CRTC Consultation 2019-57 5G Spectrum, Wavelength, Related Harm and Charter Breaches, Prepared in Support of the Intervention of EMF-OFF!

AFFIDAVIT May 15, 2019

Dr. Magda Havas, B.Sc., Ph.D., Professor Emeritus
Trent School of the Environment, Trent University
1600 West Band Drive, Peterborough, ON, K9J 7B8, Canada
mhavas@trentu.ca

This documents provides an overview of the effects on humans, plants and animals of non-ionizing electromagnetic pollution from extremely low frequency (ELF) electromagnetic fields (EMF) to radio frequency (RF) and microwave (MW) radiation flowing through the air, along the ground, along wires and other conducting objects. It provides a critique of Health Canada's Safety Code 6 and questions why the Government of Canada has failed to respond to HESA recommendations on radio frequency radiation issued by the Standing Committee on Health in 2015. Furthermore, concern is raised about the rapid deployment of 5th generation (5G) telecommunication technology, the use of mmwaves, increased exposure to frequencies commonly used in 3G and 4G technology and the potential long-term biological and health effects to humans and other organisms associated with 5G and the Internet of Things (IoT).

I. ACADEMIC CREDENTIALS

1. My name is Magda Havas, B.Sc., Ph.D. and I am a recently retired professor from Trent University (Trent School of the Environment), Peterborough, Ontario, Canada. My background is in environmental toxicology and for the past 44 years I taught and conducted research on the biological effects of chemical pollutants (1975–2000) and non-ionizing electromagnetic pollution (1995–present). I also do research on the beneficial effects of pulsed electromagnetic frequencies. My *Curriculum Vitae* is attached (Exhibit A).

2. Since 1995 I have become increasingly involved with assessing the potentially harmful effects of electromagnetic pollution (commonly referred to as electrosmog). I have conducted research and published in the area of extremely low frequency electromagnetic fields, poor power quality, radio frequency and microwave radiation, as well as ground current pollution.

3. I regularly give lectures and workshops at medical conferences where doctors receive medical accreditation. I am internationally recognized as an expert on the health effects of electromagnetic pollution. To date I have lectured in 30 countries and at 25 universities and have more than 190 publications. I co-authored the book, *Public Health SOS: The Shadow Side of the Wireless Revolution.* I provide advice about electrosmog to governing bodies and NGOs around the world (Canada, U.S., U.K., Spain, Italy, Netherlands, Brussels, South Africa, Australia). During the past few years I have provided expert

testimony related to electrohypersensitivity (EHS) and to the health effects of high voltage transmission lines, radio antennas, cell phone antennas, smart meters, and occupational & residential exposure to electromagnetic fields/radiation.

II. TYPES AND SOURCES OF NON-IONIZING ELECTROMAGNETIC POLLUTION (ELECTROSMOG)

4. In this affidavit, I refer to non-ionizing radiation (NIR) and to both electromagnetic fields (EMF) and electromagnetic radiation (EMR). NOTE: Non-ionizing radiation (NIR) refers to the entire electromagnetic spectrum below ultraviolet (UV) radiation (Figure 1). NIR includes extremely low frequency electric and magnetic fields (less than 300 Hz); intermediate frequencies (kHz range); radio frequencies (3 kHz to 300 MHz); microwave radiation (300 MHz to 300 GHz); and mmwaves (30 to 300 GHz), which is part of the 5th generation (5G) telecommunication technology and the Internet of Things (IoT). Infrared radiation and visible light are also NIR, but are not included in this affidavit.

5. Electromagnetic pollution (commonly referred to as electrosmog) can flow through the air, along wires and other conducting materials, and along the ground (see Figure 2).

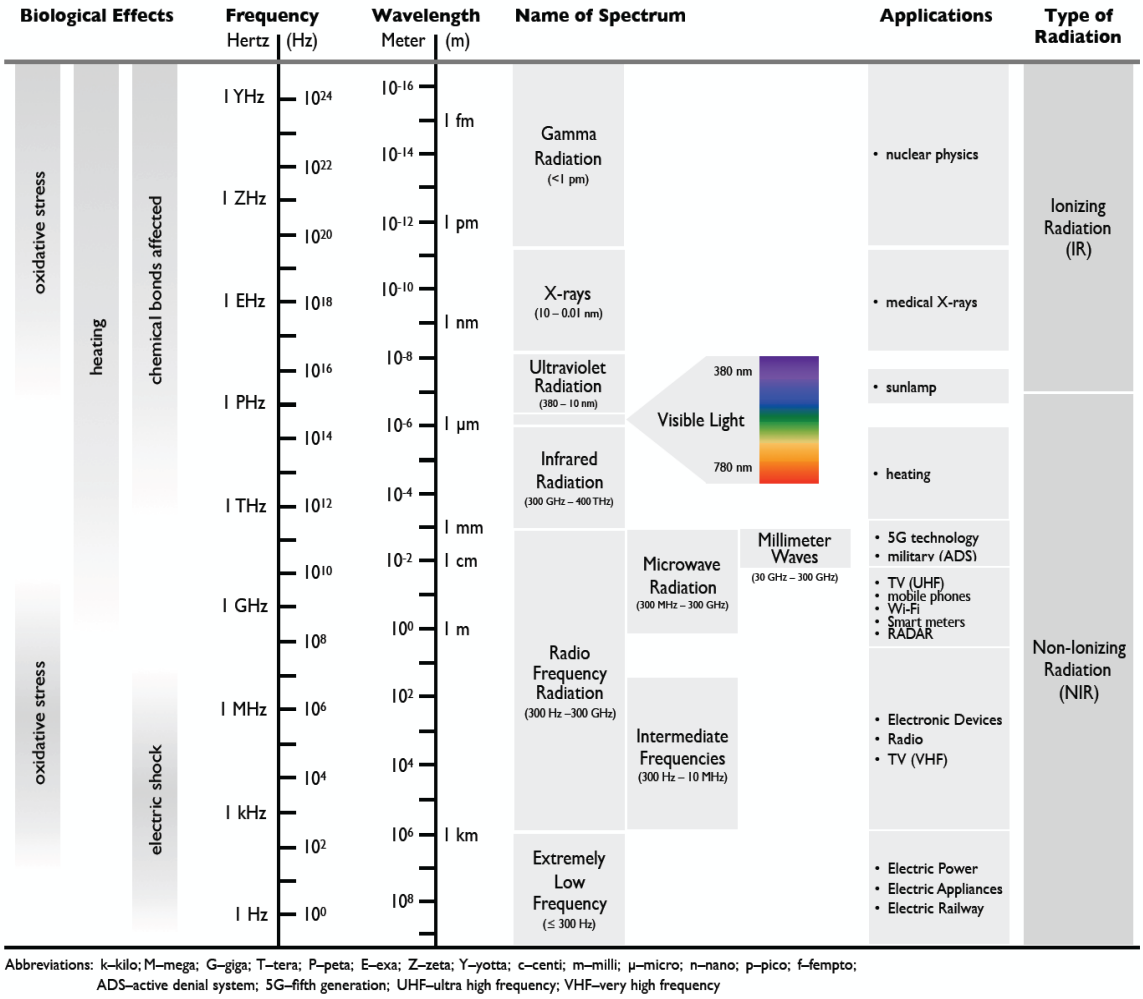


Figure 1. The electromagnetic spectrum showing frequency, wavelength, applications and biological effects.

6. Radio frequency and microwave radiation are generated by wireless devices (cell phones, Wi-Fi routers, smart meters, smart appliances; radar as well as by radio and televisions broadcast antennas). Extremely low frequency electromagnetic fields (ELF EMFs) are generated during the use, distribution and transmission of electricity. Poor power quality (or dirty electricity) refers to high frequency voltage transients (surges) on power lines, which are caused by arcing and energy efficient appliances as well as by electronic devices, wind

turbines, and solar power when converted from direct to alternating current (AC). 5G technology incorporates mmwaves (above 6 GHz and generally between 30 and 300 GHz) as well as lower frequencies in the 600 to 700 MHz range. The various frequencies that will be used for 5G has yet to be determined.

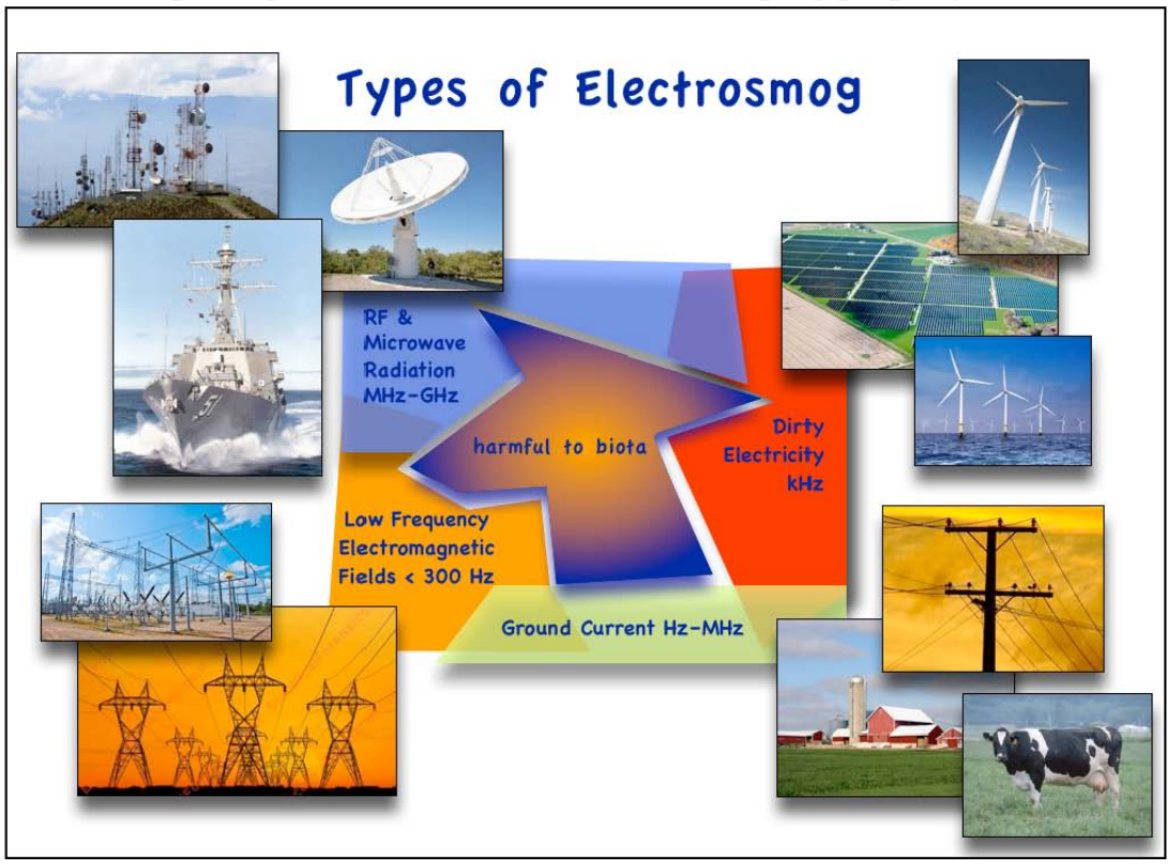


Figure 2. Different types of electrosmog generated by anthropogenic sources.

III. EFFECTS OF ELECTROSMOG ON HUMANS

7. Human health effects of electrosmog fall into three categories: cancers, reproductive problems; and neurological/hormonal disorders that are collectively referred to as electrohypersensitivity (EHS).

CANCERS

8. RFR has been associated with cancers in people who use cell phones for more than 10 years. The tumors occur primarily on the same side of the head exposed to the cell phone (ipsilateral tumors) and they include gliomas, meningiomas, acoustic neuromas, and salivary gland tumors (Hardell et al. 2009; Cardis et al. 2011; Sadetski et al. 2008).

9. People who live near cell phone base stations, radio and TV broadcast antennas and radar installation have a greater risk of developing and dying from cancers than people who live further away (Hocking et al 1996; Michelozzi et al. 1998; Dode et al. 2011; Yakymenko et al. 2011). Many of these studies show an increase in leukemias especially among children.

10. Those who are occupationally exposed to RFR/MW radiation have a greater risk of developing different types of cancers (Wirth et al. 2013).

11. Residential exposure to ELF EMF has been associated with an increased risk of childhood leukemia at and above 2–3 mG. The higher the magnetic field strength the greater the risk of cancer (Figure 3).

12. With adults the values at which an increased risk of adverse health effects have been documented are generally higher than for children and range from 10–12 mG for brain cancer (Savitz and Loomis 1996; Savitz et al. 2000); 10 mG for adult leukemia (Bethwaite et al. 2001); 12 mG for breast cancer, and 20 mG for chromosomal aberrations (cited in Havas 2000). All of the studies except for

breast cancer are based on occupational exposure in epidemiological studies and demonstrate an association between exposure and outcome.

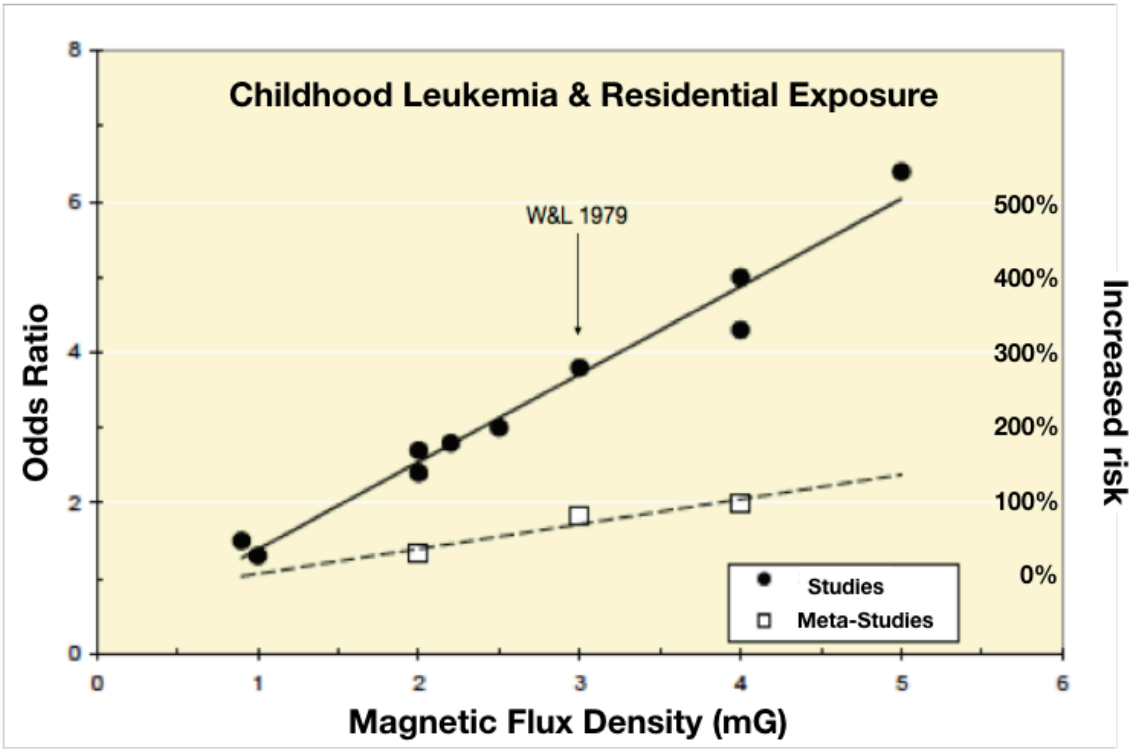


Figure 3. Epidemiological studies of childhood leukemia and residential magnetic field exposure indicate a dose-response relationship. Studies include: Wertheimer and Leeper, 1979; Savitz et al. 1988; Olsen 1992; Feychting and Albom 1993; Linet et al. 1997, Schulz et al. 2001; and for the meta-studies Albom et al. 2000; Greenland et al. 2000; and Wartenberg et al. 2001.

13. In one study (Milham and Morgan 2008), high frequency voltage transients (HFVT) or dirty electricity was associated with an increased risk of various cancers among school teachers in a California school. The risk or odds ratio (OR) for all cancers combined was 2.78 and was statistically significant. The risk for individual cancers was 9.19 for cancer of the uterus; 9.76 for malignant melanoma; and 13.3 for thyroid cancer (all highly significant).

14. These are all epidemiological studies and such studies show an *association* between exposure (or a surrogate of exposure like distance) and an increased risk of cancer that increases with cumulative exposure.

15. We also have at least three large, well-controlled, animal studies documenting that MW radiation causes cancer (Chou et al. 1992; NTP 2018; Falcioni et al. 2019) and several studies showing that MW radiation damages DNA in rodents (Phillips et al. 2009). More information is provided below when I discuss effects of RFR on laboratory animals.

16. Ionizing radiation (IR), in contrast to NIR, has enough energy to dislodge electrons from atoms, damage DNA and thus cause cancer. For decades, scientists believed that NIR, because it didn't have enough energy to break chemical bonds, could not cause cancer. However, we now know that NIR increases free radicals by interfering with the neutralization of reactive oxygen species (ROS) that are a natural byproduct of metabolism and respiration (Yakymenko et al. 2016).

17. ROS generate oxidative stress and are known to cause cancer and are implicated in various disease states including but not limited to arthritis, asthma, dermatitis, sexual dysfunction, liver damage, retinal damage, cataracts, stroke, atherosclerosis, and heart attack.

18. Since free radical damage is one of the key mechanisms in electrosmog health effects for both ELF and RF radiation and because a lay audience poorly

understands the concept of free radical damage, I provide a brief description here (see also Havas 2017).

19. A stable molecule has a pair of electrons in its outer orbital (Figure 4, blue face). Oxidizing agents (red face) like ionizing radiation and certain chemical pollutants can remove an electron and generate a free radical (green face). Free radicals are chemically reactive and cause oxidative damage (a type of rusting) to cells and organelles. Anti-oxidants (yellow face) are chemicals (like vitamin C, E, B12; minerals like zinc, selenium, manganese; melatonin, CoQ10 and various enzymes like superoxide dismutase) that are able to donate electrons to free radicals and thus begin to repair oxidative damage.

20. There are two ways to increase free radical damage in the body. One is to increase exposure to oxidizing agents and the other is to reduce exposure to anti-oxidants. IR creates free radicals while NIR interferes with anti-oxidant repair mechanisms. Both mechanisms can contribute to cancer (Havas 2017).

REPRODUCTION

21. Considerable evidence shows that NIR damages sperm. At least twenty studies show abnormalities in sperm, which have clear implications for male infertility. At least five studies show DNA damage, which could be teratogenic (affecting the development of the embryo or fetus) and multi-generational.

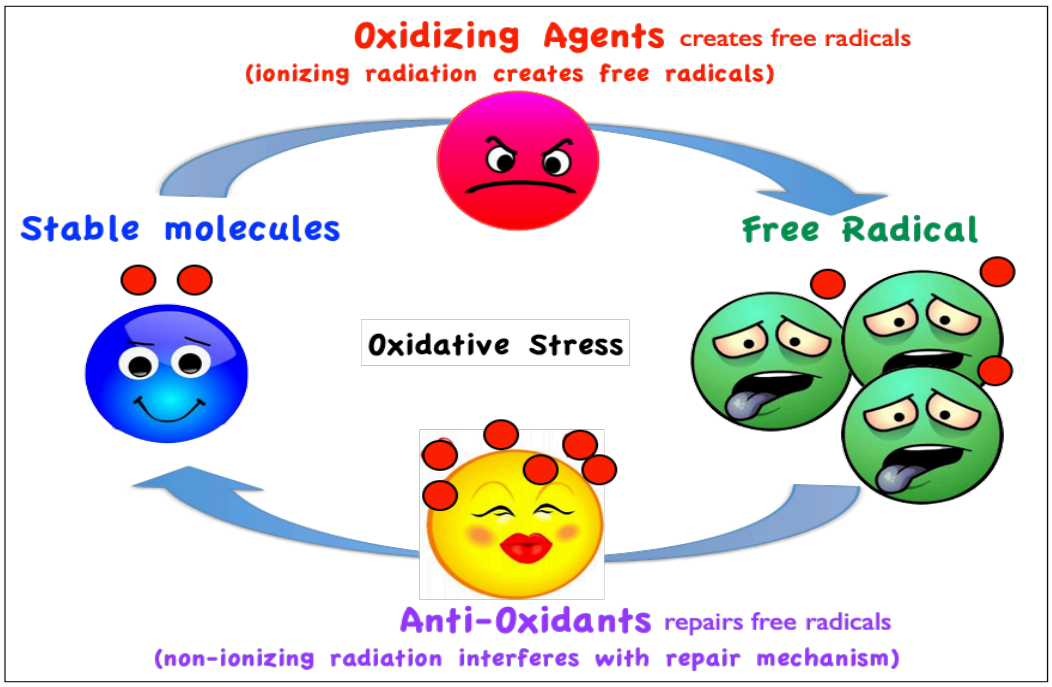


Figure 4. Oxidizing agents and anti-oxidants are responsible for generating and repairing free radical damage and oxidative stress. Source: Havas 2017.

22. Agarwal et al. (2008) documented reduced sperm count, reduced sperm motility, reduced sperm viability and increased abnormal sperm morphology among men who use cell phones. The longer they use cell phones each day the greater the damage to sperm (Figure 5). This study shows a dose-response relationship and such results suggest *causation*.

23. Adams et al. (2014) conducted a meta-analysis based on ten studies regarding the effects of mobile phones on sperm quality and presented the following conclusions in their abstract:

We conclude that pooled results from in vitro and in vivo studies suggest that mobile phone exposure negatively affects sperm quality. Further study is

required to determine the full clinical implications for both sub-fertile men and the general population.

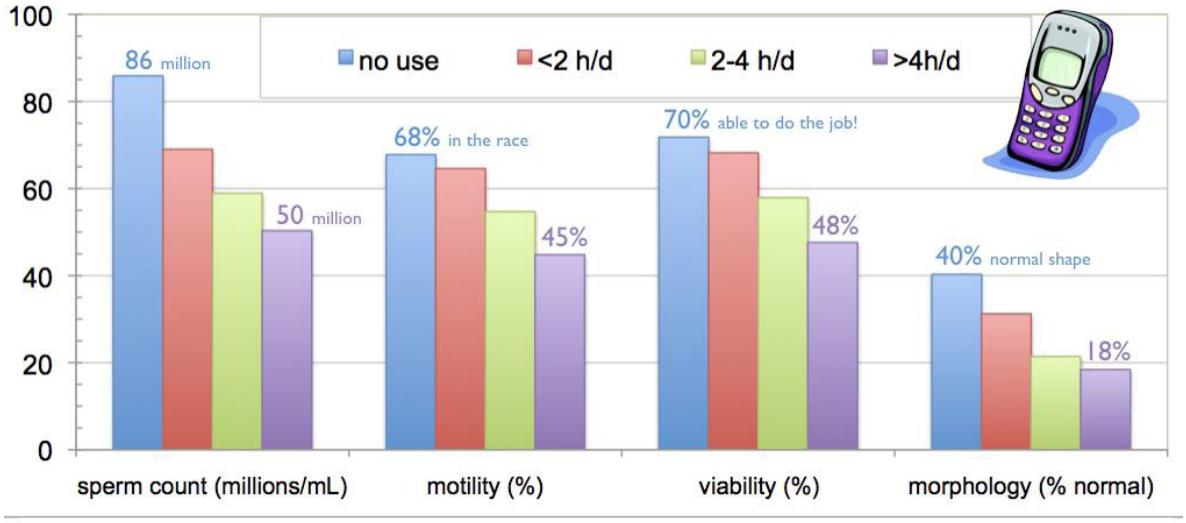


Figure 5. Cell phone use and sperm quality. The categories are based on the amount of cell phone use by men during a day that range from no use (blue); less than 2 hours daily (red); 2 to 4 hours daily (green) and more than 4 hours daily (purple). Data based on Agarwal et al. 2008.

24. In one laboratory study (Kesari et al. 2011) reactive oxygen species (ROS) were shown to reduce testosterone in rats exposed to mobile phone radiation. Lower levels of testosterone are often associated with altered sperm production. Note testosterone levels were also lower for people who live within 500 m of cell phone antennas (Eskander et al. 2012).

25. We have scientific evidence from both human and animal studies documenting damage to sperm, impaired reproduction and altered hormonal levels. There is nothing more powerful in science as when studies, conducted in different ways, in different countries, with various organisms including humans, by many researchers point in the same direction and support the concept that RF and

MW radiation harms sperm, reduces testosterone levels and adversely affects reproduction.

26. In addition to sperm damage, there is also evidence that women who are exposed to RF/MW radiation while pregnant have a greater risk of giving birth to offspring with attention deficit hyperactivity disorder (ADHD) (Divan et al. 2008). Authors concluded that, "Exposure to cell phones prenatally—and, to a lesser degree, postnatally—was associated with behavioral difficulties such as emotional and hyperactivity problems around the age of school entry. These associations may be noncausal and may be due to unmeasured confounding. If real, they would be of public health concern given the widespread use of this technology."

27. Exposure of pregnant women to elevated levels of ELF EMF (16 mG or higher) increases their risk of having a miscarriage (Li et al. 2002). Maternal exposure to low frequency magnetic fields above 2 mG is associated with a significant increased risk (252%) of asthma in offspring (Li et al. 2011).

ELECTROHYPERSENSITIVITY (EHS)

28. EHS also called *radio wave sickness* refers to a medical condition that includes poor sleep; chronic fatigue; cognitive dysfunction including brain fog, difficulty concentrating and poor short-term memory; mood disorders including depression and anxiety; chronic pain including headaches and/or migraines; dizziness; nausea; tinnitus; heart palpitations; abnormal blood sugar; skin problems; asthma; among others (Bevington 2018). This syndrome was

originally called *neurasthenia* or *asthenic syndrome* and later *microwave illness* or *radio wave sickness*. The scientific community has recognized these symptoms since the early to mid 1900s.

29. Dodge (1969) states that electromagnetic radiation affects the central nervous system, autonomic nervous system, neurohumoral systems, endocrine glands and function, eye and ocular functions, blood and hemapoietic system and miscellaneous organs in humans.

30. Santini et al. (2002) reported the health symptoms of people who live at different distances from cell phone antennas. People who lived closest to the antennas (within 10 m, red columns, Figure 6) had the highest incidence of symptoms and those furthest away (beyond 300 m, black columns) had the lowest incidence. Similar results have been reported in other countries.

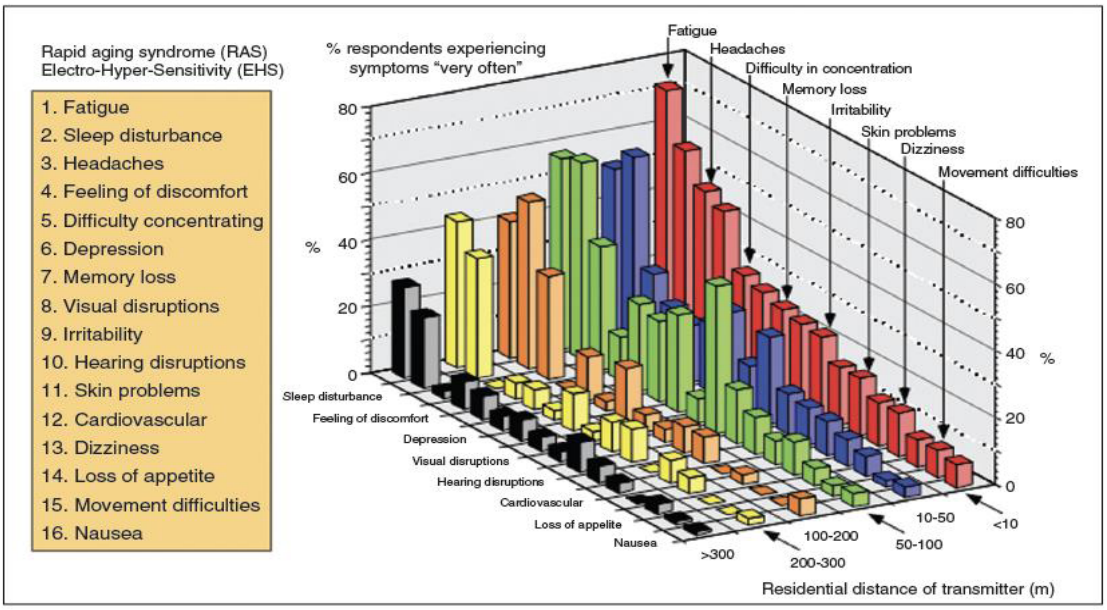


Figure 6. Symptoms experienced by people living near cellular phone base stations. Based on work by Santini et al. 2002. Reproduced from Havas 2013.

31. A number of people who have developed EHS complain of heart palpitations when they are exposed to microwave radiation. We did double-blind, placebo-controlled study with 25 human volunteers in Colorado to test the effects of radiation from a mobile phone base station on heart rate variability (HRV) (Havas et al. 2010). While many of the volunteers were not affected by the radiation, we found that those who were sensitive to this radiation developed either tachycardia (rapid heart rate) or arrhythmia (irregular heart rate) when exposed to 2.4 GHz frequencies generated by a cordless phone base station placed near their head. For some, the body went into a "fight, flight or faint" response as indicated by their autonomic nervous system (ANS) with an up regulation of their sympathetic tone and a down regulation of their parasympathetic tone. When this happens, a person feels as though he/she is having either an anxiety attack or a heart attack. The former is a more accurate description of what is happening. When the cordless phone base station was disconnected from the electrical outlet, the heart rate and the autonomic nervous system returned to normal. Some of the early research also indicates that MWs affect the autonomic nervous system and the heart and some scientists recommend that those who are going to work with MW radiation should be screen to ensure they can tolerate the exposure.

32. There is evidence that MWs affect the heart, the ANS, as well as the blood (Havas 2013). My own blood becomes more viscous when I am exposed to MW radiation for 10 minutes and this can be observed under a microscope

(Plate 1). Symptoms of this can involve cold, numbness or tingling in fingers and toes; dizziness and nausea; with more severe symptoms leading to blood clots, strokes, or heart attacks.

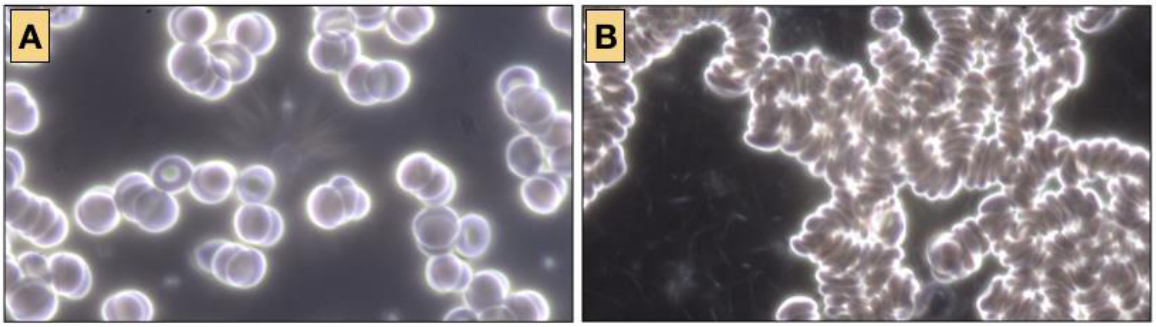


Plate 1. Live blood under dark field microscopy. (A) is in an electromagnetically clean environment and (B) is after a 10-minute exposure of the body to microwave radiation generated by a home Wi-Fi router. The red blood cells on the right (B) are sticking together in what is known as rouleau formation. This interferes with exchange of gases and nutrients and can lead to serious health problems and is one of the responses of people who are hypersensitive to electromagnetic radiation.

33. There are now tens of thousands of peer-reviewed documents on these effects, and what few people realize is that the effects mentioned above have been known for decades. Dr. Zory R. Glaser, former U.S. Navy Researcher and the Navy's key person responsible for microwave health, NIOSH Manger and Executive Secretary to the U.S. FDA, gave me his entire collection of declassified research articles, letters, and notes (more than 6000 documents) when he retired. Some of those articles are on my website: http://magdahavas.com/category/from-zorys-archive/ .

34. As early as 1971, Dr. Glaser published a paper that listed more than 2000 references documenting the adverse effects of microwave radiation. The Glaser document counters the statements that "credible" research showing non-thermal effects does not exist. The research that I summarized is newer research and is

just a small sample of what is available in the scientific literature. The statement that there are no adverse biological effects below the thermal guidelines is a false statement promoted by those who are either unaware of the scientific literature or unwilling to admit this radiation–at levels to which we are currently exposed–can be harmful. Good science that most people would consider "credible" does exist and has been around for decades, although many have largely ignored this science as it contradicts their worldview that this radiation is safe.

35. The above-mentioned effects (cancers, reproductive problems and neurological disorders) are documented at levels well below current U.S. and Canadian guidelines, which were designed only to prevent a heating effect in healthy adult males. These guidelines have not been updated despite the fact that our exposure to RF/MW radiation has increased considerably with the invention of wireless technology and that this exposure is no longer limited to the military or occupations but is found in homes, schools, hospitals, etc. and is difficult to avoid.

36. The intensity of RF radiation is measured as *power density* and the units are *Watts per meter squared* or *Watts per centimeter squared*. In the scientific literature values can range 12 or more orders of magnitude and so the units will vary from Watts (W) to milliW (1/1,000th of a W) to microW (1/1,000,000th of a W). In this document to minimize confusion I will convert all values to microW/cm^2.

37. The FCC guidelines have been significantly reduced in stages from 100,000 to 1,000 microW/cm^2 but are still 100 times higher than the current Russian guideline (which is 10 microW/cm^2).

38. Steneck et al. (1980) reviewed the origins of the U.S. safety standards for microwave radiation. The significance of this research is provided on my website [http://magdahavas.com/pick-of-the-week-2-origins-of-1966-u-s-safety-standards-for-microwave-radiation/ and is partly reproduced below. Based on published and unpublished literature as well as interviews and questionnaires, the authors of this report pieced together the process that led to the 1980 standard of 10 milliW/cm^2 (which is the same as 10,000 microW/cm^2) designed to protect military and occupationally exposed personnel from microwave radiation. The original recommended standard, established in 1953, was 100 milliW/cm^2 (100,000 microW/cm^2) and was based on a quick-and-dirty calculation that was grossly flawed and was almost immediately revised downward to 10 milliW/cm^2 (or 10,000 microW/cm^2). This calculation was based on the ability of a 70-kg man to dissipate heat. The 100 milliW/cm^2 (100,000 microW/cm^2) was obviously too high so a safety factor of 10 was introduced to reduce it to 10 milliW/cm^2 (10,000 microW/cm^2). In the 1990s, this value was deemed too high and was further reduced to 1 milliW/cm^2 (1,000 microW/cm^2), which is the current guideline internationally and in the U.S. Canada recently reduced their guideline by about 50% for microwave radiation but these levels are still too high to protect the public.

39. If a particular level of exposure is deemed harmful, then often a "safety factor"

is introduced to provide a margin of safety. Initially the disagreement about the appropriate safety factor ranged from a safety factor of 10 recommended by the US military to 100 suggested by General Electric to 1,000 suggested by Bell Telephone Laboratories. The military prevailed. Evidence for non-thermal effects was discounted. Had the Bell Laboratories' guideline prevailed current guideline would be 100 times lower and closer to those in Russia.

40. What few people realize is that emphasis at the time was to protect military operations and secondarily to protect military personnel. Protection of the general public was barely discussed, and no public standards were set because microwaves were viewed as radar and radar was limited to military and industrial exposure.

41. Both *microwaves* and *intermediate frequencies* (IF) are classified as radio frequencies although they are at different parts of the RF spectrum. MWs range from 300 MHz to 300 GHz and IFs are primarily in the kHz range. When RFR is used for telecommunication, it is modulated at frequencies ranging from extremely low to thousands of cycles per second (kHz). Indeed, it is these frequencies that provide the information. Consequently, exposure consists of the carrier wave and the modulated frequencies, both of which can elicit a biological response. So while we can discuss isolated regions of the electromagnetic spectrum and their effects, in real life situations, people are exposed to multiple frequencies that include combinations of ELF and RFR.

42. While MWs travel through the air and can penetrate buildings, IFs flow along electrical wires in the home and can radiate from these wires. Another term for

these IFs is "dirty electricity," which contributes to poor power quality. Dirty electricity consists of high frequency voltage transients (HFVT) that can be measured using an oscilloscope. HFVTs contribute to electromagnetic interferences (EMI) that can damage sensitive electronic equipment. Similarly, these frequencies can interfere with the electrical circuitry in the body. Ontario Hydro (1996) has a 130-page reference guide, entitled *Power Quality,* dealing with remediating poor power quality as it is the utility's responsibility to bring clean, safe power to its clients.

43. We have worked with pre-diabetics and diabetics (type 1 and type 2) and found that some of these individuals have great difficulty regulating their blood sugar in an environment where they are exposed to poor power quality or RF radiation (Havas 2008). When levels of dirty electricity are high their blood sugar increases rapidly (within a matter of 20 minutes) and when they move to an electromagnetically clean environment their blood sugar drops just as rapidly. Often these individuals require more medication in an environment with EMF pollution. Being unable to control blood sugar can be life threatening and can contribute to chronic illness including but not limited to organ damage, poor circulation, blindness, neuropathy and–in some cases–the eventual need for amputation of limbs. Diabetics who respond to electrosmog in this manner are deemed to be electrically hypersensitive.

44. According to the Center for Disease Control (CDC), 30 million people in the U.S. (9.4% of the American population) had diabetes in 2015. With so many diabetics and pre-diabetics in the U.S. it is unwise to increase their exposure to

electromagnetic radiation if this can be avoided. Exacerbating symptoms of diabetes, for those diabetics and pre-diabetics who are sensitive to this radiation, is likely to be quite costly from a human health perspective and will place greater pressure on the health care system in this country.

45. We have done studies with people who have Multiple Sclerosis (MS) and found that their symptoms improve when the dirty electricity in their home is reduced (Havas 2006). We have video evidence of tremors and ability to walk before and after remediation with no change in medication (see http://magdahavas.com/multiple-sclerosis-and-dirty-electricity/).

46. The symptoms of MS and EHS are similar and it is quite likely that some patients with EHS have been misdiagnosed as having multiple sclerosis.

47. We also have evidence that living in a home for seven years with reduced levels of dirty electricity repairs sclerosis in the brain as measured by MRI scans and hence this cannot be considered a placebo effect. In addition to improved physical symptoms like balance and tremors, we also noticed an improvement in cognitive activity when the dirty electricity in the environment was reduced.

48. When we reduced the levels of dirty electricity in schools, we found that teacher health and student behavior improved during remediation (Havas and Olstad 2008). The teacher symptoms that recovered are similar to those of radio wave sickness. The student behavior that improved resembles symptoms of attention deficit hyperactivity disorder (ADHD).

49. If *reducing* dirty electricity in a home or school improves the health and wellness of some individuals, one may expect that *increasing* the levels of dirty

electricity or modulated RFR may have the opposite effect. Many people have told me that their health problems began shortly after a smart meter was installed on the side of their home or a cell tower was erected nearby. Smart meters produce both MWs and dirty electricity.

50. Since 1997, EMF and RF experts have submitted more than 60 appeals stating that levels below existing guidelines are making people ill and that governments need to develop non-thermal guidelines that truly protect the health of the pubic and especially of children and pregnant women. http://magdahavas.com/international-experts-perspective-on-the-health-effects-of-electromagnetic-fields-emf-and-electromagnetic-radiation-emr/ and http://www.cellphonetaskforce.org/governments-and-organizations-that-ban-or-warn-against-wireless-technology/.

51. Of particular note is the International EMF Scientist Appeal, which was signed by more than 240 scientists and doctors who publish in this field from more than 40 countries (Blank et al. 2015). Collectively we requested that:

i. *children and pregnant women be protected;*
ii. *guidelines and regulatory standards be strengthened;*
iii. *manufacturers be encouraged to develop safer technology;*
iv. *utilities responsible for the generation, transmission, distribution, and monitoring of electricity maintain adequate power quality and ensure proper electrical wiring to minimize harmful ground current;*
v. *the public be fully informed about the potential health risks from electromagnetic energy and taught harm reduction strategies;*
vi. *medical professionals be educated about the biological effects of electromagnetic energy and be provided training on treatment of patients with electromagnetic sensitivity;*
vii. *governments fund training and research on electromagnetic fields and*

health that is independent of industry and mandate industry cooperation with researchers;

viii. *media disclose experts' financial relationships with industry when citing their opinions regarding health and safety aspects of EMF-emitting technologies; and*

ix. *white-zones (radiation-free areas) be established.*

52. A non-expert may conclude that the scientific community is conflicted when it comes to determining whether or not existing guidelines are safe. However, an examination of the source of funding and the results of studies indicates that research funded by industry has a preponderance of "no effects", while those independently funded are showing a preponderance of significant adverse effects (Figure 3) (Huss et al. 2007).

53. In Figure 3, only 8% of the studies funded by industry reported a statistically significant adverse effect of mobile phone use, whereas 45% to 64% of the studies with mixed funding or non-industry funding showed adverse effects of cell phone use. Conversely, 84% of the authors funded by industry reported "no effects" of cell phone use, whereas 23% to 46% in the studies otherwise funded reported "no effects". These results are statistically significant and suggest an inherent bias attributed to the industry-funded studies.

54. This potential bias in scientific publications is becoming so extreme that journals are requiring information on funding sources and disclaimers of conflict of interest.

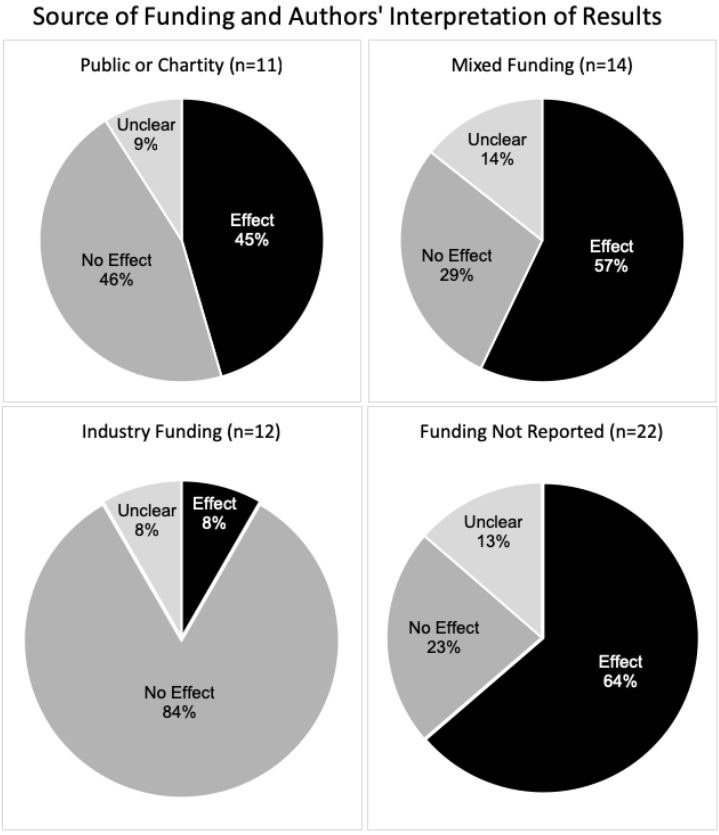


Figure 7. Relationship between funding source and outcome of research. Data from Huss et al. 2007 (Table 2).

55. Some people use the term "credible evidence" to mislead those who are not experts in this field. *Credible* according to what criteria and according to whom? The term "credible" is not a scientific term but one used by agencies and individuals attempting to downplay adverse effects. *Credible* is a value-laden term and one that most scientists would avoid using. Either the science is good or bad. If it is "bad" and does not follow the scientific method or has some inherent flaws it is not considered science.

56. The evidence that RF radiation is harmful to human health is overwhelming. In addition to cancer, RF radiation damages human sperm (at levels well below

FCC and HC guidelines) and reduces testosterone levels in laboratory rats. There is an association with people living near (within 500 m from) cellular antennas and a decrease in hormones (testosterone, plasma ACTH, serum cortisol, T3, T4 and progesterone), which gets worse with duration of exposure from 1 to 3 to 5 years (Eskander et al. 2012).

57. We have recent reviews with thousands of additional documents referenced for a variety of health effects (Carpenter and Sage 2007) available at www.bioinitiative.com. These documents cannot continue to be ignored. What must be kept in mind is that a study that reports "no effect" does not negate a study that finds an effect. If all of the studies reporting adverse effects were due entirely to chance, then we should have an equal number of studies showing beneficial effects of this radiation (also due to chance). Very few of these studies exist.

V. EFFECTS OF ELECTROSMOG ON ANIMALS AND PLANTS

58. These studies include effects on biota living under natural conditions and recently exposed to NIR; as well as effects on various species exposed to NIR in controlled laboratory experiments. There are now hundreds of such studies available (Balmori 2006, 2010; Warnke 2009; Expert Group 2010; Hillman et al. 2013; Halgamuge 2015; Manville 2016). This affidavit is intended to provide an *overview* that highlights some key research in this area.

59. NIR in the form of power frequency (50/60 Hz) electric and magnetic fields; dirty electricity (kHz); radio frequency and microwave radiation (kHz to GHz)

has been associated with adverse health and reproductive effects in animals and with adverse effects on plants. The effects include the following:

A. Bee Populations: aggressive behavior, reduced productivity, swarming, abandonment of hive (colony collapse disorder)

B. Birds Populations:

   i. Wild and Domestic: impaired reproduction, aggressive behavior, bird deaths;

   ii. Migration: interference with migratory behavior;

C. Mammals:

   i. dairy cows: reduced milk yield, altered milk quality, reduced fertility and impaired reproduction, miscarriages and deformities in offspring, infections that won't heal with antibiotics, behavioral changes, sudden death;

   ii. rodents: impaired reproduction, cancers;

   iii. cats and dogs: impaired reproduction;

D. Amphibians: deformities, population decline;

E. Plants: reduced growth, stunted roots, reduced yield, increased infections.

A. Bee Populations

60. Considerable concern has been raised worldwide regarding the sudden disappearance of bees from their hives, referred to as colony collapse disorder (CCD). Bees provide not only honey, wax, and pollen but are responsible also for the pollination of approximately 85% of all flowing plants that result in fruit and seed production. Without bees, production of fruits (cherry, apple, pear and plum); vegetables (tomato, cucumber, pumpkin) and agricultural crops (rap, sunflower, red clover, horse bean) would be severely reduced (Warnke 2009).

61. CCD has been reported in Canada, U.S., Germany Switzerland, Austria, Italy, Spain, Poland and New Zealand. Losses of bee colonies range from less than 10% to greater than 90% depending on location. Beekeepers agree that the bees are not developing properly, and while they may survive the winter, in spring they disappear leaving the colony empty. Only the brood remains in the hives and they are unable to survive without the care of the older bees (cited in Warnke 2009).

62. Several hypotheses have been put forward as to why bees are disappearing that include natural parasites and predators, extreme weather conditions and manmade stressors such as pesticides, genetically modified food crops, monocultures and electrosmog. While it is likely that all of these are adversely affecting bee colonies, this affidavit will focus on studies documenting the effects of only electrosmog.

63. Ferdinand Ruzicka, scientist and beekeeper reports (Ruzicka, 2003 as cited in Warnke 2009):

"I observed a pronounced restlessness in my bee colonies (initially about 40) and a greatly increased urge to swarm. As a frame-hive beekeeper, I use a so-called high floor, the bees did not build their combs in this space in the manner prescribed by the frames, but in random fashion. In the summer, bee colonies collapsed without obvious cause. In the winter, I observed that the bees went foraging despite snow and temperatures below zero and died of cold next to the hive. Colonies that exhibited this behavior collapsed, even though they were strong, healthy colonies with active queens before winter. They were provided with adequate additional food and the available pollen was more than adequate in autumn. The problems only materialised from the time that several transmitters were erected in the immediate vicinity of my beehives."

64. A survey through the magazine Der Bienenvater (2003/9) provided the following response from beekeepers (20 responses):

Table 1. Questions asked of Bee Keepers (n=20).

#	Question asked of Bee Keepers	% answering "yes"
1	Is there a mobile radio antenna within 300 m of your beehives?	100%
2	Are you observing increased aggressiveness of the bees compared to the time before the transmitters were in operation?	37.5%
3	Is there a greater tendency to swarm?	25%
4	Are colonies inexplicably collapsing?	65%

65. Several experiments have been performed to determine how microwave radiation affects bees in their hives.

66. In one study, Harst et al. (2006), placed a mobile phone near bee colonies and documented how quickly the bees returned to their hives. Twenty-five bees from control colonies (not exposed to mobile phone radiation) and 25 bees from exposed colonies were marked and taken 800 meters away from their hives. The return of the bees during a 45-minute period was assessed. Sixty-five percent of bees from the control colonies and less than 25% of the bees from the exposed colonies returned during the 45-minute period. At the end of the season, the exposed hives were 20% lighter with less honey and pollen than control hives. Apparently bees do not want to live in a hive exposed to electrosmog in the form of microwave radiation.

67. Favre (2011) exposed his hives to the handset of a mobile phone. The sound made by the bees was recorded and analyzed. The presence of actively communicating mobile phone handsets near honeybees within 25 to 40 minutes induced worker piping (a special sound which indicates distress and the signal to swarm and leave the hive). Repeated testing under different environmental conditions produced the same result. The experiment was terminated after 20 hours before any swarming could occur. Honeybees are reacting in a stressful way to pulsed electromagnetic fields generated by mobile telephones. While such phones are unlikely to be near beehives on a permanent basis, the radiation coming from nearby cellular phone base stations and future 5G transmitters are likely to elicit the same response.

68. In a similar study with a mobile phone placed near a beehive with much longer exposure (5 to 10 days), the colony collapsed. Worker bees left the hives with queen, eggs and immature bees, and failed to return home after foraging (Pattazhy 2009).

69. This study has been repeated with slightly different exposure conditions. Sahib (2011) exposed three colonies of honeybees to test conditions that consisted of a mobile phone in working conditions for10 minutes a day at 900 MHz frequency for ten days and had 3 control colonies, not exposed to this radiation. The results are shown in Table 2.

70. The results in Table 2 are dramatic and indicate that the worker bees left the colony after the 10-day experiment, which is what happens in CCD. Prior to

leaving, the activity of the workers decreased significantly as did the number of eggs laid by the queen. Under such conditions a colony is unable to survive.

Table 2: Change in colony status of honeybees exposed to mobile phones. The results are shown as the mean ± the standard deviation (% of control) (Sahib, 2011).

Parameters		Before Exposure		During Exposure		After Exposure	
Worker Bees	Control	40.7 ± 15		41.5 ±14		42.4 ± 14	
leaving the hive entrance/min	Treated	38.2 ± 12	94%	18.5 ± 13	45%	Nil	0%
Returning	Control	42.5 ±15		43.6 ±14		44.6 ± 13	
Ability of Worker Bees	Treated	39.5 ± 14	93%	15.6 ± 13	36%	Nil	0%
Honey	Control	9		9		9	
Productivity (# frames)	Treated	9	100%	5	56%	1	11%
Egg Laying Rate	Control	365		362		350	
of Queen/day	Treated	355	97%	199	55%	100	29%

71. Kumar et al. (2011) exposed adult worker bees (*Apis mellifera*) to cell phone radiation. The bees displayed two types of behaviour. The initial response, during which time bees were much less active and had increase concentrations of biomolecules (proteins, carbohydrates and lipids), was followed by an en masse migration reminiscent of the *fight or flight* stress response.

72. Exposure of beehives to high voltage power lines also seems to be detrimental to the colony although perhaps for slightly different reasons. Greenberg et al. (1981) placed beehives at different distances from a 765 kV, 60 Hz transmission line. When the electric field was at 7 kV/m, there was increased activity with higher hive temperatures, abnormal propolization; reduced hive weight; loss of queen bee; decreased sealed brood; and poor winter survival. Foraging rates were significantly lower at 7 and 5.5 kV/m. Step-potential

induced currents up to 0.5 μA were measured in an electrically equivalent bee model placed on the honeycomb. A high electric field shock is likely to be involved as a stressor inducing elevated body current.

73. Collectively these studies indicate that bees are able to sense and react to both power frequency EMFs and microwave radiation generated by cell phones (and presumably cell phone base station antennas). The exposure elicits an aggressive bee reaction, and, if sufficiently prolonged (several days), workers bees leave the hive and the remaining brood and queen remain defenceless with no ability to survive. This could very well be contributing to colony collapse disorder globally since microwave exposure from wireless telecommunication antennas is now widespread. At this stage we have no idea how the bee populations are going to react to mmwaves that are part of the 5G rollout.

B. Bird Populations – i. Wild and Domesticated

74. Research on the effects of electromagnetic fields on bird populations includes studies of behavioral changes and nesting success in the field and experimental exposure of eggs (mostly chicken eggs) under controlled laboratory conditions.

75. Balmori (2004) studied white stork populations nesting within 200 meters of phone masts compared to those nesting more than 300 meters away. He documented failures in breeding in nests near the antennas. Pairs of white storks near the masts were aggressive and had difficulty building their nests.

76. House sparrow populations have been decreasing during recent decades in the U.S., U.K. and several European countries (Balmori and Hallberg, 2007). Between October 2002 and May 2006, house sparrow populations were monitored and electric fields (1 MHz to 3 GHz) were measured along a transect in Valladolid, Spain. Significant declines (p=0.0037) were observed in bird density over time, and lowest bird densities were observed in areas with high electric fields. The authors concluded that electromagnetic pollution may be responsible, either by itself or in combination with other factors, for the recently observed decline of this species in European cities.

77. Everaert and Bauwens (2007) made similar observations in Belgium. Fewer house sparrow males were observed in areas with elevated electric fields from cell phone base stations supporting the concept that long-term exposure to higher levels of RFR reduces the abundance and alters the behavior of house sparrows in the wild.

78. Fernie et al. 2010 tested whether EMFs affect reproductive success of captive American kestrels. Birds were bred for 2 years under either controlled or EMF exposure that was equivalent to that experienced by wild kestrels. In both years fertility was higher, but hatching success was lower in EMF pairs than control pairs. EMF eggs were larger, with more yolk, albumen, and water, but had thinner eggshells than control eggs. EMF exposure affected reproductive success of kestrels, increasing fertility, egg size, embryonic development, and

fledging success but reducing hatching success. Reduced hatching success could put the population at risk.

79. In a follow-up study, EMF exposure altered melatonin, behavior, growth, and reproduction of captive American kestrels, particularly of males, and male kestrels exposed to EMFs experienced higher levels of oxidative stress (Fernie and Bird 2001).

80. Tanner and Romero-Sierra (1982) exposure chickens (white leghorns) to very low intensity continuous wave microwave radiation at 7.06 GHz for 248 days. Field intensity in each cage (without birds) ranged from 0.19 microW/cm^2 in the outer cages to 360 microW/cm^2. Egg production of the irradiated colony was greater (13.7%) than that of the control colony but was accompanied by twice the mortality rate. The irradiated birds that survived showed a profound deterioration in health when autopsied.

81. Grigoriev (2003) exposed chicken embryos to EMF from a cell phone for 21 days during embryonic development. He reported an increase in embryo mortality in exposed chicks (75%) compared with the controls (16%). Similar results were obtained for chick eggs exposed to 900 MHz frequencies (Ingol and Ghosh, 2006). Developmental abnormalities were observed in chick eggs exposed to 100 Hz, 2.1 μs pulse, 1 μT (10 mG) magnetic field (Ubeda et al. 1994).

82. Collectively these studies show that birds are sensitive to RFR and that this radiation affects behavior and reproductive success.

B Bird Populations: ii. Migratory Birds

83. Birds that migrate great distances navigate with several redundant systems that include visible clues of landscape, location of the sun, and the earth's geomagnetic field for which they have magneto-receptors in their skull. Power lines, antennas for radar, broadcast, and cell phone communication can interfere with their magnetic compass and put them off course permanently or temporarily until other cues are able to correct their course. Factors that increase energy consumption of migratory birds, decrease their ability to survival. Another concern is collisions with towers or power lines or wind turbines.

84. According to a review of 14 studies, an estimated 12 to 64 million birds are killed annually in the U.S. by power lines; 8 to 57 million by collision, and 0.9 to 11.6 million by electrocution (Loss et al. 2014). Authors conclude that the amount of bird mortality at U.S. power lines is substantial and that conservation management and policy is necessary to reduce this mortality.

85. Birds are not the only flying species that are adversely affected by technology. Nicholls and Racey (2007) noted that many bats are killed by colliding with wind turbines.

86. Extremely low frequency (ELF) communications systems from 3 to 300 Hz were used by the U.S. Navy to communicate with submarines from the continental United States between 1950 and 1980. These large antenna arrays extended thousands of miles and provided one-way communication with

submarines submersed in several hundred feet of salt water anywhere in the world. Three separate programs were considered during this period: SEAFARER, SANGUINE, and SHELF. All three communication systems used the same ELF frequency band. The effects on human health and wildlife were of particular concern at the time.

87. An experimental array that could be turned on and off allowed for testing this system on bird migration. The ability of migrating birds to sense low intensity low frequency alternating current was documented more than 40 years ago (Southern 1975; Larkin and Sutherland 1977).

88. Gull chicks tested on clear days in the normal geomagnetic field clustered and headed in the direction of migration. When a large antenna (Sanguine) was energized, individual birds dispersed randomly leading the author to conclude that magnetic fields associated with such conductors interfere with bird navigation (Southern 1975).

89. Migrating birds within the field of the SEAFARER's antenna turned or changed altitude more frequency when the antenna was *on* compared to when it was turned *off*. Birds during nocturnal migratory flights rely largely on the earth's geomagnetic field and changes in that field can disrupt orientation (Larkin and Sutherland 1977).

90. Wiltschko et al. (2015) noted that radio frequency fields in the MHz range disrupted birds' orientation. In one experiment birds were unable to navigate as long as the RFR was present. Two different exposures were used: 7 MHz at 480

nT (4.8 milliG) and 1.315 MHz at 1 nT (0.01 milliG). Once the field was turned off, birds were able to orient to the local geomagnetic field.

91. Engels et al. (2015) demonstrated in a double blind experiment with European robins that migratory birds were unable to use their magnetic compass in the presence of urban electromagnetic pollution that ranged from 50 kHz to 5 MHz. Birds use a magnetic compass (magneto-receptors) in their skull or beak depending on species that provides information about their relative position to the earth's geomagnetic field. This field does not oscillate but does decrease in strength from the poles to the equator. Alternating current from power line frequencies to microwave radiation appears to interfere with their internal magnetic compass throwing them off course during migration. The more energy they extend to correct their course the less they have to complete their flight plan.

92. Bird feathers are piezoelectric and act like antennas receiving microwave radiation. Bigu-del-Blanco and Romero-Sierra (1975) showed that bird feathers "received" or absorbed microwave radiation in the 10 to 16 GHz region. So, in additional to magneto–reception, feathers may also play a role in birds being able to detect and react to microwave radiation. This "feather" reaction is likely to be more pronounced with 5G technology and mmwaves.

C. Mammals: i. Dairy Cows, Ground Current and Radio Frequency Radiation

93. NOTE: "Ground current", also referred to as *tingle voltage*, *stray voltage* and *uncontrolled electricity*, refers to electrons flowing along the ground that can

come from off-farm sources being distributed by the power grid and influenced by technology that is connected to electricity (wind turbines, broadcast antennas, mobile phone base stations, nearby factories, etc.).

94. By far the most information on the effects of electrosmog on livestock comes from studies with dairy cows. Hillman et al. (2013) provide a concise literature review as well as a field study based on thirteen farms with serious ground current pollution in Wisconsin and Michigan. They show that dirty electricity flowing along the ground as ground current has serious effects on cow health and productivity. Levels at which this happens are well below existing guidelines.

95. Ground current may be due to a combination of both on-farm and off-farm sources. On-farm sources include lighting, variable speed frequency drives on motors, radio frequency identification system and off-farm sources are due to a poor primary neutral return on the utility side of the distribution system (Stetzer et al. 2016). Cows exposed to ground current above a 10 mV at kHz frequencies experience mastitis, foot sores that won't heal, swollen hocks. They have difficulty getting pregnant and produce less milk. Some become ill, refuse to eat, and once this happens there is little the farmer can do to prevent them from dying. In a dairy barn with a serious ground current problem, cows are seen lifting their feet off the ground as though they were "dancing". This lifting of the foot, temporary reduces the electrical current flowing through their body. Little is being done to help farmers or to protect livestock despite two

private member's bills being considered in the Ontario Legislative Assembly during the past 12 years.

96. To test the effects of power frequency EMFs on milk production and feed intake, lactating Holstein cows were experimentally exposed to 10 kV, 30 μT (300 mG), 60 Hz electric and magnetic fields under controlled conditions (Burchard et al. 2003). Exposure to EMFs resulted in an average decrease of 4.97% in milk yield and 16.39% in milk fat as well as an increase of 4.75% in dry matter intake. So the cows ate more but produced less milk of lower fat content resulting in a financial loss to the farmer.

97. In a related study (Rodriguez et al. 2003) EMF exposure altered the estrous cycle, which may help explain some of the reproductive problems cows experience when exposed to ELF EMFs.

98. In a follow-up study, (Burchard et al. 2006) conclude that in a "worst case" scenario exposure of dairy cattle to 10 kV/m, 30 μT (300 mG) EMF influences blood levels of thyroxine (T4) levels. Thyroxine is a hormone made in the thyroid gland for the regulation of metabolism, body heat production, blood pressure, and the normal development of the skeletal and nervous systems. While focus on dairy farms has been on cows, farmers have similar symptoms and suffer from the same exposure (reproductive impairment, chronic pain, swollen joints, etc.).

99. RFR also seems to adversely affect cows. On a dairy farm in Germany, after a mobile phone base station was erected nearby, calves born on this farm had a

higher incidence of cataracts compared with the Swiss average (Hassig et al. 2012). Neither chemical poisons nor infection could explain these findings. Microwave radiation is known to cause cataracts (Glaser 1971).

100. Loscher and Kas (1998) studied a herd of dairy cows on a farm near a TV and cell phone transmitting antenna over a two-year period and reported reduced milk yield, increasing health problems and behavioral abnormalities. Radiation from the antennas was monitored and ranged in frequency from 2.2 to 734 MHz. The highest power density reading in and around the stable was 45 microW/cm^2 at 512 MHz (well below international and Health Canada guidelines).

101. The following symptoms were observed:

    1. Most animals in the herd showed conjunctivitis with strong tear flow (constant wet cheeks) and eye itching (some animals were constantly scratching their eyes on reachable stable arrangements or neighboring animals).
    2. Many animals squeezed with their heads the breast area of their neighboring animal; thus, all animals ended up positioning their heads in the same direction.
    3. One animal showed remarkable head motions, periodically moving the head back and forth; periods of calmness were superseded by the above described behavior which could last for as long as 30 minutes.
    4. Calves and cows let out on the meadow grazed only for a few minutes, then they "took shelter" from the transmission tower behind the stable building.
    5. Cows, mostly after the third or fourth calving, fell into decay. When they were getting up after having lain down, their legs started trembling, and this condition became worse very quickly. The decay happened within a few weeks, and then the animals died.

102. In this study, various tests were performed to determine what was affecting the cattle.

1. To rule out metabolic disturbances the feed was analyzed. Feed quality was high and the amounts given to the animals corresponded to their needs.
2. Autopsy of a four-year old cow indicated that death was caused by acute heart circulatory problems with internal bleedings in several organs. No signs of acute or chronic organ changes.
3. Analysis of miscarriage material provided no microscopic or serological evidence of germs that could have caused the miscarriages.
4. One animal with behavioral disturbances was relocated to a similar stable some 20 kilometers away from the transmission tower, together with another cow of the herd. After five days in the new stable the observed behavioral disturbances disappeared completely. The animals were brought home to the stable near the transmission station after two weeks. Already after a few days the symptoms could be observed in the animal again.
5. The symptoms experienced by these cows could not be explained by poor farm management and resemble effects documented for cows near high voltage power lines and cows exposed to ground current (Burchard et al. 1996; Hillman et al. 2013), two other forms of electrosmog.

103. Anything that interferes with reproduction is likely to have serious financial consequences for people who breed domesticated animals. Technology connected to the electricity grid can contribute to currently flowing along the earth and contributing to illness in animals that is often noticed on dairy farms but also in other operations that have a carefully controlled breeding program.

104. In a Michigan study, Marks et al. (1995) documented reproductive problems in terms of infertility, low or absent sperm count, impaired estrous cycling and high percentage of deaths of new born puppies and kittens, many of which were

deformed. These effects were associated with current flowing along the ground that was coming from off-farm sources.

105. Two dairy farmers in the same County reported similar health, reproductive and management concerns in their cows. Tests performed at these dairy farms revealed the presence of ground current or stray voltage. This current flows along metal structures and can adversely affect animals and humans. The level of voltage on the wellhead was 2.45 volts and consisted of high voltage transients or dirty electricity. Similar problems were evident in a kennel about 15 miles away. Experts from the power company, the Public Service Commission, and two independent consultants confirmed the presence of stray voltage (AC and DC) with periodic voltage spikes, as well as magnetic fields and electric fields.

C. Mammals: ii. *Rodents & Cancer*

106. Mice and rats are used in controlled experiments as a surrogate for experiments with humans. Magras and Xenos, (1997) placed twelve pairs of mice, divided into two groups, in locations around an “antenna park" where the RF power densities ranged from 168 nW/cm^2 to 1053 nW/cm^2 (0.168 to 1.053 microW/cm^2).The pairs were mated five times. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. The prenatal development of the newborns in smaller litter sizes was improved.

107. The U.S. National Toxicology Program (NTP 2018) conducted one of the largest and most expensive rodent studies to date and released their final report in 2018. Rats were exposed to RFR similar to modulations currently used in U.S. wireless cellular networks starting *in utero* and continuing throughout their lifetime. An increased incidence of malignant brain gliomas and heart schwannomas as well as potentially pre-cancerous lesions were observed in male rats exposed to RFR. The tumors observed were similar to tumors observed in some epidemiology studies of cell phone use. These findings support the International Agency for Research on Cancer (IARC) conclusions regarding the possible carcinogenic potential of RFR.

108. Another similar study conducted at the Ramazzini Institute (RI) in Italy, released a few months later (Falcioni et al. 2019) reported similar findings. This is the largest, long-term study that documents the effects of 1.8 GHz GSM antennas on Sprague-Dawley rats. The RI study also reported brain (gliomas) and heart tumors despite having lower exposures than the NTP study. These two laboratory studies in combination with RF epidemiological studies provide sufficient evidence for IARC to re-evaluate their classification of RFR from a "possible" to a "probable" human carcinogen.

109. An earlier study (Chou et al. 1992) that exposed rats for 25 months to 2.45 GHz frequencies (the same frequency used by Wi-Fi routers) reported a 100% increase in metastatic tumors and a 260% increase in primary tumors. There was also evidence that the immune system was impaired by the radiation.

110. Repacholi et al. (1997) exposed mice to 900 MHz microwave radiation pulsed at 217 Hz, specific absorption rate 0.007 to 4.3 W/kg for 30 minutes daily for up to 18 months. Exposed mice developed twice as many lymphomas as the unexposed mice.

111. These *in vivo* studies under controlled conditions demonstrate that RFR at both cell phone frequencies and Wi-Fi frequencies and at levels below current guidelines cause cancer in laboratory animals.

D. Amphibians: deformities, population decline;

112. Amphibians are considered bio–indicators of environmental quality. Changes in their populations bode poorly for other species. Balmori (2006) reviewed the literature on amphibian declines and found that 32% of the 5743 populations studied, were in threat of extinction. Amphibians with deformed, absent or extra limbs are also found in the environment. Both these deformities and declines are due to complex ecosystem interactions. One factor that is receiving increasing attention is the increase in microwave and radio frequency radiation in the environment from mobile phone antennas base stations.

113. The following effects are summarized in Balmori's review:

1. Radiation of frogs at 30–60 $\mu W/cm^2$ altered heart rhythm;
2. Radiation of toad hearts with 1425 MHz at 0.6 $\mu W/cm^2$ increased heart rate and produced arrhythmia;
3. Experimental frog tadpoles development was delayed compared to control tadpoles;
4. Electromagnetic fields (EMF) caused allergies and changes in blood counts;

5. Amphibians are particularly sensitive to weak electrical fields and respond to frequencies from 0.1 Hz to 2 kHz;
6. EMFs increase tadpole morality;
7. Electromagnetic radiation (EMR) alters the immune, nervous, and endocrine systems;
8. EMR produces stress on the immune system that interferes with DNA;
9. Heat shock proteins may play a role in protecting animals exposed to EMR;
10. Susceptibility to EMR varies among species and among populations.

E. ***Plants***

114. Plants are also sensitive to electrosmog in various forms, but especially radio frequency and microwave radiation. Halgamuge (2016) reviewed 45 scientific publications describing 169 experimental observations to detect changes in plants exposed to weak radio frequency radiation. Almost 90% of the studies documented physiological and/or morphological effects. Maize, roselle, pea, fenugreek, duckweeds, tomato, onions and mungbeans were particularly sensitive to RF-EMFs. Frequencies with the greatest effect were from 0.8 to 1.5 GHz; 1.5 to 2.4 GHz; and 3.5 to 8 GHz. Biological effects relied on field strength and amplitude modulation of the applied field. The effects were more pronounced in short-term (up to 13 weeks) rather than long-term (3 months to 6 years) exposure studies implying there may be some adaption to this exposure.

115. In 1990, permanent plots were established near the Skrunda Radio Station in Latvia, which had been operating for the previous 20 years, and a nearby control area to test the growth of pine trees using tree ring data and examining annual growth rate (Balodis et al. 1996). The annual growth rate can be

determined by tree ring radius. There was a significant negative relationship ($p<0.01$) between the annual increment in tree growth and the intensity of the electric field that was traced back to 1970 when the station began operation. No other environmental factor could account for this response except the radiation from the radio station.

116. In 2015, the intensity of RFR was mapped in two Germany cities (Bamberg and Hallstadt). A total of 120 trees were selected for detailed analysis of damage. Sixty of these were damaged trees, 30 were from low RF environments and 30 were selected at random (Waldmann-Selsam et al. 2016). Significant differences were observed between the damaged side facing a phone mast and the opposite side of trees. Damage was associated with power flux density and damage afflicted on trees by mobile phone towers usually started on one side and extended to the whole tree over time. The trees selected from low radiation areas (no phone mast visible and <50 $\mu W/m^2$) (0.005 $\mu W/cm^2$) showed no damage. This study demonstrates that electromagnetic radiation from mobile phone masts is harmful for trees.

117. Tree decline is one indicator of environmental stress as the declines are often associated with infestations (insects, fungi, etc.), air pollution or altered climatic conditions. Since 2004, rapid declines in aspen clones ere documented in Colorado, and the hypothesis that this decline was associated with RFR from nearby broadcast and cellular antennas was investigated (Haggerty 2010).

118. Seedlings were grown in shielded (aluminum screen) faraday cages and with mock-shielding (fiberglass screen). A portable radio was used to test the effectiveness of the shielding and indicated that there was no reception within the aluminum cages as compared with the mock shielding and unshielded controls. Conditions in the shielded and mock-shielded enclosures were similar except for the difference in RF background intensities.

119. Plants in the shielded and mock-shielded enclosures looked different at the end of the study. The RF background appeared to be adversely affecting leaf and shoot growth and inhibiting fall colors associated with leaf senescence in trembling aspen seedlings. The mock-shielded plants had many more necrotic spots on the leaves than the shielded plants (see Plate 2). According to the author, these effects suggest that exposure to the RF background may be an underlying factor in the recent rapid decline of aspen populations in Colorado.

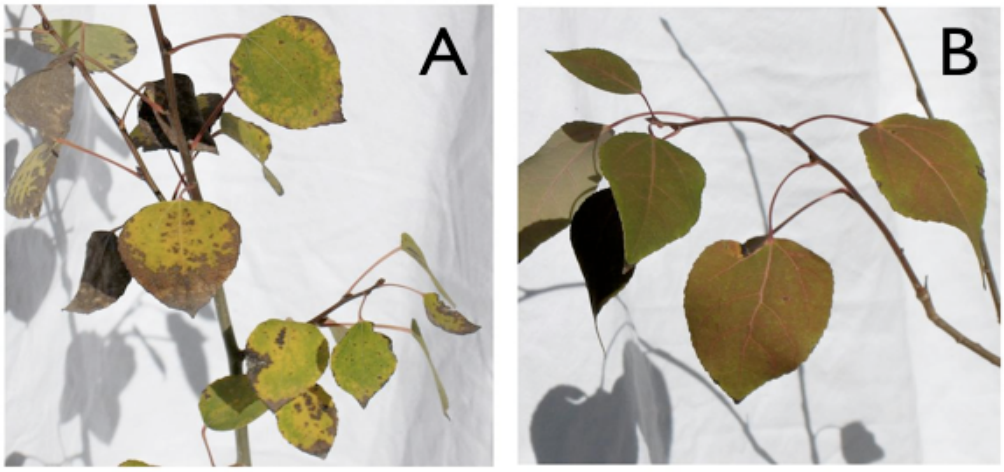


Plate 2. More necrosis visible on mock-shielded (A) than shielded (B) aspen seedlings. Also leaf veins of mock-shielded plants are yellow or green and petioles are light red to pink and less healthy than leaf veins and petioles of shielded plants (Oct 6, 2007). [Source: Haggerty 2010]

120. Another experiment was conducted under controlled conditions testing the effect of radiation from a Wi-Fi router on the germination and growth of edible and fast germinating seedlings (garden cress, broccoli, red clover and pea) (Havas and Symington 2016). Radiation levels were 0.00001 $\mu W/cm^2$ for the controls. The mean and maximum exposure levels for the RF-exposed seedlings were 2–4 microW/cm^2 and 9.6 microW/cm^2 respectively. These levels are well below international and Health Canada's guidelines for RF exposure.

121. There were no effects on germination of the seedlings. However, dry weight of the broccoli and peas (Plate 3) exposed to Wi-Fi radiation was much lower than controls at the end of the experiment ($p<0.01$). Wi-Fi exposure inhibited root growth of several species. It also caused root tips to turn brown and reduced root hairs of cress compared with the reference treatment. Broccoli seedlings closest to the Wi-Fi router grew away from the router; cress seedlings had larger leaves and were chlorotic compared with controls; and several of the Wi-Fi replicates had obvious growth of mould in Petri plates with unhealthy seedlings. Radiation generated by Wi-Fi routers can adversely affect plant growth and may interfere with a plant's ability to protect itself from opportunistic mould.

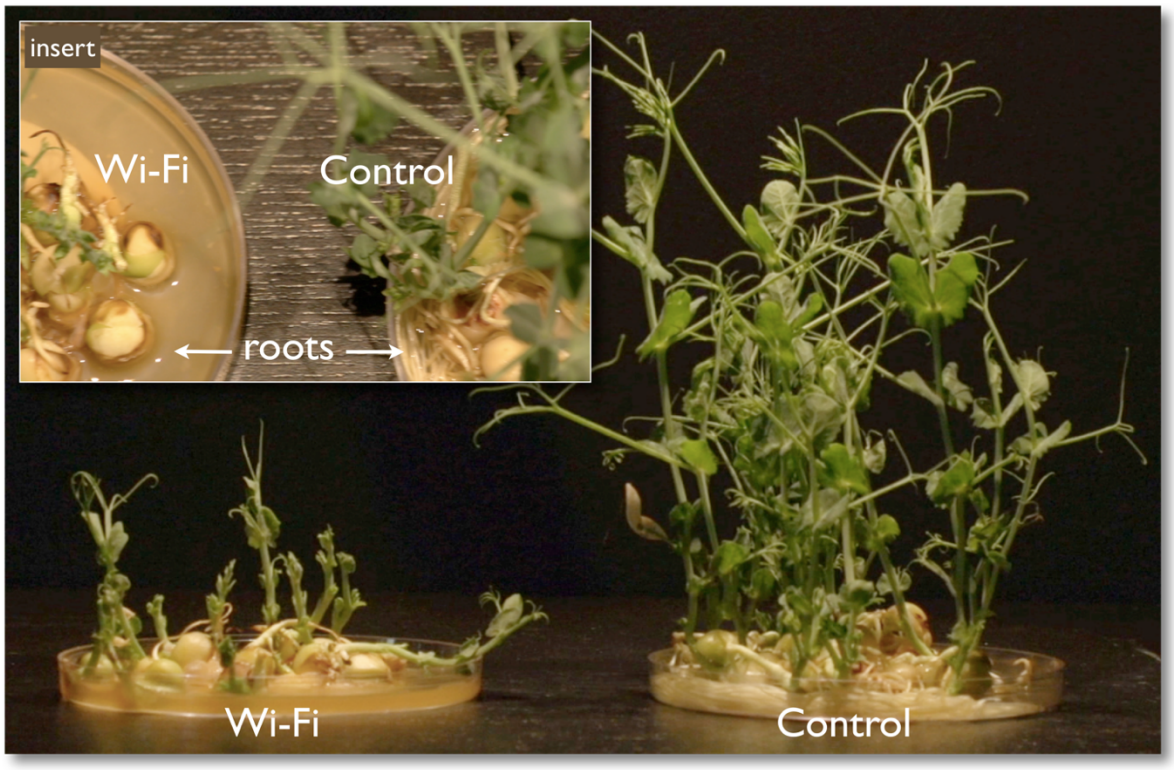


Plate 3. Growth of pea seedlings exposed to Wi-Fi radiation for one month compared with controls that were not exposed to RFR. Wi-Fi radiation reduced root growth (insert) and reduced above ground biomass. [Source: Havas and Symington (2016)]

V COMMENTS ABOUT SCIENCE, THE SCIENTIFIC METHOD, SCIENTIFIC CONCEPTS AND SCIENTIFIC TERMINOLOGY

122. Popular words sometimes have different meanings when used in science and this can lead to confusion in legal cases due to miscommunication. In this report I would like to focus on just a few terms and concepts that may facilitate communication.

123. *Guidelines vs. Standards*: Health Canada provides exposure *guidelines* in their Safety Code 6 document that is updated every 5 to 10 years. *Standards* are mandatory controls while *guidelines* are non-mandatory controls. Health Canada's guidelines are limited to individuals working at, or visiting, federally

regulated sites. It is my understanding that there is no program to monitor the environment for radio frequency radiation and a guideline that is not monitored cannot be enforced.

124. Since a person's home is not a federally regulated site, Canadians are not protected by these guidelines. Radiation at 2.45 GHz (microwave oven, Wi-Fi router, cordless phone, baby monitor, home security system, smart light bulbs, etc.) does not require a license and as such is not regulated. The more of these devices people have at home, school or work the higher their exposure is likely to be. People who live in multiunit dwellings are also exposed to microwave radiation generated by their neighbours.

125. *Significance*: The term *significance* is used to imply *statistical significance*, which is set by convention (unless otherwise noted) to a probability of 5% or less. This means that the probability of obtaining a result due to chance or error is less than 5%.

126. *Weak association*: A *weak association* generally used in epidemiological studies indicates that the odds ratio (OR, ratio of observed to expected outcome) is low (less than 2). A weak association can be significant. For example, the OR for tobacco and lung cancer is considered high (OR above 5) whereas the association between low frequency magnetic fields and childhood leukemia was originally believed to be low (≤ 2). Both were significant. We have since learned that this association with childhood leukemia in dose-

dependent and can be much higher than 2 depending on the magnetic field exposure (Figure 3).

127. *Acute vs. chronic exposure*: Generally *acute* refers to high-level short-term exposure, while *chronic* refers to low-level long-term exposure. For example, a person working very close (within 10 meters) to a live antenna for a few hours would have acute exposure and a person living near (within 400 m) of an antenna for months or years would experience chronic exposure. The effects of both chronic and acute exposure seem to be similar, with a few exceptions.

128. *Cumulative exposure*: This is a form of chronic exposure and is quantified using *time-weighted average*, which is the exposure intensity multiplied by the duration of exposure. For example, a microwave oven can cook a potato at 100% power within 5 minutes; at 50% power it requires 10 minutes and at 20% power it requires 25 minutes.

129. *Weight-of-evidence*: There are several issues with the concept of *weight-of-evidence.* Health authorities (including Health Canada) use this concept when they describe how they evaluate the science on the biological and health effects of electromagnetic pollution.

130. First, this concept is a management tool and is not part of the scientific method. *Weight-of-evidence* has far too many subjective elements that are seldom explicitly stated when doing this type of assessment. Management decisions are based on a combination of science, societal values, public opinion, and both technological and economic factors.

131. Second, weight-of-evidence is applied incorrectly by Health Canada and a few other health agencies. These organizations compare studies that show a significant effect to studies that do not show an effect, as though non-effect studies cancel statistically significant studies. This is nonsense. What they should be doing is similar to what is done with drug research where the beneficial effects of the drug are compared with the harmful side-effects of a drug. The corollary is comparing the biologically harmful effects of cell phones to the biologically beneficial effects of cell phones. When this is done the harmful effects become increasingly obvious. The rational behind this relates to the 5% probability mentioned above. The statistical outcome in any study may be due to chance (5% of the time) and finding something harmful vs. something beneficial by chance (by error) should be the same. Comparing studies with positive vs. negative outcomes should eliminate this type of "error".

132. *Scientific Method*: The scientific method, according to Popper involves falsification. Procedurally a hypothesis is formulated that can be tested and falsified. The example most often cited involves swans. One cannot prove that all swans are white by seeing and counting white swans. However, the statement that "*all swans are white"* can be falsified by finding one black swan. Similarly scientific studies that document adverse health effects below existing guidelines and that are repeatable indicate that guidelines are non-protective.

133. *Epidemiological vs. in vivo vs. in vitro Studies*: Scientists use multiple techniques to test a scientific hypothesis. These tests fall into three categories

within environmental health research. They include epidemiological studies, *in vivo* studies, and *in vitro* studies. Often a combination of these tests is required to address key environmental health concerns as they each provide different information.

134. *Epidemiological studies* test the **association** between an agent (cell phones) and an outcome (brain cancer) in human populations living under realistic conditions. So statements that a particular epidemiological study does not prove that cell phones cause cancer is not necessary because these studies are not designed to show cause-effect relationship and when this is provided in a scientific article it is misinterpreted by the public. The strength of a well-conducted epidemiological study is that it is under realistic conditions. This can also be one of the weaknesses as there may be confounding factors that can influence the results. Well-conducted studies attempt to correct for confounders.

135. *In vivo* studies test the effect of an agent on living organisms under controlled conditions. These studies indicate a **cause-effect** relationship between the agent and the outcome. The test organism may be a human being or–when testing a human subject is unethical–rats, mice, rabbits and other species are used. The strength of *in vivo* studies is that everything is controlled and can be repeated by other labs. The weakness is that it can be difficult translating the data to human if test animals are used as different species and even different strains of the same species have different sensitivities.

136. *In vitro* studies use biological tissue under controlled conditions to determine **mechanisms** of action an agent may have on living cultures. Once again, the strength of such research is that it can be repeated and the weakness is that what happens in a test tube may not always happen in a living organisms as homeostatic mechanism come into play.

137. When all three types of research point in the same direction, we can be certain that the evidence is real and not an artefact. This is the case for microwave radiation (cell phone use and living near cell towers) and cancer.

1. epidemiological studies showing an association between an agent and an outcome (i.e. cell phone base stations and cancer, Brazil, Israel, Germany);
2. *in vivo* studies showing a cause-effect relationship in laboratory rats (cancer in rats exposed to cell phone radiation, NTP 2018, Falcioni et al. 2019 study); and
3. *in vitro* studies that provide the mechanism of action (oxidative stress and production of free radicals that are carcinogenic).

VI HEALTH CANADA'S SAFETY CODE 6 – CRITICAL ASSESSMENT

138. Health Canada (HC) is responsible for establishing guidelines and standards to protect the Canadian public against electromagnetic pollution. When it comes to NIR, HC is failing to fulfill its mandate. Very briefly I have some concerns about Health Canada's Safety Code 6 (SC6), the document that provides guidelines for electromagnetic pollution. Those concerns are as follows:

1. HC does not have guidelines for electromagnetic frequencies below 3 kHz. Consequently, we have no guidelines for ELF electric or ELF

magnetic fields associated with our use of electricity despite the fact that studies are documenting, a) an increase in various types of cancers with occupational exposure to ELF EMFs; b) an increase in childhood leukemia for residential exposure to ELF EMFs; and c) reduced oncostatic effect of melatonin and tamoxifen on breast cancer in the presence of a magnetic field of 12 mG (Havas 2000). Consequently people who live near high voltage power lines or are exposed occupationally to ELF EMFs are not protected due to absence of guidelines. This is unacceptable. Canada needs guidelines for ELF EMFs and those guidelines should differ for children and adults as we know that children exposed to magnetic fields at or above 3 mG have a greater risk of developing leukemia whereas adults appear to develop cancers at higher magnetic field exposures in the range of 10 to 12 mG. Indeed IARC recognized this in 2002 when they classified ELF EMFs as possibly carcinogenic to humans.

2. HC's guidelines for frequencies between 3 kHz and 300 GHz are out of date and are based on the false assumption that only shock (at lower frequencies) and thermal effects (at higher frequencies) are important from a biological/health perspectives. In other words, if you don't get a shock and if your body temperature does not increase you are safe. Once again, thousands of studies at levels well below thermal effects document adverse health effects that are being ignored by HC.

3. Guidelines are for a small subset of the population and not for all Canadians. In HC's "Understanding Safety Code 6" https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/understanding-safety-code-6.html they state: "The safety limits in this code apply to all individuals working at, or visiting, federally regulated sites." There are no guidelines for schools, hospitals, or occupational settings. This is unacceptable.

4. To establish if guidelines are exceeded, HC relies on the average readings based on a 6-minute period of monitoring. There are two concerns related to this. Averages are used by engineers but living organisms respond to extremes and not averages. Consequently someone can scald their hand within a matter of seconds with boiling water even if they then place their hand in a cool water bath giving a lower average temperature. The second concern is effects of short-term exposure differ considerably from long-term exposure and we have no guidelines for long-term, continuous exposure irrespective of what Health Canada states.

5. In an earlier version of SC6 (1999) the following statement appeared on page 11, "Certain members of the general public may be more susceptible to harm from RF and microwave exposure." This statement was removed from more recent versions with no explanation provided for that removal.

6. It is unclear which scientific documents HC relied on for their guidelines and which ones they ignored as no monograph has been produced and no references are provided. This is in sharp contrast to the two excellent monographs produced by IARC for ELF (2002) and RF (2012) exposure. What is missing is transparency.

139. Perhaps what I find most disturbing is HC's Fact Sheet entitled, "Busting Myths on Safety Code 6." These are "myths" and "facts" according to HC.

140. Health Canada provides the following myths/facts that I challenge below: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/fact-sheet-what-safety-code-6.html

141. Myth #1: Safety Code 6 limits only provide protection based on limited exposure for healthy adults. The guideline does not account for vulnerable populations such as children or people with electro hypersensitivity disorder.

142. **HC Fact**: Even a small child, following continuous exposure from multiple sources of RF energy, would not experience adverse health effects provided that the exposure limits set in Safety Code 6 are respected.

143. **My Comments:** Where is the scientific evidence supporting this statement? I know of no study that deliberately exposed a small child to continuous RF radiation and documented the health effects. Indeed this type of research would be ethically unacceptable. What does seem to be happening is that students in schools with Wi-Fi are complaining of ill health (see 16 by 9 the bigger picture

Wi-Fi in Schools dangerous, http://www.emf-safety.com/169-wifi-in-schools-dangerous.html).

144. **HC goes on to state**: While the symptoms attributed to electrohypersensitivity conditions are real, scientific evidence has failed to demonstrate that they are caused by exposure to electromagnetic fields.

145. **My Comments:** A double blind, placebo controlled study showed that exposure to 2.4 GHz microwave radiation at levels below 5 microW/cm^2 (i.e. less than 1% of SC6 guidelines) affects the heart and the autonomic nervous system of those who are electrically sensitive (Havas et al. 2010).

146. Dr. William Rea and colleagues (1991) tested the response of 100 patients to different electromagnetic frequencies from 0.1 Hz to 5 MHz and found that 16 regularly responded only to EM exposure and not to blank exposures. Most of the reactions were neurological (such as tingling, sleepiness, headache, dizziness, and in severe cases unconsciousness) although a variety of other symptoms were also observed including pain of various sorts, muscle tightness particularly in the chest, spasm, palpitation, flushing, tachycardia, edema, nausea, belching, pressure in ears, burning and itching of eyes and skin.

147. In addition to the clinical symptoms, instrument recordings of pupil dilation, respiration, and heart activity were also included in the study using a double-blind approach. Results indicate a 20% decrease in pulmonary function and a 40% increase in heart rate. Patients sometimes had delayed or prolonged responses. These objective instrumental recordings, in combination with the

clinical symptoms, demonstrate that EMF sensitive individuals respond physiologically to certain EMF frequencies.

148. **Myth #2**: Frequent users of cell phones, such as children and teenagers, are at an increased risk of adverse health effects caused by exposure to RF energy.

149. **HC Fact**: There is no evidence that children and teenagers are at increased risk when Safety Code 6 exposure limits are respected.

150. **My Comments:** Hardell et al (2009) showed that young people who used a cell phone before the age of 20 had a greater risk of developing a brain tumor than did adults. Gandhi et al (1996) showed that radiation from a cell phone penetrates much more deeply into the brain of a children than that of an adult (Figure 8).

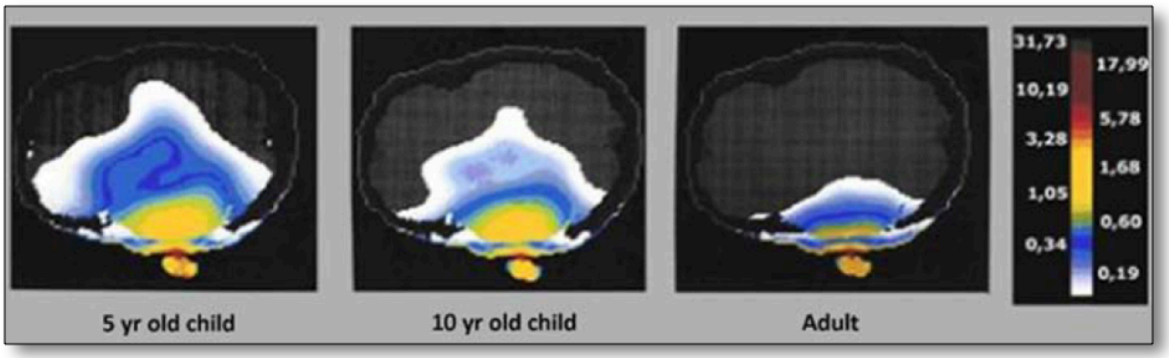


Figure 8. Depth of absorption of cell phone radiation in a 5-year old child, a 10-year old child, and in an adult from GSM cell phone radiation at 900 MHz. Color scale on right shows the SAR in Watts per kilogram. Source: Gandhi et al., 1996.

151. To their credit, HC provides information on how to reduce your risk in their fact sheet on *Cell Phones and Cell Phone Towers*

https://www.canada.ca/en/health-canada/services/consumer-radiation/safety-cell-phones-cell-phone-towers.html. They state the following:

Health Canada reminds cell phone users that they can take practical measures to reduce their RF exposure by:

- limiting the length of cell phone calls
- using "hands-free" devices
- replacing cell phone calls with text messages
- Health Canada also encourages parents to take these measures to reduce their children's RF exposure from cell phones since children are typically more sensitive to a variety of environmental agents.

152. **My comments:** So HC does recognize that children are more sensitive than adults to a variety of environmental agents, but they don't apply this concept to their RF guidelines.

153. Myth #3: Many countries have limits 100 times lower than Safety Code 6. This must mean Safety Code 6 doesn't protect my health.

154. **HC Fact**: Canada's limits are consistent with the science-based standards used in other parts of the world, including the United States, the European Union, Japan, Australia and New Zealand.

155. **My Comments:** Countries that rely on the science-based evidence recognize non-thermal effects and hence have much lower guidelines than does Canada. Guidelines globally fall into one of three categories: thermal, non-thermal and precautionary principle. Canada's guidelines are thermal and are the least protective.

156. **Myth #4**: Health Canada ignores certain studies, especially those that show adverse health effects resulting from exposure to RF energy.

157. **HC Fact**: When developing the exposure limits in Safety Code 6, Health Canada scientists consider all peer-reviewed scientific studies and employ a weight-of-evidence approach.

158. **HC goes on to state:** The weight-of-evidence approach takes into account both the quantity of studies on a particular endpoint (whether adverse or no effect), and, more importantly, the quality of those studies.

159. **My Comments:** First it is not possible to consider "all" peer-reviewed scientific studies as there are hundreds of thousands of them. Second, HC does not provide any of the studies upon which they relied so it is not possible to determine which studies were omitted or ignored. And finally, HC conducts weight-of-evidence improperly and comes to the wrong conclusion from a scientific basis. As they state above, they consider whether a study documents adverse or no effects. What about studies that document a beneficial effect? How does HC deal with those studies? When conducting weight-of-evidence analysis studies showing adverse effects are compared to studies showing beneficial effects. Studies showing no effect are ignored. The appropriate way to conduct research and to establish guidelines is demonstrated by IARC in their two monographs on ELF (2002) and RFR (2012) both of which are longer than 400 pages. These monographs provide the studies considered and the rationale for the conclusions drawn. This is the appropriate way to conduct and

communicate research in a transparent manner that allows for further dialogue among experts.

160. **Myth #5**: Safety Code 6 is based only on preventing thermal (heating) effects and doesn't consider other harmful non-thermal/biological effects.

161. **HC Fact**: Health Canada scientists consider all peer-reviewed scientific studies and consider many different potential health effects including thermal, non-thermal and biological effects.

162. **HC goes on to state:** The exposure limits in Safety Code 6 for frequencies above 10 MHz are therefore set below the level at which heating (thermal effects) could occur. Harmful non-thermal/biological effects at levels below the limits in Safety Code 6 have not been scientifically established.

163. **My comments**: If HC believes that non-thermal effects have not been scientifically established then they must have ignored all the scientific literature documenting non-thermal effects. Many of these studies are available in the BioInitiative Report (Carpenter and Sage 2007).

164. **Myth #6**: I live and work in a major city, so I am constantly exposed to RF energy, all the time. Safety Code 6 does not account for the cumulative effects of this exposure to RF energy.

165. **HC Fact**: Canadians are protected from the cumulative effects of RF energy when Safety Code 6 is respected.

166. **My Comments:** Where is the evidence supporting the statement above? Instead of providing evidence, HC simply repeats their mantra that "no adverse health effects will occur from exposure to RF energy at the levels permitted by Safety Code 6." What scientists are finding is that the long-term chronic and cumulative exposures are contributing to adverse health conditions including but not limited to cancers.

167. **Myth #7**: Safety Code 6 does not protect my health, as it's based on an exposure time of only six minutes. Given our constant exposure to RF energy, especially in urban environments, this is not enough.

168. **HC Fact**: Canadians are protected from continuous exposure to multiple sources of RF energy when Safety Code 6 is respected.

169. **HC goes on to state**: This reference period is not a maximum exposure time. It means that the levels of RF energy from *all sources combined* shall not exceed the exposure limits in Safety Code 6 in *any* six-minute time period throughout the day.

170. **My Comments:** Where is the evidence and who is measuring exposure of Canadians to ensure that SC6 is not exceeded? To my knowledge neither HC nor Innovation, Science & Economic Development Canada do routine monitoring of RF exposure. If you don't monitor it you can't enforce it!

171. **Myth #8**: The International Agency for Research on Cancer (IARC) classified radiofrequency energy as potentially carcinogenic. This means that I will get cancer due to my exposure to RF energy.

172. **HC Fact**: The IARC did not find a direct link between RF energy exposure and cancer.

173. **HC goes on to state:** IARC … classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use. However, the vast majority of research to date does not support a link between RF energy exposure and cancers in humans.

174. **My Comments:** How many studies are needed to justify that there is a direct link between cancers (for example) and RF exposure? To date we have dozens of studies showing an association between cell phone use and gliomas, that occur on the same side of the head where the cell phone is placed; that rats exposed to RFR have a greater risk of developing various tumors including gliomas; that the age-standardized incidence rate for stage 4 gliomas in the frontal and temporal lobes are increasing in both the England and California according to cancer registries. Surely these studies provide enough scientific evidence to recognize a direct link between RF exposure and the formation of gliomas and other tumors.

175. **Myth #9**: Because Health Canada regularly reviews Safety Code 6, it must mean the current Code doesn't offer me enough protection.

176. **HC Fact**: The exposure limits recommended in Safety Code 6 protect the health of Canadians.

177. **HC goes on to state**: The Department continues to monitor and analyze ongoing scientific research on this issue and should new scientific evidence arise demonstrating that exposure to RF fields poses a health risk to Canadians, Health Canada will take the appropriate action to safeguard the health of Canadians.

178. **My comments:** While HC states that they continue to analyze ongoing scientific research there is no evidence that they recognize any of the research dealing with non-thermal effects. The health risk to Canadians from RF is clear yet HC fails to act and to protect the public. Indeed, no testing is done to find out what people are actually exposed to and whether the limits are exceeded. Health Canada and Innovation, Science & Economic Development Canada (ISEDC) (formerly Industry Canada) rely on the telecom industry to provide them with information on exposures. And since these companies report only on what they are emitting who is measuring the combined exposure from multiple antennas on towers where co-occupancy is required? Who is detecting "hot spots" when RFR is re-radiated by metallic objects?

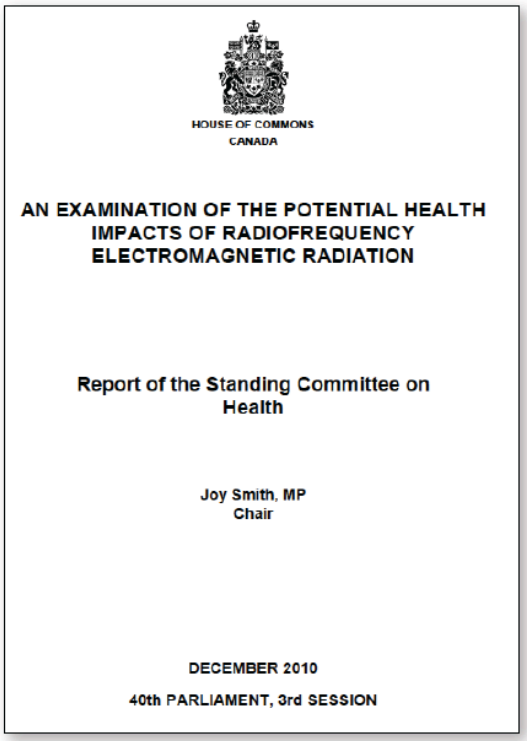
VII HESA RECOMMENDATIONS ON RADIO FREQUENCY RADIATION

179. In 2010 and again in 2015, The Standing Committee on Health (HESA) held hearings on Radio Frequency Radiation and made a number of

recommendations to the Government of Canada. Those recommendations are summarized in Tables 3 and 4.

180. To my knowledge, the Government of Canada and its various Departments and Agencies have largely ignored these recommendations.

Table 3. HESA Standing Committee Recommendations to the Government of Canada, 2010.



HOUSE OF COMMONS
CANADA

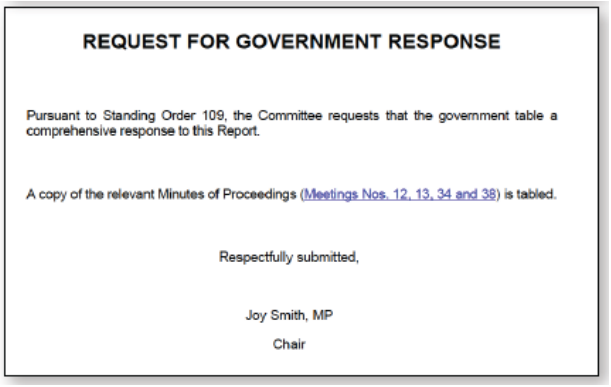
AN EXAMINATION OF THE POTENTIAL HEALTH IMPACTS OF RADIOFREQUENCY ELECTROMAGNETIC RADIATION

Report of the Standing Committee on Health

Joy Smith, MP
Chair

DECEMBER 2010

40th PARLIAMENT, 3rd SESSION



REQUEST FOR GOVERNMENT RESPONSE

Pursuant to Standing Order 109, the Committee requests that the government table a comprehensive response to this Report.

A copy of the relevant Minutes of Proceedings (Meetings Nos. 12, 13, 34 and 38) is tabled.

Respectfully submitted,

Joy Smith, MP
Chair

RECOMMENDATION 1

The Government of Canada consider providing funding to the Canadian Institutes of Health Research in support of longterm studies examining the potential health impacts of exposure to radiofrequency electromagnetic radiation.

RECOMMENDATION 2

Health Canada request that the Council of Canadian Academies or another appropriate independent institution conduct an assessment of the Canadian and international scientific literature regarding the potential health impacts of short and long-term exposure to radiofrequency electromagnetic radiation, which would include an examination of electromagnetic sensitivity and a comparison of public policies in other countries governing exposure to radiofrequency electromagnetic radiation; and report on its findings.

RECOMMENDATION 3

Health Canada and Industry Canada develop a comprehensive risk awareness program for exposure to radiofrequency electromagnetic radiation, which would include Health Canada making public in an accessible and transparent way all the studies and analyses undertaken by the Department on the impact of radiofrequency electromagnetic radiation on human health, as well as the provision of information promoting the safe use of wireless technologies.

Table 3 continued …

RECOMMENDATION 4
Health Canada and Industry Canada offer to provide information, including awareness sessions on exposure to radiofrequency electromagnetic radiation.

RECOMMENDATION 5
Health Canada ensure that it has a process in place to receive and respond to reports of adverse reactions to electromagnetic radiation emitting devices.

---

181. Recommendation 3 above requests that Health Canada and Industry Canada make public *in an accessible and transparent way* all the studies and analyses undertaken by the Department on the impact of radio frequency electromagnetic radiation on human health. Nine years have passed and Health Canada has failed to provide the studies it relied on to formulate Safety Code 6.

Table 4. HESA Standing Committee Recommendations to the Government of Canada, 2015.

Radiofrequency Electromagnetic Radiation and the Health of Canadians, Report of the Standing Committee on Health; Ben Lobb, Chair; 41st Parliament, Second Session, June, 2015.

RECOMMENDATION 1
That the Government of Canada, in collaboration with the health departments of the provinces and territories, examine existing cancer data collection methods to improve the collection of information relating to wireless device use and cancer.

RECOMMENDATION 2
That Statistics Canada consider including questions related to electromagnetic hypersensitivity in the Canadian Community Health Survey.

RECOMMENDATION 3
That the Government of Canada, through the Canadian Institutes of Health Research, consider funding research into electromagnetic hypersensitivity testing, diagnosis and treatment, and its possible impacts on health in the workplace.

RECOMMENDATION 4
That the Canadian Medical Association, the Royal College of Physicians and Surgeons, the College of Family Physicians of Canada and the World Health Organization consider updating their

guidelines and continuing education materials regarding the diagnosis and treatment of electromagnetic hypersensitivity to ensure they are based on the latest scientific evidence and reflect the symptoms of affected Canadians.

RECOMMENDATION 5
That the Government of Canada continue to provide reasonable accommodations for environmental sensitivities, including electromagnetic hypersensitivity, as required under the Canadian Human Rights Act.

RECOMMENDATION 6
That Health Canada ensure the openness and transparency of its processes for the review of Safety Code 6, so that all Canadians have an opportunity to be informed about the evidence considered or excluded in such reviews, that outside experts are provided full information when doing independent reviews, and that the scientific rationale for any change is clearly communicated.

RECOMMENDATION 7
That the Government of Canada establish a system for Canadians to report potential adverse reactions to radiofrequency fields.

RECOMMENDATION 8
That an independent scientific body recognized by Health Canada examine whether measures taken and guidelines provided in other countries, such as France and Israel, to limit the exposure of vulnerable populations, including infants, and young children in the school environment, to radiofrequencies should be adopted in Canada.

RECOMMENDATION 9
That the Government of Canada develop an awareness campaign relating to the safe use of wireless technologies, such as cell phones and Wi-Fi, in key environments such as the school and home to ensure that Canadian families and children are reducing risks related to radiofrequency exposure.

RECOMMENDATION 10
That Health Canada conduct a comprehensive review of all existing literature relating to radiofrequency fields and carcinogenicity based on international best practices.

RECOMMENDATION 11
That the Government of Canada, through the Canadian Institutes of Health Research, consider funding research into the link between radiofrequency fields and potential health effects such as cancer, genetic damage, infertility, impairment to development and behaviour, harmful effects to eyes and on the brain, cardiovascular, biological and biochemical effects.

RECOMMENDATION 12
That the Government of Canada and manufacturers consider policy measures regarding the marketing of radiation emitting devices to children under the age of 14, in order to ensure they are aware of the health risks and how they can be avoided.

---

182. HESA clearly recognizes the importance of electromagnetic hypersensitivity as it is mentioned in several of the recommendations above. It is unclear which of these recommendations have been implemented.

VIII 5G AND THE INTERNET OF THINGS (IOT)

183. Various countries around the globe are racing ahead to install and have 5G operational by 2020. 5G represents the 5th generation of telecommunication technology with 1G being voice (1982), 2G being voice and text (1992), 3G being voice, text, internet (2001) and 4G being voice, text, internet and video (2012). 5G promises much faster speeds of down loading information from the Internet. These faster speeds allow for autonomous cars and a whole host of new devices that rely on real-time computing.

184. In order to have these faster speeds, high frequencies are going to be used for 5G along with some lower frequencies in the 600 and 700 MHz range. The high frequencies are called millimetre waves (mmwaves) and these are currently being used at airport scanners where the airport staff are complaining of health effects.

185. The U.S. military also uses mmwaves as part of their active denial system (ADS) for non-lethal crowd control. Large parabolic antennas on trucks or tanks are aimed at a person or several people in a crowd and when the operator engages the joy stick, a highly intense beam of radiation causes extreme heat/pain for those in its path. The radiation penetrates clothing and causes the surface of the skin, and especially the sweat glands to heat up resulting in excruciating pain. According to the military these short-burst of mmwaves have no long-term health effects. What they fail to mention is that eyes are extremely sensitive to this type of radiation.

186. In Canada, the Ontario-Quebec corridor is going to be among the first to get 5G technology as soon as Ottawa begins to auction this part of electromagnetic spectrum.

187. The primary concern shared by many scientists is that there has been no testing of the long-term effects of exposure to 5G radiation and mmwaves.

188. The eyes and the testicles (both of which are highly sensitive to microwave radiation and a heating effect) are likely to be adversely affected following prolonged exposure to mmwaves.

189. Scientists are also warning that insects are likely to be adversely affected as their body is similar in size to the waves and this causes resonance and a greater absorption of energy.

190. Since moisture in the air and trees readily absorb these higher frequencies and smaller wavelengths, the transmitters will need to be within line-of-sight of each other in order to function properly. This will result in millions of small cell antennas placed on light, hydro and telephone poles at an interval of ever few hundred meters. Consequently small cells that transmit and receive mmwaves will be placed in front of every 3rd to 5th home depending on the density of the homes in any one neighbourhood. This rollout will cost hundreds of millions of dollars and will be paid for by the consumers of the technology.

191. The infrastructure for 5G will consist of satellites, large cells, small cells and fibre optics using a combination of mmwaves and lower frequency microwaves.

192. Clearly with 5G there will be winners and losers. The Industry is predicting 5 billion people will be connected, resulting in $4 trillion dollars in revenue

opportunities as 25 plus millions of apps are developed and embedded into of intelligent systems. All of this will enable 50 trillion GBs of data to be generated. All of this "data" means more RF exposure since most of the transfers will be through the air rather than through wires or fibre optics.

193. Since we have no research on the long-term effects it is difficult to predict the biological and health responses to 5G technology.

194. Russell (2018), reviewed what limited research is available and came up with the following conclusion.

1. sweat glands will be the target as they act like miniature antennas to mmwaves.

2. systemic signaling in the skin can result in physiological effects on the nervous system, heart, and immune system mediated through neuroendocrine mechanisms;

3. some frequencies had no effect (61 and 75 GHz) while other frequencies (55 and 73 GHz) caused pronounced arrhythmia. For this very reason, testing is essential to identify the frequencies that are least likely to be harmful should we move ahead with 5G technology.

4. there is likely to be an epidemic of ocular pathology with long-term exposure and an increase in cataracts in both young and old;

5. evidence that the immune system is impaired after a single dose resulting in 50% suppression of phagocyctic activity in healthy mice;

6. teratogenic effects (birth defects) were detected in drosophila (fruit flies that are used in the lab for studies involving several generations).

7. evidence that bacterial growth may increase or decrease depending on the species tested and on frequency and intensity of the mmwaves; and

8. evidence of antibiotic resistance caused by mmwaves.

195. Clearly, we need to be very carefully to avoid harmful biological and health effects to humans and other species if we are to expose virtually the entire population of Canada (and the world) to mmwaves.

196. Professor Martin Pall (2018) predicts four types of blindness associated with 5G technology: cataracts, detached retinas, glaucoma and macular degeneration. He goes on to state, "Putting in tens of millions of 5G antennae without a single biological test of safety has got to be about the stupidest idea anyone has had in the history of the world."

197. Many scientists agree that 5G needs to be placed on hold until proper scientific testing of the biological effects is complete. Scientists and doctors have signed a 5G appeal http://www.5gappeal.eu/scientists-and-doctors-warn-of-potential-serious-health-effects-of-5g/ and warn of potential serious health effects of 5G. They recommend a moratorium on the roll-out of 5G for telecommunication until potential hazards for human health and the environment have been fully investigated by scientists independent from industry. 5G will substantially increase exposure to radio frequency electromagnetic fields (RF-EMF) on top of the 2G, 3G, 4G, Wi-Fi, etc. RF-EMF has been proven to be harmful for humans and the environment at current levels. Increasing exposure is likely to make things that much worse.

198. This 5G Appeal, has been signed by more than 231 scientists in 40 nations as of April 30, 2019.

IX FINAL COMMENTS

199. Overall, the studies examining the effects of various types of electromagnetic pollution from power frequency electric and magnetic fields to microwave radiation are documenting adverse effects on reproduction, health and longevity of humans and wildlife as well as reduced productivity in agriculturally and commercially important animals, insects and plants. Increased cancers in rats exposed to microwave radiation at cell phone and Wi-Fi frequencies under controlled conditions have also been documented in at least three large, well funded studies. These effects and these studies cannot continue to be ignored. As levels of electromagnetic pollution continue to increase and as the areas of exposure continue to expand a growing number of people and species are being placed at risk. Some of these species have critical functions in ecosystems and their disappearance can have widespread adverse effects on societies around the world.

200. This concludes my testimony.

201. I, Magda Havas, residing at 304 Woodward Avenue, Peterborough, Ontario, Canada solemnly affirm that the information presented above is, to the best of my knowledge, true.

202. I hereby agree to waive confidentially with the present Report.

_____ May 15, 2019

Magda Havas, B.Sc., Ph.D. date

REFERENCES CITED

Adams JA, TS Galloway, D Mondal et al. 2014. Effect of mobile telephones on sperm quality: A systematic review. Environment International 70: 106-112.

Agarwal A, F Deepinder, RK Sharma et al. 2008. Effect of cell phone usage on semen analysis in men attending infertility clinic: an observational study. Fertil Steril, 89:124–8.

Balmori A and O Hallberg. 2007. The Urban Decline of the House Sparrow (*Passer domesticus*): A Possible Link with Electromagnetic Radiation. Electromagnetic Biology and Medicine 26 (2): 141–151.

Balmori A. 2004. Effects of Electromagnetic Fields of Phone Masts on a Population of white storks (*Ciconia ciconia*). Electromagnetic Biology and Medicine 24: 109–119

Balmori A. 2006. The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle? Toxicological & Environmental Chemistry 88 (2): 287–299.

Balmori A. 2010. Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: the city turned into a laboratory. Electromagn Biol Med. 29 (1–2):31–35.

Balodis V, G Briimelis, K Kalviskis, et al. 1996. Does the Skrunda Radio Location Station diminish the radial growth of pine trees? The Science of the Total Environment 180: 57-64.

Bethwaite, P, A Cook, J Kennedy and N Pearce. 2001. Acute leukemia in electrical workers: a New Zealand case-control study. Cancer, Causes and Control 12:683-689.

Bevington, M. 2018. Selected Studies on Electrosensitivity (ES) and Electromagnetic Hyper-Sensitivity (EHS). Electrosensitivity UK, 4th Edition, March 26, 2018. 146 pp.

Bigu-del-Blanco J and C Romero–Sierra. 1975. The properties of bird feathers as converse piezoelectric transducers and as receptors of microwave radiation. II. Bird feathers as dielectric receptors of microwave radiation. Biotelemetry 2 (6): 354–364.

Blank, M, E Kelley, M Havas, H Lai, JM Moskowitz. 2015. International Appeal: Scientists call for protection from non-ionizing electromagnetic field exposure Eur J. Oncol. Vol. 20, n. 3/4, pp. 180-182, 2015;

Burchard JF, DH Nguyen DH, and M Rodriguez. 2006. Plasma concentrations of thyroxine in dairy cows exposed to 60 Hz electric and magnetic fields. Bioelectromagnetics 27 (7): 553–559.

Burchard JF, H Monardes, and DH Nguyen. 2003. Effect of 10 kV, 30 microT, 60 Hz electric and magnetic fields on milk production and feed intake in nonpregnant dairy cattle. Bioelectromagnetics 24 (8): 557–563.

Cardis, E, BK Armstrong, and JD Bowman et al. 2011. Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five interphone countries. Occup Environ Med. 68(9):631–460.

Carpenter D and C Sage. 2007. BioInitiative Report, A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF), 610 pp.

Chou C-K, A Guy, LL Kunz, RB Johnson, JJ Crowley and J. H. Krupp. 1992. Long-Term, Low-Level Microwave Irradiation of Rats, Bioelectromagnetics 13:469–496.

Divan, HA. L Kheifets, C Obel, and J Olsen. 2008. Prenatal and Postnatal Exposure to Cell Phone Use and Behavioral Problems in Children. Epidemiology 19(4):523-529.

Dode et al. 2011 *Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil.* Science of the Total Environment. 409: 3649–3665.

Dodge CH. 1969. Clinical and hygienic aspects of exposure to electromagnetic fields. Biological Effects and Health Implications of Microwave Radiation, Symposium Proceedings, Richmond Virginia, Sept 17–19, 1969.

Engels S, N-L Schneider, N Lefeldt, et al. 2015. Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. Nature 509: 353.

Eskander EF, SF Estefan, AA Abd-Rabou. 2012 How does long term exposure to base stations and mobile phones affect human hormone profiles? Clinical Biochemistry 45:157–161.

Everaert J and D Bauwens. 2007. A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (*Passer domesticus*) Electromagn Biol Med. 26 (1): 63–72.

Expert Group. 2010. Report on Possible Impacts of Communication Towers on Wildlife including Birds and Bees. Ministry of Environment and Forests, Government of India, 88 pages. Appendix IV lists 919 scientific publications.

Falcioni L, L Bua, E Tibaldi, et al. 2019. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environmental Research 165:496–503.

Favre D. 2011. Mobile phone-induced honeybee worker piping. Apidologie 42 (3): 270–279.

Ferni KJ, NJ Leonard and DM Bird. 2010. Behavior of free-ranging and captive American kestrels under electromagnetic fields. J. Tox. and Environ. Health Part A Vol 59 (8).

Fernie KJ and DM Bird. 2001. Evidence of oxidative stress in American kestrels exposed to electromagnetic fields. Environ Res. 86 (2): 198–207.

Fernie KJ, DM Bird, RD Dawson, and PC Laguë. 2000. Effects of electromagnetic fields on the reproductive success of American kestrels. Physiol Biochem Zool. 73 (1): 60–65.

Gandhi OP, LL Morgan, AA de Salles, et al. 2012. Exposure limits: The underestimation of absorbed cell phone radiation, especially in children. Electromagnetic Biology and Medicine, 31(1): 34–51,

Glaser ZR. 1971. Bibliography of Reported Biological Phenomena ('Effects') and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation, Research Report. Project MF12.524.015-00043, Report No. 2 Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland 20014, U.S.A.

Goldsmith JR. 1997. Epidemiologic evidence relevant to radar (microwave) effects. Environ Health Perspect 105 (Suppl 6):1579-1587.

Greenberg B, VP. Bindokas, and JR. Gauger. 1981. Biological effects of a 765-kV transmission line: Exposures and thresholds in honeybee colonies. Bioelectromagnetics 2(4): 315–328.

Grigoriev Y. 2003. Biological effects of mobile phone electromagnetic field on chick embryo (risk assessment using the mortality rate). [Article in Russian]. Radiats Biol Radioecol. 43 (5): 541–543.

Haggerty K. 2010. Adverse Influence of Radio Frequency Background on Trembling Aspen Seedlings: Preliminary Observations. International Journal of Forestry Research 2010, 7 pages.

Halgamuge MN, SK Yak, ad JL Eberhardt. 2015. Reduced Growth of Soybean Seedlings After Exposure to Weak Microwave Radiation From GSM 900 Mobile Phone and Base Station, Bioelectromagnetics 36:87–95.

Halgamuge MN. 2016. Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. Electromagn Biol Med. 2016 Sep 20:1–23. [Epub ahead of print]

Hardell L, M Carlberg, KH Mild. 2009. Epidemiological evidence for an association between the use of wireless phones and tumor diseases. Pathophysiology 16 (2–3):113–122.

Harst W, J Kuhn, and H Stever. 2006. Can electromagnetic exposure cause a change in behaviour? Studying possible non-thermal influences on honey bees–An approach within the framework of Educational Informatics. Acta Systematica – IIAS Intern. J. 6: 1–6.

Hässig M, F Jud, and B Spiess. 2012. Increased occurrence of nuclear cataract in the calf after erection of a mobile phone base station. [Article in German]. Schweiz Arch Tierheilkd. 154 (2): 82–86.

Havas M. 2000. Biological effects of non-ionizing electromagnetic energy: A critical review of the reports by the US National Research Council and the US National Institute of Environmental Health Sciences as they relate to the broad realm of EMF Bioeffects. J. Env. Rev. 8: 173–253.

Havas M. 2006. Electromagnetic hypersensitivity: biological effects of dirty electricity with emphasis on diabetes and multiple sclerosis. Electromagn Biol Med. 25(4):259–268.

Havas M. 2008. Dirty Electricity Elevates Blood Sugar Among Electrically Sensitive Diabetics and May Explain Brittle Diabetes. Electromagnetic Biology and Medicine, 27: 135–146.

Havas, M. 2013. Radiation from wireless technology affects the blood, the heart, and the autonomic nervous system, Rev Environ Health 28(2-3): 75–84.

Havas M. 2017. When theory and observation collide: Can non-ionizing radiation cause cancer? Environmental Pollution. 221:501–5;

Havas M and A Olstad 2008. Power quality affects teacher wellbeing and student behavior in three Minnesota Schools. Sci Total Environ. 402(2-3):157–62;

Havas M and MS Symington. 2016. Effects of Wi-Fi Radiation on Germination and Growth of *Garden Cress (Lepidium sativum),* Broccoli *(Brassica oleracea), Red Clover (Trifolium pratense) and* Pea (Pisum sativum) Seedlings: A Partial Replication Study. Current Chemical Biology 10 (1): 65–73.

Havas M, J Marrongelle, B Pollner, et al. 2010 Provocation study using heart rate variability shows microwave radiation from 2.4 GHz cordless phone affects autonomic nervous system. Eur. J. Oncol. Vol. 5: 273–300.

Health Canada Safety Code 6.

Hillman D, D Stetzer, M Graham, CL Goeke, et al. 2013. Relationship of electric power quality to milk production of dairy herds – Field study with literature review. Science of the Total Environment 447: 500–514.

Hocking B, Gordon IR, Grain HL, and Hatfield GE. 1996. Cancer Incidence & Mortality & Proximity to TV Towers, Med. J. Aust.165(11-12):601–5.

Huss, A, E Matthias, K Hug, et al. 2007. Source of funding and results of studies of health effects of mobile phone use: Systematic review of experimental studies. Environ. Health Perspectiv 115(1):1-4.

IARC 2002. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields. Vol. 80 445 pp. IARC Press, Lyon France

IARC 2012. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Non-Ionizing Radiation Part 2: Radiofrequency electromagnetic fields Vol. 102, 481 pp. IARC Press, Lyon France

Ingol, IV and SK Ghosh. 2006. Exposure to radio frequency radiation emitted by cell phone and mortality in chick embryos (*Gallus domesticus*). Biomedical Research 17 (3): 205–210.

Kesari et al. 2011 *900-MHz microwave radiation promotes oxidation in rat brain*. Electromagnetic Biology and Medicine, 30(4): 219–234.

Kumar NR, S Sangwan and P Badotra. 2011. Exposure to cell phone radiations produces biochemical changes in worker honey bees. Toxicol Int. 18 (1): 70–72.

Larkin RP and PJ Sutherland. 1977. Migrating birds respond to Project Seafarer's electromagnetic field. Science. 195 (4280): 777–9.

Li D-K, H Chen and R Odouli. 2011 Maternal exposure to magnetic fields during pregnancy in relation to the risk of asthma in offspring. Arch Pediatr Adolesc Med. 165 (10): 945-950.

Li D-K, R Odouli, S Wi, et al. 2002. A Population-Based Prospective Cohort Study of Personal Exposure to Magnetic Fields during Pregnancy and the Risk of Miscarriage. Epidemiology 13:9–20.

Löscher W, and G Käs. 1998. Extraordinary Behavior Disorders in Cows in Proximity to Transmission Stations. Translated from German language. Der Praktische Tierarz 79 (5): 4377 444.

Loss SR, T Will and PP Marra. 2014. Refining estimates of bird collision and electrocution mortality at power lines in the United States. PLoS One. 9 (7): e101565.

Magras IN and TD Xenos. 1997. RF radiation-induced changes in the prenatal development of mice. Bioelectromagnetics 18 (6): 455–461.

Manville AM. 2016. A Briefing Memorandum: What We Know, Can Infer, and Don't Yet Know about Impacts from Thermal and Non-thermal Non-ionizing Radiation to Birds and Other Wildlife — for Public Release, Wildlife and Habitat Conservation Solutions; Adjunct Professor, Johns Hopkins University's Krieger School of Arts and Sciences, DC Campus; and former U.S. Fish and Wildlife Service agency lead on avian-structural impacts — including from radiation July 14, 2016.

Marks TA , CC Ratke, and WO English. 1995. Stray voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: a discussion. Vet Hum Toxicol. 37 (2): 163–172.

Michelozzi P, C Ancoona, D Fusco et al. 1998. Risk of leukemia and residence near a radio transmitter in Italy. Epidemiology. 1998; 9(4)(Suppl):S111.

Milham S and LL Morgan 2008 A new electromagnetic exposure metric: High frequency voltae transients Associated with increased cancer incidence in teachers in a California school. A. J. Ind Med.

Nicholls B and PA Racey. 2007. Bats avoid radar installations: could electromagnetic fields deter bats from colliding with wind turbines? PLoS One. 2007 Mar 14;2(3):e297.

NTP 2018. NTP Technical Report on the Toxicology and Carcinogenesis Studies in Hsd:Sprague Dawley SD Rats exposed to Whole-body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) used by Cell Phones. National Institutes of Health, Public Health Service, U.S. Departet of health and Human Services. 384 pp.

Ontario Hydro 1996. Power Quality Reference Guide, 6th edition. 130 pp.

Pall ML. 2018. 5G: Great risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them, 90 pp.

Pattazhy S. 2009. Mobile phone towers a threat to honey bees: Study. The Times of India, August 2009. http://timesofindia.indiatimes.com/NEWS/Science/Mobile-phone-towers-a-threatto-honeybees-Study/articleshow/4955867.cms .

Phillips JL, NP Singh and H Lai. 2009. Electromagnetic fields and DNA damage. Pathophysiology 16(2–3):79–88.

Rea WJ, Y Pan, EJ Fenyves, et al. 1991. Electromagnetic field sensitivity. J. Bioelectr. 10: 241–256.

Repacholi MH, A Basten, V Gebski, et al. 1997 Lymphomas in E mu-Pim1 transgenic mice exposed to pulsed 900 MHZ electromagnetic fields. *Radiat Res*. 147(5): 631–640.

Rodriguez M, D Petitclerc, JF Burchard, et al. 2003. Responses of the estrous cycle in dairy cows exposed to electric and magnetic fields (60 Hz) during 8-h photoperiods. Animal Reproduction Science 77 (1-2): 11–20.

Russell, CI. 2018. 5G wireless telecommunications expansions: Public health and environmental implications. Environmental Research 165:484–495.

Sadetski S, A Chetrit, A Jarsus-Hakak et al. 2008. Cellular Phone Use and Risk of Benign and Malignant Parotid Gland Tumors—A Nationwide Case-Control Study. Am J Epidemiol 167:457–467.

Sahib S. 2011. Electromagnetic Radiation (EMR) Clashes with Honey Bees. International Journal of Environmental Sciences, 1 (5): 897–900.

Santini R, Santini P, Danze JM, et al. 2002. Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex. Pathol Biol (Paris), 50(6): 369–73.

Savitz DA and DP Loomis. 1995. Magnetic field exposure in relation to leukemia and brain cancer mortality among electric utility workers. Am. J. Epidmiol. 141(2):123-134.

Savitz DA et al. 2000. Case-Cohort analysis of brain cancer and leukemia in electric utility wokers using a refined magnetic field job-epxousre matrix. Am. J. Indust. Med. 38: 417–425.

Southern WE. 1975. Orientation of gull chicks exposed to project Sanguine's electromagnetic field. Science. 189 (4197): 143–145.

Steneck NH, Cook HJ, Vander AJ and Kane GL. 1980. The Origins of the U.S. Safety Standards for Microwave Radiation. Science 208:1230–1237;

Stetzer D, AM Leavitt, CL Goeke, and M Havas. 2016. Monitoring and remediation of on-farm and off-farm ground current measured as step potential on a Wisconsin dairy farm: A case study. Electromagnetic Biology and Medicine 35 (4): 321–336.

Tanner JA and C Romero-Sierra. 1982. The Effects of Chronic Exposure to Very Low Intensity Microwave Radiation on Domestic Fowl. Journal of Bioelectricity 1 (2): 195–205.

Ubeda A, MA Trillo, L Chacon, MJ Blanco and J Leal. 1994. Chick embryo development can be irreversibly altered by early exposure to weak extremely-low-frequency magnetic fields. Bioelectromagnetics 15 (5): 385–398.

Waldmann-Selsam, A Balmori-de la Puente, H Breunig and A Balmori. 2016. Radiofrequency radiation injures trees around mobile phonebase stations. Science of the Total Environment 572: 13 554–569.

Warnke U. 2009. Bees, Birds and Mankind. Destroying Nature by ‘Electrosmog’ Effects of Wireless Communication Technologies, A Brochure Series by the Competence Initiative for the Protection of Humanity, Environment and Democracy, 47 pp.

Wiltschko R, P Thalau, D Gehring, C Niessner, T Ritz and W. Wiltschko. 2015. Magnetoreception in birds: the effect of radio-frequency fields. J R Soc Interface 12(103).

Wirth M, JE Vena, EK Smith et al. 2013. The Epidemiology of Cancer Among Police Officers. Am J Ind Med. 56(4): 439–453.

Yakymenko et al. 2011 Long-term exposure to microwave radiation provokes cancer growth: Evidence from radars and mobile communication systems. Exp. Oncol. 33(2):62–70.

Yakymenko I, O Tsybulin, E Sidorik et al. 2016 Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation. Electromagn Biol Med, Early Online: 1–16.

XXX

***** END OF DOCUMENT *****