Report from the Health Council of Marin

Accepted by the Marin County Board of Supervisors, August 20, 2024

The following report was written to offer information on issues surrounding "novel" forms of pollution in our air habitat. For the purposes of this report, these include electromagnetic frequencies and the toxins that emanate from fragranced products. The report concerns the effects of these novel pollutants on the environment, the climate, and the general public, with special attention to the effects on people with disabilities. The report also covers some of the legal and regulatory aspects impacting the mitigation of these effects. Last, the committee suggests possible solutions.

Part One: An overview of novel forms of air pollution and their effects on humans and flora and fauna

Part Two: A comprehensive definition of *disability* and ways in which to acquire a reasonable accommodation

Part Three: A detailed examination of the features of microwaves and millimeter waves, their effects on living organisms and climate, and their viability as a successful, sustainable, safe technology

Part Four: An in-depth look at the legal and regulatory issues surrounding the management of electromagnetic frequencies

Part Five: Possible solutions to controlling and mitigating harmful effects of these types of pollution

Part One

Air as Habitat: Overview

The *Concise Oxford English Dictionary* defines *habitat* as "the natural home or environment of an organism" ("Habitat"). Most people think of their habitats as the houses or apartments they live in; their surrounding yards and/or streets; their small towns or big cities; the mountains, plains, oceans nearby. But there is one common element in all of those environments: air. No matter where we are, we live in—and we live on—air. In her article "Effects of Nonionizing Electromagnetic Fields on Flora and Fauna, Part 1," science journalist Blake Levitt writes, "It is time to . . . develop rules at regulatory agencies that designate air as 'habitat.'" Her intent here is not simply to clarify what constitutes habitat. Her ensuing discussion expands our understanding of novel forms of pollution that enter the air and impact our health and ecological systems. Levitt's main target is electromagnetic frequencies (EMFs) and radiofrequency radiation (RFR) from wireless devices. This report will also examine the man-made chemical substances in fragrance that emanate from many of our common products and fill the air around us. Radiofrequency radiation/electromagnetic frequencies and numerous fragrance chemicals are not recognized as pollutants and are not properly labelled or regulated in ways that will protect humans, animals, and the environment. This must change.

Fragrance Toxicity

Many of the products we use every day emit toxins into the air that we breathe, allowing them to enter our blood streams and cause harm. Some of the worst culprits are those man-made chemicals that are specifically intended for us to inhale: fragrances. The harmful aspects of these chemicals were acknowledged decades ago. The following was stated in a 1986 United States House of Representatives Report:

> In 1986, the National Academy of Sciences targeted fragrances as one of the six categories of chemicals that should be given high priority for neurotoxicity testing. The other groups include insecticides, heavy metals, solvents, food additives and certain air pollutants. The report states that 95 percent of chemicals used in fragrances are synthetic compounds derived from petroleum. They include benzene derivatives, aldehydes, and many other known toxics and sensitizers, which are capable of causing cancer, birth defects, central nervous system disorders and allergic reactions. (qtd. in "Neurotoxins")

Despite this recognition, not much has been done in the past thirty-seven years to mitigate the dangers of chemical fragrances. Currently, the term *fragrance* on ingredient labels refers to a formulation that contains many chemicals that are not individually listed, some of which are toxic to all of us. Unfortunately, we fail as a country to label the contents of fragrance formulations so that the public knows what chemicals constitute their products. We fail as a society to define chemical fragrance as a pollutant in our air habitat. And we fail to regulate and ban the toxic contents of these products.

California is a recent pioneer on the labeling stage, but only in the case of cosmetics. On January 1, 2022, the state passed SB 312, the Cosmetic Fragrance and Flavor Ingredients Right to Know Act. As cited in the *Legislative Counsel's Digest*:

> This bill would, commencing January 1, 2022, require a manufacturer of a cosmetic product sold in the state to disclose to the Division of Environmental and Occupational Disease Control a list of each fragrance ingredient or flavor ingredient that is included on a designated list, as defined, and a list of each fragrance allergen that is present in the cosmetic product in specified concentrations. The bill would, commencing January 1, 2022, require the division to post on its existing database of cosmetic product information

> a list of those fragrance ingredients and flavor ingredients in the cosmetic product and its associated health hazards. By creating a new crime, the bill would impose a state mandated local program. ("SB 312")

Some of the chemicals required to be listed include, but are not limited to, carcinogens; mutagens; endocrine disruptors; allergens; neurotoxins; chemicals causing reproductive harm; chemicals that are bioaccumulative, persistent, and inherently toxic; and priority pollutants in water quality control—as defined by specific agencies ("SB 312").

This is a hopeful step forward. However, more states and, indeed, the federal government, should pass similar laws—and not just for cosmetics. New laws should include any other products that contain man-made chemical fragrance. And since the dangers of fragrance ingredients are clearly recognized by such laws, these substances should be banned outright.

There are numerous studies confirming the toxicity of fragrance chemicals, amplifying the need to list them individually on product labels. Anne Steinemann has conducted many of them. She has a doctorate from Stanford University, is an internationally recognized expert on fragranced consumer products and a professor at the University of Melbourne and James Cook University, and serves as an adviser to governments, organizations, and industries around the world. In one recent study, "The Fragranced Products Phenomenon: Air Quality and Health, Science and Policy," she covers usage and effects of fragranced products in four countries: the United States, the United Kingdom, Australia, and Sweden. In each country, she studied fragrances in air fresheners, laundry products, cleaning supplies, personal care products, sunscreens, baby products (shampoos, lotions, hair sprays, fragrances), commercial essential oils, and car air fresheners. The 249 products studied produced 1,108 potentially hazardous volatile organic compounds (VOCs), and 99% of the products emitted potentially hazardous

volatile organic compounds. According to the Environmental Protection Agency, volatile organic compounds "are compounds that have a high vapor pressure and low water solubility. . . [and] are emitted as gases from certain solids or liquids. volatile organic compounds include a variety of chemicals, some of which may have short- and long-term adverse health effects" ("What Are Volatile Organic Compounds?"). The American Lung Association says, "Some are harmful by themselves, including some that cause cancer. In addition, some can react with other gases and form other air pollutants after they are in the air" ("Volatile Organic Compounds"). In Steinemann's research, the most prevalent of these volatile organic compounds were limonene, ethanol, and acetaldehyde ("Fragranced Products").

Across all of Steinemann's studies, product labels and data sheets listed fewer than 4% of the volatile organic compounds and fewer than 5% of the potentially hazardous volatile organic compounds. Steinemann states, "No law requires that consumer products (i.e.., products other than foods, drugs, and cosmetics) disclose all the ingredients on the label, safety data sheet, or elsewhere. These products are not even required to list the general term 'fragrance'" ("Fragranced Products"). As mentioned earlier, the new California law is limited to cosmetics. Fragrance ingredients in hundreds of other products are left unlabeled and unknown to the public. All of us remain unaware and exposed to the toxins in these fragrance chemicals.

These volatile organic compounds and other toxic substances can cause health problems, some of which are disabling. People with multiple chemical sensitivities (MCS), allergies, asthma, and other conditions are hit the hardest and are often handicapped by the ubiquitous nature of fragrance in our air habitat. But even those without sensitivities suffer in ways they do not immediately recognize. Steinemann found the following health effects across the four countries: respiratory problems, mucosal symptoms, migraine headaches, skin problems, asthma

attacks, neurological problems, cognitive problems, gastrointestinal issues, cardiovascular problems, immune system issues, and musculoskeletal problems. The effects were even more pronounced in vulnerable populations (Steinemann, "Fragranced Products").

Volatile organic compounds are not the only substances that can cause health problems through exposure to fragrance. Phthalates, often used as plasticizers to soften plastic products and make them more durable, are also used in fragrance to amplify scent and make it last. According to the Centers for Disease Control and Prevention (CDC), they are "weak endocrine disruptors and androgen blocking chemicals. . . when absorbed into the body [they] can either mimic or block female hormones, or in males, suppress the hormones involved in male sexual development. Phthalates cross the placenta" ("Phthalates Factsheet"). According to the Environmental Working Group, phthalates are "linked to problems of the reproductive system, including decreased sperm motility and concentration in men and genital abnormalities in baby boys . . . More recently they've also been linked to asthma and allergies" ("Cheat Sheet – Phthalates"). Russ Hausser, the Frederick Lee Hisaw Professor of Reproductive Physiology and Professor of Environmental and Occupational Epidemiology at Harvard, concurs with this conclusion that phthalates have anti-androgenic effects on the development of the male reproductive tract. He adds neurological problems to the effects:

> In the last ten years, epidemiologic studies have also shown that prenatal exposure to phthalates affects children's neurodevelopmental and neurobehavioral outcomes . . . more than a dozen studies . . . have shown that maternal exposure to ortho-phthalates during pregnancy can impair child brain development and increase children's risks for learning, attention, and behavioral disorders. (Hauser)

The potential harm to our children should be enough to inspire a ban on phthalates in all products, including fragrances.

Yet, as in the case of volatile organic compounds, these dangerous chemicals are not even revealed to consumers. Hauser notes the following:

> In 2017, the Consumer Product Safety Commission banned the use of eight orthophthalates in children's toys and child-care articles. But in terms of their use in . . . personal care products, there's currently no specific legislation by other governmental agencies . . . If phthalates in the product are considered part of the scent formulation, they don't need to be listed on the ingredient list, because scents are considered proprietary.

With sperm counts plummeting and other disorders rising, we should demand full transparency. And these chemicals should be banned in scent formulas, just as they are in children's toys and care products.

Because they are propelled into the air that we breathe and emitted by the clothing we wear, fragranced laundry products deserve special attention. These include detergents, fabric softeners, scent boosters, and dryer sheets. If an enemy were to consider the best way to poison a whole population, they could hardly come up with a better method than blowing toxins out of residential dryer vents or having millions of carriers walk around emitting toxic fumes from their clothes. According to Michael Dover, a retired environmental scientist and a member of the Hitchcock Center for the Environment Board of Directors, more than twenty-five volatile organic compounds have been found in dryer-vent air. He writes, "Of these, seven are listed as hazardous air pollutants by the US Environmental Protection Agency, including two—benzene and acetaldehyde—that are classified as probable carcinogens. The EPA says there is no safe level of exposure to these two compounds" (Dover). He continues, "Clothes washed and dried with

fragrances continue to exude VOCs into the space around the people wearing them. Everyone who comes in contact with someone wearing these clothes gets a dose of whatever chemicals are around the wearer" (Dover). In fact, phthalates in clothing cling to anything they touch, such as blankets, bedding, couch cushions, other people, and so on. And yet, most people, including hospital staff, use scented laundry products, especially dryer sheets—potentially making the sick even sicker. Indeed, fragrance has become the new secondhand smoke.

Another serious culprit is air freshener in any form: aerosol sprays, solids, plug-ins, hang tags, and freshener pumped into rooms from automatic dispensers. According to Made Safe, a certification program for consumer products, air fresheners contain the following toxins:

- 1,4-dichlorobenzene (1,4 DB): a volatile organic compound that may impair lung function, of special concern for those who have asthma or other respiratory illnesses, especially children
- acetaldehyde: a probable carcinogen
- benzene: a known carcinogen and developmental and reproductive toxin
- d-limonene: associated with skin and eye irritation, a sensitizer, which means it is likely to increase the odds of a future allergic reaction
- formaldehyde: a known carcinogen
- parabens: linked to breast cancer and effects associated with hormone disruption
- phthalates: associated with effects from endocrine disruption, including damage to the female reproductive system, birth defects, and lower sperm counts
- styrene: associated with cancer and neurotoxicity
- toluene: linked to developmental and reproductive toxicity

- xylene: linked to the effects of central nervous system depression, such as headache, dizziness, depression, and impaired short-term memory
- volatile organic compounds: substances that readily become vapors or gases; because a wide range of substances are known as volatile organic compounds, the associated health impacts span a wide range; numerous volatile organic compounds are known to be toxic (some of the other substances on this list are volatile organic compounds).

Not only do these fresheners contain phthalates and volatile organic compounds, but one of the volatile organic compounds is 1,4-dichlorobenzene. This chemical is a level 2 carcinogen and an Environmental Protection Agency (EPA) registered pesticide linked to lung damage ("How Air Fresheners Are Killing You"). It is the main ingredient used to manufacture the pesticide DDT and its related chemicals DDE and DDD. Dichlorobenzene "freshens" by damaging the mucous membrane—supposedly temporarily—to block your olfactory sense. In other words, it knocks out your ability to smell, all the while diminishing your lung capacity for—well—we don't know how long. No long-term studies have ever been done to test the effects of chronic exposure ("How Air Fresheners Are Killing You"). But given what we do know of its effects in DDT, this chemical should be banned in all other products.

We are all affected by these toxins in our air environment. But people with multiple chemical sensitivities and other sensitivities are more severely affected and often debilitated by even small exposures. According to Gesualdo Zucco and Richard Doty in an article in *Brain Sciences*, multiple chemical sensitivities is "an acquired multifactorial syndrome characterized by a recurrent set of debilitating symptoms." They state that the constellation of symptoms and intolerances occur in a two-phase process by which sufferers acquire the illness: sensitization and triggering (Zucco and Doty). During the sensitization phase, people can be exposed over time to

low-level chemicals (largely petroleum-based) or to a single high-level dose, causing aversion to the original toxin. Following this phase, affected people are triggered in a more generalized way to even tiny amounts of a larger set of toxins in fragranced substances and chemicals. The symptoms can involve multiple organ systems and include sensitivity to the smell of chemicals, nausea, dizziness, headache, upper respiratory discomfort, runny eyes, chest and throat pain, arthralgia, dyspepsia, fatigue, brain fog, depression, anxiety, mood disruption, and a range of other cognitive disturbances (Zucco and Doty). Many of our most common synthetic fragrances are also the most common causes and triggers.

Lawrence B. Afrin, a hematology and oncology specialist at AIM Center for Personalized Medicine, has long supported the same position that Zucco and Doty propose. Since the early 2000s, Afrin has contended that the onset of multiple chemical sensitivities "typically follows a high-level exposure. Thereafter, even very low-level re-exposures can trigger flares, plus the range of sensitivities typically expands over time even without further high-level exposures" (Afrin, "Mast Cell Activation"). He also discusses a newly articulated syndrome—mast cell activation syndrome—that he describes as "the root cause of the modern epidemics of chronic inflammatory diseases" (Afrin, *Never Bet Against Occam*). Mast cells are white blood cells that are part of the immune system that incites inflammation. Mast cell activation syndrome arises from the interaction of environmental factors with inherited genetic risks, and gets initiated by a multitude of stressors (Afrin, *Never Bet Against Occam*). These stressors can include drugs, foods, viruses/bacteria, physical stimuli, and—for our purposes here—man-made chemicals such as fragrance (Afrin, "Mast Cell"). The damaged mast cells release mediators which engage other mast cells, creating a multitude of varied symptoms individualized to the person (Afrin, *Never*

Bet Against Occam). Afrin suggests "the possibility that MCs [mast cells] may play an integral and perhaps even a primary role in MCS [multiple chemical sensitivities]" ("Mast Cell"). Chemical fragrances may be triggers and possibly causes of the condition. Afrin and colleagues Raymond F. Palmer and Tania C. Dempsey stress the following in a recent article in *The Journal of Xenobiotics*: "From a public health standpoint, improved regulation of environmental initiators such as pesticides and combustion products and triggers such as fragranced consumer products and food additives may help reduce the impact of CI [chemical intolerance] and MCAS [mast cell activation syndrome]." Afrin stresses that we are in the early stages of understanding this relationship and that more research is being done ("Mast Cell").

There are additional theories concerning the physiological mechanisms involved in multiple chemical sensitivities, and no one explanation has been widely accepted. But one thing is certain—increasing numbers of people are clearly suffering as more people are exposed to more fragrance toxins. In 2000, the California Department of Health Services found that 15.9% of survey respondents reported being "allergic or unusually sensitive to everyday chemicals." The same survey found that 11.9% reported being "sensitive to more than one chemical" and that 6.3% had been "doctor-diagnosed with MCS or EI [environmental intolerance]" (Steinemann, "National Prevalence"). In 2001, a Marin County survey found 17% of respondents considered themselves "sensitive to everyday chemicals." In her 2016 study based on a "nationally representative cross-sectional population-based sample of [1,137] adult Americans," Anne Steinemann states, "MCS is widespread and increasing in the US population: an estimated 25.6 million adults (12.8%) are diagnosed with MCS, and an estimated 51.8 million adults (25.9%) report chemical sensitivity" (Steinemann, "National Prevalence"). She found that this represents "an increase of 300% in diagnosed MCS and 200% in self-reported chemical sensitivity in little

more than 10 years" (Steinemann, "National Prevalence"). A Canadian study in June 2021 found the incidence of self-reported sensitivity to be as high as 32% (Carrier et al.). Clearly, the incidence of both self-reported and diagnosed cases of multiple chemical sensitivities has markedly increased over time.

It is worth noting that multiple chemical sensitivity is recognized as a disorder in Germany (since 1998), Austria, Luxemburg, Spain, Finland, Japan, some Canadian agencies, and some regional authorities in Italy. In the United States, the Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA), Housing and Urban Development (HUD), the Social Security Administration (SSA), and the Americans with Disabilities Act (ADA) have all, to varying degrees, accepted it as a disability as well (Zucco and Doty).

These sufferers are not all imagining things. They are the canaries in the coal mine. Their symptoms are warning the rest of us that certain substances are toxic. They are no different from the people who were affected by second-hand smoke or those who suffered from fibromyalgia, chronic fatigue syndrome, or post-traumatic stress disorder—all of whom were dismissed as overly sensitive or mentally unstable until medical science finally paid heed. Multiple chemical sensitivities sufferers deserve the same consideration as those with more commonly understood ailments. While we would never think of force feeding a diabetic a big piece of cake or giving a peanut butter and jelly sandwich to a child with a peanut allergy, we regularly (if inadvertently) assault multiple chemical sensitivities sufferers with toxic fragrances through our daily habits and institutional practices. It is time we took these sufferers seriously, raised public awareness about their condition, and treated them with compassion. We must do this for the good of the

sufferers—and for the good of anyone who breathes air. What is affecting sufferers now will soon be affecting everyone else.

Radiofrequency Radiation and Electromagnetic Frequencies

Fragrance chemicals are not the only novel forms of pollution that add toxins to our air habitat. As early as fifty years ago, the dangers of airborne radiofrequency radiation and electromagnetic frequencies (RFR/EMFs) were apparent. Zorach Glaser, PhD, LT, MSC, USNR conducted studies for the Naval Medical Research Institute, as well as six other Naval departments. An international expert in radiofrequency bioethics, Glaser found central, peripheral, and autonomic nervous system effects; blood and vascular disorders; enzyme and biochemical changes in vitro; psychological disorders; gastrointestinal disorders; histological and endocrine gland changes; metabolic disorders; behavioral changes in animals; and genetic chromosomal changes. These effects were all coincident with low-level, nonionizing electromagnetic frequency exposure to "radiofrequency radiation initially [from] radar; then RF heat sealers and computers; and more recently various sources of wireless technology including mobile phones, broadcast, and WiFi or WiMax antennas, wireless routers, [and] smart meters . . ." (Glaser). These results are significant precisely because the studies were done with no agenda except to test the safety of wireless equipment for military personnel—not to stop an industry rollout. Since that time, wireless towers and devices have proliferated in modern society, and people have been exposed worldwide.

Many more recent studies have come to the same conclusions that Glaser did. Although there are too many studies to examine in detail here, most can be viewed on the Federal Communications Commission (FCC) website, which lists hundreds of peer-reviewed studies submitted by independent scientists from multiple countries under "Filings." Among some of the

more widely known is the "BioInitiative Report" by twenty-nine experts from ten countries. It lists exhaustive studies that demonstrate evidence for effects on gene and protein expression, the blood–brain barrier, immune function, the stress response, neurology, and behavior. It further covers genotoxic effects, disruption of the moderating signal, and the influence of radiofrequency radiation and electromagnetic frequencies on brain tumors, acoustic neuromas, and breast and childhood cancers. In short, it concludes that radiofrequency radiation "puts global health at risk" ("BioInitiative Report 2012"). In addition, more than 259 scientists and doctors from forty-four countries who have published peer-reviewed research have claimed that RFR has "proven . . . harmful for humans and the environment**"** ("EMF Scientist Appeal"). They sent an "International Scientist Appeal" to the United Nations, the World Health Organization, the United Nations Environment Programme, and United Nations Member Nations calling for stronger exposure limits. The appeal asserts the following:

> Numerous recent scientific publications have shown that EMF affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life. ("EMF Scientist Appeal")

These findings mirror many of those found fifty years ago by Zorach Glaser.

As stated, humans are not the only ones affected negatively by radiofrequency radiation and electromagnetic frequencies. According to Levitt et al. in "Effects of Non-ionizing

Electromagnetic Fields on Flora and Fauna, Part 2 Impacts: How Species Interact with Natural and Man-Made EMF,"

> Numerous studies across all frequencies and taxa indicate that current low-level anthropogenic EMF can have myriad adverse and synergistic effects, including on orientation and migration, food finding, reproduction, mating, nest and den building, territorial maintenance and defense, and on vitality, longevity and survivorship itself. Effects have been observed in mammals such as bats, cervids, cetaceans, and pinnipeds among others, and on birds, insects, amphibians, reptiles, microbes and many species of flora.

Malka Halgamuge, a senior lecturer in cybersecurity at RMIT University, Melbourne, Australia, and the chair of the Institute of Electrical and Electronics Engineers Computational Society, further discusses plants in her article, "Review: Weak Radiofrequency Radiation Exposure from Mobile Phone Radiation on Plants." She states, "The data from a substantial amount [sic] of the studies on RF-EMFs from mobile phones show physiological and/or morphological effects (89.9%, $p < 0.001$)" (Halgamuge). A nine-year field study by Cornelia Waldmann-Selsam et al. in 2016 found significant impacts to trees near cell antennas, and an investigation of hundreds of trees found damage starts on the side of the tree with the highest radiofrequency (Waldmann-Selsam et al.).

Despite substantial evidence, however, critics claim that correlation is not causation, that there is no known mechanism that would validate the connection between radiofrequency radiation/electromagnetic frequencies exposure and health problems. But Martin L. Pall, professor emeritus of biochemistry and basic medical sciences at Washington State University, Blake Levitt, and Henry Lai, professor emeritus in the Department of Bioengineering, University

of Washington, have posited credible explanations. Their positions are slightly different but not mutually exclusive. Pall focuses on the ways in which electromagnetic frequencies activate voltage-gated calcium channels in the plasma membrane of cells, producing excessive calcium, leading to oxidative stress. This stress reaction can be therapeutic in some cases or pathophysiological if it leads to cell damage (Pall). Levitt and Lai claim that cellular stress responses resulting from electromagnetic frequency exposure can aid in cell repair, partial destruction of the cell, or cell death, depending on the nature and extent of the cell damage. A recently recognized danger occurs when the stress reaction leads neither to cell repair nor to cell death, but rather is incomplete and allows damaged or mutated cells to replicate, as in cancer, neurodegenerative disease, and electromagnetic hypersensitivity (Lai and Levitt). The scientists all cite the potential beneficial results of electromagnetic frequency exposure but explain how this can go awry.

Additional explanations for electromagnetic sensitivity are emerging as we learn more about the role of mast cell activation. As mentioned earlier in relation to multiple chemical sensitivity, mast cell activation syndrome can be triggered by many environmental stressors. Olle Johannson is a world-leading authority on the health effects of electromagnetic frequency and radiation, formerly at the Karolinska Institute and the Royal Institute of Technology. His research indicates that electromagnetic frequencies and radiation are some of the stressors leading to this syndrome (Johannson). His studies found that exposure to electromagnetic frequencies appears to increase both the size and quantity of mast cells along with increasing their capacity to release a multitude of pro-inflammatory mediators (Johannson). This response then triggers a cascade of inflammatory events in the body, resulting in the various symptoms experienced by sensitive individuals (Johannson). Johannson emphasizes that our understanding

of this syndrome in relation to electromagnetic sensitivity is nascent and more research will lend clarity.

Of course, some scientists still doubt that exposure to radiofrequency radiation and electromagnetic frequencies causes the reported effects. They point to studies that question the connection. However, an exceptionally exhaustive study was done on these very studies by Professor of Biochemistry Dariusz Leszczynski, of the University of Helsinki, who looked at the following science databases: PubMed, EMF-Portal, and the Oceania Radiofrequency Scientific Advisory Association (ORSAA). These sites catalog tens of thousands of relevant studies. Leszczynski used only peer-reviewed original experimental studies published in the English language until March 2021. He found that, while many current studies over the past thirty years could not prove a causal link, they were inadequate in multiple ways:

- The majority of research data was subjective and described nonspecific symptoms.
- There was no way to confirm whether the diagnoses of the volunteers were accurate.
- The studies lacked objective biochemical and biophysical markers of electromagnetic frequency effects.
- The studies focused too much on the nocebo effect.
- Low numbers of electromagnetic hypersensitivity (EHS) volunteers participating in the studies might cause selection bias.
- The studies used a very large diversity of electromagnetic frequency exposure protocols.
- Acquiring data either during the exposure or soon afterward precluded looking at the late or chronic effects. Only acute effects could be measured. (Leszczynski)

Professor Leszczynski concluded the following:

> The opinion that there is no causality link between electromagnetic hypersensitivity and electromagnetic frequencies is unproven. This opinion, expressed by the World Health Organization EMF Project, the International Commission on Non-Ionizing Radiation Protection, International Committee on Electromagnetic Safety and numerous governmental organizations, should be revised because the scientific research data is of insufficient quality to be used as a proof of the lack of causality.

It is worth noting that the oil and gas industries, the tobacco industry, and the pharmaceutical industry have all made similar claims that harm from their products could not be proven despite an abundance of correlative evidence and peer-reviewed studies indicating otherwise. This is the exact situation that should be met by employing the precautionary principle, which stated briefly says that a new product or process should be resisted if its ultimate effects are disputed or unknown (see Part Three Appendix, section 1, for full text).

While some may still dispute it, we have ample evidence that radiofrequency radiation and electromagnetic frequencies can cause harm to humans, animals, and plants at low, nonthermal levels of exposure—and no reliable, conclusive evidence that it does not. We also now know the likely mechanisms by which this can happen. Yet we have failed to define radiofrequency radiation and electromagnetic frequencies as pollution, and we have failed to regulate them properly to prevent harm. Industry and government continue to claim that radiofrequency radiation and electromagnetic frequencies are safe technology, even though the Environmental Protection Agency has never tested the effects of nonthermal radiation and no long-term studies have been done by the Federal Communications Commission or the industries it is supposed to regulate. According to the Environmental Health Trust, “Currently there is no US Government-funded research program into the non-thermal biological effects of RF

emissions to the environment. The EPA, which formerly conducted such research, lost all of its research funding in 1996, and has done nothing since" ("Congress Has Failed"). When questioned by Senator Richard Blumenthal in a 2019 senate hearing, wireless industry representatives also admitted that no industry tests had been done on the biological effects of 5G (Elkind). (See Part Four for quotes.)

The 1996 Telecommunication Act, whose standards are based on obsolete studies done only on thermal effects, goes a step further by actually forbidding the consideration of health consequences when local municipalities create their wireless ordinances or attempt to deny a wireless application. According to this law, local officials may consider only issues such as practicality and aesthetics when mandating the location of wireless facilities. Physicians for Safe Technology state:

> The language was codified in Section 704 of the Telecommunications Act, which prohibits environmental concerns (or health concerns by purported lack of substantial evidence) as a reason for denial of cell towers. This is despite growing awareness and scientific confirmation of both environmental and health effects from exposure to cell tower radiation and all radiofrequency wireless devices. ("Section 704")

Clearly, it is easy to claim a "lack of purported evidence" for harm when no studies have been done by industry or regulatory agencies, and studies by independent scientists are discounted or ignored.

A telling exception to the Telecommunication Act rules occurred in 2004 when a group of Los Angeles firefighters began fighting the installation of cell towers on their fire stations for health reasons. According to a report on the website Physicians for Safe Technology,

> Within a week of installation in one station most of the firefighters developed unusual symptoms of headaches, fatigue, insomnia, memory loss, confusion, nausea and weakness. After a time, these firefighters in stations with adjacent cell towers were found to have forgotten CPR or became lost responding to a fire in a city they grew up in. ("Firefighters Fighting Fires")

As a result, the International Association of Firefighters (IAFF) commissioned a neurological study on six of these firefighters who had lived in stations for up to five years. The study was led by Gunnar Heuser, MD, PhD. Heuser's study found symptoms that included "slowed reaction time, lack of focus, lack of impulse control, severe headaches, anesthesia-like sleep, sleep deprivation, depression, and tremors." Moreover, SPECT scans found "a pattern of abnormal change which was concentrated over a wider area than would normally be seen in brains of individuals exposed to toxic inhalation, as might be expected from fighting fires" ("Firefighters Fighting Fires").

This protest and resultant study led to the overwhelming passage of IAFF Resolution 15 in August of 2004 ("Firefighters Fighting Fires"). Introduced by the California firefighters, it called for a one-million-dollar study of firefighters across the United States and Canada. It also called for a moratorium on the placement of cell towers on fire stations until results of the study were known. Unfortunately, the Telecommunications Act in both the United States and Canada scotched the funding for the study. However, this resolution led to much greater consideration for firefighters when telecommunication bills were introduced. Although California Assembly Bill 57 and Senate Bill 649, both designed to streamline wireless deployment, were ultimately vetoed by Governor Newsom, firefighters were given exemptions from having cell towers placed on or adjacent to their stations ("Firefighters Fighting Fires"). Had the bills passed, the exemptions

would have been upheld. And yet the Telecommunications Act still maintains the same prohibition against the consideration of health effects for the rest of the population.

Despite these clear instances of damage, the recognition that they were caused by radiofrequency radiation and electromagnetic frequency exposure, and the willingness to mitigate harm in this one case as a result of these findings, the telecommunications industry and government regulatory agencies have still chosen the path of willful ignorance—no studies have been done. Consequently, our current United States standards for safe exposure are compromised by a lack of research and knowledge, and they are markedly weaker than those in many other countries. By comparison, Russia, China, India, Bulgaria, Switzerland, Italy, Poland, Lichtenstein, Belgium, and Ukraine have established radiofrequency radiation exposure limits ten to a hundred times lower than those in the United States and recognize the nonthermal biological effects of wireless radiation ("Conversion Chart").

In December of 2019, the Federal Communications Commission was charged with reviewing United States exposure standards for wireless radiation. However, it simply renewed the outdated standards that had not been revised since 1996. In August of 2021, the District of Columbia Circuit Court of Appeals stated that the Federal Communications Commission 's unmodified renewal of old standards was "arbitrary and capricious." The court directed the Federal Communications Commission to explain making this decision, despite having "material evidence" challenging the standards, and address the impacts of radiofrequency radiation on children and the environment, as well as the health implications of long-term exposure to ubiquitous wireless devices (United States Court of Appeals). James Lin, who helped create radiofrequency radiation exposure limits when he was a member of the International Commission on Nonionizing Radiation Protection (ICNIRP) and the Institute of Electrical and

Electronic Engineers, stated that our current standards

> are not applicable to long-term exposure at low levels. Instead of advances in science, they are predicated on assumptions using outdated exposure metrics, thus their ability [sic] to protect children, workers, and the public from exposure to the RF radiation or people with sensitivity to electromagnetic radiation from wireless devices and systems. Furthermore, the limits are based on outdated information and circumvent important animal data. These issues are even more relevant in the case of millimeter-wave radiation from 5G mobile communications for which there are no adequate health effects studies in the published literature. Finally, the guidelines do not adequately address conclusions from scientific organizations, such as the IARC [International Agency for Research on Cancer]. Thus, many of the recommended limits are questionable from the standpoint of scientific justification for the safety and public health protection. (Lin)

So far, no action has been taken to obey the directions of the District of Columbia Circuit Court of Appeals.

Clearly, changes are needed in the make-up of the committees that determine these standards. As Lai and Levitt state, “There should be a preponderance of committee members with backgrounds in biology, not just physics/engineering as is the case today.”

And surely, standard revisions based on current science and current conditions are long overdue. Until we understand how to deploy this technology safely, we should adhere to the precautionary principle (mentioned previously and in Part Three Appendix, section 1).

Conclusion

Whether the pollution is from radiofrequency radiation and electromagnetic frequencies or chemical fragrance, it threatens our air habitat for the entire human population—not just for those with disabilities or sensitivities. The public must be made aware of the dangers, and those in authority must be compelled to label, mitigate, and ban these toxins in all products that use them.

Works Cited

Afrin, Lawrence B. "Mast Cell Activation Disease and the Modern Epidemic of Chronic Inflammatory Disease." *Translational Research*, 18 Jan. 2016, doi:10.1016/j.trsl.2016.01.003.

___. *Never Bet Against Occam: Mast Cell Activation Disease and the Modern Epidemics of Chronic Illness and Medical Complexity*. Sisters Media, 15 Mar. 2016.

"BioInitiative Report 2012." *Bioinitiative*, 2012, bioinitiative.org/.

Carrier, Gaétan, et al. "Multiple Chemical Sensitivity Syndrome, an Integrative Approach to Identifying the Pathophysiological Mechanisms." *Institut National de Sante Publique de Quebec*, 29 Jun. 2021, www.inspq.qc.ca/en/publications/2730.

"Cheat Sheet – Phthalates." *Environmental Working Group*, 5 May 2008, https://www.ewg.org/news-insights/news/cheatsheet-phthalates.

"Congress Has Failed to Fund EPA Research into Biological Effects of RF Emissions on Human Health." *Environmental Health Trust*, 12 Oct. 2020, ehtrust.org/congress-has-failed-to-fund-epa-research-into-biological-effects-of-rfemissions-on-human-health/.

"Conversion Chart, World Exposure Limits, Human Exposures EMR/EMF." *Physicians for Safe Technology,* 24 Oct. 2023, https://mdsafetech.org/conversion-and-exposure-limits-emremf/.

Dover, Michael. "Laundry's Dirty Little Secret: Wearable Air Pollution." *Hitchcock Center*, 2020, www.hitchcockcenter.org/earth-matters/laundrys-dirty-little-secret-wearable-airpollution/.

Elkind, Peter. "How the FCC Shields Cell Phone Companies from Safety Concerns." *ProPublica*, 10 Nov. 2022, www.propublica.org/article/fcc-5g-wireless-safetycellphones-risk.

EMF Portal, https://www.emf-portal.org/en. Accessed 26 Nov. 2023.

"EMF Scientist Appeal." *EMFScientist.org*, 11 May 2015, emfscientist.org/index.php/emfscientist appeal."

"Filings." *Federal Communications Commission*, www.fcc.gov/ecfs/search/searchfilings/results?proceedings_name=13-84&q=filers.name:(*Environmental Health Trust*)&sort=date_disseminated,DESC. Accessed 23 Aug. 2023.

"Firefighters Fighting Fires … and Now Cell Towers." *Physicians for Safe Technology*, 29 Sept. 2019, mdsafetech.org/2019/09/28/firefighters-fighting-fires-and-now-cell-towers/.

Glaser, Zorach. "Bibliography of Reported Biological Phenomena ('Effects') and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation." Naval Medical Research Institute, 4 Oct. 1971, Bibliography-of-reported-biologicalphenomena-effects-and-clinical-manifestations-attributed-to-microwave-and-radiofrequency-radiation-c.

"Habitat, *N*." *Concise Oxford English Dictionary*. 11th ed., edited by Catherine Soanes and Angus Stevenson, Oxford UP, 2009, p. 639.

Halgamuge, Malka N. "Weak Radiofrequency Radiation Exposure from Mobile Phone Radiation on Plants." *Electromagnetic Biology and Medicine*, vol. 36, no. 2, 2017, pp. 213-35, doi:10.1080/15368378.2016.1220389.

Hauser, Russ. "Why Phthalates Should Be Restricted or Banned from Consumer Products."

News, 10 Mar. 2021, Harvard T. H. Chan School of Public Health, www.hsph.harvard.edu/news/features/the-big-3-why-phthalates-should-be-restricted-orbanned-from-consumer-products/.

"How Air Fresheners Are Killing You." *The Health Wyze Report*, Fidelity Ministry, healthwyze.org/reports/184-how-air-fresheners-are-killing-you. Accessed 4 Sept. 2023.

Johannson, Olle. "Disturbance of the immune system by electromagnetic fields—A potentially under-lying cause for cellular damage and tissue repair reduction which could lead to disease and impairment." *Pathophysiology*, 23 Apr. 2009, https://doi.org/10.1016/j.pathophys.2009.03.004.

Lai, H., and B. Blake Levitt. "Cellular and Molecular Effects of Non-ionizing Electromagnetic Fields." *Reviews on Environmental Health*, 7 Apr. 2023, *De Gruyter*, doi:10.1515/reveh2023-0023.

Leszczynski, Dariusz. "Review of the Scientific Evidence on the Individual Sensitivity to Electromagnetic Fields (EHS)." *Reviews on Environmental Health*, 6 Jul. 2021, *De Gruyter*, doi:10.1515/reveh-2021-0038.

Levitt, B. Blake, et al. "Effects of Non-ionizing Electromagnetic Fields on Flora and Fauna, Part 1. Rising Ambient EMF Levels in the Environment." *Reviews on Environmental Health*, 27 May 2021, *De Gruyter*, doi:10.1515/reveh-2021-0026.

---. "Effects of Non-ionizing Electromagnetic Fields on Flora and Fauna, Part 2 Impacts: How Species Interact with Natural and Man-Made EMF." *Reviews on Environmental Health*, 8 Jul. 2021, *De Gruyter*, doi:10.1515/reveh-2021-0050.

Lin, J. C. "RF Health Safety Limits and Recommendations [Health Matters]." *IEEE Microwave*

Magazine, vol. 24, no. 6, pp. 18-77, June 2023, doi:10.1109/MMM.2023.3255659.

"Neurotoxins: At Home and the Workplace: Report to the Committee on Science and Technology, US House of Representatives, Ninety-Ninth Congress, Second Session," *Report 99-82*, University of Michigan Library, 16 Sept. 1986.

Oceania Radiofrequency Scientific Advisory Association, https://www.orsaa.org/. Accessed 26 Nov. 2023.

Pall, Martin. "Electromagnetic Fields Act Similarly in Plants as in Animals: Probable Activation of Calcium Channels via Their Voltage Sensor." *Current Chemical Biology*, vol. 10, no. 1, 2016, pp. 74-82.

Palmer, Raymond F., et al. "Chemical Intolerance and Mast Cell Activation: A Suspicious Synchronicity." The Journal of Xenobiotics, 12 Nov. 2023, https://www.mdpi.com/2039-4713/13/4/45.

"Phthalates Factsheet." *National Biomonitoring Program*, 5 Apr. 2021, Centers for Disease Control and Prevention, www.cdc.gov/biomonitoring/Phthalates_FactSheet.html.

PubMed. *National Library of Medicine*, https://pubmed.ncbi.nlm.nih.gov/. Accessed 26 Nov. 2023.

"SB 312 Cosmetic Fragrance and Flavor Ingredient Right to Know Act of 2020." *California Legislative Information,* 2 Oct. 2020, leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB312.

"Section 704." *Telecommunications Act of 1996*, 3 Jan. 1996, pp. 117-18, mdsafetech.org/telecommunications-act-of-1996/.

Steinemann, A. "The Fragranced Products Phenomenon: Air Quality and Health, Science and Policy." *Air Quality, Atmosphere, and Health*, vol. 14, 19 Sept. 2020, pp. 235-43.

---. "National Prevalence and Effects of Multiple Chemical Sensitivities." *Journal of*

Occupational and Environmental Medicine, vol. 60, no. 3, 12 Jan. 2018, pp. e152-56, NIH National Library of Medicine, www.ncbi.nlm.nih.gov/pmc/articles/PMC5865484/.

"Toxic Chemicals in Air Fresheners." *Made Safe*, 19 Jan. 2020, www.madesafe.org/toxicchemicals-in-air-fresheners/.

United States Court of Appeals for the District of Columbia Circuit, 13 Aug. 2021, www.cadc.uscourts.gov/internet/opinions.nsf/FB976465BF00F8BD85258730004EFDF7/$file/20-1025-1910111.pdf.

"Volatile Organic Compounds." *American Lung Association*, www.lung.org/clean-air/athome/indoor-air-pollutants/volatile-organic-compounds. Accessed 1 Oct. 2023.

Waldmann-Selsam, Cornelia, Alfonso Balmori-de la Puente, Helmut Breunig, and Alfonso Balmori. "Radiofrequency Radiation Injures Trees Around Mobile Phone Base Stations." *Science of the Total Environment*, vol. 572, 1 Dec. 2016, pp. 554-69, doi:10.1016/j.scitotenv.2016.08.045.

"What Are Volatile Organic Compounds?" *Environmental Protection Agency*, 15 Mar. 2023, www.epa.gov/indoor-air-quality-iaq/what-are-volatile-organic-compounds-vocs.

Zucco, Gesualdo M., and Richard L. Doty. "Multiple Chemical Sensitivities." *Brain Sciences*, vol. 12, no. 1, 29 Dec. 2021, doi:10.3390/brainsci12010046.

Part Two

Definition of *Disability* and How to Acquire Reasonable Accommodation

The Americans with Disabilities Act (ADA) became law in 1990. The purpose of the law is to ensure that people with disabilities have the same rights and opportunities as everyone else. The Americans with Disabilities Act's definition of *disability* is more expansive than the way in which it is defined under some other laws, such as for Social Security disability-related benefits. The Americans with Disabilities Act defines a person "with a disability" as a person who has a physical or mental impairment that substantially limits one or more major life activities. This includes people who have a record of such an impairment (even if they do not currently have a disability) and those who are generally regarded as having a disability. In simpler terms, an individual with a disability is a person who has a physical or mental impairment that "substantially limits major life activities; has a record of such an impairment; or is regarded as having such an impairment" ("Intro. to ADA"):

> Physical or mental impairment" includes, but is not limited to, the following: visual, speech, and hearing impairments; mental retardation; emotional illness; and specific learning disabilities; cerebral palsy; epilepsy; muscular dystrophy; multiple sclerosis; orthopedic conditions; cancer; heart disease; diabetes; and contagious and noncontagious diseases such as tuberculosis and HIV disease (whether symptomatic or asymptomatic). ("Intro. to ADA")

Major life activities are those functions that are important to most people's daily lives. Major life activities include functions such as "breathing, walking, talking, hearing, seeing, sleeping, caring for oneself, performing manual tasks, and working" ("ADA Amendments"). Major life activities also include major bodily functions such as the following:

> immune system functions, normal cell growth, digestive, bowel, bladder, neurological, brain, respiratory, circulatory, endocrine, and reproductive functions. ("ADA Amendments")

The preceding definition considers many specific conditions that qualify as disabilities. Whether a particular condition constitutes a disability within the meaning of the Americans with Disabilities Act requires a case-by-case determination. The Act does not specifically name all of the impairments that are covered. Rather, as previously noted, it evaluates each case on a caseby-case basis depending on the severity of the limitation ("Intro. to ADA").

It is important to note that the Access Board of the Americans with Disabilities Act recognizes electromagnetic sensitivities and multiple chemical sensitivities as disabilities: The Board recognizes that multiple chemical sensitivities (MCS) and electromagnetic sensitivities (EMS) may be considered disabilities under the ADA if they so severely impair the neurological, respiratory or other functions of an individual that it substantially limits one or more of the individual's major life activities. ("Indoor Environmental Quality")

In addition, the Social Security Administration (SSA) defines *disability* such that electromagnetic sensitivities and multiple chemical sensitivities may qualify as disabilities under certain circumstances as well:

> The inability to engage in *substantial gainful activity (SGA)* because of *medically determinable* physical or mental *impairment(s)* that has lasted or is expected to last for a continuous period of *at least 12 months* OR is expected to *result in death.* ("Disability Determination Process")

An even broader definition of *disability* is held under the California Fair Employment and Housing Act (FEHA), the Unruh Civil Rights Act, and the Disabled Persons Act:

> In California, disabilities are broadly defined as conditions that limit a major life activity, including physical and mental disabilities, as well as medical conditions such as cancer or HIV/AIDS. California definitions and protections can be broader than protections under federal law. (“Discrimination Laws”)

In fact, a suit by a teacher in Los Angeles has been permitted to go forward past the pleading stage under the Fair Employment and Housing Act. The teacher sued for reasonable accommodation for electromagnetic sensitivities. The Court of Appeals held that the teacher’s symptoms qualified as a disability under the broad scope of the Fair Employment and Housing Act even if her diagnosis was unclear (Timm).

Federal laws (and some state laws, as mentioned) allow people with disabilities to request reasonable accommodation in their work and living environments. In the case of housing, the Fair Housing Act, Section 504, and Titles II and III of the Americans with Disabilities Act all grant people with disabilities the right to request reasonable accommodation. This is defined briefly as “a change, exception, or adjustment to a rule, policy, practice, or service that may be necessary for a person with disabilities to have an equal opportunity to use and enjoy a dwelling, including public and common use spaces, or to fulfill their program obligations” (“Reasonable Accommodations”). Housing and Urban Development (HUD) also specifies the following: Federal nondiscrimination laws that protect against disability discrimination cover not only tenants and home seekers with disabilities, but also buyers and renters without disabilities who live or are associated with individuals with disabilities. These laws also prohibit housing providers from refusing residency to persons with disabilities, or placing conditions on their residency, because they require reasonable accommodations or modifications. (“Reasonable Accommodations”)

Employers are also obliged to offer reasonable accommodations to people with disabilities under Title I of the Americans with Disabilities Act . *Reasonable accommodation* in this case is defined as follows:

> a modification or adjustment to a job, the work environment, or the way things are usually done during the hiring process. These modifications enable an individual with a disability to have an equal opportunity not only to get a job, but successfully perform their job tasks to the same extent as people without disabilities. ("Accommodations")

People with electromagnetic sensitivities and multiple chemical sensitivities should have access to fair, effective, nondiscriminatory treatment in their living and working environments. Too often, employers, housing managers, administrators, and even the general public dismiss sufferers' claims. We hope that the information herein compels them to reconsider. With advocacy from all of us, action by our elected officials, and administrative compliance with the laws, these sufferers should receive the compassionate understanding and effective accommodation that they need and deserve.

On October 3, 2023, President Joe Biden spoke in honor of the passing of the Americans with Disabilities Act and the Rehabilitation Act. He closed with the following statement about the act:

> It marked progress that wasn't political but personal for millions of disabled American veterans and families. Folks, for more than 61 million Americans living with disability, these laws are a source of opportunity, meaningful inclusion, participation, respect, and, as my dad would say, the most important of all, dignity. Being treated with dignity.

Works Cited

"Accommodations." *United States Department of Labor*, www.dol.gov/agencies/odep/programareas/employers/accommodations. Accessed 10 Aug. 2023.

"ADA Amendments Act of 2008 Frequently Asked Questions: What Is the Expanded Definition of 'Major Life Activities' Under the ADAAA?" *United States Department of Labor*, 1 Jan. 2009, www.dol.gov/agencies/ofccp/faqs/americans-with-disabilities-actamendments#Q5.

"Disability Determination Process." *Social Security Administration*, www.ssa.gov/disability/determination.htm. Accessed 3 Oct. 2023.

"Discrimination Laws Regarding People with Disabilities." *Civil Rights Department State of California*, 2023, calcivilrights.ca.gov/peoplewithdisabilities/#disabilityEmploymentBody.

"Indoor Environmental Quality." *IEQ Report*, 14 Sept. 2021, www.accessboard.gov/files/research/IEQ-Report.pdf.

"Introduction to the Americans with Disabilities Act." *United States Department of Justice*, www.ada.gov/topics/intro-to-ada/. Accessed 11 July, 2023.

"Reasonable Accommodations and Modifications." *United States Department of Housing and Urban Development*, www.hud.gov/program_offices/fair_housing_equal_opp/reasonable_accommodations_and_modifications. Accessed 11 July, 2023.

Timm, Bruce M. "What's That Ringing Sound? Court of Appeal Holds Electromagnetic Hypersensitivity Can Constitute a 'Physical Disability' Under FEHA." *Boutin Jones Inc.,*

Attorneys at Law, 21 Mar. 2021, https://boutinjones.com/whats-that-ringing-sound-courtof-appeal-holds-electromagnetic-hypersensitivity-can-constitute-a-physical-disabilityunder-feha/.

Part Three

The Features of 5G Millimeter Frequencies and Associated Power Levels, Distances Traveled, and Effects on Humans, the Environment, and Climate

Telecommunications operations are remarkably complex. These operations involve many different transmitter sizes, varying maximum distances covered, and differing power levels achieved. There is a dizzying number of factors involved in determining which applications might be safe and which are not, which are sustainable, what their effects are on humans and the environment, and whether they live up to their promise. More research is needed to examine all of these aspects to make responsible, health-conscious, climate-conscious, and energy-conscious policies. It is vital that we practice the precautionary principle, which briefly stated says that a new product or process should be resisted if its ultimate effects are disputed or unknown (see Appendix, section 1, for Marin County's comprehensive definition). We have seen the dangers of letting fossil fuel technology proliferate under industry claims that climate danger could not be proved. A pause on our current wireless rollouts is advisable before we create yet another undoable situation with all of its harmful consequences.

Why Microwaves, Including Millimeter Waves, Are Particularly Damaging

Nevertheless, 5G millimeter communication microwave technology is currently being rolled out in cities across the country. And there is much that we already do know about the health consequences. Perhaps the most important issues surrounding wireless technologies are the effects they have on living organisms, particularly humans. According to Andrew Goldsworthy, a retired expert from Imperial College London, humans are not adapted to the levels of man-made microwaves that we are currently exposed to:

> Higher frequencies such as the microwaves used in cell phones, WiFi and DECT phones, are the most damaging. Our present exposure to man-made microwaves is about a million billion billion (one followed by eighteen zeros) times greater than our natural exposure to these frequencies. We did not evolve in this environment and we should not be too surprised to find that at least some people may not be genetically adapted to it. As with most populations faced with an environmental change, those members that are not adapted either become ill, die prematurely or fail to reproduce adequately. (Goldsworthy)

According to Goldsworthy, "The main reason why microwaves are especially damaging is probably because of the ease with which the currents that they generate penetrate cell membranes." He continues:

> Cell membranes have a very high resistance to direct currents but, because they are so thin (about 10 nm), they behave like capacitors so that alternating currents pass through them easily . . . microwave currents pass through the membranes of cells and tissues more easily than radio waves of lower frequencies and can therefore do more damage to the cell contents. (Goldsworthy)

Distance Traveled by Millimeter Waves Inside the Human Body and Effects

The telecom industry claims that the millimeter waves produced by their technology do not have penetrating effects on the body. However, multiple peer-reviewed independent studies have found this not to be true. Joel Moskowitz, the Director of the Center for Family and Community Health at the University of California Berkeley, states the following in his article "We Have No Reason to Believe 5G Is Safe":

> Millimeter waves are mostly absorbed within a few millimeters of human skin and in the surface layers of the cornea. Short-term exposure can have adverse physiological effects in the peripheral nervous system, the immune system and the cardiovascular system. The research suggests that long-term exposure may pose health risks to the skin (e.g. melanoma), the eyes (e.g. ocular melanoma) and the testes (e.g. sterility). (Moskowitz)

As touched on in Part One, Martin Pall goes further to examine the mechanisms by which this penetration occurs and to distinguish between absorption of electric fields and absorption of magnetic fields. He focuses on the effects of these fields on voltage-gated calcium channels. These channels conduct action in nerve, muscle, and other electrically excitable cells. In his article "Millimeter (MM) Wave and Microwave Frequency Radiation Produce Deeply Penetrating Effects: The Biology and the Physics," Pall states that "the electric but not magnetic part of MM-EMFs are almost completely absorbed within the outer 1 mm of the body. However, the magnetic fields are very highly penetrating."

Pall's study revealed that "rodents are reported to have penetrating MM-wave impacts on the brain, the myocardium, liver, kidney and bone marrow. MM-waves produce electromagnetic sensitivity-like changes in rodent, frog and skate tissues" (Pall). In humans, Pall found that "MM-waves have penetrating effects including impacts on the brain, producing EEG changes and other neurological/neuropsychiatric changes, increases in apparent electromagnetic hypersensitivity and produce changes on ulcers and cardiac activity."

Pall's research reveals three very important findings that are rarely recognized in the electromagnetic frequency scientific literature:

1. Electronically generated EMFs are coherent, producing much higher electrical and magnetic forces than do natural incoherent EMFs.

2. Millimeter electrical waves are almost completely absorbed in the outer 1 mm of the body, but magnetic fields are much more penetrating.

3. EMF pulses act via their forces on the voltage sensor in our calcium channels. These pulses generate highly penetrative effects, producing excessive calcium in the cell. This leads to oxidative stress and cell damage.

(See Appendix, section 2, for a detailed explanation.)

Pall concludes by saying, "It is probable that genuine safety guidelines must keep nanosecond time scale variation of coherent electric and magnetic fields below some maximum level in order to produce genuine safety. These findings have important implications with regard to 5G radiation."

Both Pall and Levitt discuss the possible benefits of using millimeter waves to treat certain health conditions (Part One). In their article "Millimeter-Wave Technology for Medical Applications," authors Fujiang Lin, Wei Hu, and Ao Li would agree.

> All living cells generate alternating electromagnetic fields. Cells communicate within our body in millimeter waves . . . Unbalances in these waves are a basic cause for [a] health problem. If an external low power . . . source with [the] right frequency is brought to [the] right exposure site, it can stimulate[s] and establish communicat[ion] with body cells and cell membranes.
>
> Harmonic and balanced resonance contact with the frequencies of the body can thus correct the unbalances in the organism. This non-thermal low-intensity electromagnetic energy treatment is millimeter-wave therapy (MWT), a new revolutionary method in health care. (Lin et al.)

The authors further state that “over 40 years of research[es] and clinic trials have been conducted, in particular in Russia. It has shown clear healing effect for cardiovascular disorders, diabetes, dermatitis, gastrointestinal disorders, wound healing, pain relief, and the reduction of toxic side effects of chemotherapy in cancer patients, depression, etc.” (Lin et al.).

However, unlike the radiofrequency radiation and electromagnetic frequencies from wireless communication that have gone untested by industry or the government, these treatments have undergone many years of careful calibration of the right frequencies to achieve this delicate harmonic and balanced resonance. Were this not the case, as Levitt and Lai discuss in Part One, cell damage could occur and cause disease. If, indeed, our cells communicate using specific frequencies of millimeter wave, and medical devices are being developed on this principle, should not the general telecom use of this microwave spectrum band for telecommunications be paused or halted until more research is available on the possible unintentional deleterious effects on all living things?

Not only should we be sure that our normal, daily usage is safe, we should also be wary of more intentionally harmful deployment of this technology. More than twenty years ago a person could do an internet search and find many articles on research being done on the development of electromagnetic weaponry using millimeter wave technologies using many different millimeter wave frequencies and targeting many different body systems. These websites and articles are no longer available for perusal although many people will be familiar with the Active Denial System, which is publicly acknowledged for its use in crowd control. This system wields an invisible directed energy beam of millimeter waves that travel at the speed of light at distances up to and beyond small-arms range. Information about this technology is openly available on the internet (“Active Denial”).

Just as telecom companies claim there is no effect of their 5G and 10G millimeter communication waves beyond the skin surface of the body, the Active Denial fact sheet states there is no penetration of the 95 gigahertz Active Denial millimeter waves below the outer 1/64th inch of the skin structure—while admitting that it produces "an intolerable heating sensation, compelling the targeted individual to instinctively move" ("Active Denial"). Considering the more recent research that shows the deep body penetration of magnetic field waves from millimeter waves directed at the skin surface, this information needs to be revisited and updated.

Other Remarkable Penetrations by Millimeter Waves

Seeing Through Walls

It is particularly timely to pause rollout of 5G technologies as research has been done showing millimeter waves can even penetrate walls using the appropriate phased array antennas and signal strength. In a paper titled "Through-Wall Imaging Radar," the authors describe using millimeter waves to image moving persons or still persons (breathing distinguishes the body from surrounding inert objects) through ten-centimeter-thick solid concrete walls (Peabody).

An Israeli paper titled "Millimeter Waves Sensing Behind Walls—Feasibility Study with FEL Radiation" discusses the use of pulsed millimeter-wave FEL radiation (FEL is the acronym for "free electron laser"). The radiofrequency peak power at the free electron laser output was 150 watts in the vicinity of 100 gigahertz. They tested the penetration capabilities through different wall substances such as wood board, gypsum board, and cement tile with the objective of constructing a functional through-wall millimeter-wave sensor (Kapilevich). This ability brings up the questions of both safety and privacy.

Vaporizing Rock

Massachusetts Institute of Technology researcher Paul Woskov has been researching the use of gyrotrons to produce megawatts of power to facilitate millimeter waves in vaporizing rock. This technology could be used to bore into the Earth's crust to access geothermal energy more efficiently than traditional drilling techniques. It is also much faster and eliminates the use of drilling mud. The walls of the bore holes will be vitrified (glassy) as the melted rock solidifies, and this will help reinforce and strengthen the deep holes (Rivenberg).

Engineers will use millimeter frequencies of thirty to a hundred gigahertz and will efficiently have a penetration rate of 230 feet per hour. They can modify the bore size or speed of penetration by adjusting the frequency to lower ranges from a hundred kilowatts to two megawatts. The Massachusetts Institute of Technology Plasma Science and Fusion Center has created a company called Quaise that is raising money to drill down 12.4 miles in just 100 days to access temperatures around 932 degrees Fahrenheit. They will use the heat to superheat water to turn turbines and generate electricity. They plan to have their first power plant running by 2028 (Rivenberg). (See Appendix, section 7, for information on a millimeter-wave signal generator for a medical body scanner.)

These uses demonstrate the massive effects of millimeter waves at certain power levels. Clearly, we must be extremely judicious in our use of this technology. Given the Federal Communication Commission's lax exposure standards in the United States and the lack of testing by industry and the government, we should be tremendously reluctant to impose this power on the public until we know a great deal more about its effects.

Placement of 5G Transmitters and 5G Cell Towers

Despite all we already know about the health effects of wireless radiation, many of the transmitters will be placed quite close together and close to human activity. For those transmitters that may be placed at greater distances, the power levels will be higher and thus more dangerous. (See Appendix, section 5, for explanation of the microwave and millimeterwave spectra.) Unlike 3G and 4G systems, which place cell transmitters on towers at distantly dispersed locations because their communication frequencies can travel far distances, most of the first 5G cell transmitters are being placed on poles or in boxes at street level every few houses because the carriers say the signals will travel only a short distance. (For the ranges of current 5G bandwidth, see Appendix, section 3.) According to Nordrum and Clark of *IEEE Spectrum*, "To prevent signals from being dropped, carriers could install thousands of these stations in a city to form a dense network that acts like a relay team, receiving signals from other base stations and sending data to users at any location."

Hence, the perception of 5G transmitters is that they will all be small transmitters placed at frequent intervals between houses and other buildings. These have been the first transmitters installed, but there is actually a multiplicity of sizes and accompanying maximum distances covered and maximum power levels achieved. Refer to Appendix, sections 4 and 6, for further explanations and a chart from "A Guide to 5G Small Cells and Macrocells" posted by Essentra Components, which manufactures components for 5G transmitters, telecom cable, and fiber-optic cable as well as electromagnetic frequency shielding for data centers and sensitive devices in the United States and internationally ("A Guide").

Recently, United States carriers and university research groups have posted the longer distances (up to ten kilometers or 6.2 miles) they have been able to achieve in the transmission of

millimeter-wave signals in rural settings using various technologies. These antennas can narrow the signal to a beam to function as a directional antenna. More power (decibels) is needed to push the signal farther. A higher power level is needed to push the narrow signal beam through wind and rain (Alleven). Indeed, the telecommunications industry is eager to use the fiberless "backhaul" to reduce the costs of providing service.

It is worth noting that another study from China shows the use of an inexpensive directly modulated millimeter-wave laser (DML) to push a sixty-gigahertz signal through a radio-overfiber (RoF) system (Liu et al). This would seem to be a much preferable system because it limits exposure to high-powered millimeter aerial signals to wildlife, plants, insects, and humans. The United States should examine this method before using higher power levels to achieve greater distances.

"Small" 5G Transmitter Cells Are Not Small

The following information is posted on the Environmental Health Trust website ("What You Need to Know"): "Small cells" is an industry term for cell towers with transmitting antennas close to the ground near our homes. The FCC has estimated over 800,000 new "small" cells will be installed throughout the USA and millions worldwide. Radiating cell antennas with 5G, 4G, 3G, and 2G technology will be mounted on

- streetlights
- trashcans
- utility poles
- bus stops
- rooftops of buildings.

Also, on the EHT website: “Wireless antennas emit microwaves—nonionizing radiofrequency radiation—and essentially function as cell towers. Each installation can have over a thousand antennas that are transmitting simultaneously” (“What You Need to Know”). The following are examples of how “small” cells are not small:

- They increase electromagnetic radiation near homes.
- 5G will use new “beam-forming” antenna designs that create multiple streams of signal from each fixture.
- They have refrigerator-sized (and larger) equipment cabinets.
- Property values drop after a cell tower is built near homes.
- Taller and wider poles are needed for the antennas.
- Fixtures weigh hundreds of pounds (“What You Need to Know”).
- The insurance authority Swiss Re classifies 5G as a “high” emerging risk, cautioning that “potential claims for health impairments may come with a long latency” (“Swiss Re Classifies”). If insurance companies will not take the risk, why should we?

Clearly, the radiation exposure from these antennas is not small.

The Very Huge, Not Small Effects of 5G on Energy Use and Climate

Another important way in which 5G is not small is the huge impact it can have on energy consumption and climate change. According to the Environmental Health Trust, with 5G we are faced with skyrocketing energy consumption: “Engineers say 5G is ‘an energy hog.’ The millions of new short ‘small’ cell towers and over 64 billion IoT (Internet of Things) devices are expected by 2025. Industry reports repeatedly state that energy efficiency goals will not be fully met, and that energy use from wireless devices and networks will grow exponentially, ever increasing our carbon footprint” (“What You Need to Know”).

Furthermore, environmental experts warn that the IoT is unsustainable:

> The unbridled energy consumption of our wireless revolution, 4G, 5G and the Internet of Things is contributing to climate change. 5G requires millions of new cellular antennas called "small cells"—basically shorter cell towers—to be built in neighborhoods directly in front of our homes. These 5G antennas are to connect with billions of new wirelessly connected "smart" devices referred to as the Internet of Things (IoT). Massive Increases in 5G Equipment = Massive Increases in Energy Use Technology and will contribute to climate change ("Climate Change, 5G and The Intenet of Things").

Could this rollout contribute to climate change in addition to having biological effects on all organisms living on Earth? We should not be advancing this technology at our current rate without first finding out.

The Environmental Health Trust continues:

> Researchers are warning us that the energy consumption of 5G and the IoT is growing and projected to skyrocket. 5G is not sustainable. The demand for technology is outstripping the increase in efficiency. Energy consumption will rise sharply due to the ever-increasing IoT energy demands at every stage of the lifecycle of 5G equipment, from device manufacture to data centers to data transmissions and networks.

- 70.2 million "small cell" tower bases to be installed by 2025.
- 500 billion devices are expected to be connected to the Internet by 2030.
- 8.9 billion mobile phone subscriptions worldwide by 2024.
- 60% growth a year in the production of wireless peripherals (Wi-Fi/ Bluetooth speakers, appliances, wearables).
- 7-fold increase in mobile data traffic globally is projected between 2017 and 2022.

("Climate Change, 5G and the Internet of Things")

Some researchers are planning a harvestable 5G power grid. This is no small thing. An article in *Scientific Reports* states that "5G has been designed for blazing fast and low-latency communications. To do so, mm-wave frequencies were adopted and allowed unprecedentedly high radiated power densities by the FCC. Unknowingly, the architects of 5G have, thereby created a wireless power grid capable of powering devices at ranges far exceeding the capabilities of any existing technologies" (Eid et al.).

According to Dexter Johnson in *IEEE Spectrum*, 5G base stations are also expected to consume around three times as much power as 4G base stations. He states, "A lurking threat behind the promise of 5G delivering up to 1,000 times as much data as today's networks is that 5G could also consume up to 1,000 times as much energy." Why? Because there will be an increase in the number of small cells, massive multiple-input multiple-output (MIMO) antennas, cloud computing and an explosion of internet connected devices (Johnson).

5G is not a sustainable or green technology. Much more fossil fuel will be consumed to facilitate its implementation. It will be difficult to build enough solar panel arrays to power the burgeoning 5G network and related technologies. According to a 2020 study by Environmentally Sustainable 5G Deployment, an agency that quantifies the energy footprint for 5G deployment and identifies best practices to encourage energy sustainability, "As 5G usurps LTE, energy consumption is expected to increase 61x between 2020 to 2030 due to the energy demands of powerful network elements like massive MIMO and edge servers, the proliferation of 5G cell sites, and the flexibility of the 5G networks in both consumer and enterprise use cases." The study concludes that "power consumption of the 5G network is expected to soar due to active

network elements like energy-hungry baseband units, remote radio heads, small cells, and core networks" (qtd. in "Reports on the Increasing Energy Consumption").

In "Data Centers of the World Will Consume 1/5 of Earth's Power by 2025," Joao Marques Lima agrees that 5G will be an "energy hog": "Alarming new research suggests that failure to source renewable energy could make data centers one of the biggest polluters in just seven years . . . new alarming research suggests that data centers will be one of the biggest energy consumers on the planet, beating many countries' energy consumption levels" (qtd. In "Reports on the Increasing Energy Consumption").

Besides powering all the wireless technologies, where does all this wireless microwave and millimeter energy go? The answer is into the air and the general environment and into our bodies, the trees and plants and animals and soil microbiology. The more the 5G system is powered up, the more impact is likely to occur on the health of all things.

Fiber-optic cable and ethernet cable consume far less energy than 5G cells or WiFi (Sikdar). 5G generates twice the greenhouse gas emissions as wired fiber optics per a 2020 study ("Video Streaming"). Clearly, we should be investing more in these methods that have far fewer wide-reaching costs and effects. The potentially enormous consequences of a 5G network on human health, animals, plants, the climate, and even property values indicate that we should proceed with much more caution than we are.

Can It Even Work?

The industry's biggest selling point is that 5G is lightning fast. However, not everyone finds this to be the case. The Environmental Health Trust says, "Despite the industry message that 5G will be faster, in reality 5G is turning out to be slower. Testing finds 5G in the field is actually nearly the same speed or slower than 4G. It is not working out so well" ("What You

Need to Know"). *Computerworld* claims that "at this point, 5G is a bad joke. . . unless you live or work right next to an mmWave transceiver, you're simply not going to see those promised speeds or anything close to them" (Vaughan-Nichols).

Moreover, can 5G cope with the heat it creates by itself in conjunction with rising temperatures? Millimeter-wave networks on 5G already face an uphill battle, given their tiny range and high power consumption relative to LTE. Now they face their most implacable foe of all: the summer sun. Thermal management will be vital for 5G.

5G technology, radio units, and active antenna devices contain a greater density of highpower components in smaller spaces. This increased power requires more energy consumption, which generates more heat.

Uncontrolled heat can, however, cause components to burn out, which negatively affects the wider network. Overheating can lead to performance dips or complete breakdown and failure, resulting in network problems, outages, and downtime. This, in turn, may leave many people without connections, affecting their personal and professional lives.

So, whether thermal management for 5G antennae or smartphone thermal management, dissipating heat in 5G technology is important to ensure performance does not drop and devices do not fail.

5G devices such as 5G smartphones are literally burning their operator's hands when they approach higher gigabytes per second speeds that are still well within specified guidelines. *The Wall Street Journal* recently published an article titled "iPhone 15 Pro Owners Complain About Overheating Problems," which stated, "The new iPhone 15 Pro may be too hot for some to handle. Literally . . . The iPhone 15 ProMax hit 106 degrees Fahrenheit while charging and

temperatures up to 112 degrees when simultaneously charging and doing processor-intensive tasks, such as gaming" (Tilley et al.).

5G cell phones also cannot take the overly hot summer temperatures we are currently experiencing and respond by switching to lower-speed 4G networks to cool down.

The 5G modems are also overheating. Some consumers are putting fans on them to keep them cool. According to Martin Rowe of *5G Technology World*, "5G's antennas and the devices that drive them generate more heat than their LTE predecessors. That creates new cooling problems for wireless devices and systems." He continues by saying the following:

> If you listen to and read the hype surrounding 5G, you'll come away thinking that 5G is truly hot. That's the marketing perspective. From an engineering design perspective, 5G is also hot. Indeed, it's hotter than LTE in terms of the heat dissipated by the electronics because of the multiple antennas. If you're designing 5G into a router or other fixedaccess device, you will encounter thermal issues to a greater "degree" than in products that use LTE for wireless communications, even though the energy-per-bit might be less than LTE because of 5G's greater bandwidth. (Rowe)

Will there be power levels that are just too high and dangerous to manage?

To make matters worse, heat is not the only enemy of 5G. Other weather conditions such as rain, humidity, clouds, snow, and ice can also interfere with or shut down transmissions. Peter Christiansen of HighSpeedinternet.com explains "rain fade":

> Liquid water has a broad absorption spectrum in microwave wavelengths (which is how microwave ovens work). Most satellite, fixed-wireless, Wi-Fi, and 5G signals fall into these frequencies, which means that if there's rain or clouds between the transmitter and

> your receiver, some of the signal will be absorbed. Water droplets can also scatter the signal if the frequency of the signal and the size of the droplets match up in the right way.

Christiansen includes ice and snow as problems: "Cold weather can affect internet connections in several ways. Snow and ice particles in the air can contribute to rain fade, but they also pose an additional problem for wireless internet since snow can build up on antennas." Robert Triggs from Android Authority concurs:

> Millimeter-wave signal strength will degrade somewhat when it rains, which will first result in slightly slower speeds and then potentially connection problems. How much it degrades will depend on just how hard it's raining, and other factors like the distances from the cell tower. Rain will cause the most problems when connecting at the edge of a mmWave base station's range. (Triggs)

Christiansen concludes that "rain fade poses a considerable challenge for the deployment of new technologies like millimeter-wave 5G in tropical areas. Fortunately, new countermeasures are also being developed to mitigate these effects on wireless signals." He does not describe what these measures are, but it is reasonable to think they may consider raising the power levels to increase signal strength, potentially causing problems for human, animal, and plant health; energy use; climate change; and sustainability.

One possible solution is a DSL internet connection, which transmits signals over copper landlines. With a battery to keep a router and computer going, "DSL internet will continue to run without electricity, just like a landline phone" in a power outage or loss of connection (Christiansen).

Unfortunately, copper landlines are being phased out. We will all be subject to the unreliable service provided by wireless connections. This is not just an inconvenience, but a safety issue.

Finally, while 5G appears to be able to "see through" walls, it cannot penetrate them well, nor does it transmit reliably through trees. Because millimeter waves are so tiny compared with lower microwave and radio frequencies, objects such as walls and trees block the 5G millimeter signals as long as they are transmitting with a lower power level.

An article by The National Institute of Standards and Technology (NIST) states the following:

> However, millimeter waves also have drawbacks, including their limited ability to penetrate obstacles. These obstacles include buildings, but also the trees that dot the landscape. Until recently little was known about how trees affected millimeter wave propagation. And just as few of us would want to imagine a landscape without greenery, few designers would be able to plan networks around it without such a crucial fundamental detail. ("NIST Helps Next-Generation Cell Technology")

NIST then conducted a study on how trees and shrubs affect the transmission of millimeter waves. They measured how much each type of plant and its leaves reduce the decibel power of the transmission signal. Nadia Golmie, a NIST researcher, stated, "The tree study is one of the few out there that looks at the same tree's effect on a particular signal frequency through different seasons. Even the shape of leaves affects whether a signal will reflect or get through" ("NIST Helps Next-Generation Cell Technology").

In addition, telecoms are finding that 5G millimeter waves that they planned to go through windows are not penetrating through energy and light-efficient windows in more modern buildings (Jones).

Clearly, 5G has many functional drawbacks.

Conclusion

Given the health risks, the environmental risks, the lack of testing, the lax exposure standards, the energy consumption, and the unreliability of the technology itself, we should pause the rollout of any additional wireless systems and any placement of additional antennas in communities. We need to more thoroughly examine the existing studies and commission more publicly funded scientific studies on the safety of millimeter communication systems before this technology is further deployed.

Appendix

1. Precautionary Principle Ordinance – Marin County 2010.

"When activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically":

Marin County's Precautionary Principle Ordinance requires a thorough exploration and a careful analysis of a wide range of alternatives. Based on the best available science, the Precautionary Principle Ordinance requires the selection of the alternative that presents the least potential threat to human health and the county's natural systems. Public participation and an open and transparent decision-making process are critical to finding and selecting alternatives.

Where threats of serious or irreversible damage to people or nature exist, lack of full scientific certainty about cause and effect shall not be viewed as sufficient reason for the county to postpone reasonable measures to prevent the degradation of the environment or protect the health of its citizens. Any gaps in scientific data uncovered by the examination of alternatives will provide a guidepost for future research but will not prevent the county from taking protective action. As new scientific data become available, the county will review its decisions and make adjustments when warranted.

Where there are reasonable grounds for concern, the precautionary approach to decisionmaking is meant to help reduce harm by triggering a process to select the least potential threat. The key elements of the Precautionary Principle Ordinance's approach to decision-making include:

1. Anticipatory Action: There is a duty to take anticipatory action to prevent harm. Government, business, and community groups, as well as the general public, share this responsibility.
2. Right to Know: The community has a right to know complete and accurate information on potential human health and environmental impacts associated with the selection of products, services, operations or plans. The burden to supply this information lies with the proponent, not with the general public.
3. Alternatives Assessment: An obligation exists to examine a full range of alternatives and select the alternative with the least potential impact on human health and the environment, including the alternative of doing nothing.
4. Full Cost Accounting: When evaluating potential alternatives, there is a duty to consider all the reasonably foreseeable costs, including raw materials, manufacturing, transportation, use, cleanup, eventual disposal, and health costs—even if such costs are not reflected in the initial price. Short- and long-term benefits and time thresholds should be considered when making decisions.
5. Participatory Decision Process: Decisions applying the Precautionary Principle Ordinance must be transparent, participatory, and informed by the best available science and other relevant information. (Precautionary Principle Ordinance)

2. Explanation of Voltage-Gated Calcium Channels (VGCC) (Pall):

Time-varying magnetic fields have central roles in producing highly penetrating effects. The primary mechanism of EMF action is voltage-gated calcium channel (VGCC) activation with the EMFs acting via their forces on the voltage sensor, rather than by depolarization of the plasma membrane. Two distinct mechanisms, an indirect and a

direct mechanism, are consistent with and predicted by the physics, to explain penetrating MM-wave VGCC activation via the voltage sensor. Time-varying coherent magnetic fields can put forces on ions dissolved in aqueous phases deep within the body, regenerating coherent electric fields which activate the VGCC voltage sensor. In addition, time-varying magnetic fields can directly put forces on the 20 charges in the VGCC voltage sensor. (Pall)

Pall emphasizes the key role of both modulating and pure EMF pulses in greatly increasing very short-term high-level time variation of magnetic and electric fields. These pulses generate highly penetrative effects, producing excessive calcium leading to oxidative stress and cell damage. (Pall)

3. **Bandwidth Ranges (Hollington):**

The 5G bandwidth (5G meaning fifth generation and not five gigahertz) currently encompasses three ranges: low band is below millimeter-wave ranges (less than one gigahertz); medium band is one gigahertz to six gigahertz (T-Mobile, 2.5 GHz; AT&T, 2.45-3.55 GHz; Verizon, 3.7-3.98 GHz); high band is six gigahertz and above (Verizon/TMobile, 28 GHz; AT&T/Verizon/T-Mobile, 39 GHz; T-Mobile/Dish, 47 GHz) (Hollington). When the telecommunications industry was rolling out 5G, they divided the frequencies into two ranges, sub-6 GHz (Sub-6) and millimeter wave (mmWave). Sub-6 frequencies encompass all those below six gigahertz, and the 5G mmWave spectrum starts at approximately twenty-four gigahertz and goes up from there (Hollington). (Note that Sub-6 still includes the bottom of the millimeter frequency range from one gigahertz through six gigahertz.)

4. **Sizes, Distances, and Maximum Power Levels Achieved (“A Guide”):**

Specification	Femtocell	Picocell	Microcell	Macrocell
Transmit power	20 dBm	24 dBm	33–37 dBm	45 dBm
Power consumption	Low	Low	Moderate	High
Distance covered	Up to 32 feet	Up to 656 feet	Up to 1.2 miles	5–18 miles
Deployment	Indoor	Indoor and outdoor	Indoor and outdoor	Outdoor
Number of users	8–16	32–64	200	2,000+
Backhaul connectivity	Wired, fiber	Wired, fiber	Wired, fiber, microwave	Microwave, fiber
Installation	User	Operator	Operator	Operator

dBm = decimals per milliwatt.

Note that this chart does not include specific frequencies used by each transmitter as this varies by telecom carrier and country, and note as well that the frequencies used will impact the distances traveled and the necessary power level.

5. Micro- and Millimeter-Wave Spectra (Zhi et al.; Slattery):

Millimeter waves are part of the microwave spectrum. An article in *Military Medical Research Journal* considers microwaves to be the frequencies ranging from three hundred megahertz to three hundred gigahertz (Zhi). As for "millimeter-wave spectrum," there are several different interpretations. Perhaps there has not been a standard definition created yet. According to *TechTarget* in one interpretation, "Millimeter wave (MM

wave), also known as *millimeter band*, is the band of spectrum with wavelengths between 10 millimeters (30 GHz) and 1 millimeter (300 GHz). It is also known as the extremely high frequency (EHF) band by the International Telecommunication Union (ITU)" (Slattery). For conversion of gigahertz to millimeter wavelength, one gigahertz equals three hundred millimeters, three gigahertz equals one hundred millimeters, thirty gigahertz equals ten millimeters, and three hundred gigahertz equals one millimeter. Below three hundred megahertz is the radio-wave spectrum.

6. **Pros and Cons of Small Cells and Macrocells ("A Guide"):**

Overview: advantages of small cells

- extend the coverage of cellular networks indoors
- provide coverage in areas where signals are either weak or unavailable
- enable service at all times in densely populated areas
- cheaper to install than macrocell base stations
- use available frequency spectrum by re-using same frequencies in a given area
- energy efficient—use low power compared with macrocells
- offload cellular traffic and boost network efficiency
- faster to deploy than macrocells

Disadvantages of small cells

- much shorter range than macrocells
- more limited capabilities—handle fewer simultaneous sessions of voice and data calls and internet searches
- as more small cells are needed to cover a limited area, overall deployment more expensive than one microcell

- vulnerable to signal interference

Advantages of macrocells

- enable 5G networks to cover larger areas
- easy to upgrade the equipment
- enable faster response times, reducing latency
- using massive multiple-input multiple-output, thousands of people can connect at the same time
- wireless, so can be placed in locations where it is not feasible to use cables

Disadvantages of macrocells

- impacted by multipath signal loss
- security vulnerabilities due to contact over the air
- high deployment costs
- physical obstruction and elements (rain, etc.) can interfere with transmission
- Lower data rate compared with a wired network

7. Millimeter-Wave Signal Generator for a Medical Body Scanner ("UCI Engineers"):

According to the online article "UCI Engineers Develop Powerful Millimeter-Wave Signal Generator" published on February 7, 2017, by the University of California, Irvine School of Engineering, engineers at the University of Irvine have developed a powerful millimeter-wave chip that is a signal generator.

Developed in the Heydari lab, it is a tiny device only about one-third inch across that has the highest efficiency and power level of any device in its category. The article says it can be used in a biomedical hand-held scanner to image internal organs and then send gigabytes of the data to a remote data computing and storage device. It operates in the 110 to 300 gigahertz range,

frequencies that facilitate penetration of solid surfaces, and provides extremely high-resolution pictures.

The little device is classified as a radiator and can perform other functions as well. The engineers envision them being embedded in machines, cars, and any device with antennae and sensors that make up the Internet of Things. They could become very important in the driverless car industry to allow the cars to detect and avoid other objects. One has to wonder what power levels they will operate on to accomplish these myriad functions ("UCI Engineers").

Works Cited

"Active Denial Technology Fact Sheet." *Joint Non-Lethal Weapons Program*, May 2016, jnlwp.defense.gov/Portals/50/Documents/Press_Room/Fact_Sheets/ADT_Fact_Sheet_May_2016.pdf.

Alleven, Monica. "NYU Wireless Research Shows Real Potential for Millimeter Wave in Rural Areas." *NYU Wireless*, 11 Oct. 2016, wireless.engineering.nyu.edu/nyu-research-mmwave-in-rural-areas.

Vaughan-Nichols. "At this point, 5G is a bad joke." *Computerworld*, 16 Sept, 2020, https://www.computerworld.com/article/3575510/at-this-point-5g-is-a-bad-joke.html.

Blain, Loz, "Fusion Tech Is Set to Unlock Near-Limitless Ultra-Deep Geothermal Energy." *New Atlas*, 25 Feb. 2022, newatlas.com/energy/quaise-deep-geothermal-millimeter-wave-drill/.

Christiansen, Peter. "Does Weather Impact Internet Connection Speeds?" *HighSpeedInternet.com*, 18 Sept. 2023, www.highspeedinternet.com/resources/doesweather-impact-internet-connection-speeds.

"Climate Change, 5G and the Internet of Things." *Environmental Health Trust*, 10 Dec. 2019, https://ehtrust.org/climate-change-and-5g/.

Eid, Aline, et al. "5G as a Wireless Power Grid." *Scientific Reports*, vol. 11, 2021, www.nature.com/articles/s41598-020-79500-x.

Goldsworthy, Andrew. "The Biological Effects of Weak Electromagnetic Fields, Problems and

Solutions." *Semantic Scholar*, March 2012, www.semanticscholar.org/paper/The-Biological-Effects-of-Weak-Electromagnetic-and Goldsworthy/95ee12337fa7c1262b614b22ad1ed72f6700dce3.

"A Guide to 5G Small Cells and Macrocells." *Essentra Components*, 10 Dec. 2021, www.essentracomponents.com/en-us/news/industries/telecoms-data/a-guide-to-5g-smallcells-and-macrocells.

Hollington, Jessie. "What Frequency Is 5G? All the Different 5G Ranges, Explained." *Digital Trends*, 10 Jul. 2022, www.digitrends.com.

Johnson, Dexter. "The 5G dilemma: More Base Stations, More Antennas—Less Energy?" *IEEE Spectrum*, 8 Oct. 2013, spectrum.ieee.org/will-increased-energy-consumption-be-theachilles-heel-of-5g-networks.

Jones, Dan. "Could 5G Have Found Its Glass Ceiling?" *Light Reading*, 20 Sept. 2017, www.lightreading.com/5g/could-5g-have-found-its-glass-ceiling-.

Kapilevich, B., et al. "Millimeter Waves Sensing Behind Walls—Feasibility Study with FEL Radiation." *Proceedings of FEL 2007*, 2007, accelconf.web.cern.ch/f07/PAPERS/THBAU04.pdf.

Lin, F., et al. "Millimeter-Wave Technology for Medical Applications." *IEEE MTT-S International Microwave Workshop Series on Millimeter Wave Wireless Technology and Applications*, 2012, *IEEE Xplore*, doi: 10.1109/IMWS2.2012.6338252.

Liu, Siming, et al. "A Long-Distance Millimeter-Wave RoF System with a Low-Cost Directly Modulated Laser." *IEEE Photonics Technology Letters*, 2009, ieeexplore.ieee.org/document/8395441.

Moskowitz, Joel M. “We Have No Reason to Believe 5G Is Safe.” *NYSUMA*, 2 Dec. 2019, www.nysuma.org/blog/2019/12/2/we-have-no-reason-to-believe-5g-is-safe.

“NIST Helps Next-Generation Cell Technology See Past the Greenery.” *NIST*, 4 Jan. 2022, www.nist.gov/news-events/news/2022/01/nist-helps-next-generation-cell-technology-seepast-greenery.

Nordrum, Amy, and Kristen Clark. “Everything You Need to Know About 5G.” *IEEE Spectrum*, 27 Jan. 2017, spectrum.ieee.org/everything-you-need-to-know-about-5g.

Pall, Martin. “Millimeter (MM) Wave and Microwave Frequency Radiation Produce Deeply Penetrating Effects: The Biology and Physics.” *Reviews on Environmental Health*, 26 May 2021, doi: 10.1515/reveh-2020-0165.

Peabody, J., et al. “Through-Wall Imaging Radar.” *Semantic Scholar*, 2012, www.semanticscholar.org/paper/Through-Wall-Imaging-Radar-PeabodyCharvat/c9f497a2b4afa440387398466681d872a6354568.

Precautionary Principle Ordinance: Marin County 2010. *TamAlmonte*, 8 Sept. 2012, www.tamalmonte.org/info/Precautionary_Princ_fnl_GSM.

“Reports on the Increasing Energy Consumption of Wireless Systems and Digital Ecosystems.” *Environmental Health Trust*, ehtrust.org/science/reports-on-power-consumption-andincreasing-energy-use-of-wireless-systems-and-digital-ecosystem/**.** Accessed 15 July 2023.

Rivenberg, Paul. “Rock, Drill Bit, Microwave: Paul Woskov Explores a New Path Through the Earth’s Crust.” *MIT News*, 12 Apr. 2016**,** news.mit.edu/2016/paul-woskov-explores-newpath-through-earth-crust-0412**.**

Rowe, Martin. “5G is Hot, Keep Your Components and Systems Cool.” *5G Technology World,* 24 Mar. 2020, www.5gtechnologyworld.com/5g-is-hot-keep-your-components-andsystems-cool/.

Sikdar, Biplab. “A Study of the Environmental Impact of Wired and Wireless Local Area Network Access.” *IEEE Xplore*, 1 Feb. 2013, ieeexplore.ieee.org/document/6490245.

Slattery, Terry. “Millimeter Wave (MM Wave).” *TechTarget,* www.techtarget.com/searchnetworking/definition/millimeter-wave-MM-wave. Accessed 8 June 2023.

“Swiss Re Classifies 5G as ‘High’ Impact Emerging Risk in White Paper.” *Environmental Health Trust,* 29, May, 2019, https://ehtrust.org/swiss-re-classifies-5g-as-high-risk-in-whitepaper/.

Tilley, Aaron, et al. “iPhone 15 Pro Owners Complain About Overheating Problems.” *The Wall Street Journal*, 30 Sept. 2023, www.wsj.com/tech/personal-tech/apple-new-iphone-15overheat-dbd5171a.

Triggs, Robert. “5G mmWaves: Facts and Fictions You Should Definitely Know.” *Android Authority,* 14 Mar. 2023, www.androidauthority.com/what-is-5g-mmwave-933631/.

“UCI Engineers Develop Powerful Millimeter-wave Signal Generator.” *UCI Samueli School of Engineering*, 7 Feb. 2017, engineering.uci.edu/news/2017/2/uci-engineers-developpowerful-millimeter-wave-signal-generator.

“Video Streaming: Data Transmission Technology Crucial for Climate Footprint.” *Umwelt Bundesamt*, 9 Oct. 2020, www.umweltbundesamt.de/en/press/pressinformation/videostreaming-data-transmission-technology.

"What You Need to Know About 5G Wireless and 'Small' Cells." *Environmental Health Trust*, 2 Aug. 2018, ehtrust.org/wp-content/uploads/5G_What-You-Need-to-Know.pdf.

Zhi, Wei-Jia, et al. "Recent Advances in the Effects of Microwave Radiation on Brains." *Military Medical Research Journal*, 21 Sept. 2017, doi: 10.1186/s40779-017-0139-0.

Part Four

Legal Aspects and Delays Following the District of Columbia Circuit Court Case Directing the Federal Communications Commission to Revisit Its 1996 Radiofrequency Exposure Limits

On August 13, 2021, The United States Court of Appeals ruled in a landmark case in favor of environmental health groups and petitioners and found that the Federal Communications Commission had violated the Administrative Procedure Act and failed to respond to comments on environmental harm ("Court Judgement").

The Court ruled that the Federal Communications Commission had been arbitrary and capricious in their December 2019 decision to retain its 1996 radiofrequency human exposure safety standards by relying on conclusory statements by the Food and Drug Administration on safety standards and in neglecting to consider evidence in the administrative record that exposure to radiofrequency radiation below the Federal Communications Commission's current limits may cause negative effects unrelated to cancer, thus putting at risk the health and safety of the public (US Court of Appeals).

Furthermore, the Court stated that the Federal Communications Commission completely failed to acknowledge or respond to comments on the impacts of long-term wireless exposure, the testimony of people injured by wireless radiation, impacts to children, impacts on reproduction and on the developing brain in utero, and impacts to wildlife and the environment ("Court Judgement").

To view the body of information and studies on this topic regularly being submitted to the Federal Communications Commission, visit the Federal Communications Commission website

(https://www.fcc.gov/), view “Filings” and search for “wireless radiation.” As of Nov. 13, 2023, there are 11,844 documents listed, including health and environmental studies and other filings.

Petitioners filed eleven thousand pages of evidence—447 exhibits in twenty-seven volumes—in support of their claims documenting research indicating brain damage, memory problems, reproduction damage, synergistic effects, brain cancer, DNA and genetic damage, harm to trees, plants, and birds and bees (“EHT Wins”).

The current (1996) Federal Communications Commission standards are inadequate for many reasons. Here are four of them:

- The Federal Communications Commission considered only the measurement of thermal effects of electromagnetic fields. Research has shown that electromagnetic fields at levels well below those that cause heat emissions still have a multitude of biological effects, and these emissions can arguably be more impactful.
- The Federal Communications Commission standards were developed with technology of the 1990s and do not reflect the effects of the new higher frequencies and combination of frequencies being generated and increasingly powerful fields that are being generated by the more modern technologies. Besides cell phones, these technologies include smart meters, baby monitors, WiFi, smart televisions, Bluetooth devices, medical wireless devices, wireless security devices, Internet-of-Things enabled home appliances and business tools, and now millimeter-wave 5G, 6G and 10G wireless cell phones, other 5G devices, and their transmitters.
- The measurement standards of the time did not take into account chronic direct contact with the body. Standards measured radiofrequency from cellular radio transmitting antennas and tested sources two or more inches away from the body.

When phones are tested to ensure they are below SAR limits, the phone is not directly contacting the body. This does not reflect real-world usage where cell phone users talk with the device pressed against their ear (and therefore head) and laptops are mostly on people's laps. Federal Communications Commission standards were not formulated with this scenario in mind.

- Body types are diverse, and the Federal Communications Commission did not take this into consideration. The Federal Communications Commission used a twohundred-pound six-foot male dummy, which represents about three percent of the population. Electromagnetic frequency radiation is known to be more impactful and harmful to children, pregnant women, seniors, those with compromised immune systems and other illnesses such as Lyme's-related syndromes, neurological conditions such as multiple sclerosis, epilepsy, and migraines, and cardiovascular diseases such as heart arrhythmias and circulatory conditions, to name a few (Debaun).

We hope the Federal Communications Commission rises to the occasion and employs the good advice of the many health and environmental scientists and medical professionals who have discovered, researched, and/or written about the issues the Federal Communications Commission needs to examine to formulate their new standards and protect public health and the environment.

Why Is It Taking So Long for the Federal Communications Commission to Review and Examine the Data and Resubmit an Updated Radiofrequency Limit Standard?

The Federal Court ruling took place August 13, 2021, yet we have not seen any sign that the Federal Communications Commission has made any in addressing the issue at hand. Why is this? First, the District Court ruling gave no date by which the reexamination of research to update its regulations must be completed.

Second, to further understand the delay, we may have to look at the structure of the Federal Communications Commission itself: The Federal Communications Commission's mission is to "make available so far as possible, to all the people of the United States, without discrimination on the basis of race, color, religion, national origin, or sex, rapid, efficient, nationwide, and world-wide wire and radio communication services with adequate facilities at reasonable charges." The mission statement also provides that the Federal Communications Commission was created "for the purpose of the national defense" and "for the purpose of promoting safety of life and property through the use of wire and radio communications." The Federal Communications Commission has also chosen four goals for its 2018 to 2022 Strategic Plan: "Closing the Digital Divide, Promoting Innovation, Protecting Consumers & Public Safety and Reforming the FCC's Processes" ("About the FCC").

The directors of the Federal Communications Commission are five commissioners who are appointed by the president of the United States. The president of the United States appoints one of the five commissioners to be the chair. Only three of the commissioners may be members of the same political party. None may have any financial interest in a business related to the Federal Communications Commission. Each serves a five-year term. Recently, there had been only one seat open, which meant that there was bipartisan roadblock in commission business proceedings, for example, the effort to renew net neutrality rules to require internet providers to treat online content equally ("Office Overview").

This seat had been open since Commissioner Ajit Pai's term ended in 2021. Gigi Sohn was nominated by President Biden in October 2021 and faced three confirmation hearings, which became contentious and ended in her withdrawing her nomination in March of 2023 (Feiner and Capoo). Sohn had worked in a senior staff position at the Federal Communications Commission under Commissioner Tom Wheeler. She was also co-founder and chief executive officer of Public Knowledge, a technology and communications policy organization advocating the interests of consumers, and she was executive director of the Media Access Project, which is a communications public interest law firm, among many other accomplishments ("Gigi Sohn").

Subsequently, President Biden nominated Anna Gomez, who has worked as an attorney at the Federal Communications Commission and other government agencies. Her senate hearing was held on Thursday June 22, 2023. The president also nominated for reappointment Commissioners Brendan Carr and Geoffrey Starks for additional five-year terms (US Senate Committee). "It's been far too long since the Federal Communications Commission had a full five members on the commission: 882 days," said Senator Ben Ray Luján (D-NM), who chairs the panel's telecom subcommittee . . . "I hope that sinks in for a bit" (Lima and DiMolfetta).

The senate recently approved Gomez's nomination. Hopefully, the review process of the scientific evidence for radiofrequency radiation and electromagnetic frequency health and environmental effects will now go forward.

One key issue with previous study reviews is that the Federal Communications Commission has in the past relied on the literature review of radiofrequency studies by other government agencies, as in the aforementioned Food and Drug Administration case.

The Food and Drug Administration website on Scientific Evidence for Cell Phone Safety appears outdated and in fact begins with a photo of a person with a cell phone pressed against

their head. The National Institute for Occupational Safety and Health studies on electromagnetic fields and health have been acquired by the Centers for Disease Control and Prevention and archived on their website with the annotation that "the web page is archived for historical purposes and is no longer being updated" ("Other NIOSH Studies"). Searches of electromagnetic fields and health on the Centers for Disease Control web page lead back to the archived page. The National Institute of Environmental Health Sciences does have a section on electric and magnetic fields and acknowledges that more research is needed in the field of exposures causing health and environmental effects. There are references to electromagnetic frequency studies on their website ("Electric & Magnetic Fields").

All in all, it appears that there needs to be more inclusive and unbiased attention by the Federal Communications Commission or other governmental agency to the issue of radiofrequency and electromagnetic exposure and the health and environmental consequences. The Federal Communications Commission has various offices and bureaus on various aspects of telecommunication. Recently, they established the Space Bureau and Office of International Affairs. It might now seem judicious to find a way of establishing a Federal Communications Commission office or bureau for the oversight of health and environmental effects from electromagnetic and radiofrequency devices and include, as staff, experienced scientific advisers, environmental advisers, academic researchers, and knowledgeable medical practitioners who are experienced in the diagnosis and treatment of persons suffering from electromagnetic frequency and radiofrequency-induced illnesses. This would help balance out the professional backgrounds of Federal Communications Commission staff who, for the most part, derive from the legal or telecommunications background and do not have the scientific or medical background to assess

the gravitas of this important issue. This is especially important now as the telecommunications industry wants to roll out 5G, 6G, and 10G technologies.

In the senate, the Committee on Commerce, Science, and Transportation, along with the Subcommittee on Communications, Media, and Broadband, oversee the Federal Communications Commission. Where are the medical sciences and the environmental sciences oversight committees? The citizens of the United States need and deserve this representation.

Consider the following from ProPublica:

> To see how completely the US telecom industry has prevailed in the rhetorical war over cellphone safety so far, consider this example. In February 2019, near the end of a hearing largely devoted to extolling the wonders of 5G technology, Sen Richard Blumenthal D-Conn asked representatives of two wireless industry trade groups what sort of research the industry was funding on the biological effects of 5G, which remains largely untested. “There are no industry-backed studies, to my knowledge, right now” replied Brad Gillen of the CTIA (originally called the Cellular Telecommunications Industry Association). “I’m not aware of any” replied Steve Berry of the Competitive Carriers Association. (Elkind)

In an article in the journal *Environmental Health* from the International Commission on the Biological Effects of Electromagnetic Fields titled “Scientific Evidence Invalidates Health Assumptions Underlying the FCC and ICNIRP Exposure Limit Determinations for Radiofrequency Radiation: Implications for 5G,” the authors state the following:

> In this paper, we show how the past 25 years of extensive research on RFR demonstrates that the assumptions underlying the FCC's and ICNIRP's exposure limits are invalid and continue to present a public health harm. Adverse effects observed at exposures below

> the assumed threshold SAR include non-thermal induction of reactive oxygen species, DNA damage, cardiomyopathy, carcinogenicity, sperm damage, and neurological effects, including electromagnetic hypersensitivity. Also, multiple human studies have found statistically significant associations between RFR exposure and increased brain and thyroid cancer risk. ("ICBE-EMF")

An article in the journal *Frontiers in Public Health* is titled "The Assumption of Safety Is Being Used to Justify the Rollout of 5G Technologies." The authors conclude that studies on millimeter-wave technologies showing biological effects are not being properly analyzed by some international organizations and government agencies. When the International Commission for Non-ionizing Radiation Protection has set exposure limits, they have not addressed the early evidence of biological effects that have the potential to cause harm as is required by a risk management approach. Their radiation protection philosophy is therefore deficient and not in keeping with the International Commission on Radiation Protection (ICRP) (McCreddon, et al.).

The International Commission for Non-ionizing Radiation Protection is a private nongovernmental organization (NGO) with only fourteen invited-only members that was founded by an industry-funded scientist and is registered in Germany (ICNIRP). According to an Environmental Health Trust investigation, its funding comes from the telecommunications industry or from governmental agencies (sometimes agencies that have been given funds by the telecommunications industry, as has happened in Australia). The International Commission for Non-ionizing Radiation Protection considers only thermal studies, thereby ignoring all studies of lower-intensity nonthermal effects such as those the BioInitiative Working Group and the European Academy of Environmental Medicine take into account. International Commission for

Non-ionizing Radiation Protection studies are not checked for scientific accuracy or for conflicts of interest (EHT Wins). International Commission for Non-ionizing Radiation Protection studies or radiofrequency limit recommendations should not be considered by any reputable agency or organization according to more than a few sources.

The *Frontiers in Public Health* article also looks at how industry funding influences outcomes of studies. Industry-funded millimeter-wave studies produce a lower total proportion of "effect" versus "no effect" outcomes when compared with institution-funded and governmentfunded studies: government studies—83% effect versus 17% no effect; institution studies—93% effect versus 7% no effect; industry studies—58% effect versus 42% no effect (McCredden et

al.).

An article titled "Environmental Procedures at the FCC: A Case study in Corporate Capture" by Erica Rosenberg appeared in the journal *Environment: Science and Policy for Sustainable Development* in 2022. Rosenberg is a former Federal Communications Commission attorney who states that the Federal Communications Commission fails to follow environmental laws and is failing the public. She says that like all federal agencies, the Federal Communications Commission must follow environmental laws, including the National Environmental Policy Act. The National Environmental Policy Act requires the Federal Communications Commission to assess possible environmental impacts before it authorizes, funds, or licenses towers, antennas, and other communications infrastructure and to consider the concerns of communities and citizens in the process.

As outlined in an Environmental Health Trust publication from April 18, 2013, Rosenberg states that the Federal Communications Commission fails to comply with the

National Environmental Policy Act in a multitude of ways:

1) It ignores major federal actions (MFAs) that require environmental review, such as its distribution to industry of billions of dollars that support build-out for wireline service or updated wireless service. To circumvent NEPA, it improperly deems some MFAs as non-MFAs as the DC Circuit Court of Appeals found in 2019 in United Keetoowah vs FCC with regard to small cells.
2) Its NEPA rules create an unsupported and overly broad Categorical Exclusion (exemption from NEPA assessment) so that, for example, satellite licensing and submarine licensing are categorically excluded from review.
3) With little oversight or tracking, it delegates determinations of level of environmental review, for example, whether a written Environmental Assessment (EA) is required, and EA drafting to the industry proponents of the project.
4) Its environmental review process is so perfunctory that it omits consideration of countless potential environmental effects, including aesthetic impacts and large-scale tree clearing.
5) It fails to vigorously enforce its NEPA rule so that industry noncompliance is rampant.
6) It fails to provide adequate notice and opportunities for public comment on projects.
7) It fails to make environmental documents, such as radiofrequency (RF) studies emissions studies, readily available to the public.
8) It routinely ignores or dismisses public comments so that it authorizes virtually all wireless projects as proposed, regardless of environmental concerns raised. (Rosenberg)

The Federal Communication Commission's lack of oversight and failure to comply with environmental laws have caused cumulative and incalculable environmental damage: views of protected landscapes and historic sites ruined, wetlands filled, endangered species habitat cleared, sacred sites desecrated, burial sites and archaeological sites disturbed, and fragile underwater environments degraded. Equally important, citizens and localities are left with little or no voice in siting decisions affecting them and their communities. And as wireless technologies continue to proliferate, the impacts will multiply.

In September 2023, federal agencies were required to revise their National Environmental Policy Act rules, and hopefully, the Council on Environmental Quality, which oversees National Environmental Policy Act compliance, held the Federal Communications Commission to a higher standard for National Environmental Policy Act compliance.

President Biden recently nominated Fara Damelin as inspector general of the Federal Communications Commission, and her nomination was approved. The Office of the Inspector General's mission is to detect and prevent fraud, waste, and abuse and violations of law and to promote economy, efficiency, and effectiveness in the operations of the Federal Communications Commission. The Office of the Inspector General is an independent office within the Federal Communications Commission that strives to promote accountability and performance in the management of Federal Communications Commission programs, policies, and people by independently conducting audits and investigations and recommending corrective action, when necessary (US Senate Committee).

The new inspector general will certainly have her hands full of investigative projects from Rosenberg's accounts and the DC District Courts Directives to the Federal Communications Commission—we wish her the best of luck.

Works Cited

"About the FCC." *Federal Communications Commission*, www.fcc.gov/about/overview. Accessed 20 Jul. 2023.

"Court Judgment on FCC's Record Review of 1996 Wireless Radiation Standards." *Environmental Health Trust*, 27 Oct. 2021, ehtrust.org/court-judgment-on-fccs-recordreview-of-1996-wireless-radiation-standards/.

Debaun, Daniel T. "FCC Loses Landmark Case Showing 5G and Wireless Radiation Standards Fail to Adequately Protect the Public and Children from EMF Radiation." *DefenderShield*, 20 Aug. 2021, defendershield.com/us-court-decides-fcc-wirelessradiation-safety-standards-need-to-be-updated-aug-2021. Accessed 10 Apr. 2023.

"EHT Wins in Historic Decision, Federal Court Orders FCC To Explain Why It Ignored Scientific Evidence Showing Harm from Wireless Radiation." *Environmental Health Trust*, 16 Aug. 2021*,* ehtrust.org/in-historic-decision-federal-court-finds-fcc-failed-toexplain-why-it-ignored-scientific-evidence-showing-harm-from-wireless-radiation/.

"Electric and Magnetic Fields." Centers for Disease Control, Sept. 1996, www.cdc.gov/niosh/topics/emf/default.html.

"Electric & Magnetic Fields*." National Institute of Environmental Health Sciences,* www.niehs.nih.gov/health/topics/agents/emf/index.cfm.

Elkind, Peter. "How the FCC Shields Cell Phone Companies from Safety Concerns." *ProPublica,* 10 Nov. 2022, www.propublica.org/article/fcc-5g-wireless-safetycellphones-risk.

"FCC Nominee Gigi Sohn Withdraws After More Than a Year of Fighting for Post." *Politico,* 7 Mar. 2023, www.politico.com/news/2023/03/07/gigi-sohn-fcc-nominee-withdraws00085918.

"Filings." Federal Communications Commission, https://www.fcc.gov/ecfs/search/searchfilings/results?q=(wireless%20radiation). Accessed 26 Nov. 2023.

Feiner, Lauren, and Ashley Capoo. "Biden FCC Nominee Gigi Sohn Withdraws, Citing 'Cruel Attacks' in Battle with Cable and Media Industries." *CNBC*, 3 Mar. 2023, www.cnbc.com/2023/03/07/biden-fcc-nominee-gigi-sohn-withdraws-citing-cruel-attacks-.html.

"Former FCC Attorney: How the FCC Fails to Follow Environmental Laws and Fails the Public." *Environmental Health Trust*, 18 Apr. 2023, ehtrust.org/former-fcc-attorney-howthe-fcc-fails-to-follow-environmental-laws-and-fails-the-public/.

"Gigi Sohn." *Wikipedia*, en.wikipedia.org/wiki/Gigi_Sohn. Accessed 5 May 2023.

ICBE-EMF. "Scientific Evidence Invalidates Health Assumptions Underlying the FCC and ICNIRP Exposure Limit Determinations for Radiofrequency Radiation: Implications for 5G." *Environmental Health*, vol. 21, art. no. 92, 2022, doi: 10.1186/s12940-022-00900-9.

"ICNIRP: Published Research on Conflicts of Interest and Lack of Protection." *Environmental Health Trust*, 20 Mar. 2022, ehtrust.org/icnirp-published-research-on-conflicts-ofinterest-and-lack-of-protection/.

Lima, Cristiano, and David DiMolfetta. "Biden's Nominee Faces a Less Hostile Senate GOP." *Washington Post*, 23 Jun. 2023,

www.washingtonpost.com/politics/2023/06/23/bidensnew-fcc-nominee-faces-less-hostile-senate-gop/.

McCredden, Julie E., et al. “The Assumption of Safety Is Being Used to Justify the Rollout of 5G Technologies.” *Frontiers in Public Health*, 26 Jan. 2023, www.frontiersin.org/articles/10.3389/fpubh.2023.1058454/full.

“Office Overview: Inspector General.” *Federal Communications Commission*, 28 Jun. 2022, fcc.gov/inspector-general/overview.

“Other NIOSH Studies Related to Radiation Exposure.” Centers for Disease Control and Prevention, https://www.cdc.gov/niosh/oerp/other.html. Accessed 26 Nov. 2023.

Rosenberg, Erica. “Environmental Procedures at the FCC: A Case Study in Corporate Capture.” *Environment: Science and Policy for Sustainable Development,* vol. 64, no. 5-6, pp. 1727, 12 Dec. 2022, doi: 10.1080/00139157.2022.2131190.

“Scientific Evidence for Cell Phone Safety.” *US Food and Drug Administration*, 12 Feb. 2020, www.fda.gov/radiation-emitting-products/cell-phones/scientific-evidence-cell-phonesafety.

United States Court of Appeals for the District of Columbia Circuit, 13 Aug. 2021, www.cadc.uscourts.gov/internet/opinions.nsf/FB976465BF00F8BD85258730004EFDF7/$file/20-1025-1910111.pdf.

US Senate Committee on Commerce, Science and Transportation, www.commerce.senate.gov.

Part Five

What Is to be Done?

First, let us promote the idea that air is habitat, as Blake Levitt has suggested (see Levitt, "Effects, Part 1" in Works Cited, Part One). Regulatory agencies can then formulate—or extend—rules to help protect this "space" the way they protect parks, property, waterways, facilities, and other habitats where organisms live and work. As one example, the Clean Air Act could be expanded to include radiofrequency radiation and electromagnetic frequencies, benzene, ethanol, acetaldehyde, d-limonene, dichlorobenzene, and phthalates that enter the air—along with the six common "criteria pollutants" that are already prohibited or regulated: particulate matter (also known as particle pollution), ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead.

Second, let us ask our legislators, health-care providers, employers, housing managers, and administrators of medical and care facilities to recognize that multiple chemical sensitivities and electromagnetic sensitivities are real disabilities as defined by the Access Board of the Americans with Disabilities Act. Let us emphasize the impact these disabilities have on "major life activities" and "major bodily functions" ("Intro. to ADA"; "ADA Amendments"). We must lobby our elected officials to support efforts to mitigate effects of radiofrequency radiation/electromagnetic frequencies and toxic chemicals and to provide easy access to reasonable accommodation for those affected.

Third, we must appeal to legislators to define radiofrequency radiation/electromagnetic frequencies, volatile organic compounds, dichlorobenzene, and phthalates as air-borne pollutants and to mandate the comprehensive labeling of these toxins on all consumer products that contain them, with clear warnings.

Fourth, we should lobby legislators to oppose legislation that reduces local control in decision-making contexts, such as the placement of wireless facilities. And we should support legislation to amend the outdated Telecommunications Act of 1996 to allow for the consideration of health effects of wireless radiation.

Fifth, we must request that elected officials set rules minimizing the use of radiofrequency radiation/electromagnetic frequencies in all medical facilities. Encourage hospitals and care facilities to use the lowest levels possible to perform diagnostics and treatments. Schools and congregate living facilities should be safeguarded from cell towers and small-cell installations through legislation and local control that determines safe distances.

Some states are taking promising steps. New York is following New Hampshire by introducing a bill "to establish a commission to study evolving 5G technology":

> The legislature finds that fifth generation, or 5G, wireless technology is intended to greatly increase device capability and connectivity but also may pose significant risks to humans, animals, and the environment due to increased radio frequency radiation exposure. Therefore, the legislature finds a commission is needed to examine the advantages and risks associated with 5G technology, with a focus on its environmental impact and potential health effects on citizens of our state. ("Votes")

Sixth, we should also support legal efforts to force the Federal Communications Commission to revise exposure standards on the basis of biological data. To ensure that this is

carried out, we should establish a Federal Communications Commission office or bureau for the oversight of health and environmental effects from electromagnetic and radiofrequency devices. The staff must include experienced scientific advisers, environmental advisers, academic researchers, and knowledgeable medical practitioners who are experienced in the diagnosis and treatment of persons suffering from radiofrequency radiation/electromagnetic frequencies-induced illnesses. And, as per the Environmental Health Trust suit against the Federal Communications Commission, we should "inform [our] elected officials at local, state and federal levels about [the DC Circuit] Court decision. We need all decision makers onboard for the next step, which is to ensure the accountability of federal health agencies that will now be tapped to provide input to the FCC" ("EHT Wins").

Seventh, we must promote further studies on the biological effects of radiofrequency radiation/electromagnetic frequencies—especially 5G— as well as on the distances radiation from wireless facilities can travel and their respective power levels. Both of these aspects need to be fully understood to determine proper safety standards and inform local lawmakers when writing ordinances. See the Hollington in Works Cited on frequencies.

Eighth, we must lobby elected officials to ban all fragranced products that contain toxins. Medical providers and administrators, elected officials, and the public must pressure the fragrance industry to eliminate toxins from their products, no matter how profitable these additives are. Banning d-limonene, acetaldehyde, ethanol, benzene, all phthalates, and other known toxins from fragrance ingredients would be a wise step by the federal or state governments. Human health must trump the profit motive.

Ninth, until these toxins are banned, we must lobby legislators to support legislation that eliminates fragranced products from all medical and care facilities and long-term living facilities.

Fragrance-free rules must specifically include scented laundry products and air fresheners of all types. Air fresheners should be banned from all congregate living facilities. And the sale of scented laundry products in laundromats and stores should be banned by local municipalities. New York State is the first state in the nation to set a limit of 1.4-dioxane, a probable carcinogen, at two parts per million. This led to the banning of multiple popular laundry products such as, but not limited to, Tide Original, Arm and Hammer Clean Burst, and Gain Original + Aroma Boost. We need this type of protection from all of our states for more of our products.

Tenth, we should promote public awareness of the issues at hand and support funding for teaching institutions to conduct studies and classes examining these novel forms of pollution that threaten our health and our environment.

Eleventh, in all cases, follow the precautionary principle.

It will take all of us to make these steps happen. But the health of our air habitat and our entire ecosystem depends upon it.

Works Cited

"ADA Amendments Act of 2008 Frequently Asked Questions: What Is the Expanded Definition of 'Major Life Activities' Under the ADAAA?" *US Department of Labor*, 1 Jan. 2009, www.dol.gov/agencies/ofccp/faqs/americans-with-disabilities-act-amendments#Q5.

"Clean Air Act Requirements and History." *Environmental Protection Agency*, 20 Apr. 2023, www.epa.gov/clean-air-act-overview/clean-air-act-requirements-and-history.

"EHT Wins in Historic Decision, Federal Court Orders FCC To Explain Why It Ignored Scientific Evidence Showing Harm from Wireless Radiation." *Environmental Health Trust*, 16 Aug. 2021, ehtrust.org/in-historic-decision-federal-court-finds-fcc-failed-toexplain-why-it-ignored-scientific-evidence-showing-harm-from-wireless-radiation/.

Hollington, Jesse. "What frequency is 5G? All the different 5G ranges, explained," *digitaltrends*, 10 July 2022, https://www.digitaltrends.com/mobile/what-frequency-is-5gall-the-different-5g-ranges-explained/.

"Introduction to the Americans with Disabilities Act." *US Department of Justice*, www.ada.gov/topics/intro-to-ada/. Accessed 10 Apr. 2023.

"Votes: NY A07229 | 2023-2024 |General Assembly." *Legiscan,* legiscan.com/NY/votes/A07229/2023.

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