A survey of electromagnetic radiation levels on Gabriola Island

Introduction

This survey is in response to concerns that electromagnetic radiation might be a health hazard. I personally don't share those concerns;[1] however, some people disagree, and the Internet is rife with obfuscation on this topic.

It is of course impossible to prove that exposure to radiation is safe because no matter how long and often you test the hypothesis that it is hazardous, there will always remain the possibility that it is hazardous in a way that nobody has yet foreseen. Saying a particular technology should not be used until proven safe is tantamount to saying it should never be used because it *might* be unsafe.

I have not made any measurements inside buildings used by the general public. I feel to do so would require the owner or manager's permission, even though cell-phone users apparently do not require it.

The survey covered two frequency ranges:
1 MHz–8 GHz
which includes part of the medium frequency band (MF, 1–3 MHz), the high frequency band (HF, 3–30 MHz), the very-high frequency band (VHF, 30–300 MHz), the ultra-high frequency band (UHF, 300 MHz–3 GHz), and part of the super-high frequency band (SHF, 3–8 GHz). "Microwaves" can be in the range 300 MHz–300 GHz, though some engineers restrict use of the term to 1–100 GHz (3–300 mm);

40 Hz–100 kHz
which includes part of the super-low frequency band (SLF, 40–300 Hz), the ultra-low frequency band (ULF, 300 Hz–3 kHz), the very-low frequency band (VLF, 3–30 kHz), and part of the low frequency band (LF, 30–100 kHz). The extremely-low frequency band (ELF) is 3–30 Hz, but many writers include 50/60 Hz power supply frequencies in this.

There is a gap in this spectrum between 0.1 and 1 MHz (parts of the MF and HF frequency band), but sources in this range are almost certainly distant from Gabriola. Radio stations have been using this frequency band throughout the 20th century without giving any indication that the radiation is dangerous at low levels.

It is very unlikely that there are detectable sources on Gabriola in the upper part of the super-high frequency band (SHF, 8–30 GHz) or extremely-high frequency band (EHF, 30–300 GHz). Radiation at these frequencies is attenuated by the atmosphere which restricts their usefulness.

The far-infrared frequency band (FIR) starts at 300 GHz, and radiation above that frequency is dominated by the intense electromagnetic radiation from the sun.

[1] http://www.nickdoe.ca/pdfs/Webp52c.pdf

Instruments and measurement techniques

Units: For survey reporting purposes, I use units of watt per square metre (W/m^2), volt/metre (V/m), and tesla (T) with, as required, the appropriate SI prefix.

SI prefixes are:
n = nano- (0.000000001 = 10^{-9}); µ = micro- (0.000001 = 10^{-6}); m = milli- (0.001 = 10^{-3});
k = kilo- (1000 = 10^3); M = mega- (1000000 = 10^6); G = giga- (1000000000 = 10^9).

0.001 mW is a millionth of a watt or one microwatt (1 µW).

dBm are power levels relative to 1 milliwatt on a decibel scale.
For example, 6 dBm = $10^{6/10}$ = 4 mW and, conversely, 4 mW = 10 × $\log_{10}(4)$ = 6 dBm.

Frequencies are in hertz (Hz). Some of us used to call these cycles per second.

1. CORNET ED-85EX for electromagnetic field power density. Manual ED-85EX2 V.3.1L.

Antenna: The external whip antenna supplied with the instrument. The manual says this is centred for 2.4 GHz and can be used for "general use" up to 6 GHz.

Receiver bandwidth: 1 MHz–8 GHz.

Receiver sensitivity: –65 dBm although the lowest displayed calibrated level is –55 dBm. According to my reckoning, a disturbed sun would produce a signal of around -85 dBm in the receiver's 8-GHz bandwidth (12µV in 50 ohms), but natural atmospheric noise in the range 1–20 MHz might add a few dB to this.

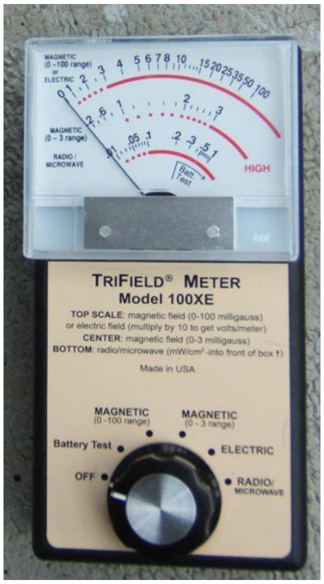
Receiver maximum input: The receiver maximum input is +10 dBm (5.8 W/m^2) confusingly also stated in the manual as 100 mW which is +20 dBm.

Calibration: For survey purposes, I calculate from the manual that the antenna calibration factor is 580. For example. A –20 dBm signal strength translates to a power density of 5.8 mW/m^2 and vice versa. Most sources fluctuate, so a more precise calibration is usually fairly meaningless anyway.

Floor value: The displayed floor level of the instrument –55 dBm is strictly speaking 0.0018 mW/m^2, though this is displayed as 0.001 mW/m^2, a negligible difference. Floor levels were noted in dBm and then converted to mW/m^2.

Peak value: I did not take any account of duty cycles of sources, and some were very low, radar and sporadic radio transmissions especially. The peak values are as recorded by the meter in mW/m^2 within an approximately two-minute period. The peak value range of the meter is 0.0015 mW/m^2 to 580 mW/m^2.

2. ALPHA LAB TriField Meter 100XE for electric and magnetic field strength.



The meter has three orthogonal axes for electric and magnetic fields, which eliminates sensitivity to field polarization.

Frequency: Calibrated at 60 Hz. Proportional to frequency in the range 40 Hz–500 Hz. Flat from 500 Hz–2 kHz. Inversely proportional to frequency 2 kHz–100 kHz.

The electromagnetic sensor has a frequency response: 50 MHz–3 GHz.

Electric field: scale: 10–1000 V/m

Magnetic field:
low scale: 0.2–3 mG (milligauss). Reported as 0.02–0.3 μT
high scale: 1–100 mG. Reported as 0.1–10 μT

Radio/Microwave fields: 0.01–1 mW/cm^2. Reported in this survey as 100–10,000 mW/m^2.

Standards

There are two general types of standard in use throughout the world. One type sets the level at which there is a known danger less a safety margin. The other type sets an arbitrary low level for which there is no convincing supporting evidence that it need be that low but based on a precautionary principle that it might be.

Electromagnetic

For electromagnetic power density, the ED-85EX meter displays its own standards. There are eight slightly adapted levels plus one "no signal" level of my own, as follows:

RED 3:	>200$^+$ mW/m^2 (–5 dBm)	Caution!
RED 2:	60$^+$–200 mW/m^2 (–10 dBm)	Caution!
RED 1:	20$^+$–60 mW/m^2 (–15 dBm)	Caution!
YELLOW 3:	6$^+$–20 mW/m^2 (–20 dBm)	Safe
YELLOW 2:	2$^+$–6 mW/m^2 (–25 dBm)	Safe
YELLOW 1:	0.6$^+$–2 mW/m^2 (–30 dBm)	Safe
GREEN 3:	0.20$^+$–0.6 mW/m^2 (–35 dBm)	Safe
GREEN 2:	0.001$^+$–0.20 mW/m^2 (–40 dBm)	Safe
GREEN 1:	= 0.001 mW/m^2 (–55 dBm)	No signal

According to the manual, I haven't checked these figures, standards are:

International:	5000–10,000 mW/m^2	RED 3
Austria:	6000–10,000 mW/m^2	RED 3
Belgium:	1000–2500 mW/m^2	RED 3
China:	6000–10,000 mW/m^2	RED 3
Germany:	4000–10,000 mW/m^2	RED 3
Italy:	1000 mW/m^2	RED 3
Japan:	6000–10,000 mW/m^2	RED 3
Netherlands:	7000–18,000 mW/m^2	RED 3
Russia:	20 mW/m^2	RED 1
Switzerland:	40–100 mW/m^2	RED 2
USA:	6000–12,000 mW/m^2	RED 3
Canada's is	10,000 mW/m^2	RED 3

The IARC ranks electromagnetic fields as Class 2B (insufficient evidence to reach a conclusion).

Facing the sun on a clear day is about 1 kW/m^2 (1000,000 mW/m^2) at ultra-violet, visible, infra-red, & radio frequencies. Standing one metre from a clothed person, exposes you to about 8000 mW/m^2 at infrared frequencies. Moonlight at its maximum is about 1 mW/m^2 at optical frequencies. You'd need a radio telescope to detect RF radiation from the moon, but it does exist.

Natural sources of RF electromagnetic radiation aside from the sun and moon include the atmosphere, stars (in the Milky Way especially), planets (Jupiter especially), and cosmic radiation left over from the Big Bang. Light and radiated heat are also electromagnetic.

Electric

Electric field strengths seldom seem to be a health issue for several reasons.

One is that natural atmospheric electric fields can be quite strong, even if there is no thunder and lightning about; fair-weather electric fields often exceed 100 V/m.

A second is that fields become relatively small when scaled down to biological-cell size compared with fields that are generated naturally by ionized and polarized biochemicals.

A third is that when anything moves in an electric field, it generates a magnetic field, so all but static electric fields are partly covered by magnetic field standards.

The arbitrary standards I use in this survey for quick scanning of the results are:

RED:	> 5 kV/m Caution! The 100XE limit is 1 kV/m, so overload was taken as RED	
YELLOW:	500^+ V/m	High, but unlikely to be unsafe
GREEN 2:	0^+ V/m	Measurable, but quite safe
GREEN 1:	0 V/m	No signal

The IARC ranks low-frequency and static electric fields as Class 3 (no evidence for concern).

By my reckoning, noise from (globally) distant lightning in the meter's bandwidth is around 5 V/m, which is close to the meter's lowest reading, but the meter usually reads what looks like zero away from power lines.

Magnetic

The arbitrary standards I use in this survey for quick scanning of the results are:

RED:	> 83 µT @ 60 Hz (100 µT @ 50 Hz) The 100XE limit is 10 µT, so overload was taken as RED	Caution!
YELLOW:	8.3^+ µT @ 60 Hz	High, but unlikely to be unsafe
GREEN 2:	0.02^+ µT	Measurable, but quite safe
GREEN 1:	0.02 µT	No signal

The IARC ranks static magnetic fields as Class 3 (no evidence for concern), but low-frequency magnetic fields as Class 2B (insufficient evidence to reach a conclusion).

The Earth's (quasi-static) magnetic field is about 60µT at our latitude. A typical fridge magnet (static) is about 500 µT.

The meter has no zero on its most sensitive scale so I take the lowest possible reading, 0.02 µT, as being "no signal".

Survey results

Electromagnetic power densities in inland areas away from roads and residences

	mW/m^2 floor	mW/m^2 peak		
707CP everywhere	0.001	0.001	GREEN 1	
S'ul-hween X'pey Reserve	0.001	0.001	GREEN 1	
MAX		0.001	GREEN 1	

Several hours of walking in the 707CP failed to produce a single detectable signal. Sites checked included the three high spots—Beacon Hill, Contemplation Hill, and Fresh Air View.

The effective distance ranges for the meter are for a CB Radio about 280 metres; for a cell-phone about 200 metres; and for a Wi-Fi LAN about 60 metres, so the message appears to be that anywhere on Gabriola more than 300 metres from a transmitter of any kind is free of significant radiation from a health-hazard perspective.

Electromagnetic power densities along the accessible coast

	mW/m^2 floor	mW/m^2 peak		
Brickyard Beach	0.001	0.001	GREEN 1	
Cemetery	0.001	0.001	GREEN 1	
Spring Beach	0.001	0.001	GREEN 1	
Degnen Wharf	0.001	0.178	GREEN 2	busy
Drumbeg Park	0.001	0.012	GREEN 2	sailboat radar?
Page’s Marina	0.001	0.012	GREEN 2	busy
Silva Bay Wharf	0.058	0.503	GREEN 3	busy
Siva Bay Inn Wharf	0.058	0.145	GREEN 2	
Dragon’s Lodge	0.006	0.044	GREEN 2	
Whalebone east	0.007	0.009	GREEN 2	
Whalebone west	0.002	0.010	GREEN 2	
Sandwell Park	0.002	0.030	GREEN 2	radar Entrance Is.?
Berry Point	0.002	0.089	GREEN 2	radar Entrance Is.?
Pilot Bay	0.001	0.001	GREEN 1	
Taylor Bay	0.009	0.041	GREEN 2	cell-phone(s)
Malaspina Gallery	0.006	0.039	GREEN 2	cell-phone(s)
Descanso Park	0.007	0.051	GREEN 2	
Ferry Terminal	0.001	0.001	GREEN 1	no traffic or ferry
Easthom Beach	0.001	0.001	GREEN 1	
	MAX	0.503	GREEN 3	

Contrary to my expectations, I did not see anything that could be ascribable to a ship’s radar out in the strait. The Silva Bay measurements were made before the new tower was operational.

Electromagnetic power densities at Descanso and Silva Bays

	mW/m^2 floor	mW/m^2 peak		
Ferry approaching		0.064	GREEN 2	ferry radio?
Ferry docked	0.001	0.002	GREEN 1	radar undetectable
Ferry unloading	0.001	0.366	GREEN 3	traffic at 4 m
Silva Bay COW*	0.730	1.460	YELLOW 1	at 1 m
Silva Bay COW	0.058	0.580	GREEN 3	at 10 m
Silva Bay COW		0.252	GREEN 3	at 13 m
Silva Bay COW	0.116	0.146	GREEN 2	at 20m
Silva Bay COW	0.018	0.023	GREEN 2	at 40 m
Silva Bay COW	0.018	0.029	GREEN 2	80m undetectable
Silva Bay tennis court	0.009	0.009	GREEN 2	
Log church	0.001	0.001	GREEN 1	at 138 m
Boat School yard	0.005	0.073	GREEN 2	
Liquor Store parking	0.092	0.183	GREEN 2	
	MAX	1.460	YELLOW 1	

*COW = cell on wheels [cell-phone towers are usually $10mW/m^2$ or less at ground level]

Note that the cell-phone tower radiation levels were less than those observed from cell-phones on the ferry.

~~A new tower to replace the COW will be operational soon.~~ New tower figures are as follows:

	mW/m^2 floor	mW/m^2 peak		
Silva Bay new tower		1.958	YELLOW 2	edge of base
Silva Bay new tower		3.483	YELLOW 2	at 1 m
Silva Bay new tower		0.356	GREEN 3	at 10 m
Silva Bay new tower		1.667	YELLOW 1	at 20m
Silva Bay new tower		0.174	GREEN 2	at 40 m
Silva Bay new tower		0.107	GREEN 2	at 80m
Log church		0.107	GREEN 2	at 138 m
Silva Bay new tower North Road	0.001	0.001	GREEN 1	at 195 m
Silva Bay new tower South Road	0.001	0.001	GREEN 1	at 203 m
	MAX	3.483	YELLOW 2	

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Electromagnetic power densities in public parking lots

NOTE: It is far from certain that the source of the radiation is the named business or that the measurement is repeatable. Anyone passing by with a cell-phone could have determined the reading.

Because of the variability of the measurements, I made two separate measurements on different days at each location. On the first pass, I looked at the "floor" levels and noted the peak using only the meter's dBm scale. On the second pass, I looked only at the peak readings as recorded by the meter in mW/m^2 over a two minute period.

	mW/m^2 floor	pass1 mW/m^2 peak	pass2 mW/m^2 peak	pass 1	pass 2
Wild Rose	0.001	0.001	0.001	GREEN 1	GREEN 1
Hope Centre	0.001	0.001	0.001	GREEN 1	GREEN 1
Islands Trust/RDN	0.001	0.016	0.001	GREEN 2	GREEN 1
Rollo	0.001	0.001	0.001	GREEN 1	GREEN 1
School	0.001	0.001	0.003	GREEN 1	GREEN 2
Commons	0.002	0.026	0.066	GREEN 2	GREEN 2
EMCON yard	0.001	0.001	0.001	GREEN 1	GREEN 1
Insurance Office	0.001	0.003	0.003	GREEN 2	GREEN 2
Gabriola Health Centre	0.002	0.007	0.031	GREEN 2	GREEN 2
Credit Union Bank	0.007	0.018	0.110	GREEN 2	GREEN 2
Harvest Thyme	0.002	0.183	0.276	GREEN 2	GREEN 3
Rollo Park	0.001	0.001	0.001	GREEN 1	GREEN 1
Robert's/ROXY	0.002	0.023	0.025	GREEN 2	GREEN 2
Co-op	0.001	0.001	0.325	GREEN 1	GREEN 2
Liquor store	0.002	0.046	0.356	GREEN 2	GREEN 2
Raven	0.001	0.001	0.005	GREEN 1	GREEN 2
Sounder	0.002	0.073	0.071	GREEN 2	GREEN 2
Architrave	0.001	0.001	0.022	GREEN 1	GREEN 2
Mad Rona's	0.002	0.023	0.061	GREEN 2	GREEN 2
Woodfire	0.001	0.001	0.006	GREEN 1	GREEN 2
Arbutus	0.001	0.001	0.001	GREEN 1	GREEN 1
Village Food	0.001	0.001	0.002	GREEN 1	GREEN 2
Pharmacy	0.005	0.183	0.015	GREEN 2	GREEN 2
Artworks	0.009	0.037	0.022	GREEN 2	GREEN 2
Raspberry's	0.009	0.023	0.027	GREEN 2	GREEN 2
Library	0.009	0.015	0.390	GREEN 2	GREEN 2
Realty Office	0.004	0.037	0.835	GREEN 2	YELLOW 1
Law Office	0.001	0.001	0.761	GREEN 1	YELLOW 1
Post Office	0.007	0.029	0.087	GREEN 2	GREEN 2
Museum	0.001	0.001	0.001	GREEN 1	GREEN 1
SKOL Pub	0.002	0.092	0.002	GREEN 2	GREEN 2

United Church busy	0.001	0.001	0.001	GREEN 1	GREEN 1
Fellowship Church	0.001	0.001	0.001	GREEN 1	GREEN 1
Shingle	0.001	0.001	0.001	GREEN 1	GREEN 1
Twin Beach Med.Centre	0.001	0.004	0.006	GREEN 2	GREEN 2
SKOL store	0.018	0.058	1.076	GREEN 2	YELLOW 1
Visitor Centre	0.015	0.037		GREEN 2	
Automotive	0.001	0.004	0.503	GREEN 2	GREEN 3
	MAX	0.183	1.076	GREEN 2	YELLOW 1

Electromagnetic power densities along major roads

For all roads, with no exceptions, there were long stretches at the “no signal” level (GREEN 1). All peak readings were only seen along short (<100 m) stretches or were transient.

	mW/m^2 floor	mW/m^2 peak		
South Road	0.001	0.003	GREEN 2	except- 100 m warm spot Wi-Fi?
South Road		0.061	GREEN 2	
North Road	0.001	0.009	GREEN 2	except- village warm spots
North Road		0.020	GREEN 2	
Tait/Ferne	0.001	0.007	GREEN 2	
Easthom/Harrison	0.001	0.001	GREEN 1	
Taylor/Berry	0.001	0.012	GREEN 2	
Barrett/Moby Dick/Whalebone	0.001	0.014	GREEN 2	1warm spot
Stephens/Dirkson	0.001	0.028	GREEN 2	cell-phone?
Pat Burns/Dempsey	0.001	0.004	GREEN 2	
Peterson	0.001	0.001	GREEN 1	
Stalker/Coast	0.001	0.007	GREEN 2	
Thompson/Island/Spring/Price	0.001	0.007	GREEN 2	
Hess/Chernoff	0.001	0.028	GREEN 2	2 warm spots
Norwich/Spruce/Hemlock	0.001	0.016	GREEN 2	
	MAX	0.061	GREEN 2	

Electric and magnetic field strengths along major roads

	μT	V/m	magnetic	electric	
South Road east beneath power lines	0.2	20	GREEN 2	GREEN 2	
South Road east opposite side to power line	0.2	0	GREEN 2	GREEN 1	
South Road west beneath power lines	0.6	0	GREEN 2	GREEN 1	
South Road west opposite side to power line	0.6	0	GREEN 2	GREEN 1	
South Road BCH feeder from V.I.	2.20	300	GREEN 2	GREEN 2	
North Road beneath line	0.06	20	GREEN 2	GREEN 2	3-phase
North Road beneath line	0.06	80	GREEN 2	GREEN 2	1-phase
Taylor Bay Road beneath line	0.18	0	GREEN 2	GREEN 1	
Taylor Bay Road opposite side to power line	0.3	0	GREEN 2	GREEN 1	
Ferry terminal area	0.16	0	GREEN 2	GREEN 1	
Silva Bay area	0.02	0	GREEN 1	GREEN 1	
MAX	2.20	300	GREEN 2	GREEN 2	

As expected, 3-phase distribution lines sometimes produced less signal than the 1-phase feeds to side roads and groups of houses. For a balanced 3-phase line, the fields drop with the cube of the distance, not just the square of the distance, once you are more than about 30 m from the line.

Some people believe that you can reduce your exposure to magnetic fields from power lines along roads by walking on the opposite side of the road. This is completely wrong if the power line is a 3-phase line. These have been designed to be balanced and so produce only a small field, but this only works if you are the same distance away from each of the three wires. Going to the opposite side of the road distorts the geometry and hence increases, not decreases, the combined field strength. For the T-style poles along Gabriola's roads, the magnetic field on the opposite side of the road (9 m away) of a balanced 3-phase line is theoretically 8.3 times higher than the magnetic field beneath the line. You'd have to move 27 m (88 feet) away from the line before the field was less than it is directly beneath the line.

In practice, it might not be nearly as bad as this because the line won't be perfectly balanced. If we assume for example that one wire is carrying 10% more current than the centre wire, and one is carrying 10% less, then the magnetic field on the opposite side of the road will theoretically be practically the same as it is directly under the line, which is close to what was observed.

Electromagnetic power densities personal space

	mW/m^2 floor	mW/m^2 peak		
Car	0.001	0.001	GREEN 1	
Car - under hood	0.001	0.001	GREEN 1	
Desk, PC on, CRT	0.001	0.001	GREEN 1	
Desk, iMac, LCD, wired router	0.015	0.105	GREEN 2	LCD screen?
Main guest bedroom	0.116	0.418	GREEN 3	ADSL wiring?
Second guest bedroom	0.001	0.001	GREEN 1	
Upstairs area	0.006	0.006	GREEN 2	
Upstairs bathroom	0.004	0.037	GREEN 2	
Stairwell	0.004	0.004	GREEN 2	
Living room, close to TV on	0.116	0.146	GREEN 2	CRT, Shaw digital modem
Living room, TV off	0.015	0.015	GREEN 2	
Kitchen, not in use	0.001	0.001	GREEN 1	
Dining area, µwave on		10.6	YELLOW 3	
Kitchen, µwave on		76	RED 2	
Kitchen, µwave door		too high for meter	RED 3	100XE reads in 5-10W/m^2 range
Deck	0.001	0.001	GREEN 1	
Master bedroom	0.200	0.366	GREEN 3	TV cable wiring?
Wireless phone idle	0.009	0.031	GREEN 2	at 1 m
Wireless phone in hand	0.009	0.091	GREEN 2	
Wireless phone in use		76	RED 2	ear level
Master bathroom	0.001	0.001	GREEN 1	
Utility room	0.001	0.001	GREEN 1	
	MAX		RED 3	

Electric and magnetic field strengths personal space

These field strengths don't mean a whole lot in detail because field strengths in the near-field are strongly dependent on distance from the source; doubling the distance will usually approximately reduce the strength by 4. To make these measurements, I made no effort to approach specific sources but just moved around as I would normally do; one can always get higher readings by approaching to less than 30 cm from specific sources.

	µT	V/m	magnetic	electric	
Desk, PC, lights	0.32	5	GREEN 2	GREEN 2	CFLs, CRT
Desk, PC	0.31	0	GREEN 2	GREEN 1	CRT
Office, PC, lights	0.03	13	GREEN 2	GREEN 2	incandescents, CRT
Office, PC	0.03	0	GREEN 2	GREEN 1	CRT
Desk, iMac, lights	0.12	8	GREEN 2	GREEN 2	incandescents, LCD
Upstairs area, lights	0.24	100	GREEN 2	GREEN 2	incandescents
Upstairs area	0.02	0	GREEN 1	GREEN 1	
Upstairs bathroom, lights	0.02	250	GREEN 1	GREEN 2	incandescents
Upstairs bathroom	0.02	0	GREEN 1	GREEN 1	
Main guest bedroom, bedside light	0.03	0	GREEN 2	GREEN 1	incandescent
Main guest bedroom	0.03	0	GREEN 2	GREEN 1	
Second guest bedroom	0.03	0	GREEN 2	GREEN 1	
Master bedroom	0.02	0	GREEN 1	GREEN 1	
Hairdryer	10	0	YELLOW	GREEN 1	
Kitchen, all off	0.03	0	GREEN 2	GREEN 1	
Kitchen, lights	0.07	0	GREEN 2	GREEN 1	incandescent
Kitchen, µwave	0.8	0	GREEN 2	GREEN 1	
Kitchen, fridge, at door	0.45	0	GREEN 2	GREEN 1	
Kitchen, oven at door	1.0	0	GREEN 2	GREEN 1	
Deck	0.02	0	GREEN 1	GREEN 1	
Stairwell	0.03	0	GREEN 2	GREEN 1	
Car interior	0.17	0	GREEN 2	GREEN 1	
TV @ 1 m	1.2	100	GREEN 2	GREEN 2	CRT
Breaker box @ 1 m	0.03	0	GREEN 2	GREEN 1	
Electromechanical meter @ 30 cm	1.0	0	GREEN 2	GREEN 1	
Smart meter @ 30 cm	0.2	0	GREEN 2	GREEN 1	quiescent
Living room, lights, TV	0.22	0	GREEN 2	GREEN 1	incandescents, CRT
Yard, beneath feed to house	0.02	0	GREEN 1	GREEN 1	
MAX	10	250	YELLOW	GREEN 2	

Electromagnetic power densities on the Nanaimo ferry

Measurements on the ferry were difficult because they varied so much both in location and with time. None of these readings are really steady-state levels.

Many of the sources are cell-phones or other hand-held electronic devices—I've no idea what people are actually doing when they're peering intently at their little gadgets. I made two sets of measurements on separate voyages. All readings while underway.

Passenger-carried sources were clearly stronger than sources used on the ferry for navigation and communication.

Theoretically, you need to be 1.5 metres (5 feet) away from a 600-milliwatt cell-phone source before the power density falls to 20 mW/m^2, which is about what I observed while passing by fellow passengers and not attracting their attention.

	mW/m^2 floor	mW/m^2 peak		
Vehicle deck voyage 1	0.058	0.224	GREEN 3	peaked under bridge one cell-phone
		1.7	YELLOW 1	
Lounge voyage 1	0.01	17.9	YELLOW 3	cell-phone at about 1m—six such devices in use
Vehicle deck voyage 2	0.037	0.503	GREEN 3	0.001 floor was also seen at front & back of vessel—peaked under the bridge
Lounge voyage 2	0.006	0.053	GREEN 2	no cell-phones observed
	MAX	17.9	YELLOW 3	

Discussion

Gabriola is evidently remarkably free of electromagnetic radiation. When I started this survey, I had in mind producing a map with contours showing radiation power densities, much like contours on a topographical map. As it turns out however, with few exceptions, once you are away from people and buildings, there is no measurable radiation. I spent many hours in the 707CP, for example, with my meters, and never once recorded a signal above the instruments' internal thermal noise levels.

The critical factor in all cases is how close you are to the source of the radiation, and for this reason, levels I recorded were always highest in my own home. At 60 Hz, for example, our hairdryer produced 10μT of magnetic radiation; yet, standing directly under the power line feeder to Gabriola, the highest I could get my meter to read was 2.2 μT. Similarly at radio and microwave frequencies, standing with my face peering in at the microwave oven with the door shut, something I almost never do, produced about 10 W/m^2; yet, the only place I could find that came anywhere close to this, leaving out pressing a wireless phone to my ear, was on the ferry when about six people in the passenger lounge were using some sort of wireless device and producing around 0.02 W/m^2 where I sat.

Although I cannot be sure, I would say most of the radio frequency radiation I observed was coming from cell-phones. There were a few exceptions—a radar was detected at Berry Point and a radio transmission from a boat—but not many. Some sources that might be expected to be significant sources of radiation turned out not to be, notably the ~~temporary COW (cell on wheels)~~ cell-phone tower at Silva Bay. I could not detect the radar on the ferry, but I could some of the bridge navigation equipment and the radio, even though the radiation produced by the vessel was less than that generated by passengers. Wi-Fi networks have a limited range and long stretches of all roads on Gabriola were essentially free of microwave radiation.

Nowhere during this survey on Gabriola outside my home did I encounter a radiation level at any frequency that exceeded the most stringent safety standard in the world.

Appendix: Smart meters

We have one BC Hydro smart meter installed on our street (El Verano); however, they transmit so infrequently and so briefly that I have not seen, or been able to measure, any radiation from it.

Determining the power density radiation levels of the meters is not a simple matter for several reasons: we have to be clear which of three possible transmitters within the meter we are talking about (one is for the 900 MHz RF LAN, an end-point meter function, one is for the Zigbee 2.4 GHz HAN, an optional home-area-network end-point meter function, and one is for the WWAN connection, a cell-relay function not used in the BC Hydro configuration); and the antennas in the meters are anisotropic because of shielding by the metal box and the wall of the house. The effect of variable ground reflections have also to be included.

All of these details have been studied in depth and the results reported in: Electric Power Research Institute, *An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter*, 2010 Technical Report available from EPRI. Readers of this report will also need the FCC (1997) OET Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, to translate FCC MPE (maximum permissible exposure) units used throughout the report.[2]

I would conclude from the results of these reports that smart meters would have had no effect on the results of this survey saving only perhaps a single measurement made on my own property in the vicinity of the meter at a time when the meter was active, or perhaps in the vicinity of a data-collector mounted on a pole at the roadside.

Radiation levels from the meter into the interior of my house are, according to the EPRI study, likely to be much lower than from the front of the meter due to shielding by the wall (–6 dB) and reflection within the meter (–18 dB). The report (Tables 9-6 & 9-8, 900 MHz) records the equivalent of 0.6 mW/m^2 (0.01% MPE) directly behind the meter inside the houses, and a floor level of around 0.03 mW/m^2 (0.0005% MPE) elsewhere, likely due to Wi-Fi routers used for Internet connectivity, and not due to the meter.

Given a conservative estimate of 0.04% for the duty cycle of a residential meter (p.12-5), that is the transmitter is on for periods of less than 35 seconds per day,[3] I would again conclude that a smart meter at my home would have had no effect on the results of this survey. ◊

[2] My detailed notes on these reports is included in http://www.nickdoe.ca/pdfs/Webp659.pdf

[3] BC Hydro says their's will be on for less than one minute a day.