ER21-47 ENGINEERING REPORT

HD RADIO COVERAGE MEASUREMENT

IN

VANCOUVER, BC

(VERSION 1)

Submitted by

CBC Radio-Canada

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Date : November 22, 2021

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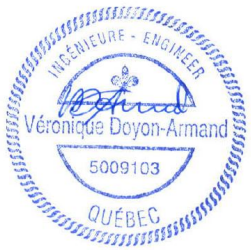

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MODIFICATIONS

REVISION	DESCRIPTION	DATE	DONE BY
1	First version	November 22, 2021	Véronique Doyon-Armand, P. Eng.

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1 INTRODUCTION

This report presents the results of the measurements campaign for the HD Radio stations in the region of Vancouver, BC. The purpose of the mobile campaign is to verify the coverage of CBC/Radio-Canada's HD Radio service: CBU-2-HD.

2 DISCUSSION

CBC/Radio-Canada recently started to broadcast HD Radio on CBU-2-FM in Vancouver, BC in November 2021. For the moment, only HD1 is activated and the content is solely Radio One. In order to verify the HD coverage and help the Medias decide on which content to broadcast on supplemental channels HD2 and HD3 in Vancouver, a measurement campaign was performed in the Greater Vancouver Area and its surroundings on November 1 to 4, 2021. The objective was to determine if the HD audio could be decoded in some areas where the analog FM reception is known to be problematic.

This report presents the results of the mobile measurement campaign performed with the Octave Communications equipment: the HDR/FM Nomad Analyzer. This tool allows the recording the field strength level of the multiples analog FM stations, and monitoring the presence of the HD carriers and when they can be decoded. With those metrics, we can conclude where the digital audio signal can be listened to. During this campaign, the CBU-2-FM and CBU-2-HD were measured with the Nomad. In addition, a modified Subjective Sound Quality Assessment (SSQA) was also performed with the car receiver on CBU-2-HD.

This report also presents conclusions about the preparation of a HD Radio coverage measurement campaigns and coverage planning, in regards to the C/N+I level we should use in the future. Based on the modified SSQA, we will also be able to validate the Nomad results by comparing them to a listener's experience using a typical car radio receiver.

The complete results are presented in Google Earth format for Radio One station either attached to this document or on Livelink at this link. In this report, we will mainly discuss about the CBU-2-HD Radio One coverage.

3 SERVICES PARAMETERS

The parameters of all services measured during the campaign are presented in Annexe A.

CBC/Radio-Canada stations CBU-2-FM/CBU-2-HD are broadcast from the Mount Seymour transmission site in Vancouver. The FM antenna is a Jampro JAHD-8/2, 8 bays / 2 panels per bays, with a directional pattern and circular polarization.

Note that next year, the other FM antenna at Mount Seymour (Kathrein K5332187, 6 bays / 3 panels) will be replaced. The stations CBU-2-FM/CBU-2-HD will then be broadcasted from the new Rymsa AT12-303, 8 bays / 2 panels.

4 METHODOLOGY

The measurement campaign was performed by Jason Byers and John Fulton on November 1 to 4, 2021 with the Transmission's truck, a Chevrolet Silverado 2500. The itinerary was based on the simulation of CBU-2-HD's expected coverage.

The description of how we simulated and evaluated the FM analog signal is in Annexe B. Here's in the following section the description for the HD signal.

4.1 HD INDICATORS

In the following report, the measured HD signals are characterized by two indicators: the HD Acquired and the Digital Audio Acquired. The HD Acquired indicates that the Nomad receiver has detected the presence of HD carriers and is in the process of attempting to decode them. The Digital Audio Acquired confirms if the quality level of the HD signal is good enough for the audio to be decoded. This is the key metric to evaluate the HD radio coverage.

4.2 HD SIMULATIONS

The realistic algorithm used for simulation is the model CRC Predict v. 3.21 (with Computamap2 land cover) with an Rx antenna at 2 meters above ground level and is shown in the Google Earth file with the following color scheme:

Nomad HD Indicator Equivalent	Simulated C/N+I Contour Fill (dB)	Colour
Digital Audio Acquired	20 to 200	
HD Acquired	10 to 20	
	0 to 10	

TABLE 1 – HD SIGNAL - SIMULATION COLOUR SCHEME

4.3 MOBILE MEASUREMENTS AT 2 METERS

The HD mobile measurements are performed with the HDR/FM Nomad Analyzer and then exported to a Google Earth file based on the colour scheme below. Note blue is use only for the figures in this report to facilitate the visualization as it provides a higher contrast with Google Earth's satellite imagery background.

Nomad HD Indicator	Yes	No
Digital Audio Acquired		
HD Acquired		

TABLE 2 – HD SIGNAL INDICATORS COLOUR SCHEME

4.4 MODIFIED SUBJECTIVE SOUND QUALITY ASSESSMENT (SSQA)

The SSQA was performed for the Radio One CBU-2-HD service on the car radio receiver. The table below shows the scales used and a brief description of each level. A GPS tracking application was used to track and connect each recorded SSQA point to its corresponding geographical coordinates.

Scale	Colour	Nomad HD Indicator Equivalent	Definition
5		Digital Audio Acquired	The digital audio is decoded by the car receiver. The HD logo is orange, or the album art appears on the screen.
3		HD Acquired	The HD carriers is detected by the car receiver. The HD logo is grey and appears on the screen.
1		FM analog only	The HD carriers is not detected by the car receiver. Only the FM signal is received.

TABLE 3 – MODIFIED SUBJECTIVE SOUND QUALITY ASSURANCE COLOUR SCHEME

FIGURE 1 – EXAMPLE OF A CAR HD RADIO RECEIVER

5 MEASUREMENTS RESULTS PRESENTATION

This section presents the results analysis of the survey. This analysis will mainly compare the SSQA and the Nomad results for CBU-2-HD in order to establish where the HD signal can be decoded in the Vancouver region. The results specifically for CBU-2-HD are attached to this report. The complete results of the measurement campaign are available on Livelink at this link. In order to properly visualize the results, you need to install Google Earth on your computer by clicking here.

Google Earth Files

The following figure show the full result of Digital Audio Acquired indicator recorded with the HDR/FM Nomad Analyzer, together with the HD simulations performed with the software Covlab.

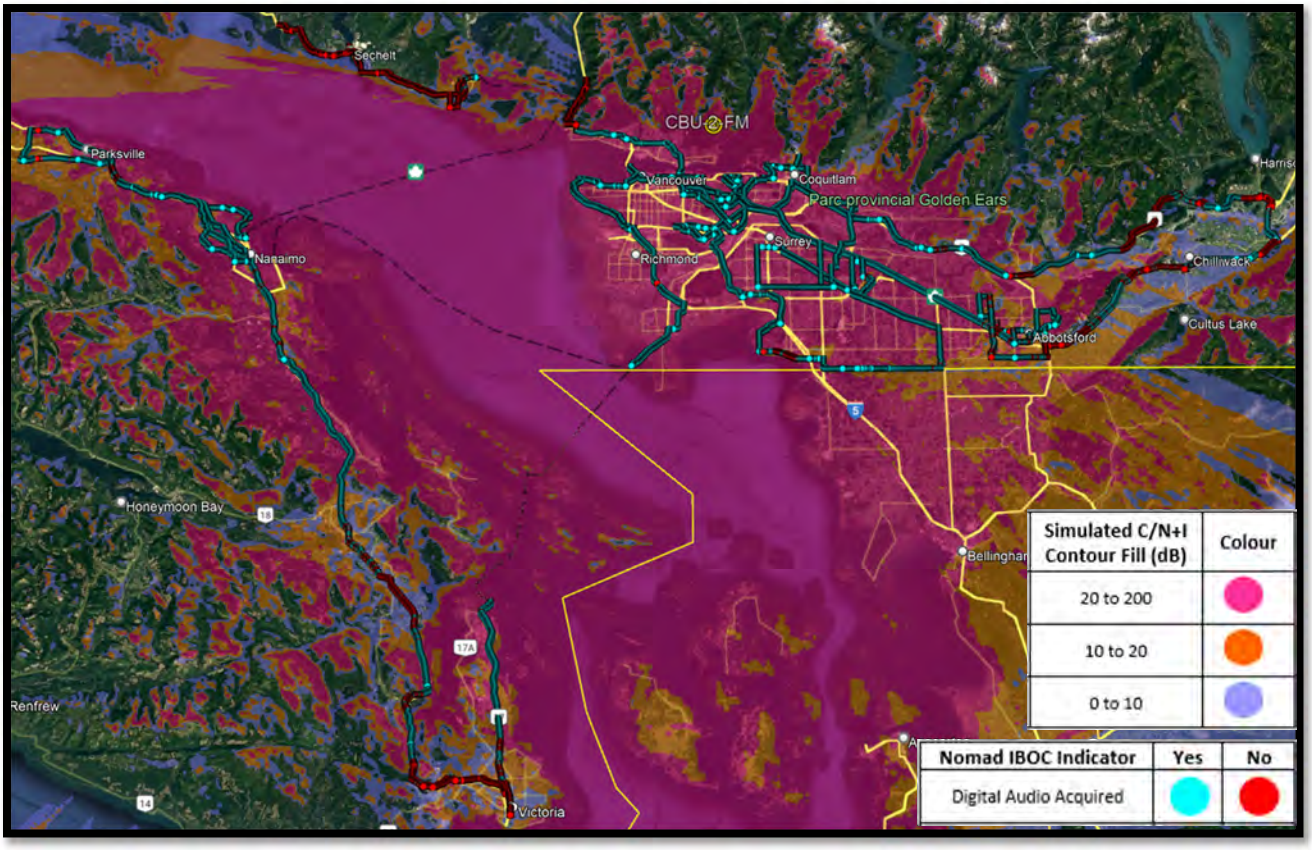

FIGURE 2 - DIGITAL AUDIO ACQUIRED – CBU-2-HD

In the following subsections, the figures show the result of the SSQA and Digital Audio Acquired indicator for specific regions in the Greater Vancouver Area and its surroundings. The simulations are not shown in the next figures.

5.1 GREATER VANCOUVER AREA

The Greater Vancouver area is very well covered by the new HD Radio station. We observe that the results obtain with the HDR/FM Nomad Analyzer are really similar to the modified SSQA evaluation. Let's discuss specifically about the zones where the HD signal could not be decoded.

In the district of West Vancouver, on the highway 99, the digital audio is decoded until Caulfeild with the HDR/FM Nomad Analyzer. We also note that the HD Acquired indicator was still present further than Caulfeild. Based on the modified SSQA, the HD audio was also lost in Caulfeild, but the HD carrier was still detected by the car receiver. By comparing the Nomad result with the simulation, we can conclude also that the digital audio can be decoded with a C/N+I above 20 dB.

FIGURE 3 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD WEST VANCOUVER

In the city of Coquitlam, the Digital Audio Acquired indicator was lost only on a small portion of David Avenue. The SSQA provides a similar result. We note that the C/N+I simulation is below 20 dB in this area.

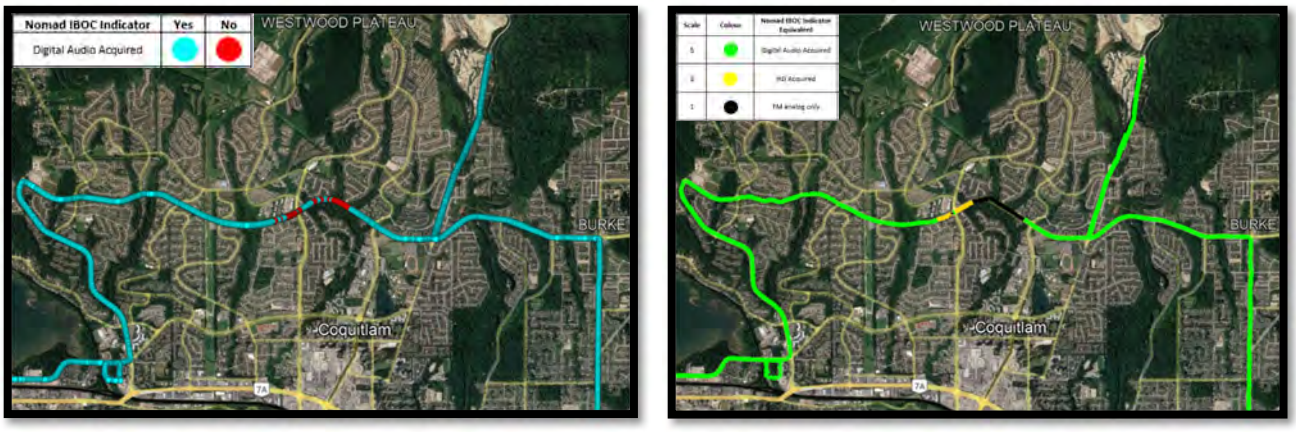

FIGURE 4 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD COQUITLAM

In Willowbrook, the Digital Audio Acquired indicator was lost on a small portion of Crush Crescent and 72 Avenue, only zone where the simulation is below 20 dB. We observe a similar result with the modified SSQA but in addition, the car receiver lost the HD signal on Willowbrook Drive too.

FIGURE 5 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD LANGLEY

In White Rock, the Nomad and car receivers were not able to decode the HD Radio signal on Marine Drive. We note again that the C/N+I simulation is below 20 dB in this area.

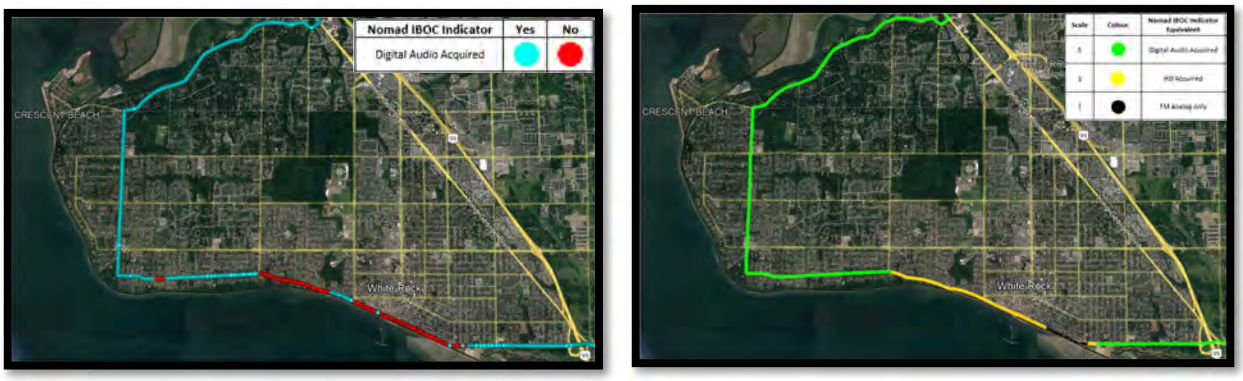

FIGURE 6 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD WHITE ROCK

Finally, in Whonnock on highway 7, the HD audio was not decoded by both receivers. The simulation of the C/N+I ratio drops below 20dB in this area.

FIGURE 7 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD WHONNOCK

5.2 ABBOTSFORD

In Abbotsford, the HD signal from Vancouver is not decoded everywhere as shown on Figure 8 and Figure 9. This was predictable based on the HD simulations: the C/N+I ratio is often below 20 dB in his area. On the other hand, the HD Acquired indicator was lock almost everywhere in the region, meaning that the HD carrier was detected by the HDR/FM Nomad Analyzer.

It is important to mentioned that CBC/Radio-Canada operates the station CBU-1-FM in Abbotsford, so the population receives the Radio One analog service in this area.

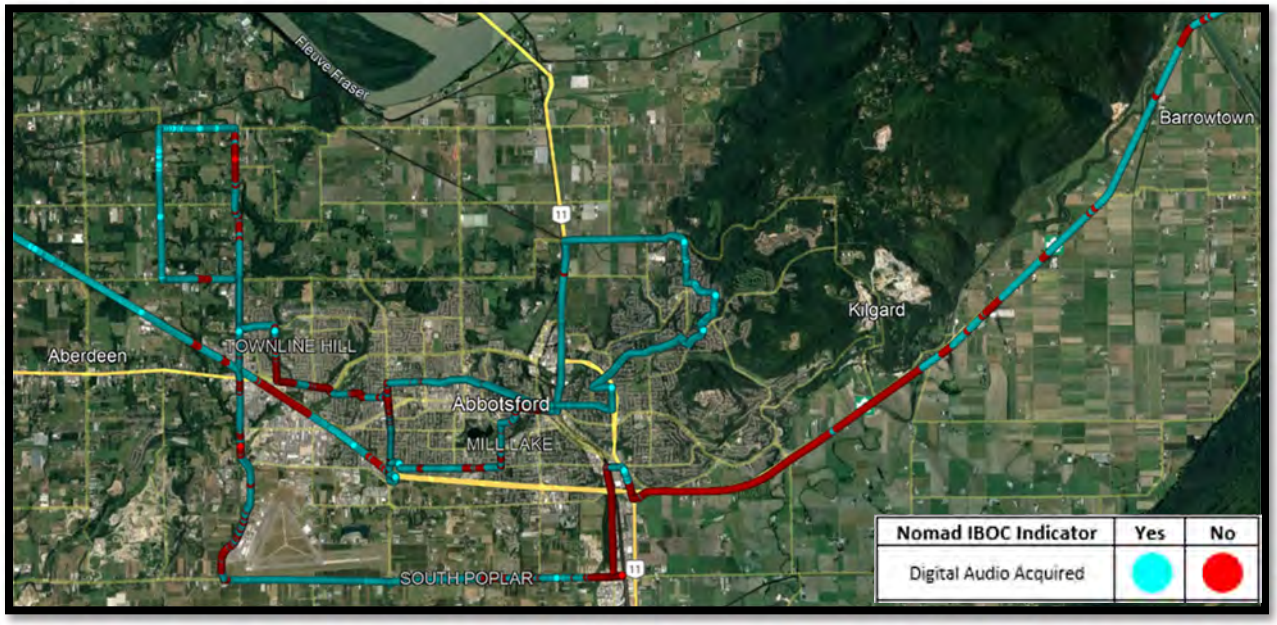

FIGURE 8 – DIGITAL AUDIO ACQUIRED – CBU-2-HD ABBOTSFORD

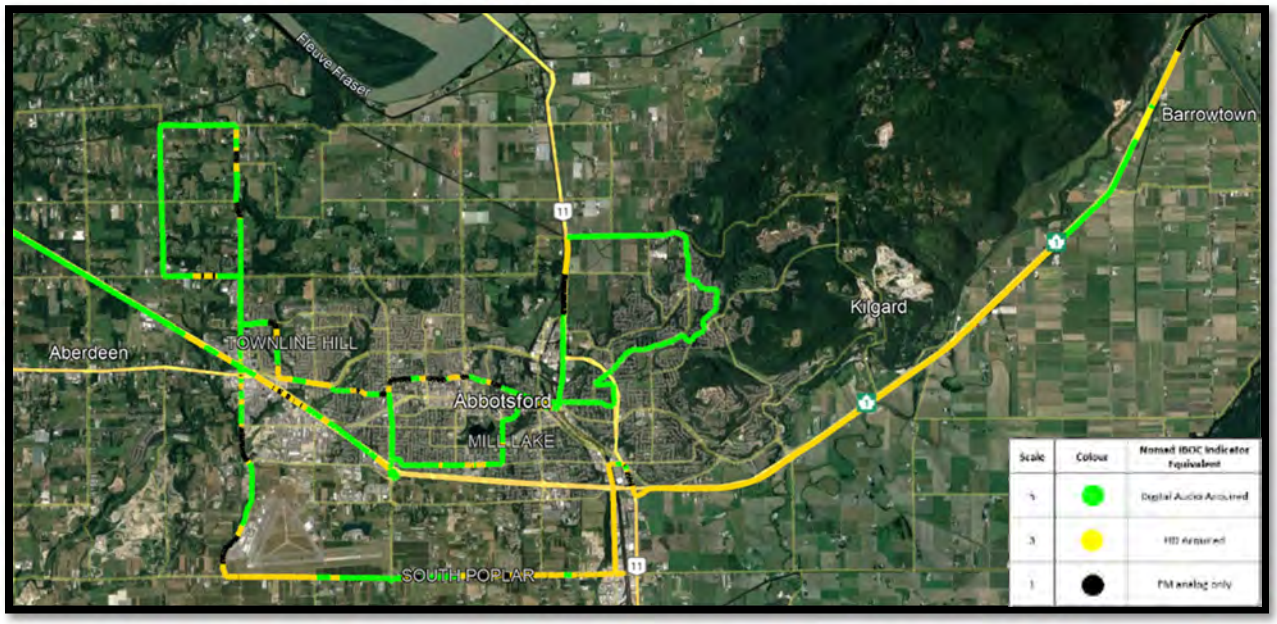

FIGURE 9 – SSQA – CBU-2-HD ABBOTSFORD

5.3 CHILLIWACK AND ITS SURROUNDINGS

In the region of Chilliwack, the HD signal from Vancouver is mostly not decoded as shown on Figure 10 and Figure 11. Only some portions of highways 1, 7 and 9 are well covered. As most of the towns in this area are in valleys, the digital audio cannot be decoded by the Nomad and car receivers. Again, this result is in line with the C/N+I simulation, which is below 10 dB in that region. On the other hand, the HD Acquired indicator was lock almost everywhere in the region, meaning that the HD carrier was detected by the HDR/FM Nomad Analyzer.

It is important to mentioned that CBC/Radio-Canada operates the station CBYF-FM in Chilliwack, so the population receives the Radio One analog service in this area.

FIGURE 10 – DIGITAL AUDIO ACQUIRED – CBU-2-HD CHILLIWACK AND ITS SURROUNDINGS

FIGURE 11 – SSQA – CBU-2-HD CHILLIWACK AND ITS SURROUNDINGS

5.4 SUNSHINE COAST

On Sunshine Coast Highway between Langdale and Halfmoon Bay, the car receiver detected the HD carrier but could not decode the HD audio. We obtain the same result with the HDR/FM Nomad Analyzer: the HD Acquired indicator was detected but not the Digital Audio Acquired indicator. The HD simulation shows a C/N+I below 10 dB in this region.

FIGURE 12 – DIGITAL AUDIO ACQUIRED – CBU-2-HD SUNSHINE COAST

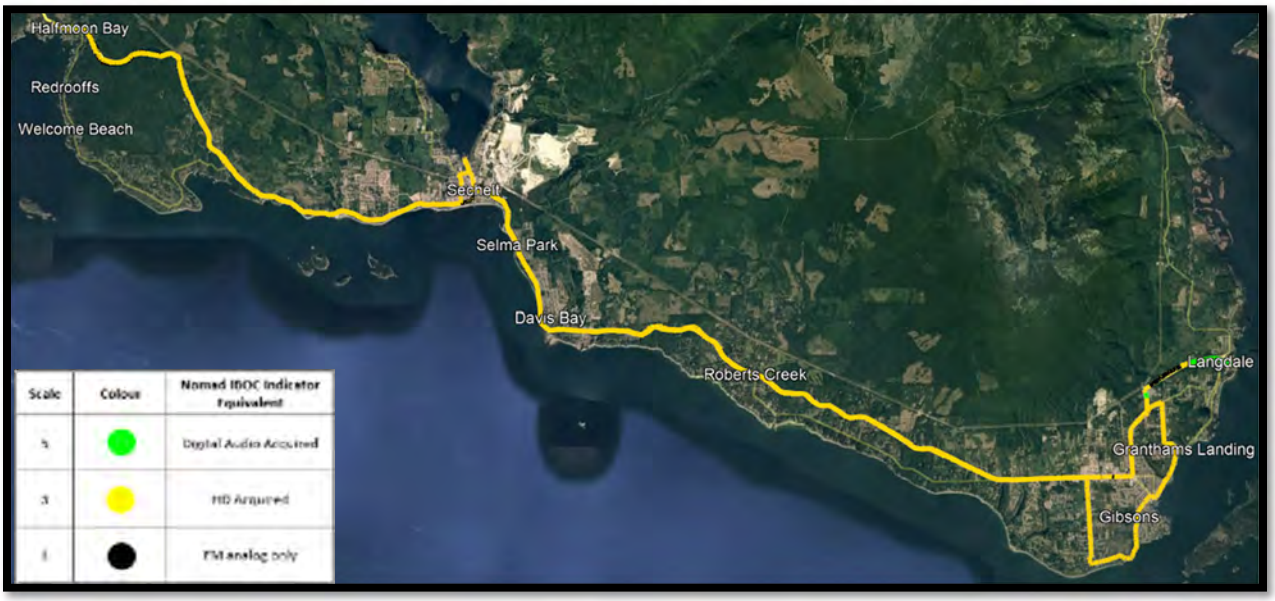

FIGURE 13 – SSQA – CBU-2-HD SUNSHINE COAST

5.5 EAST COAST OF VANCOUVER ISLAND

In general, the HD signal could be decoded by both receivers on the East coast of the Vancouver Island, especially in the Nanaimo region. Let's discuss in details of each areas measured during the part of the campaign.

North of Nanaimo, between Qualicum Beach and Lantzville, the HD signal could be decoded almost everywhere. This region is mostly covered by the HD simulation above 20 dB, but we noticed that the Digital Audio Acquired indicator was recorded in zone where the C/N+I ratio is between 10 and 20 dB.

FIGURE 14 – DIGITAL AUDIO ACQUIRED – CBU-2-HD NORTH OF NANAIMO

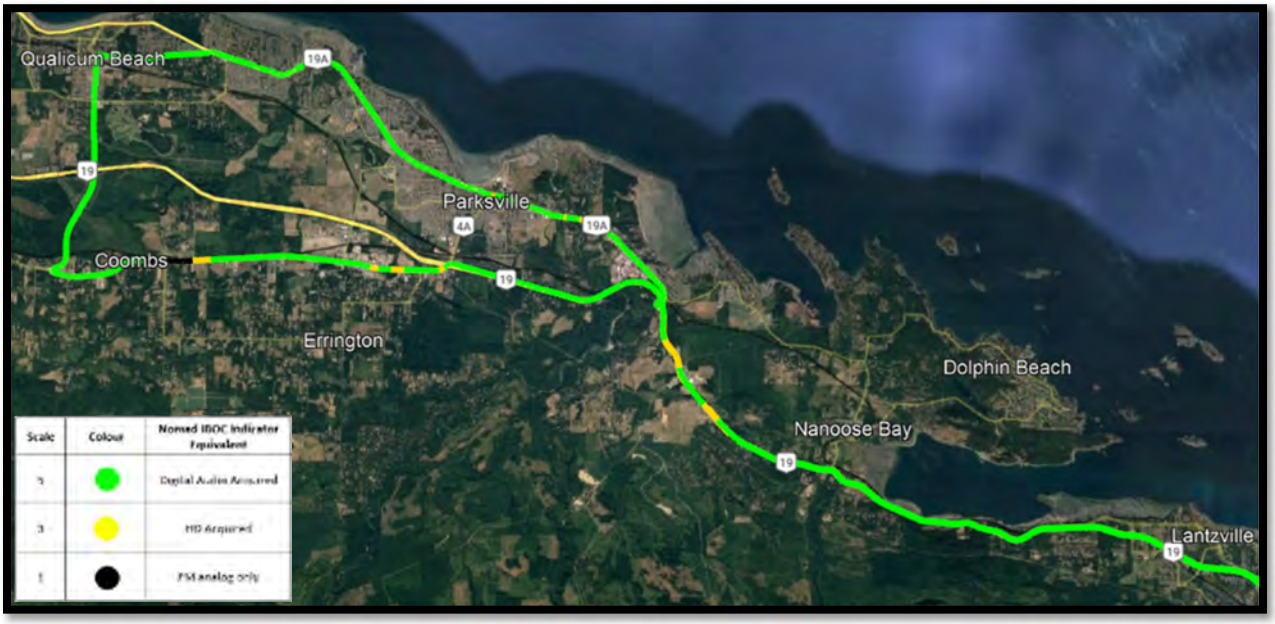

FIGURE 15 – SSQA – CBU-2-HD NORTH OF NANAIMO

In Nanaimo, it was possible to listened to the HD signal almost everywhere. The HD audio was lost only in few small portions of the city. According to the HD simulation, Nanaimo is very well covered mostly by a C/N+I ratio above 20 dB. The city of Nanaimo is well covered by the HD Radio station in Vancouver.

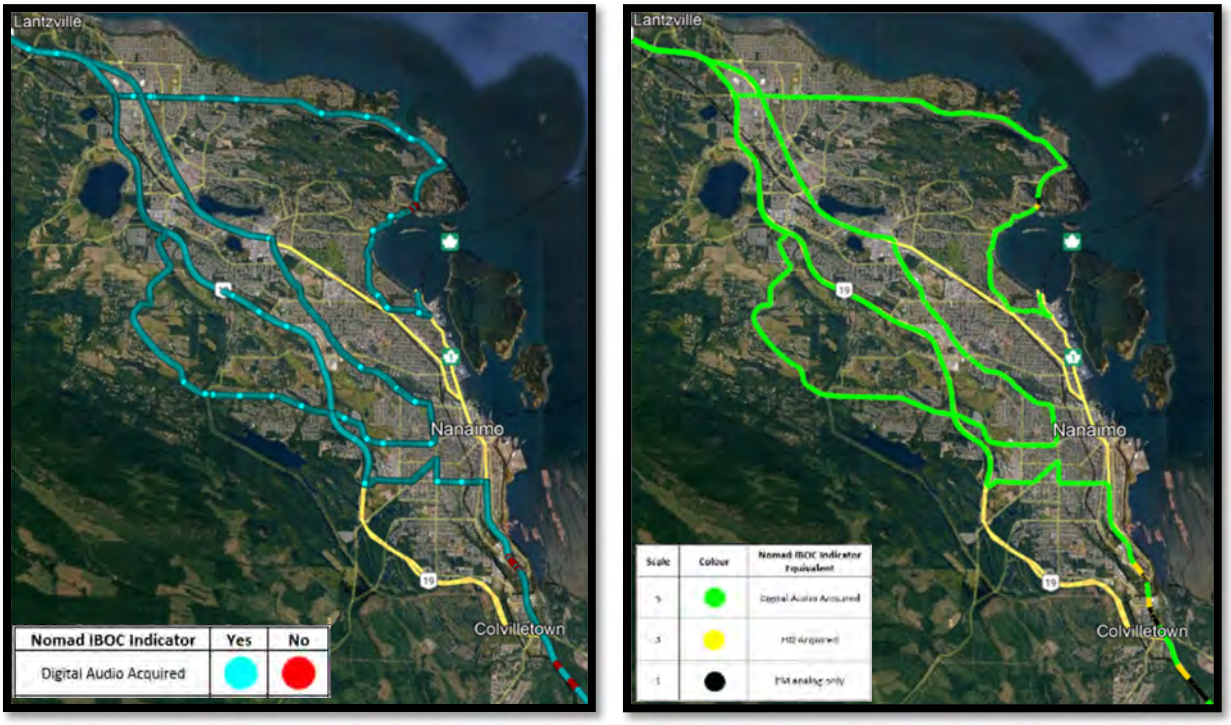

FIGURE 16 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD NANAIMO

South of Nanaimo, on highway 1 between South Wellington and Westholme, the HD signal was decoded except in Cassidy. The town of Ladysmith is well covered by the HD Radio station in Vancouver. This region is covered by the HD simulation above 20dB.

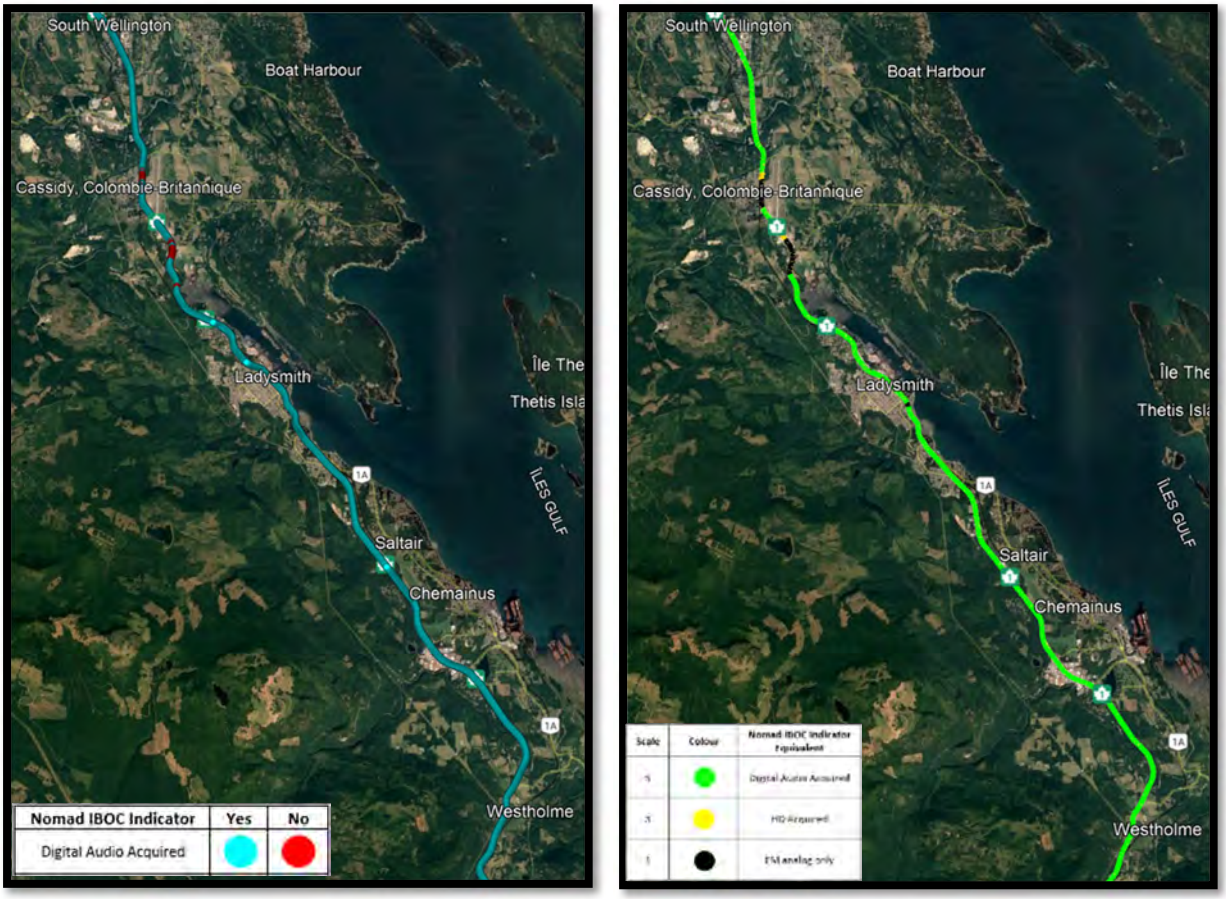

FIGURE 17 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD SOUTH OF NANAIMO

On highway 1 towards Victoria, the HD signal stops to be continuously decoded approximatively at Duncan, where the HD simulation shows a C/N+I ratio below 20 dB. Note however that CBCV-FM Radio One analog station in Victoria covers the Duncan region.

After Cobble Hill on highway 1 and between Victoria and Swarts Bay on highway 17, it was still possible to listened to the HD Radio signal in a few areas (not shown on Figure 18).

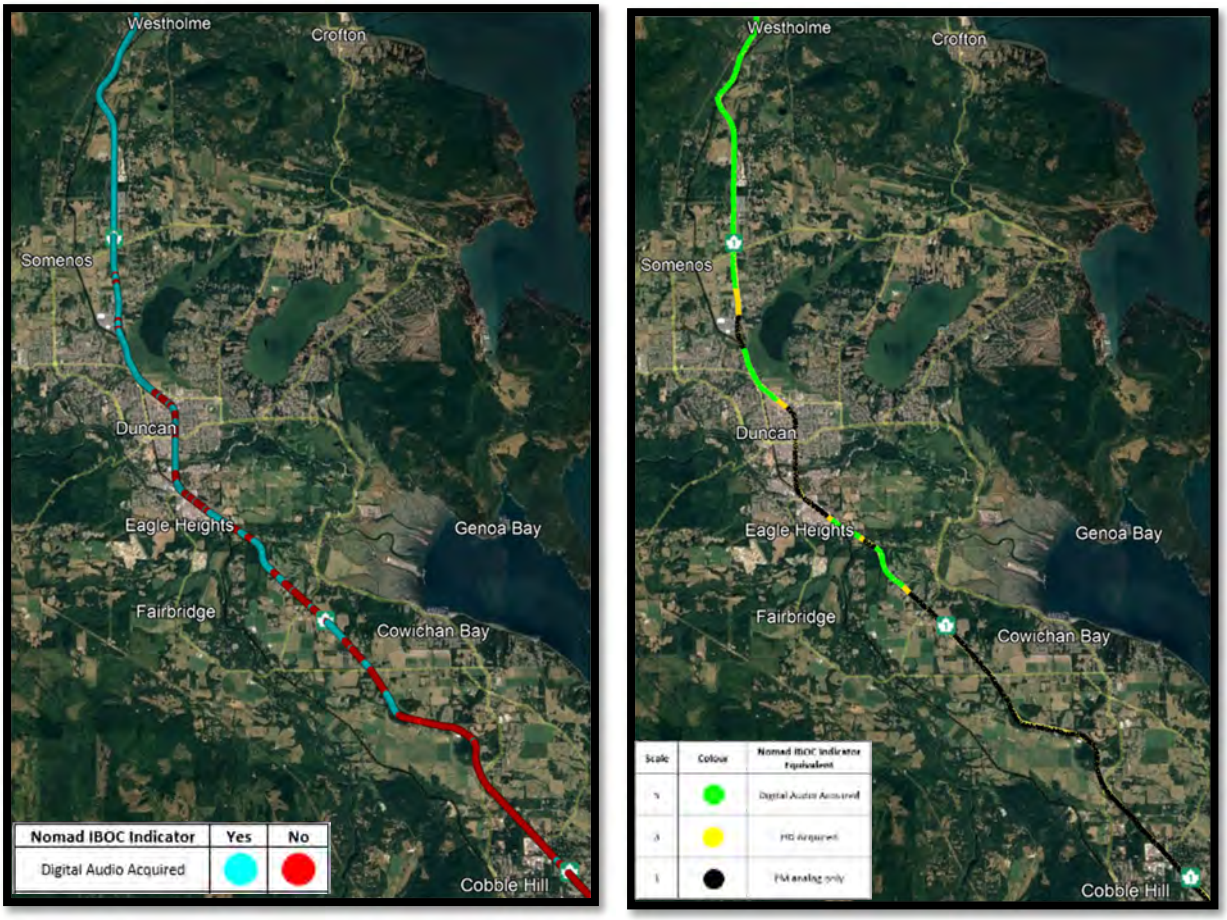

FIGURE 18 – DIGITAL AUDIO ACQUIRED AND SSQA – CBU-2-HD DUNCAN AND ITS SURROUNDINGS

6 CONCLUSION

The main purpose of this measurement campaign was to confirm the realistic actual coverage of the new HD Radio One CBU-2-HD station in Vancouver, BC.

In conclusion, CBU-2-HD covers well the following regions:

- Most of Greater Vancouver Area
- Nanaimo region, including the highway 1 between Qualicum Beach and Duncan

CBU-2-HD does not completely cover the following regions:

- Abbotsford
- Chilliwack
- Sunshine Coast
- Duncan and the South portion of highway 1 on Vancouver Island

It is important to note that CBU-2-HD is well received in Nanaimo and its surroundings. The supplemental channel HD2 or HD3 could be used to broadcast a specific content of Radio One for Victoria.

This report presents the conclusion for the actual coverage of CBU-2-HD broadcasted with the Jampro antenna at Mount Seymour. A second measurement campaign will be performed once Radio One will be broadcast from the future Rymsa antenna, in 2022.

The data collected in the campaign allowed us to conclude that HD indicators provided by the HDR/FM Nomad Analyzer receivers generally match the modified SSQA evaluation performed manually with on the car receiver. Consequently, for future HD radio surveys, it is probably not necessary to perform a manual subjective evaluation using the phone app since we can rely on the Nomad results.

In general, we also observed that the simulation of the C/N+I ratio above 20 dB correspond where the Nomad receiver decode the Digital Audio Acquired indicator, or where we rated the SSQA to 5 with the car receiver. Note that following the measurement campaign performed in the Great Toronto Area on the new CBLA-HD station (refer to ER20-05), we conclude that a C/N+I ratio above 10 dB correspond where the Nomad receiver decode the Digital Acquired indicator. We explain this difference between Toronto and Vancouver conclusions to the terrain elevation. We observe that due to the mountains in Vancouver region, the reflections could have a negative impact on the reception of the HD signal.

ANNEXE A SERVICES DESCRIPTION

Site	Service	Call Sign	Frequency	Channel	Class	EHAAT (m)	ERP H (W)	ERP V (W)	TPO (W)	Pattern	Polarization
Mount Seymour - Vancouver, BC	Radio One	CBU-2-FM	88.1 MHz	201	C	605.8	97 600	97 600	13 040	Directional	CP

						IBOC Injection Level					
Site	Service	Call Sign	Frequency	IBOC Mode	IBOC Split	Lower Side Band	Upper Side Band	Total	IBOC ERP H (W)	IBOC TPO (W)	
Mount Seymour - Vancouver, BC	Radio One	CBU-2-HD	88.1 MHz	MP3	Equal	-12.2 dBc	-12.2 dBc	-9.2 dBc	11 750	1 571	

ANNEXE B DESCRIPTION OF THE FM ANALOG SIGNAL - SIMULATIONS AND MEASUREMENTS

Simulations

The measured field strength is categorized in two levels, the 54dBµV/m and the 69.5dBµV/m. The 54dBµV/m threshold usually equals to a near-perfect reception using a car radio or an average quality radio receiver. The 69.5dBµV/m level represents the urban service contour. At this level, the FM signals are easily tunable in-building even with low quality receivers such as clock or portable radios.

The realistic algorithm used for simulation is the model CRC Predict v. 3.21 (with Computamap2 land cover) with an Rx antenna at 2 meters above ground level and is shown in the Google Earth file with the following color scheme:

Simulated Contour Fill (dBµV/m)	Colour
69.5 to 200	
54 to 69.5	

TABLE 4 – FM ANALOG SIGNAL - SIMULATION COLOUR SCHEME

Mobile Measurements at 2 meters

The mobile measurements at 2 meters were performed using Octave HDR/FM Nomad Analyzer. The receiving antenna is a magnetic monopole installed on the roof top of the car, which is an excellent ground plane. The Nomad allows measuring multiple FM carriers at the same time. It records the field strength levels and the geographical position of the device. It converts the readings in dBµV/m to compare them with the realistic simulation in real time during the campaign. For more information about the Nomad, refer to the system specifications by clicking here.

After the survey, the field strength measurements are exported in a Google Earth file (*Analog Main RF Level*) based on the colour scheme below.

Measurement (dBµV/m)	Colour
69.5 and above	
54 to 69.5	
48 to 54	
44 to 48	
40 to 44	
0 to 40	

TABLE 5 - FIELD STRENGTH MEASUREMENT COLOUR SCHEME

You'll find also the comparison between the realistic simulation and the measurement in Google Earth file (*RF Level vs Model Comparison*), according to the color scheme below.

Differential (dBµV/m)	Colour	Differential (dBµV/m)	Colour
-20 and less		+20 and more	
-10 to -20		+10 to +20	
-3 to -10		+3 to +10	
		-3 to +3	

TABLE 6 - FIELD STRENGTH MEASUREMENT COLOUR SCHEME

The measured multipath levels are exported in a Google Earth file based on the colour scheme below.

SSQA Equivalent	Occurence	Colour
5	0 to 5	
4	5 to 10	
3	10 to 15	
2	15 to 20	
1	20 to 25	
1	25 and more	

TABLE 7 – MULTIPATH COLOUR SCHEME