POPULATION BY TYPE

	Number	%
Total Population in Group Quarters	0	
Institutionalized Population	0	
Correctional Facilities for Adults	0	
Juvenile Facilities	0	
Nursing Facilities/Skilled-nursing Facilities	0	
Other Institutional Facilities	0	
Noninstitutionalized Population	0	
College/University Student Housing	0	
Military Quarters	0	
Other Noninstitutional Facilities	0	

FAMILY TYPE BY PRESENCE AND AGE OF OWN CHILDREN

	Number	%
Total Families	1,027	100.0
With Own Children Under 18 Years	390	38.0
Husband-Wife Family	857	83.4
With Own Children Under 18 Years	296	28.8
Male Household, No Wife Present	53	5.2
With Own Children Under 18 Years	33	3.2
Female Household, no Husband Present	117	11.4
With Own Children Under 18 Years	61	5.9

Housing Characteristics - Census 2010, Summary File 1 (Little River Township)

HIGHLIGHTS	2000	2010	% Change
Housing Units	1,261	1,516	20.22
Occupied Housing Units	1,166	1,403	20.33
Owner Occupied	1,021	1,225	19.98
Renter Occupied	145	178	22.76
Average Household Size	2.61	2.46	-5.75
Owner Occupied	2.65	2.5	-5.66
Renter Occupied	2.32	2.25	-3.02
Vacant Housing Units	95	113	18.95

Source: U.S. Census Bureau Census 2000 & 2010

VACANCY STATUS

	Number	%
Total	113	100.00
For Rent	16	14.16
Rented, Not Occupied	1	0.88
For Sale Only	19	16.81
Sold, Not Occupied	8	7.08
For Seasonal, Recreational, or Occasional Use	13	11.50
For Migrant Workers	1	0.88
All other Vacants	55	48.67

TENURE

	Number	%
Total	1,403	100.00
Owner Occupied	1,225	87.31
Owned with a Mortgage or a Load	868	61.87
Owned free and Clear	357	25.45
Renter Occupied	178	12.69

Attachment D

Support Article:

Effects of Distance to Care and Rural or Urban Residence on Receipt of Radiation Therapy Among North Carolina Medicare Enrollees with Breast Cancer

ORIGINAL ARTICLE

Effects of Distance to Care and Rural or Urban Residence on Receipt of Radiation Therapy Among North Carolina Medicare Enrollees With Breast Cancer

Stephanie B. Wheeler, Tzy-Mey Kuo, Danielle Durham, Brian Frizzelle, Katherine Reeder-Hayes, Anne-Marie Meyer

BACKGROUND Distance to oncology service providers and rurality may affect receipt of guideline-recommended radiation therapy (RT), but the extent to which these factors affect the care of Medicare-insured patients is unknown.

METHODS Using cancer registry data linked to Medicare claims from the Integrated Cancer Information and Surveillance System (ICISS), we identified all women aged 65 years or older who were diagnosed with stage I, II, or III breast cancer from 2003 through 2005, who had Medicare claims through 2006, and who were clinically eligible for RT. We geocoded the address of each RT service provider's practice location and calculated the travel distance from each patient's residential address to the nearest RT provider. We used ZIP codes to classify each patient's residence as rural or urban according to rural-urban commuting area codes. We used generalized estimating equations models with county-level clustering and interaction terms between distance categories and rural-urban status to estimate the effect of distance to care and rural-urban status on receipt of RT.

RESULTS In urban areas, increasing distance to the nearest RT provider was associated with a lower likelihood of receiving RT (odds ratio [OR] = 0.54; 95% confidence interval [CI], 0.30–0.97) for those living more than 20 miles from the nearest RT provider compared with those living less than 10 miles away. In rural areas, those living within 10–20 miles of the nearest RT provider were more likely to receive RT than those living less than 10 miles away (OR = 1.73; 95% CI, 1.08–2.76).

LIMITATIONS Results may not be generalizable to areas outside North Carolina or to non-Medicare populations.

CONCLUSIONS Coordinated outreach programs targeted differently to rural and urban patients may be necessary to improve the quality of oncology care.

Differences in the quality of breast cancer care, which can directly influence health outcomes, have been documented across different settings and subpopulations [1-5]. A variety of patient, provider, and health system factors can contribute to poor-quality cancer care [6-10]. An underappreciated factor that influences quality of care is access to oncology service providers [11, 12]. Cancer patients who must travel long distances to reach oncology care providers are potentially at high risk of going untreated or being undertreated [11, 13-15]. In addition, differential availability of resources such as transportation across rural and urban settings may contribute to differences in the quality of care patients receive [16, 17]. Treatments that require frequent visits to a provider, such as radiation therapy (RT), may be particularly sensitive to geographic barriers. The extent to which distance to care and rurality influence receipt of guideline-recommended RT by breast cancer patients in North Carolina is unknown.

Distance to care has been shown to affect receipt of appropriate cancer screening and treatment in a variety of settings [10, 11, 18-26]. However, studies of the relationship between distance to care and cancer care utilization have been inconsistent, possibly due to variability in how distance to care is measured. In addition, such variation may be greater in suburban and rural areas than in urban areas [27, 28]. To our knowledge, no published studies have evaluated the impact of distance to care and rurality on receipt of breast cancer treatment in North Carolina. Because North Carolina is a large, diverse state with a variety of rural and urban environments, it is important to understand how quality of care for breast cancer varies across these settings.

In light of these gaps and to understand barriers to care in North Carolina, we sought to examine geographic variables and receipt of care. Specifically, we assessed whether the distance to oncology service providers and rural or urban residence explained a portion of the variation in receipt of adjuvant RT among Medicare-insured breast cancer patients who had completed surgery.

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0029-2559/2014/75402

Methods

Data sources. For our analyses, we employed a novel data resource, the North Carolina Integrated Cancer Information and Surveillance System (ICISS). [Editor's note: For more information about ICISS, refer to the commentary by Meyer and colleagues on pages 265-269]. This statewide, population-based data set includes cancer registry data and multipayer insurance claims data; because of its richness and comprehensiveness, ICISS is uniquely suited to evaluate distance to care and quality of care. ICISS covers a wide variety of geographic subregions, with varying densities and distributions of populations and health care facilities, and it includes physician identifiers and geocoded patient and physician locations. The cancer registry data provide detailed clinical information about cancer diagnosis, stage, grade, and biomarker status, as well as demographic information about patients. The Medicare claims data include demographic information and details about any health care services or procedures for which an insurance claim was filed, along with corresponding diagnoses.

Cohort selection. We created a retrospective cohort that included women diagnosed with breast cancer between January 1, 2003, and December 31, 2005 whose records could be linked to Medicare insurance claims. Using the North Carolina Central Cancer Registry (NCCCR), we identified all women aged 65 years or older who were diagnosed with stage I, II, or III breast cancer from 2003 through 2005; we then linked these patient records to Medicare claims data to identify services and procedures received from 3 months before diagnosis through 1 year after diagnosis. To identify women who clearly met clinical guidelines for RT [29, 30], we limited our sample to women who had undergone breast-conserving surgery or who had undergone mastectomy and had tumors larger than 5 cm, using claims-based definitions from prior research [10, 31]. Although women with lymph-node-positive disease are also candidates for RT, we chose to focus specifically on indications for RT of the breast rather than RT of the axilla.

Using the registry, we obtained records for 7,653 women with breast cancer that was newly diagnosed from 2003 through 2005. We then excluded patients diagnosed at death (n = 7); patients without complete claims from 3 months before through 12 months after diagnosis (n = 1,987); patients with stage 0, stage IV, or unstaged disease (n = 1,608); patients who did not meet clinical criteria for RT (n = 516); and patients with end-stage renal disease (n = 1). Among the remaining women, we further limited our sample to women who had undergone breast-conserving surgery (n = 1,798) or women who had undergone mastectomy and had tumors larger than 5 cm (n = 140).

Measurement of RT (dependent variable). We used Medicare claims to determine whether RT was ever received within 1 year of diagnosis, as was done in prior studies [10, 32]. We used the procedure codes listed in Table 1 to identify surgeries and RT performed following a breast cancer diagnosis.

Measurement of distance to care (independent variable). To enable calculation of distance to RT providers, we identified all physicians in the claims database who provided RT to Medicare-insured breast cancer patients from 2003 through 2005. Using the physicians' unique physician identification numbers (assigned by Medicare), we obtained physician address information from the Registry of Medicare Physician Identification and Eligibility Records. We then used this information to build a master list of all physicians providing RT to breast cancer patients in North Carolina and the physicians' addresses.

Patient addresses were geocoded by NCCCR, following guidelines published by the North American Association of Central Cancer Registries [33]. In this study, the initial geocoding of physician addresses was performed by Mapping Analytics, a firm that provides custom mapping and analysis services. The remaining unmatched addresses (approximately 15%) were cleaned and geocoded using Esri ArcGIS 10.1 software [34], which increased the match rate to greater than 95%. Road network distances were then computed from every patient in the sample to every phy-

TABLE 1.
Codes Used to Identify Breast Cancer Treatments

Type of code	Codes used
Diagnosis code	ICD-9-CM diagnosis codes 174.0, 174.1, 174.2, 174.3, 174.4, 174.5, 174.6, 174.8, 174.9, 238.3, 239.3, V10.3
Code for aggressive mastectomy	ICD-9-CM procedure codes 85.41, 85.42, 85.43, 85.44, 85.45, 85.46, 85.47, 85.48
	CPT/HCPCS codes 19140-19180, 19182, 19200, 19220, 19240, 19260-19272, 19303-19307
Code for breast-conserving surgery	ICD-9-CM procedure codes 85.20, 85.21, 85.22, 85.23, 85.24, 85.25
	CPT/HCPCS codes 19110, 19120, 19125, 19126, 19160, 19162, 19301, 19302
Code for radiation therapy	ICD-9-CM procedure codes 92.21-92.29
	CPT/HCPCS codes 77260-77499, 77520, 77522, 77523, 77525, 77750-77799, 0073T, G0256, G0261
	Revenue center codes 0330, 0333, 0339
	Diagnosis-related group code 409
	ICD-9-CM diagnosis codes V58.0, V66.1, V67.1

Note. CPT, current procedural terminology; HCPCS, Healthcare Common Procedure Coding System; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.

sician in the state who provided RT to Medicare enrollees with breast cancer. These distances were calculated using ArcGIS's Network Analyst extension and street data from Esri's StreetMap Premium for ArcGIS to identify road networks between the patient and the physician. *Distance to nearest provider* was defined as the shortest road-network path from the patient's address to that of the nearest RT provider.

We also computed Euclidean (straight-line) distances between providers and patients using the GEODIST function of SAS software [35]. We examined both the Euclidean and road-network measurements of distance to care and explored differences between them, but we opted to focus on road-network distances only, as they are known to be more accurate [28, 36]. We chose to measure the shortest distance rather than the shortest travel time because distance (based on the length of the road features in the GIS data set) is a more reliable measure than time calculations (based on imprecise speed attributes assigned to road segments). We examined multiple specifications of distance in sensitivity analyses, including distance measured continuously and in 5-mile and 10-mile categorical increments. We opted to use 10-mile categorical increments (less than 10 miles; 10–20 miles; and greater than 20 miles) in the primary analysis because they provided improved model fit statistics and larger cell sizes with less granular categorization (resulting in better model stability).

Classification of residence as rural or urban (independent variable). We used ZIP code information to determine whether each patient's address was rural or urban according to the rural-urban commuting area (RUCA) codes crosswalk, version 2.0, created by the Rural Health Research Center [37]. We created a binary measure for rural-urban status following guidance from the Rural Health Research Center. The RUCA rural-urban classification system combines information about population and commuting relationships, and researchers have used this system to compare urban and rural differences in more detail than is possible using the county-level definition [38-41]. We interacted our categorical distance measures with rural-urban status to test whether the effect of distance to RT providers is different in rural areas than in urban areas.

Covariates. As was done in previously published research [10, 31, 32], we adjusted models to account for patient sociodemographic characteristics that have previously been shown to influence receipt of RT, including age (65–69 years; 70–74 years; 75–79 years; 80 years or older), race (nonwhite; white), marital status (married; not married), and state buy-in (whether the state pays the individual's Medicare premiums, which serves as a binary proxy for low-income status) [42]. We also adjusted for important disease characteristics, including American Joint Commission on Cancer stage (stage I; stage II; stage III), hormone receptor status at diagnosis, which is based on whether the tumor has estrogen and/or progesterone receptors (negative; positive; or unknown), any prior cancer, and year of diagnosis. We recoded variables with missing data in order to retain as many observations as possible. For example, there were many women for whom the hormone receptor status of their tumor was unknown; therefore we created a separate category, "unknown."

Using methods consistent with those described in previously published research [10, 31, 43], we adjusted for comorbidities identified from Medicare claims using the National Cancer Institute Combined Index, with some modification to allow us to capture comorbid conditions co-occurring during the cancer treatment period [44]. Specifically, comorbidity was measured according to the Charlson Index from 3 months prior to diagnosis through 12 months after diagnosis, and breast-cancer–specific weights were calculated for each condition [44].

Lastly, studies have shown that county-level characteristics may affect receipt of health care services [45-47]. Therefore, as has been done in other studies [48, 49], we controlled for the following sociodemographic characteristics at the county level: percentage of the population that is nonwhite, population density, and median household income, all of which were obtained from the Area Resource File published in 2000 by the Health Resources and Services Administration [50].

Analyses. We used descriptive statistics to examine distributions in the data, performed bivariate analyses employing chi-squared tests for categorical variables, and performed *t* tests for continuous variables. We then used a generalized estimating equations (GEE) model with logit link function, exchangeable working correlation, and county-level clustering to examine the effect of geospatial measures on receipt of RT after breast-conserving surgery, controlling for other known confounders. The GEE model obtains population-based estimates by accounting for variances in correlated data (ie, people living in the same county share county-level characteristics) [51]. Individuals residing in the same county are no longer considered independent observations; therefore a GEE model is appropriate for patients living in the same geographic area, who are expected to be more related (correlated) to one another than to those living in different areas. Without such adjustment, the variance estimates tend to produce biased and smaller standard errors, which can lead to biased conclusions.

To determine whether distance to care had different effects in urban areas than in rural areas, we included interaction terms between the rural-urban indicator variable and categorical distance variables, and we conducted a Wald test to determine the significance of the overall interaction effect. We calculated odds ratios (ORs) for our overall model and stratified by rural-urban residence. All analyses were conducted using SAS version 9.3 software [35].

This study was approved by the institutional review board of the University of North Carolina at Chapel Hill.

Results

The final analysis sample included 1,938 patients living in 98 different counties in North Carolina, with between 1 and 131 women in each county. Overall, 65% of the women in the study sample received guideline-recommended RT. Table 2 presents the sample characteristics and the results of bivariate analyses, by receipt of RT. More than 50% of the women in our sample lived within 10 miles of a physician who provided RT. There were statistically significant differences in receipt of RT among the 3 distance-to-care categories and between rural residents and urban residents.

TABLE 2.
Sample Characteristics and Bivariate Results by Radiation Therapy (RT) Status

Variable	Total sample (N = 1,938)	Received RT (n = 1,253)	Did not receive RT (n = 685)	*P*-value
Age group				
65–69 years	534 (28%)	415 (33%)	119 (17%)	<.001
70–74 years	510 (26%)	358 (29%)	152 (22%)	
75–79 years	480 (25%)	291 (23%)	189 (28%)	
80 years or older	414 (21%)	189 (15%)	225 (33%)	
Race				
White	1,655 (85%)	1,082 (86%)	573 (84%)	.10
Nonwhite	283 (15%)	171 (14%)	112 (16%)	
Marital status				
Married	807 (42%)	588 (47%)	219 (32%)	<.001
Not married	1,131 (58%)	665 (53%)	466 (68%)	
State Medicare buy-in[a]				
Buy-in	295 (15%)	155 (12%)	140 (20%)	<.001
No buy-in	1,643 (85%)	1,098 (88%)	545 (80%)	
AJCC stage at diagnosis				
Stage I	1,181 (61%)	740 (59%)	441 (64%)	<.001
Stage II	570 (29%)	363 (29%)	207 (30%)	
Stage III	187 (10%)	150 (12%)	37 (5%)	
Hormone receptor status of tumor[b]				
ER/PR negative	144 (7%)	92 (7%)	52 (8%)	.20
ER/PR positive	746 (38%)	465 (37%)	281 (41%)	
Unknown	1,048 (54%)	696 (56%)	352 (51%)	
Year of diagnosis				
2003	529 (27%)	379 (30%)	150 (22%)	<.001
2004	803 (41%)	520 (42%)	283 (41%)	
2005	606 (31%)	354 (28%)	252 (37%)	
Comorbidity index score[c]	0.358	0.317	0.433	<.001
Prior cancer				
Yes	325 (17%)	197 (16%)	128 (19%)	.10
No	1,613 (83%)	1,056 (84%)	557 (81%)	
Urban or rural residence, at zip code level				
Urban	1,276 (66%)	857 (68%)	419 (61%)	<.01
Rural	662 (34%)	396 (32%)	266 (39%)	
Road network distance to nearest provider				
Less than 10 miles	1,075 (55%)	711 (57%)	364 (53%)	<.01
10–20 miles	425 (22%)	290 (23%)	135 (20%)	
Greater than 20 miles	438 (23%)	252 (20%)	186 (27%)	
County-level predictors				
Mean % of population nonwhite	27.14	26.88	27.61	.28
Mean population density per square mile	364	379	336.4	<.01
Median household income	$39,907	$40,241	$39,297	<.01

Note. AJCC, American Joint Committee on Cancer; ER, estrogen receptor; PR, progesterone receptor.
[a]Medicare buy-in means that the state of North Carolina was paying the patient's Medicare premiums; this was used as a proxy for low-income status.
[b]Hormone receptor status was classified as positive if the patient's tumor had any estrogen receptors or progesterone receptors; it was classified as negative if the tumor had no estrogen receptors or progesterone receptors.
[c]The higher the comorbidity index score, the greater the number of comorbid conditions.

In general, women who received RT were younger, more likely to be married, and more likely to be higher-income compared with women who did not receive RT; women who received RT were also generally diagnosed in earlier study years, had cancer that was more advanced, and had fewer comorbid conditions. Women who lived in counties with a higher population density and/or higher median household income were also more likely to receive RT.

The results of multivariable analyses are presented in Table 3. With respect to distance to RT providers and rural-urban status, the results indicate significant interaction effects between these 2 variables (Wald statistic = 6.97; $P<.05$). In the subsample of urban patients, increasing distance to the nearest RT provider was significantly associated with lower odds of receiving RT (OR = 0.54; 95% confidence interval [CI], 0.30–0.97) for those living at least 20 miles from the nearest provider, compared with those living less than 10 miles from the nearest provider (see Table 4). In the subsample of breast cancer patients residing in rural areas, increasing distance to the nearest RT provider was significantly associated with higher odds of receiving RT (OR = 1.73; 95% CI, 1.08–2.76) for those living within 10–20 miles of the nearest RT provider compared with those living less than 10 miles from the nearest RT provider. For those living more than 20 miles from the nearest provider, distance did not significantly affect receipt of RT, compared with those living less than 10 miles from the nearest provider.

After controlling for all other factors, the odds of receiving RT were significantly higher for women who were married (OR = 1.40; 95% CI, 1.12–1.74) and for those diagnosed with stage III disease compared with stage I disease (OR = 2.93; 95% CI, 1.94–4.42). The odds of receiving RT were significantly lower for several groups of women: those older than 80 years compared with those aged 65–69 years (OR = 0.27; 95% CI, 0.21–0.35); those with lower incomes (OR = 0.66; 95% CI, 0.49–0.89); those diagnosed in 2004 compared with those diagnosed in 2003 (OR = 0.72; 95% CI, 0.56–0.92) or those diagnosed in 2005 compared with those diagnosed in 2003 (OR = 0.54; 95% CI, 0.35–0.82); and those with higher comorbidity scores (OR = 0.82; 95% CI, 0.70–0.98).

To further evaluate the robustness of the differential distance effect between urban and rural residence, we conducted a stratified analysis separating urban and rural samples while keeping all of the covariates in both models (results not shown). Statistically significant effects persisted in rural areas for the distance category of 10–20 miles, compared with less than 10 miles (OR = 1.76; 95% CI, 1.07–2.87). For urban areas, the significant finding for the distance category of greater than 20 miles, compared with less than 10 miles, becomes marginally significant (OR = 0.57; 95% CI, 0.32–1.02; Table 4). In addition, we grouped the distance categories in 5-mile increments and still found a significant distance effect in rural areas for the category of 15–20 miles, compared with less than 5 miles (OR = 2.14;

TABLE 3.
Multivariable Generalized Estimating Equations Model Results for Receipt of Radiation Therapy (RT), with County-Level Clustering (N = 1,938)

Variable	Estimated odds ratio (95% CI)	*P*-value
Age group		
65–69 years (reference)	1.00	
70–74 years	0.70 (0.52–0.94)	.02
75–79 years	0.47 (0.38–0.59)	<.0001
80 years or older	0.27 (0.21–0.35)	<.0001
Race		
Nonwhite (reference)	1.00	
White	1.04 (0.79–1.38)	.762
Marital status		
Not married (reference)	1.00	
Married	1.40 (1.12–1.74)	.003
State Medicare buy-in[a]		
No buy-in (reference)	1.00	
Buy-in	0.66 (0.49–0.89)	.006
AJCC stage at diagnosis		
Stage I (reference)	1.00	
Stage II	1.07 (0.89–1.30)	.452
Stage III	2.93 (1.94–4.42)	<.0001
Hormone receptor status of tumor[b]		
ER/PR negative (reference)	1.00	
ER/PR positive	1.16 (0.68–1.96)	.585
Unknown	0.95 (0.55–1.63)	.845
Year of diagnosis		
2003 (reference)	1.00	
2004	0.72 (0.56–0.92)	.009
2005	0.54 (0.35–0.82)	.004
Comorbidity index score	0.82 (0.70–0.98)	.03
Prior cancer		
No (reference)	1.00	
Yes	0.96 (0.74–1.26)	.790
Urban or rural residence at ZIP code level		
Rural (reference)	1.00	
Urban	1.91 (1.23–2.96)	.004
Road network distance to nearest RT provider		
Less than 10 miles (reference)	1.00	
10–20 miles	1.73 (1.08–2.76)	.02
Greater than 20 miles	1.09 (0.73–1.63)	.662
Urban or rural residence and road network distance interaction		
Rural × less than 10 miles (reference)	1.00	
Urban × 10–20 miles	0.50 (0.27–0.94)	.03
Urban × greater than 20 miles	0.50 (0.24–1.02)	.058
County-level predictors		
Mean % of population nonwhite	0.99 (0.98–1.01)	.313
Population density	0.99 (0.98–1.01)	.309
Median household income	1.00 (1.00–1.00)	.439

Note. AJCC, American Joint Committee on Cancer; CI, confidence interval; ER, estrogen receptor; PR, progesterone receptor.
[a]Medicare buy-in means that the state of North Carolina was paying the patient's Medicare premiums; this was used as a proxy for low-income status.
[b]Hormone receptor status was classified as positive if the patient's tumor had any estrogen receptors or progesterone receptors; it was classified as negative if the tumor had no estrogen receptors or progesterone receptors.

95% CI, 1.05–4.34). In urban areas, we found a marginally significant effect for the distance category of greater than 20 miles, compared with less than 5 miles (OR = 0.55; 95% CI, 0.3–1.01).

Discussion

We examined receipt of RT as a metric that reflects the quality of breast cancer care and patients' access to oncology service providers. We found that distance to care and rural-urban status were significantly associated with receipt of RT by breast cancer patients for whom RT was clinically indicated. Within urban areas, increasing distance to the nearest RT provider was generally associated with lower likelihood of receiving RT; in rural areas, living within 10–20 miles of the nearest RT provider was associated with greater odds of receiving RT, compared with living less than 10 miles from the nearest RT provider.

These findings may be explained in several ways. First, urban residents may be more likely to rely on public transportation than on personal transportation to reach health providers, and the burden of accessing care via this mode of transportation (which operates on set schedules) is likely to be greater as distance to care increases. In an urban area, living more than 20 miles away from the nearest RT provider may mean commuting an hour or more (via either public or personal transportation), and this may be an insurmountable barrier for elderly women with cancer.

In contrast, rural residents may be more likely to rely on personal transportation to access health care services and may be more accustomed to traveling longer distances for health care, because they often travel long distances to access other types of goods and services. As a result, people in the most remote rural areas (and by extension, those furthest from RT providers) may be more willing or able to drive further to access health care and other types of goods and services, and they may combine visits to health care providers with other errands. This supposition is supported by the research of Gesler and colleagues [52], who found that more than 85% of rural health care visits involved transportation by private car. Arcury and colleagues [17] found that in rural North Carolina, access to transportation—having a driver's license or knowing someone who could provide transportation—was more important for health care utilization than distance to health care providers. In addition, residents of the most remote rural areas may be more willing to bypass the nearest RT provider in order to access oncology care at a larger, more centralized facility that is affiliated with a medical school or a cooperative group such as the Eastern Cooperative Oncology Group (ECOG), the National Surgical Adjuvant Breast and Bowel Project (NSABP), the North Central Cancer Treatment Group (NCCTG), or the Southwest Oncology Group (SWOG) [53, 54]. Our distance-to-care measure assessed distance to the nearest provider; as a next step in future analyses, it would be important to explore whether women living in the most remote areas are bypassing closer RT providers to obtain care at a larger health care facility and, if so, how far they are traveling to do so.

The interaction effects between distance to care and rural-urban residence suggest that rural and urban settings in North Carolina differ in terms of how distance to a health care provider affects access to care. These findings imply a need to consider these settings differently when planning interventions. Specifically, cancer patients living in urban environments may benefit from dedicated buses that transport multiple patients to and from RT (and chemotherapy) appointments, organized carpools, or public transportation vouchers. Experience suggests that such programs are fragmented, often poorly organized, and unequally distributed across providers and patients. In contrast, cancer patients living in rural areas, who are accustomed to driving themselves to RT and other health care appointments, may benefit from parking vouchers and reimbursement for gasoline. Because it may not be pragmatic or logistically feasible to organize group transportation for patients living in disparate and remote rural areas, and because our research suggests that factors beyond distance to care may present greater barriers for rural women, efforts should focus on targeting assistance to the most vulnerable rural patients (eg, women who are poor, older, and/or socially isolated). Community-based nonprofit organizations, cancer support networks, insurers/payers, and health care facilities may be able to pool resources to support such initiatives. Both large academic cancer centers and smaller community-based RT practices can play major roles in helping to coordinate and facilitate such options for patients in North Carolina.

Additional nonclinical factors—such as older age, being unmarried, and low-income status—were significantly associated with lack of RT, a finding that is consistent with the results of prior studies [2, 10, 32, 55]. Patients in these categories are likely to be more vulnerable, and they may require more intensive outreach, support, and resources to help ensure they receive guideline-recommended RT. Among women who lived near an RT provider yet did not receive RT, unmeasured factors—such as social isolation, lack of transportation, and frailty—may have prevented them from accessing RT despite the geographic nearness of providers [16].

Secondary, administrative, and linked data analyses have several inherent limitations. First, registry-linked claims data do not reveal anything about patient-provider communication in decision making; therefore, it is impossible to discern whether RT was foregone or delayed for a clinically valid reason. Second, because these data are specific to North Carolina, our findings may not be generalizable to other states and settings. In particular, because our analysis required continuous enrollment in fee-for-service Medicare, our results may not be applicable to patients enrolled in health maintenance organizations or other insurance plans or to patients with more transient health insurance coverage. Third, geospatial methods and measurement of dis-

TABLE 4.
Effects of Distance to Nearest Radiation Therapy (RT) Care Provider on Receipt of RT, by Rural-Urban Status

Distance to care (reference group, less than 10 miles)	Urban dwellers (n = 1,276)		Rural dwellers (n = 662)	
	Odds ratio (95% CI)	*P*-value	Odds ratio (95% CI)	*P*-value
10–20 miles	0.87 (0.61–1.24)	.444	1.73 (1.08–2.76)	.022
Greater than 20 miles	0.54 (0.30–0.97)	.040	1.09 (0.73–1.63)	.662

Note. CI, confidence interval.
These odds ratios and confidence intervals were computed using the SAS estimate statement in the generalized estimating equations multivariable model presented in Table 3 (including the exact same covariates). To obtain the odds ratio of the interaction between distance to care of 10–20 miles (versus <10 miles) within urban areas, in the estimate statement we set the parameters to 1 for both 10–20 miles and the interaction term of "10–20 miles * urban area."

tance to care are evolving sciences, and our approach may not be perfect. With more granular location data about patients and providers, analyses might reveal different or more complex relationships between distance to care and receipt of RT [56].

In summary, this study sought to understand geographic predictors of underuse of guideline-recommended RT among elderly breast cancer patients in North Carolina. Using a novel, population-based cancer data system—the Integrated Cancer Information and Surveillance System (ICISS), which is supported by the state of North Carolina through the University Cancer Research Fund—we found that distance to RT providers and rural-urban residence were important correlates of receipt of RT, controlling for all other factors, and that observed effects of distance to care were different in rural versus urban areas. These findings suggest that the subpopulations of breast cancer patients who are most vulnerable to underuse of life-prolonging therapies may need to be targeted for intervention and supported in creative ways to ensure their access to oncology care services. NCM

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