AM is in trouble!

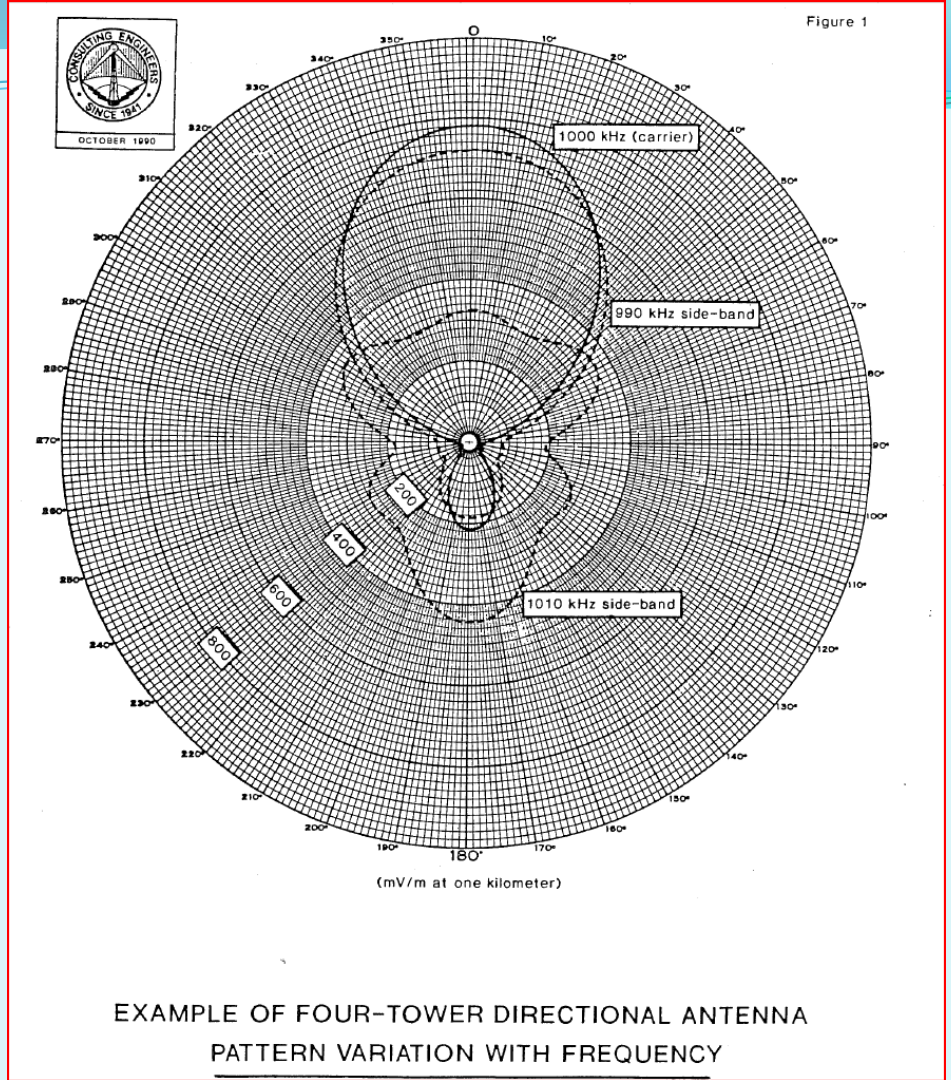
- Little or no profitability
- Little or no resale value
- Few listeners
- Aging infrastructure
- Poor quality radios – narrow bandwidth
- Many stations going dark
- BMW leaves out AM on its electric models

AM Radio is Noisy - Environmental Interference

- Dimmer Switches
- Overhead power lines
- Florescent Lights - Ballasts
- LED lights - switching power supplies
- Computers - big and small
- Televisions, particularly with Plasma Screens
- Motors
- Switches
- Car ignitions
- Lightning
- Electronic Filters

IBOC and Pattern Bandwidth Issue

Adjacent frequencies do not have the same patterns



c/o Ron Rackley

Proposals to ‘fix’ AM ???

- All digital modulation – reinventing AM, taking years?
- Modify AM antenna efficiency standards – (downward)
- Reduce day/night community coverage standards
- Eliminate the “Ratchet” rule – which reduces interference contributions - for minor changes by 10%
- Open a window for FM translator applications for AM stations
- Mandate receiver improvements – return to broader bandwidth
- Wider use - modulation dependent carriers (saves elec.)

FM Broadcast Band

- Freeze on applications for new commercial, NCE and translators stations
- LPFM application window closed, major change settlements taking place
- NCE and commercial FM minor changes only
- Allocation Petitions, any granted go to auction
- General Motors removes FM IBOC from several models
- Lack of IBOC adoptions outside of major markets

Sources of Interference

- FM radio not affected as much as AM by noise (Thank you Mr. Armstrong.)
- Environmental noise – computer routers, switching power supplies, etc., some LED lights
- Cable leakage
- LPFM – 1,222 new C.P.s, reduce FM coverage past protected 60 dBu
- Weaknesses in FCC contour protection methodology
- IBOC – Short spaced stations – dropouts coupled with bad synchronization of analog

Signal to Noise ratio “Interference” when running FM IBOC

SNR Versus IBOC injection levels

- Dave Hershberger, Continental Electronics

- IBOC –Injection level – higher the IBOC power the lower the SNR

Digital power	Composite SNR, no IF filter	Composite SNR, sharp IF filter
1%	50.0 dB	54.1 dB
4%	42.8 dB	48.4 dB
10%	36.9 dB	44.3 dB

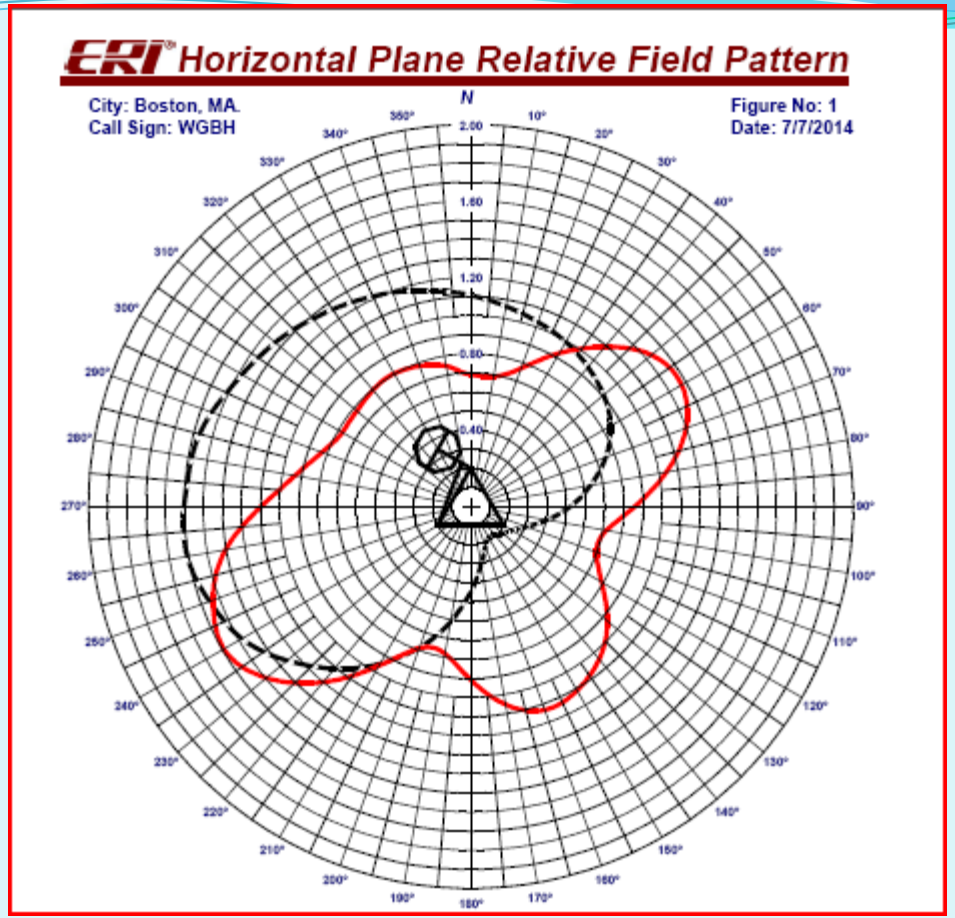
- Radio World, 10/19/2010

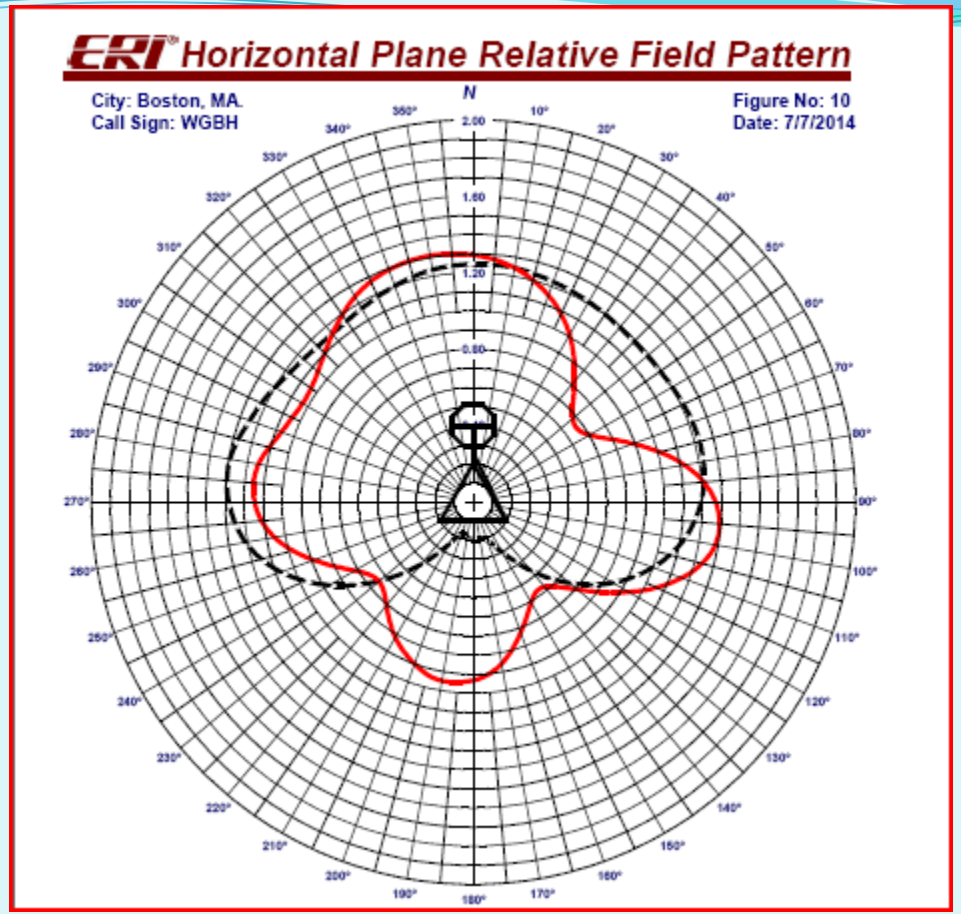
Interference from side-mounted, so-called, “Omni-directional FM antennas”

All side-mounted antennas are directional

Horizontal = Red
Vertical = Black

Relative Field




ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 10
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
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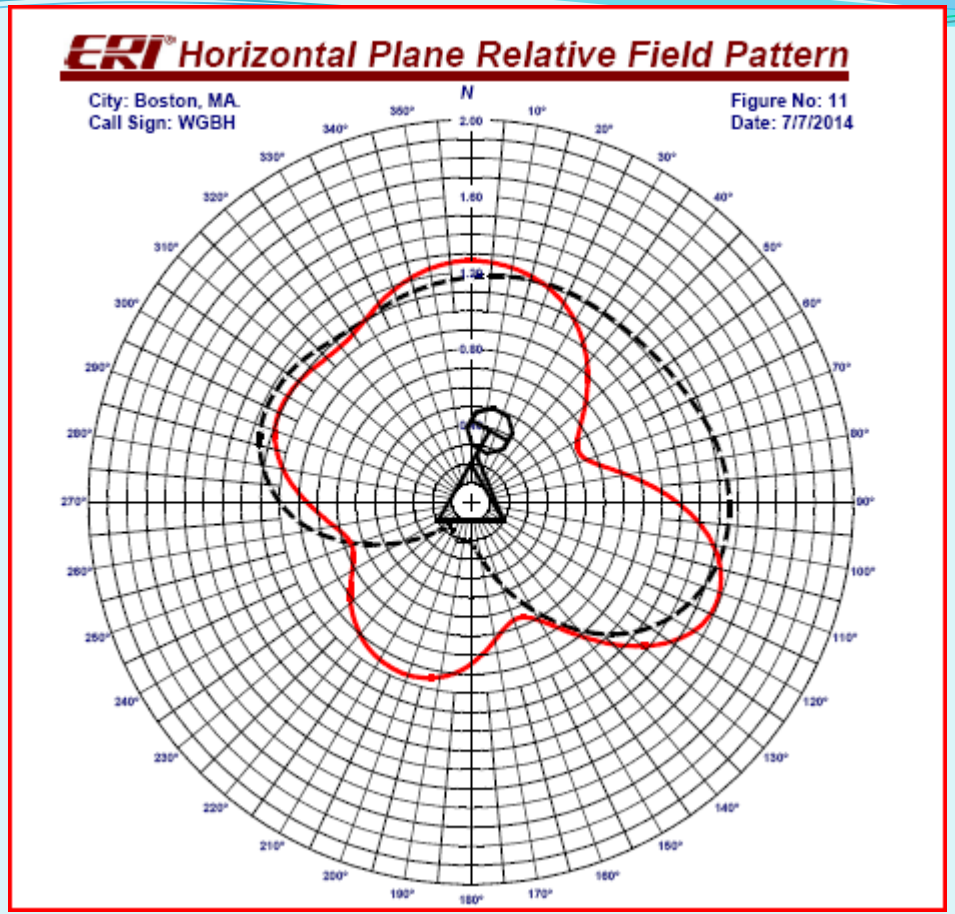
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 11
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
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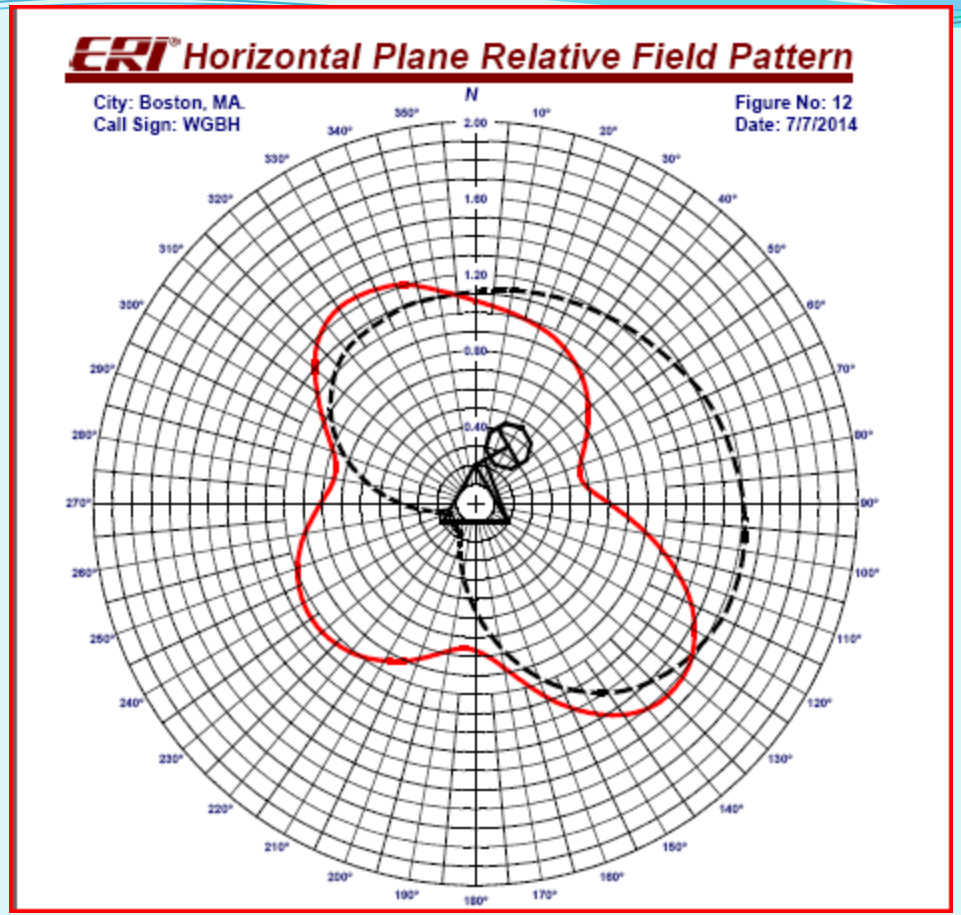
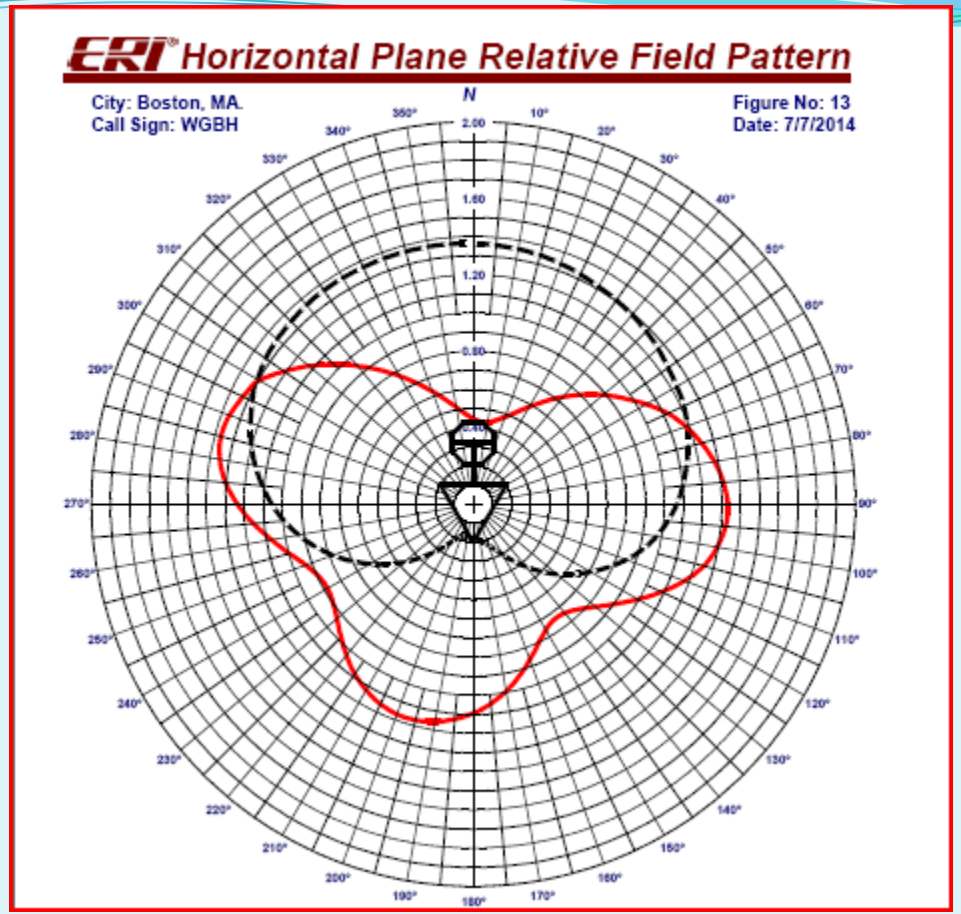
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 12
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 13
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
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240°
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280°
290°
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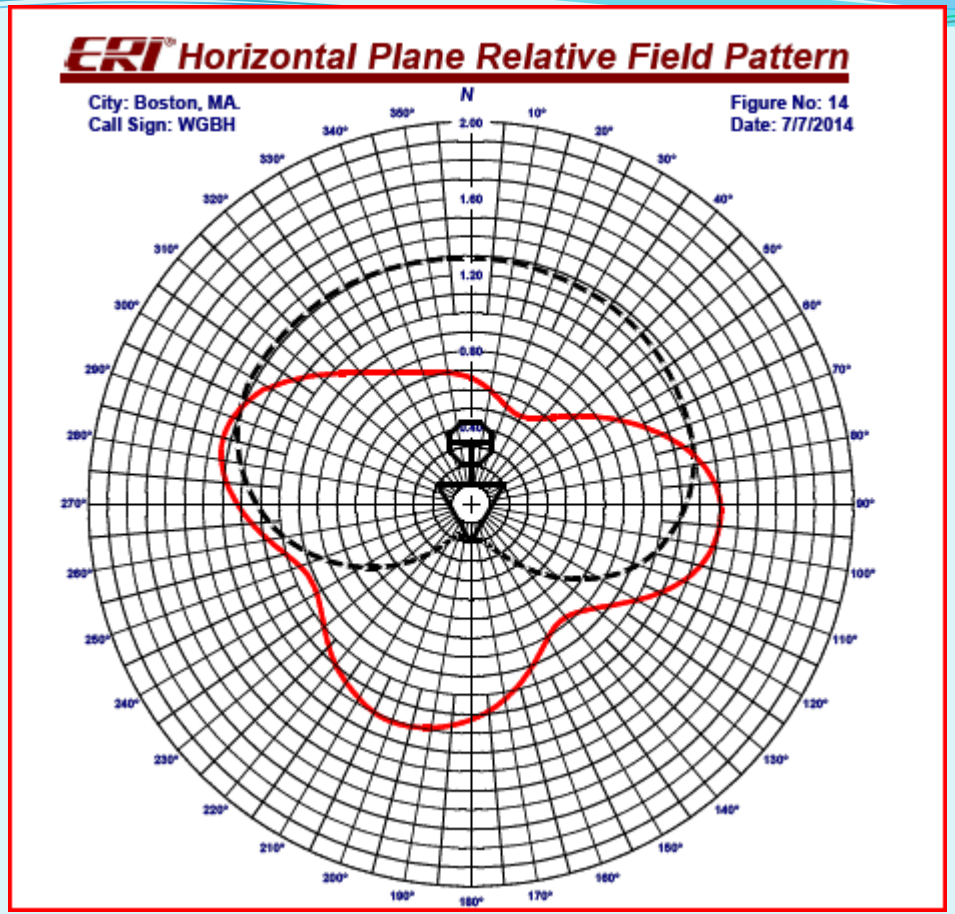
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 14
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
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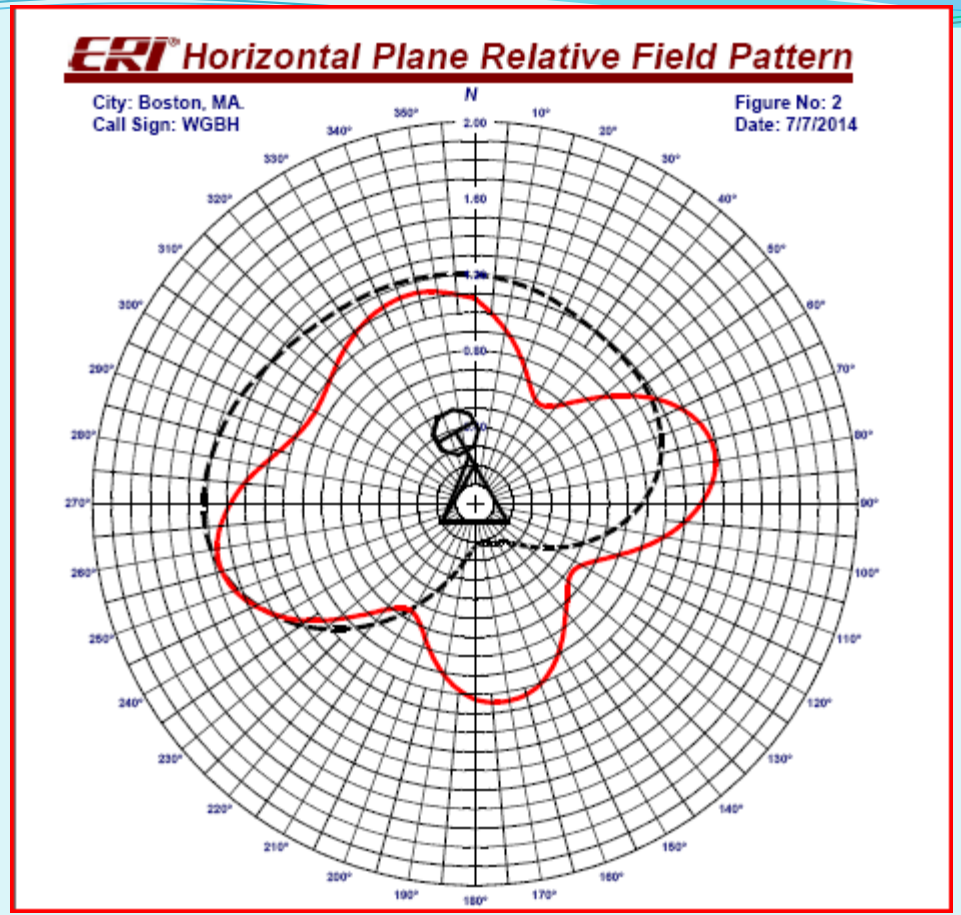
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 2
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
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260°
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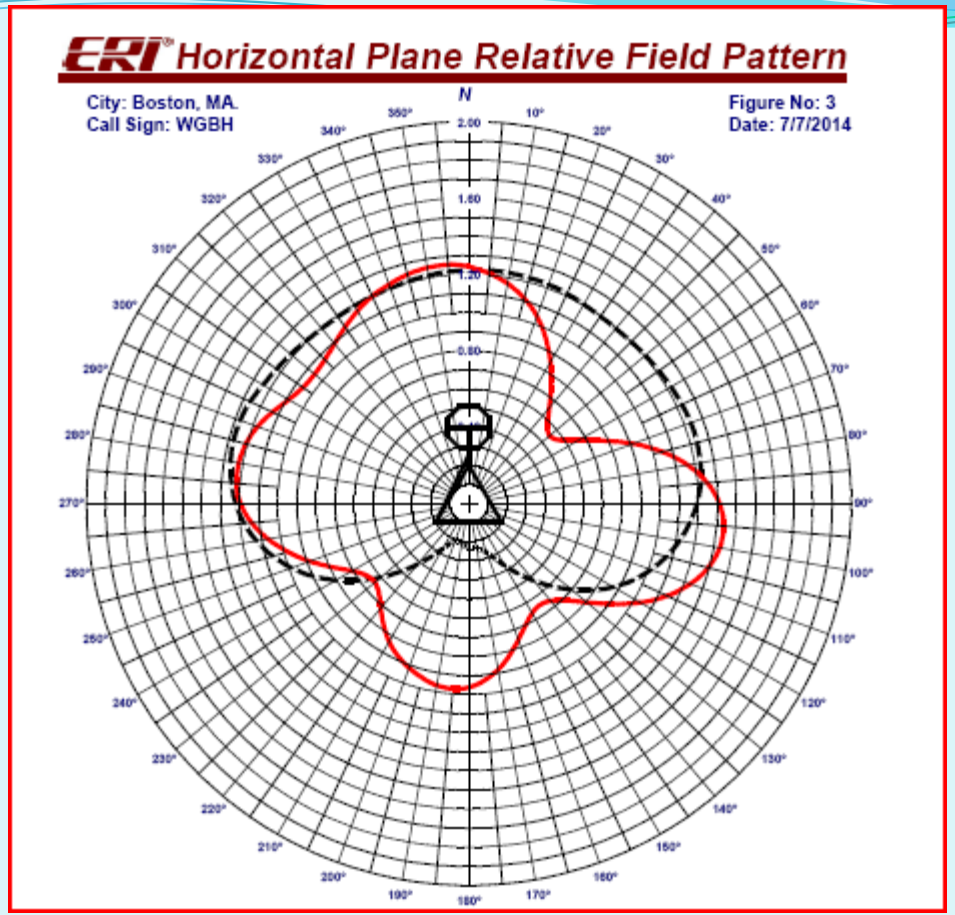
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 3
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
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230°
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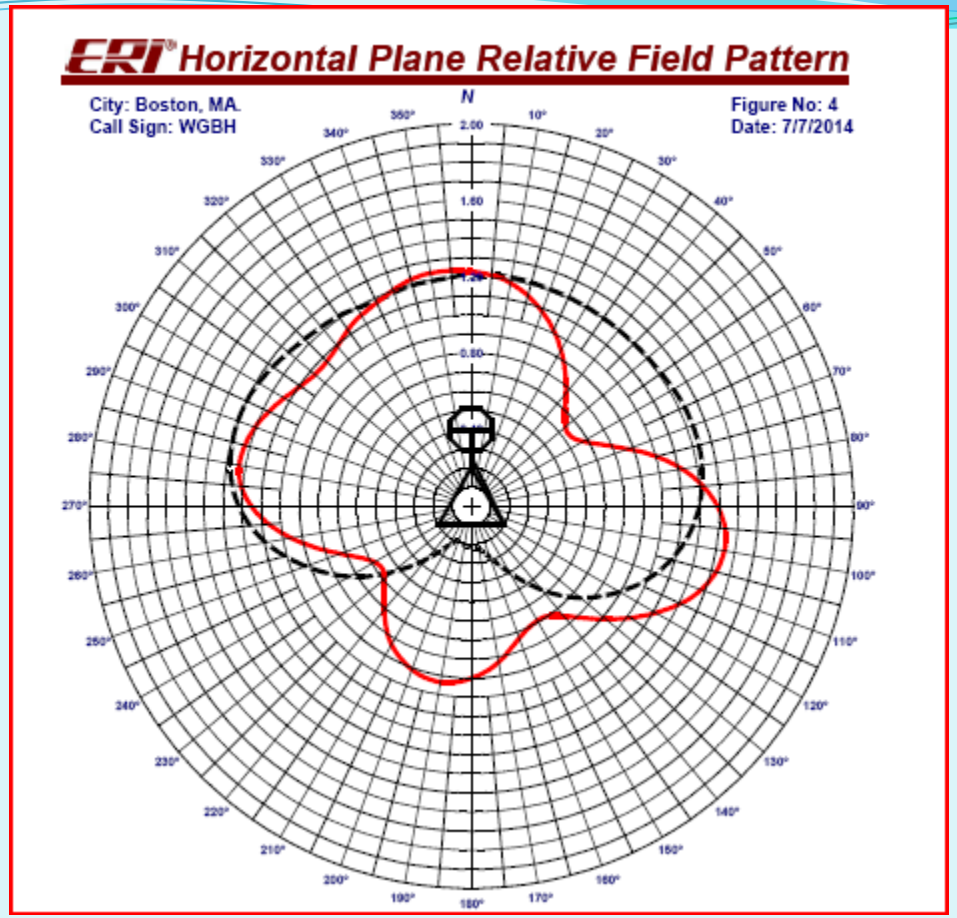
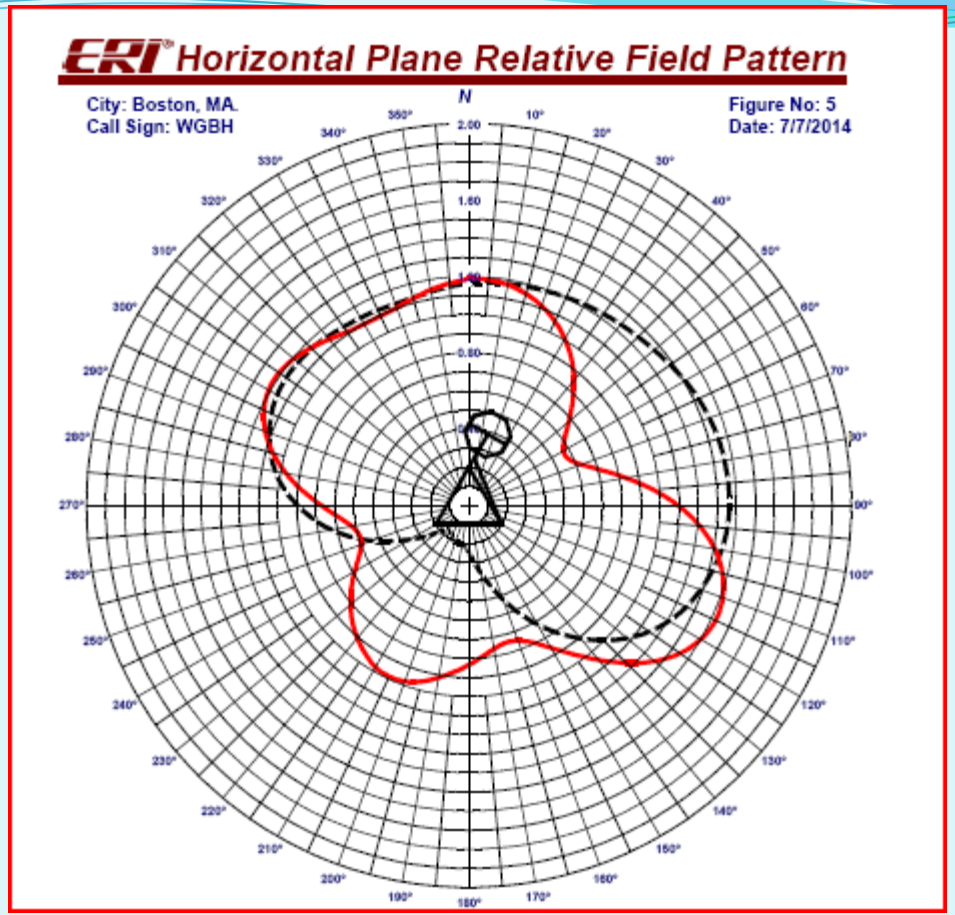
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 4
Date: 7/7/2014
N
2.00
1.50
1.00
0.50
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 5
Date: 7/7/2014
N
2.00
1.50
1.00
0.50
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
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240°
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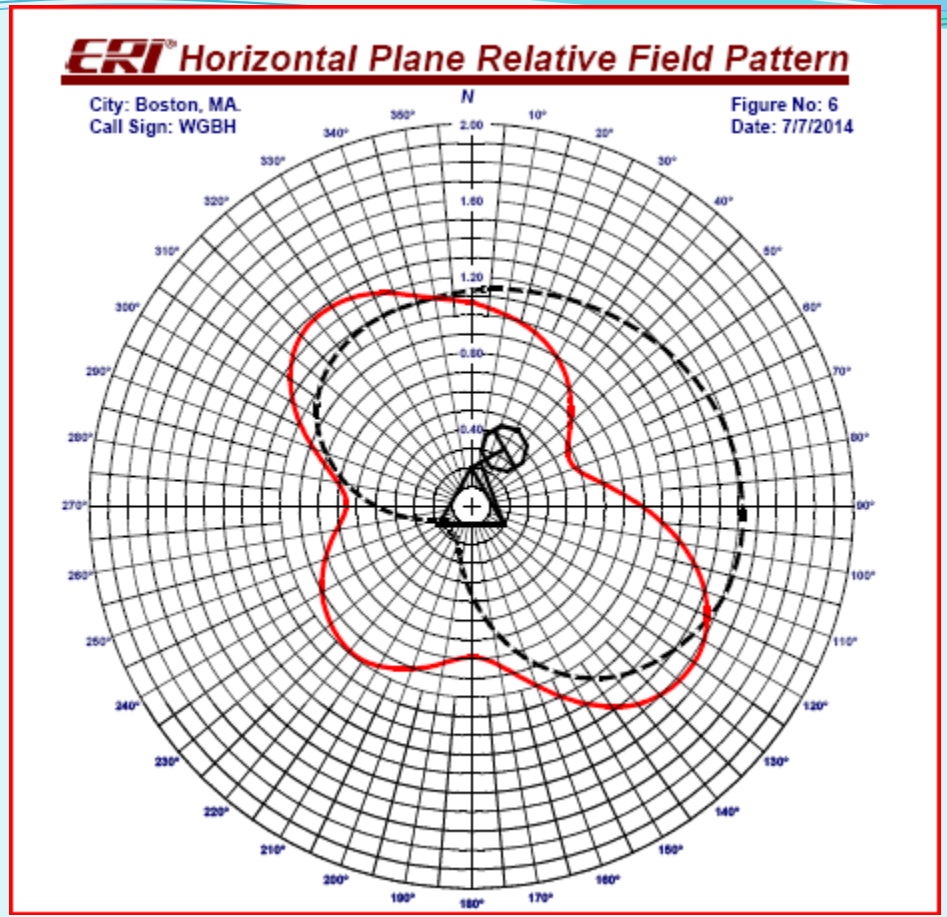
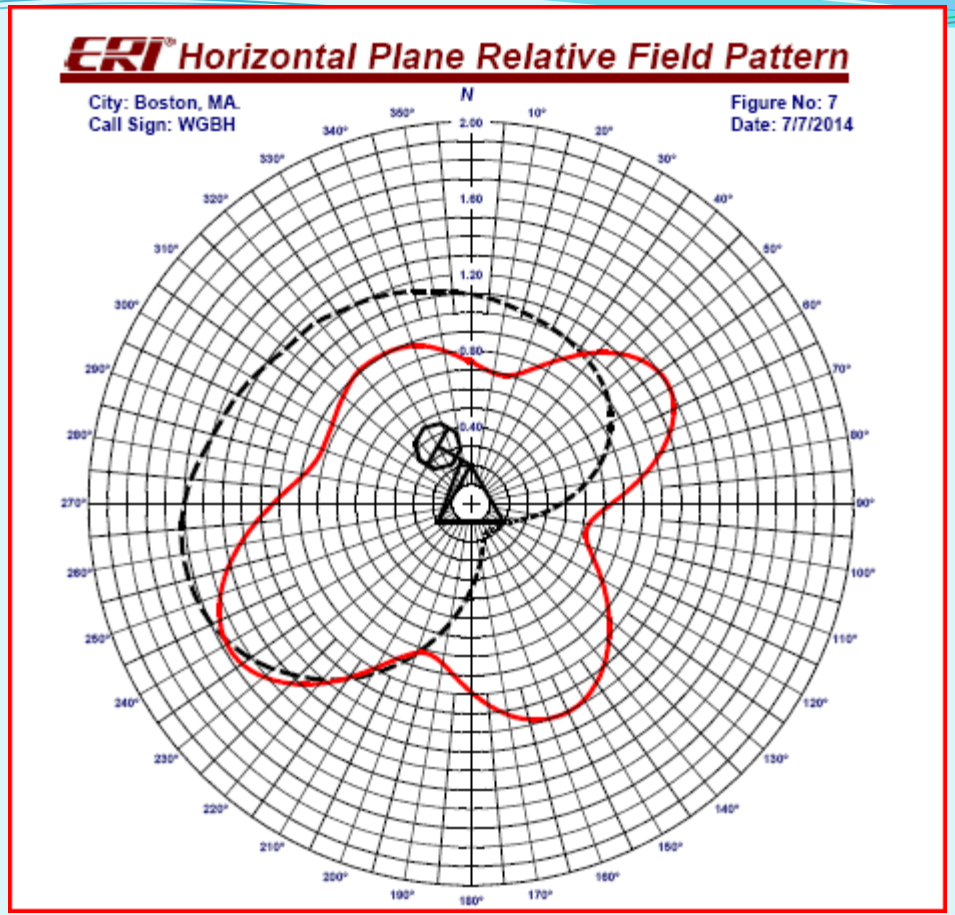
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 6
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 7
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
0.40
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
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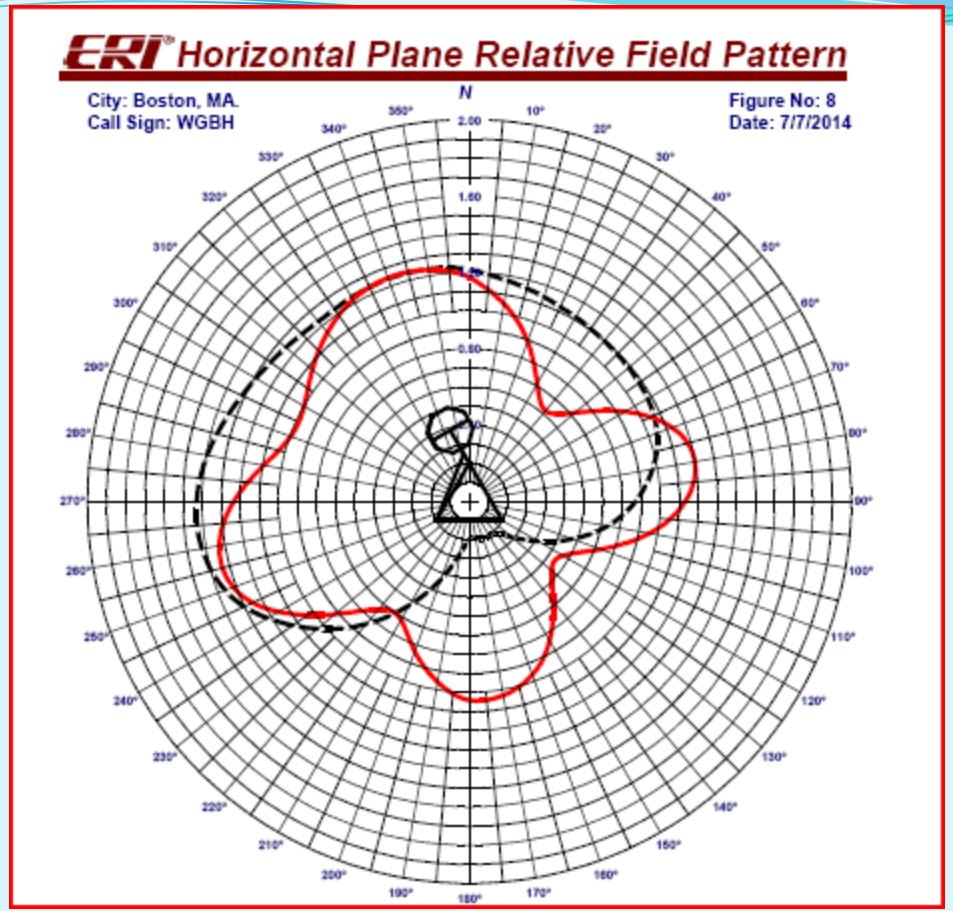
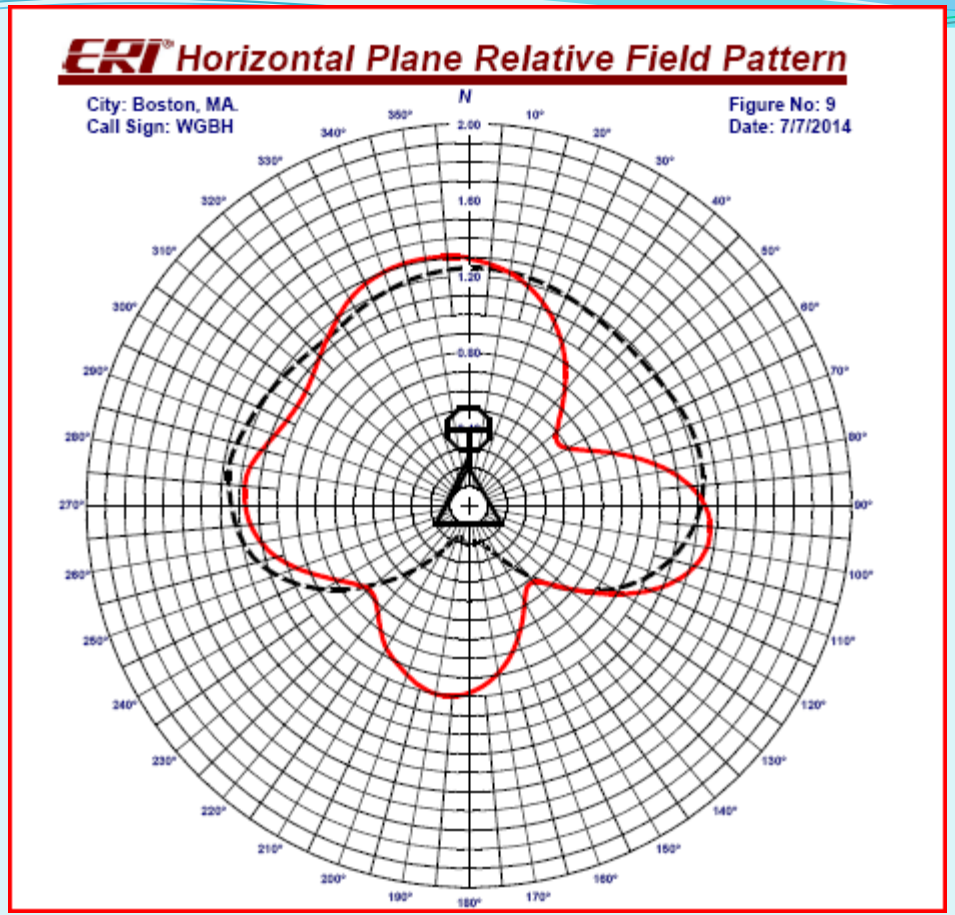
310°
320°
330°
340°
350°


ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 8
Date: 7/7/2014
N
2.00
1.50
1.00
0.50
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°

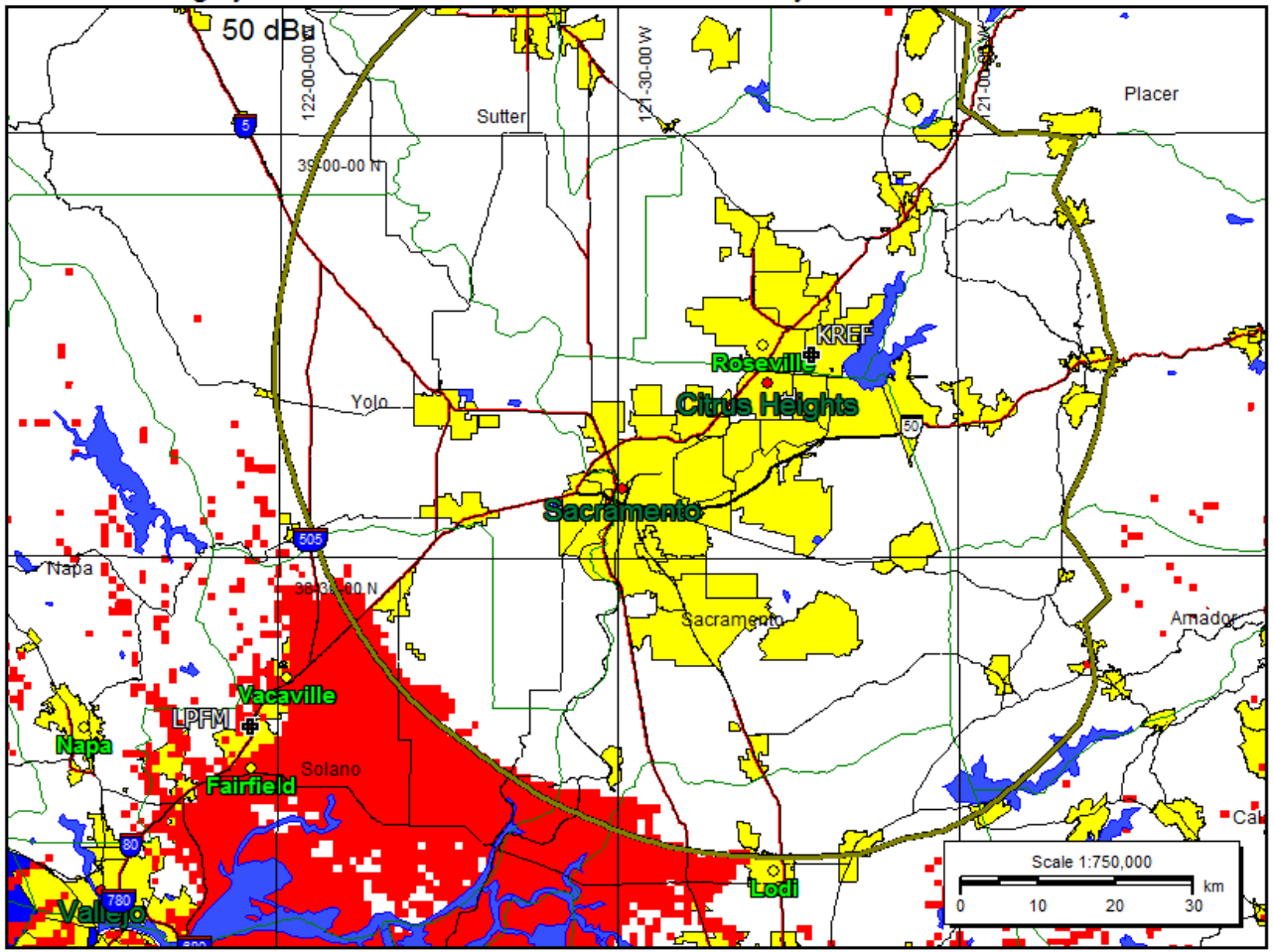

ERI Horizontal Plane Relative Field Pattern
City: Boston, MA.
Call Sign: WGBH
Figure No: 9
Date: 7/7/2014
N
2.00
1.60
1.20
0.80
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°

New Interference caused by translators and LPFM stations

Longley-Rice Co-channel LPFM Interference Study - standard U/D -20 dB

KREF
BLH19940615KA
Latitude: 38-44-22 N
Longitude: 121-12-50 W
ERP: 25.00 kW
Channel: 229
Frequency: 93.7 MHz
AMSL Height: 203.0 m
Elevation: 82.0 m
Horiz. Pattern: Omni

LPFM
Latitude: 38-17-53 N
Longitude: 122-02-19 W
ERP: 0.037 kW
Channel: 229
Frequency: 93.7 MHz
AMSL Height: 140.05 m
Elevation: 63.61 m
Horiz. Pattern: Omni
Vert. Pattern: No



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Cedar Falls, Iowa 50613
Telecommunication Consultants

FCC Contour Prediction Method

- Looks only at terrain from 2-10 miles, 54 points
- Can't see a mountain at 10.1 miles
- Based on simple curves that combine free-space equations and actual measurements
- Inaccuracies are introduced when the terrain varies widely from original measurements, i.e. rugged terrain
- Minimum Class separations lead to anomalies

Longley-Rice Method

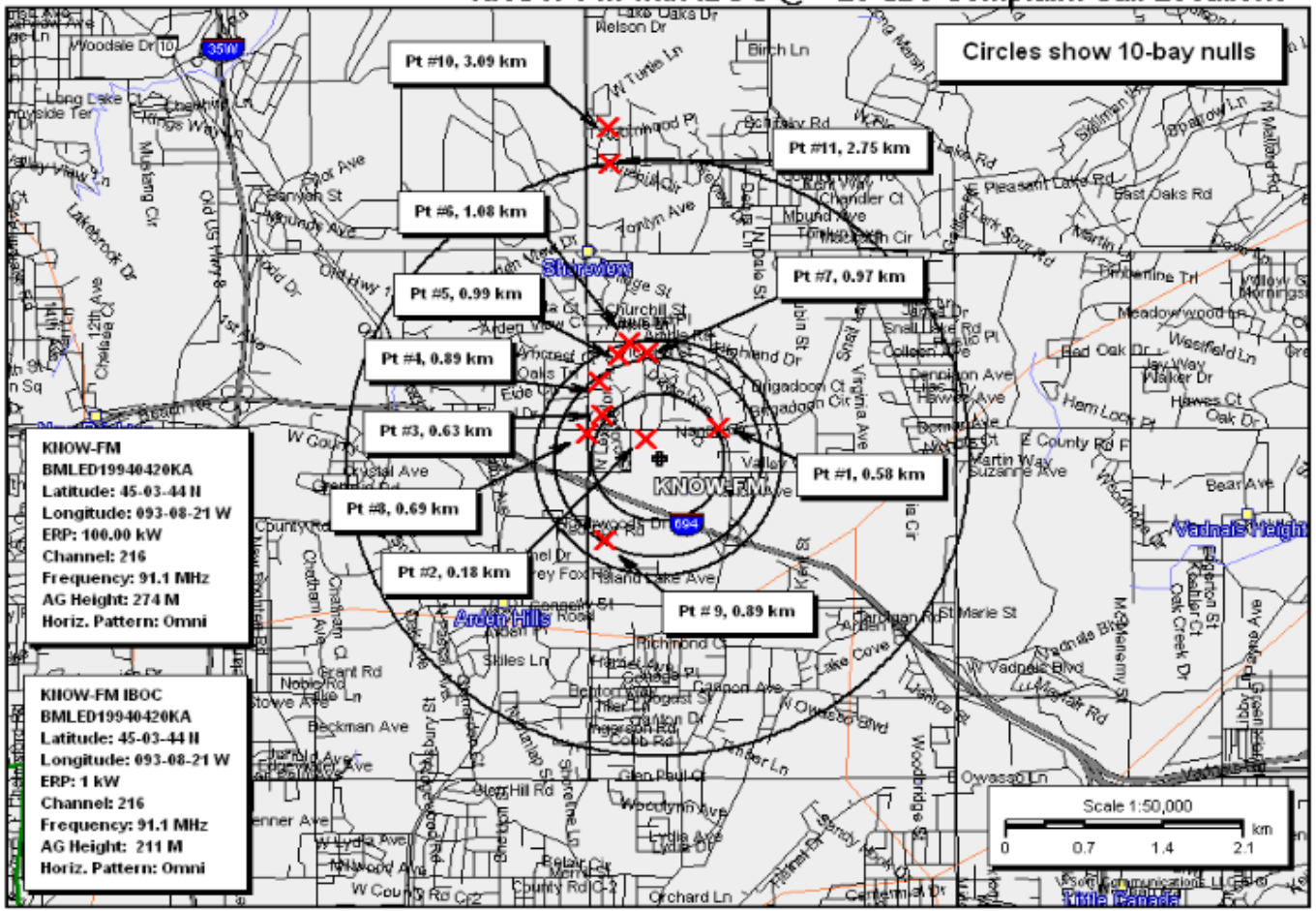
- P.L. Rice & A.G. Longley – National Bureau of Standards
- Considers atmospheric absorption, by water vapor and Oxygen
- Rain attenuation and sky noise temperature
- Terrain roughness
- Knife-edging, diffraction, forward scatter and long term fading
- Used for all DTV assignments

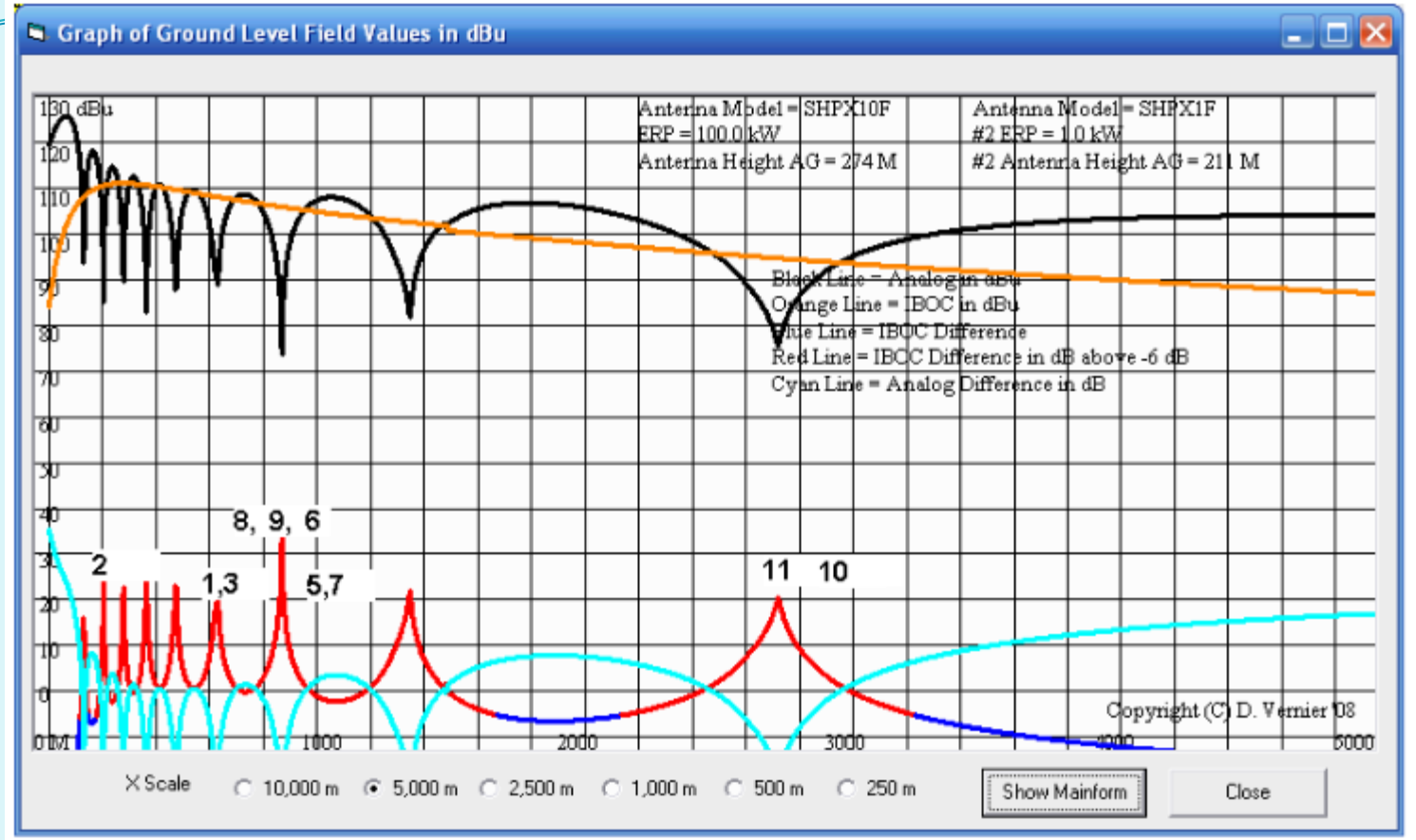
IBOC Host Interference

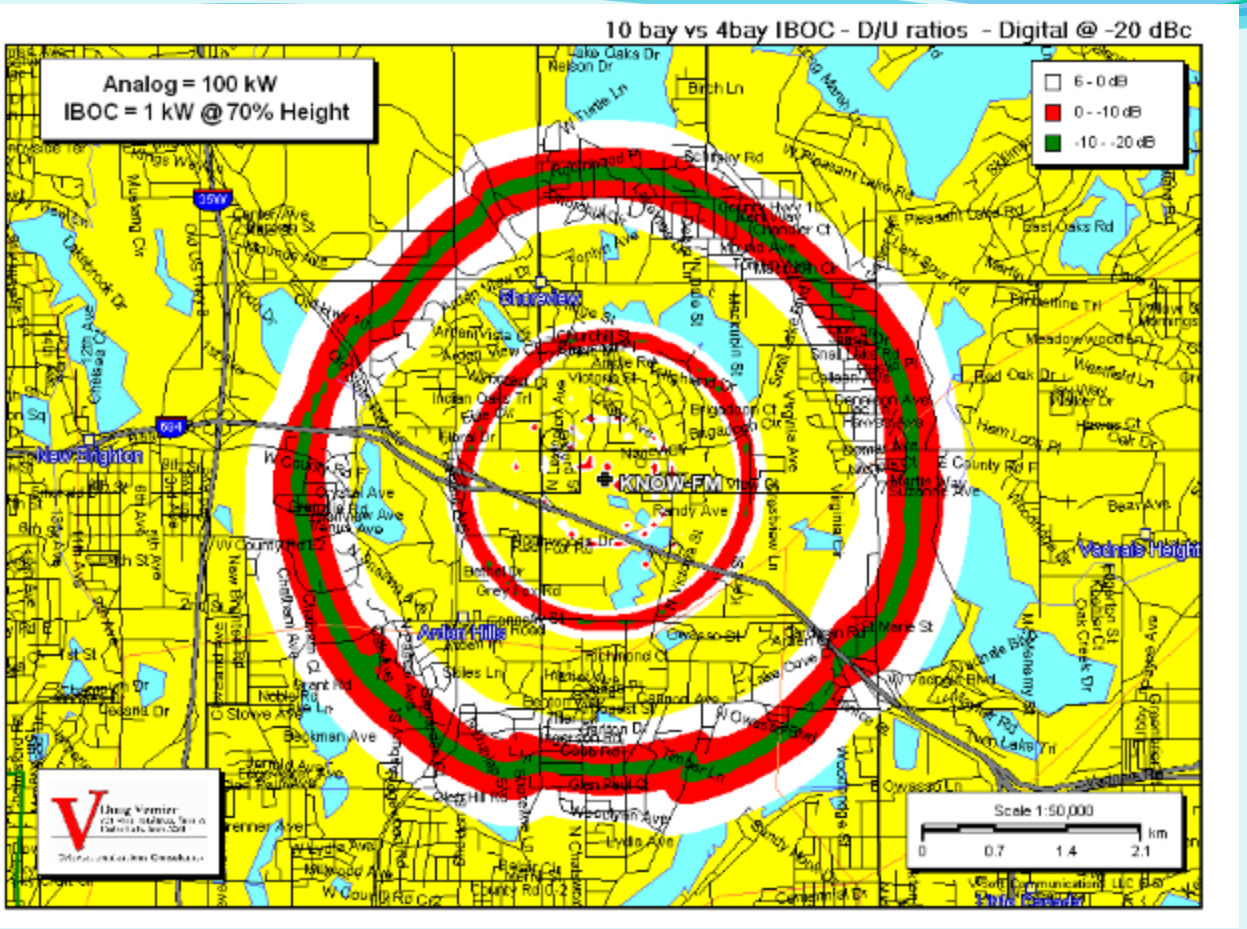
Using a separate co-located antenna for IBOC

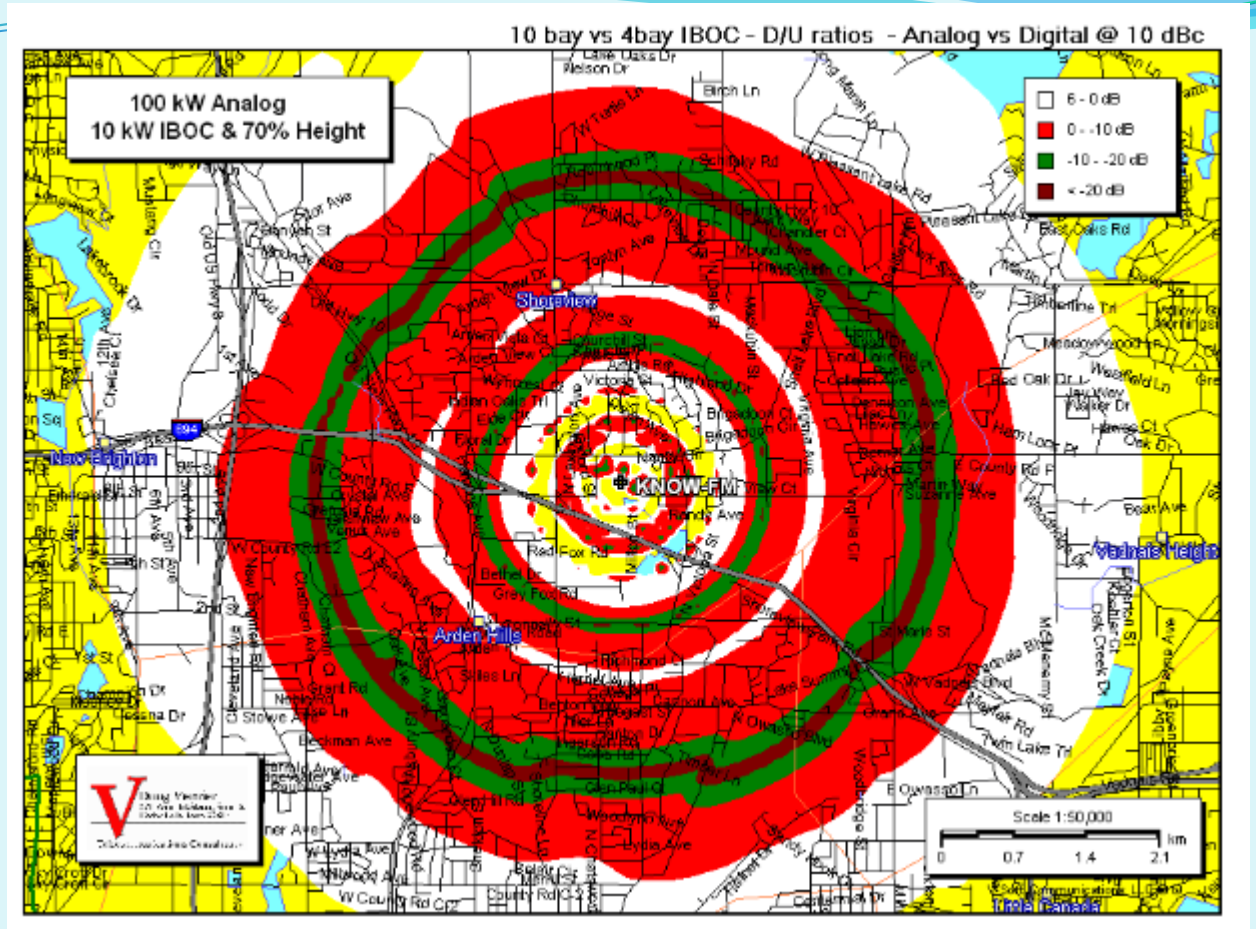
(www.radioworld.com/article/the-looming-danger-of-digital-host-interference/689)

KNOW-FM with IBOC @ - 20 dBc Complaint Call Locations




Graph of Ground Level Field Values in dBu
130 dBu
120
110
100
90
80
70
60
50
40
30
20
10
0
0 M
1000
2000
3000
4000
5000
Antenna Model = SHPX10F
ERP = 100.0 kW
Antenna Height AG = 274 M
Antenna Model = SHPX1F
#2 ERP = 1.0 kW
#2 Antenna Height AG = 211 M
Black Line = Analog in dBu
Orange Line = IBOC in dBu
Blue Line = IBOC Difference
Red Line = IBOC Difference in dB above -6 dB
Cyan Line = Analog Difference in dB
8, 9, 6
2
1,3
5,7
11
10
Copyright (C) D. Vernier '08
X Scale
10,000 m
5,000 m
2,500 m
1,000 m
500 m
250 m
Show Mainform
Close


10 bay vs 4bay IBOC - D/U ratios - Digital @ -20 dBc
Analog = 100 kW
IBOC = 1 kW @ 70% Height
6 - 0 dB
0 - -10 dB
-10 - -20 dB
KNOW-FM
New Brighton
Arden Hills
Shoreview
Vadnais Heights
Scale 1:50,000
0
0.7
1.4
2.1
km


10 bay vs 4bay IBOC - D/U ratios - Analog vs Digital @ 10 dBc
100 kW Analog
10 kW IBOC & 70% Height
6 - 0 dB
0 - -10 dB
-10 - -20 dB
< -20 dB
KNOW-FM
Shoreview
New Brighton
Arden Hills
Mounds View
Scale 1:50,000
0
0.7
1.4
2.1
km

First adjacent Interference Caused by IBOC

Using Longley-Rice methodology and U/D ratios calculated from recent measurements to calculate Analog Interference.

KVMR
BLED20001020AAK
Latitude: 39-14-47 N
Longitude: 120-57-48 W
ERP: 1.75 kW
Channel: 208
Frequency: 89.5 MHz
AMSL Height: 1205.0 m
Elevation: 1173.0 m
Horiz. Pattern: Omni
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

KQEI-FM
BLED20110411AAI
Latitude: 38-42-38 N
Longitude: 121-28-54 W
ERP: 3.30 kW
Channel: 207
Frequency: 89.3 MHz
AMSL Height: 114.9 m
Elevation: 2.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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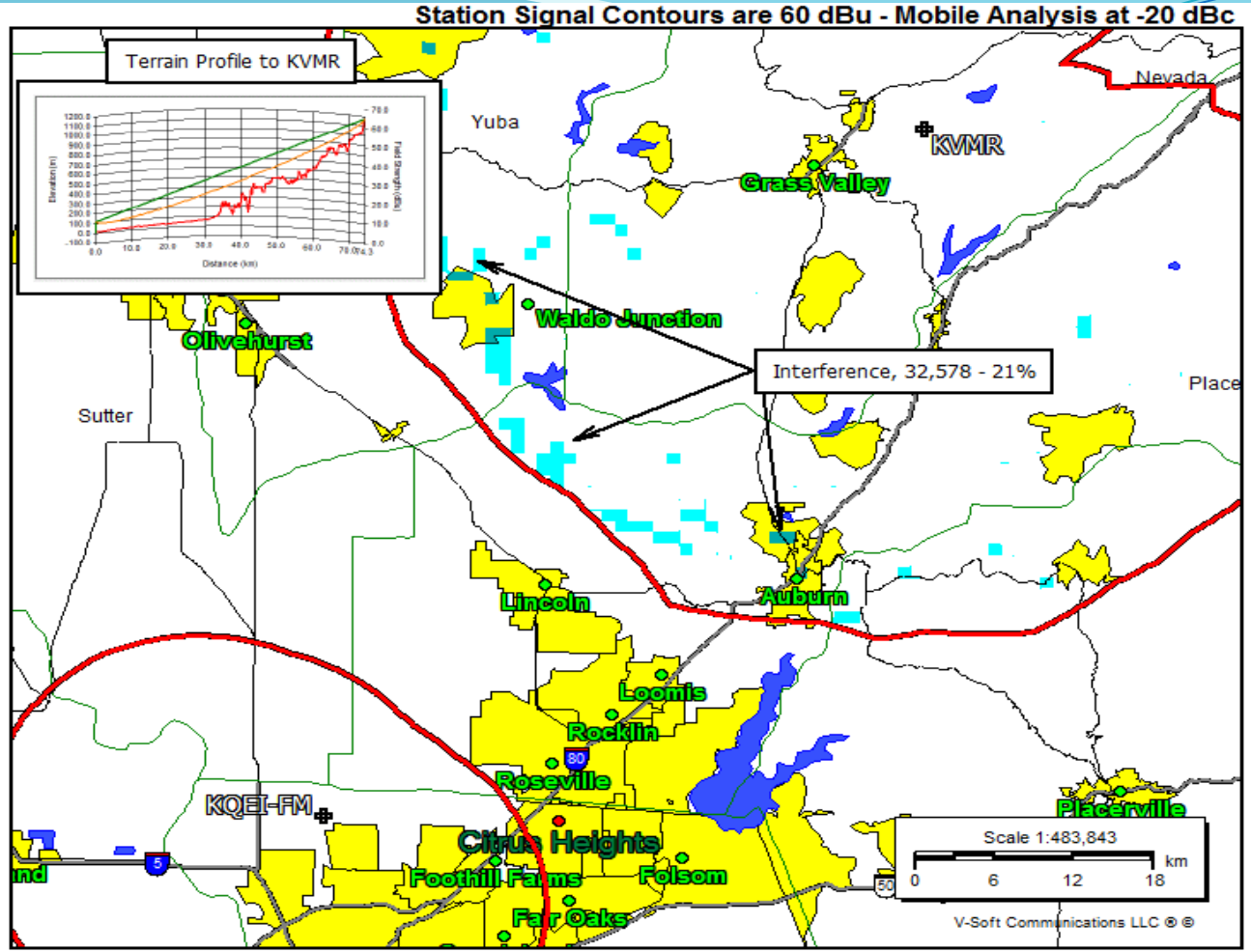

KVMR
BLED20001020AAK
Latitude: 39-14-47 N
Longitude: 120-57-48 W
ERP: 1.75 kW
Channel: 208
Frequency: 89.5 MHz
AMSL Height: 1205.0 m
Elevation: 1173.0 m
Horiz. Pattern: Omni
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

KQEI-FM
BLED20110411AAI
Latitude: 38-42-38 N
Longitude: 121-28-54 W
ERP: 3.30 kW
Channel: 207
Frequency: 89.3 MHz
AMSL Height: 114.9 m
Elevation: 2.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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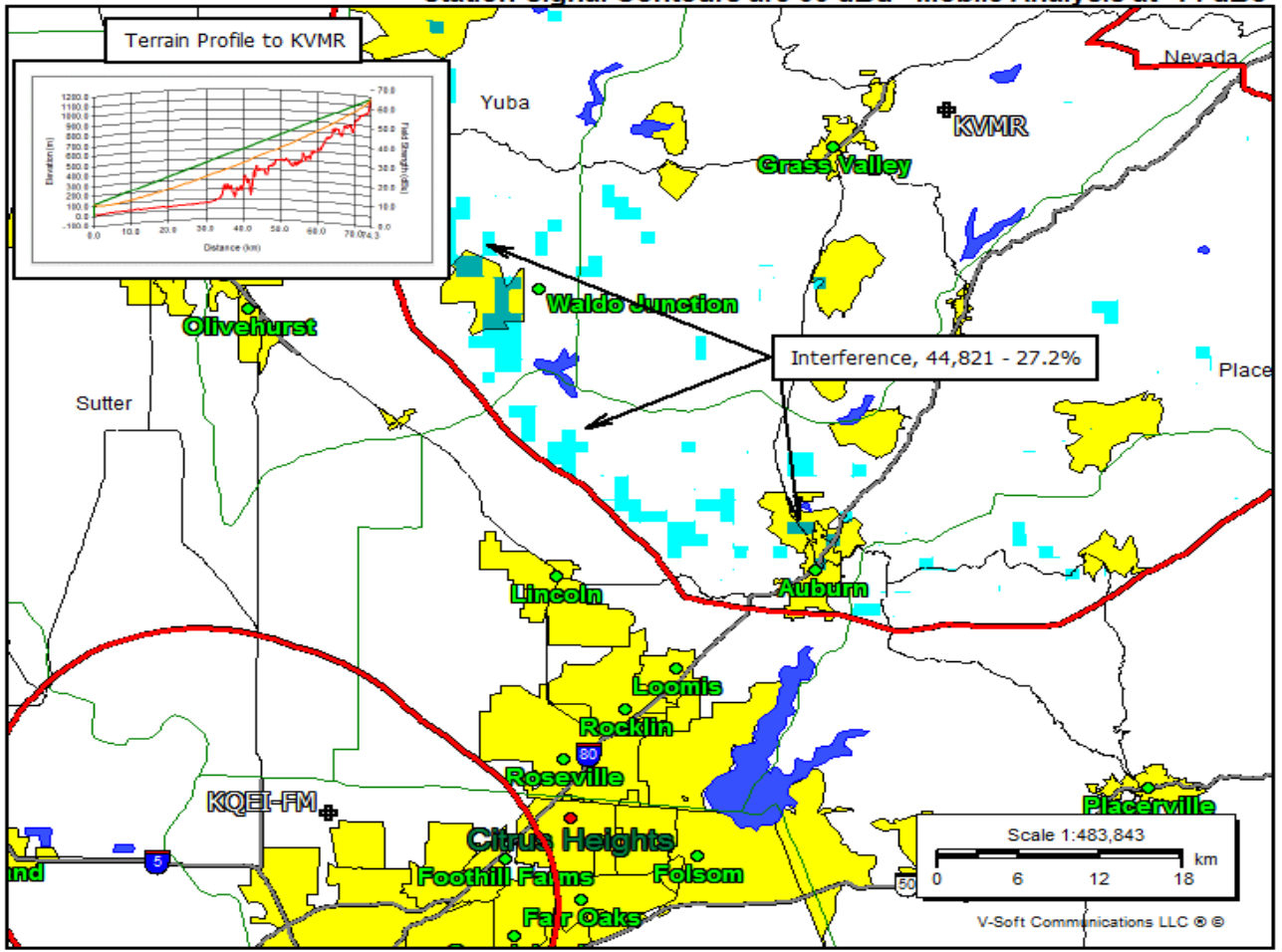
Telecommunication Consultants



KVMR
BLED20001020AAK
Latitude: 39-14-47 N
Longitude: 120-57-48 W
ERP: 1.75 kW
Channel: 208
Frequency: 89.5 MHz
AMSL Height: 1205.0 m
Elevation: 1173.0 m
Horiz. Pattern: Omni
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

KQEI-FM
BLED20110411AAI
Latitude: 38-42-38 N
Longitude: 121-28-54 W
ERP: 3.30 kW
Channel: 207
Frequency: 89.3 MHz
AMSL Height: 114.9 m
Elevation: 2.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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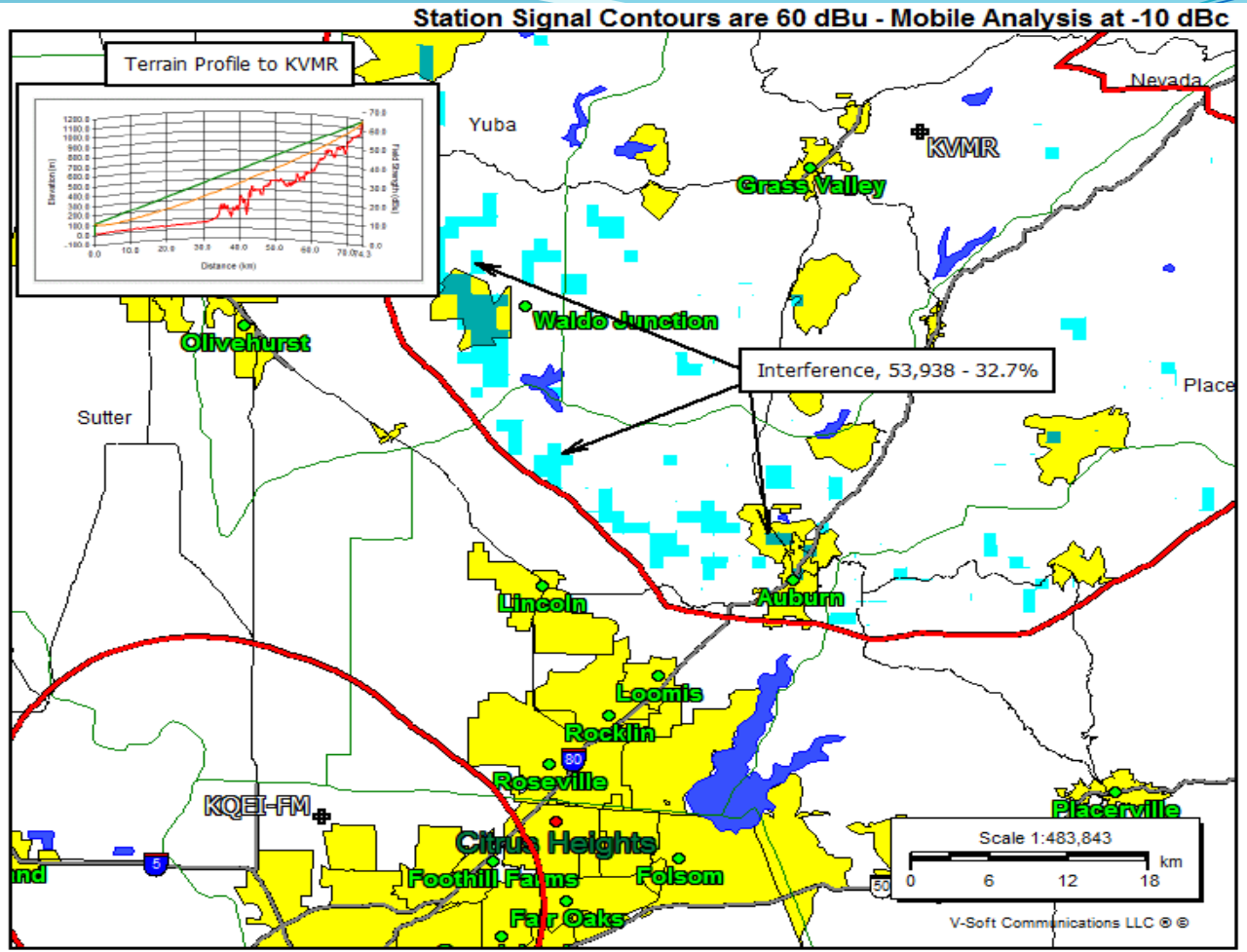
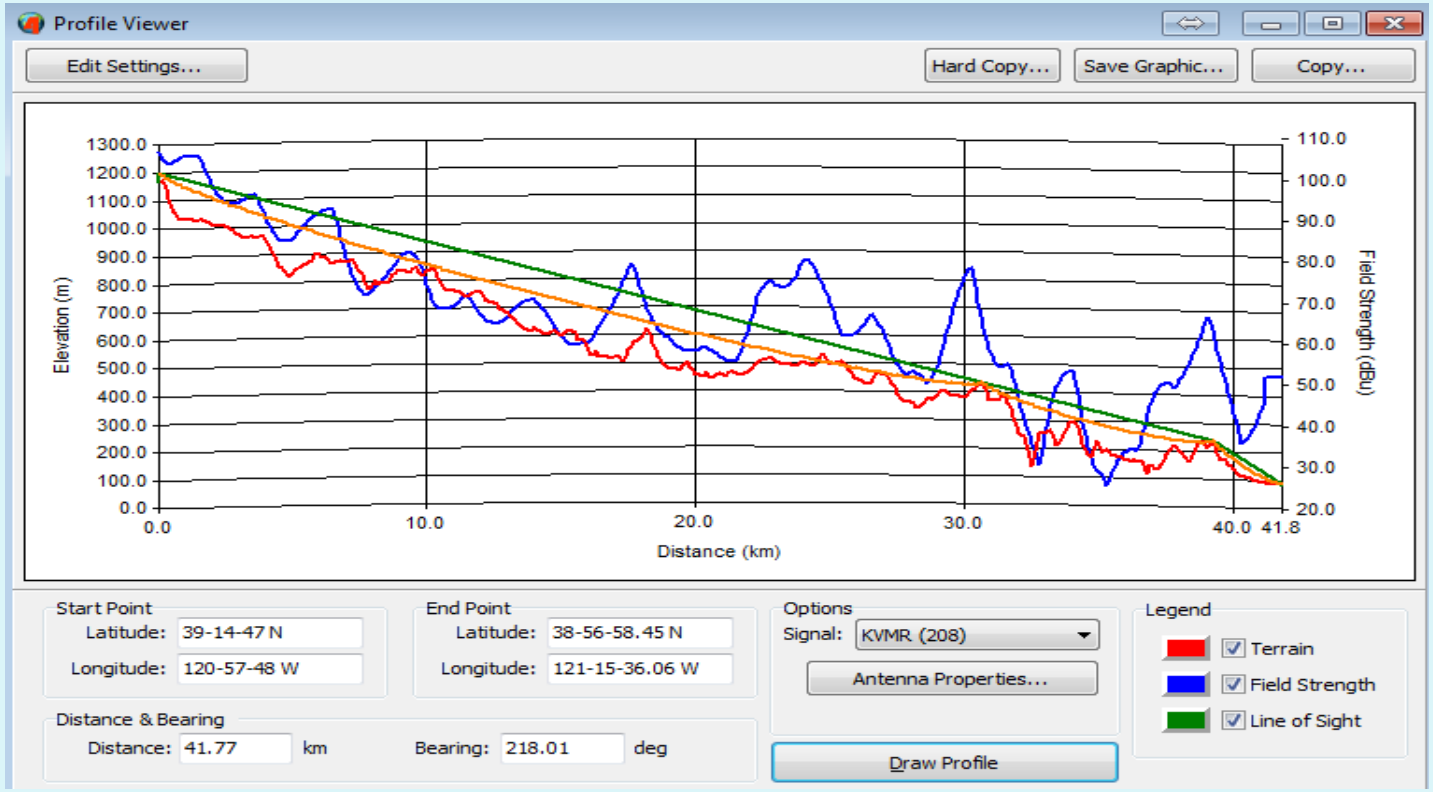


Path from KVMR toward KQEI-FM - to its 60 dBu Contour



WRNI-FM
BLED20120403AAJ
Latitude: 41-25-27 N
Longitude: 071-28-38 W
ERP: 1.95 kW
Channel: 274
Frequency: 102.7 MHz
AMSL Height: 84.0 m
Elevation: 26.0 m
Horiz. Pattern: Omni
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

WKLB-FM
BLH20090515ABT
Latitude: 42-18-37 N
Longitude: 071-14-14 W
ERP: 14.00 kW
Channel: 273
Frequency: 102.5 MHz
AMSL Height: 320.0 m
Elevation: 47.0 m
Horiz. Pattern: Omni
Vert. Pattern: No

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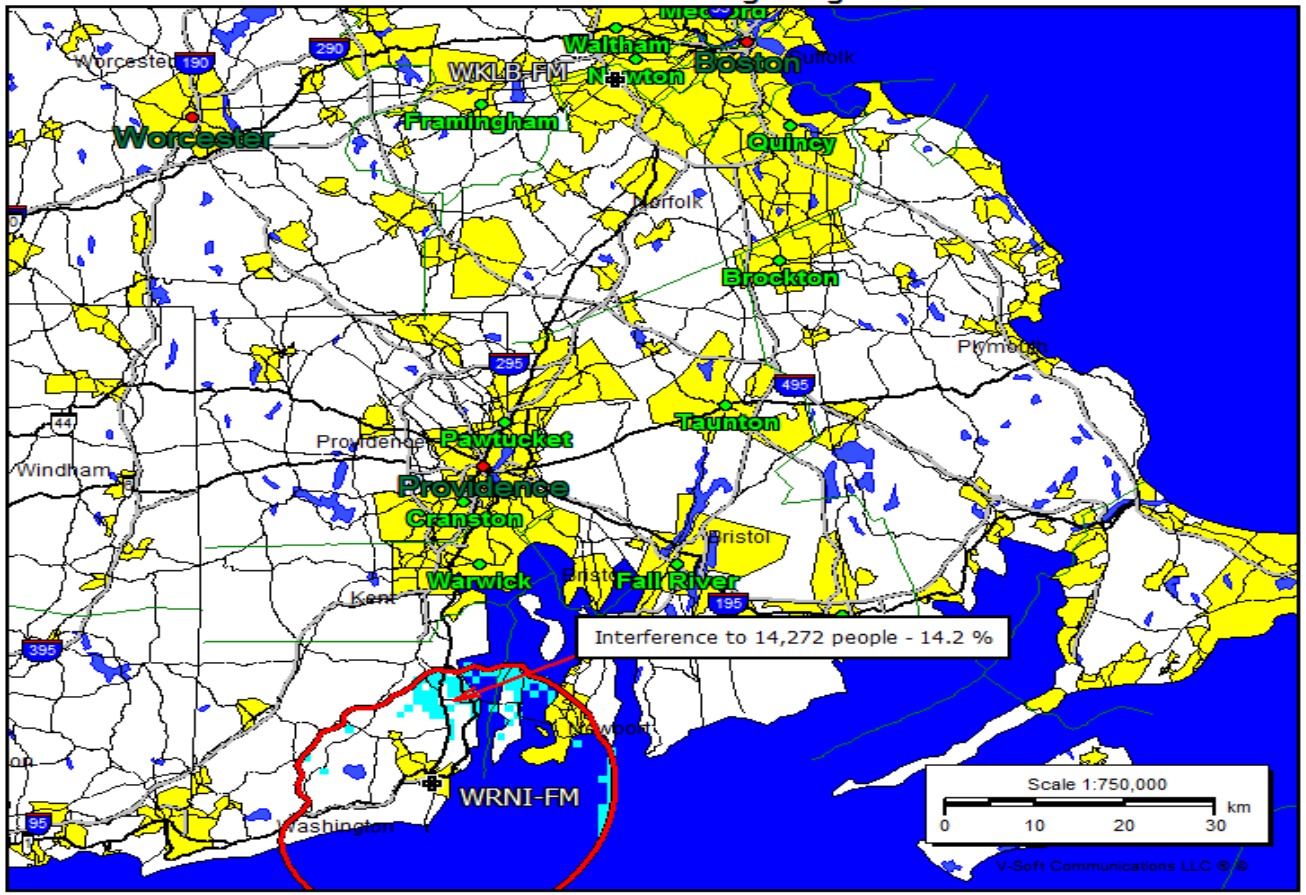
Interference caused to WRNI-FM analog using U/D for -20 dBc -Indoor 2 M Rcrv



Interference caused to WRNI-FM analog using U/D for -14 dBc -Indoor 2 M Rcrv

WRNI-FM
BLED20120403AAJ
Latitude: 41-25-27 N
Longitude: 071-28-38 W
ERP: 1.95 kW
Channel: 274
Frequency: 102.7 MHz
AMSL Height: 84.0 m
Elevation: 26.0 m
Horiz. Pattern: Omni
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

WKLB-FM
BLH20090515ABT
Latitude: 42-18-37 N
Longitude: 071-14-14 W
ERP: 14.00 kW
Channel: 273
Frequency: 102.5 MHz
AMSL Height: 320.0 m
Elevation: 47.0 m
Horiz. Pattern: Omni
Vert. Pattern: No

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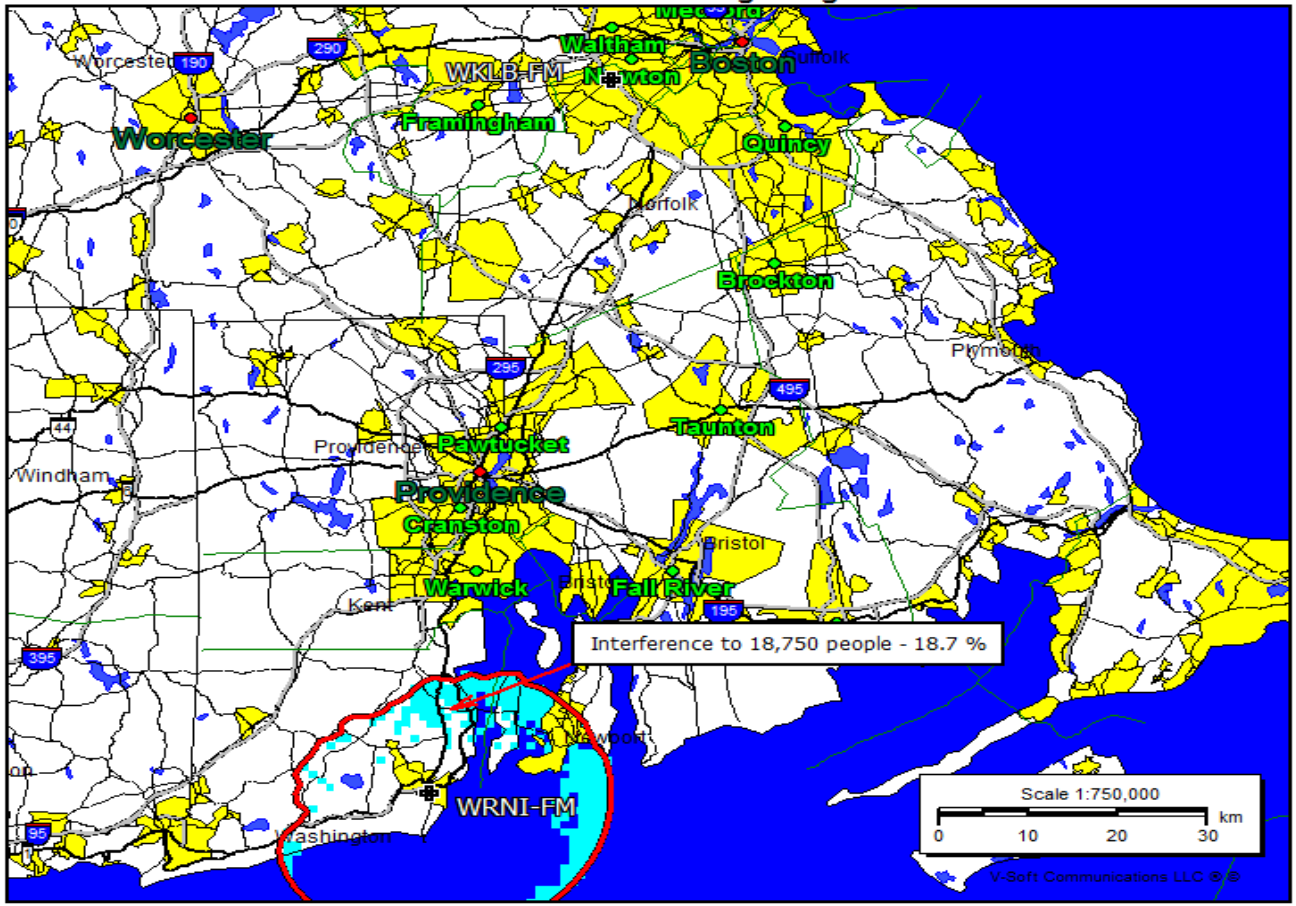
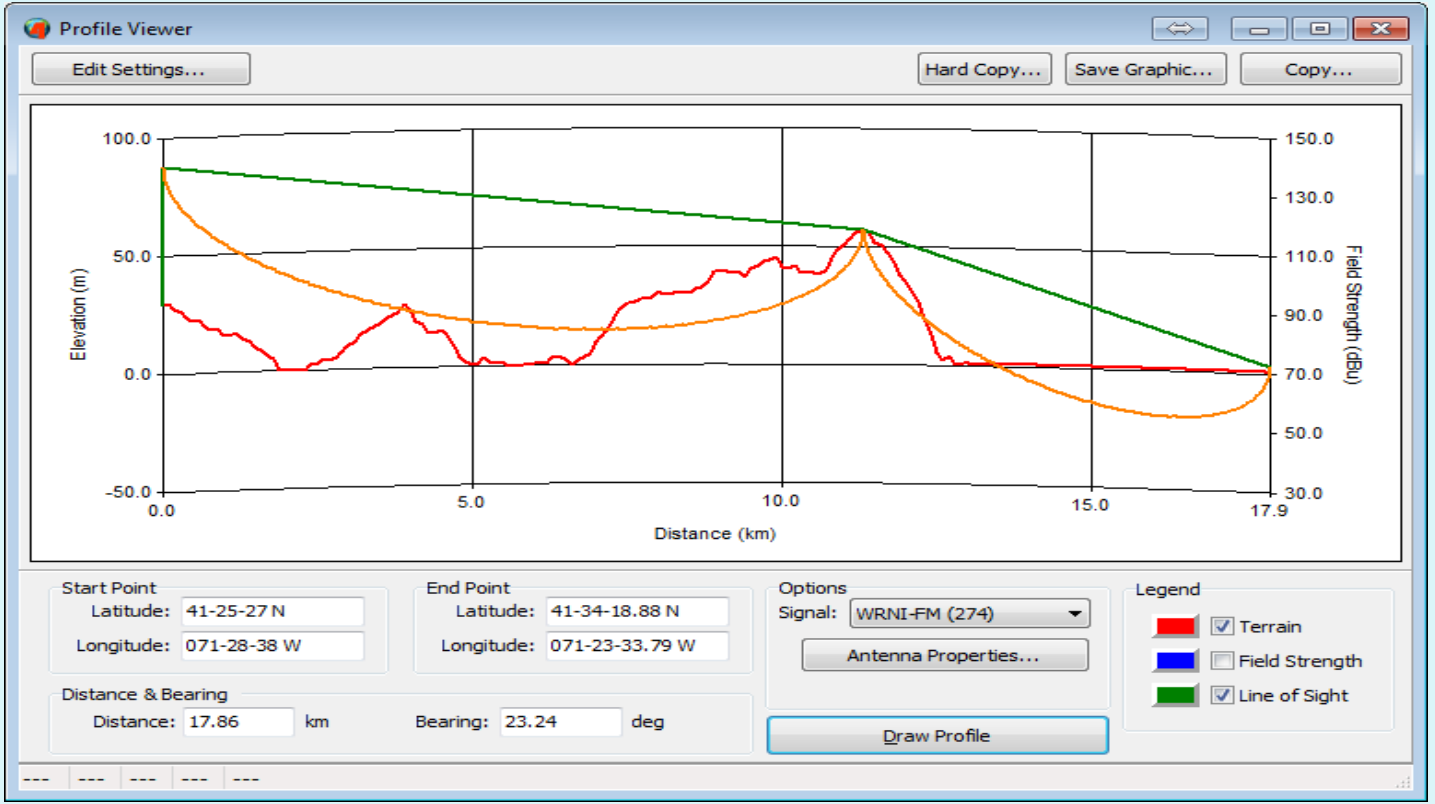


Path from WRNI-FM to the 60 dBu Contour on Azimuth to WKLB-FM



WRUR-FM
BLED20110810ABU
Latitude: 43-08-07 N
Longitude: 077-35-03 W
ERP: 15.10 kW
Channel: 203
Frequency: 88.5 MHz
AMSL Height: 262.9 m
Elevation: 205.0 m
Horiz. Pattern: Directional
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

WBFO
BLED20080424ACE
Latitude: 43-00-12 N
Longitude: 078-45-56 W
ERP: 50.00 kW
Channel: 204
Frequency: 88.7 MHz
AMSL Height: 305.0 m
Elevation: 178.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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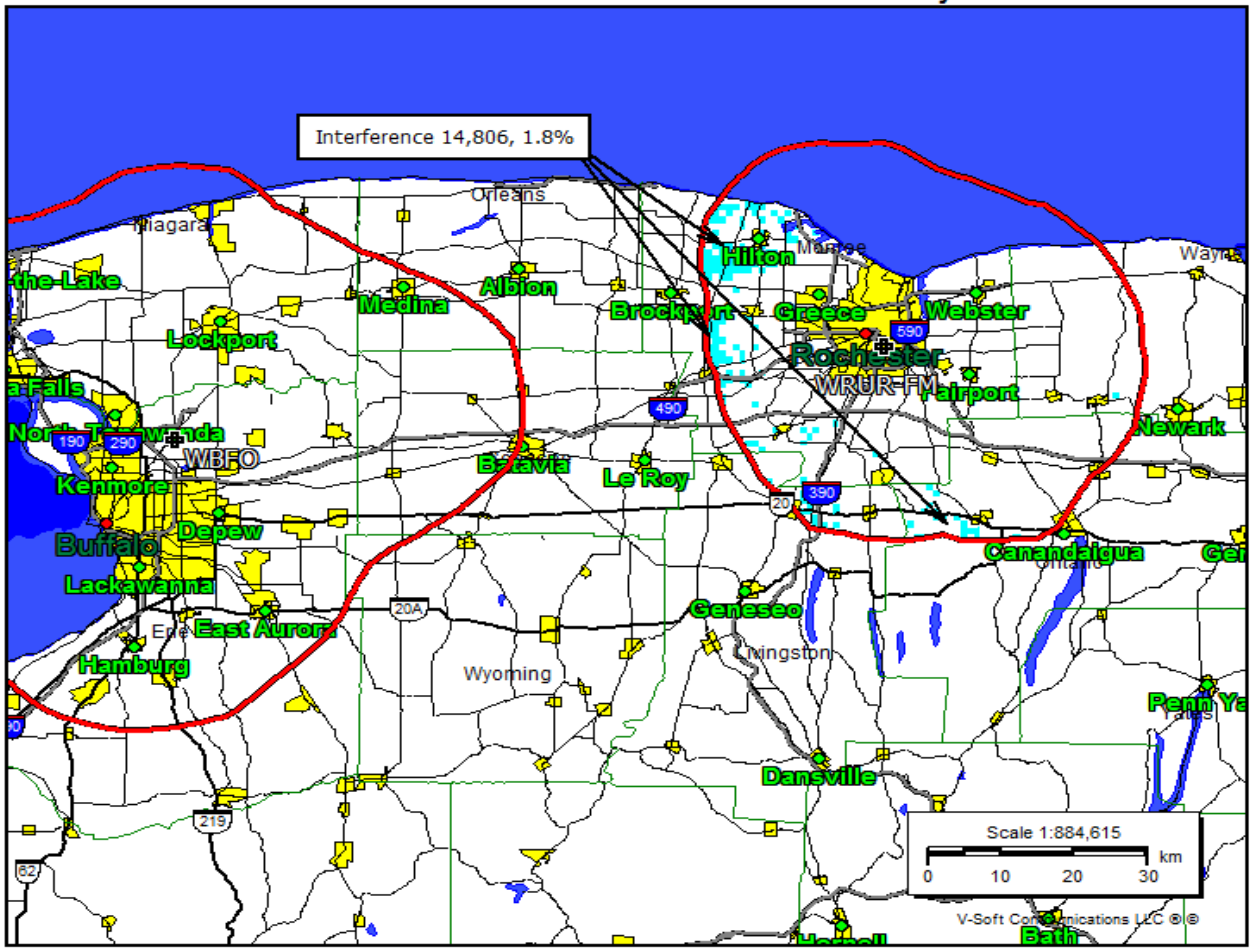
60 dBu Contours are Shown - Mobile Analysis -20 dBc 2 m Rcrv



WRUR-FM
BLED20110810ABU
Latitude: 43-08-07 N
Longitude: 077-35-03 W
ERP: 15.10 kW
Channel: 203
Frequency: 88.5 MHz
AMSL Height: 262.9 m
Elevation: 205.0 m
Horiz. Pattern: Directional
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

WBFO
BLED20080424ACE
Latitude: 43-00-12 N
Longitude: 078-45-56 W
ERP: 50.00 kW
Channel: 204
Frequency: 88.7 MHz
AMSL Height: 305.0 m
Elevation: 178.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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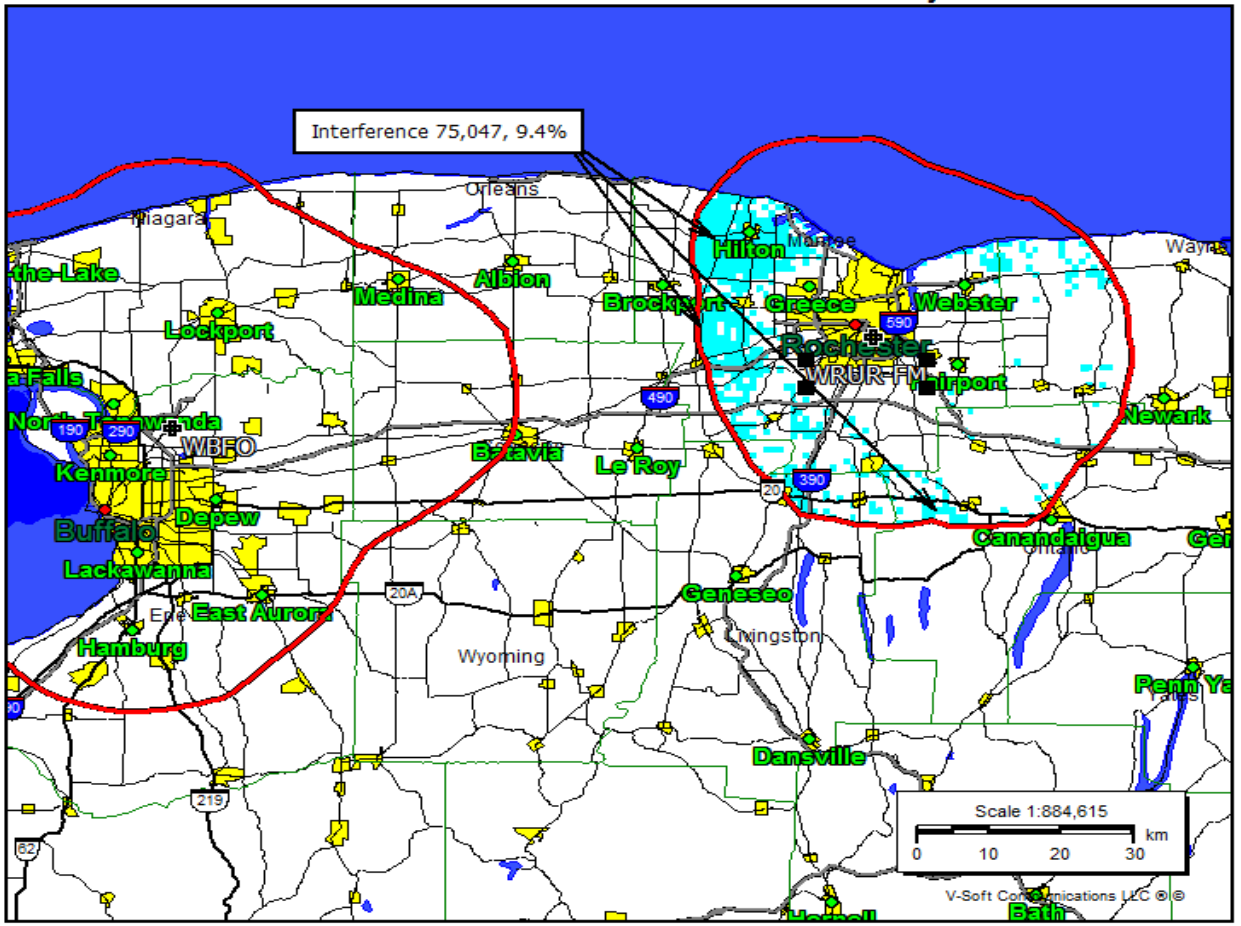
60 dBu Contours are Shown - Mobile Analysis -10 dBc 2 m Rcrv



WBFO
BLED20080424ACE
Latitude: 43-00-12 N
Longitude: 078-45-56 W
ERP: 50.00 kW
Channel: 204
Frequency: 88.7 MHz
AMSL Height: 305.0 m
Elevation: 178.0 m
Horiz. Pattern: Directional
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

WRUR-FM
BLED20110810ABU
Latitude: 43-08-07 N
Longitude: 077-35-03 W
ERP: 15.10 kW
Channel: 203
Frequency: 88.5 MHz
AMSL Height: 262.9 m
Elevation: 205.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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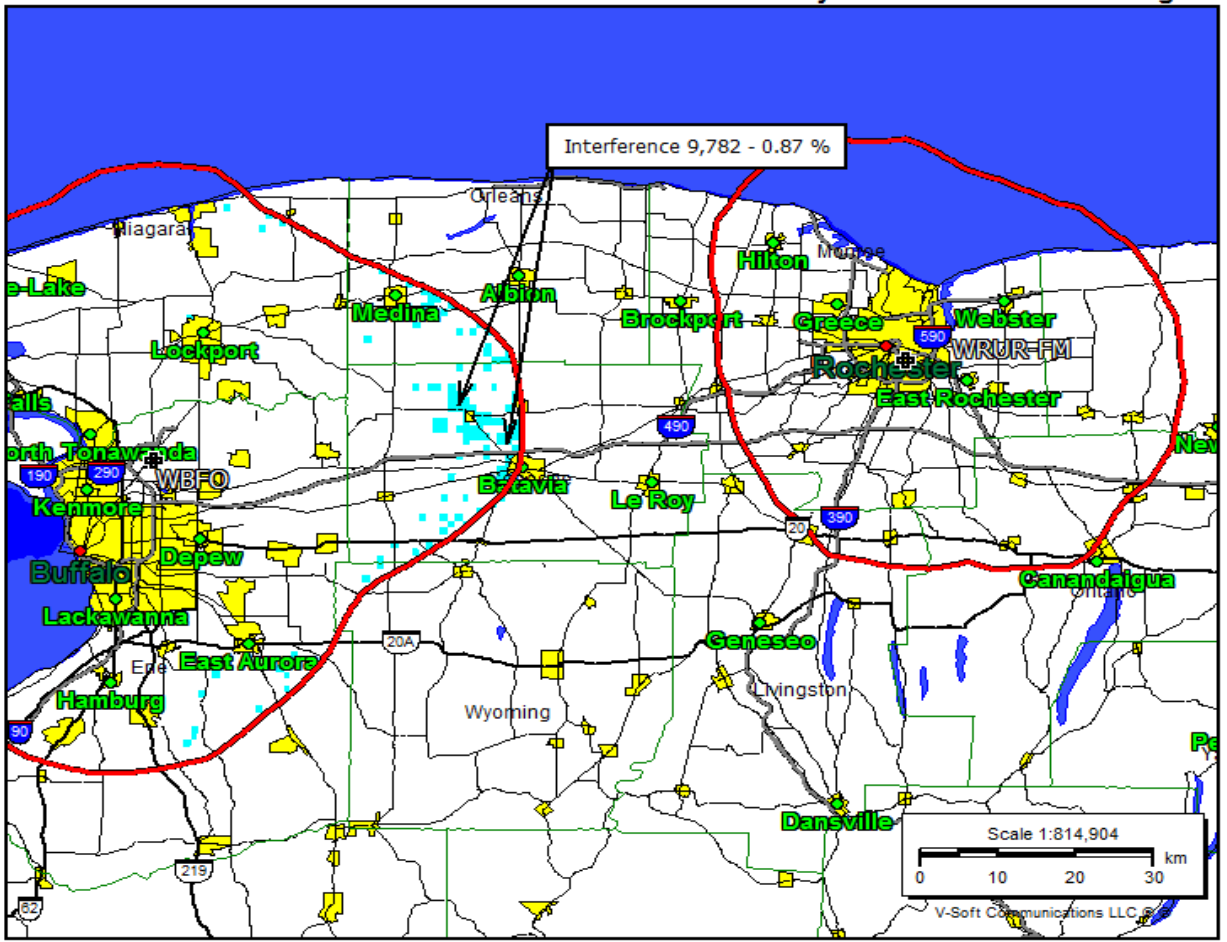
Mobile Analysis -20 dBc - 2 m Rcrv Height



WBFO
BLED20080424ACE
Latitude: 43-00-12 N
Longitude: 078-45-56 W
ERP: 50.00 kW
Channel: 204
Frequency: 88.7 MHz
AMSL Height: 305.0 m
Elevation: 178.0 m
Horiz. Pattern: Directional
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 2.0 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

WRUR-FM
BLED20110810ABU
Latitude: 43-08-07 N
Longitude: 077-35-03 W
ERP: 15.10 kW
Channel: 203
Frequency: 88.5 MHz
AMSL Height: 262.9 m
Elevation: 205.0 m
Horiz. Pattern: Directional
Vert. Pattern: No

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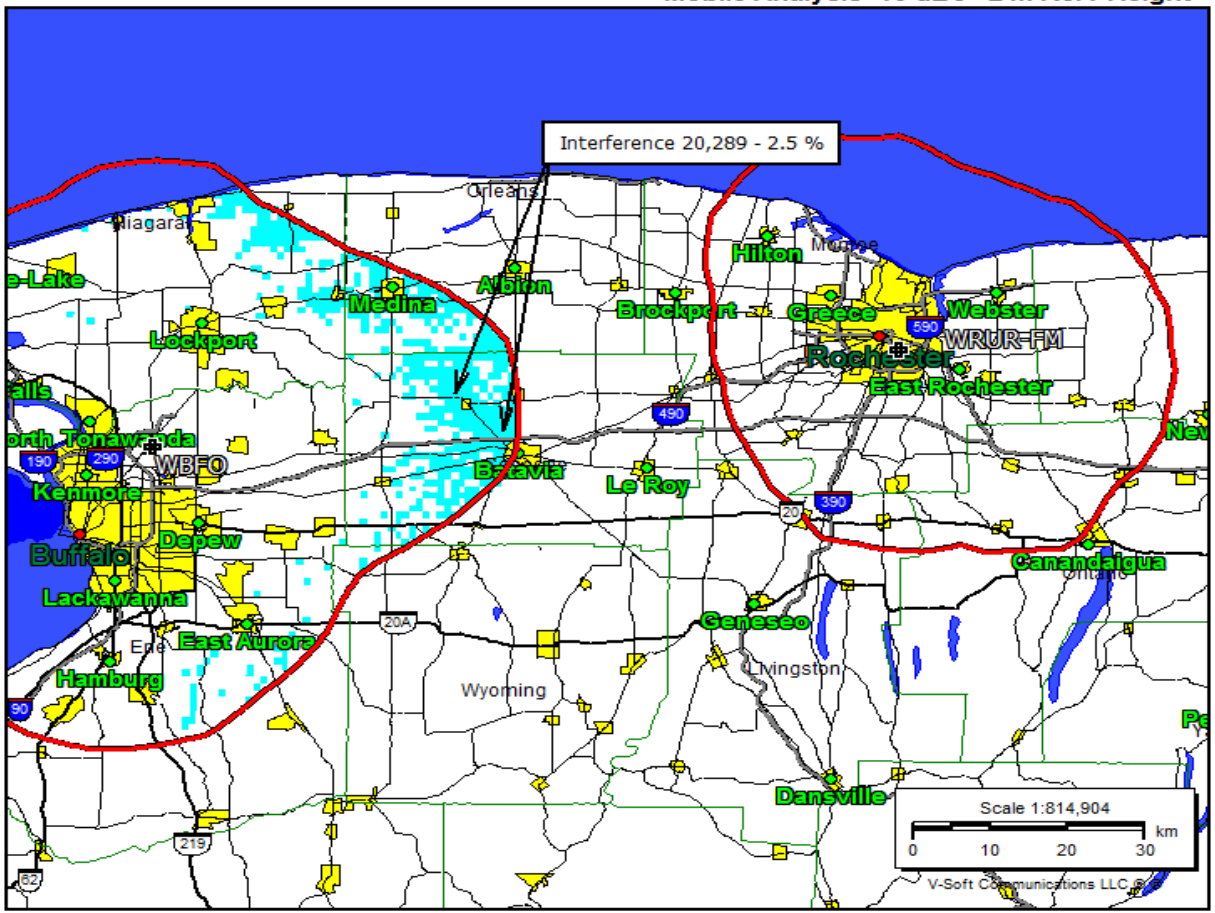
Mobile Analysis -10 dBc - 2 m Rcrv Height



KUNI
BMLED19841106LW
Latitude: 42-18-59 N
Longitude: 091-51-31 W
ERP: 100.00 kW
Channel: 215
Frequency: 90.9 MHz
AMSL Height: 799.0 m
Elevation: 310.0 m
Horiz. Pattern: Omni
Vert. Pattern: No
Prop Model: Longley-Rice
Climate: Cont temperate
Conductivity: 0.0200
Dielec Const: 15.0
Refractivity: 315.0
Receiver Ht AG: 9.1 m
Receiver Gain: 0 dB
Time Variability: 50.0%
Sit. Variability: 50.0%
ITM Mode: Broadcast

KNSB
BLED20100616ADO
Latitude: 41-32-43.80 N
Longitude: 90-22-23.6 W
ERP: 0.74 kW
Channel: 216
Frequency: 91.1 MHz
AMSL Height: 311.4 m
Elevation: 203.9 m
Horiz. Pattern: Omni
Vert. Pattern: No

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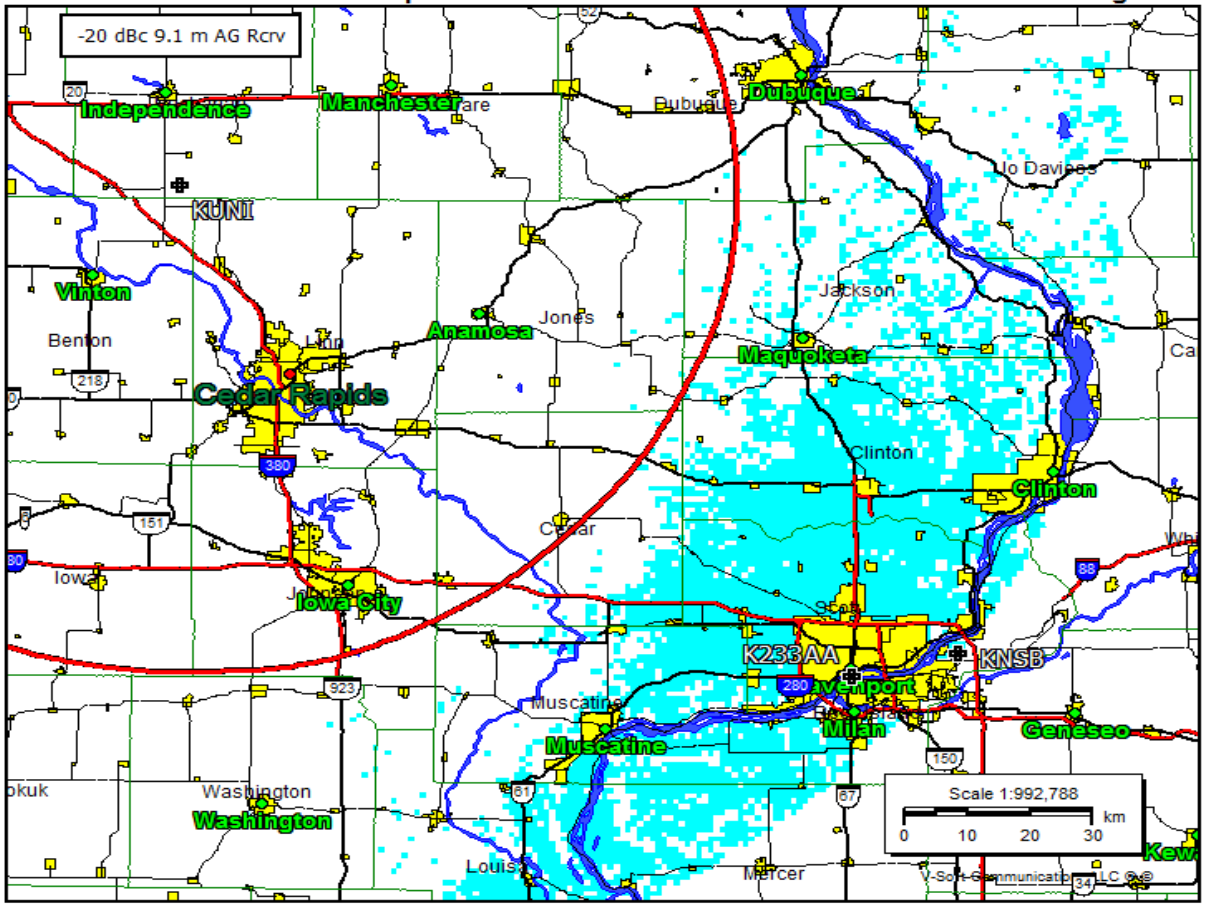
Map shows IBOC Interference to Translator Re-broadcasting KUNI



The TV Band

Repacking

- FCC: "Our central goals are to repurpose the maximum amount of UHF spectrum for flexible licensed and unlicensed use, while at the same time preserving a healthy, diverse broadcasting service."
- Goal is to recover 120 MHz of continuous spectrum, ~ 20 TV channels
- TV - 2-13, 14-51, 52 -69 – Now 2-50, after repacking 2-30???
- Currently TV and LPTV Minor changes are allowed
- No protection proposed for LPTV or TV translators under re-packing

TV Interference

- Environmental noise – DTV pixilation – black screen
- DTV signal weakness - Low Band channels (2-13)
- Longley-Rice – OET-69 - KWX points are thrown out
- Repacking, Cellular/Telco Interference –LTE into DTV
- Co-channel – unusual propagation

TV Station Choices in Incentive Auction

- Relinquish their license and discontinue broadcasting
- Relinquish their 6 MHz of spectrum to share a single 6 MHz allotment with another television station (“channel share”)
- Accept reassignment from a UHF to a VHF channel
- Accept reassignment from a high VHF channel to a low VHF channel.

What can we do?

- Support AM revitalization to the extent that no new interference is caused
- Petition the FCC to do a better job of regulating environmental interference
- Adding DSP noise filtering receiver mandates
- Isn't the FM band crowed enough, do we need a new C4 class? (Be vigilant.)
- Do we really need -10 dBc IBOC?
- Keep DTV in the UHF spectrum
- Does Telcom really need that 120 MHz of spectrum?

Your Answers, Questions?

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