DENNY & ASSOCIATES, P.C.
CONSULTING ENGINEERS
OXON HILL, MARYLAND

ENGINEERING REPORT
SURVEY OF INTERFERENCE CAUSED TO FULL POWER FM BROADCAST STATIONS BY LOW POWER FM STATION OPERATION ON A NON-FULLY SPACED THIRD ADJACENT CHANNEL
NATIONAL ASSOCIATION OF BROADCASTERS WASHINGTON, D.C.

INTRODUCTION

The National Association of Broadcasters (NAB) retained the consulting engineering firm of Denny & Associates, P.C. (D & A), to prepare and file an application with the Federal Communications Commission (FCC) for Special Temporary Authority (STA) to operate an experimental Low Power FM (LPFM) station in the area proximate to Washington, D.C. The purpose of the STA was to determine the extent to which commonly available portable and personal consumer FM radio receivers are affected in the real world by an undesired third-adjacent channel LPFM station operating inside the so-called *protected contour*[1] of a desired full power FM station. D & A conducted field tests to document the interference caused by a LPFM station

[1] The 60 dBμ V/m (1 millivolt per meter (mV/m)) F(50,50) contour is the protected contour for all classes of full power FM stations except Class B and Class B1 stations. For Class B and Class B1 stations, the protected contour field strengths are 54 dBμ (0.5 mV/m) and 57 dBμ (0.7 mV/m) respectively.

operating three channels removed from (third adjacent) and within the protected contour of a full power FM station on various portable and personal consumer FM radio receivers while being worn or carried in a fashion comparable to normal consumer listening in a mobile environment.

PREPARATION

NAB secured the consent of Bonneville International Corporation to allow three of their full power FM stations operating in the Washington, D.C., market to be used as "victim" stations for LPFM third adjacent channel testing. At the time of the survey, the call signs of the stations were: WGMS-FM (now WTOP-FM), Washington, D.C.; WWZZ(FM) (now WGMS-FM), Waldorf, Maryland; and WTOP-FM (now WTWP-FM), Warrenton, Virginia.

On February 11, 2005 NAB applied for an experimental authorization under Section 5.51(a) of the FCC rules. Because the NAB proposal was of a scientific nature, the FCC's Office of Engineering and Technology (OET) accepted the application and processed it pursuant to Part 5 of the FCC rules. OET granted the NAB experimental authorization

on April 1, 2005, and issued the experimental portable LPFM station the call sign WC9XDJ.

The experimental LPFM station consisted of the following transmission and ancillary equipment:

1. Marti Electronics (Broadcast Electronics, Inc.), model PNP-1000, frequency agile solid state1000-watt FM transmitter,
2. Shively Labs, model 6812-B1, circularly polarized, single bay antenna,
3. Omnia, model FM-3t, audio processor and stereo generator,
4. QEI FM modulation monitor, and
5. Digital audio player.

The test receivers (supplied by NAB and D & A) are pictured below. Starting with the front row from left to right, the portable consumer receivers used in the testing were as follows:

Sony WMFS421, digital tuning AM, FM, Cassette Walkman
Aiwa TX386, digital tuning AM, FM, Cassette personal portable
Sony SRF-49, analog tuned AM, FM Walkman
Sony SRF-M35, digital tuning AM, FM Walkman
Sony SRF-M37V, current model digital tuning AM, FM Walkman
Sony CFD-Z110, analog tuned AM, FM, CD, cassette bookshelf system

Photos of the system deployed in the field follow.

Mixer, stereo generator, modulation monitor and FM transmitter operating in the van.

Bucket truck with antenna deployed, van with electronic equipment and generator set up near The George Washington University Prince William Campus.

TEST LOCATION SELECTION CRITERIA

Test locations were chosen within the predicted 60 dBμV/m F(50,50) contour of the desired station. Although the protected contour of the Bonneville Class B stations is 54 dBμV/m, D&A selected the higher signal level of 60 dBμV/m because this is the protected contour level for both Class A and Class C FM stations. The Longley-Rice propagation model was used to identify those areas where the desired station's field strength at a height of two meters above ground level would be 60 dBμV/m or better.

All test LPFM sites used in the field testing were viable locations for an LP100 LPFM station.[2] The test sites satisfied all minimum separation requirements specified in Sections 73.207 and 73.807 of the FCC Rules with the exception that the third adjacent channel minimum distance separations specified in the current FCC rules were ignored with respect to the "victim" stations.

Candidate test sites were also chosen to have relatively even terrain out to one half mile (0.8 kilometer (km)) from the proposed test

[2] The maximum facilities for a LP100 station are established in Section 73.811 of the FCC rules to be 100 watts effective radiated power and antenna radiation center height above average terrain of 30 meters.

transmitter site to facilitate the mobile, walk-in test runs. Care also was taken to avoid local natural and man-made obstructions along the survey path that would tend to affect receiver performance and therefore bias the results.

PERMISSIBLE SITE ZONES

Channel 275 (102.9 MHz)

The permissible area to locate a LPFM test station operating on Channel 275 for evaluation in connection with the full power FM station WGMS-FM on Channel 278 is bounded by the radial distances set forth below from the following stations:

66.5 kilometers from WUSQ-FM, Winchester, Virginia
Channel 273B, 102.5 MHz, 32 kW (H & V), 192 m AAT
39° 10' 38" N, 78° 15' 53" W[3]

96.5 kilometers from WQSR, Baltimore, Maryland
Channel 274B, 102.7 MHz, 50 kW (H & V), 133 m AAT
39° 23' 11" N, 76° 43' 52" W

66.5 kilometers from WKIK-FM, California, Maryland
Channel 275A, 102.9 MHz, 4 kW (H & V), 120 m AAT
38° 22' 03" N, 76° 36' 55" W

[3] All geographic coordinates specified in this report are referenced to the 1927 North American Datum.

55.5 kilometers from WJMA-FM, Culpeper, Virginia
Channel 276A, 103.1 MHz, 0.6 kW (H & V), 313 m AAT
38° 18' 38" N, 78° 00' 12" W

The area to locate a LP100 station on channel 275 is illustrated in Figure 1 of this report.

Channel 284 (104.7 MHz)

The permissible area to locate a LPFM test station operating on Channel 284 for evaluation in connection with the full power FM station WWZZ on Channel 281 is bounded by the radial distances set forth below from the following stations:

55.5 kilometers from WGRX, Falmouth, Virginia
Channel 283A, 104.5 MHz, 2.7 kW (Max-DA, H & V), 150 m AAT
38° 16' 31" N, 77° 32' 34" W

66.5 kilometers from WAVA-FM, Arlington, Virginia
Channel 286B, 105.1 MHz, 41 kW (H & V), 165 m AAT
38° 53' 44" N, 77° 08' 04" W

111.5 kilometers from WQHQ, Ocean City-Salisbury, Maryland
Channel 284B, 104.7 MHz, 33 kW (H & V), 186 m AAT
38° 23' 15" N, 75° 17' 30" W

The area to locate a LP100 station on channel 284 is illustrated in Figure 2 of this report.

Channel 296 (107.1 MHz)

The permissible area to locate a LPFM test station operating on Channel 296 for evaluation in connection with the full power FM station WTOP-FM on Channel 299 is bounded by the radial distances set forth below from the following stations:

96.5 kilometers from WWEG, Hagerstown, Maryland
Channel 295B, 106.9 MHz, 9 kW (H & V), 237 m AAT
39° 29' 43" N, 77° 36' 42" W (NAD 27)

96.5 kilometers from WRQX, Washington, District of Columbia
Channel 297B, 107.3 MHz, 21.5 kW (H & V), 176 m AAT
38° 57' 01" N, 77° 04' 47" W (NAD 27)

23.5 kilometers from W296AU, Harrisonburg, Virginia
Channel 296D, 107.1 MHz, 9 W (H & V), 594 m AAT
38° 26' 51" N, 78° 43' 54" W (NAD 27)

The area to locate a LP100 station on channel 296 is illustrated in Figure 3 of this report.

FIELD TESTING

GEORGE MASON UNIVERSITY, MANASSAS, VIRGINIA

The first test site selected for evaluation was located adjacent to the Prince William County campus of George Mason University at geographic coordinates 38° 45' 16.00" North Latitude, 77° 31' 14.58" West Longitude. For this location, the desired station was WGMS-FM, channel 278 (103.5 MHz). This location is 26.2 miles (42.2 km) southwest of the WGMS-FM transmitter and is well inside the WGMS-FM predicted 60 dBμ F(50,50) contour. Utilizing the Longley-Rice propagation prediction model, D&A calculated WGMS-FM field strength over the George Mason test route was between 63 dBμV/m and 71 dBμV/m. The test transmitter was operated on channel 275 (102.9 MHz), the lower third adjacent channel to WGMS-FM.

The George Mason University test site is 60.8 miles (97.9 km) from WQSR(FM), Baltimore, Maryland, channel 274B (102.7 MHz), the station determining the closest boundary of the permissible site zone for a 100-watt LPFM station on channel 275, thus satisfying the 97-kilometer first adjacent channel minimum distance separation requirement as well as the other FCC

minimum distance separation requirements, except with respect to the desired third adjacent station.

For a detailed map of the Manassas test site and surrounding area, refer to Figure 4 of this report. The field strength of the desired station (WGMS-FM) ranged from 63 dBμV/m to 71 dBμV/m along the George Mason test route. The performance of the test receivers along the test route was sufficient to produce acceptable received audio quality in the absence of interference. It was found that the most consistent receiver performance was achieved with the subject walking in a radial direction, either directly toward or away from the desired station's transmitter site. For this reason, the test route, the test transmitter site, and the desired station transmitter site were always selected to result in a collinear arrangement originating at the desired station site and terminating at the LPFM test site.

LEONARDTOWN, MARYLAND

The second test site selected for evaluation was located in Leonardtown, Maryland, at geographic coordinates 38° 17' 44.98" North Latitude, 76° 38' 18.28" West Longitude. The desired station at this location

was WWZZ, channel 281B (104.1 MHz). This location is 24.9 miles (40.1 km) from the WWZZ transmitter site and is well inside the calculated WWZZ 60 dBμV/m F(50,50) contour. Utilizing the Longley-Rice propagation prediction model, D&A calculated WWZZ field strength over the Leonardtown test route is between 63 dBμV/m and 65 dBμV/m. The test transmitter was operated on channel 284 (104.7 MHz), the upper third adjacent channel to WWZZ.

This test location is 73.2 miles (117.9 km) from WQHQ, Ocean City-Salisbury, Maryland, channel 284B (104.7 MHz), the station determining the closest boundary for the permissible site zone for a 100-watt LPFM station on channel 284, thus satisfying the 112-kilometer cochannel minimum distance separation requirement as well as the other FCC minimum distance separation requirements, except with respect to the desired third adjacent station.

For a detailed map of the Leonardtown test site and surrounding area, refer to Figure 5 of this report. The field strength of the desired station at this location was sufficient to produce acceptable receiver performance in the absence of interference. Tests were conducted using all six portable FM

receivers, and continuous reference audio recordings were made over the entire test route with the LPFM transmitter off and again with the LPFM transmitter on and modulated with music.

WASHINGTON, VIRGINIA

The third test site selected for evaluation was located in the historic village of Washington, Virginia, at geographic coordinates 38° 42' 47.44" North Latitude, 78° 09' 35.37" West Longitude. The desired station was WTOP-FM, Channel 299B (107.7 MHz). This test site is 17.6 miles (28.3 km) from the WTOP-FM transmitter and is located well inside the WTOP-FM 60 dBμV/m F(50,50) contour. The calculated WTOP-FM field strength over the test route was in the range from 63 dBμV/m to 70 dBμV/m. The test transmitter was operated on channel 296 (107.1 MHz), the lower third adjacent channel to WTOP-FM.

This test location was more than 60.4 miles (97.2 km) from WRQX, channel 297B (107.3 MHz), Washington, DC. WRQX is the station determining the closest boundary for the permissible site zone for a 100-watt LPFM station on channel 296, thus satisfying the 97-kilometer first adjacent

channel minimum distance separation requirement as well as the other FCC minimum distance separation requirements except with respect to the desired third adjacent station.

For a detailed map of the Washington, Virginia, test site, refer to Figure 6 of this report. Tests were conducted using all six portable FM receivers, and continuous reference audio recordings were made over the entire test route with the LPFM transmitter off and again with the LPFM transmitter on and modulated with music.

RESULTS

At each test site, a series of audio recordings was made following a measured route beginning one half mile (0.8 km) from the location of the LPFM test transmitter and ending at the calculated blanketing contour near the test transmitter. As noted above, each test location was selected such that an observer could record the desired station's received audio while walking a route that approximated a radial drawn from the desired station's transmitter through the test site location. This route alignment was chosen to reduce reception effects caused by signals arriving at the receiver antenna

from different angles. The audio recordings were captured in digital form on the stereo audio tracks of a digital camcorder.

Two walk-ins were made for each receiver at each of the test locations. The first walk-in was made with the low power test station transmitter off, and the second walk-in was made with the low power test station on the air.

Each walk-in generated an audio file with an average length of 15 minutes; therefore, the 12 runs at each of the three locations listed above resulted in roughly nine hours of audio files. The raw data collected for each walk-in consists of recorded audio file along with timing charts denoting the relationship between the running time of each audio file and the distance from the low power station test transmitter to the portable receiver.

The two unedited audio files for a given receive at a given location were loaded into a computer-based audio editor for comparative evaluation. Time code and the timing charts were used to synchronize the two audio files to ensure that that the audio quality of the desired subject station could be

evaluated both with and without the low power station transmitter in operation.

CONCLUSIONS

For every receiver, at all three test locations, interference capable of rendering a full power station unlistenable was noted. Interference to the reception of the desired signal from the operation of the third adjacent channel low power FM station typically began at a radial distance of 600 feet (183 meters) from the operating low power test station. The quality of the received audio deteriorated rapidly as the distance to the low power station decreased. At a distance of approximately 400 feet (122 meters), the front end of the test receiver either saturated completely or overloaded resulting in severely distorted received audio.

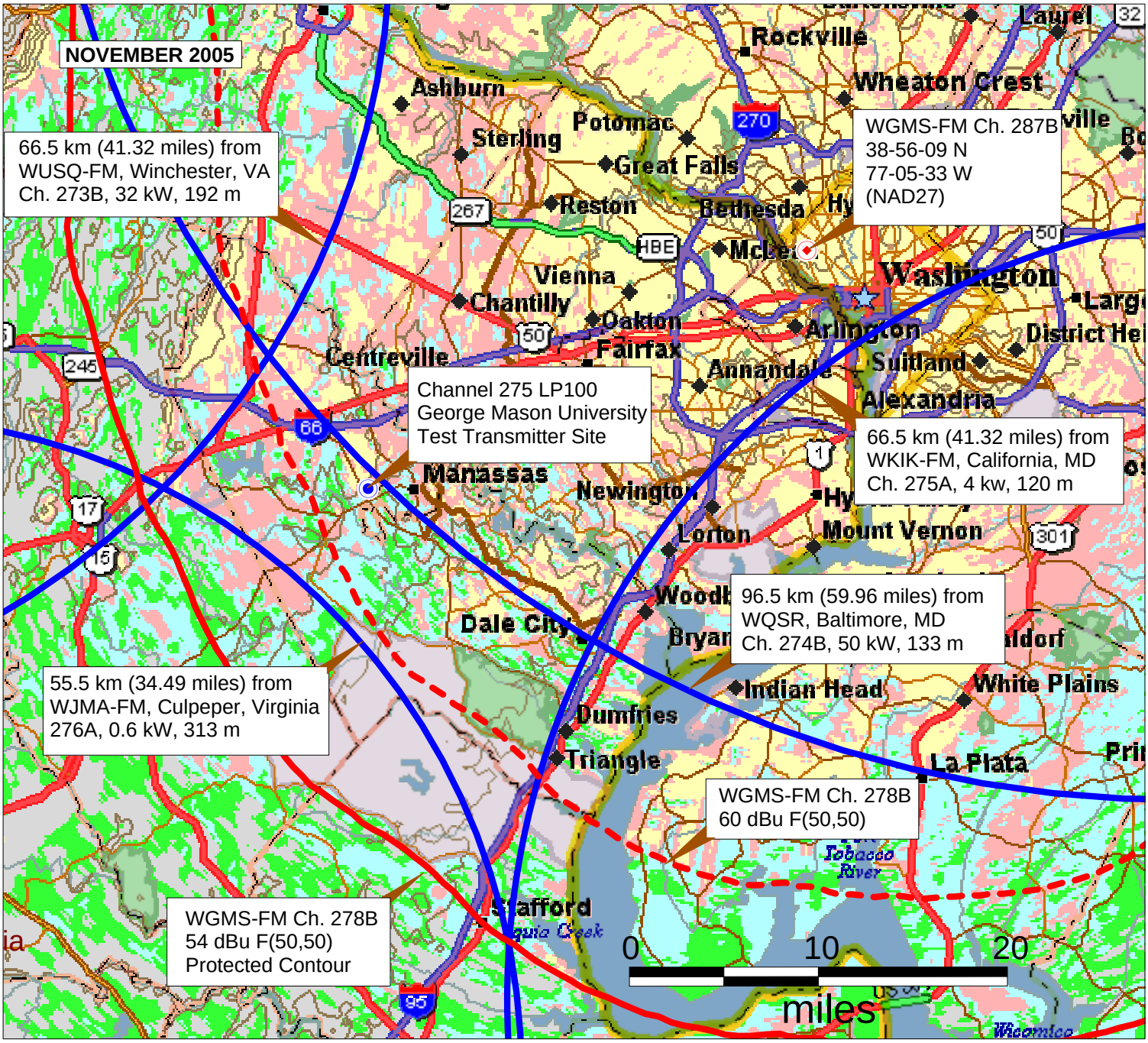
The relatively small coverage area of a low power FM station requires that the station be located near the population it wishes to serve. An interference radius of 600 feet translates to a potential interference area of almost 26 acres. In the case of the Georgetown University test site, the interference area would include occupied buildings both on campus and in the

adjoining technology office park. Similarly, the Leonardtown test site was surrounded by single family residences on 8,000- to 10,000-square-foot parcels, and the Washington test site was central to a popular historic resort community. For each test location, the operation of a low power FM station would have the potential to render a full service station unlistenable to hundreds if not thousands of persons living or working near the low power FM transmitter. New interference on this scale to a full service FM radio station is plainly harmful to the public interest.

Robert W. Denny, Jr., P.E.

October 24, 2006

Figure 1



CHANNEL 275 LP100 AREA TO LOCATE

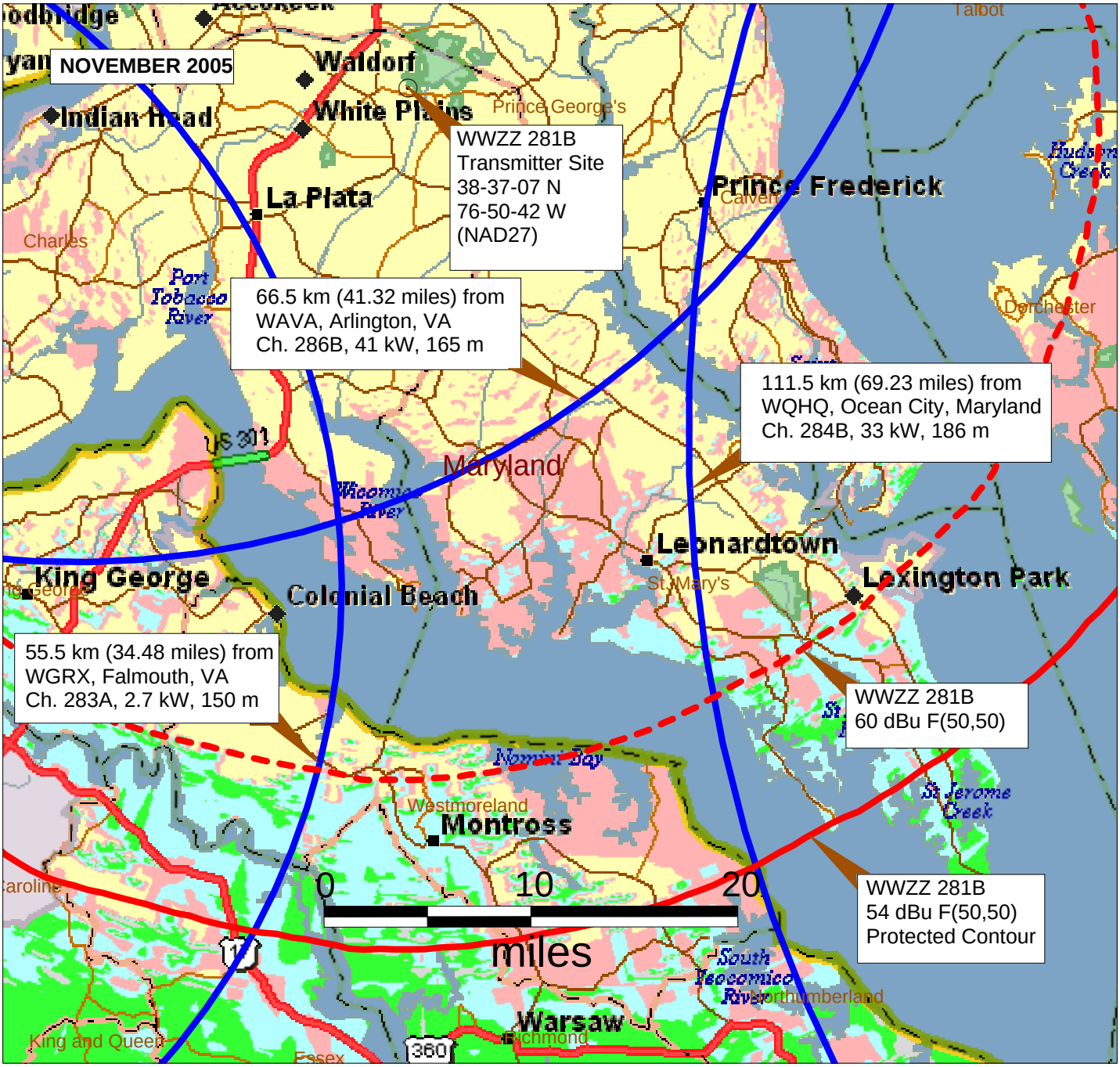
Prepared for
THE NATIONAL ASSOCIATION OF BROADCASTERS
Station WGMS-FM, Washington, DC
CH 278B 44 kw (Max-DA, H&V) 158 Meters

Denny & Associates, P.C. Consulting Engineers

Calculated WGMS Signal Level
(based on Longley-Rice
propagation model)

- > 70 dBu
- 60 - 70 dBu
- 50 - 60 dBu
- 40 - 50 dBu
- < 40 dBu

Figure 2



CHANNEL 284 LP100 AREA TO LOCATE

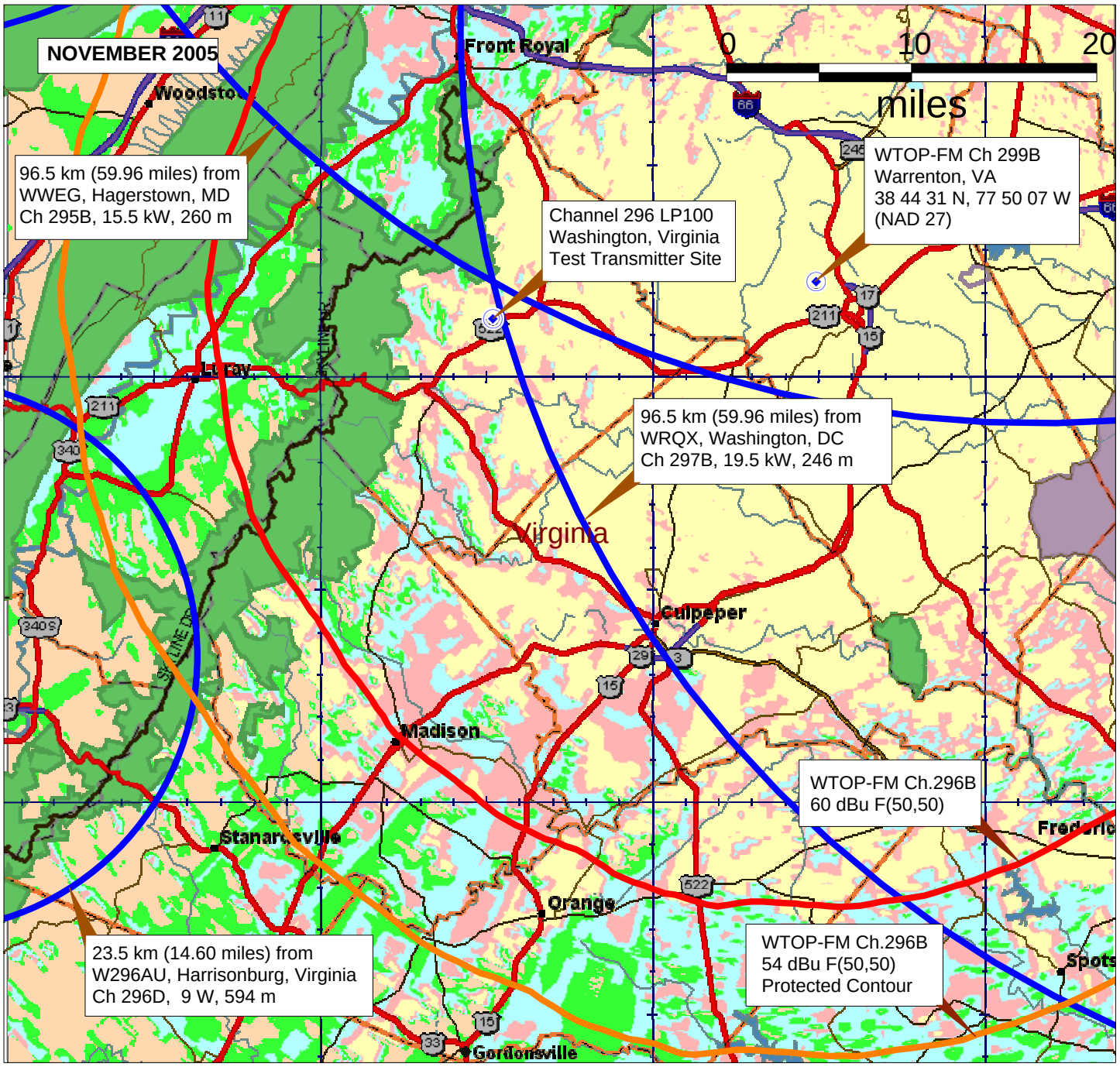
Prepared for
THE NATIONAL ASSOCIATION OF BROADCASTERS
Station WWZZ, Waldorf, Maryland
CH 281B 20 kw (H & V) 244 Meters

Denny & Associates, P.C. Consulting Engineers

Calculated WWZZ Signal Level
(based on Longley-Rice
propagation model)

- > 70 dBu
- 60 - 70 dBu
- 50 - 60 dBu
- 40 - 50 dBu
- < 40 dBu

Figure 3



CHANNEL 296 LP100 AREA TO LOCATE

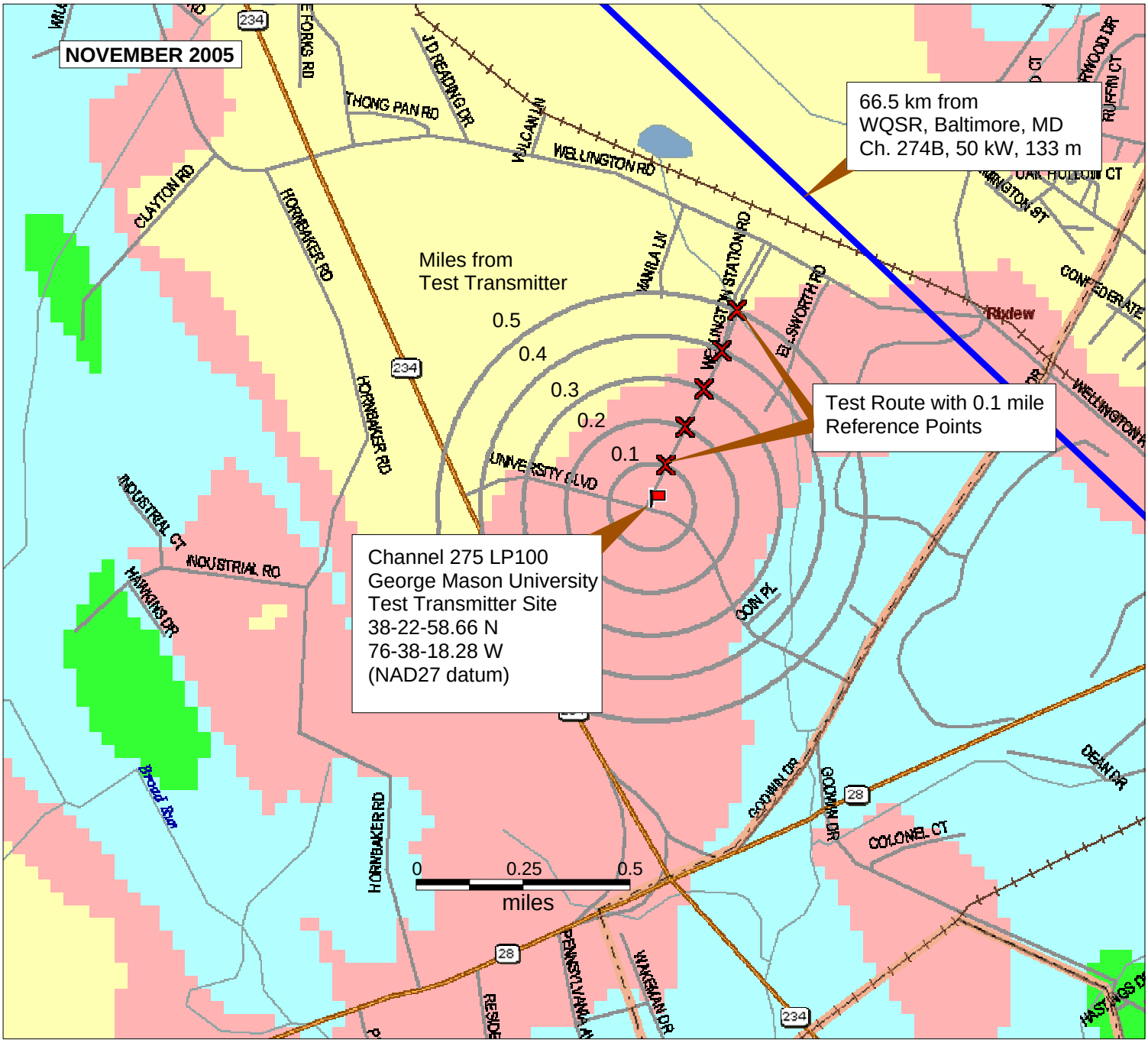
Prepared for
THE NATIONAL ASSOCIATION OF BROADCASTERS
Station WTOP-FM, Washington, Virgina
CH 299B 29 KW (H&V) 197 METERS

Denny & Associates, P.C. Consulting Engineers

Calculated WTOP-FM Signal Level
(based on Longley-Rice
propagation model)

- > 70 dBu
- 60 - 70 dBu
- 50 - 60 dBu
- 40 - 50 dBu
- < 40 dBu

Figure 4



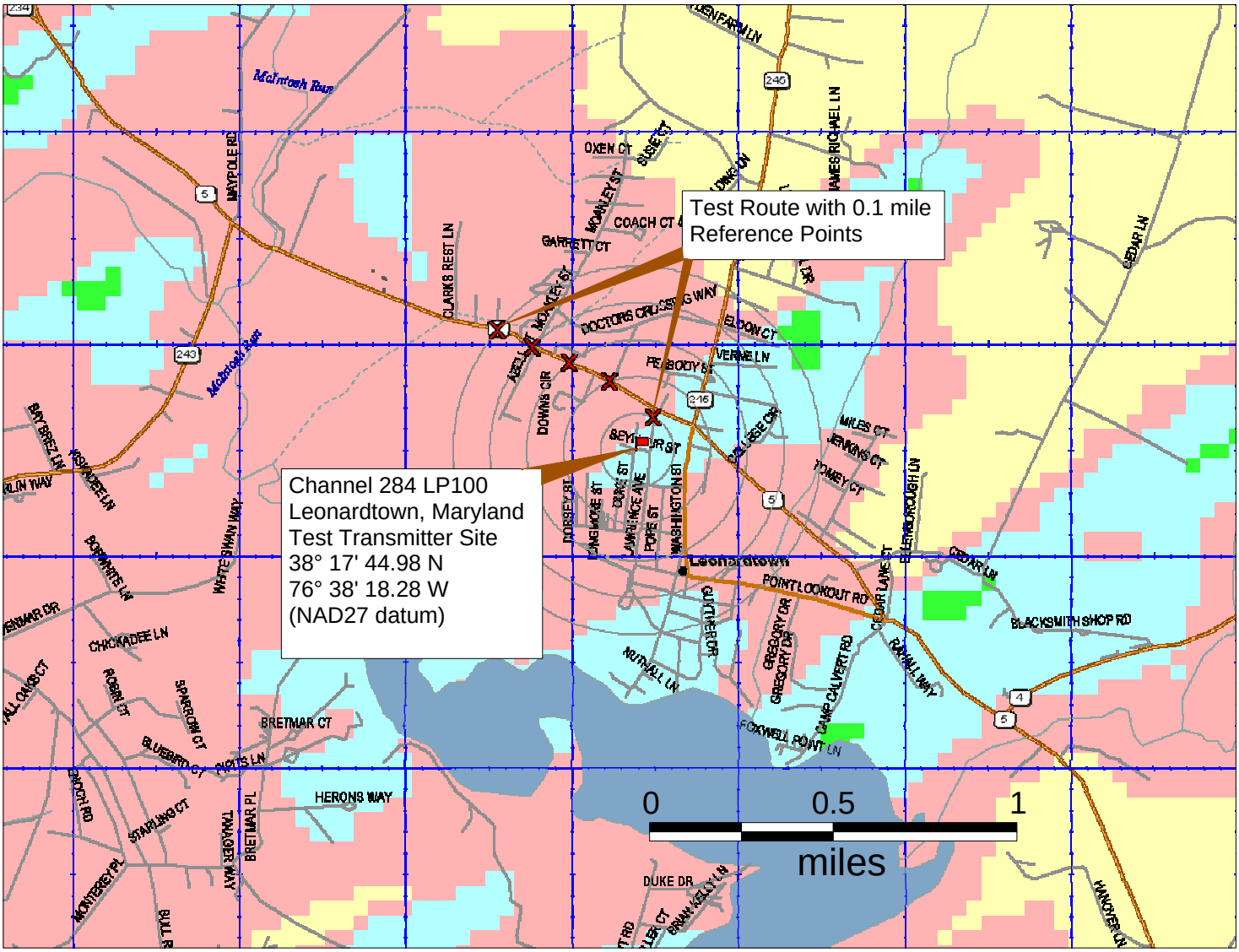
CHANNEL 275
GEORGE MASON UNIVERSITY
TEST LOCATION

Prepared for
THE NATIONAL ASSOCIATION OF BROADCASTERS
Station WGMS-FM, Washington, DC
CH 278B 44 kw (Max-DA, H&V) 158 Meters

Denny & Associates, P.C. Consulting Engineers

Calculated WGMS-FM Signal Level
(using Longley-Rice
propagation model)

- > 70 dBu
- 60 - 70 dBu
- 50 - 60 dBu
- 40 - 50 dBu
- < 40 dBu



CHANNEL 284
LEONARDTOWN, MARYLAND
TEST LOCATION

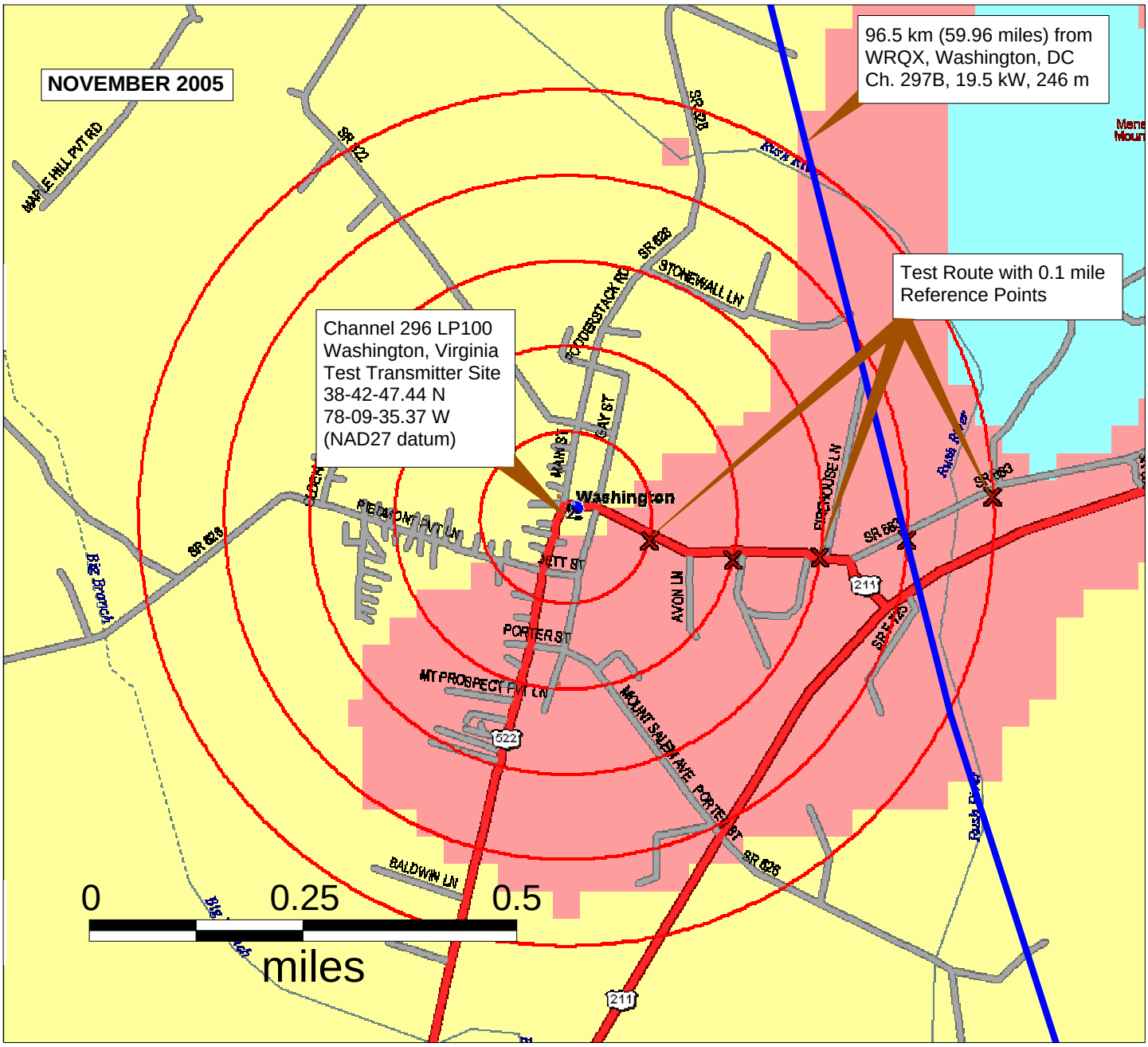
Prepared for
THE NATIONAL ASSOCIATION OF BROADCASTERS
Station WWZZ, Waldorf, Maryland
Ch. 281B 20 kw (H&V) 147 MAAT

Denny & Associates, P.C. Consulting Engineers

Calculated WWZZ Signal Level
(based on Longley-Rice
propagation model)

- > 70 dBu
- 60 - 70 dBu
- 50 - 60 dBu
- 40 - 50 dBu
- < 40 dBu

Figure 6



CHANNEL 296
WASHINGTON, VIRGINIA
TEST LOCATION

Calculated WTOP-FM Signal Level
(based on Longley-Rice
propagation model)

- > 70 dBu
- 60 - 70 dBu
- 50 - 60 dBu

Prepared for
THE NATIONAL ASSOCIATION OF BROADCASTERS
Station WTOP-FM, Warrenton, Virginia
CH 299B 29 KW (H&V) 197 METERS

Denny & Associates, P.C. Consulting Engineers