Report for

WAVY Broadcasting, LLC
Television Station WNLO-CD, Channel 14
Norfolk, VA

Concerning Lower Adjacent Channel Out-of-Band-Emissions from WNLO-CD into Land Mobile Operations below TV Channel 14

January 30, 2020

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INTRODUCTION and BACKGROUND

This report has been prepared for WAVY Broadcasting, LLC, licensee of Class A television station WNLO-CD ("WNLO"), licensed to serve Norfolk, VA. WNLO was assigned channel 14 in the outcome of the FCC's Broadcast Spectrum Incentive Auction. WNLO holds a construction permit, FCC File Number 0000072851, to construct its post-auction facility on channel 14. Pertinent authorized technical parameters can be found in Table 1 of this report.

In the construction permit authorization that was granted the following condition must be met: "*During equipment tests, authorized by Section 73.1610 of the Commissions Rules, the permittee shall take adequate measures to identify and substantially eliminate objectionable interference which may be caused to existing land mobile radio facilities in the 460 to 470 MHz band. Documentation that objectionable interference will not be caused to existing land mobile radio facilities shall be submitted along with the request for Program Test Authority. Program tests shall not be commenced under Section 73.1620(a) of the Commissions Rules and may only be started after specific authority is granted by the Commission. An application for a license must be filed within 10 days after the start of program tests.*"

WNLO has now completed its construction of the authorized facility and is ready to file for Program Test Authority. In preparation of that filing, MSW was retained to study the potential impact that WNLO operations may have on active and authorized Land Mobile facilities below channel 14.

MSW performed its study based on the as-built technical data to determine if the combined filter and transmitter response would protect LM facilities from Out-of-Band Emissions ("OOBE") and receiver desensitization/overload ("overload") from WNLO operations on TV channel 14. The study focused on a circular area with a radius of 130 km and a center point being the transmitter site coordinates as stated in the WNLO construction permit and shown in Appendix 1 of this report.

The study radius of 130 km was chosen since this is the typical LM protected contour distance that an LPTV station (typically UHF stations with an ERP of 15 kW or less) must maintain to a defined LM area center point per 74.709(b) of the Rules.

This distance also ensures any potentially affected LM stations, both near and far, would be included in the study. The study focused on the impact that WNLO would potentially have on into LM operations in the frequency range of 460 to 470 MHz.

SCOPE OF STUDY AND METHODOLOGY

The MSW study analyzed interference and receiver overload into currently authorized LM facilities using the as-built transmitter and filter OOBE response data. A list of potentially impacted LM facilities was created from the ULS database by searching for all active and licensed LM facilities within a culling distance of 130 km from the television station. A visual representation of all LM facilities found operating in the frequency range of 460 to 470 MHz and within 130 km of the WNLO transmitter site are shown in Appendix 1.

Interference and overload calculations were performed using the authorized parameters for the LM facility (e.g. frequency, antenna height, etc.). Other study parameters utilized in the study, including Irregular Terrain Model (ITM) parameters, are shown in Table 3.

The loss from the OOBE post-transmitter filter plus that of the transmitter pre-filter response, at the LM station frequency, was added to the calculated field strength along with the coupling factor which was calculated from the bandwidth of the LM station and the 500 kHz measurement bandwidth used for digital television stations. LM antenna gain and line loss was then added to obtain the effective field strength at the LM receiver input.

Overload calculations were performed by using the free space loss from the television transmitter to each LM facility studied. The received power level in the direction of the LM facility included any losses due to terrain, calculated antenna azimuth and elevation discrimination and coupling losses based on the bandwidth of the LM station and the 3dB half-power bandwidth of the television station. LM antenna gain and assumed transmission line loss for fixed base stations was also considered.

Tables 4 and 5 are example calculations for both the interference and overload LM studies, respectively. These examples are based on the results of one of the fixed base LM stations studied.

For authorized mobile LM operations the study focused on a circular area defined by the radius of operation for the mobile LM facility as authorized. If no radius was defined a default radius of 48 km was used. The center point used was the coordinates of the LM operation as authorized. The circular area was divided into 1 km/side cells and calculations were made at the geographic center of each cell. A pass/fail determination was made for each cell for both interference and overload as calculated from the television station. After analyzing all cells within the circular area the number of failures was compared to the total number of cells analyzed. If the total number of failures was at or under 2% of the total area the amount of interference or overload was considered de minimis and the facility was considered to have passed.

Most all LM operations use vertical antenna polarization. With WNLO proposing the use of horizontal only polarization, LM stations would typically experience further reduction of interference and/or overload by 15 to 20 dB. A conservative value of 8 dB of antenna cross polarization discrimination was utilized in this study for LM operations not indicating the use of horizontal, circular or elliptical polarization.

STUDY PARAMETERS

The parameters used for WNLO and LM operations are shown in Tables 1 and 2, respectively. For the individual studies to each LM facility the authorized parameters were used as stated in the station's authorization. If actual parameters were not shown on the authorization then default parameters were used.

Table 1 - Parameters for television station WNLO

Parameter	Value
Analyzed Station	WNLO-CD (Authorized CP)
Channel	14 (470-476 MHz)
Latitude (NAD83)	36-49-15.0
Longitude (NAD83)	76-30-40.0
Height of Antenna Center of radiation (AMSL)	227.4.0 m
ERP	7.72 kW
Antenna Type	Non-Directional
Antenna Pattern Relative Field per Azimuth Bearing	Calculated
Polarization	H
Elevation Pattern	Real
Electrical Tilt	0.50 degree
Antenna Pattern Relative Field per Depression Angle	Calculated
Post-transmitter Filter Type	12-Section

Table 2 - Parameters for Land Mobile Stations

Parameter	Value
Antenna Type	Omni-directional
Frequency (MHz)	As Authorized
Bandwidth	As Authorized
Height of Antenna Center of radiation (AMSL)*	FB=10.0 m, MO=2.5 m
Polarization*	V
Receive Antenna Gain*	FB=11.0 dBd, MO=0.0 dBd
Antenna Pattern Relative Field per Azimuth Bearing	1.0
Antenna Pattern Relative Field per Depression Angle	1.0
Receive Line Loss	FB=2.0 dB, MO=0.0 dB
Receiver Noise Floor	Calculated
Receiver Out of Band Rejection	80.0

* FB=Fixed Base, MO=Mobile. If parameter is not shown in authorization then the default value is used.

Table 3 shows the parameters used for the Irregular Terrain Model in calculating the WNLO OOBE signal strength into each LM facility found within the 130 km radius.

This study analyzed the impact into all LM operations authorized in the 460 to 470 MHz band.

Table 3 – Parameter settings utilized in Land Mobile Study

Parameter	Value
Study Radius	130.00 km
Study Centerpoint Latitude (NAD 83)	36-49-15.0 N
Study Centerpoint Longitude (NAD 83)	76-30-40.0 W
Cross Polarization Discrimination Factor	8.0 dB
Study cell size	1.0 km/side
Study Path Distance Increment	0.1 km
Terrain Database	1 arc second
Location Variability	50 %
Time Variability	10 %
Confidence	50 %
Ground Permittivity	15.0
Ground Conductivity	0.005 S/m
Surface Refractivity	301.0 N-units PPM
Longley-Rice Mode ‡	1
Climate Code	5 Continental Temperate
Utilize Land Use/Land Clutter in analysis	False
FCC interference criteria per Section 73.687(e)(4)(ii)	17.0 dBuV/m

‡ 1 - Individual mode used for authorized LM facility studies

STUDY METHODOLOGY AND EXAMPLE

Tables 4 and 5 show the methodology that was used for calculating interference and signal overload, respectively, into the LM Base Station shown below.

Freq	Call	Svc	Svc	DTV->LM		Ant	HAAT	HAGL	Gain	BW
Mhz	Sign	Code	Cls	Dist km	Az deg	Pol	M	M	dB	khz
463.5000	WNLB875	IG	FB4	4.4	102.7	V	13.4	15.2	3.0	11.2

Table 4 - Methodology for Predicting Interference into a Land Mobile receiver from a DTV Station

Parameter	Value
Land Mobile Station Frequency	463.5000 MHz
Longley-Rice Calculated Received Field Strength [F50,10] of WNLO	103.1 dBuV/m
Total of transmitter plus filter OOBE loss at frequency	151.0 dB
Transmitting and receiving antenna discrimination, combined†	5.0dB
DTV coupling into LM (Bandwidth: DTV=500 kHz, LM=11.2 kHz)	16.5 dB
Effective cross-polarization discrimination	8.0 dB
LM antenna gain	3.0 dB
LM line loss	2.0 dB
Calculated equivalent field strength per Section 73.687(e)(4)(ii)	-76.4 dBuV/m
FCC interference criteria per Section 73.687(e)(4)(ii)	17.0 dBuV/m
Margin to interference per Section 73.687(e)(4)(ii)	93.4 dB
Analysis result**	Pass

Table 5 - Methodology for Predicting Overload into a Land Mobile receiver from a DTV Station

Parameter	Value
Lower Band Edge Frequency of TV Station (Ch. 14) WSKC	470.0 MHz
Transmit ERP (7.72 kW)	68.9 dbm
Free Space Path Loss for dipole antenna at frequency and distance	94.4 dB
Terrain Loss	0.0 dB
Transmitting and receiving antenna discrimination†	5.0 dB
DTV coupling into LM (Bandwidth: DTV=5.38 MHz, LM=11.2 kHz)	26.8 dB
Effective Cross-polarization discrimination	8.0 dB
LM antenna gain	3.0 dB
LM line loss	2.0 dB
LM receiver out-of-band rejection	80.0 dB
Effective received DTV station interference power	-144.4 dBm
Calculated LM receiver noise floor	-124.5 dBm
Margin to overload interference	19.9 dB
Analysis result***	Pass

† Only transmit antenna azimuth and elevation discrimination factors are considered

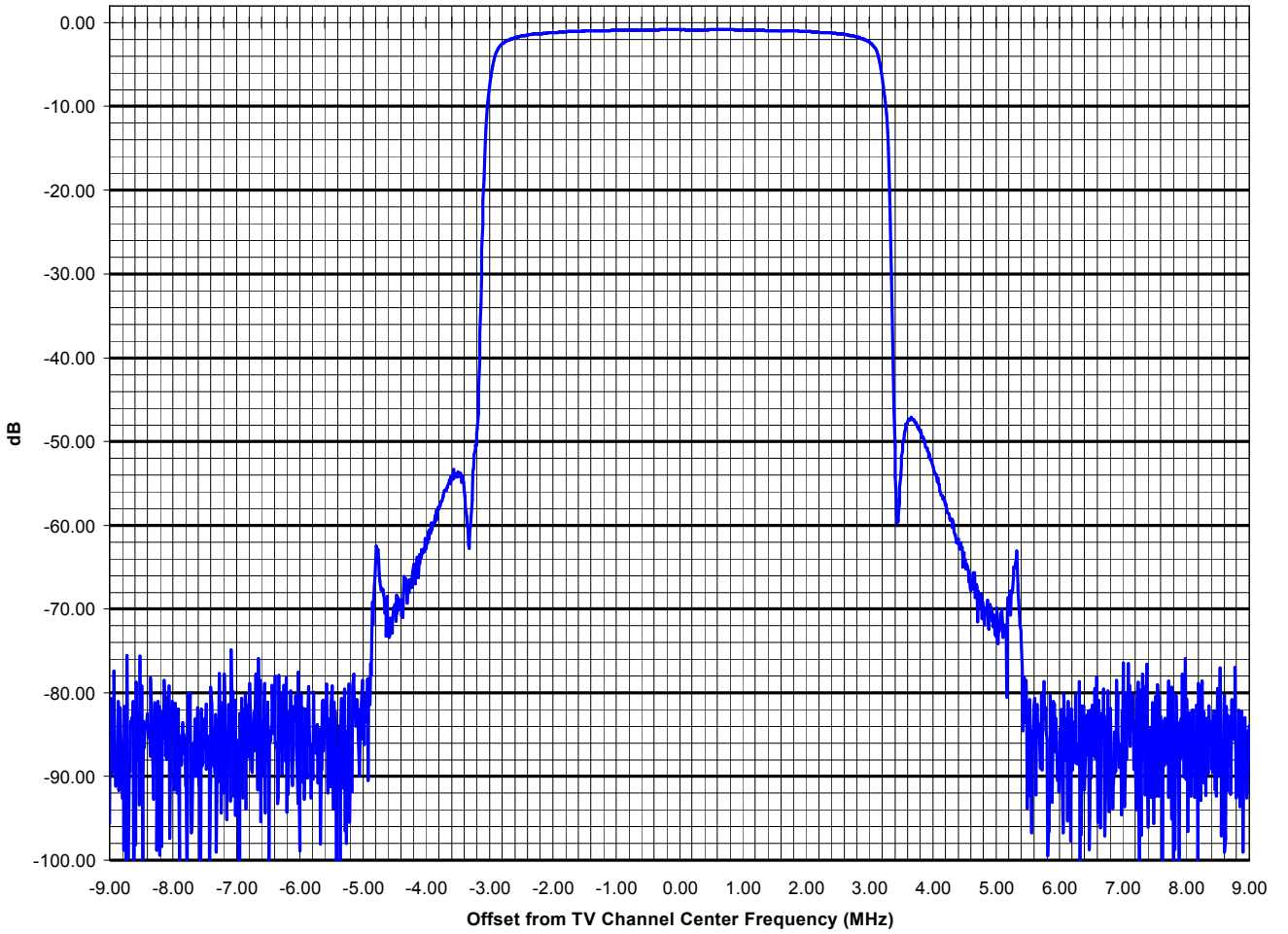
** If interference analysis fails, additional Post-transmitter filtering would be required.

*** If overload analysis fails, TV Channel 14 reject filter may be required for the LM receiver

POST-TRANSMITTER FILTER RESPONSE

The utilization of a 12-Section post-transmitter filter is a key component in reducing OOBE from WNLO into LM facilities. The plot below is the response of the as-built filter data received from the filter manufacturer.

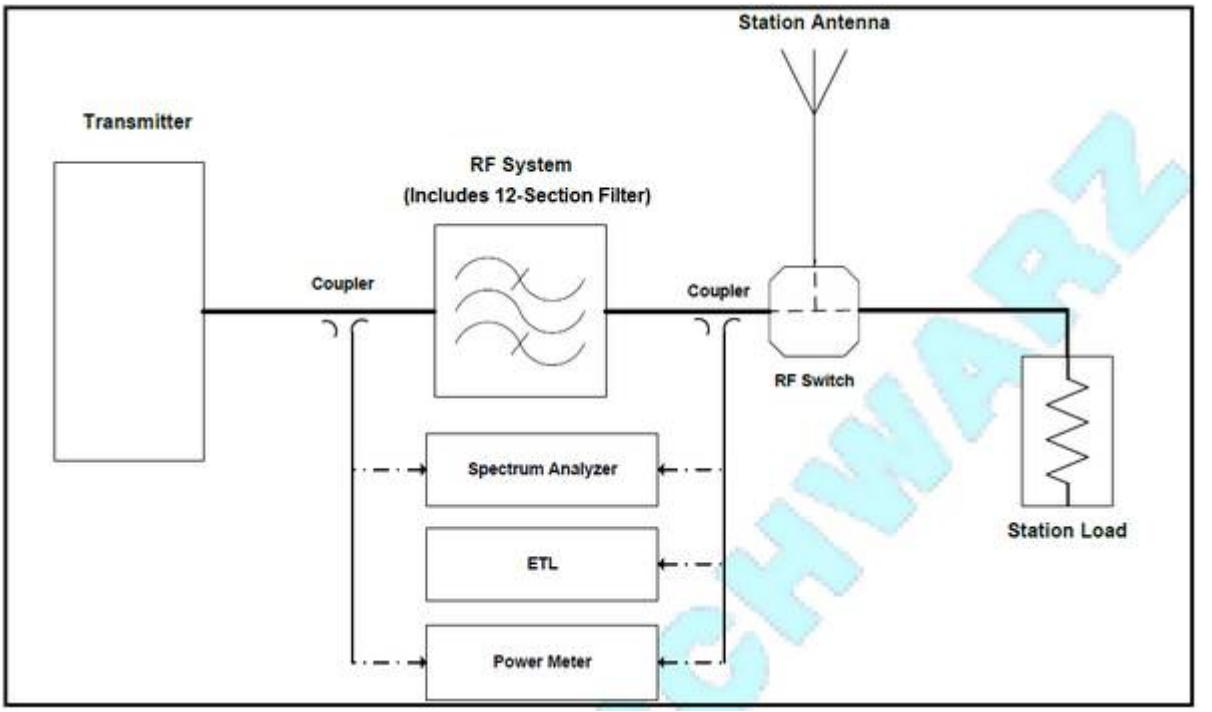
Channel 14 Transmitter Post-Filter Response Comparison



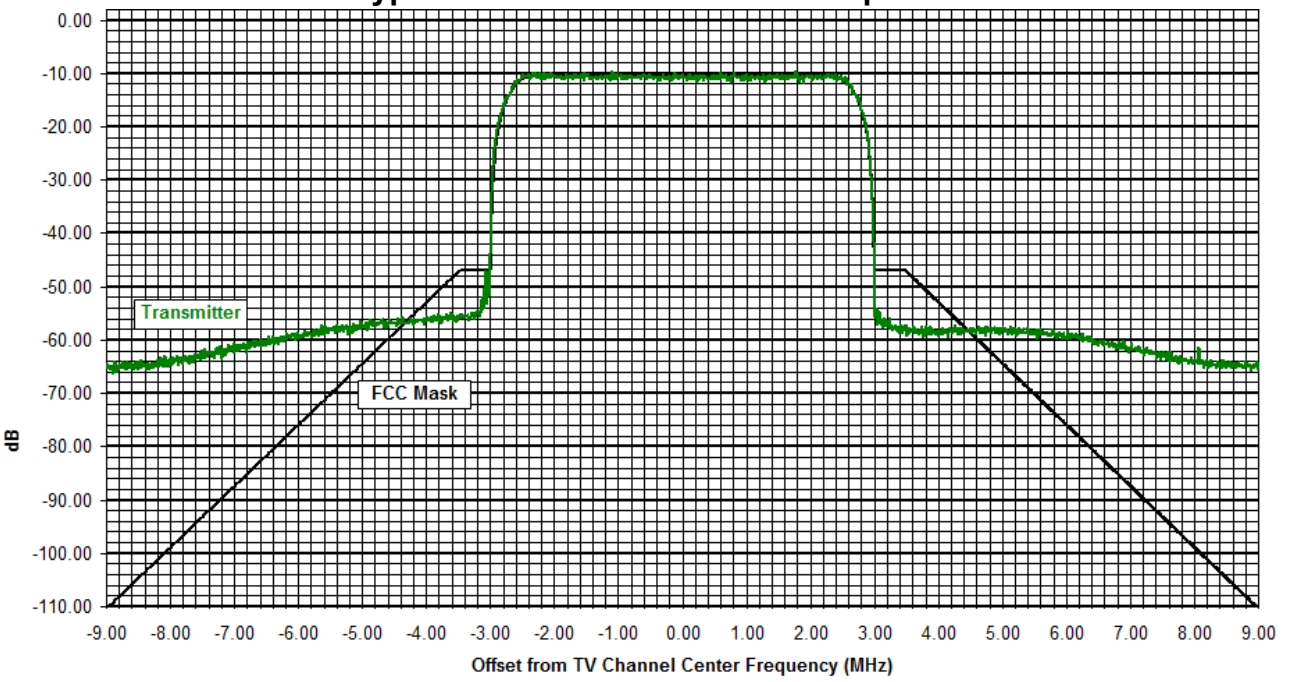
Blue: As-Built 12-Section Filter Response obtained from the Manufacturer

TRANSMISSION SYSTEM BLOCK DIAGRAM

Below is a block diagram of the RF transmission path. The diagram shows the measurement points (Couplers) used for the transmitter proof of performance. The parameters used for this LM study were based on a typical OOBE response of the transmitter, pre-filter, and the as-built response of the 12-Section Filter with the output of the filter connected to the antenna.

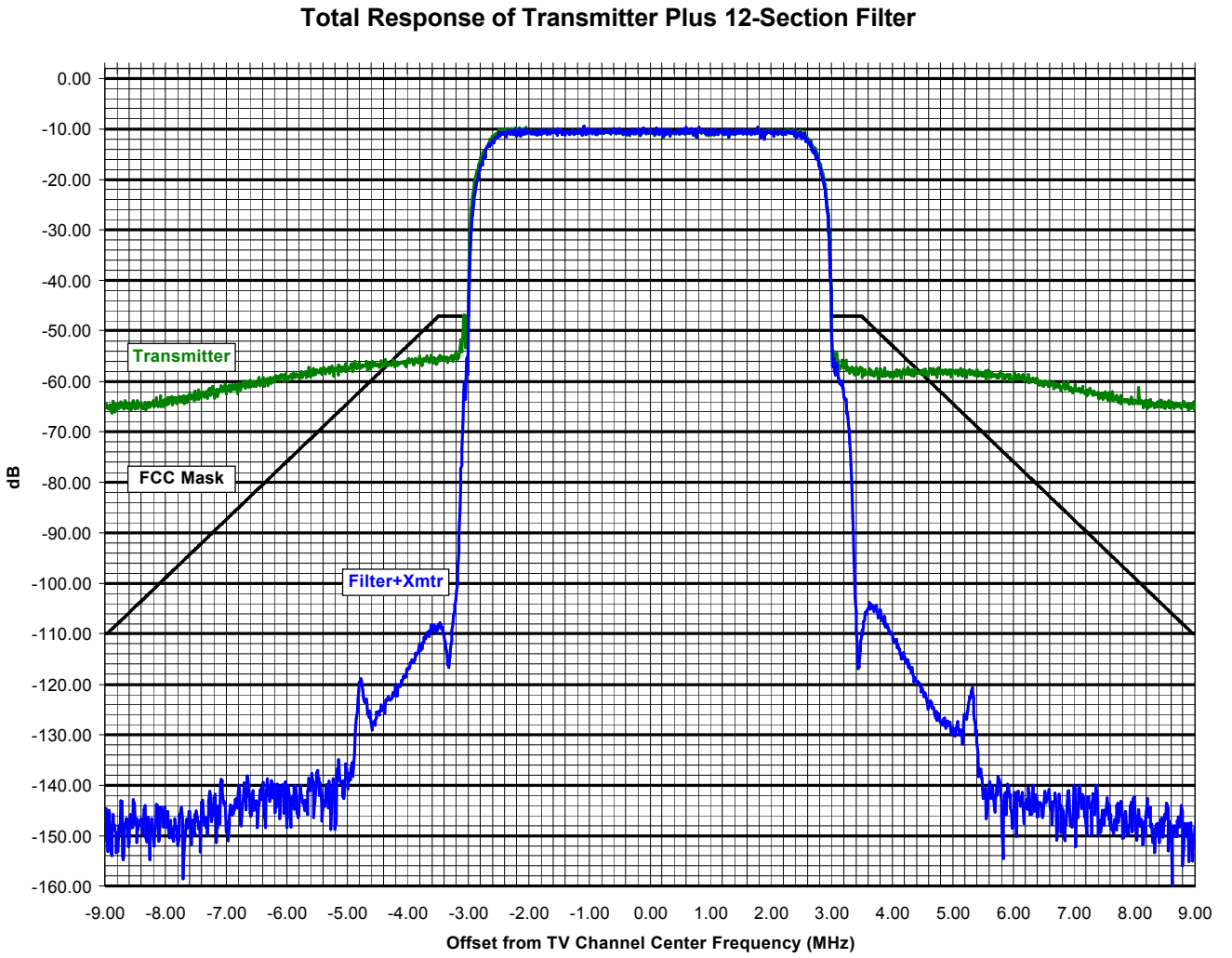


Typical Transmitter Pre-Filter Response



TOTAL OUT OF BAND EMISSIONS RESPONSE

Below is a plot of the transmitter, pre-filter, response added to that of the as-built 12-Section Filter. The plot includes an overlay of the FCC "Mask." Note the increased attenuation near the TV channel 14 band edge (-3.00 MHz Offset which is 470 MHz).



Black: FCC DTV Emission Mask per §73.622(h)(1) of the Rules
Green: Transmitter pre-filter response based on data received from the manufacturer
Blue: Response of the Transmitter (Xmtr) plus the As-Built 12-Section Filter

TRANSMITTER SYSTEM PERFORMANCE DATA ANALYSIS & RESULTS

The as-built 12-Section post-transmitter filter response was obtained from the filter manufacturer and utilized in this study.

The transmitter proof of performance data was found to closely correlate to the typical response data of the model transmitter as furnished to MSW earlier from the manufacturer.

Table 7 below shows a high level summary of the results for current licensed LM stations. This interference and overload study included all Land Mobile operations between 460 to 470 MHz and within 130 km of the WNLO transmitter site.

Table 7 – Statistics from the Analysis of Current Licensed LM facilities

Item	Value	Call Sign
LM Authorizations Found below TV Channel 14	1,049	-
LM Facilities Studied	6,476	-
Closest LM Frequency to WNLO Band Edge	469.9750 MHz	WPXG553
Closest LM Fixed Base Facility	4.4 km	WNLB875
Lowest IX Margin to Fixed Base:	75.6 dB	WNZR419
Stations Predicted to Experience Interference	0	-
Worst Overload Margin	4.5 dB	WQTX620
Stations Predicted to Experience Overload	0	
Lowest IX Margin to Mobile:	-1.2 dB	WPXG553
Stations Predicted to Experience Interference	1	WPXG553
Worst Overload Margin	9.2 dB	WQCI894
Stations Predicted to Experience Overload	0	

As shown in the table above only one case of potential interference was reported in the analysis. This is a mobile LM facility, call sign WPXG553, operating on 469.9750 MHz. Refer to the satellite image shown in Appendix 4 for the following observations.

1. WPXG553 is licensed to a Target Distribution Center that is 18.7 km from WNLO
2. Referring to the map scale, the area around the Center has 9 dB or more of margin
3. The majority of LM operations would most likely be inside the building
4. The concrete style building would provide additional WNLO signal attenuation
5. Predicted interference from WNLO into WPXG553 is in the northeast part of the LM operational area and only impacts 4% of the total LM operational area.

Appendix 2 and 3 of this report are lists showing the 30 LM facilities with the lowest predicted interference margin for mobile and fixed base operations respectively. A complete list of all 6,476 LM facilities analyzed is available upon request.

CONCLUSION

MSW performed a study for WAVY Broadcasting, LLC, licensee of Class A television station WNLO-CD. The purpose of the study was to determine the impact that WNLO, operating on TV channel 14, may have on Land Mobile operations in the frequency range of 460 to 470 MHz.

Based on the results of the study data presented in this report the following conclusions were reached.

1. Using information received from the manufacturer and transmitter proof of performance, a 12-Section post-transmitter filter was installed and is properly functioning in the transmitter RF chain to reduce Out-of-Band Emissions.

2. The out-of-band transmitter pre-filter response was examined and found to correlate with typical transmitter response data obtained from the manufacturer and contributes to further reducing Out-of-Band Emissions.

3. Out of 6,476 Land Mobile facilities studied only one case of potential interference was identified. It is unlikely, however, that WNLO will actually impact those operations due to the distance away from the center of operation and that most operations are most likely contained inside a concrete building structure. The concrete structure would further reduce the any Out-of-Band Emissions received from WNLO.

4. There were no cases of overload identified into any Land Mobile facilities in this study.

Any interference or overload issues reported will be resolved on a case by case basis.

As another step to ensure LM operations will not be adversely impacted by WNLO operating on TV channel 14 MSW was contracted to send notification to all Land Mobile operators within the area studied.

This study conducted by MSW was based on the ITM prediction model. Actual field conditions including, but not limited to, propagation conditions, errors and omissions in the FCC database, active and passive intermodulation products and LM receiver characteristics may affect the actual results in the field and are considered outside the control of MSW.

This study was performed using defined locations extracted from the FCC ULS database (e.g. geographical coordinates and well defined boundaries, such as radius and center point). The FCC database base contains hundreds of authorizations for itinerant users that are authorized over the entire country, states, counties and other wide areas. It is impractical to attempt to analyze those operations without knowing the specific location of a LM receiver if and when they are deployed in the area studied.

MSW stands ready to answer any questions regarding this report and to assist WNLO in responding to any issues that may be reported from LM operators.

CERTIFICATION

The undersigned author of this report, Joseph L. Snelson, Jr., is a Certified Professional Broadcast Engineer (CPBE) as recognized by the Society of Broadcast Engineers and possesses over 49 years of experience in Broadcast Engineering including Television signal analysis, propagation, coverage and interference prediction. He is a contract employee of Meintel, Sgrignoli and Wallace, LLC, Broadcast Television & Radio Engineers, and was assigned to identify the impact that WNLO-CD, transmitting on television channel 14, may have on authorized Land Mobile facilities operating in the lower adjacent band (460 – 470 MHz) to TV channel 14.

The undersigned hereby certifies that all statements made in this report are true and correct to the best of his own knowledge except, where noted, when data or information has been supplied by others, which he believes to be correct.

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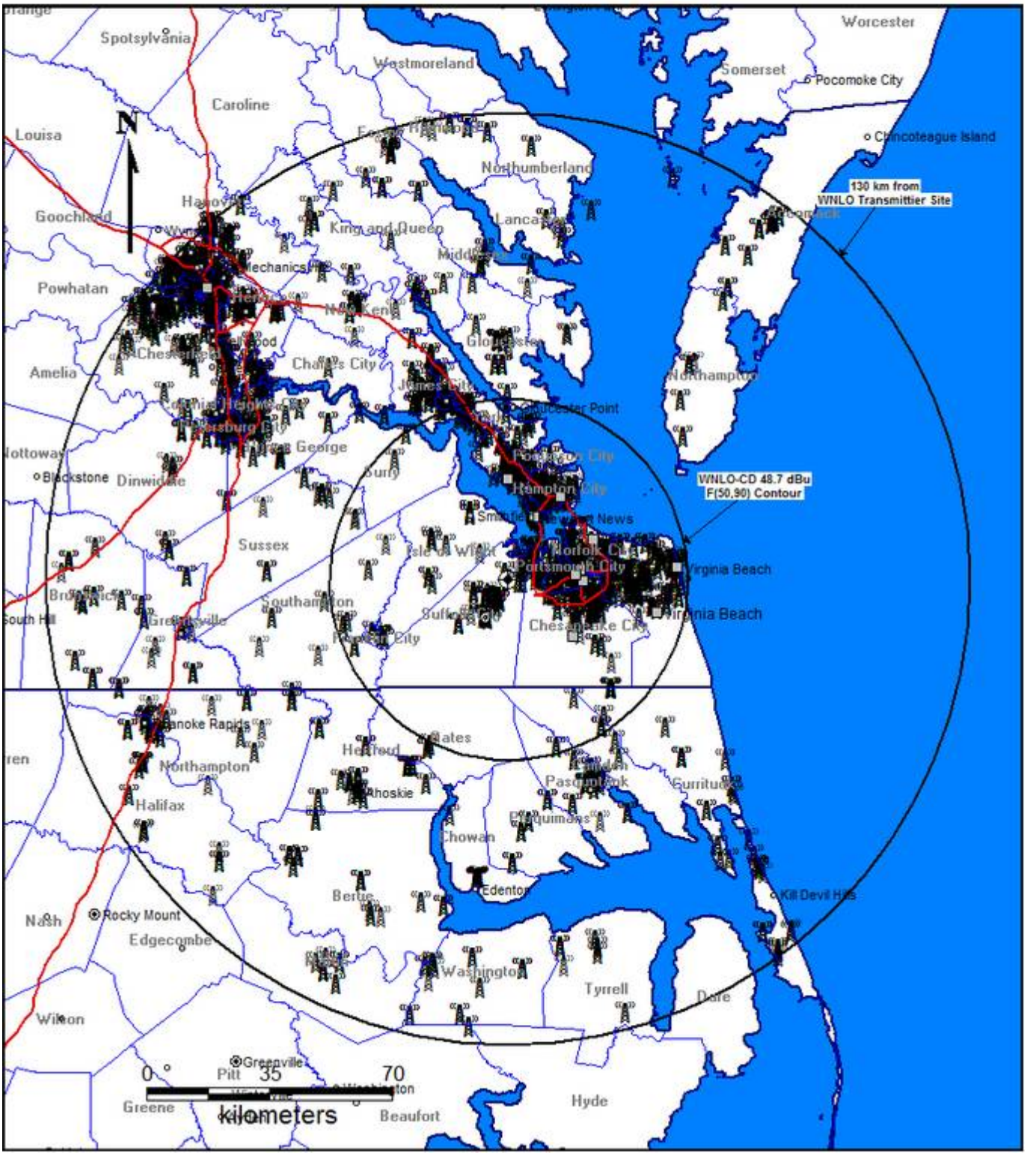
APPENDIX 1
Land Mobile Stations (6,476) below Ch 14 within 130 km of WNLO-CD
WNLO-CD, Channel 14, Norfolk, VA, Coverage Contour



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APPENDIX 2
Mobile - Land Mobile Stations with the Lowest Interference Margin
Lowest 30 out of 6,476

Freq Mhz	Call Sign	Svc Code	Svc Cls	DTV->LM Dist km	DTV->LM Az deg	Ant Pol	HAAT M	HAGL m	Gain dB	BW khz	IX Mgn dB	OL Mgn dB
469.9750	WPXG553	YG	MO	5.4	264.5	V				11.2	6.4	>20.0
469.9750	WPPG908	IG	MO	20.2	58.2	V				11.2	8.2	>20.0
469.9750	WNAC240	IG	MO	20.7	22.2	V				11.0	8.2	>20.0
469.9125	KD43582	IG	MOC	7.7	90.9	V				7.6	9.0	>20.0
469.9250	WZA648	IG	MO	20.2	58.3	V				11.2	11.4	>20.0
469.9375	WPPY932	YG	MO	18.5	80.9	V				11.2	12.5	>20.0
469.9250	WQLE949	IG	MO	19.7	56.6	V				11.2	12.8	>20.0
469.9750	WQKN470	IG	MO	7.5	94.0	V				11.2	13.2	>20.0
469.9625	WQTF254	IG	MO	28.5	19.6	V				11.2	14.0	>20.0
469.9625	WRDF544	IG	MO	26.2	23.6	V				7.6	14.6	>20.0
469.9625	WQTF254	IG	MO	31.3	85.5	V				11.2	14.6	>20.0
469.9500	WPPV869	IG	MO	8.4	203.3	V		2.0		11.2	15.3	>20.0
469.9500	WPPG908	IG	MO	20.2	58.2	V				11.2	16.6	>20.0
469.9250	WPGF708	IG	MO	28.5	93.9	V			3.0	4.0	17.6	>20.0
469.9375	WQRU646	YG	MO	31.7	6.2	V				11.2	19.5	>20.0
469.9375	WQRU646	YG	MO8	31.7	6.2	V				11.2	19.5	>20.0
469.9750	WPTY709	IG	MO	40.7	249.0	V				11.2	22.3	>20.0
469.9125	WQEV320	YG	MO	28.5	98.6	V				7.6	23.3	>20.0
469.9250	WPKR964	IG	MO	49.5	324.8	V				11.2	25.0	>20.0
469.8750	WNSO663	IG	MO	26.5	3.1	V			4.8	11.2	25.8	>20.0
469.9625	WPRA475	IG	MO	55.8	332.4	V				7.6	28.4	>20.0
469.8750	WQKR454	IG	MO	19.8	69.2	V				11.2	28.5	>20.0
469.9063	WQKX584	YG	MO	26.9	22.9	V				4.0	29.0	>20.0
469.9063	WQKX584	YG	MO	26.9	22.9	V				4.0	29.0	>20.0
469.8750	WNSO663	IG	MO	26.5	3.1	V			4.8	4.0	30.2	>20.0
469.9625	WPKB569	IG	MO	57.2	294.9	V				8.5	31.7	>20.0
469.8500	WPLG848	IG	MO	16.4	76.5	V		11.0		18.0	33.3	>20.0
469.9500	WQMD383	IG	MO	53.9	335.7	V				7.6	34.7	>20.0
469.8500	WNAA721	IG	MO	16.4	76.5	V				11.0	35.4	>20.0
469.8500	WNAA721	IG	MO	16.4	76.5	V				11.0	35.4	>20.0

Notes:

1. Mobile analysis performed within a defined area of operation from mobile LM coordinates
2. Mobile Distance/Azimuth is to the cell with the lowest margin
3. Lowest mobile interference and/or overload margins averaged over the authorized area are shown
4. 48 km radius used for mobile area of operation if not specified in authorization
5. Default parameters used for mobile where no height or antenna gain is given

APPENDIX 3
Fixed Base - Land Mobile Stations with the Lowest Interference Margin
Lowest 30 out of 6,476

Freq Mhz	Call Sign	Svc Code	Svc Cls	DTV->LM Dist km	DTV->LM Az deg	Ant Pol	HAAT m	HAGL m	Gain dB	BW khz	IX Mgn dB	OL Mgn dB
468.1750	WNZR419	PW	FX1	17.8	29.9	V		21.0		11.3	75.6	>20.0
468.1750	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	75.9	>20.0
462.1125	WQTX620	IG	FB	10.5	313.0	V	41.6	6.1	21.4	11.2	78.1	4.5
468.1500	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	79.8	>20.0
468.6250	KZK398	IG	FX1	53.2	342.2	V	28.0	13.0	6.0	7.6	83.0	>20.0
468.1250	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	83.2	>20.0
469.2000	WNDC562	IG	FX1	73.2	215.4	V	48.2	42.0	3.0	11.2	85.0	>20.0
468.1000	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	88.3	>20.0
468.0750	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	88.5	>20.0
468.0500	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	89.5	>20.0
464.9500	WPPV869	IG	FB6	8.4	203.3	V	122.0	124.0	3.0	11.2	89.7	>20.0
464.9250	WQUI429	IG	FB	5.5	210.7	V	14.0	10.6		11.2	89.8	>20.0
460.3875	WPAN611	PW	FXO	4.7	65.9	V	6.4	6.0	6.8	11.2	89.8	16.3
464.9250	WQUI429	IG	FB	5.5	209.4	V	8.0	3.6		11.2	90.0	>20.0
464.9250	WQUI429	IG	FB	5.5	210.3	V	15.0	3.6		11.2	90.0	>20.0
464.9250	WQUI429	IG	FB	5.6	209.7	V	9.0	3.6		11.2	90.0	>20.0
464.9250	WQUI429	IG	FB	5.5	210.1	V	13.0	3.6		11.2	90.1	>20.0
464.9250	WQUI429	IG	FB	5.6	211.9	V	7.0	3.6		11.2	90.1	>20.0
464.6250	WPZQ761	IG	FB2	19.2	75.9	H	41.8	40.0	5.0	11.2	90.1	17.8
468.2000	WQEV911	IG	FX1	67.4	231.9	V	44.2	30.4	3.0	7.6	90.1	>20.0
469.0750	WNSI317	IK	FXO	102.8	266.3	V	0.0	99.0	8.5	11.2	90.2	>20.0
469.1250	WNSI317	IK	FXO	113.4	254.7	V	0.0	151.0	8.5	11.2	90.4	>20.0
462.9250	WNYY212	IG	FB6	8.4	203.4	V	0.0	102.0	6.6	11.0	90.8	17.1
461.2250	WPYN623	IG	FB2	14.6	82.9	H	38.4	33.9	3.0	11.2	91.1	17.5
468.0000	WNRI441	PW	FB2	18.3	75.6	V	0.0	16.0		11.3	91.1	>20.0
462.9500	WQIU337	PW	FB2	6.8	45.5	V	23.5	22.8	5.4	11.2	91.4	17.8
463.0000	WQIU337	PW	FB2	6.8	45.5	V	23.5	22.8	5.4	11.2	91.4	17.8
463.0250	WQIU337	PW	FB2	6.8	45.5	V	23.5	22.8	5.4	11.2	91.4	17.8
463.0500	WQIU337	PW	FB2	6.8	45.5	V	23.5	22.8	5.4	11.2	91.4	17.8
463.0750	WQIU337	PW	FB2	6.8	45.5	V	23.5	22.8	5.4	11.2	91.4	17.8

APPENDIX 4
Cell Study Analysis for WPXG553
LM Facility: Target Distribution Center T-3800
15 km Radius of Operation