RADIO FREQUENCY MEASUREMENT REPORT

608-614 MHz WMTS Frequency Band

Froedtert Memorial Hospital

Prepared for

WMTS Coalition

April 2015

19700 Janelia Farm Boulevard • Ashburn, Virginia 20147, USA • Phone 703.726.5500 • Fax 703.726.5597

TABLE OF CONTENTS

Executive Summary

Comsearch performed a series of Radio Frequency (RF) tests and measurements on behalf of the WMTS Coalition ("the Coalition") in the Menomonee Falls, WI area within the vicinity of the Froedtert Memorial Hospital. The purpose of these measurements was to determine path loss values related to building losses, and to a lesser extent losses due to land clutter (foliage, buildings, man-made obstructions, etc). The tests were also performed to determine potential for interference into the GE Healthcare Systems ("GEHC") WMTS system in an attempt to characterize external interference into an installed and operative WMTS system. Comsearch worked with GEHC to identify candidate test transmitter sites. In addition, we worked with GEHC to conduct the measurements, with GEHC taking independent measurement within the WMTS system. GEHC had setup an independent test network in the hospital using transmitters simulating actual patient usage. GEHC monitored these transmitters during the testing period and will provide results in a separate report.

The measurements were conducted by establishing a test transmit signal at nine locations between 341m and 2004m from the hospital. The locations were selected based upon access and the ability to see the hospital. Comsearch set up a spectrum analyzer at specific locations in the hospital close to WMTS receive antennas to capture receive signal level as close to the WMTS receive antenna as practical. The measurement results include line-of-sight profiles from each location to the hospital at the height within the hospital of the WMTS antennas. The test transmit signals included both CW and modulated waveforms that simulate typical transmissions from unlicensed devices.

The results indicated that external signals can be measured from the inside of the hospital. When taken in conjunction with independent measurements performed by GEHC that it was possible to establish signals that could interfere with the WMTS system.

SECTION

ONE

SECTION 1

INTRODUCTION AND BACKGROUND

1.1 Introduction

Radio frequency tests and measurements were performed on behalf of the WMTS Coalition ("the Coalition") in the Franklin, WI area within the vicinity of the Froedtert Memorial Hospital. Comsearch worked with GE Healthcare Systems ("GEHC") to identify candidate test sites and develop the test plan. In addition, we worked with GEHC to conduct the measurements.

The purpose of these measurements was to determine path loss values related to building losses, and to a lesser extent losses due to land clutter (foliage, buildings, man-made obstructions, etc). Additionally, the tests were performed to determine potential interference into the GE Healthcare Systems WMTS system.

1.2 Background

The Froedtert Memorial Hospital is currently operating using frequencies in the WMTS Band, 608-614 MHz.

Comsearch has been tasked to perform RF measurements to determine the potential impact of co-channel transmitter systems operating in the same frequency band as current WMTS operations.

GE Healthcare Systems was issued a Special Temporary Authority (STA) for this test under the call sign WI9XAF (copy is attached in Appendix 1). This report documents the results of the field measurements.

1.3 Constraints

The analysis in this report is based on the following assumptions and constraints:

- The WMTS system being tested will not interfere with existing hospital operations.
- The WMTS system will be operational in a "test mode" simulating normal operating conditions.
- Test sites in the area surrounding the hospital were selected to simulate various levels of path loss.
- Signal level measurements from inside the hospital will be measured in easily accessible areas, and not cause interruptions to hospital operations.

SECTION

TWO

SECTION 2

TEST PROCEDURE

2.1 Test Equipment

To generate the required signals for the test, a Rohde & Schwarz SMBV100A Vector Signal Generator was used. This signal generator allows for the generation of radio frequency (RF) test signals in either Continuous Wave (CW) or modulated modes. The test set is capable of generating up to +22 dBm. Prior to the on-site testing, a calibrated power meter was used to measure the output of the signal generator to ensure that the displayed power level on the signal generator matched the actual power level at the generator RF port.

The antenna used to transmit the signals generated by the R&S VSG was a Katherine-Scala CL-1469B. This antenna provides a nominal 10 dB of gain at 470-862 MHz. The antenna was mounted on a tripod to facilitate an approximate centerline of 7 to 8 feet (approximately 2.4 to 2.5 meters) above ground level (AGL). Signal polarity for all tests was vertical.

The antenna for the spectrum analyzer test set used in the hospital was a Shure PA805SWB. This is a wide-band, log periodic style antenna with a nominal gain of 6.5 dBi in the frequency range of 470-952 MHz. The antenna was oriented so that it was vertically polarized.

2.2 Calibration

Figure 2.2-1 is the block diagram of the spectrum analyzer test set. All test equipment used was allowed a proper warm-up period prior to calibration. The calibrated reference signal (-80dBm) from the signal generator was then injected into the end of the coaxial cable of the test set at the point which normally connects to the test antenna. An Agilent FieldFox spectrum analyzer then measured the reference test signal level after passing through the test set. Upon completion of the calibration process, a known reference level was obtained for the measurements which correspond to a given set of spectrum analyzer display readings. Figure 2.2-2 shows the spectrum photograph of the described calibration procedure employed during the band sweep measurements.

The following formula is used to transform the measured signal level as read on the spectrum analyzer display (dBm) to an isotropic reference signal level (dBW_I) as seen at the point of test:

$$dBW_I = LI - GA$$

Where: dBW_I = Isotropic level in dBW

LI = Level (dBm) of injected signal

GA = Test antenna gain

at 609.350 MHz: $dBW_I = -80\ dBm - 6.5\ dB$

$= -86.5\ dBm_I$

In this instance, the spectrum analyzer displayed measured signal level of -80 dBm_I equates to an injected signal level of -80 dBm and represents an isotropic level of -86.5 dBm_I

Shure Wide-Band
Log Periodic Test Antenna
(+6.5 dBi Gain)

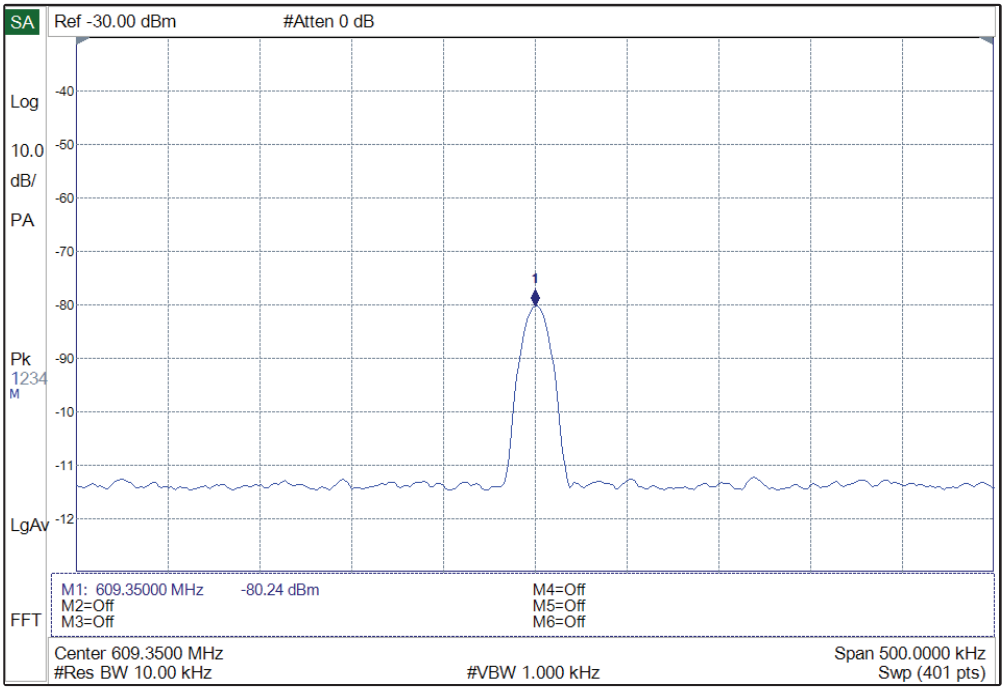
R&S SMBV100A
Signal Generator
Calibration Level = -40 dBm

Cable Moved to Antenna after Calibration

Calibration Signal Injected into Spectrum Analyzer

Agilent FieldFox
30kHz-18GHz
Spectrum Analyzer

Figure 2.2-1 600 MHz Receive Test Equipment



(A)

Res BW: 100 kHz
Video BW: 10 kHz

The -80 dBm, 609.350 MHz signal indication on the spectrum photograph represents a -80 dBm CW signal being injected into the point where the test cable connects to the output of the test antenna.

Figure 2.2-2 Spectrum Analyzer Calibration

2.3 Methodology

The purpose of these RF measurements was to determine path loss values related to building losses, and to a lesser extent losses due to land clutter (foliage, buildings, man-made obstructions, etc). The tests were also performed to determine potential for interference into the WMTS system in an attempt to characterize external interference into an installed and operating WMTS system used by the hospital (Froedtert Memorial) from an external transmitter operating in the WMTS frequencies of 608 to 614 MHz. GEHC had setup up a separate test network of four transmitters simulating devices used in actual operation at the hospital.

A testing signal source was produced by setting up a test transmitter (Rohde & Schwarz SMBV100A) for use in the in the WMTS band. The test transmitter was set to frequencies designated by GEHC to ensure non-interference into existing WMTS operational frequencies at the hospital. The transmitter was connected to a directional antenna (Kathrein Scala CL-1469 B) with centerline of 9 feet above ground and pointed toward the hospital from each test point. At each test point the HAAT was calculated. Using the calculated HAAT, power density restrictions (FCC 14-144 para.42) and separation distance restrictions (FCC 14-144 para.112) power levels for the test transmitter were calculated for a 6 MHz modulated carrier. These power levels were then translated into values for a 100 kHz modulated carrier and then used to set the RF power level at the signal generator (see table below).

EIRP (dBm)		TX Power (dBm) (minus antenna gain)	Cable Loss (dB)	Conducted Power at Signal Generator (dBm)
in 6MHz	in 100kHz			
16	-1.404	-11.404	1.47	-9.93
20	2.596	-7.404	1.47	-5.93
24	6.596	-3.404	1.47	-1.93
28	10.596	0.596	1.47	2.07
32	14.596	4.596	1.47	6.07
36	18.596	8.596	1.47	10.07

The transmitter was powered up using a CW (carrier wave) signal at the frequency of 609.3500 MHz. The signal at 609.3500 MHz was used because this was outside of the test signals used by the GEHC test network and would not be masked and therefore visible when powered on. RF measurements were performed inside the hospital using the receive test set describe in section 2.1 of the test signal which is external to the WMTS system used by the hospital. Concurrently separate RF measurements were conducted by GEHC using the WMTS distributed antenna system installed in the hospital. Upon direction from the GEHC team the CW signal was powered off and the transmitter was reconfigured to transmit a modulated (802.x – 64 QAM) 100 kHz signal at 609.3500 MHz. The signal was powered on and RF measurements were then conducted of this test signal as previously described both external and internal to the hospital's WMTS system. Again upon direction from the GEHC team the modulated signal was powered off the transmitter was reconfigured to transmit a modulated (802.x – 64 QAM) 100 kHz signal at 609.4625 MHz. The signal at 609.4625 MHz was used as it overlaid the test signals used the GE test network. Once again the signal was powered on and RF measurements were then conducted of this test signal as previously described both external and internal to the hospital's WMTS system.

SECTION

THREE

SECTION 3

Data Presentation

The following section contains street maps, aerial maps, and spectrum photographs pertaining to each test site location.

3.0 Hospital Site

- Figure 3.0-1 Street map of the Hospital location
- Figure 3.0-2 Aerial photograph of the Hospital location
- Figure 3.0-3 Street map of the Hospital and transmitter test site locations
- Figure 3.0-4 Aerial photograph of the Hospital and transmitter test site locations

3.1 Transmitter Site 1

- Figure 3.1-1 Street map of the transmitter location
- Figure 3.1-2 Aerial photograph of the transmitter location
- Figure 3.1-3 and 3.1-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.1-5 and 3.1-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 1 location and Receive test equipment
- Figures 3.1-7 through 3.1-10 RF spectrum photographs

3.2 Transmitter Site 2

- Figure 3.2-1 Street map of the transmitter location
- Figure 3.2-2 Aerial photograph of the transmitter location
- Figure 3.2-3 and 3.2-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.2-5 and 3.2-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 2 location and Receive test equipment
- Figures 3.2-7 through 3.2-10 RF spectrum photographs

3.3 Transmitter Site 3

- Figure 3.3-1 Street map of the transmitter location
- Figure 3.3-2 Aerial photograph of the transmitter location
- Figure 3.3-3 and 3.3-4 On-path view from transmitter test site location inside pharmacy area ground floor level towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.3-5 and 3.3-6 On-path view from transmitter test site location inside building on fifth floor towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.3-7 and 3.3-8 On-path view from Froedtert Memorial Hospital test location to the Transmitter Site 3 locations and Receive test equipment
- Figures 3.3-9 through 3.3-12 RF spectrum photographs

3.4 Transmitter Site 4

- Figure 3.4-1 Street map of the transmitter location
- Figure 3.4-2 Aerial photograph of the transmitter location
- Figure 3.4-3 and 3.4-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.4-5 and 3.4-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 4 location and Receive test equipment
- Figures 3.4-7 through 3.4-10 RF spectrum photographs

3.5 Transmitter Site 5

- Figure 3.5-1 Street map of the transmitter location
- Figure 3.5-2 Aerial photograph of the transmitter location
- Figure 3.5-3 and 3.5-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.5-5 and 3.5-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 5 location and Receive test equipment
- Figures 3.5-7 through 3.5-10 RF spectrum photographs

3.6 Transmitter Site 10

- Figure 3.6-1 Street map of the transmitter location
- Figure 3.6-2 Aerial photograph of the transmitter location
- Figure 3.6-3 and 3.6-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.6-5 and 3.6-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 10 location and Receive test equipment
- Figures 3.6-7 through 3.6-11 RF spectrum photographs

3.7 Transmitter Site 12

- Figure 3.7-1 Street map of the transmitter location
- Figure 3.7-2 Aerial photograph of the transmitter location
- Figure 3.7-3 and 3.7-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.7-5 and 3.7-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 12 location and Receive test equipment
- Figures 3.7-7 through 3.7-10 RF spectrum photographs

3.8 Transmitter Site 13

- Figure 3.7-1 Street map of the transmitter location
- Figure 3.7-2 Aerial photograph of the transmitter location
- Figure 3.7-3 and 3.7-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.7-5 and 3.7-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 13 location and Receive test equipment
- Figures 3.7-7 through 3.7-10 RF spectrum photographs

3.9 Transmitter Site 9

- Figure 3.7-1 Street map of the transmitter location
- Figure 3.7-2 Aerial photograph of the transmitter location
- Figure 3.7-3 and 3.7-4 On-path view from transmitter test site location towards Froedtert Memorial Hospital and the Transmitter Test Site
- Figure 3.7-5 and 3.7-6 On-path view from Froedtert Memorial Hospital test location to Transmitter Site 9 location and Receive test equipment
- Figures 3.7-7 through 3.7-10 RF spectrum photographs

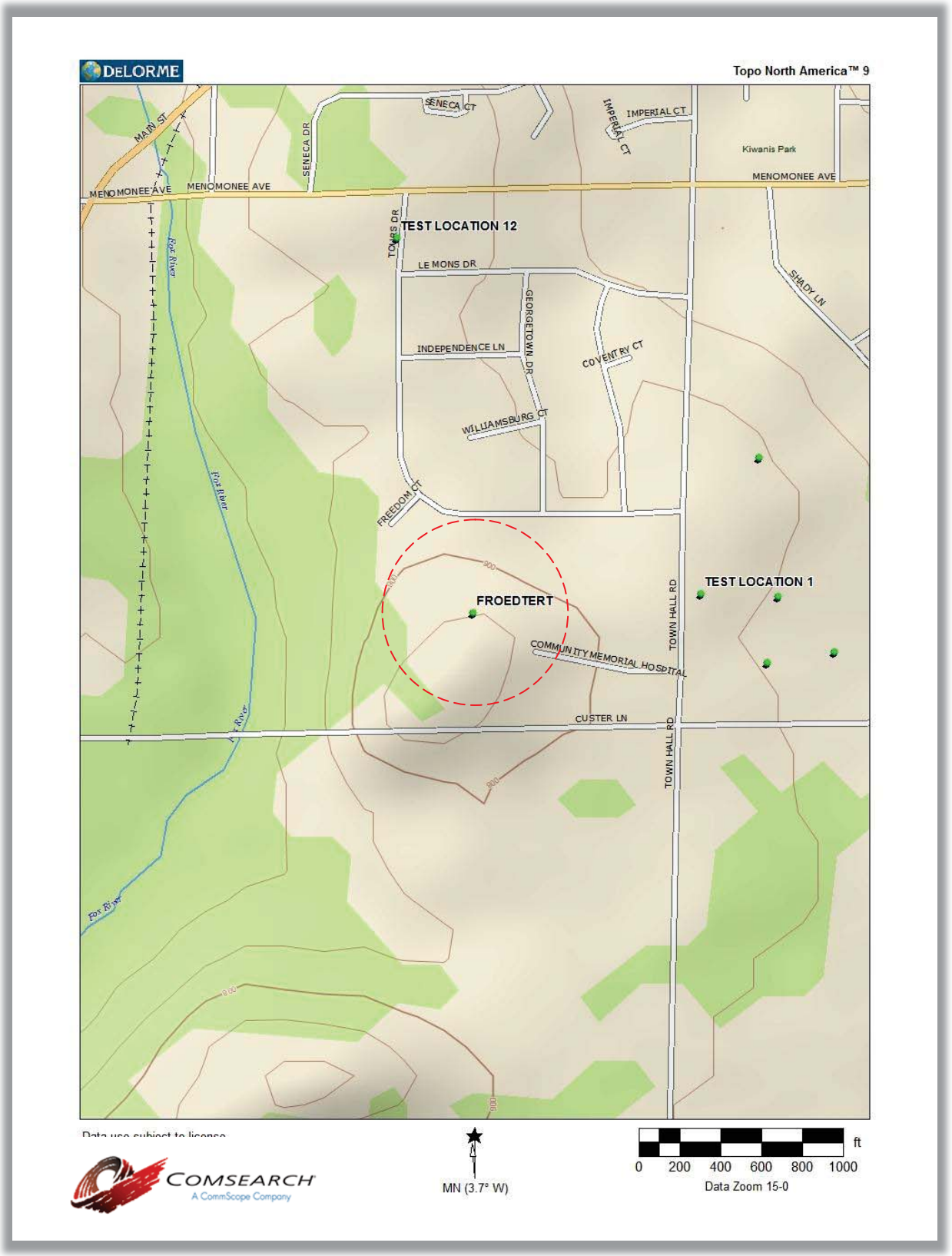


Figure 3.0-1 – Street Map –Hospital Location

Figure 3.0-2 – Aerial Map – Hospital Location

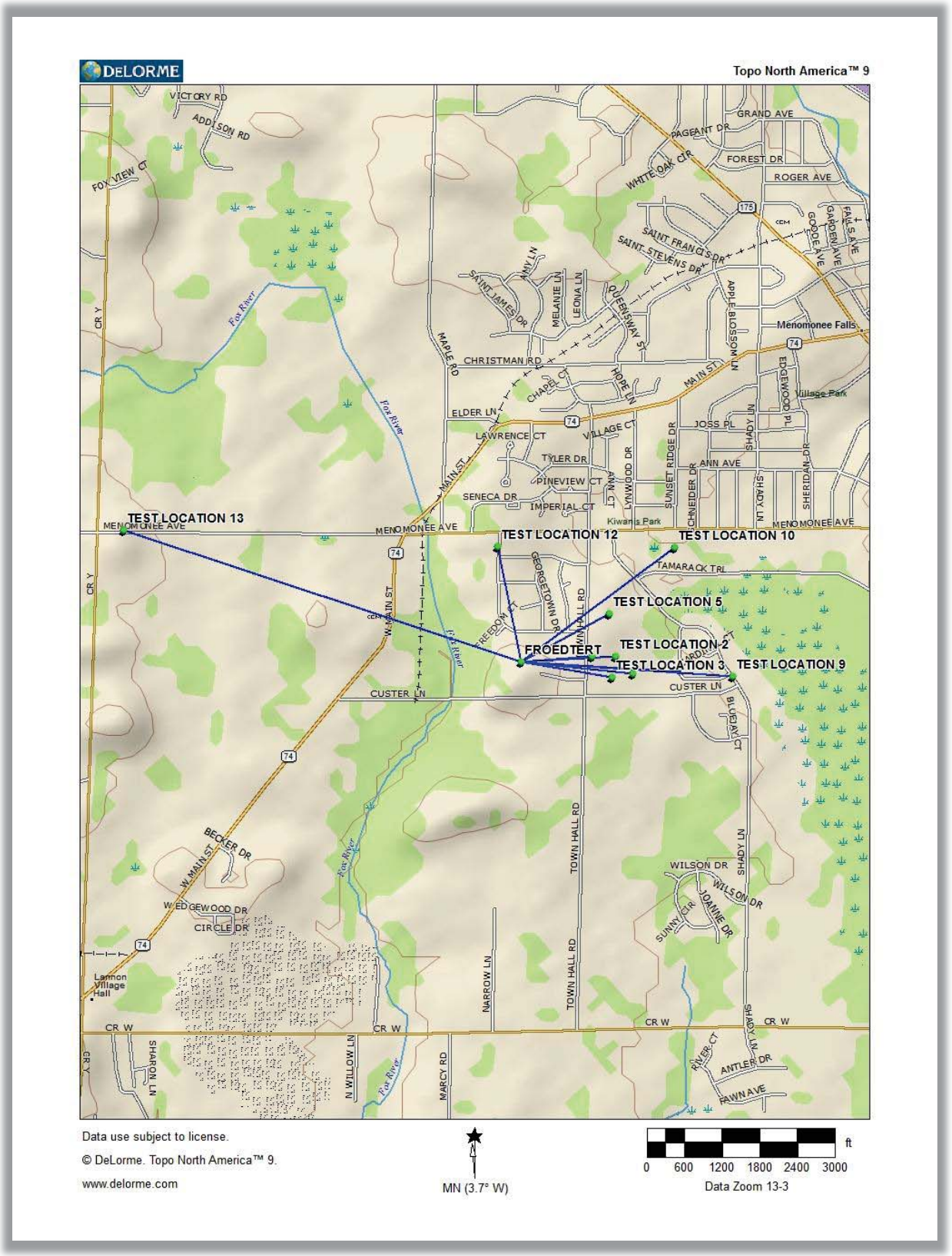


Figure 3.0-3 – Street Map – Hospital and Test Site Locations

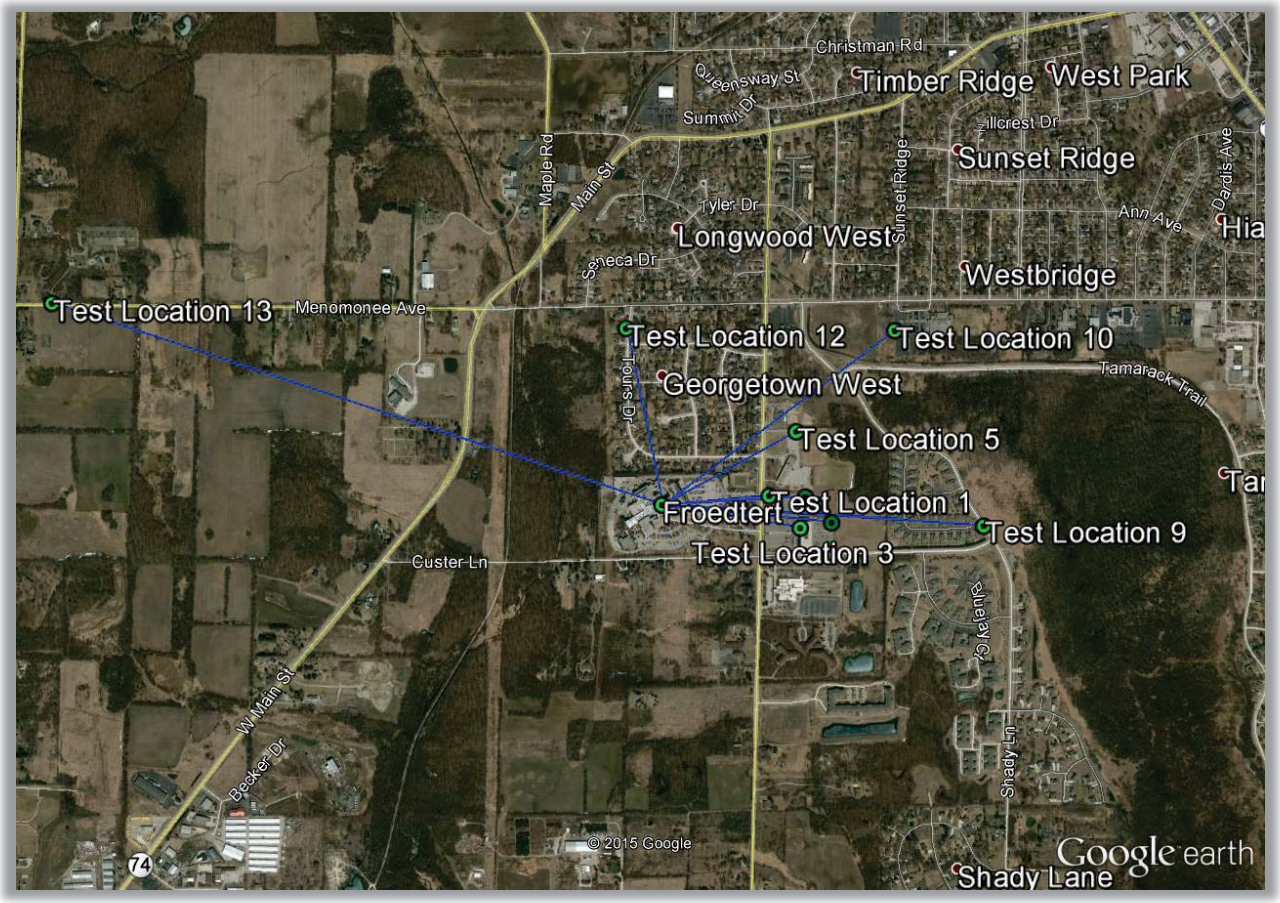


Figure 3.0-4 – Aerial Map – Hospital Test Site Locations

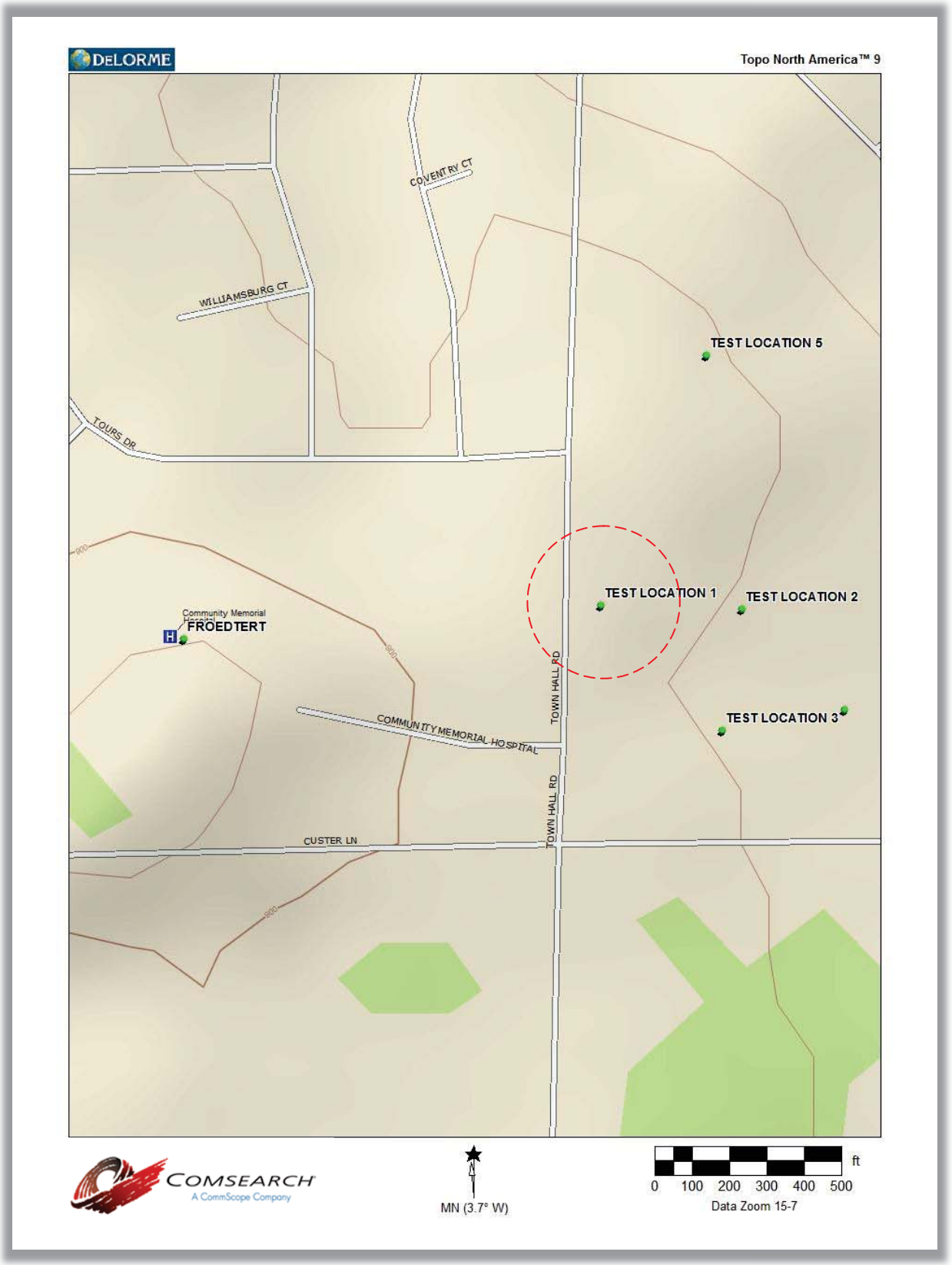


Figure 3.1-1 – Street Map – Test Point #1 Transmitter Location

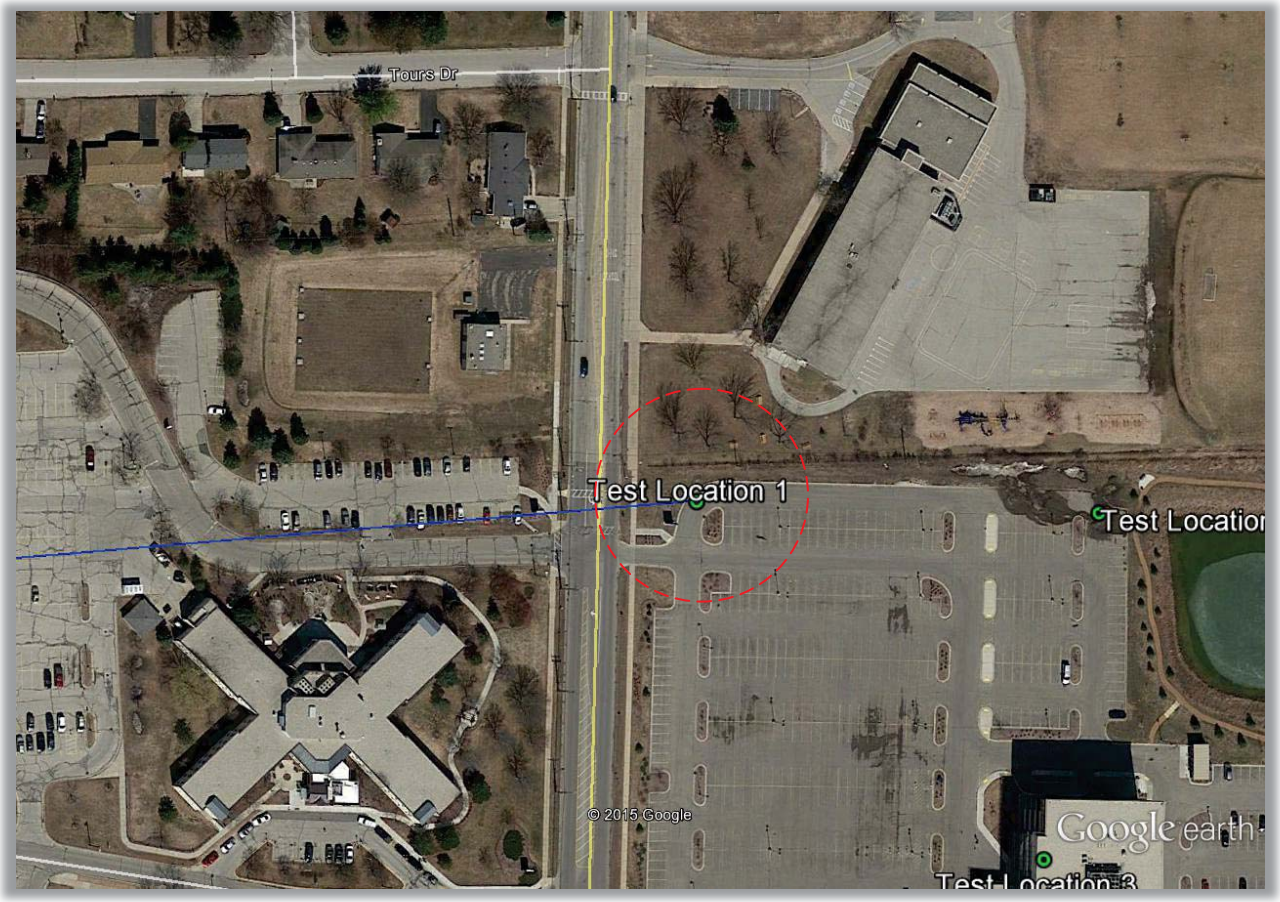


Figure 3.1-2 – Aerial Map – Test Point #1 Transmitter Location

Figure 3.1-3 – Looking on path to Froedtert Memorial Hospital from Test Point #1 location

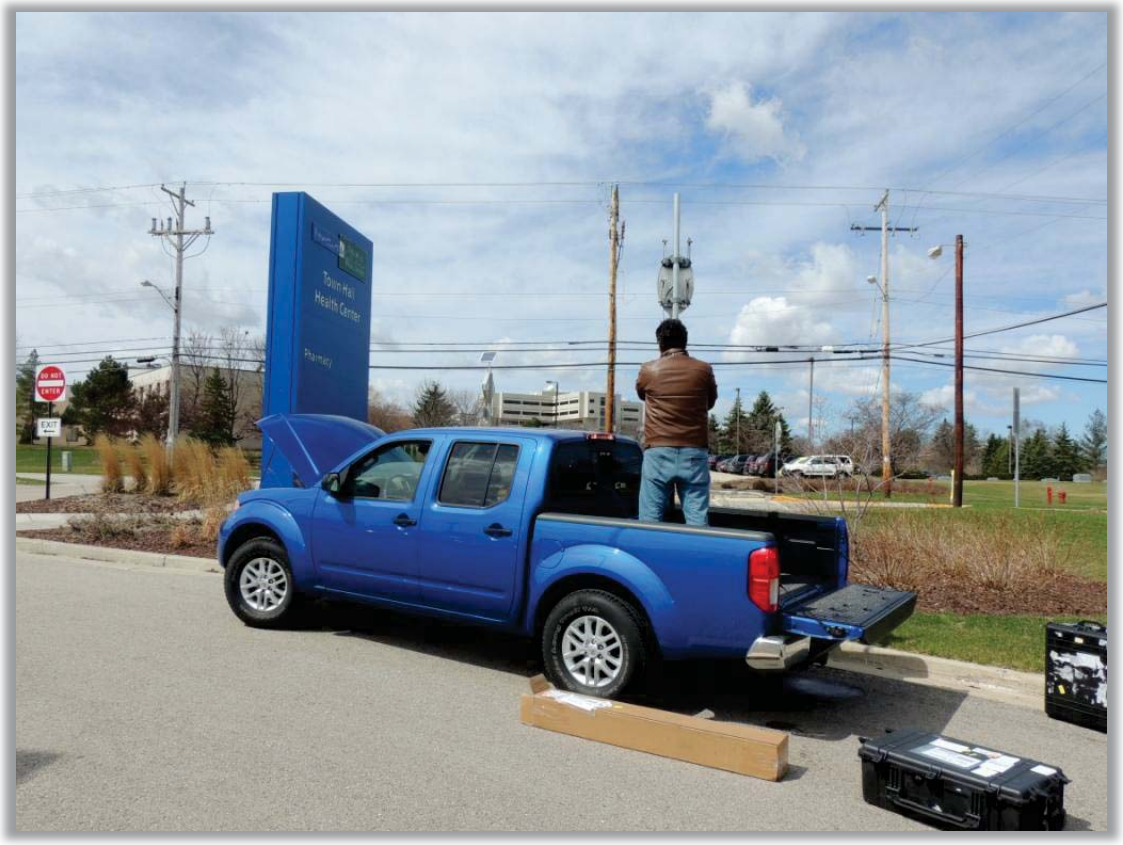


Figure 3.1-4 –Test Point #1 Transmitter

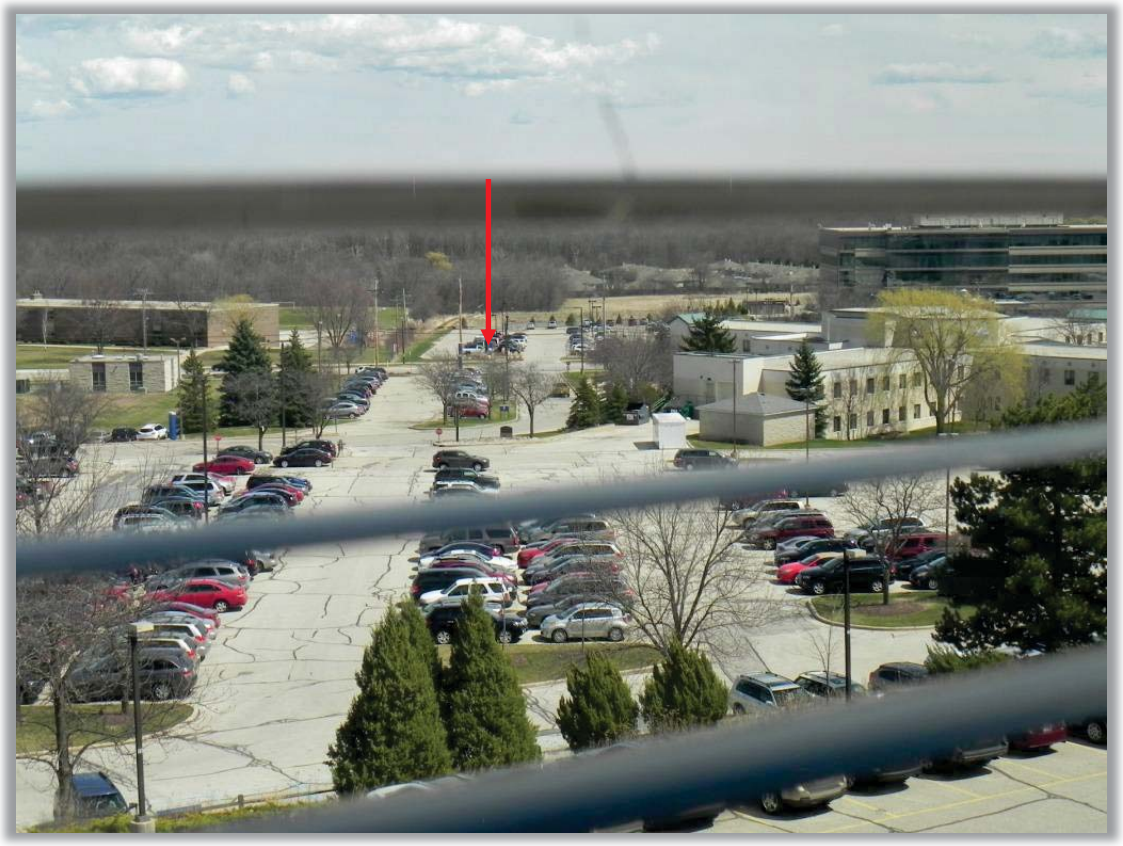


Figure 3.1-5 –View towards Test Point #1 from inside Froedtert Memorial Hospital 4th floor

Figure 3.1-6 –Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #1
Also visible is G.E. WMTS antenna (at arrow)

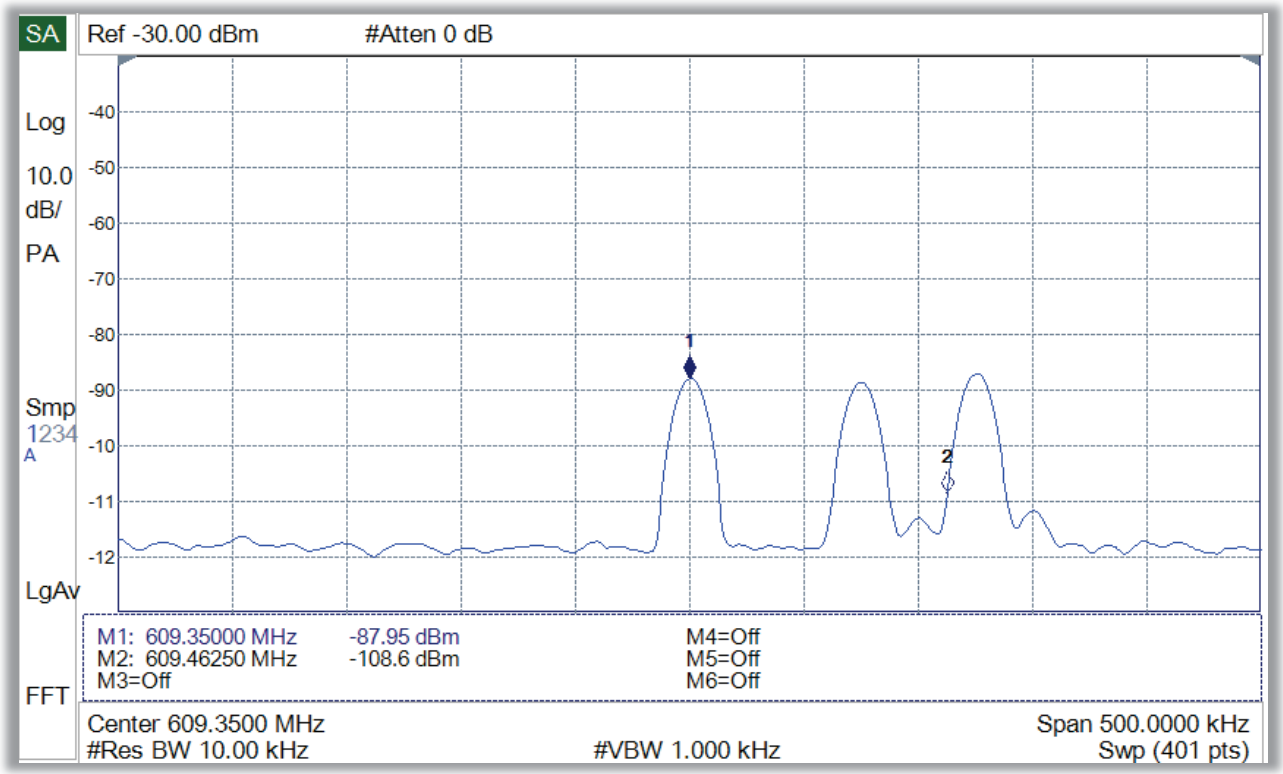


Figure 3.1-7 – Test Point #1 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 341 meters from the street level Test Point #1 site
Average recorded level -87.95 dBm (609.350 MHz) Marker 1 – Isotropic value -93.95 dBm
Transmitter EIRP -1.40 dBm (signal generator set to -9.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

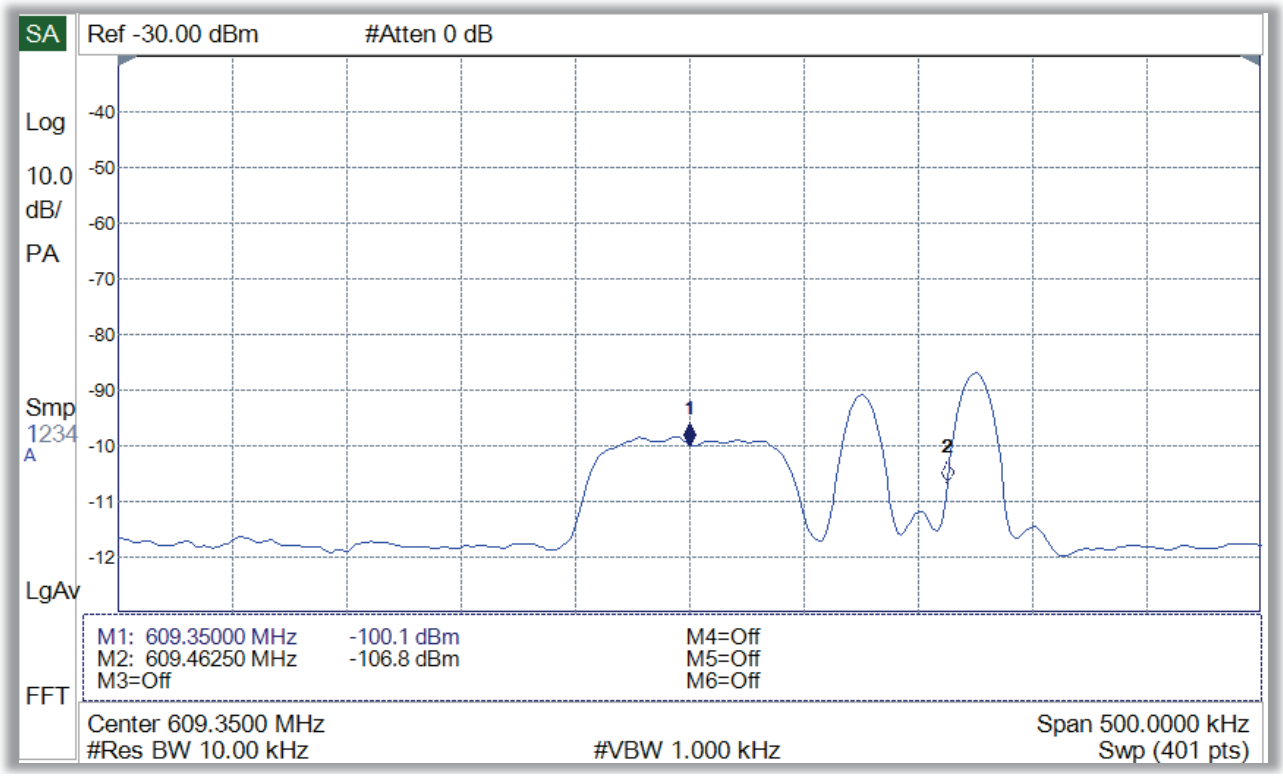


Figure 3.1-8 – Test Point #1 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 341 meters from the street level Test Point #1 site
Average recorded level -100.1 dBm (609.350 MHz) Marker 1 – Isotropic value -106.1 dBm
Transmitter EIRP -1.40 dBm (signal generator set to -9.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

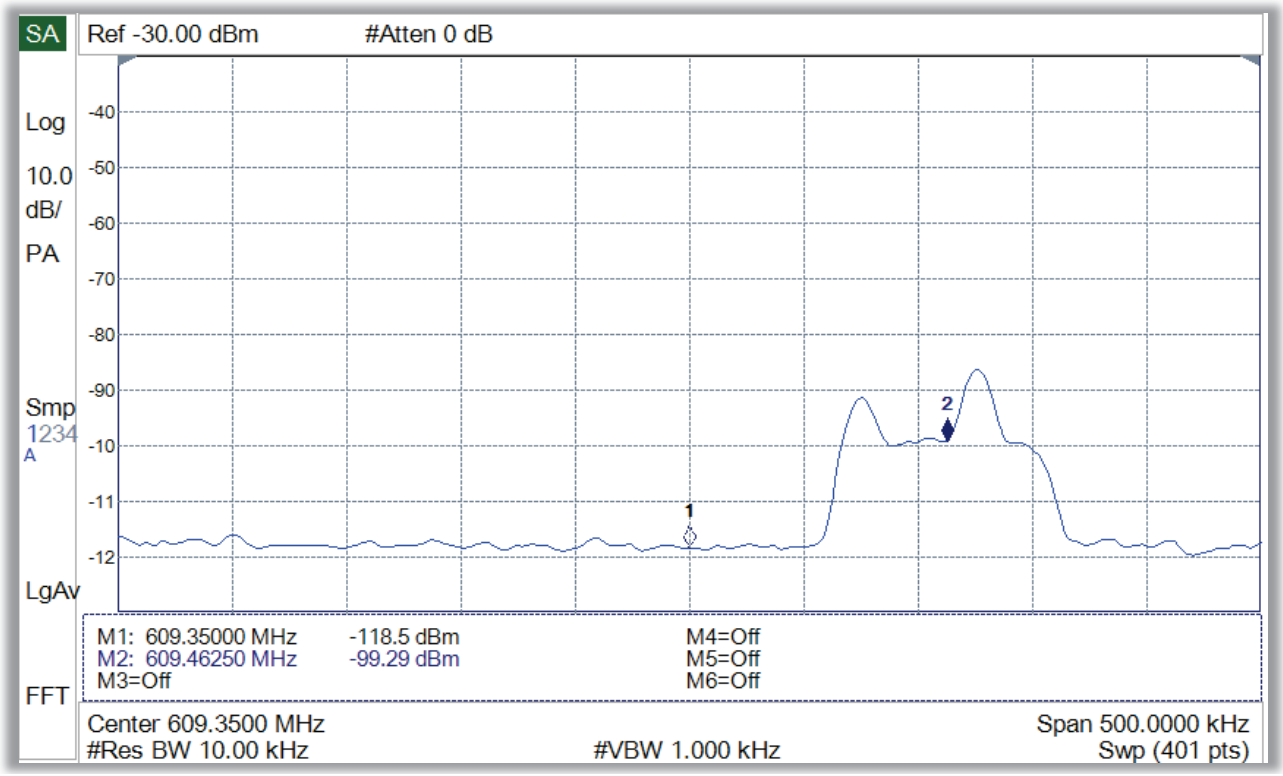


Figure 3.1-9 – Test Point #1 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 341 meters from the street level Test Point #1 site
Average recorded level -99.29 dBm (609.4625 MHz) Marker 2 – Isotropic value -105.29 dBm
Transmitter EIRP -1.40 dBm (signal generator set to -9.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

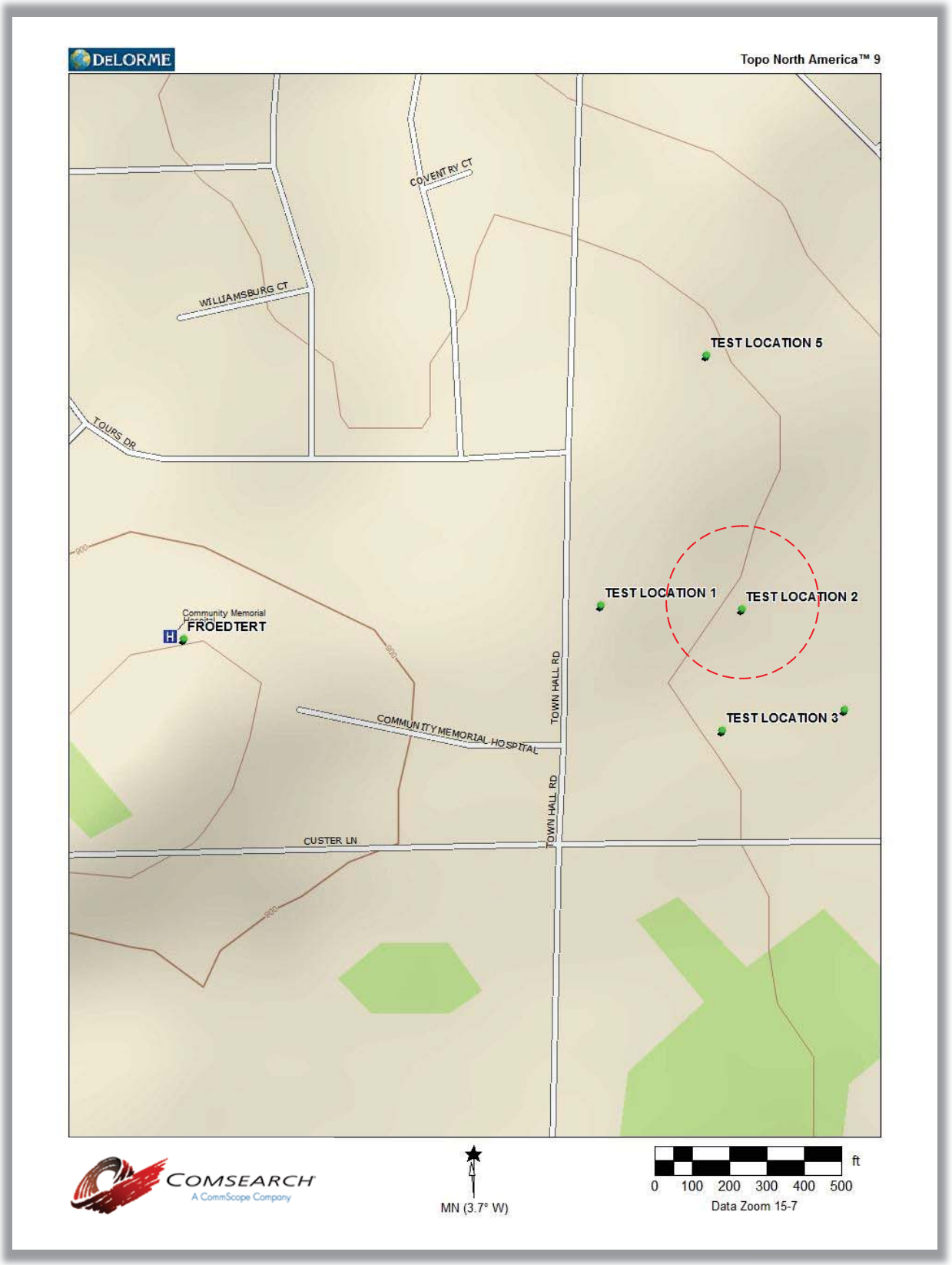


Figure 3.2-1 – Street Map – Test Point #1 Transmitter Location

Figure 3.2-2 – Aerial Map – Test Point #2 Transmitter Location

Figure 3.2-3 – Looking on path to Froedtert Memorial Hospital from Test Point #2 location

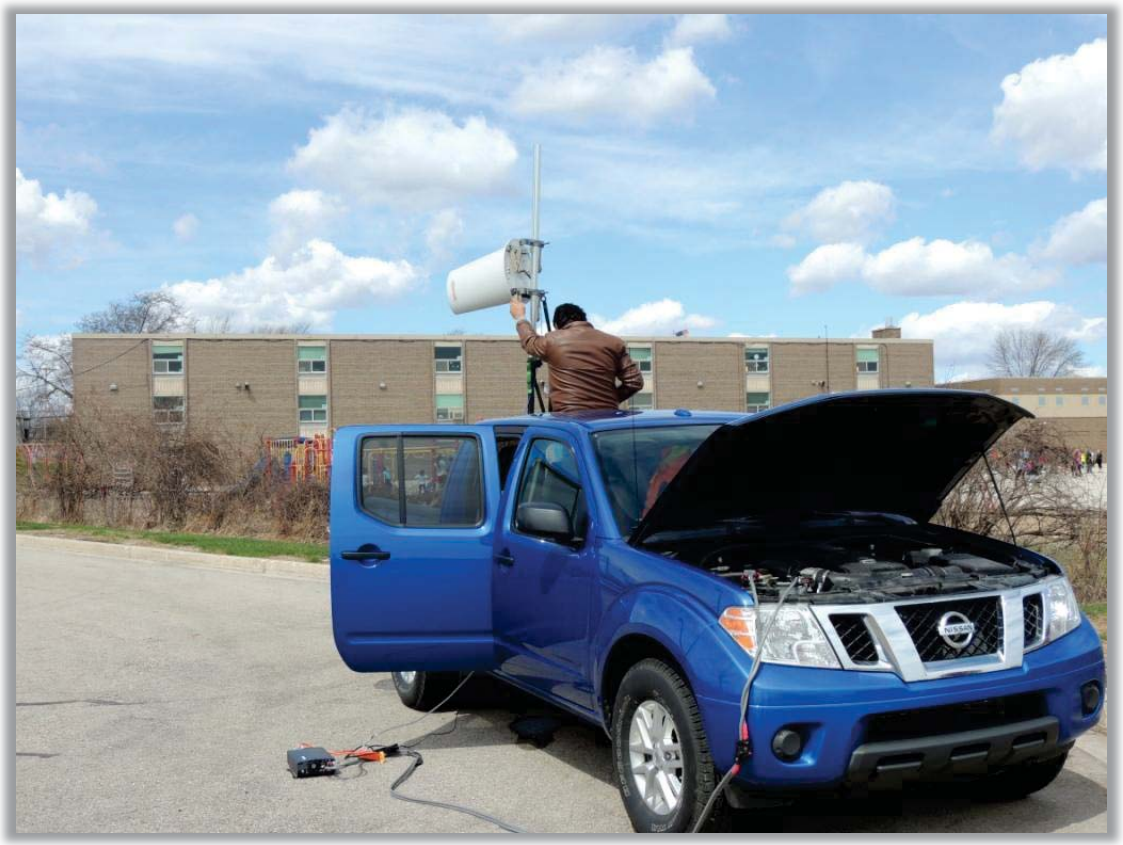


Figure 3.2-4 –Test Point #2 Transmitter

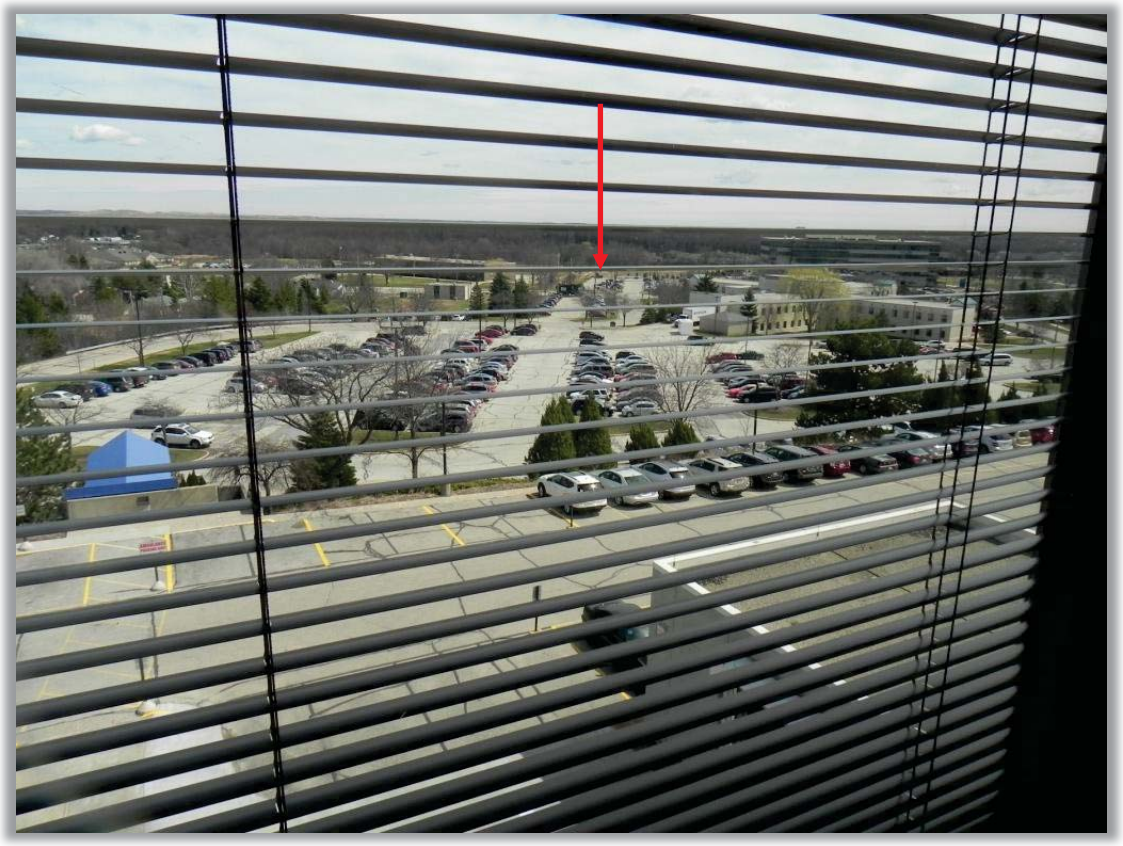


Figure 3.2-5 –View towards Test Point #2 from inside Froedtert Memorial Hospital 4th floor

Figure 3.2-6 –Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #2
Also visible is G.E. WMTS antenna (at arrow)

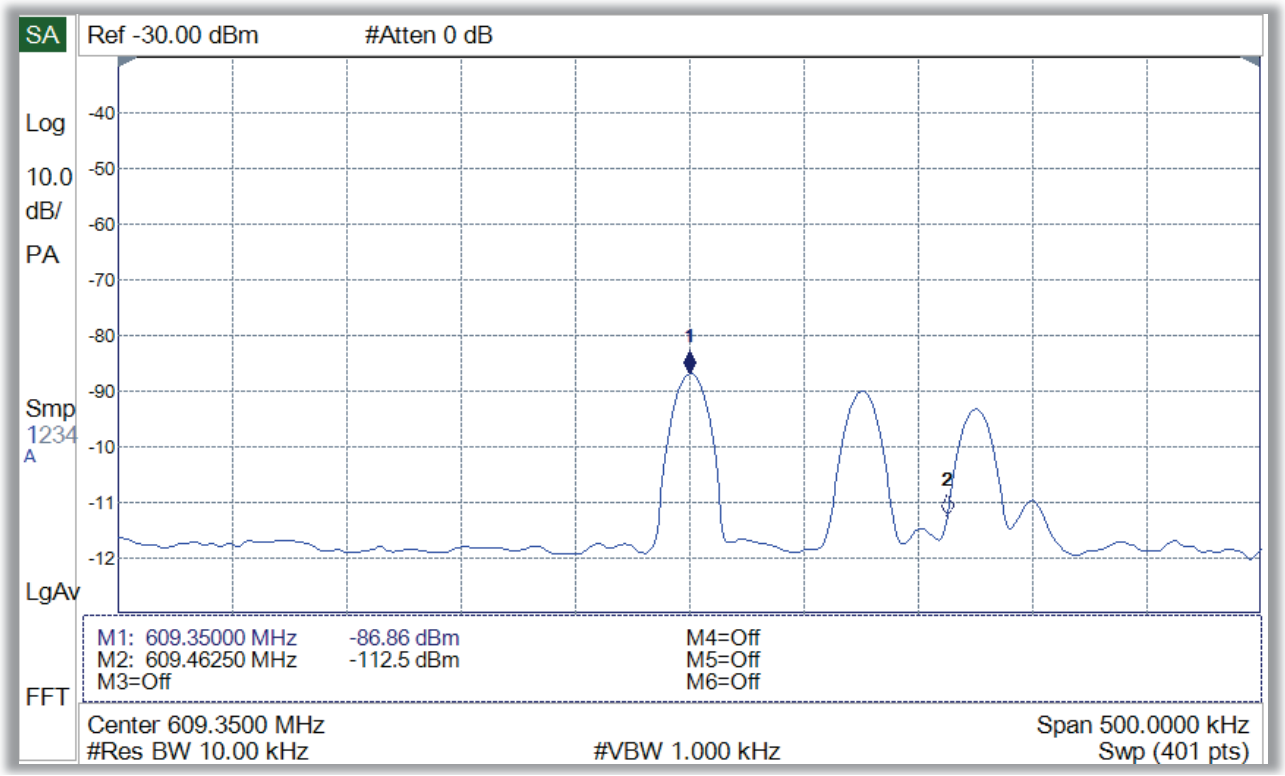


Figure 3.2-7 – Test Point #2 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 429 meters from the street level Test Point #2 site
Average recorded level -86.86 dBm (609.350 MHz) Marker 1 – Isotropic value -92.86 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

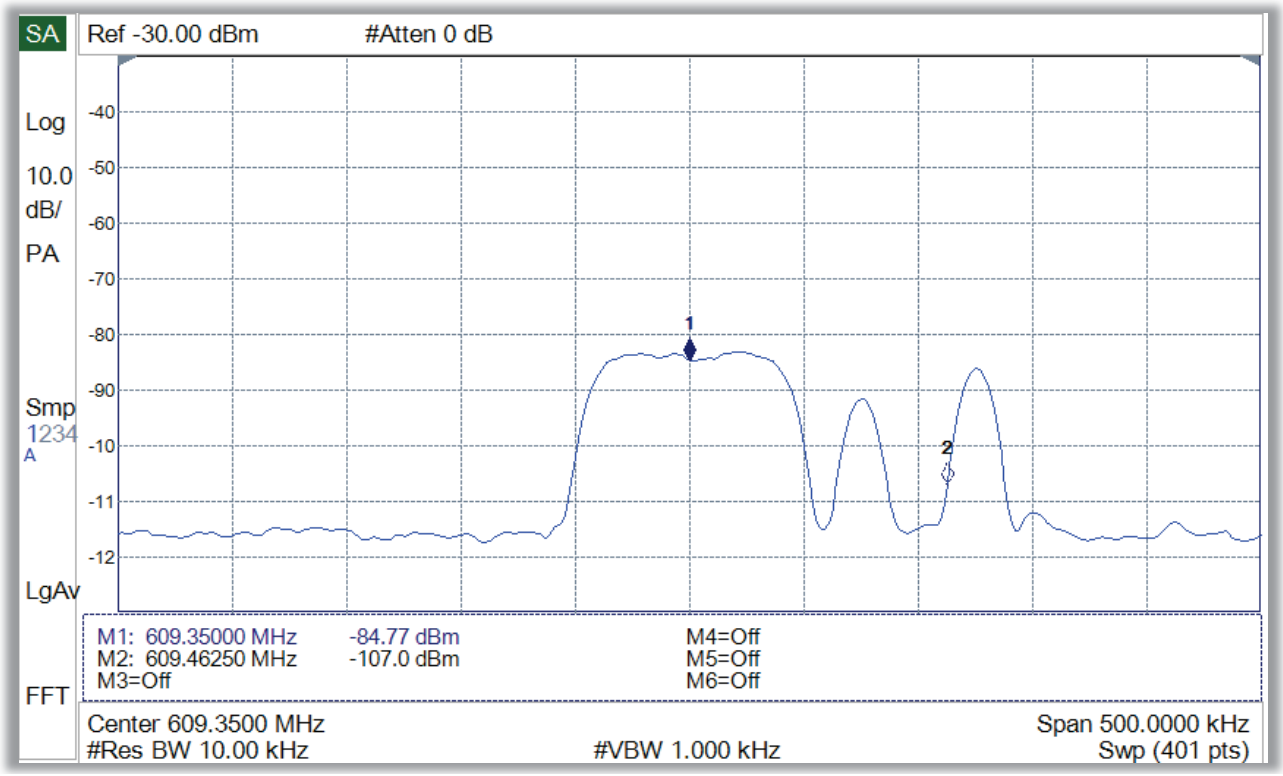


Figure 3.2-8 – Test Point #2 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 429 meters from the street level Test Point #2 site
Average recorded level -84.77 dBm (609.350 MHz) Marker 1 – Isotropic value -90.77 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

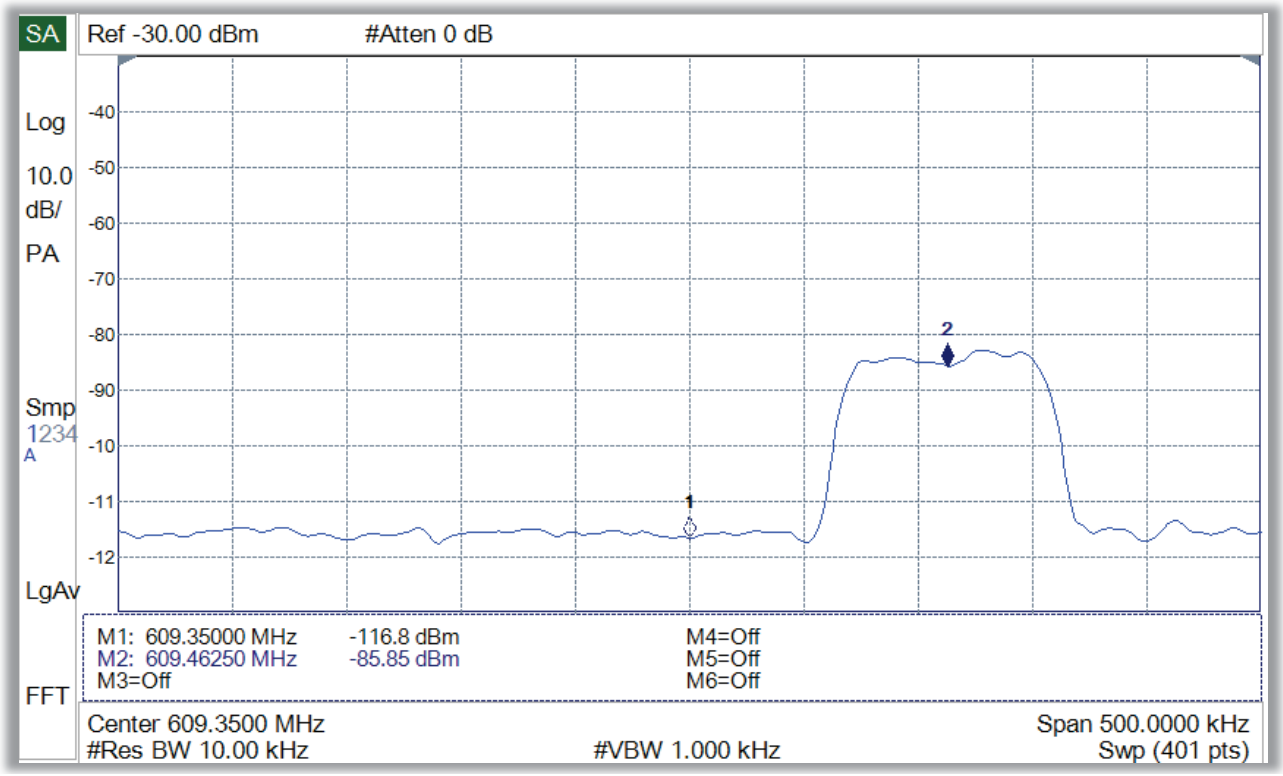


Figure 3.2-9 – Test Point #2 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 429 meters from the street level Test Point #2 site
Average recorded level -85.85 dBm (609.4625 MHz) Marker 2 – Isotropic value -91.85 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

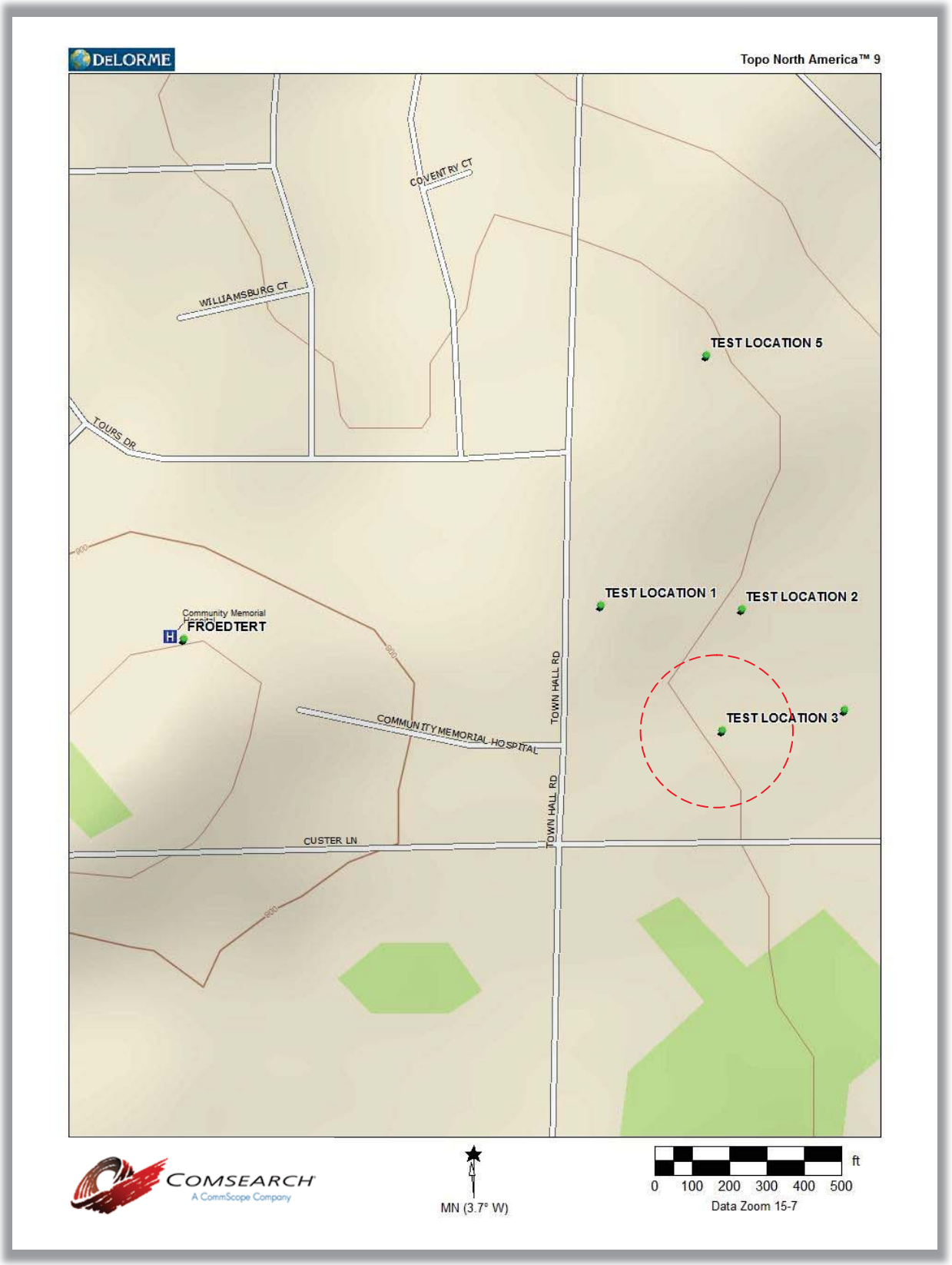


Figure 3.3-1 – Street Map – Test Point #3 Transmitter Location

Figure 3.3-2 – Aerial Map – Test Point #3 Transmitter Location

Figure 3.3-3 – Looking on path to Froedtert Memorial Hospital from Test Point #3 first floor pharmacy area location

Figure 3.3-4 –Test Point #3 Transmitter in first floor pharmacy area

Figure 3.3-5 – Looking on path to Froedtert Memorial Hospital from Test Point #3 fifth floor location

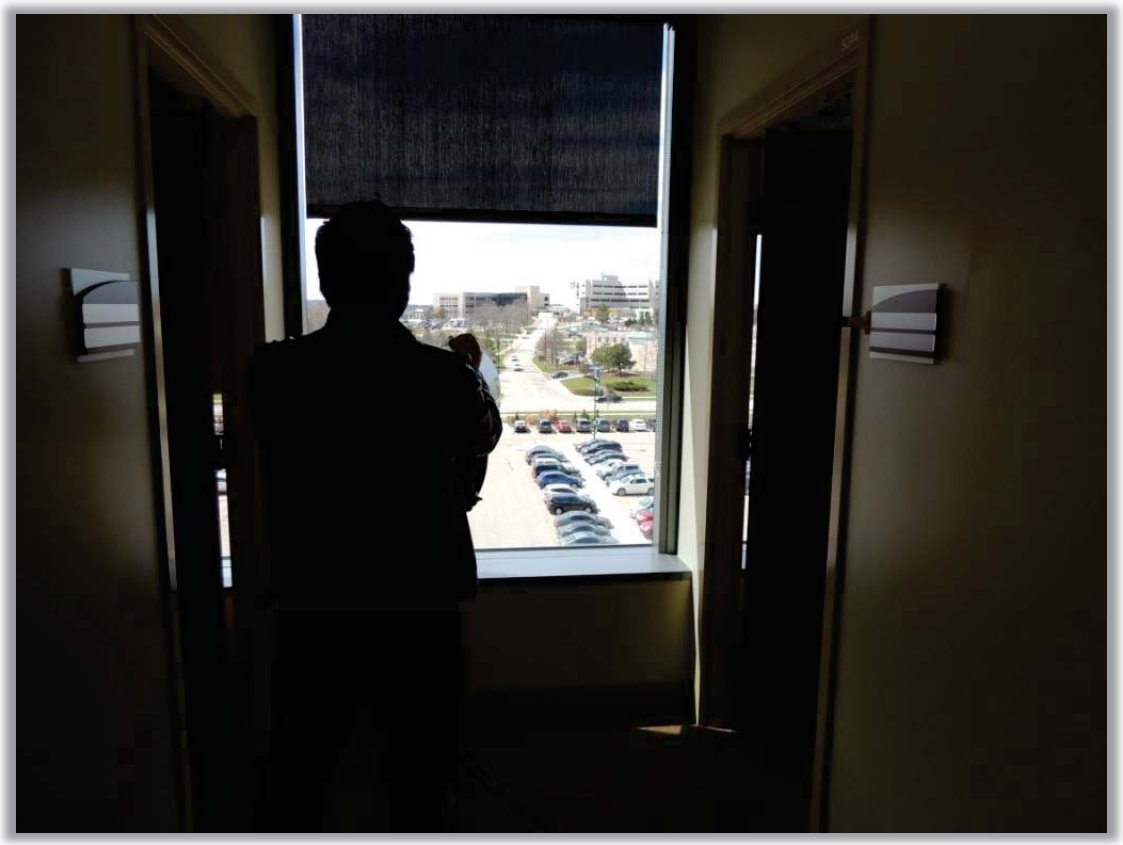


Figure 3.3-6 –Test Point #3 Transmitter on fifth floor

Figure 3.3-7 –View towards Test Point #3 first and fifth floor locations from inside Froedtert Memorial Hospital 4th floor

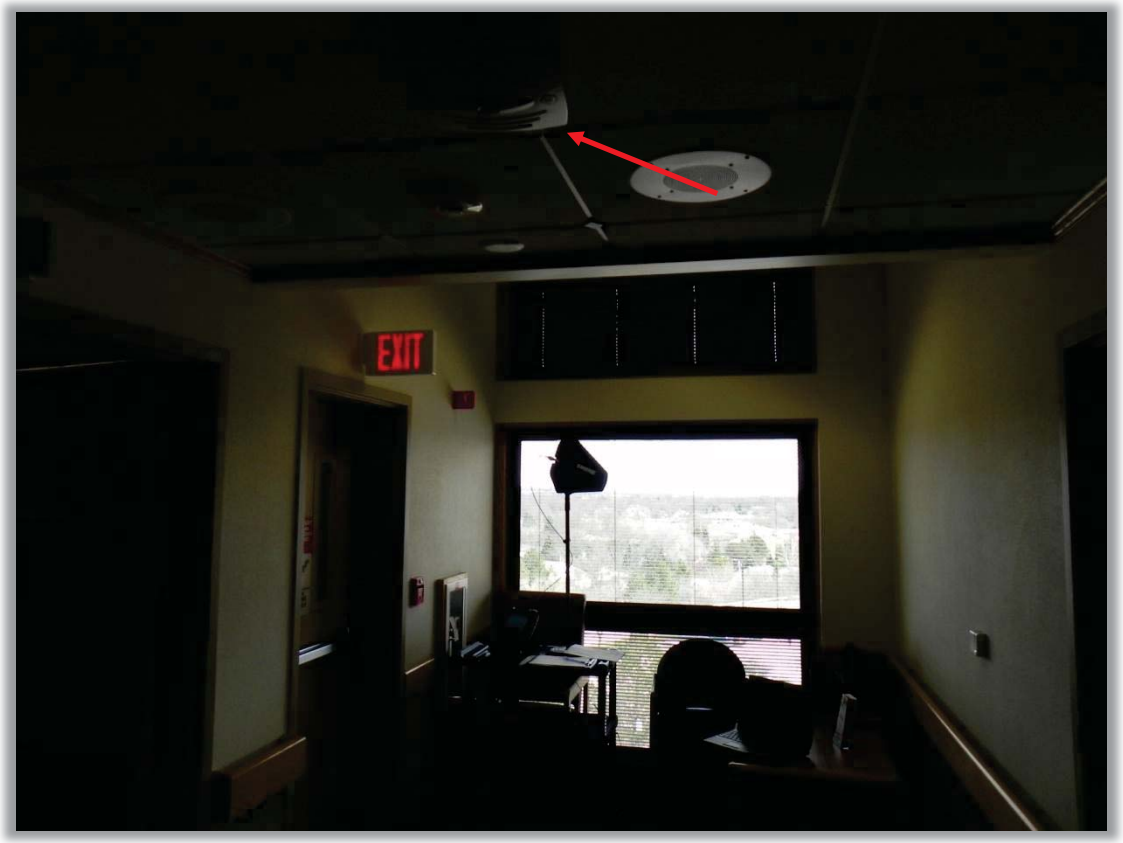


Figure 3.3-8 –Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #3
Also visible is G.E. WMTS antenna (at arrow)

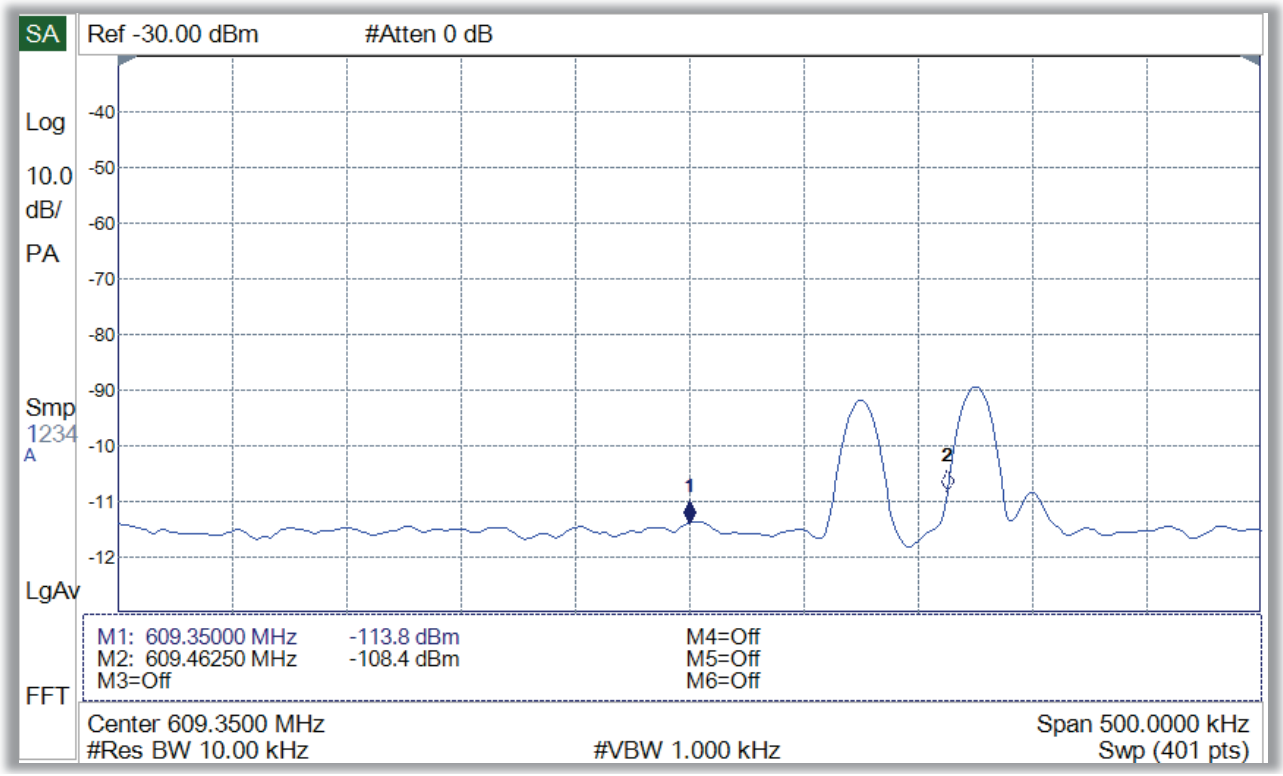


Figure 3.3-9 – Test Point #3 located in ground level pharmacy area
Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 421 meters from the in-building ground level Test Point #3 site
Average recorded level -113.8 dBm (609.350 MHz) Marker 1 – Isotropic value -119.8 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

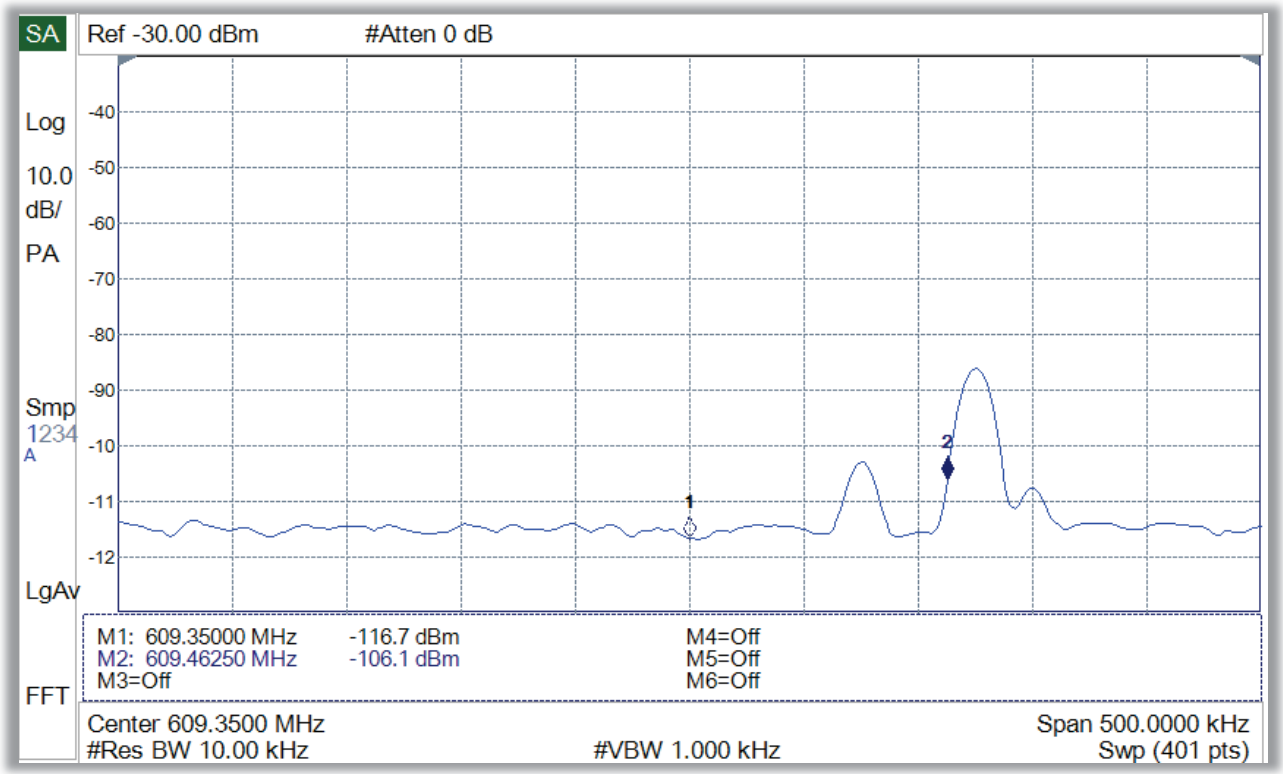


Figure 3.3-10 – Test Point #3 located on 5th floor in-building Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 421 meters from the 5th floor Test Point #3 site
Average recorded level -116.7 dBm (609.350 MHz) Marker 1 – Isotropic value -122.7 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

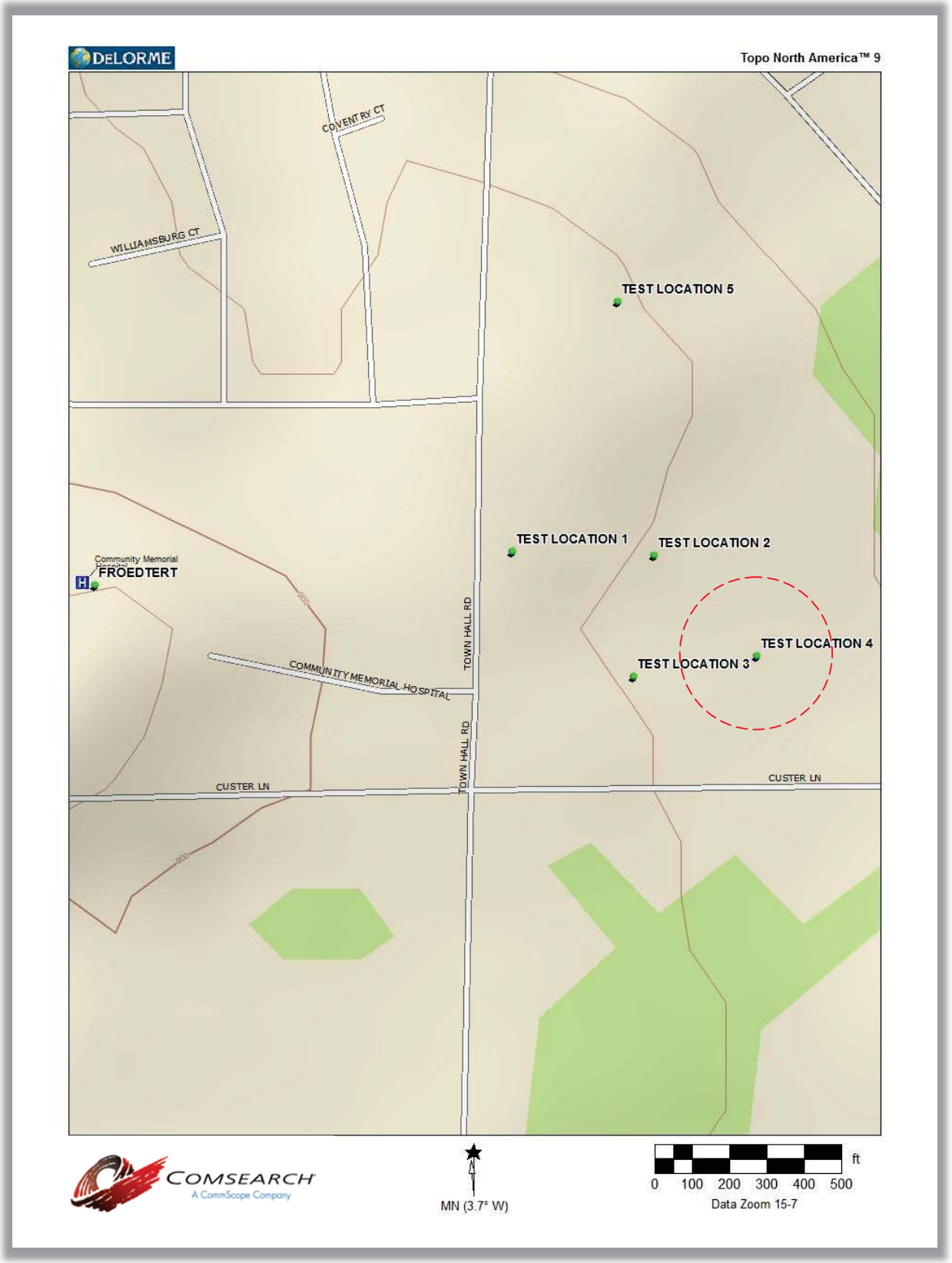


Figure 3.4-1 – Street Map – Test Point #4 Transmitter Location

Figure 3.4-2 – Aerial Map – Test Point #4 Transmitter Location

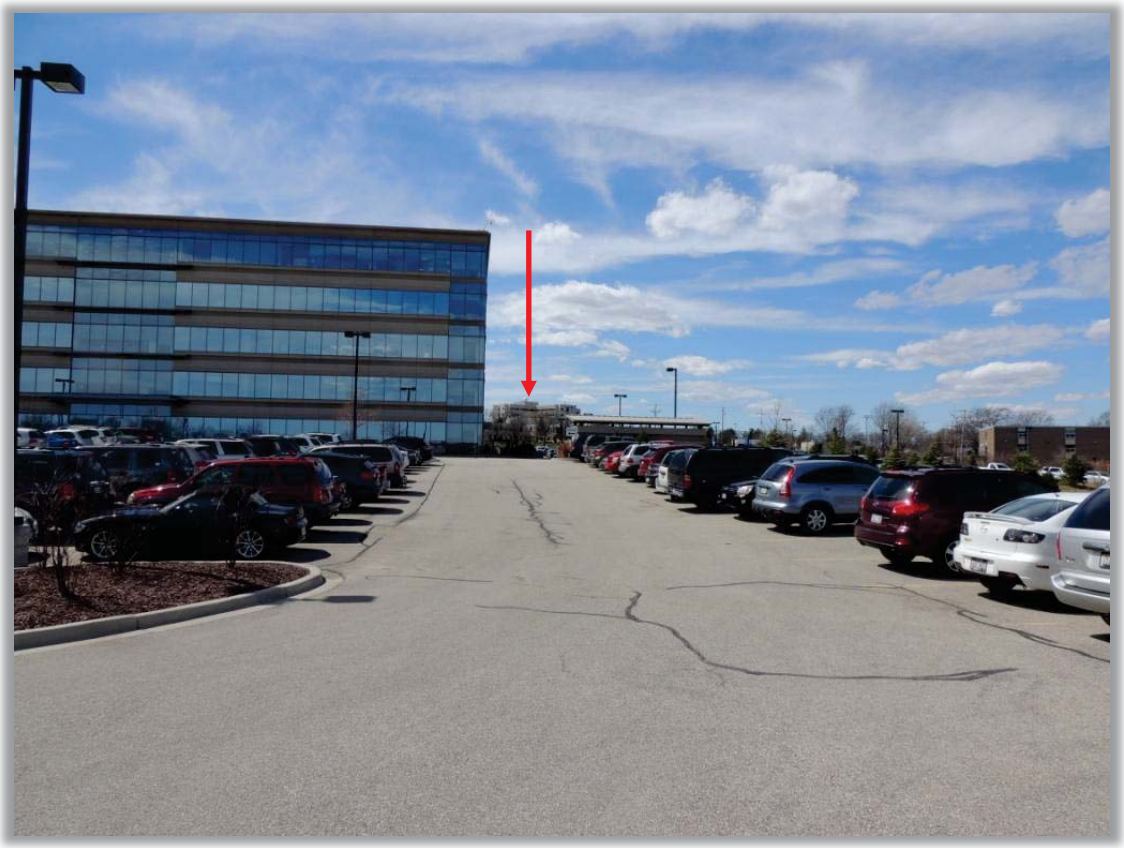


Figure 3.4-3 – Looking on path to Froedtert Memorial Hospital from Test Point #4 location

Figure 3.4-4 –Test Point #4 Transmitter

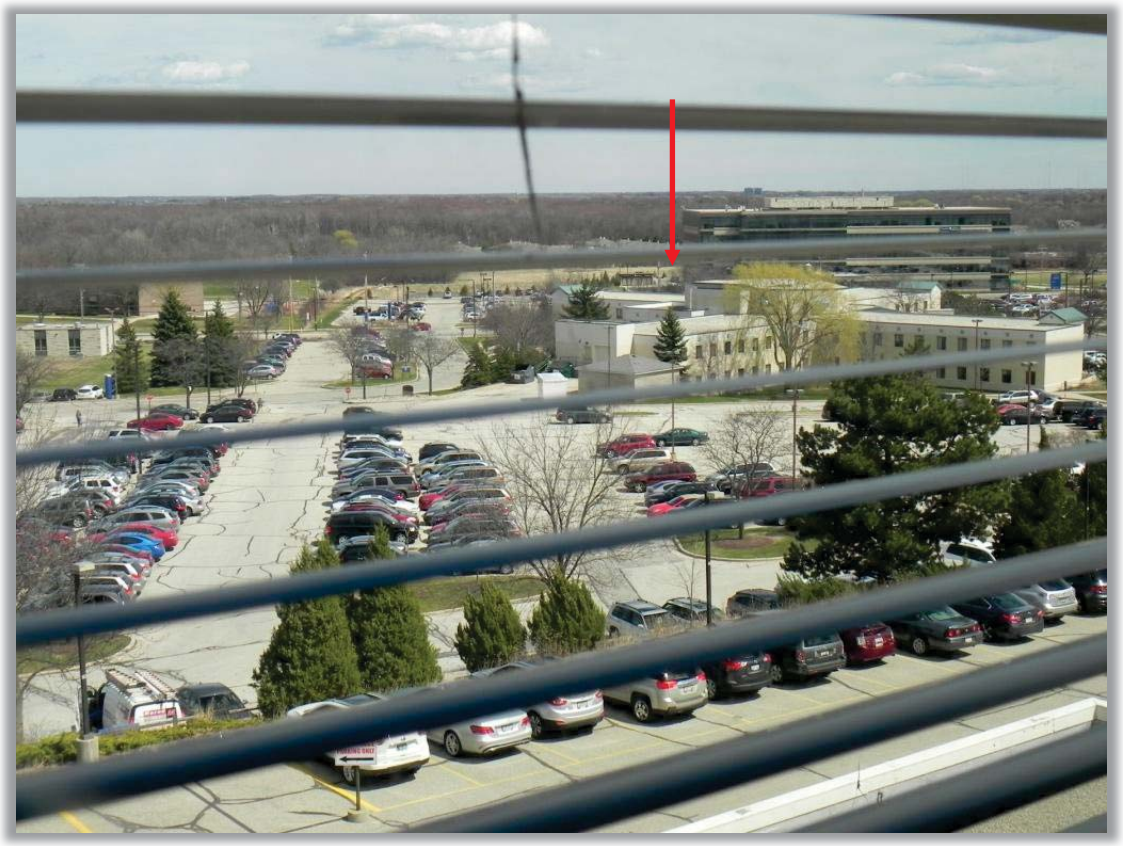


Figure 3.4-5 –View towards Test Point #4 from inside Froedtert Memorial Hospital 4th floor

Figure 3.4-6 –Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #4
Also visible is G.E. WMTS antenna (at arrow)

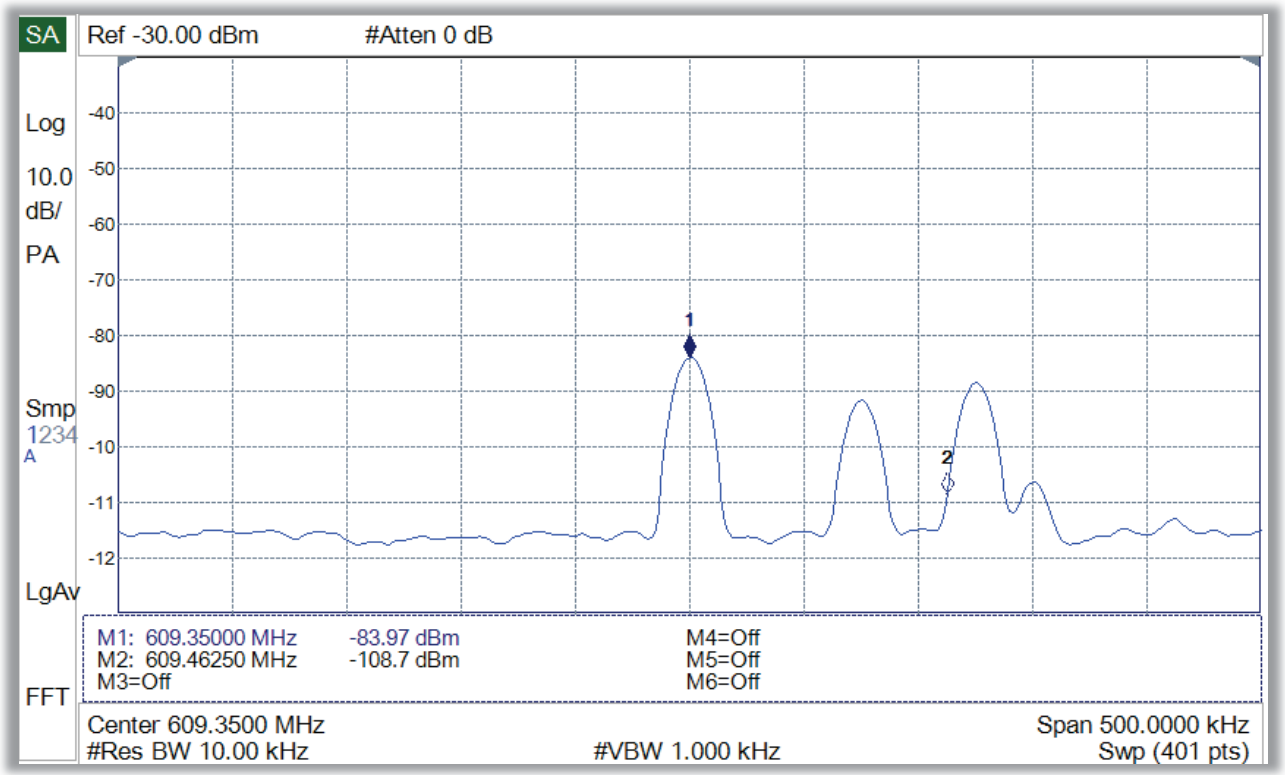


Figure 3.4-7 – Test Point #4 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 518 meters from the street level Test Point #4 site
Average recorded level -83.97 dBm (609.350 MHz) Marker 1 – Isotropic value -89.97 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

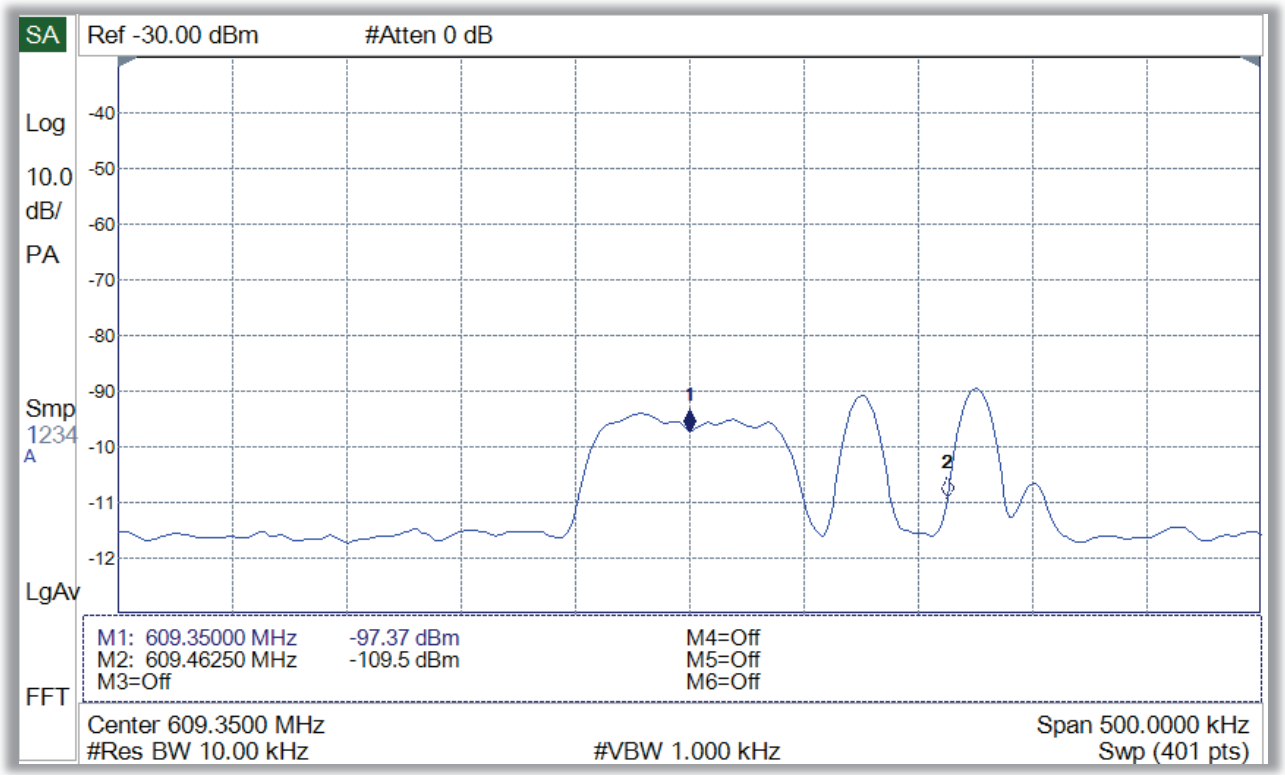


Figure 3.1-8 – Test Point #4 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 518 meters from the street level Test Point #4 site
Average recorded level -97.37 dBm (609.350 MHz) Marker 1 – Isotropic value -103.37 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

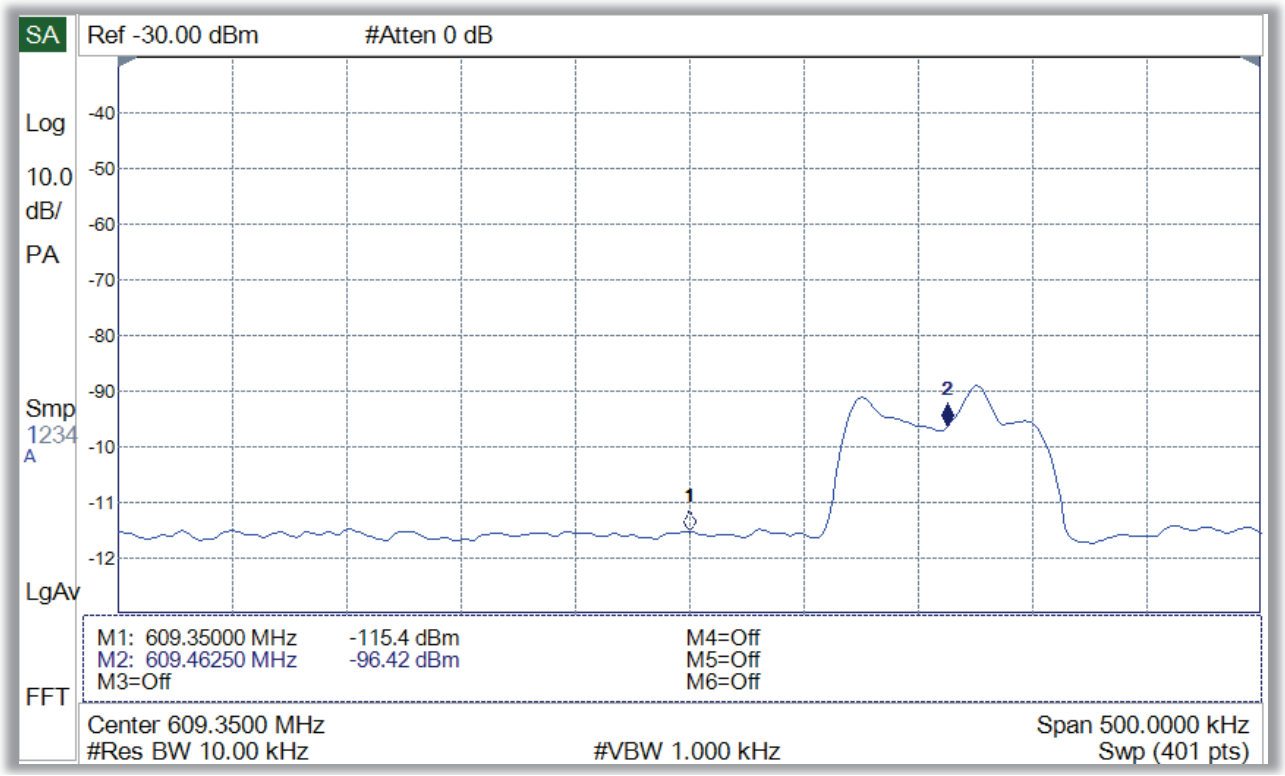


Figure 3.1-9 – Test Point #4 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 518 meters from the street level Test Point #4 site
Average recorded level -99.29 dBm (609.4625 MHz) Marker 2 – Isotropic value -105.29 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

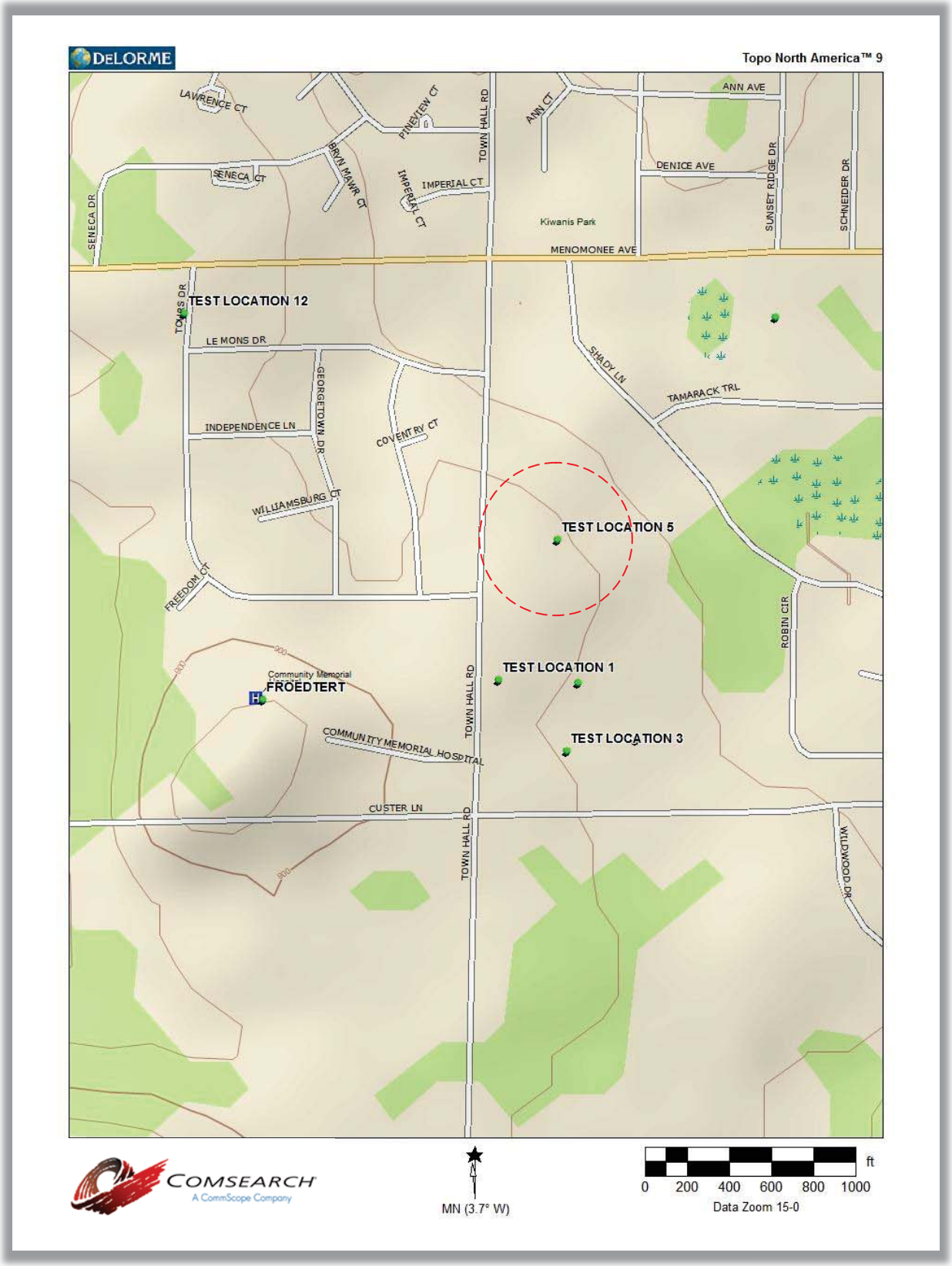


Figure 3.5-1 – Street Map – Test Point #5 Transmitter Location

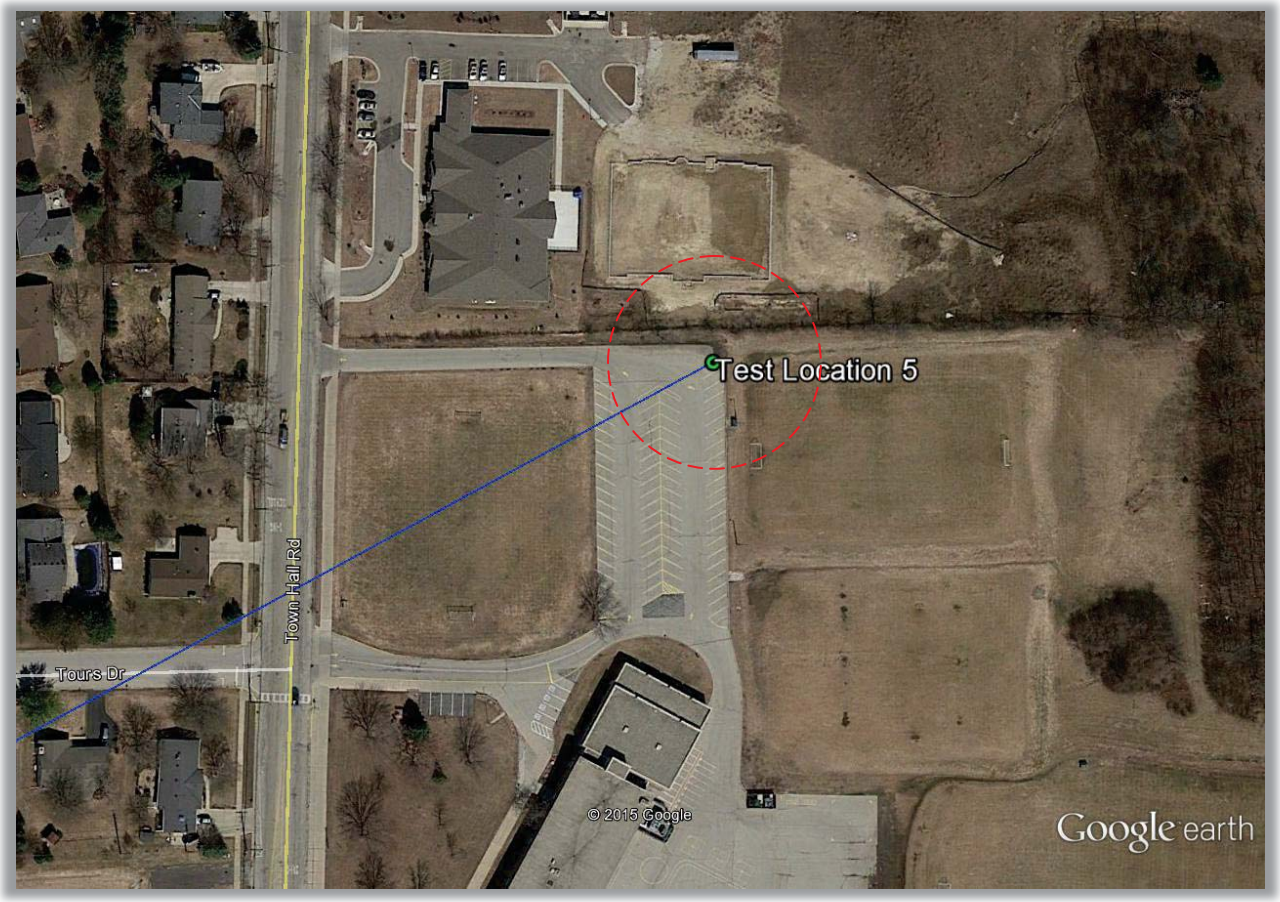


Figure 3.5-2 – Aerial Map – Test Point #5 Transmitter Location

Figure 3.5-3 – Looking on path to Froedtert Memorial Hospital from Test Point #5 location

Figure 3.5-4 –Test Point #5 Transmitter

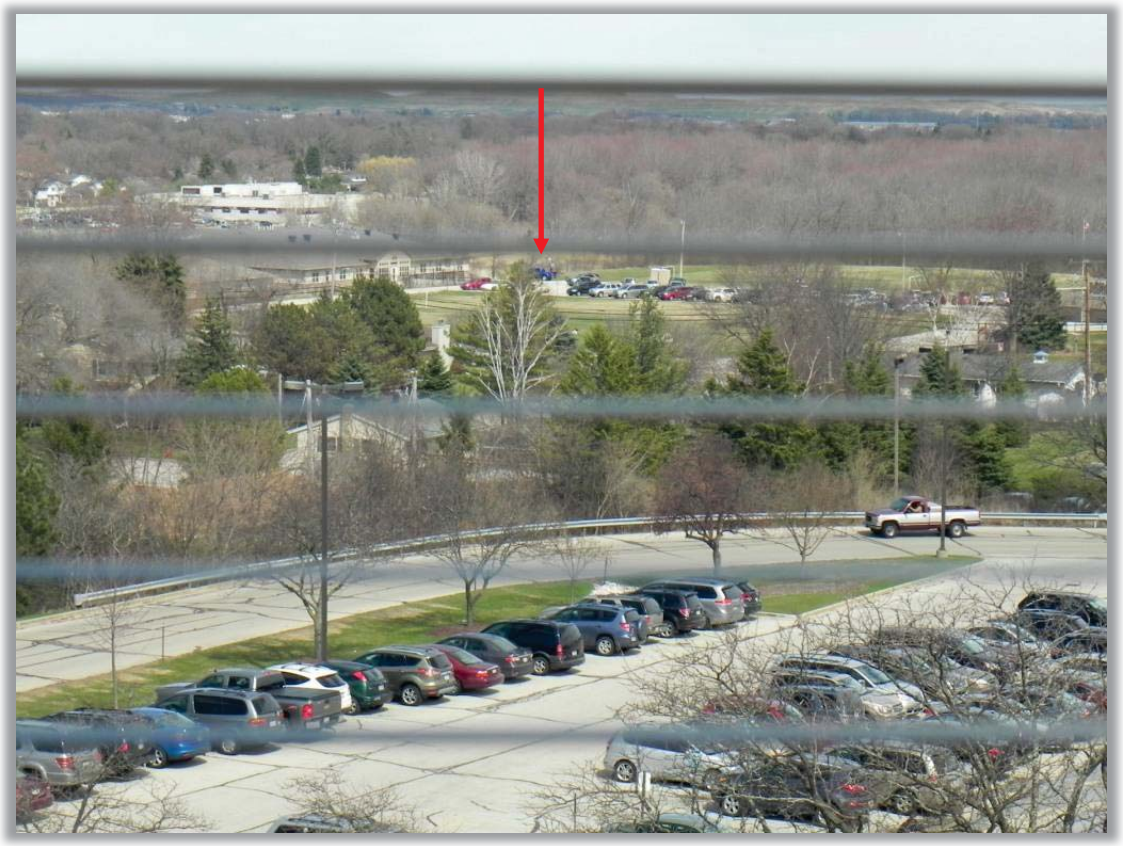


Figure 3.5-5 –View towards Test Point #5 from inside Froedtert Memorial Hospital 4th floor

Figure 3.5-6 – Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #5
Also visible is G.E. WMTS antenna (at arrow)

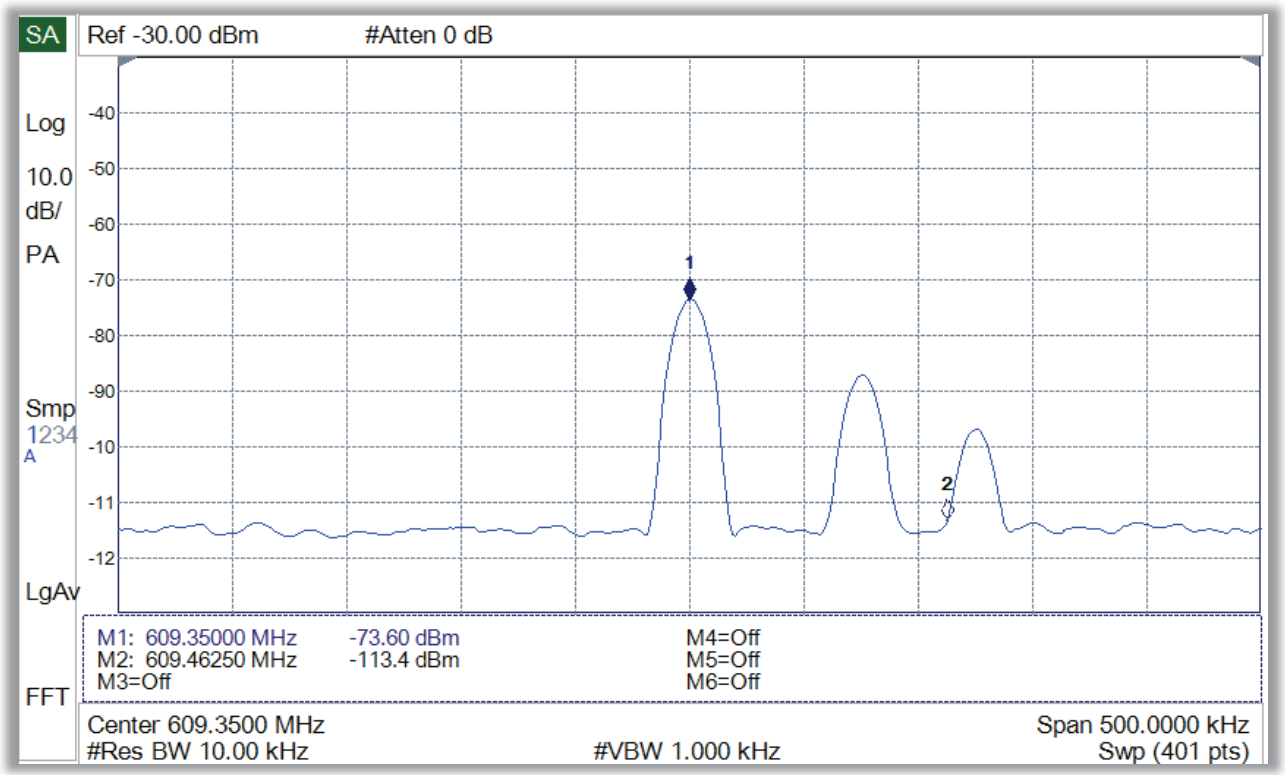


Figure 3.5-7 – Test Point #5 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 455 meters from the street level Test Point #5 site
Average recorded level -73.60 dBm (609.350 MHz) Marker 1 – Isotropic value -79.60 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

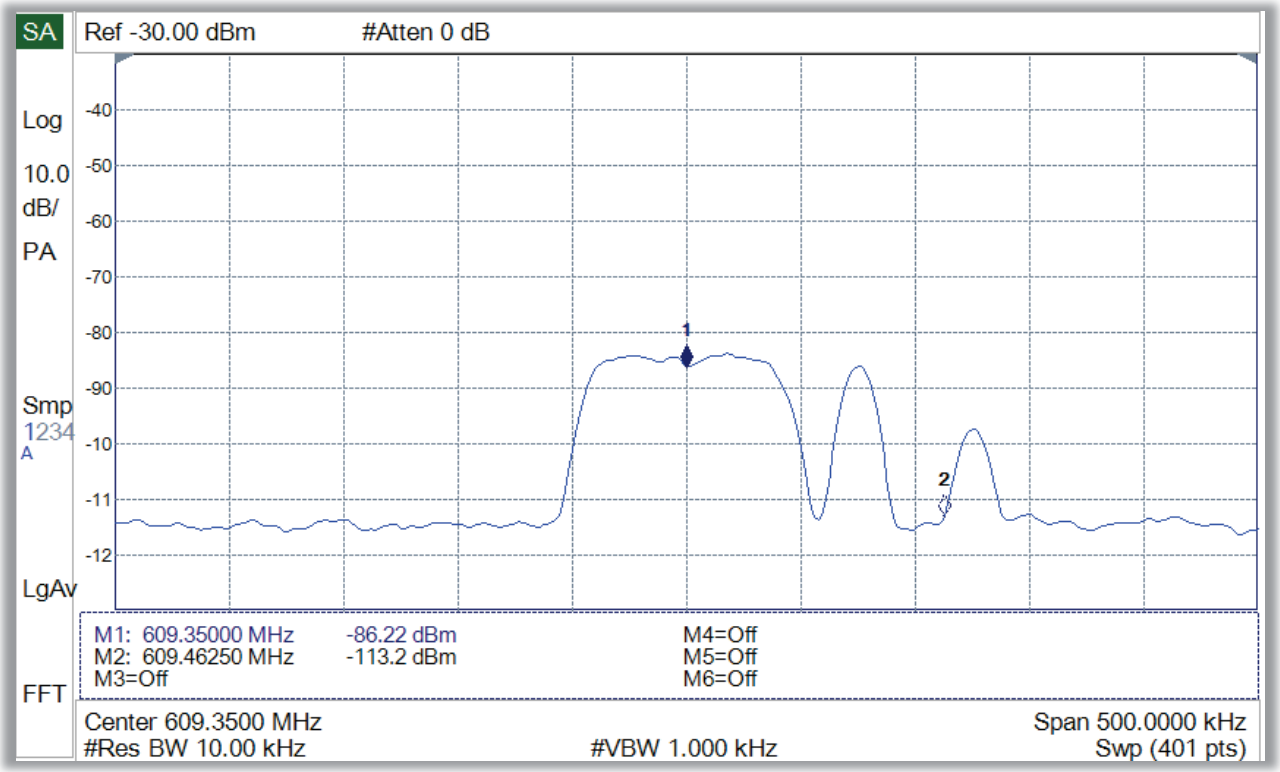


Figure 3.5-8 – Test Point #5 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 455 meters from the street level Test Point #5 site
Average recorded level -86.22 dBm (609.350 MHz) Marker 1 – Isotropic value -92.22 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

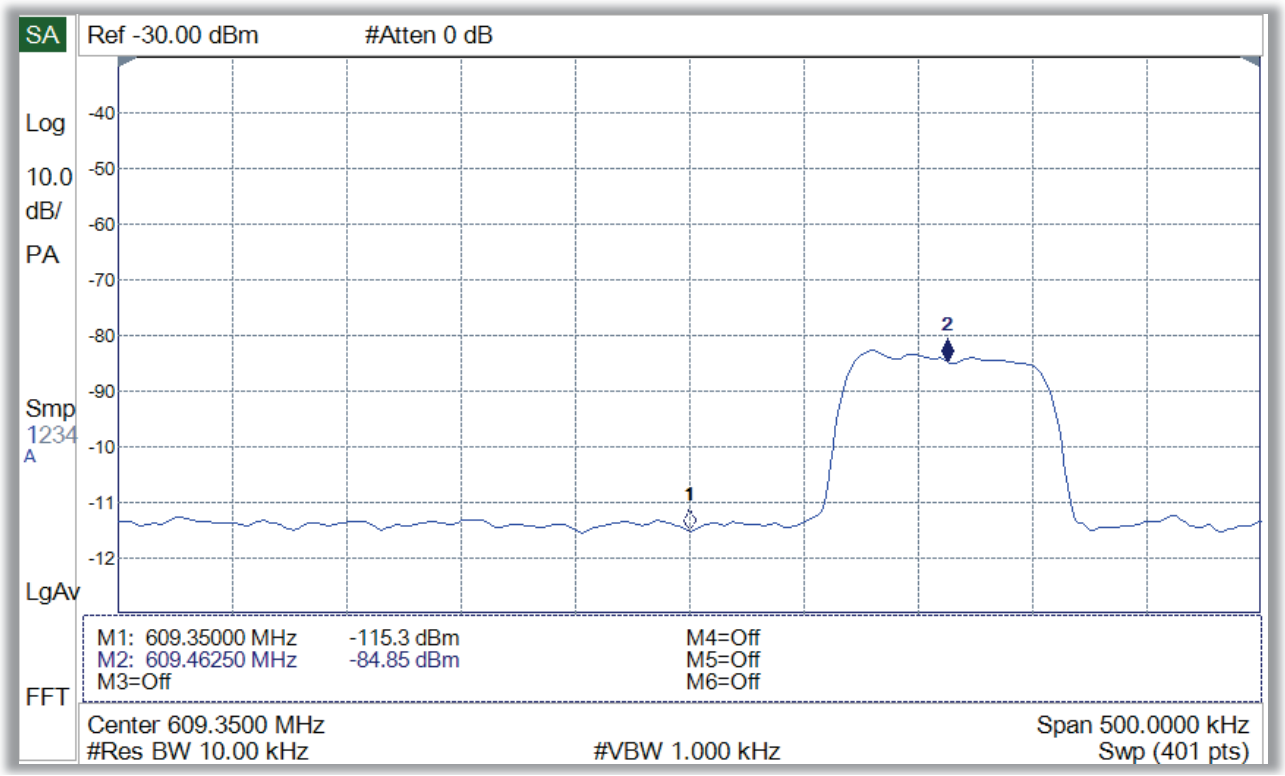


Figure 3.5-9 – Test Point #5 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 455 meters from the street level Test Point #5 site
Average recorded level -84.85 dBm (609.4625 MHz) Marker 2 – Isotropic value -90.85 dBm
Transmitter EIRP 2.60 dBm (signal generator set to -5.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

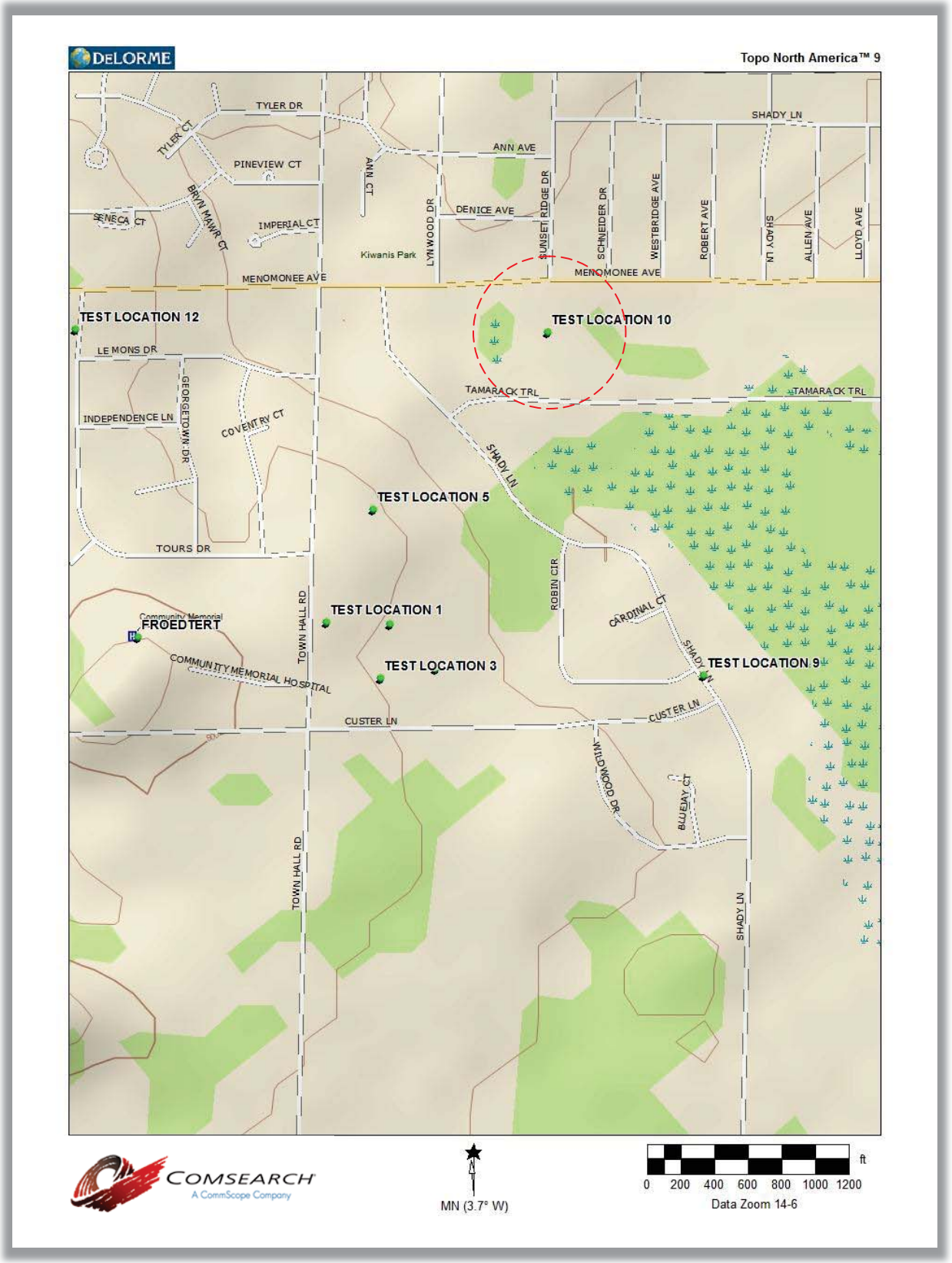


Figure 3.6-1 – Street Map – Test Point #10 Transmitter Location

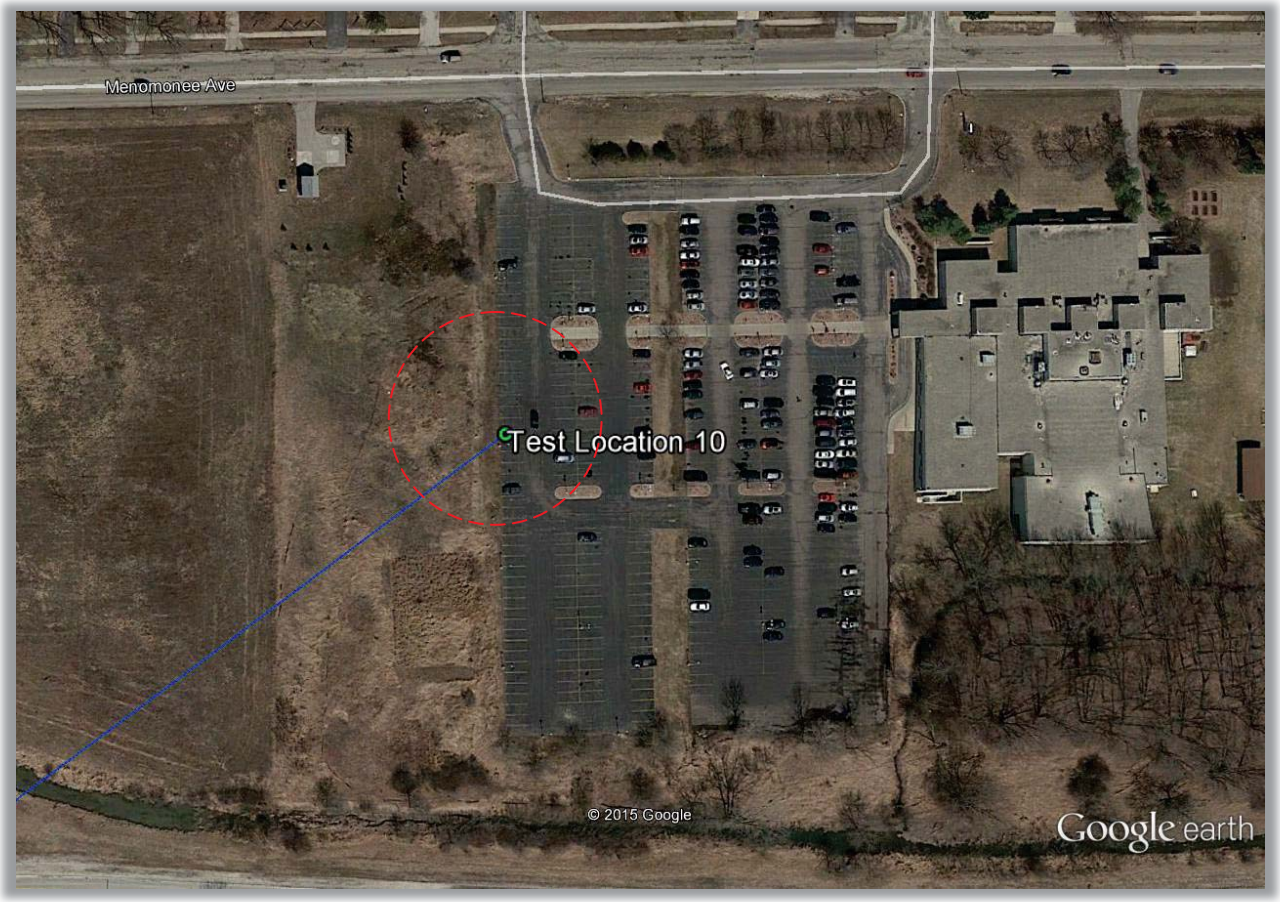


Figure 3.6-2 – Aerial Map – Test Point #10 Transmitter Location

Figure 3.6-3 – Looking on path to Froedtert Memorial Hospital from Test Point #10 location

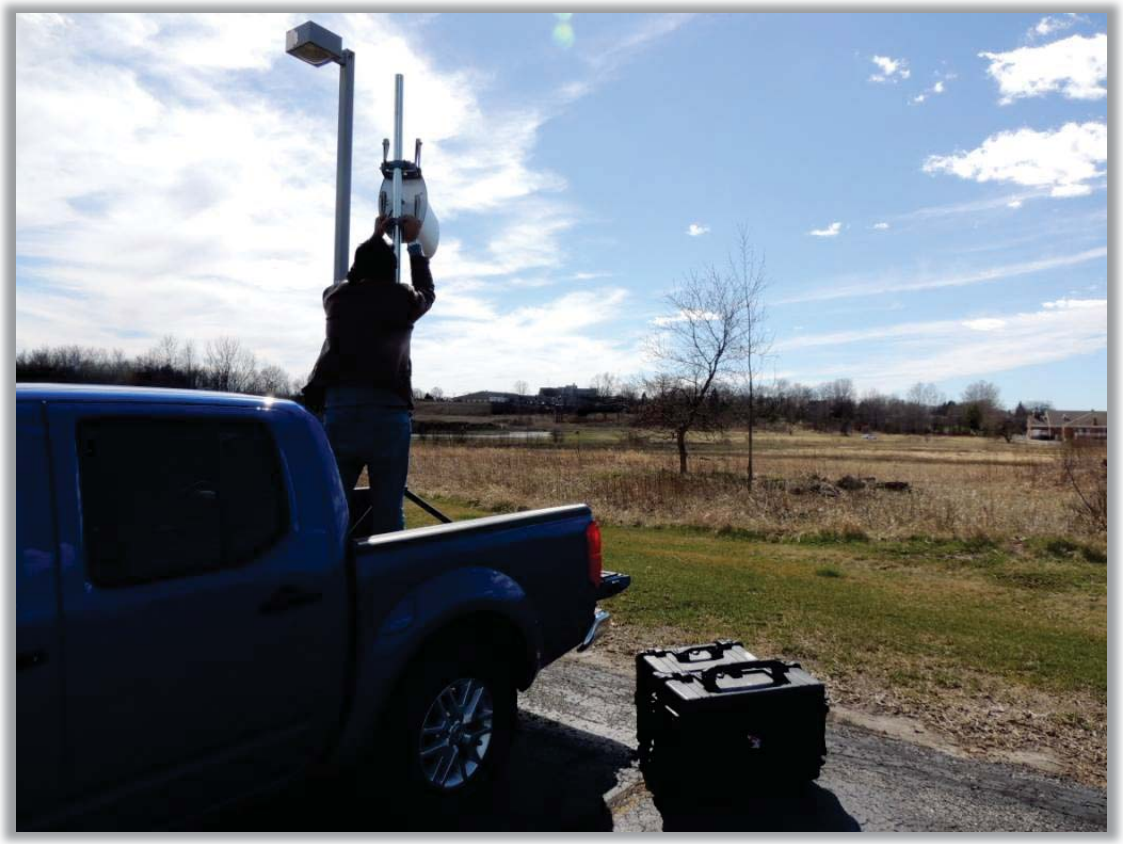


Figure 3.6-4 –Test Point #10 Transmitter

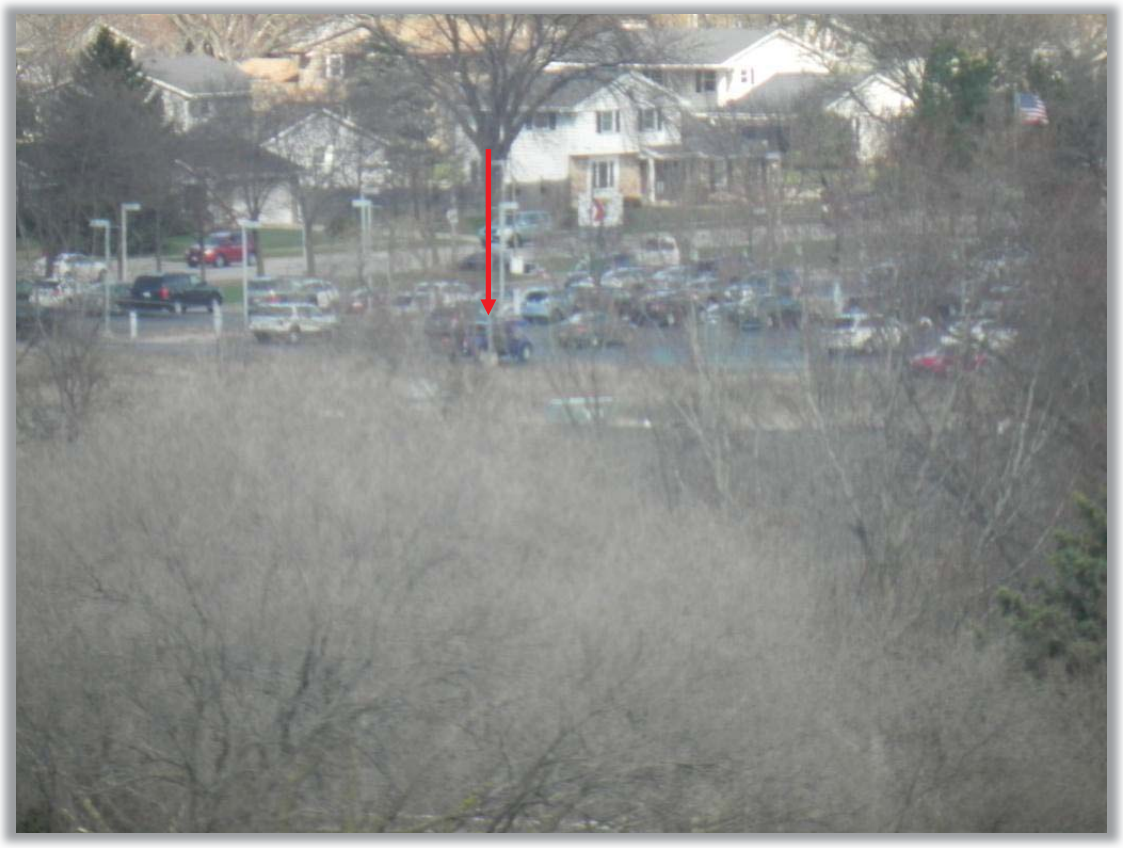


Figure 3.6-5 –View towards Test Point #10 from inside Froedtert Memorial Hospital 4th floor

Figure 3.6-6 – Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #10
Also visible is G.E. WMTS antenna (at arrow)

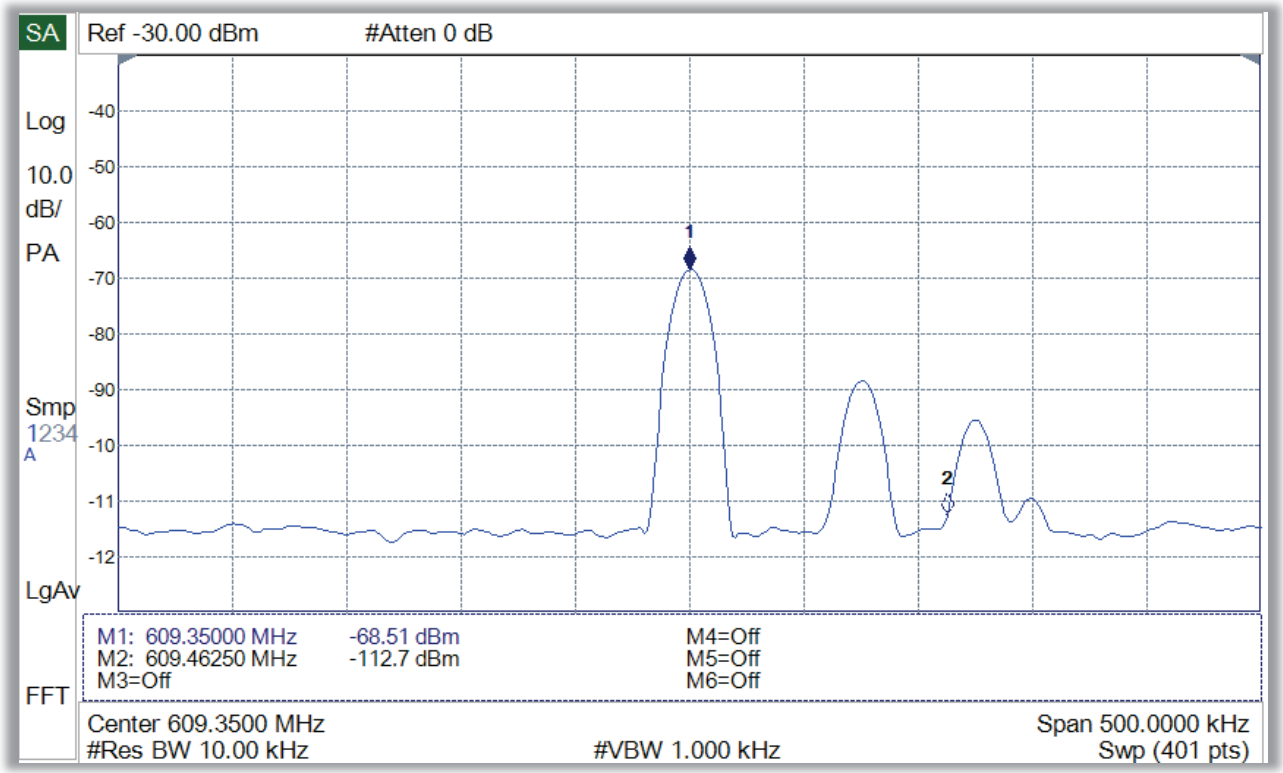


Figure 3.6-7 – Test Point #10 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 895 meters from the street level Test Point #10 site
Average recorded level -68.51 dBm (609.350 MHz) Marker 1 – Isotropic value -74.51 dBm
Transmitter EIRP 14.6 dBm (signal generator set to 6.07 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

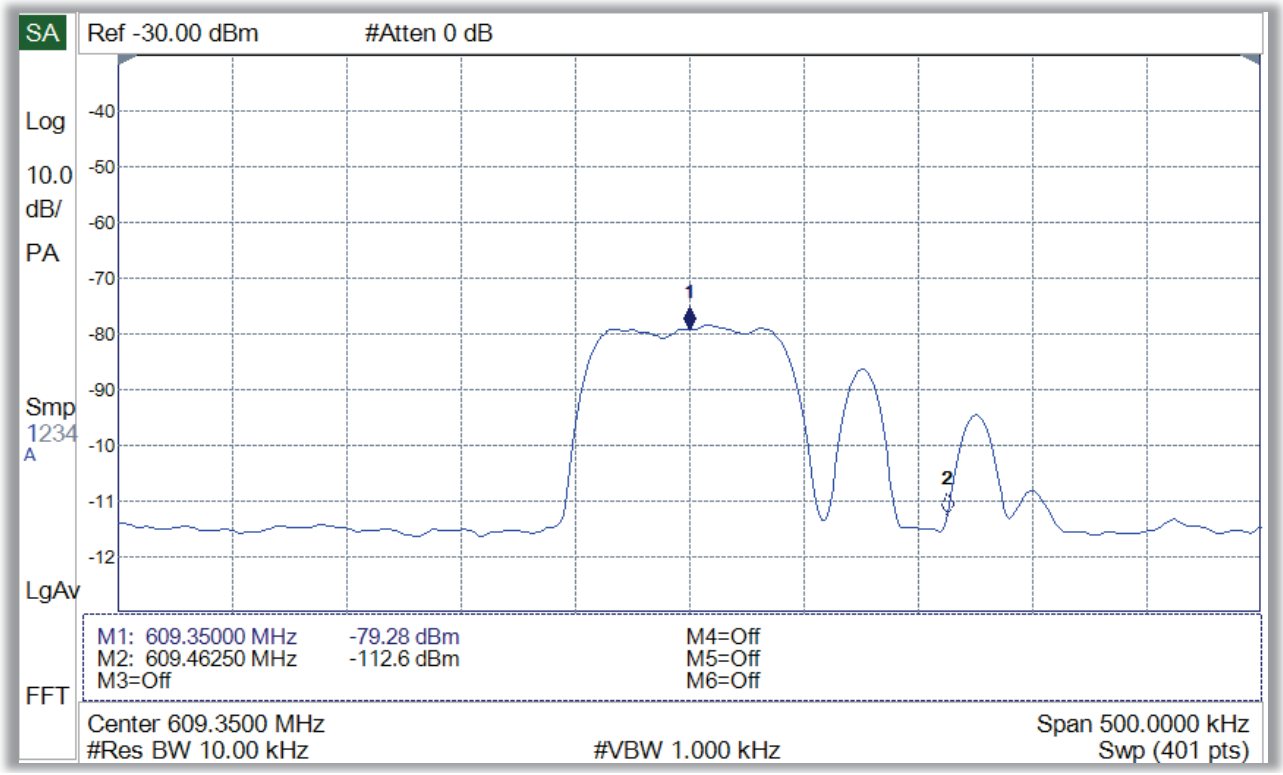


Figure 3.6-8 – Test Point #10 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 895 meters from the street level Test Point #10 site
Average recorded level -79.28 dBm (609.350 MHz) Marker 1 – Isotropic value -85.28 dBm
Transmitter EIRP 14.6 dBm (signal generator set to 6.07 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

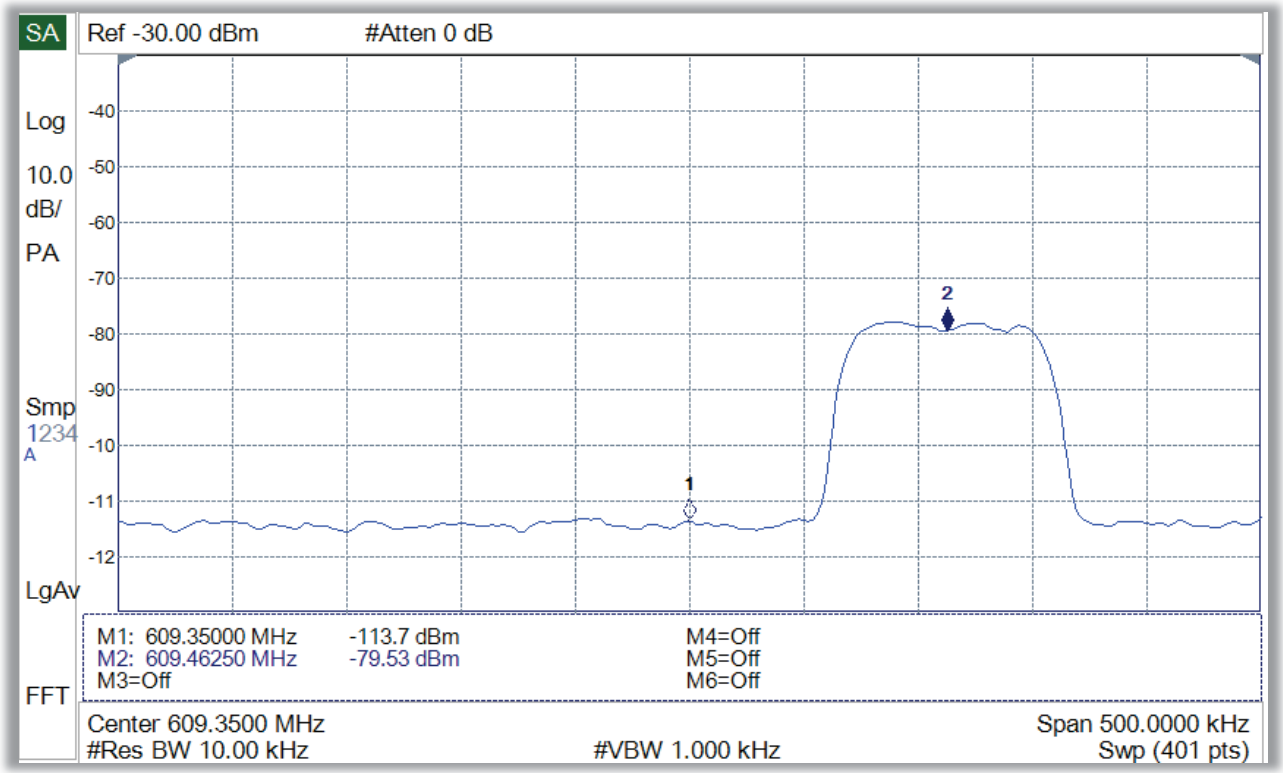


Figure 3.6-9 – Test Point #10 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 895 meters from the street level Test Point #10 site
Average recorded level -79.53 dBm (609.4625 MHz) Marker 2 – Isotropic value -85.53 dBm
Transmitter EIRP 14.6 dBm (signal generator set to 6.07 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

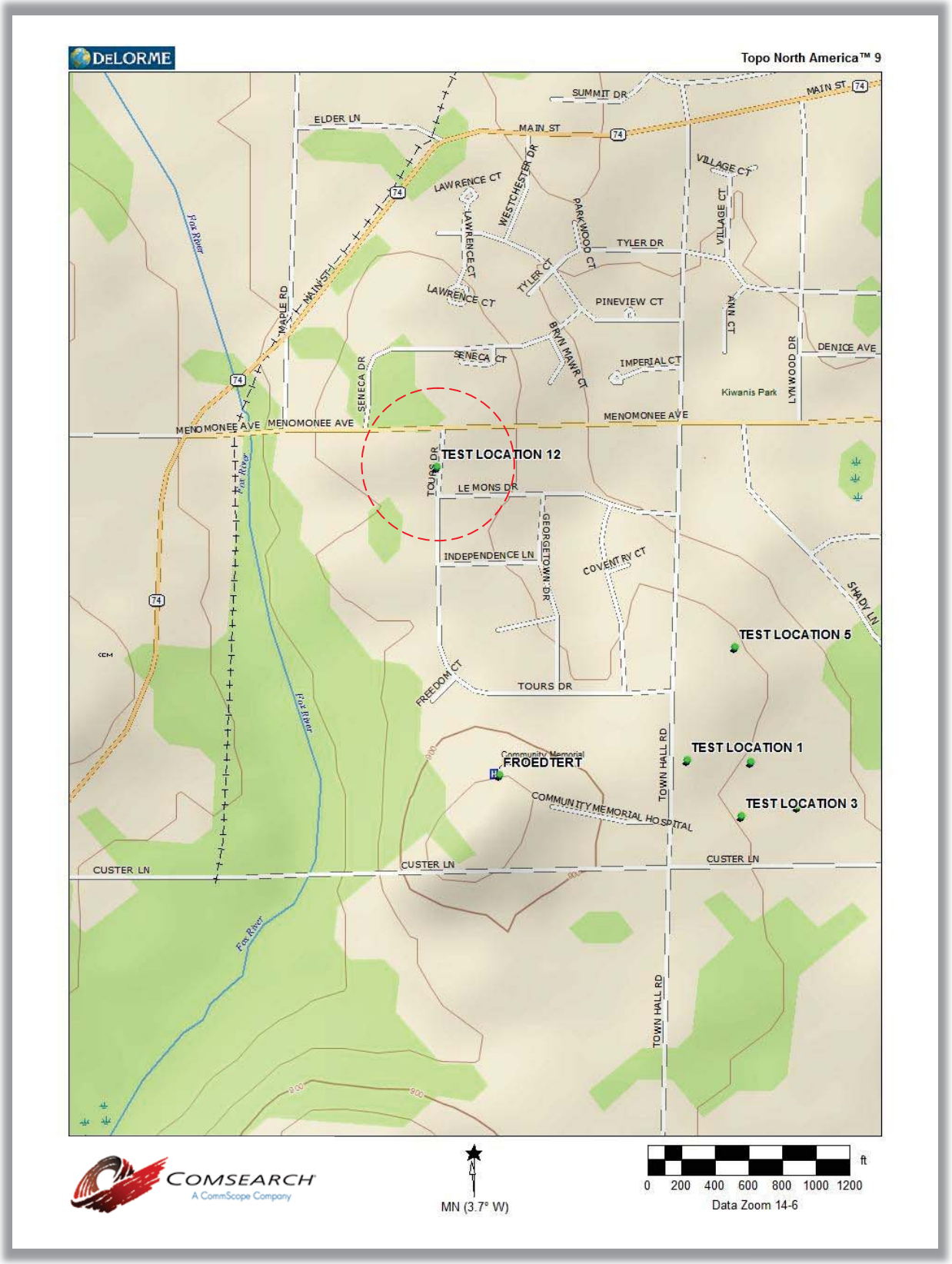


Figure 3.7-1 – Street Map – Test Point #12 Transmitter Location

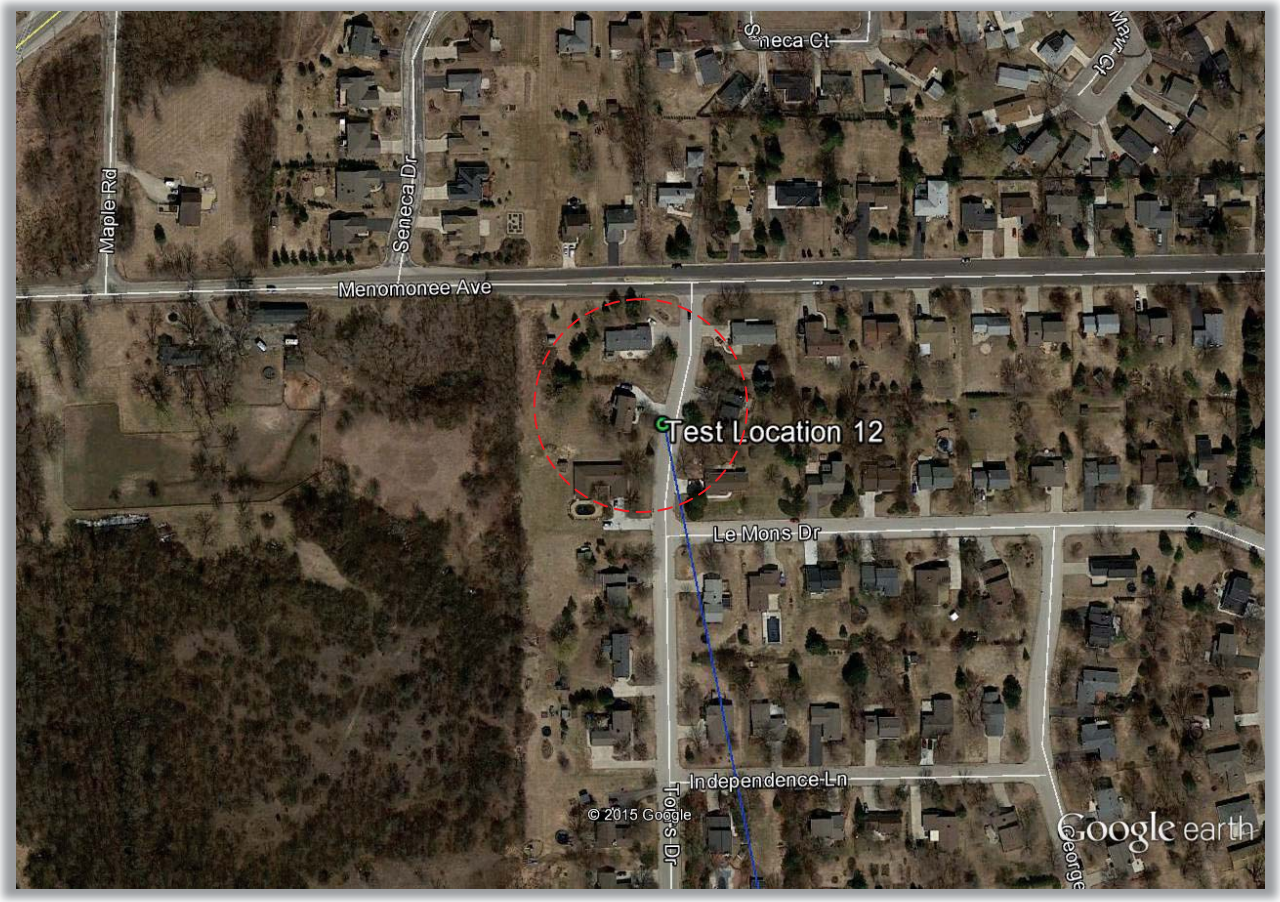


Figure 3.7-2 – Aerial Map – Test Point #12 Transmitter Location

Figure 3.7-3 – Looking on path to Froedtert Memorial Hospital from Test Point #12 location

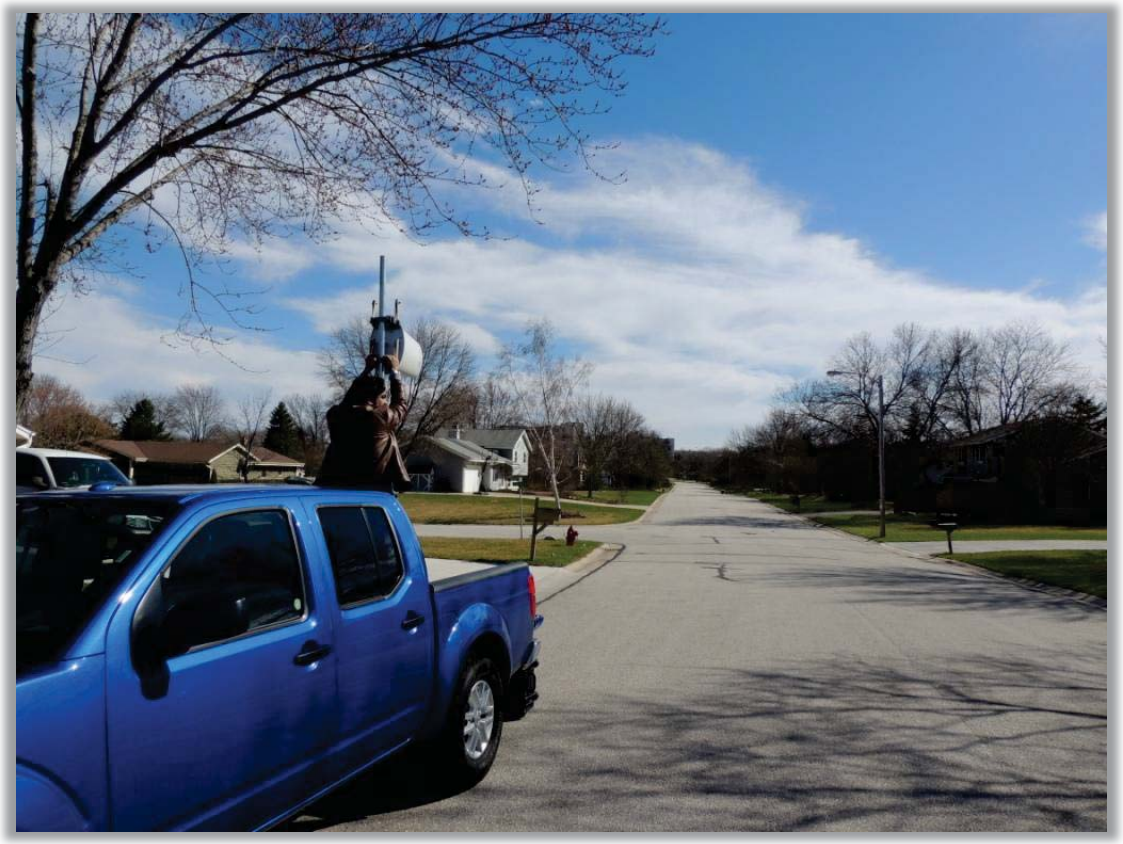


Figure 3.7-4 – Test Point #12 Transmitter

Figure 3.7-5 – View towards Test Point #12 from inside Froedtert Memorial Hospital 4th floor

Figure 3.7-6 – Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #12
Also visible is G.E. WMTS antenna (at arrow)

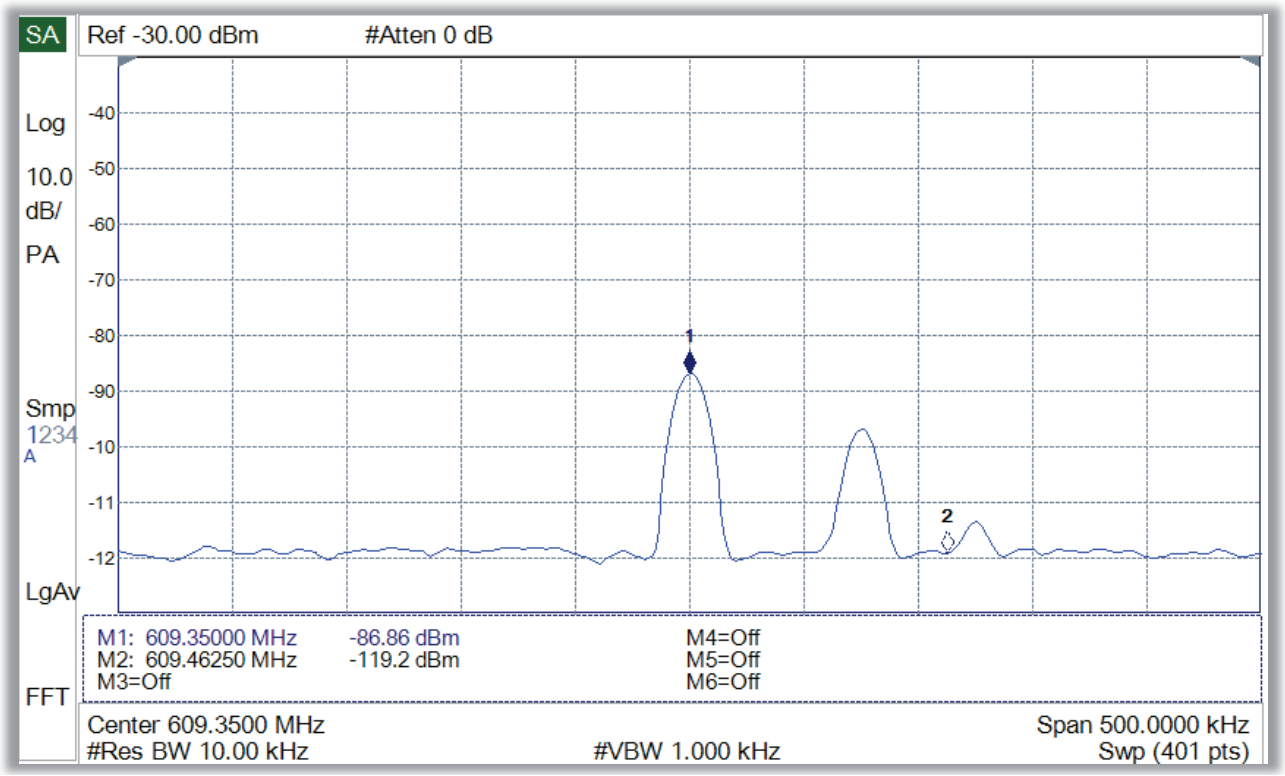


Figure 3.7-7 – Test Point #12 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 538 meters from the street level Test Point #12 site
Average recorded level -86.86 dBm (609.350 MHz) Marker 1 – Isotropic value -92.86 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

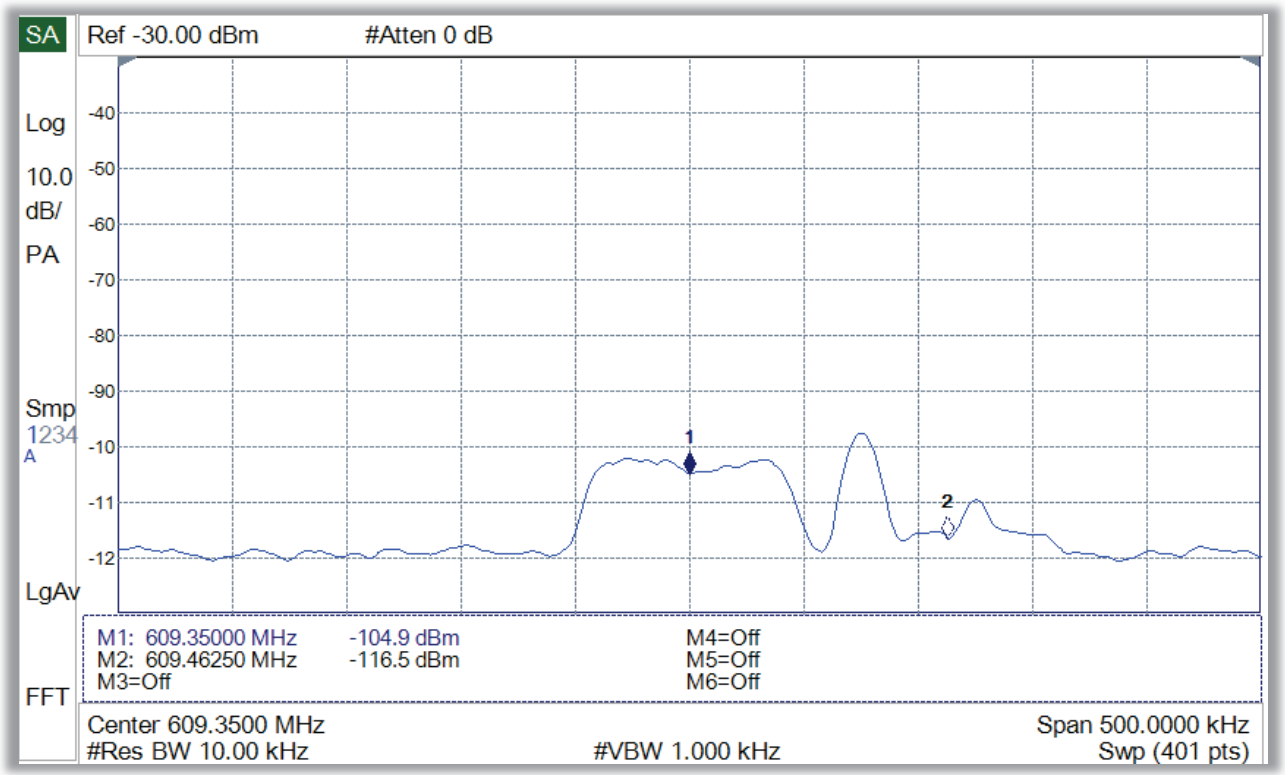


Figure 3.7-8 – Test Point #12 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 538 meters from the street level Test Point #12 site
Average recorded level -104.9 dBm (609.350 MHz) Marker 1 – Isotropic value -110.9 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

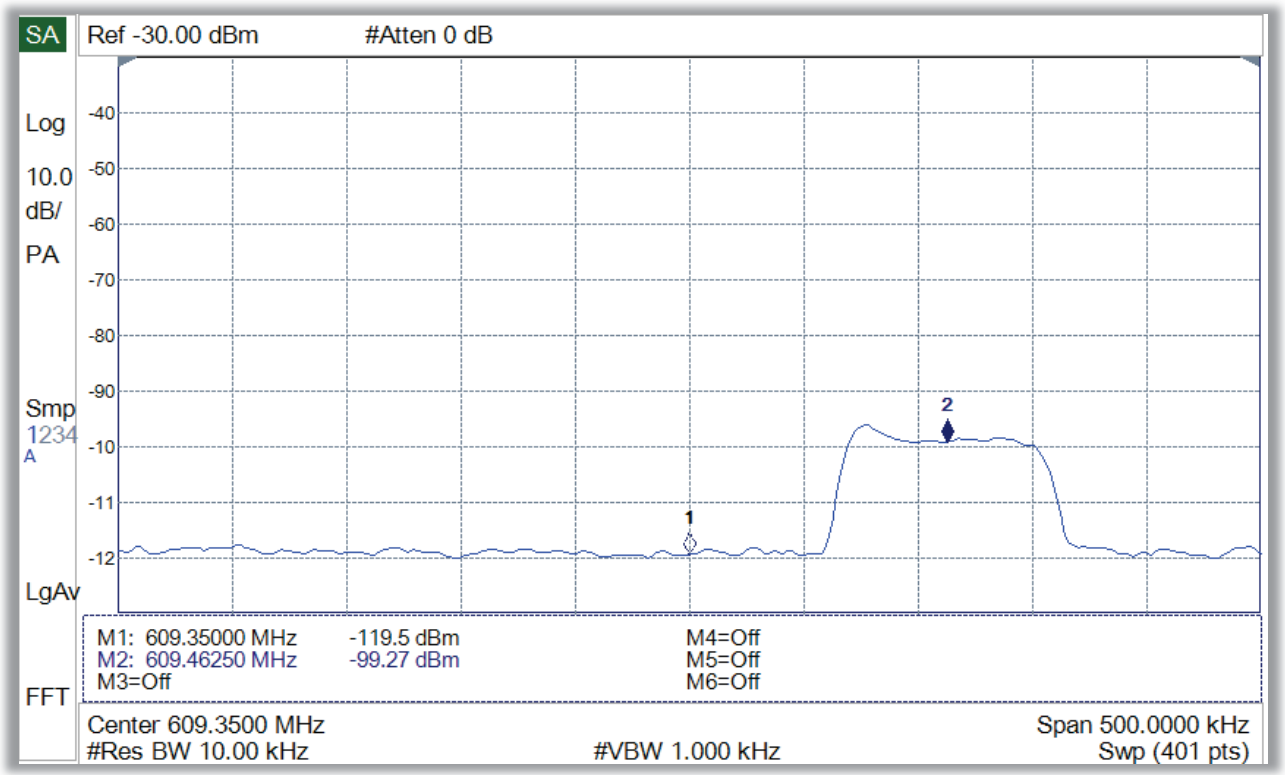


Figure 3.7-9 – Test Point #12 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 538 meters from the street level Test Point #12 site
Average recorded level -99.27 dBm (609.4625 MHz) Marker 2 – Isotropic value -105.27 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

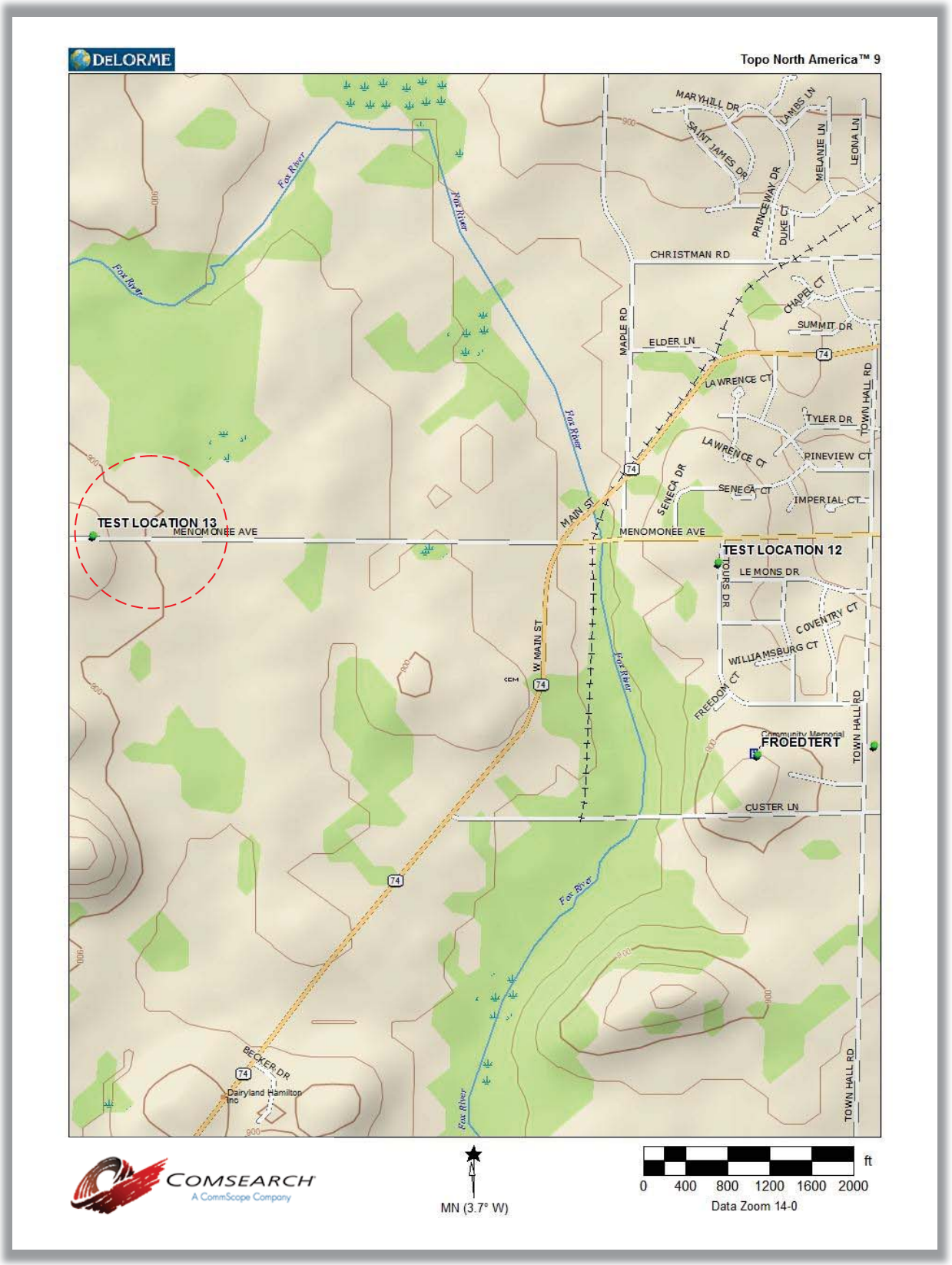


Figure 3.8-1 – Street Map – Test Point #13 Transmitter Location

Figure 3.8-2 – Aerial Map – Test Point #13 Transmitter Location

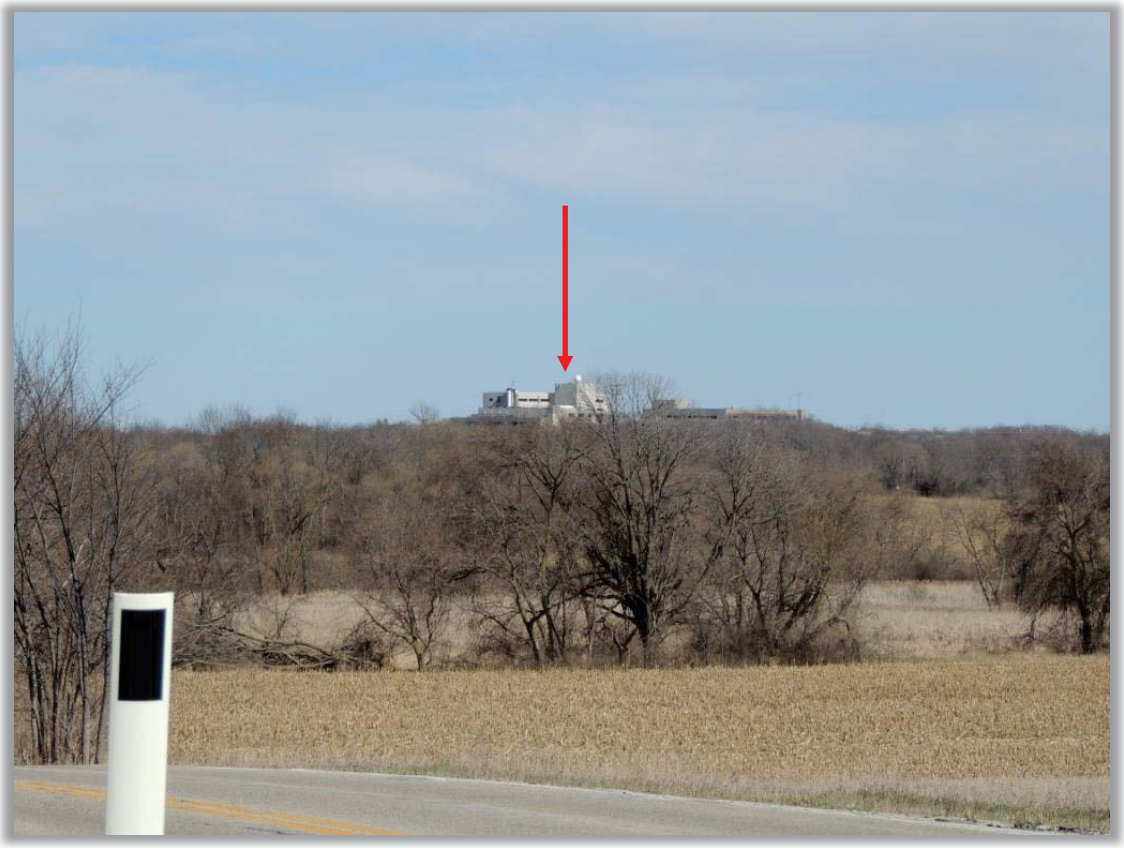


Figure 3.8-3 – Looking on path to Froedtert Memorial Hospital from Test Point #13 location

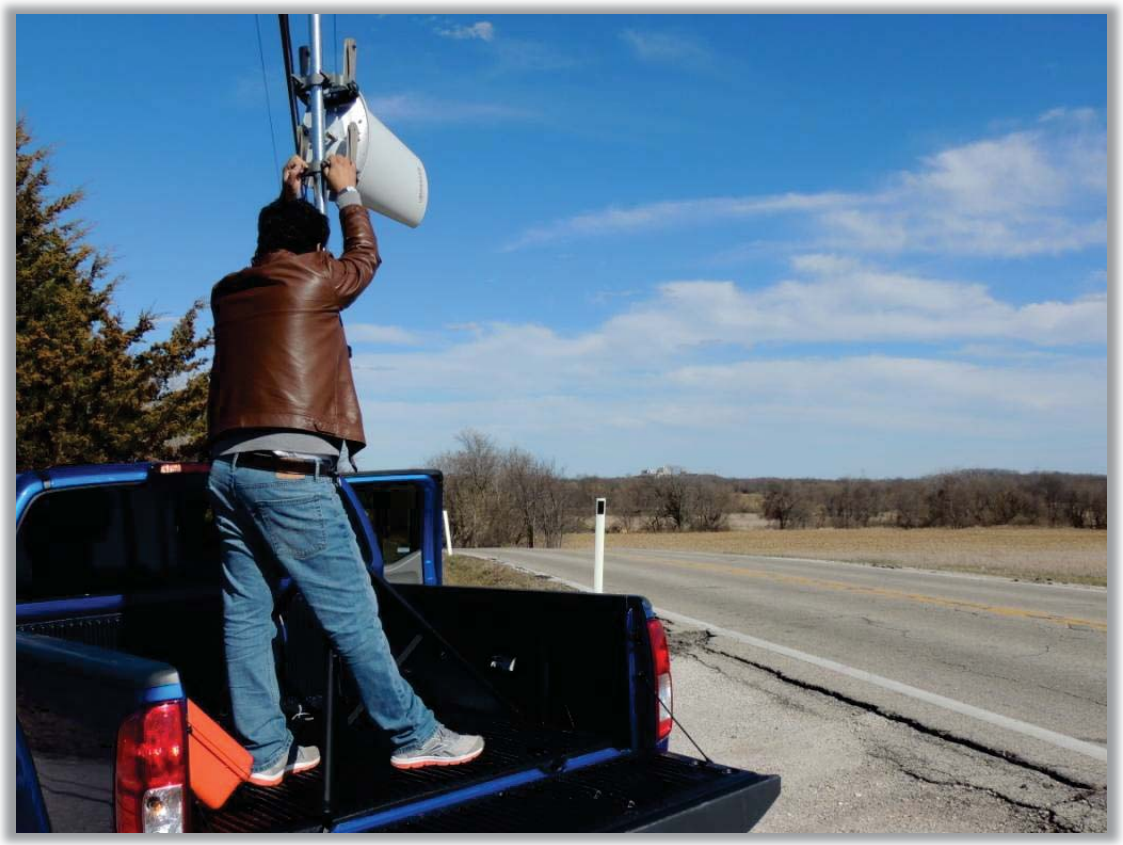


Figure 3.8-4 – Test Point #13 Transmitter

Figure 3.8-5 – View towards Test Point #13 from inside Froedtert Memorial Hospital 4th floor

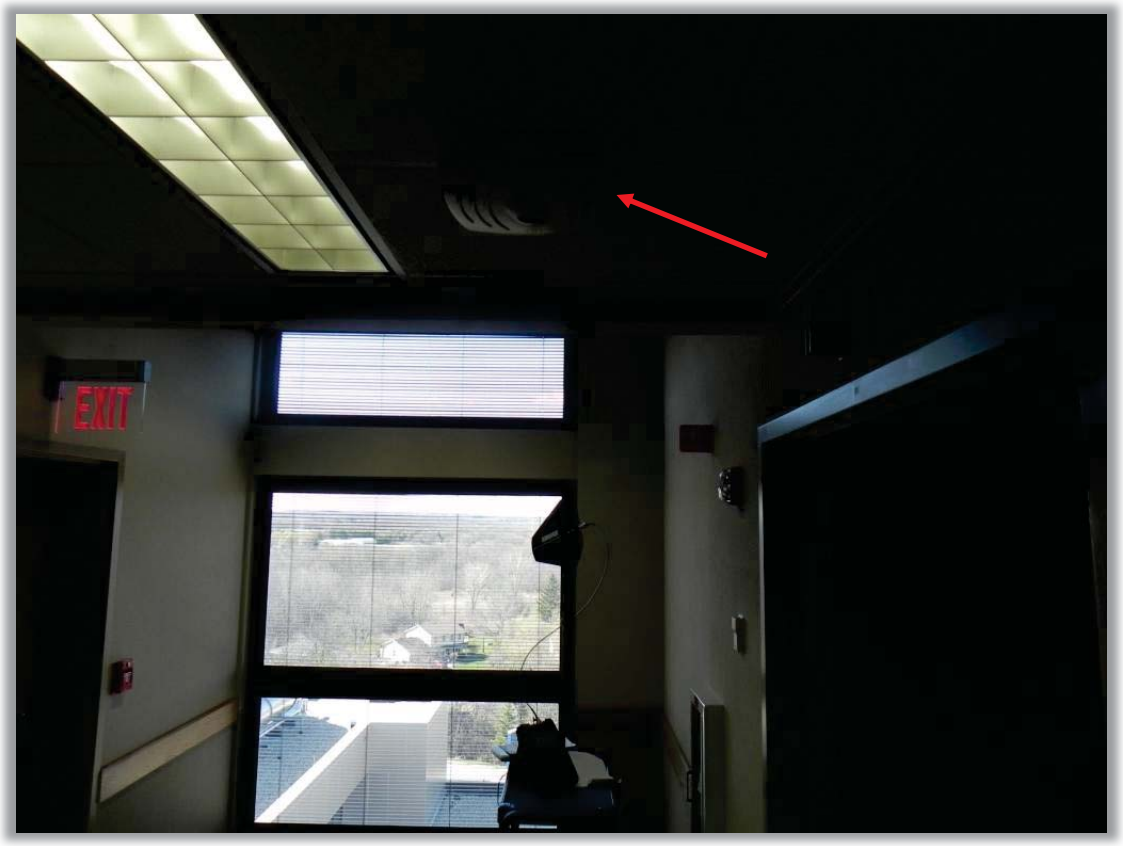


Figure 3.8-6 – Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #13
Also visible is G.E. WMTS antenna (at arrow)

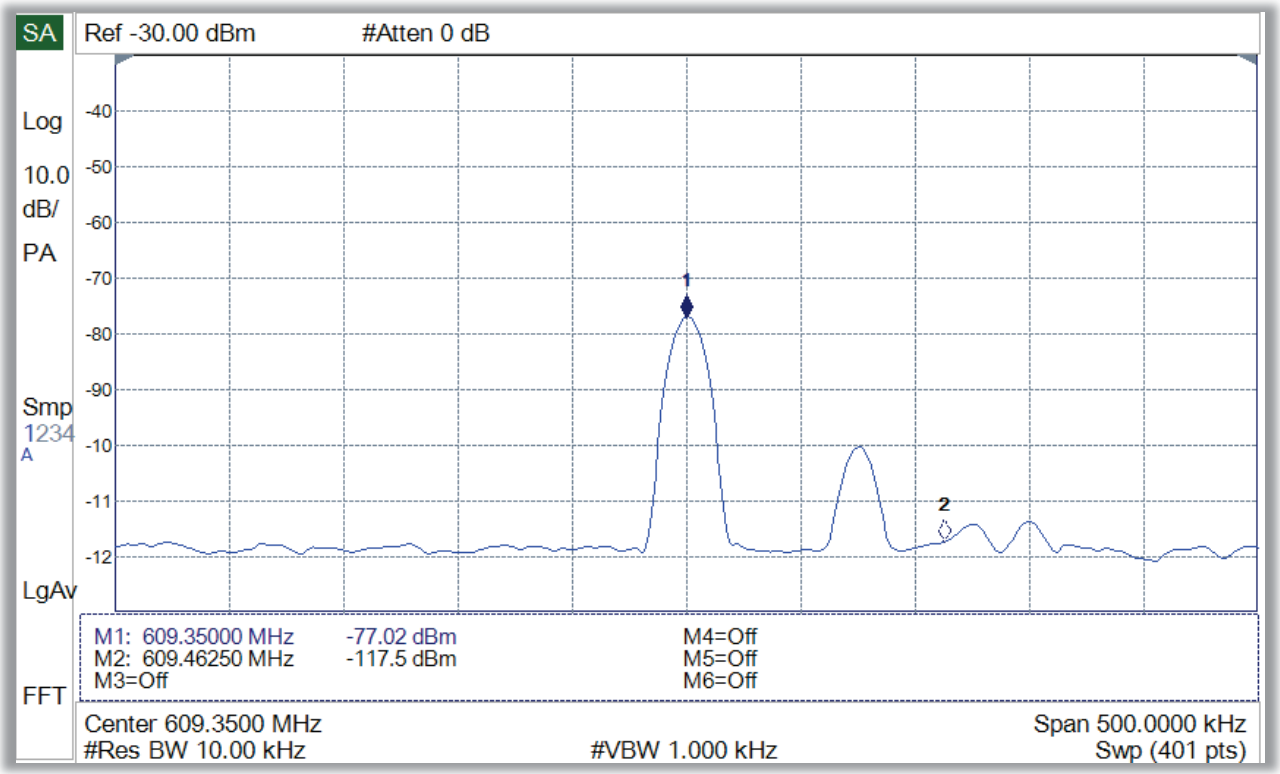


Figure 3.8-7 – Test Point #13 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 538 meters from the street level Test Point #13 site
Average recorded level -77.02 dBm (609.350 MHz) Marker 1 – Isotropic value -83.02 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

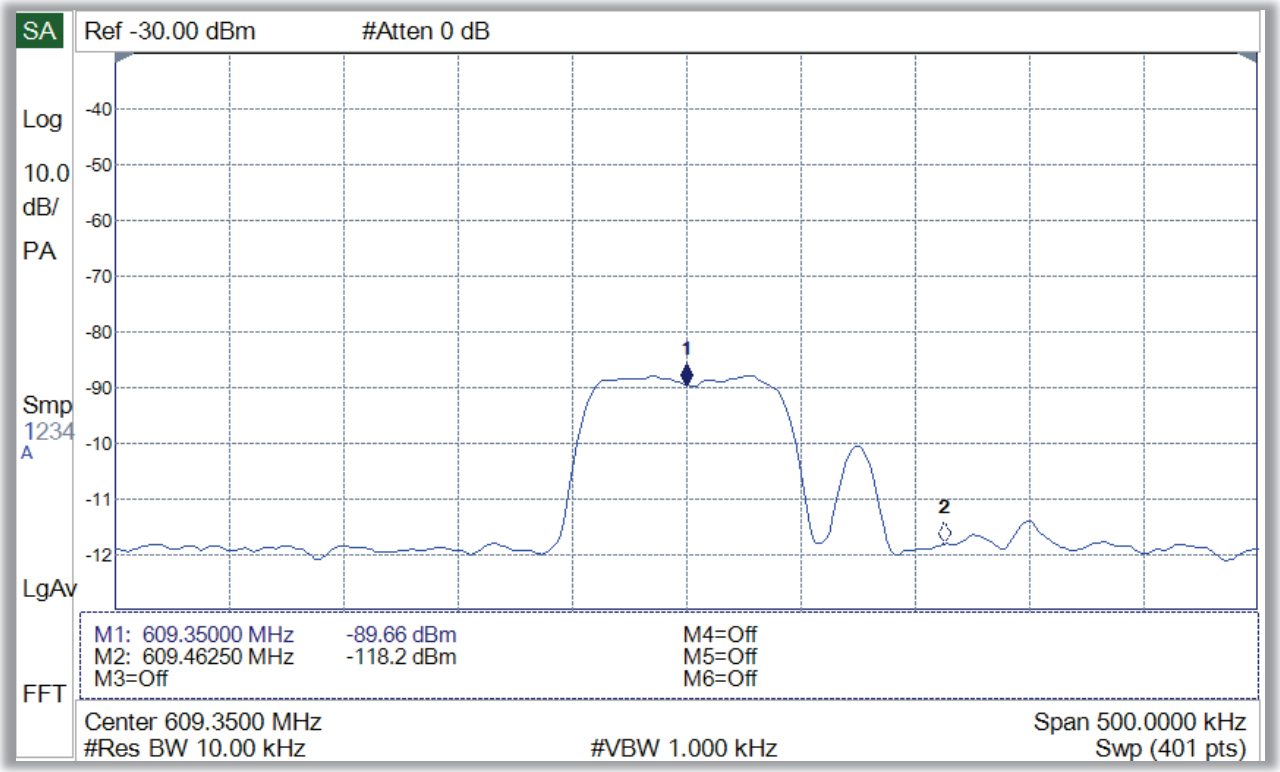


Figure 3.8-8 – Test Point #13 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 538 meters from the street level Test Point #13 site
Average recorded level -89.66 dBm (609.350 MHz) Marker 1 – Isotropic value -95.66 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

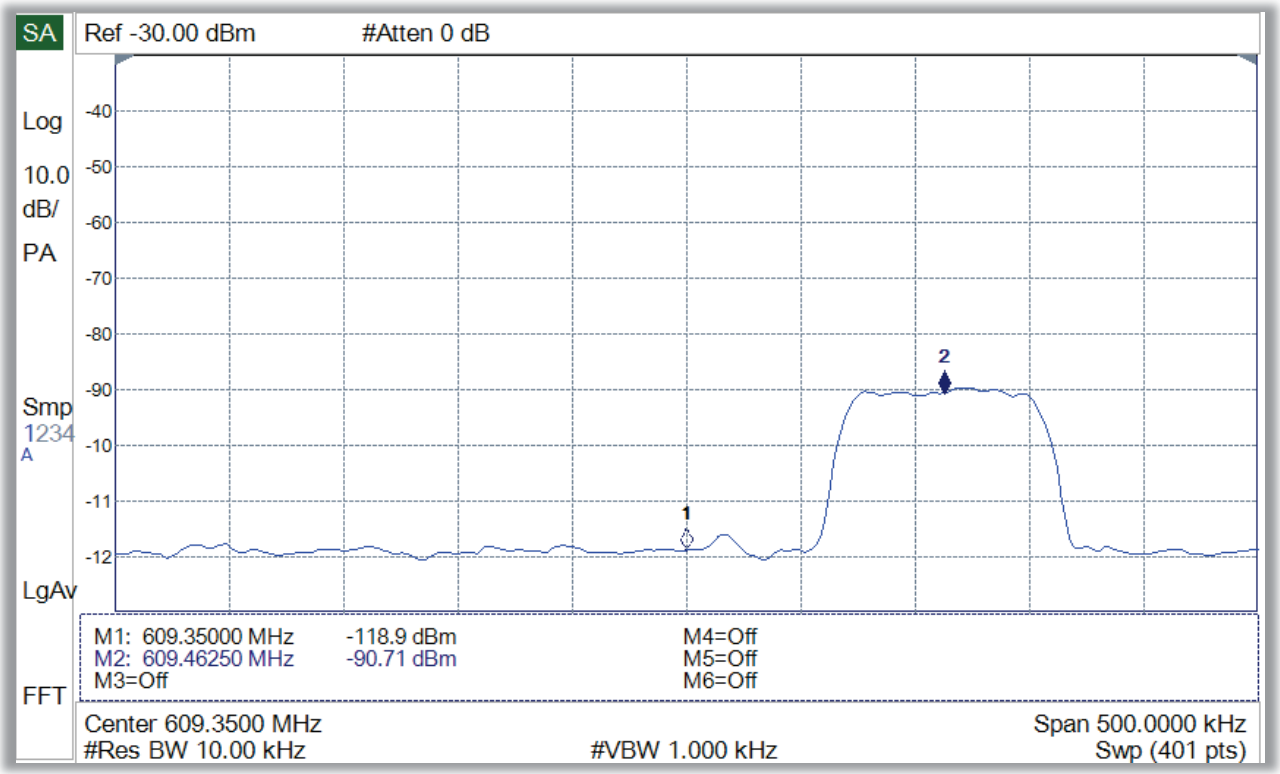


Figure 3.8-9 – Test Point #13 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 538 meters from the street level Test Point #13 site
Average recorded level -90.71 dBm (609.4625 MHz) Marker 2 – Isotropic value -96.71 dBm
Transmitter EIRP 6.60 dBm (signal generator set to -1.93 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

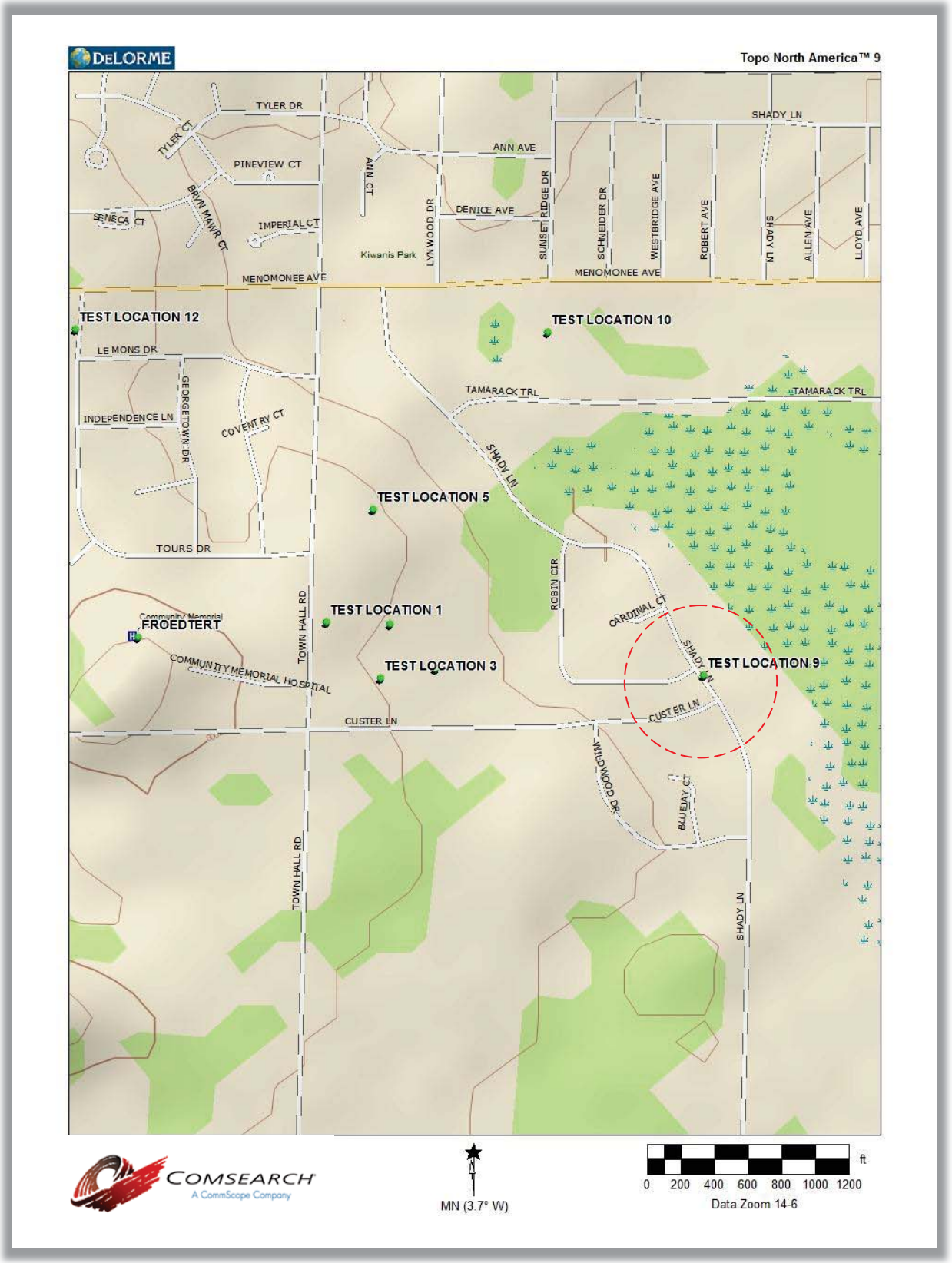


Figure 3.9-1 – Street Map – Test Point #9 Transmitter Location

Figure 3.9-2 – Aerial Map – Test Point #9 Transmitter Location

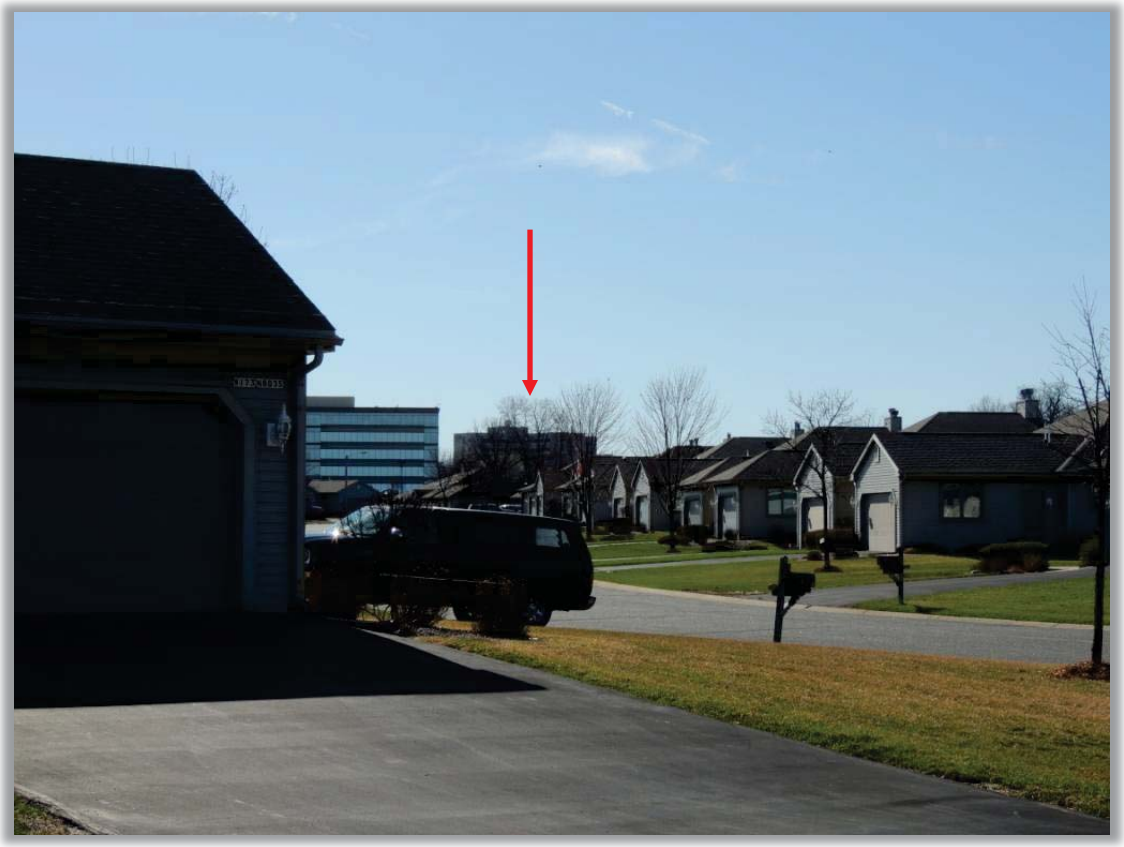


Figure 3.9-3 – Looking on path to Froedtert Memorial Hospital from Test Point #9 location

Figure 3.9-4 – Test Point #9 Transmitter

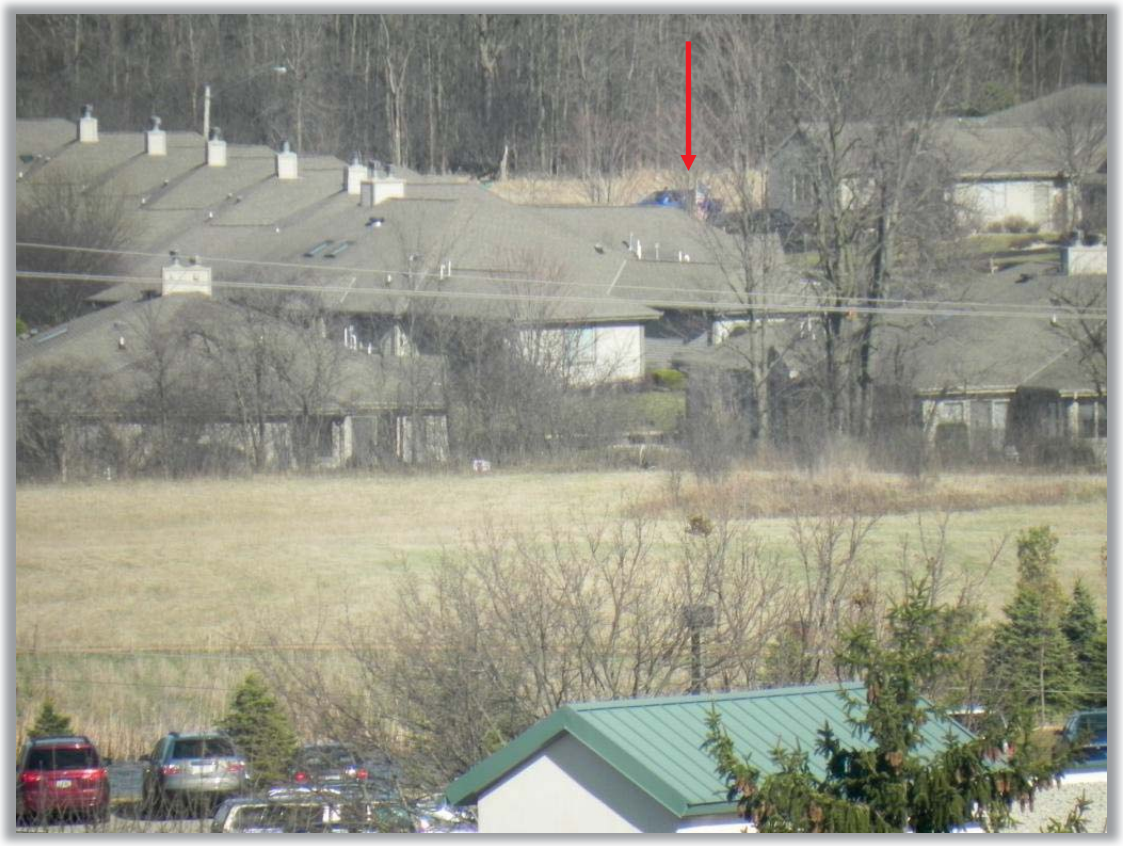


Figure 3.9-5 – View towards Test Point #9 from inside Froedtert Memorial Hospital 4th floor

Figure 3.9-6 – Receive test set inside Froedtert Memorial Hospital 4th floor exterior wall room – Test Point #9
Also visible is G.E. WMTS antenna (at arrow)

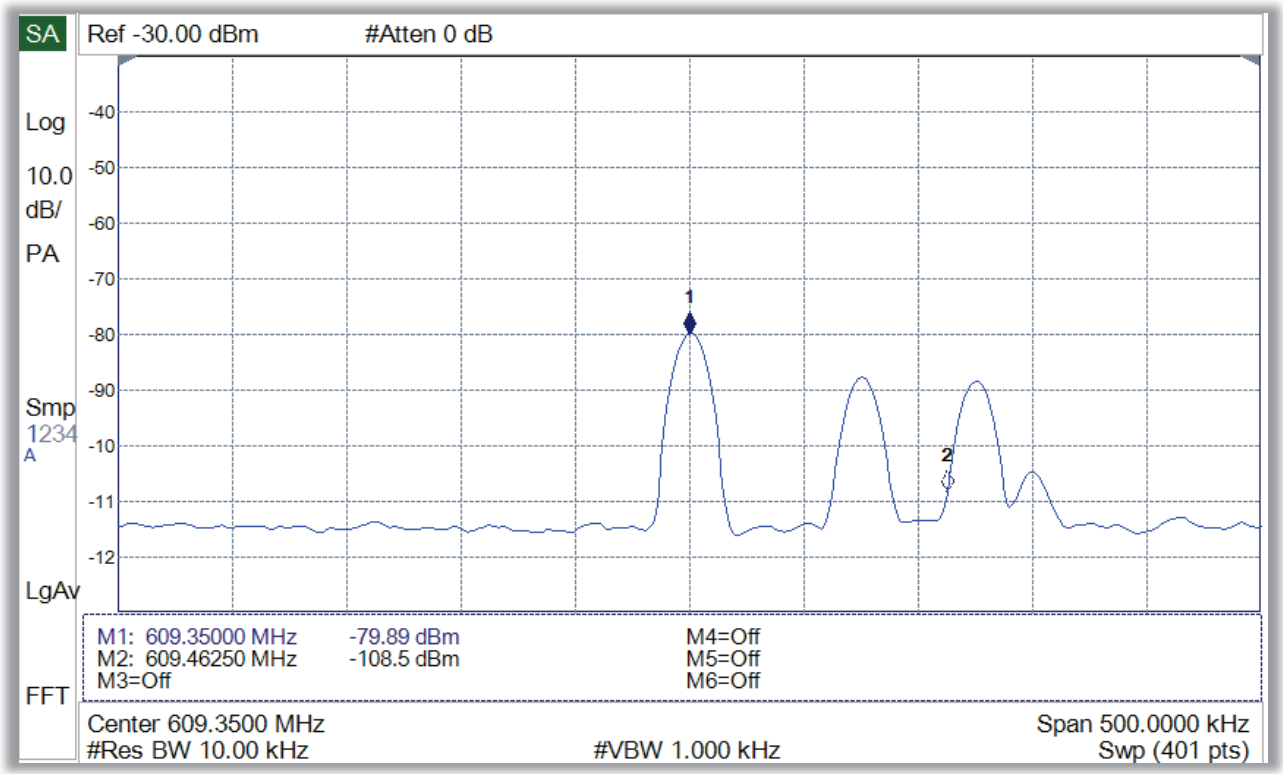


Figure 3.9-7 – Test Point #9 – Spectrum analyzer capture at 10 kHz RBW CW signal
Spectrum analyzer located on 4th floor room approximately 1003 meters from the street level Test Point #9 site
Average recorded level -79.89 dBm (609.350 MHz) Marker 1 – Isotropic value -85.85 dBm
Transmitter EIRP 36 dBm (signal generator set to 10.07 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

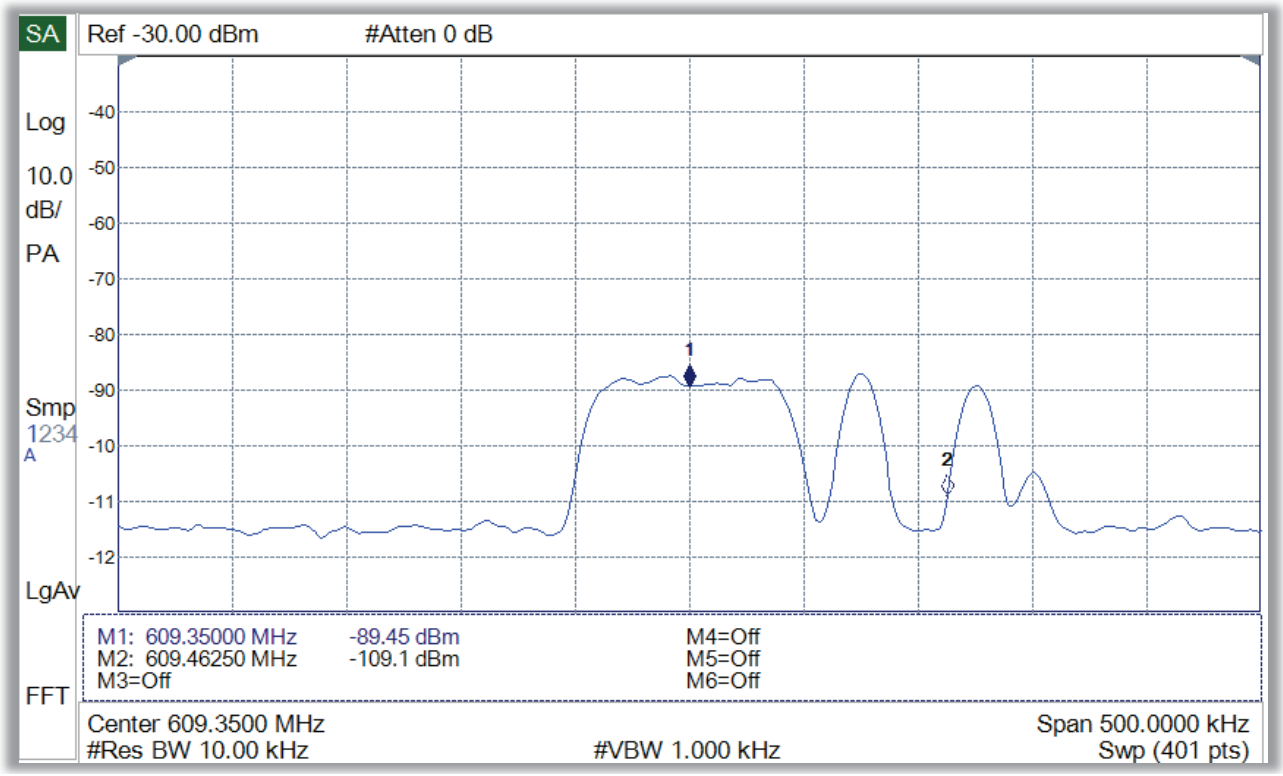


Figure 3.9-8 – Test Point #9 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 1003 meters from the street level Test Point #9 site
Average recorded level -89.45 dBm (609.350 MHz) Marker 1 – Isotropic value -95.45 dBm
Transmitter EIRP 36 dBm (signal generator set to 10.07 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

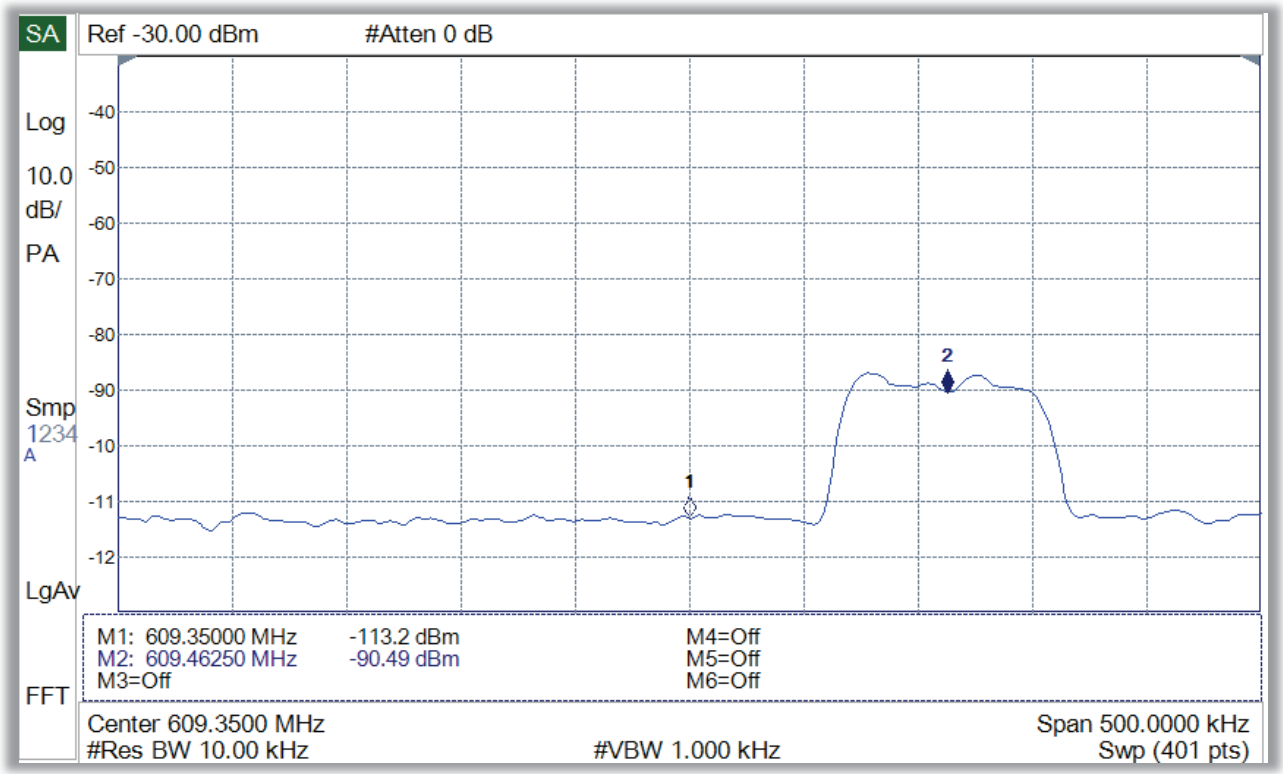


Figure 3.9-9 – Test Point #9 – Spectrum analyzer capture at 10 kHz RBW modulated signal (100 kHz BW)
Spectrum analyzer located on 4th floor room approximately 1003 meters from the street level Test Point #9 site
Average recorded level -90.49 dBm (609.4625 MHz) Marker 2 – Isotropic value -96.49 dBm
Transmitter EIRP 36 dBm (signal generator set to 10.07 dBm)
NOTE: Adjacent signals seen generated by the G.E. WMTS Test System

SECTION

FOUR

SECTION 4

SUMMARY OF RESULTS

The results of the measurements performed at each site location in the area of Froedtert Memorial Hospital are presented in this section.

4.1 RF Measurements

- There were measurements made in eight (8) locations within the Froedtert Memorial Hospital area

- Signals were observed at various levels at all locations.

- Table 4.1.1 contains the values of the measured signals from inside the Froedtert Memorial Hospital. These values are in isotropic levels.

RF Measurements Summary Results Table										
Site	Hospital	Test Site #1	Test Site #2	Test Site #3+	Test Site #4	Test Site #5	Test Site #10	Test Site #12	Test Site #13	Test Site #9
Latitude	43° 9'51.94"N	43° 9'52.85"N	43° 9'52.74"N	43° 9'49.54"N	43° 9'50.07"N	43° 9'59.44"N	43°10'9.87"N	43°10'10.05"N	43°10'7.41"N	43° 9'49.71"N
Longitude	88° 8'15.55"W	88° 8'0.44"W	88° 7'55.30"W	88° 7'56.04"W	88° 7'51.60"W	88° 7'56.61"W	88° 7'42.59"W	88° 8'20.59"W	88° 9'25.66"W	88° 7'30.02"W
Distance to Hospital (m)	-	341	429	421	518	455	895	538	2006	1003
Azimuth to Test Site	-	85.31	86.93	99.53	96.07	61.57	53.37	348.49	288.23	93.82
Azimuth to Hospital	-	265.31	266.93	279.53	276.07	241.58	233.38	168.49	108.21	273.82
Gound Elevation (m)	284.6	271.37	267.56	270.76	265.82	270.71	259.01	270.31	286.75	257.88
Max ERIP(dBm) based upon distance	-	16	20	20	24	20	32	24	36	36
Signal Generator Power (dBm)	-	-9.93	-5.93	-5.93	-1.93	-5.93	6.07	-1.93	10.07	10.07
TX Antenna Gain (dBi)	-	10	10	10	10	10	10	10	10	10
TX Cable Loss (dBm)	-	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
EIRP (100 kHz Channel) (dBm)	-	1.4	2.6	2.6	6.6	2.6	14.6	6.6	18.6	18.6
Calculated Free Space Loss (dB)*	-	78.9	81.46	81.24	82.94	81.97	87.55	83.34	94.35	88.46
Predicted CW RSL On Roof (dBm)**	-	-77.5	-78.86	-78.64	-76.34	-79.37	-72.95	-76.74	-75.75	-69.86
Isotropic RSL in Building (dBm)	-	-93.95	-92.86	-119.8 & -122.7	-89.97	-79.60	-74.51	-92.86	-83.02	-85.85
Measured Inside Pathloss (dB)***	-	95.35	95.46	122.4 & 125.3	96.57	82.20	89.11	99.46	101.62	104.45
Propagation Loss Over Free Space		16.45	14.00	41.16 & 44.06	13.63	0.23	1.56	16.12	7.27	15.99

* FSPL(dB) = 20 log (d) + 20 Log (f) + 32.45 (where d, f in KM and MHz)

** Predicted CW RSL = EIRP - Free Space Loss

*** Difference in the EIRP and Isotropic CW RSL on Roof or In-Building

+ Test Site #3 transmitter was inside nearby building on the first and fifth floors. Two different receive results were obtained.

APPENDIX 1

Matt Pekarske, 8200 West Tower Avenue, Milwaukee, WI 532233219,

United States of America
FEDERAL COMMUNICATIONS COMMISSION
EXPERIMENTAL
SPECIAL TEMPORARY AUTHORIZATION

EXPERIMENTAL	WI9XAF
(Nature of Service)	(Call Sign)
XT FX	1026-EX-ST-2014
(Class of Station)	(File Number)

NAME GE Healthcare Systems

This Special Temporary Authorization is granted upon the express condition that it may be terminated by the Commission at any time without advance notice or hearing if in its discretion the need for such action arises. Nothing contained herein shall be construed as a finding by the Commission that the authority herein granted is or will be in the public interest beyond the express terms hereof.

This Special Temporary Authorization shall not vest in the grantee any right to operate the station nor any right in the use of the frequencies designated in the authorization beyond the term hereof, nor in any other manner than authorized herein. Neither the authorization nor the right granted hereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934. This authorization is subject to the right of use of control the Government of the United States conferred by Section 706 of the Communications Act of 1934.

Special Temporary Authority is hereby granted to operate the apparatus described below:

Purpose Of Operation:
Signal strength measurements to characterize propagation loss and interference effects in the 608-614 MHz WMTS band.

Station Locations
(1) Washington (DIST OF COLUMBIA), DC - NL 38-53-24; WL 77-01-25
(2) Roanoke (ROANOKE), VA - NL 37-16-00; WL 79-56-00
(3) Harrisonburg (ROCKINGHAM), VA - NL 38-26-59; WL 78-52-08
(4) Boston (SUFFOLK), MA - NL 42-19-36; WL 71-09-04
(5) Milwaukee (MILWAUKEE), WI - NL 43-03-08; WL 87-57-21

Frequency Information

Washington (DIST OF COLUMBIA), DC - NL 38-53-24; WL 77-01-25

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
608-614 MHz	FX		4 W (ERP)	
		1M00D1D		
		2M00D1D		
		3M00D1D		
		4M00D1D		
		5M00D1D		
		6M00D1D		

This authorization effective December 08, 2014 and will expire 3:00 A.M. EST June 01, 2015

FEDERAL COMMUNICATIONS COMMISSION

Frequency Information

Washington (DIST OF COLUMBIA), DC - NL 38-53-24; WL 77-01-25

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
608-614 MHz	FX		4 W (ERP)	
		0M00N0N		

Roanoke (ROANOKE), VA - NL 37-16-00; WL 79-56-00

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
608-614 MHz	FX		4 W (ERP)	
		1M00D1D		
		2M00D1D		
		3M00D1D		
		4M00D1D		
		5M00D1D		
		6M00D1D		
		0M00N0N		

Harrisonburg (ROCKINGHAM), VA - NL 38-26-59; WL 78-52-08

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
608-614 MHz	FX		4 W (ERP)	
		1M00D1D		
		2M00D1D		
		3M00D1D		
		4M00D1D		
		5M00D1D		
		6M00D1D		
		0M00N0N		

Frequency Information

Boston (SUFFOLK), MA - NL 42-19-36; WL 71-09-04

Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
608-614 MHz	FX		4 W (ERP)	
		1M00D1D		
		2M00D1D		
		3M00D1D		
		4M00D1D		
		5M00D1D		
		6M00D1D		
		0M00N0N		

Milwaukee (MILWAUKEE), WI - NL 43-03-08; WL 87-57-21

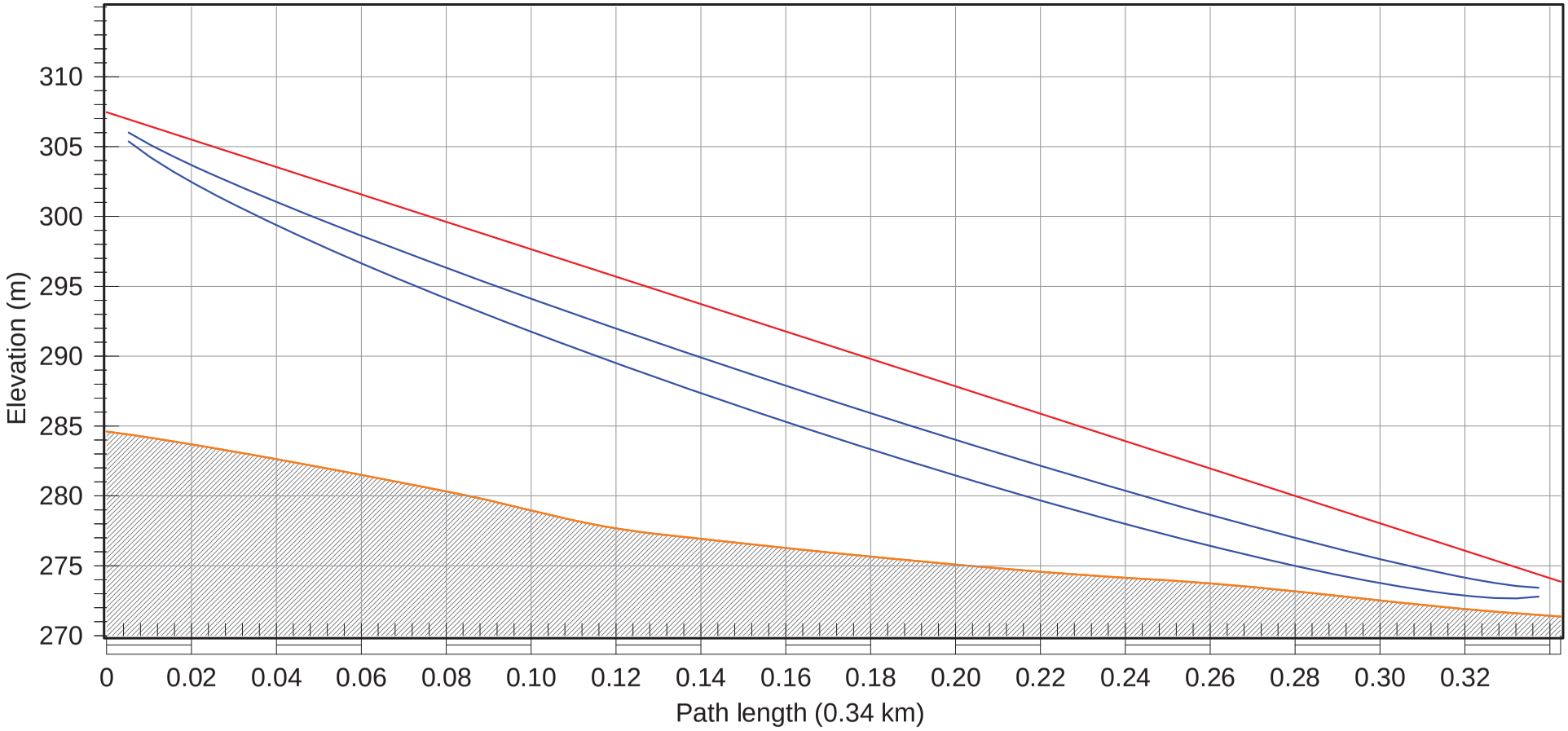
Frequency	Station Class	Emission Designator	Authorized Power	Frequency Tolerance (+/-)
608-614 MHz	FX		4 W (ERP)	
		1M00D1D		
		2M00D1D		
		3M00D1D		
		4M00D1D		
		5M00D1D		
		6M00D1D		
		0M00N0N		

Special Conditions:

(1) Operation is subject to prior coordination with the Society of Broadcast Engineers, Inc. (SBE); ATTN: Executive Director; 9102 North Meridian Street, Suite 305; Indianapolis, IN 46260; telephone, (866) 632-4222; FAX, (317) 846-9120; e-mail, executivedir @ sbe.org; information, www.sbe.org.

(2) In lieu of frequency tolerance, the occupied bandwidth of the emission shall not extend beyond the band limits set forth above.

APPENDIX 2



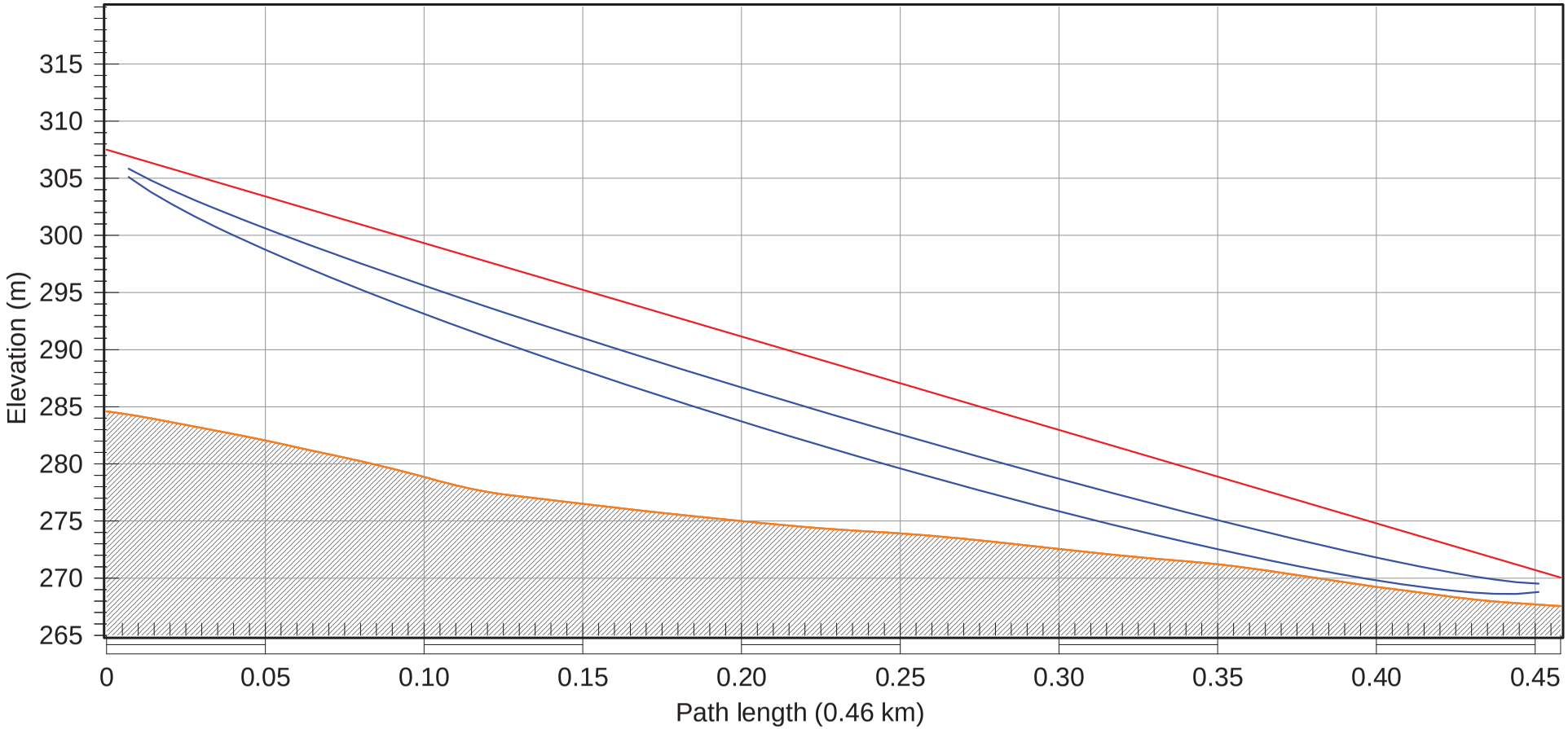
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	85.31°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 609.4
K = 1.33
%F1 = 100.00, 60.00

Test Location 1	
Latitude	43 09 52.85 N
Longitude	088 08 00.43 W
Azimuth	265.31°
Elevation	271 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 1
Latitude	43 09 51.94 N	43 09 52.85 N
Longitude	088 08 15.55 W	088 08 00.43 W
True azimuth (°)	85.31	265.31
Vertical angle (°)	-5.60	5.60
Elevation (m)	284.60	271.37
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.86	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	609.40	
Polarization	Vertical	
Path length (km)	0.34	
Free space loss (dB)	78.90	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	70.67	70.67
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.10	
Fade occurrence factor (Po)	7.358E-008	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



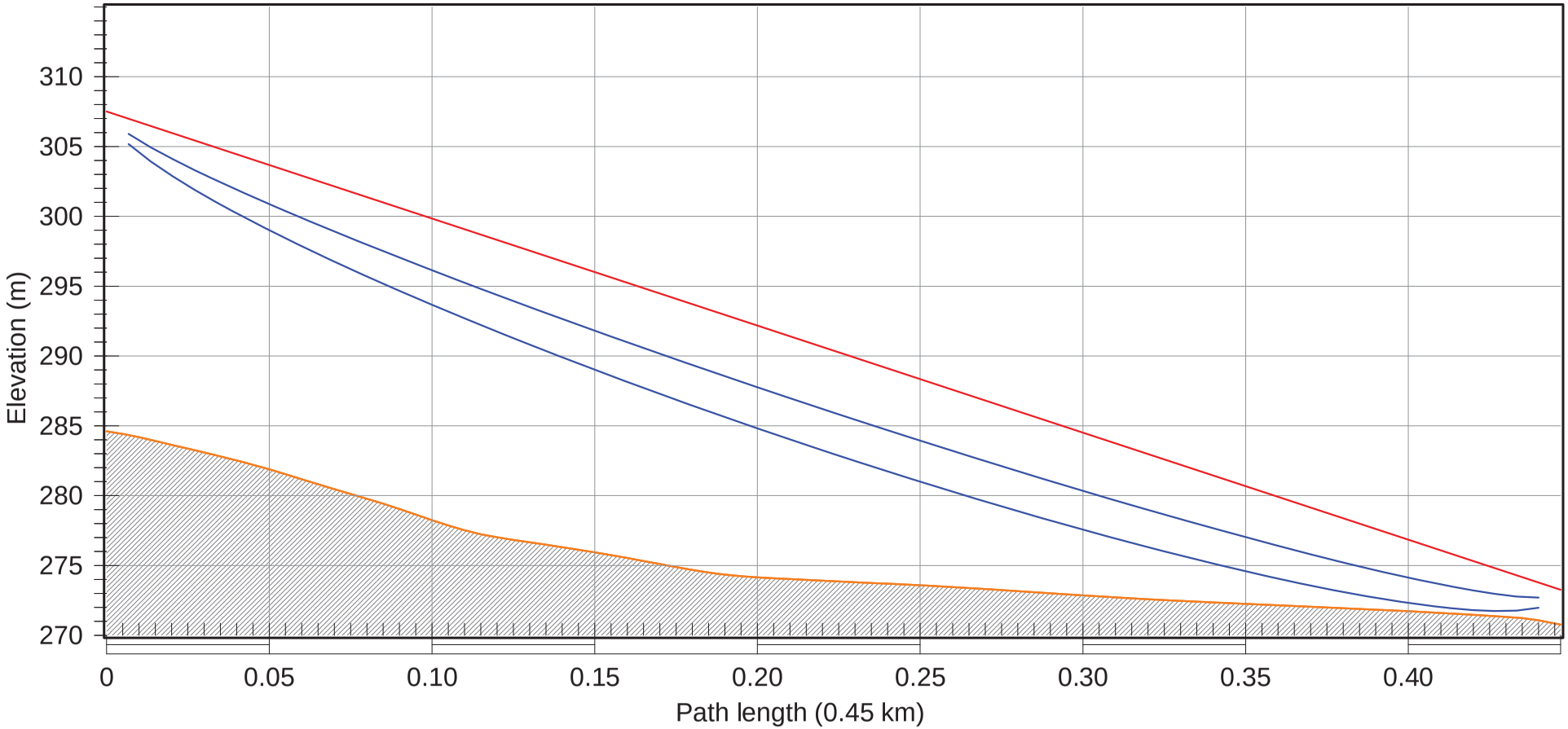
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	86.93°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 2	
Latitude	43 09 52.74 N
Longitude	088 07 55.30 W
Azimuth	266.93°
Elevation	268 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 2
Latitude	43 09 51.94 N	43 09 52.74 N
Longitude	088 08 15.55 W	088 07 55.30 W
True azimuth (°)	86.93	266.93
Vertical angle (°)	-4.68	4.67
Elevation (m)	284.60	267.56
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	0.46	
Free space loss (dB)	81.46	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	73.24	73.24
TX power (dBm)		-5.93
EIRP (dBm)		0.45
Receive signal (dBm)	-79.17	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.11	
Fade occurrence factor (Po)	1.778E-007	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



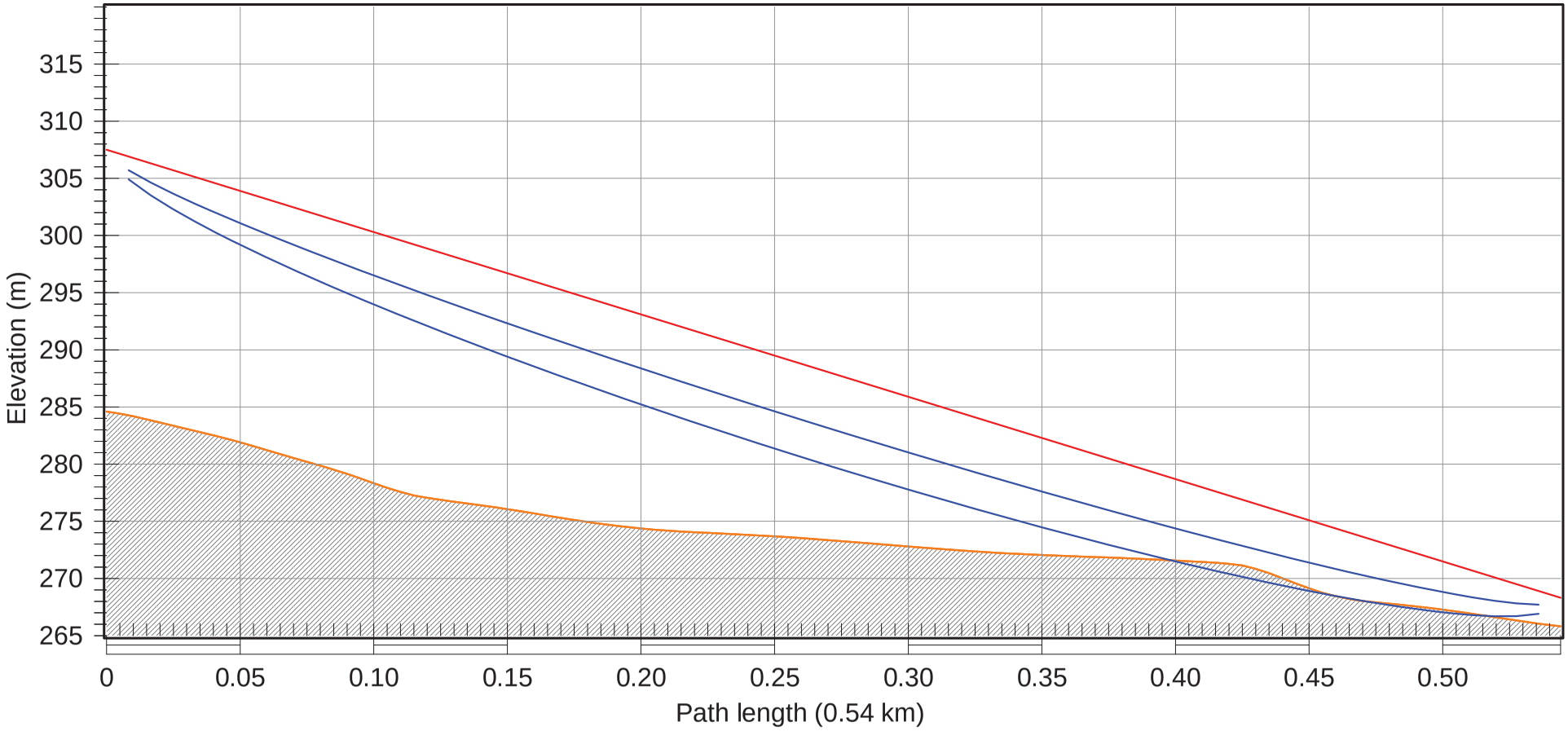
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	99.53°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 3	
Latitude	43 09 49.54 N
Longitude	088 07 56.04 W
Azimuth	279.53°
Elevation	271 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 3
Latitude	43 09 51.94 N	43 09 49.54 N
Longitude	088 08 15.55 W	088 07 56.04 W
True azimuth (°)	99.53	279.53
Vertical angle (°)	-4.38	4.38
Elevation (m)	284.60	270.77
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	0.45	
Free space loss (dB)	81.24	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	73.02	73.02
TX power (dBm)		-5.93
EIRP (dBm)		0.45
Receive signal (dBm)	-78.95	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.11	
Fade occurrence factor (Po)	1.648E-007	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



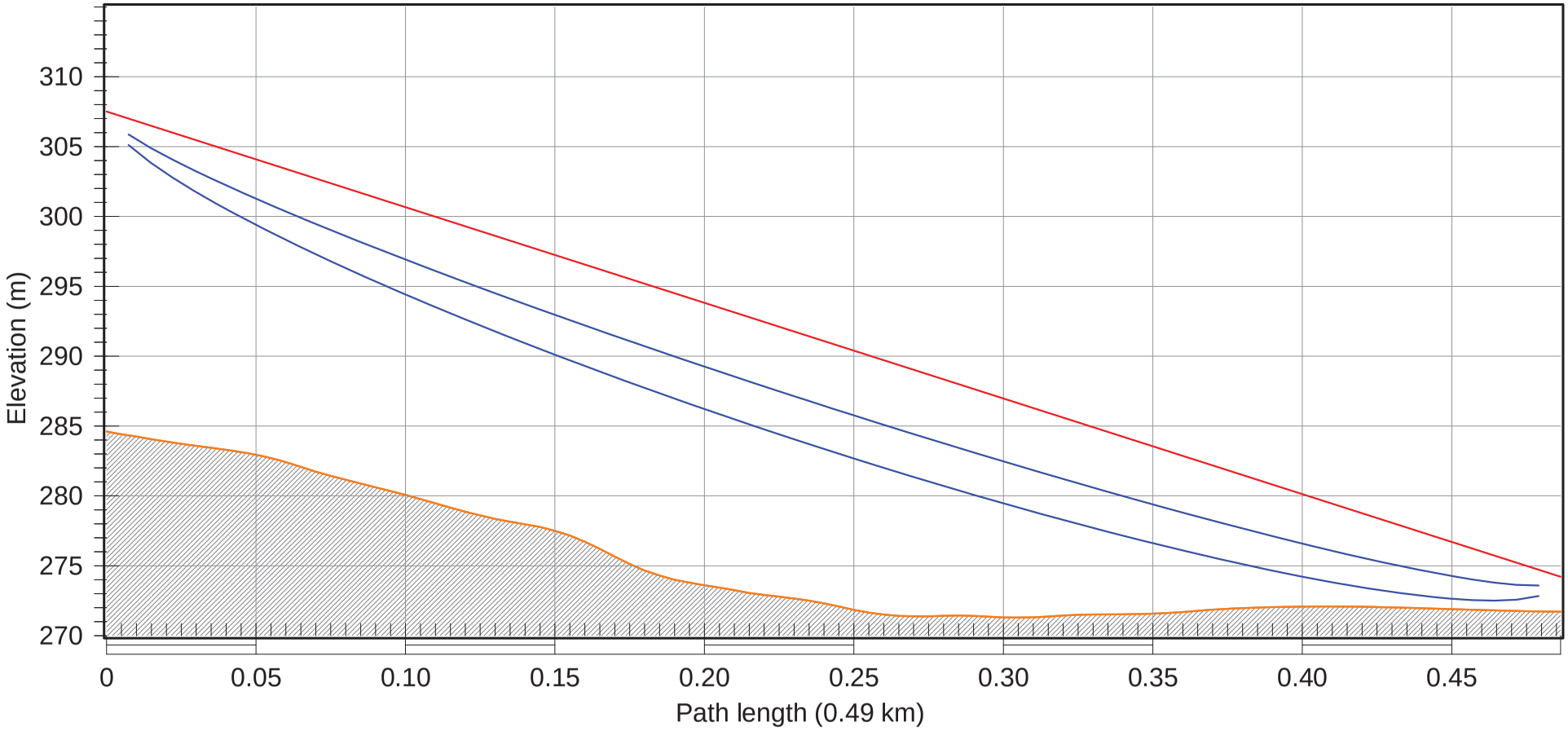
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	96.07°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 4	
Latitude	43 09 50.08 N
Longitude	088 07 51.60 W
Azimuth	276.07°
Elevation	266 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 4
Latitude	43 09 51.94 N	43 09 50.08 N
Longitude	088 08 15.55 W	088 07 51.60 W
True azimuth (°)	96.07	276.07
Vertical angle (°)	-4.12	4.12
Elevation (m)	284.60	265.82
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	0.55	
Free space loss (dB)	82.94	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	74.71	74.71
TX power (dBm)		-1.93
EIRP (dBm)		4.45
Receive signal (dBm)	-76.64	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.11	
Fade occurrence factor (Po)	2.964E-007	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



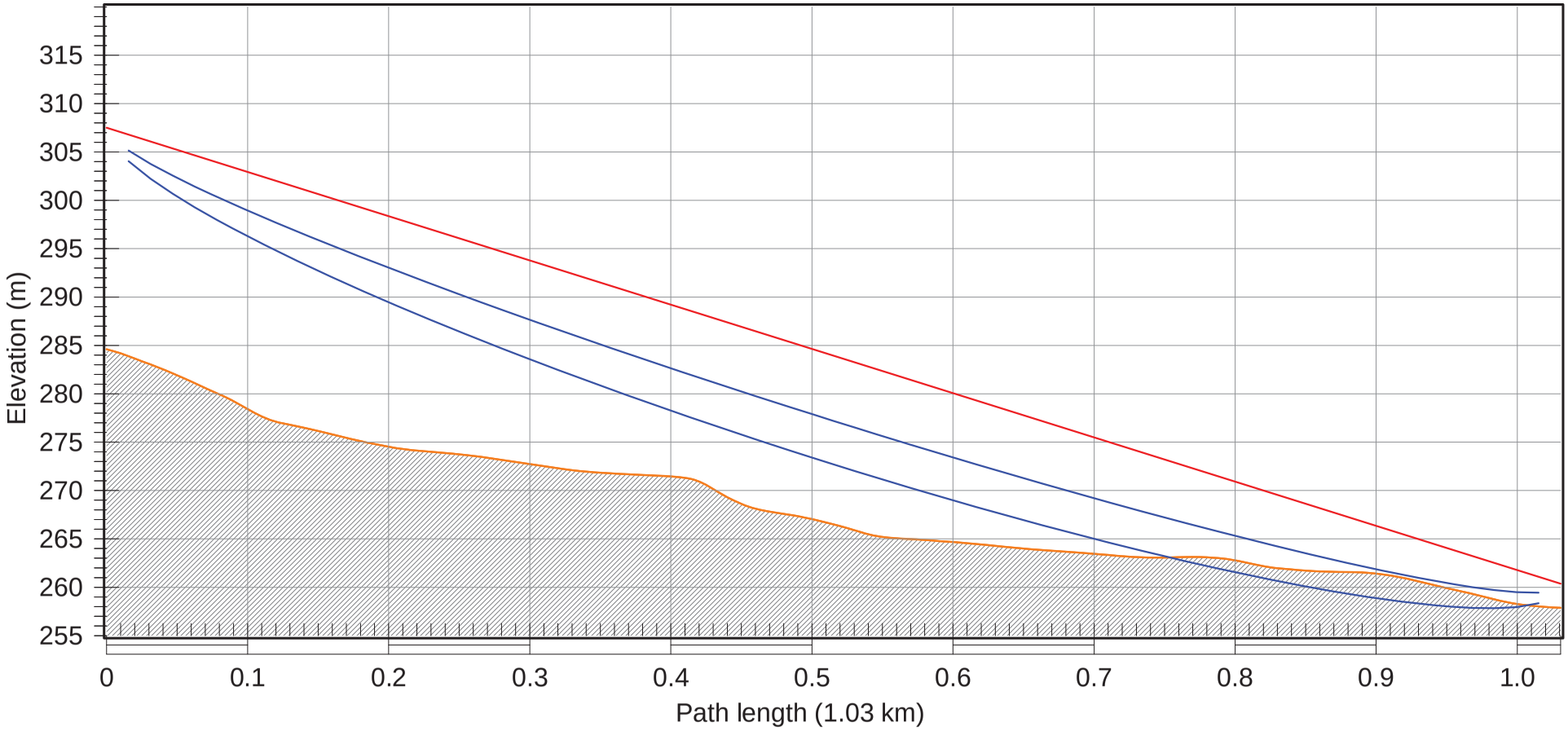
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	61.57°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 5	
Latitude	43 09 59.44 N
Longitude	088 07 56.61 W
Azimuth	241.58°
Elevation	272 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 5
Latitude	43 09 51.94 N	43 09 59.44 N
Longitude	088 08 15.55 W	088 07 56.61 W
True azimuth (°)	61.57	241.58
Vertical angle (°)	-3.92	3.91
Elevation (m)	284.60	271.71
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	0.49	
Free space loss (dB)	81.97	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	73.74	73.74
TX power (dBm)		-5.93
EIRP (dBm)		0.45
Receive signal (dBm)	-79.67	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.10	
Fade occurrence factor (Po)	2.118E-007	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



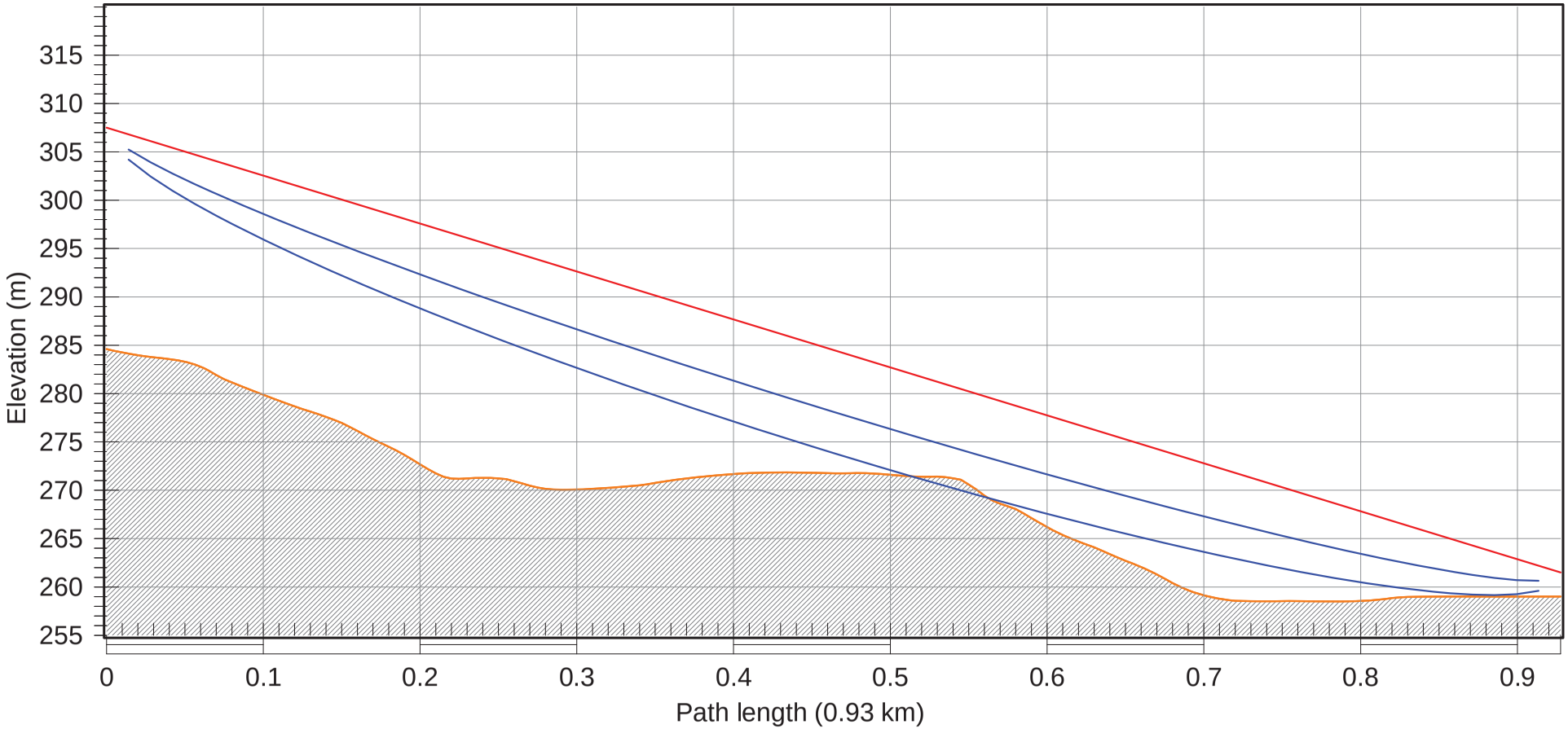
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	93.82°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 9	
Latitude	43 09 49.72 N
Longitude	088 07 30.02 W
Azimuth	273.82°
Elevation	258 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 9
Latitude	43 09 51.94 N	43 09 49.72 N
Longitude	088 08 15.55 W	088 07 30.02 W
True azimuth (°)	93.82	273.82
Vertical angle (°)	-2.62	2.61
Elevation (m)	284.60	257.88
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	1.03	
Free space loss (dB)	88.46	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	80.23	80.23
TX power (dBm)		10.07
EIRP (dBm)		16.45
Receive signal (dBm)	-70.16	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.11	
Fade occurrence factor (Po)	1.991E-006	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



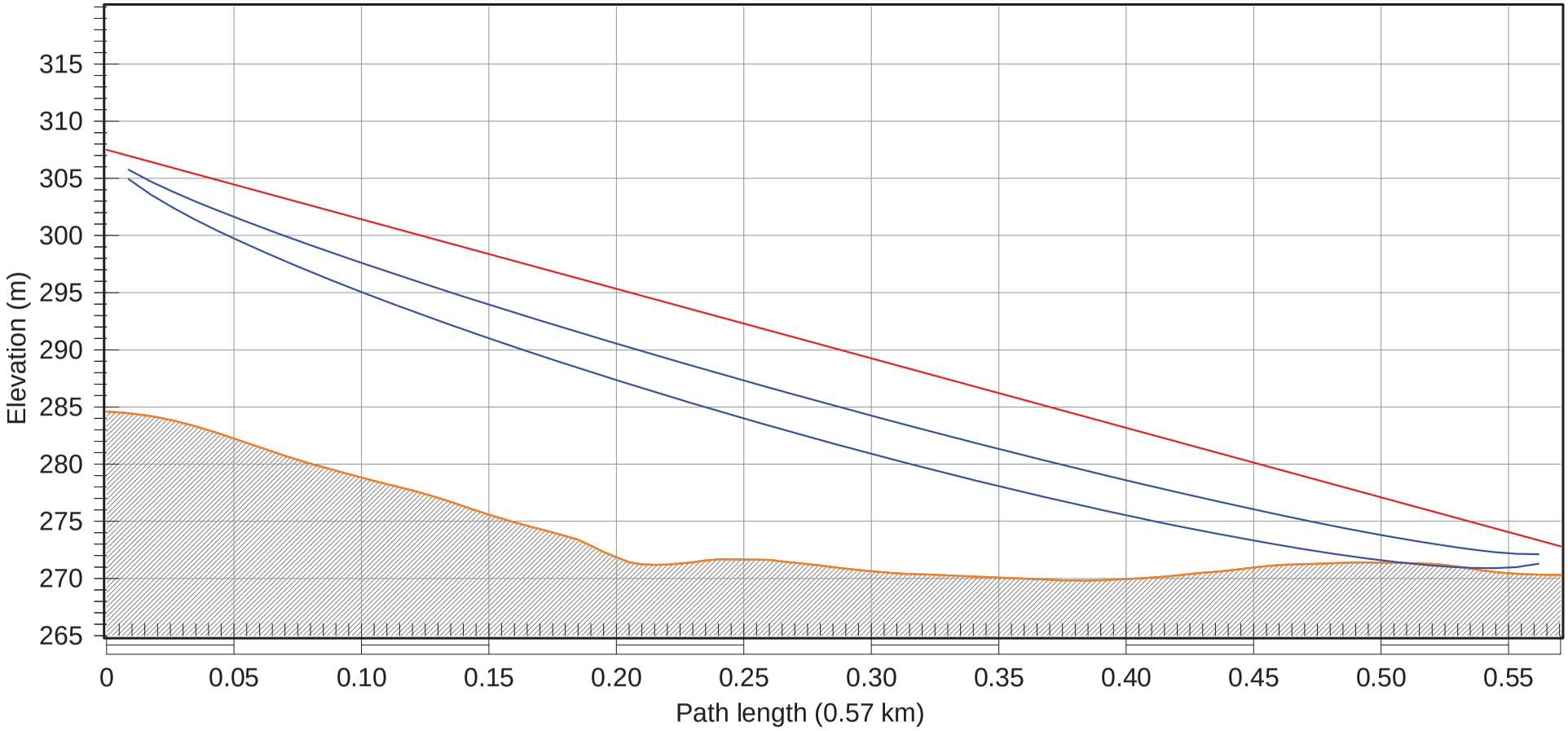
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	53.37°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 10	
Latitude	43 10 09.87 N
Longitude	088 07 42.59 W
Azimuth	233.38°
Elevation	259 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 10
Latitude	43 09 51.94 N	43 10 09.87 N
Longitude	088 08 15.55 W	088 07 42.59 W
True azimuth (°)	53.37	233.38
Vertical angle (°)	-2.84	2.84
Elevation (m)	284.60	259.01
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	0.93	
Free space loss (dB)	87.55	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	79.32	79.32
TX power (dBm)		6.07
EIRP (dBm)		12.45
Receive signal (dBm)	-73.25	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.10	
Fade occurrence factor (Po)	1.453E-006	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



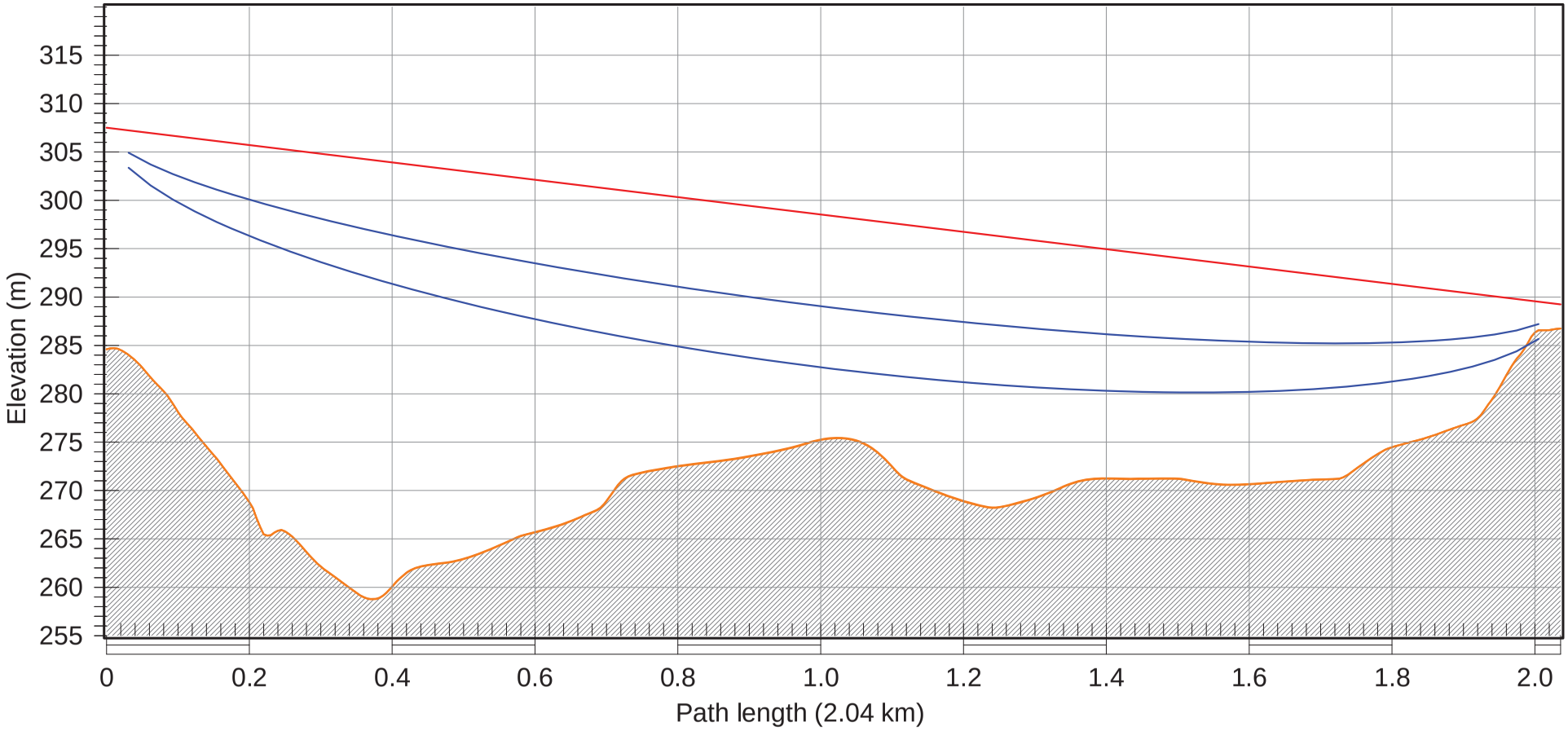
Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	348.49°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 12	
Latitude	43 10 10.05 N
Longitude	088 08 20.59 W
Azimuth	168.49°
Elevation	270 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 12
Latitude	43 09 51.94 N	43 10 10.05 N
Longitude	088 08 15.55 W	088 08 20.59 W
True azimuth (°)	348.49	168.49
Vertical angle (°)	-3.48	3.48
Elevation (m)	284.60	270.31
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	0.57	
Free space loss (dB)	83.34	
Atmospheric absorption loss (dB)	0.00	
Net path loss (dB)	75.11	75.11
TX power (dBm)		-1.93
EIRP (dBm)		4.45
Receive signal (dBm)	-77.04	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.10	
Fade occurrence factor (Po)	3.401E-007	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



Froedtert	
Latitude	43 09 51.94 N
Longitude	088 08 15.55 W
Azimuth	288.23°
Elevation	285 m ASL
Antenna CL	22.9 m AGL

Frequency (MHz) = 610.2
K = 1.33
%F1 = 100.00, 60.00

Test Location 13	
Latitude	43 10 12.57 N
Longitude	088 09 41.16 W
Azimuth	108.21°
Elevation	287 m ASL
Antenna CL	2.5 m AGL

	Froedtert	Test Location 13
Latitude	43 09 51.94 N	43 10 12.57 N
Longitude	088 08 15.55 W	088 09 41.16 W
True azimuth (°)	288.23	108.21
Vertical angle (°)	-0.52	0.51
Elevation (m)	284.60	286.75
Antenna gain (dBi)	0.00	10.00
Antenna height (m)	22.90	2.50
TX line loss (dB)	0.30	1.47
Frequency (MHz)	610.20	
Polarization	Vertical	
Path length (km)	2.04	
Free space loss (dB)	94.35	
Atmospheric absorption loss (dB)	0.01	
Net path loss (dB)	86.13	86.13
TX power (dBm)		10.07
EIRP (dBm)		16.45
Receive signal (dBm)	-76.06	
Thermal fade margin (dB)		
Dispersive fade occurrence factor	2.00	
Climatic factor	1.50	
Terrain roughness (m)	6.10	
C factor	4.94	
Average annual temperature (°C)	8.09	
Fade occurrence factor (Po)	1.526E-005	
Polarization	Vertical	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)