SMALL CELL / 5G
HEALTH CONCERNS RESEARCH

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Table of Contents

1. Executive Summary

The expanding use of wireless technology, such as small cell facilities, evokes very different responses from citizens in communities across the Country and the world. Some are very excited about the possibilities that much greater speed and capacity and significantly lower latency will provide and others have concerns about some possible implications.

The responses in McKinney have been consistent with those broader patterns of responses. Preparations for 5G/Small Cell installation have led some of McKinney's citizens to share their concerns that the use of these wireless technologies might cause risks to human health. The City conducted a Town Hall style listening session on February 12, 2020. The comments from attendees appeared to mirror the broader trends, with fairly equal numbers of citizens expressing concerns over possible health risks from 5G and others who supported this new technology.

There are several contextual factors that should be considered to have a full understanding of the current setting of 5G/Small cell technology. Examples are federal and State regulations, the history of the regulations, how the industry is working to meet those regulations, how the City can monitor compliance with the regulations, the status of the science with the health concerns and the benefits of the technology.

There are federal rules and regulations that the City of McKinney must use as guides regarding how to address the potential radiofrequency (RF) emissions health concerns of its citizens. The Federal Communications Commission (FCC) has the authority granted to it by various federal laws including the Telecommunications Act of 1996 to promulgate these rules and regulations. Many of these rules and regulations pre-empt state and local laws.

The FCC is required by the National Environmental Policy Act (NEPA) of 1969, among other things, to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. As required by NEPA, the FCC developed Maximum Permissible Exposure (MPE) Limits for both general public and occupational worker exposures to equipment that transmit wireless signals such as the signals transmitted by a personal wireless or small cell communication facility.

Another example of FCC rules and regulations that will impact the City's decision making about RF emissions health concerns can be found in Section 332(c)(7)(B)(iv) of the Telecommunications Act of 1996. This section states that *no State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with FCC regulations concerning the environmental effects of such emissions*. Courts have ruled that *environmental effects of RF emissions* includes health effects.

While this section of the Telecommunications Act limits McKinney's ability to deny the sitting of a small cell facility in the public right-of-way based on the environmental effects of RF emissions, it provides McKinney the possibility of establishing ways to ensure that the RF emissions from small cell facilities are in compliance with FCC MPE limits.

The current FCC rules and regulations were developed, written and approved in the late 1990's (for a more detailed history, see Section 6). In 2019, the FCC considered updating their policies regarding MPE limits, but in September 2019, they made a statement that they would not be making updates and that there were no adverse health impacts as long as 5G densification stayed within the limits already in place.

It is important to understand the basis of that decision. The statement specified there were no health risks as long as the total emissions stay within the current guidelines. Technologically, there are ways that there could be greater density but lower emissions (or emissions that are not greater than what currently exists). Examples of that could be:

- Improvements in infrastructure components,
- Lower emissions per cell because of the density (there are more cells, but they operate with lower emissions because of their density)
- Safety guidelines for the cells (height, distance away from people, etc.)
- Intentional spacing

There are several other devices common in our society that produce these types of emissions, with examples being cell phones, microwave ovens and baby monitors (among many others). With this proliferation, many articles and commentaries maintain any new emissions are bad. But, if this source of emissions stays the same or decreases, then the other sources would need to be evaluated on their own emission levels.

1.1 What are Small Cell Facilities

Gartner, Inc. forecasts that 20.4 billion connected things will be in use worldwide next year and most Americans now have more than a dozen devices connected to the internet. It is no wonder that mobility and ubiquitous connectivity are expectations that people have today and by many estimates, demand will continue to grow at an alarming 43% annual rate well into the future.

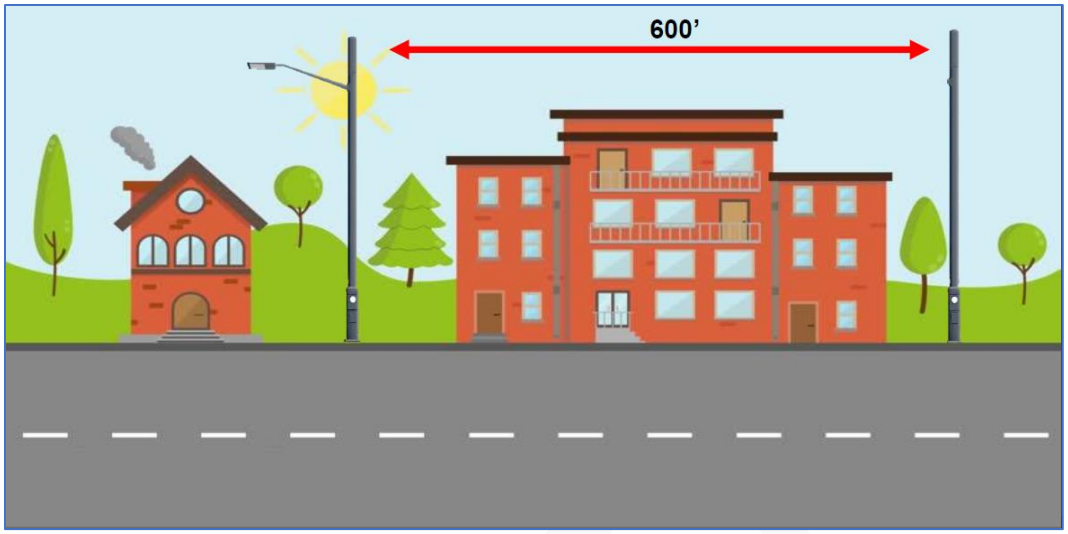
With the increasing use of Internet of Things (IoT) devices and sensors in virtually all industry sectors, as well as an increasing dependence on smartphones and always connected computers, the constraints of today's 4G LTE technologies are being exposed. In contrast, 5G, which is the next generation of wireless network, will offer improved speed, lower latency (delay), lower cost per bit, higher quality of experience and reliability. 5G will drive innovations across a broad spectrum of areas.

Small cells are low-powered cellular radio access facilities that provide a small radio footprint, which can range from 10 meters (approximately 30 feet) within urban locations to 2 km (approximately 6000 feet) for rural locations. They are "small" compared to a mobile macro cells, primarily because they have a shorter range. They make the best use of available spectrum by reusing the same frequencies over and over again within a geographical area. Fewer macro cell sites are being built, while a large number of small cells are being built as a method of increasing cellular network capacity, quality and resilience. Small cells support both 4G/LTE and 5G technologies, as well as other technologies currently under development.

1.2 What is 5G Technology

5G refers to the fifth generation of mobile phone networks. 5G will enable greater mobile speeds to enable real-time connectivity for mission-critical devices and applications. 5G networks will connect billions of IoT devices (sensors, cameras, microphones, etc.) with a wide variety of speed and data volume requirements. 5G reduces latency, which is the lag or delay between when data is sent and when it is received. In some 5G solutions, high-band spectrum offers higher capacity and speed.

5G wireless networks will use a broader range of frequencies than were utilized in earlier networks. While higher frequencies can deliver higher bandwidth and data rates, higher frequency radio waves can only be effective over shorter distances, so small cells only supply a few hundred feet of coverage.



Typical Small Cell Coverage (Source: City of Centennial, Colorado)

Deployment of large numbers of small cells with lower power creates a need for network densification. A network of small cells can be deployed anywhere needed as a complement to the existing network of macro cells to increase capacity and data rate.

5G technologies can be beneficial in a variety of ways. Including for remote workers and off-site job locations; IoT devices; and City centers, office buildings, arenas, and stadiums. 5G solutions can enhance: augmented and virtual reality, self-driving cars, robotics, repair services, power savings, smart cities, interconnect transport systems, agricultural sensors, healthcare, and industrial automation. 5G will have capacity to deal with the billions of Internet connected IoT devices in the next few years. Such huge capacity will enable almost everything to gain smart capabilities, increasing convenience and safety for everyone. 5G networks will offer the ultra-low latency demanded by certain critical tasks to ensure positive outcomes and the safety of everyone involved.

1.3 Electromagnetic Radiation

As part of the research into the health risks association with radiofrequency emissions, it is important to understand that radiation is broken down into two types: non-ionizing and ionizing:

- ***Ionizing radiation*** contains enough energy to strip electrons from atoms and molecules within tissue and alter chemical reactions in the body, causing radiation burns and/or long term, mutations which can result in cancer. Ultraviolet radiation and x-rays are examples of this type of radiation.
- ***Non-ionizing radiation*** is typically considered safe. It causes some heating effect at low power levels usually not enough to cause any type of long-term damage to tissue. ***Cell phones emit this type of radiation.***

5G technology utilizes non-ionizing radiation.

1.4 Food and Drug Administration

The Food and Drug Administration (FDA) has general jurisdiction for protecting the public from potentially harmful radiation from consumer and industrial devices and in that capacity is viewed as the expert in RF exposures that would result from consumer or industrial use of hand-held devices such as

cellular telephones. It is worth noting that the FCC relies upon the FDA for advice regarding the development of its Maximum Permissible Exposure (MPE) limits.

In 2019, the FDA stated that according to current data, the weight of scientific evidence does not show an association between exposure to radiofrequency from cell phones and adverse health outcomes. According to the FDA, the science is undecided because different studies have different results. Some say that cell phones are linked to higher occurrences of cancer and other ailments. Other studies report that cell-phone users have no higher rate of cancer than the population as a whole. The FDA states that there is consensus that additional research is warranted to address gaps in knowledge.

1.5 McKinney Recommendations

SUMMARY RECOMMENDATION: As the Mayor has stated, there is a baseline established by the FCC that communities are bound by. The City of McKinney could challenge, in court, the FCC's Declaratory Ruling and subsequent statements concerning the health risks of 5G. In a complete review of the documents and studies available to us and presented to the City, it appears to us that the FCC had access to those same studies (referencing them and having them catalogued in their public comments). Thus, at this point, there is nothing new that is substantial to add to the discussion of the FCC guidelines. So, we are not attorneys, but it is our opinion that challenging the FCC's ruling in court is a low probability, high risk effort. We recommend the City focus on the ways to manage and monitor this new technology – to control the concerns as much as possible and maximize the benefits.

Recommendation considerations:

Some of the citizens of the City of McKinney have brought their concerns regarding health effects of radiofrequency emissions to the attention of city officials. This group has indicated their opposition to the installation of small cell / 5G facilities in their community based on a number of studies, reports, articles, letters, etc. that share information about the potential health impacts of these and other cellular technologies.

There is also quite a bit available from the industry and supporters of this technology and the guidelines that are in place.

In this age of internet connectivity, it can be difficult to determine what is real science and what is opinion. As part of this process, the consultant and City have developed a matrix that evaluates documents to find as objective an opinion of the myriad of literature available on this topic. This evaluation matrix can be found in Appendix A.

The backdrop of all decisions is Section 332(c)(7)(B)(iv) of the Telecommunications Act of 1996. It limits the City's ability to deny the sitting of a small cell facility in the public right-of-way based on the environmental effects, including health effects, as long as these facilities comply with FCC regulations.

McKinney can establish ways to ensure that the RF emissions from small cell facilities are in compliance with FCC MPE limits. This is the important step that can monitor if the installations are staying within what the FCC has deemed safe since 1996.

It is important to point out that some of the FCC's rules and regulations are being challenged by local governments in federal courts.

The following are some recommendations the City might want to consider regarding addressing RF emissions health concerns.

- Include site specific RF emissions testing in small cell facilities regulations to ensure that these facilities are in compliance with FCC MPE limits.

- Require applicants to submit a site specific non-ionizing electromagnetic radiation report in small cell facilities regulations to ensure that these facilities are in compliance with FCC MPE limits.
- Track federal court cases regarding FCC rules and regulations to learn about any rulings that might impact City policies regarding how to address RF emissions health concerns.

2. Introduction

Demand for the Internet, and in particular, the use of the Internet-of-Things (IoT) continues to skyrocket. Gartner, Inc. forecasts that 20.4 billion connected things will be in use worldwide in the next few years, as most Americans have or will have more than a dozen devices connected to the internet. [5] It is no wonder that mobility and ubiquitous connectivity are expectations that people have today and by many estimates, demand will continue to grow at an amazing 43% annual rate well into the future. So, it probably goes without saying that people and devices need reliable, any-time, any-where connectivity. This expectation for faster, more dependable communication capabilities is accelerating the rollout of fiber optic-based 5G networks in an effort to keep pace not only with the today's network demands but those of the future as well.

With the increasing use of IoT devices and sensors in virtually all industry sectors, as well as an increasing dependence on smartphones and always connected computers, the constraints of today's 4G LTE technologies are being exposed. [3] In contrast, 5G, which is the next generation of wireless network, will offer new levels of speed (throughput, often measured in bits per second). Arguably, even more importantly, low latency (delay), low cost per bit, quality of experience and reliability will drive innovations across a broad spectrum of areas including virtual reality, augmented reality, smart energy grids, autonomous vehicles, telehealth, e-commerce, teleworking, education and interconnected transport systems.

Since 1982 when the first mobile phone network was introduced, succeeding standards have been implemented approximately every nine years. Today's 4G LTE standard was implemented in 2010, so, right on schedule, technology companies are transitioning to 5G. [3]

Principally, 5G refers to "5G NR (New Radio)," which is the next mobile communication standard adopted by 3GPP, an international cooperative responsible for the development of the previous mobile communication standards including current 4G/LTE standards. 5G NR allows for networks to operate on a wide variety of frequencies. [3]

The 5G NR standard divides frequencies into two groups: FR1 and FR2. Early deployments will be in the FR1 space while research proceeds into the use of FR2 frequencies, which are also known as extremely high frequency (EHF) or millimeter wave (mmWave) frequencies. [3]

Millimeter wave frequencies allow for faster data speeds; however, they have a much shorter range. For densely-populated areas, this requires deploying more base stations or what are called *small cells*. [3]

This document includes:

- An introduction to small cells with an overview of what a small cell is as well as the physical characteristics of small cells
- An introduction to 5G and 5G technologies. It will provide an overview of what a 5G is, the 5G communication standards, and the new types of devices that utilize 5G networks
- An examination of the potential human health risks of small cell facilities. It looks at the science of non-ionizing electromagnetic radiation, and the federal rules and regulations regarding health risks
- A rating of a number of studies, reports, articles, letters, etc. that share information about the potential health impacts of small cell / 5G and other cellular technologies. Some of the citizens of the City of McKinney shared these materials with city officials.

This document concludes by sharing some recommendations that the City of McKinney might want to consider in its effort to address small cell facilities health concerns.

3. Small Cell Definition

Small cells are low-powered cellular radio access facilities that provide a small radio footprint, which can range from 10 meters (approximately 30 feet) within urban locations to 2 km (approximately 6500 feet) for rural locations. They are "small" compared to a mobile macrocells, primarily because they have a shorter range. They make the best use of available spectrum by reusing the same frequencies over and over again within a geographical area. Fewer macrocell sites are being built, with a larger number of small cells being built as an important method of increasing cellular network capacity, quality and resilience. Small cells support both today's 4G/LTE technologies and tomorrow's 5G technologies, as well as potentially supporting other technologies that might be developed in the future. [8]

Small cells complement the today's macrocell network to improve coverage, add capacity, and support new services and user experiences. There are various types of small cells, with varying ranges, power levels and form factors. While the smallest units are for indoor residential use, the largest are for urban or rural outdoor uses. [8]

On September 27, 2018, the Federal Communications Commissions (FCC) adopted a Declaratory Ruling and Third Report and Order, titled "Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment" (the Order). The FCC Order defines Small Wireless Facilities or Small Cell Facilities as facilities that meet each of the following conditions [19]:

(1) The facilities—

   i. are mounted on structures 50 feet or less in height including their antennas, or

   ii. are mounted on structures no more than 10 percent taller than other adjacent structures, or

   iii. do not extend existing structures on which they are located to a height of more than 50 feet or by more than 10 percent, whichever is greater;

(2) Each antenna associated with the deployment, excluding associated antenna equipment, is no more than three cubic feet in volume;

(3) All other wireless equipment associated with the structure, including the wireless equipment associated with the antenna and any pre-existing associated equipment on the structure, is no more than 28 cubic feet in volume;

(4) The facilities do not require antenna structure registration under part 17 of the FCC Order;

(5) The facilities are not located on Tribal lands, as defined under 36 CFR 800.16(x); and

(6) The facilities do not result in human exposure to radiofrequency radiation in excess of the applicable safety standards.

4. 5G Definition

5G refers to the fifth generation of mobile phone networks. 5G will enable significantly greater mobile speeds to enable real-time connectivity for mission-critical devices and applications. In the near future, 5G networks will connect billions of IoT devices that will require a wide variety of speed and large volumes of data. [4]

The industry continues looking to the future as the uses and demands for mobile data keep expanding. 5G, which was rolled out in 2019 and will continue to grow for years to come, is being designed to provide higher speeds, while offering improved capacity, scale, latency, and reliability. [4]

As was the case with earlier steps along the way to faster mobile data, 5G will require new hardware at the network and device level that's compatible with the 5G New Radio (NR) standards. There are reportedly just a handful of commercially available handheld mobile 5G devices in the US today, with new 5G devices continuously being developed and released. [4]

4.1 Latency

Latency is the lag or delay between when data is sent and when it is received. Low latency becomes absolutely essential for critical control in certain situations such as autonomous vehicles and remotely controlled surgical procedures. [4]

4.2 Spectrum

An analogy that could be used to best describe spectrum is to think about it as a highway. The amount of spectrum determines how many lanes a highway has. With more data (cars on the highway), the more lanes (spectrum) the better. [4]

The bandwidth that is available within a spectrum determines how much network performance is available to network users. In low-band spectrum, bandwidth is typically limited, so data rates tend to be low. In mid-band and high band spectrum, the available bandwidth can be many times greater than what's available in low-band, which results in higher data rates. [4]

In some 5G solutions, high-band spectrum offers higher capacity and speed. However, the high-band spectrum has an extremely short range of just a few hundred meters. Due to its short range, this spectrum requires massive network densification. [4]

Although mid-band and high-band spectrum have reduced range, the higher frequencies involved mean that antennas can be smaller in size. [4]

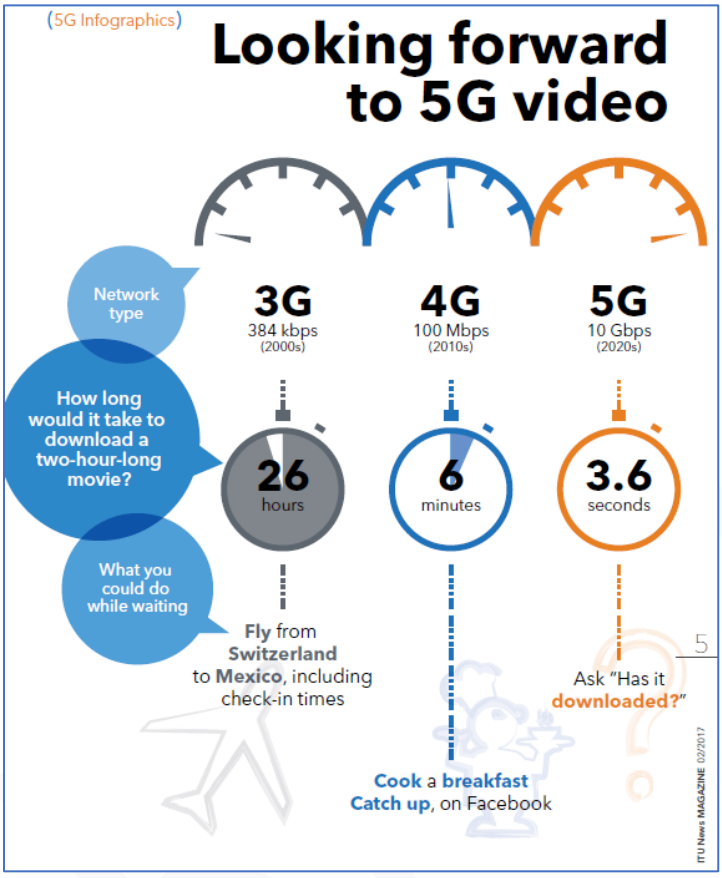
4.3 Capacity

One of the best ways to describe capacity is to examine one of the more popular uses of wireless networks, streaming a movie. When trying to stream a 4K movie over today's 4G/LTE wireless network, people probably encounter an on-screen spinning disk or other message indicating that the movie is buffering. That is because existing wireless networks often do not have enough capacity to handle demands such as streaming 4K movies due to lack of spectrum. In part, this lack of capacity stems from the relatively low frequencies used by existing networks. [4]

On the other hand, 5G will use higher frequencies and a variety of technologies to allow, for example, users to watch 4K high definition movies without being bothered by that annoying little spinning disk in the center of their screen. [4]

4.4 Speed

Because 5G will use higher frequencies, it will provide much higher data speeds. 5G is designed to incorporate a number of technologies that will enable users to do things like download an entire HD movie in a couple of minutes. [4]



Source: ITU News Magazine (February 2017) [15]

4.5 Coverage

In addition to capacity and speed, coverage is another very important factor in determining how usable any wireless network may be. If a user cannot get a signal, the potential capacity and speed are meaningless. [4]

5G wireless networks will use a much broader range of frequencies than were utilized in earlier networks. While higher frequencies can deliver much higher bandwidth and data rates, higher frequency radio waves can only be effective over much shorter distances, so small cells only supply a few hundred feet of coverage. [4]

4.6 Densification

Densification is adding more cell sites to an area. Network densification is being implemented due to the growing number of devices and increasing demand for data. When more cell sites exist in an area, users will most likely be closer to one of those sites, which means that coverage and capacity become less of a problem. [4]

Deploying a large number of low powered small cells is a solution for network densification. A network of small cells can be deployed anywhere needed as a complement to the existing network of macro cells to increase capacity and data rates. [4]

Network densification needs to be complemented by both wireless and wired backhaul such as fiber optic cables.

4.7 Standards

Standards play an important role in ensuring that products and services from different companies are compatible. Telecommunications equipment manufacturers have agreed to make equipment that is compatible with established standards. Three organizations are working to make sure that telecommunications equipment meets those standards to ensure interoperability. [4]

International Telecommunications Union (ITU)

The ITU sets performance goals as well as spectrum global policy and guidelines. The ITU is an agency of the United Nations (UN) whose purpose is to coordinate telecommunication operations and services throughout the world. The ITU plays a leading role in the work on 5G standards. [4] The ITU developed and approved the following standards in 2017:

- **ITU Y.3101** "Requirements of the IMT-2020 network" describes the features of 5G networks necessary to ensure efficient 5G deployment and high network flexibility.
- **ITU Y.3150** "High-level technical characteristics of network software for IMT-2020" describes the value of slicing in both horizontal and vertical, application-specific environments.
- **ITU Y.3130** "Requirements of IMT-2020 fixed-mobile convergence" calls for unified user identity, unified charging, service continuity, guaranteed support for high quality of service, control plane convergence and smart management of user data.

5G has been a marketing name given to the requirements and performance expected from the ITU recommendations for IMT-2020 systems. Improved Mobile Telecommunications (IMT) is a family of requirements that started with the 3G requirements. IMT Advanced is the name for the 4G requirements, and now IMT-2020 is officially called 5G. [4]

In November 2017 the ITU released the "Minimum requirements related to technical performance for IMT-2020 radio interface(s)". Here are some of those requirements:

- The minimum downlink peak data rate of 5G technologies needs to amount to 20 Gbit/s, while the uplink rate must reach at least 10 Gbit/s. [14]
- A minimum of one million connected devices for each square kilometer. [14]
- A latency that isn't higher than 4ms, or 1ms for Ultra-Reliable Low-Latency Communications (URLLC) that will likely be used for critical systems like medical solutions and some connected car systems. [14]

3rd Generation Partnership Project (3GPP)

The 3GPP standards body unites seven telecommunications standard development organizations and provides their members with an environment to produce the reports and specifications that define 3GPP technologies. [4]

According to the 3GPP website their members have worked together to create the following standards:

- In December 2017, 3GPP approved the "Non-Standalone version of the New Radio standard," which supports enhanced mobile broadband (eMBB). These specifications allow carriers to supplement existing 4G networks with 5G technologies to improve speed and reduce latency. [4]

- In June 2018, 3GPP completed the "Stand-Alone version of the New Radio standard." This specification supports the independent deployment of 5G, using core networks that are designed to support advanced IoT devices and functions. [4]

These standards set technical specifications for 5G equipment by illustrating how 5G networks should be designed and distributed. [4]

Internet Engineering Task Force (IETF)

The IETF is an open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. Technology under development by the IETF includes routing-related testing, including protocols for distributed networking, segment routing, and path computation to meet the constraints of the 5G NR. IETF works with the 3GPP on the development of 5G, covering not only new technology under IETF development but also new uses of existing technologies. [57]

One of the areas that the IETF is looking to standardize is reduction and control in the delay through the IP network. Standardizing the reduction and control is important because it will support the 1ms latency target of 5G. [57]

4.8 Technology

The 3GPP has identified three service areas where 5G should provide advantages over existing wireless mobile networks. These three service areas will coexist on the same network infrastructure which will create multiple virtual networks with differing performance profiles for differing service needs. [4]

The 5G network will be required to service many different requirements. For example, many IoT devices will use low-power, low-speed connections to enhance battery life. As self-driving vehicles become common, they will have a need for instantaneous network response to avoid creating dangerous conditions. A 5G network will have to be tailored to the specific requirements of a wide variety of uses. [4]

Enhanced mobile broadband (eMBB) [11]

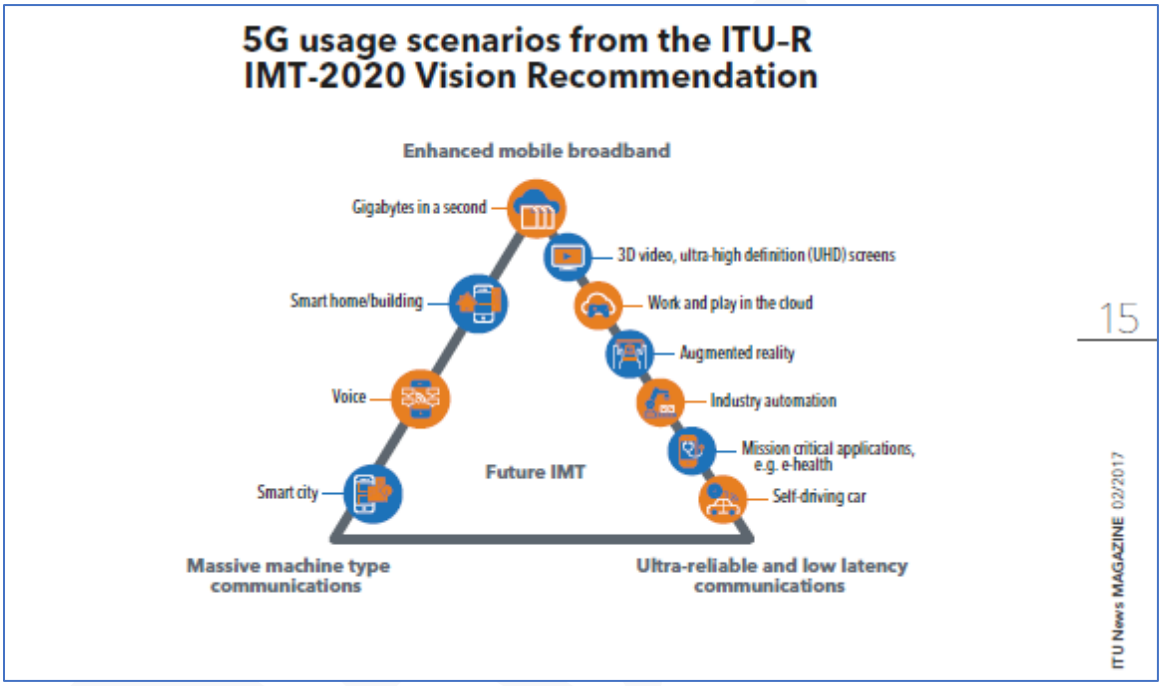
- Supports high data rates: 10 to 20 Gbps
- Supports macro and small cells
- Supports high mobility
- Provides 100Mbps whenever needed
- Helps in network energy savings
- Uses include: mobile AR (Augmented Reality), mobile VR (Virtual Reality), and 4K video streaming [4]

Ultra-Reliable Low-Latency Communications (URLLC) [11]

- Provides ultra-responsive connections.
- Offers less than 1ms air interface latency
- Offers 5ms end to end latency between a 5G mobile device and 5G base station
- Offers ultra-reliable connections and connections that are available 99.9999% of the time
- Provides low to medium data rates: 50 kbps to 10 Mbps
- Offers high speed mobility
- Uses include: factory automation, robot-enabled remote surgery, and self-driving cars [4]

Massive machine-type communication (mMTC) [11]

- Supports a high density of connected devices (e.g. IoT devices)
- Supports long range
- Supports low data rates: 1 to 100 Kbps
- Offers 10 years battery life
- Provides asynchronous access
- Uses include: monitoring and repair services, power savings, smart cities, interconnected transportation, agriculture sensors, and healthcare [4]



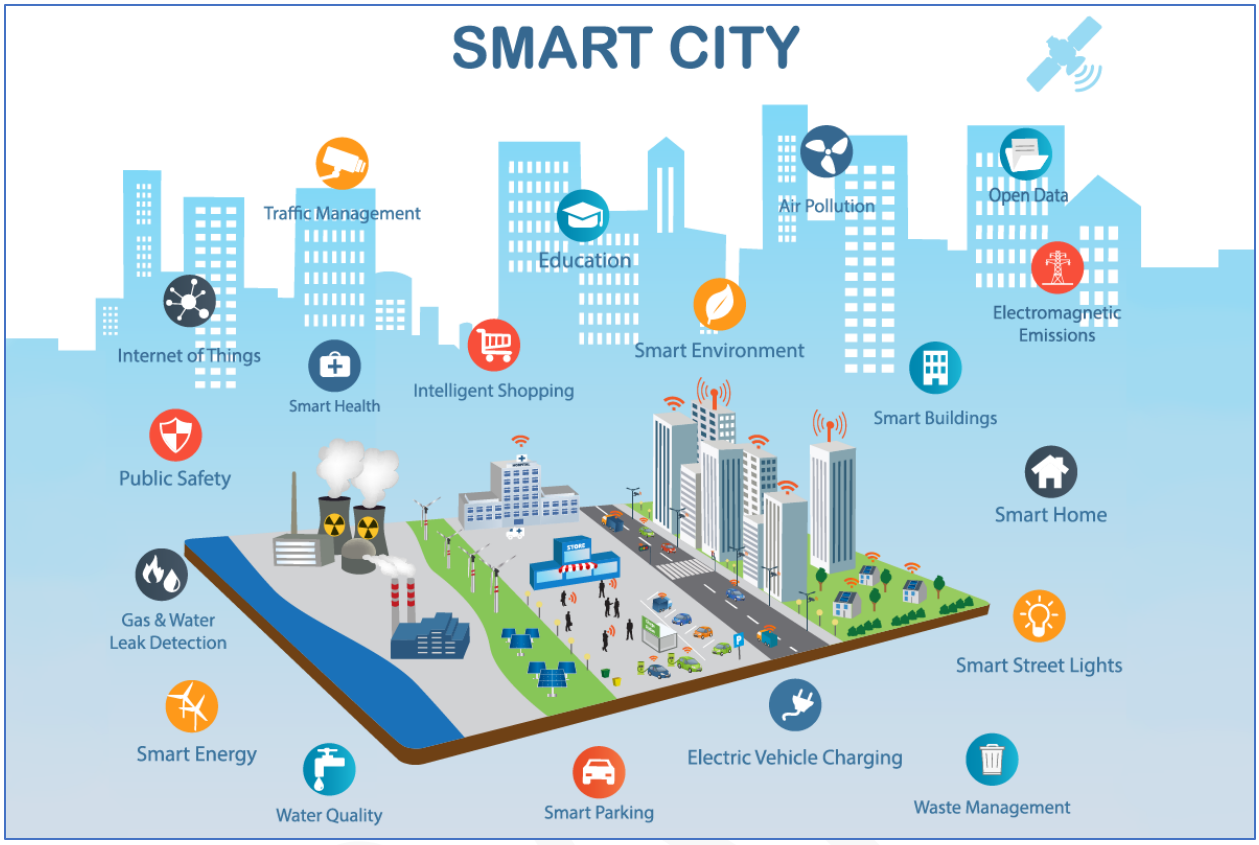
Source: ITU News Magazine (February 2017) [15]

The ways in which 5G technologies will be used are still being developed by telecommunications equipment manufacturers. Different groups have differing priorities, interests, and biases, including spectrum license purchases made with the intent of deploying 5G networks. The advantages of 5G will vary between different markets and consumers as well as enterprise market segments. [3]

4.9 Uses

There are many uses for this level of capacity, speed and low latency. The chart below lists several.

These possibilities impact many of the central components of life: healthcare, education, the environment, safety, etc. Additionally, businesses are planning for the benefits for workplace safety, logistics, maintenance, supply chain communication, energy efficiency, telecommuting, job training, IoT, etc.



Source Adtell Integration

This level of connectivity will also provide cities with tools for public safety, innovation, efficiency convenience for citizens and Economic Development. **5G** technologies can also be used to improve the quality of service for situations in which a large number of devices make use of the mobile network in densely populated areas. These benefits can be realized easily in situations with variable traffic and in areas where large numbers of employees work during the week. Densely populated city centers can also benefit from the ability of 5G networks to provide service to more devices in physically smaller spaces. [3]

4.10 Rollout

The first high-profile 5G rollout was at the 2018 Winter Olympic Games in Pyeongchang, South Korea. KT, Samsung, and Intel collaborated to deliver gigabit-speed wireless broadband, and low-latency live streaming video content to 5G-connected tablets for viewing. Similarly, Intel and NTT Docomo have announced a partnership to demonstrate 5G technology at the 2020 Tokyo Olympic Games. [3]

The following table lists the rollout status of 5G in the United States by city as of November 2019. [28]

City	AT&T	Sprint	T-Mobile	Verizon
Atlanta, GA	Live	Live	Live	Live
Austin, TX	Live	–	–	–

City	AT&T	Sprint	T-Mobile	Verizon
Boise, ID	–	–	–	Live
Boston, MA	–	–	–	Planned
Charlotte, NC	Live	–	–	Planned
Chicago, IL	–	Live	–	Live
Cincinnati, OH	–	–	–	Planned
Cleveland, OH	–	–	Live	Planned
Columbus, OH	–	–	–	Planned
Dallas-Fort Worth, TX	–	Live	–	–
Dallas, TX	Live	–	Live	Planned
Denver, CO	–	–	–	Live
Des Moines, IA	–	–	–	Planned
Detroit, MI	–	–	–	Live
Houston, TX	Live	Live	–	Planned
Indianapolis, IN	Live	–	–	Live
Jacksonville, FL	Live	–	–	–
Kansas City, KS	–	Live	–	Planned
Las Vegas, NV	Live	–	Live	–
Little Rock, AR	–	–	–	Planned
Los Angeles, CA	Live	Live	Live	–
Louisville, KY	Live	–	–	–
Memphis, TN	–	–	–	Planned
Minneapolis, MN	–	–	–	Live
Nashville, TN	Live	–	–	–

City	AT&T	Sprint	T-Mobile	Verizon
New Orleans, LA	Live	–	–	–
New York, NY	Live	Live	Live	Live
Oklahoma City, OK	Live	–	–	–
Omaha, NE	–	–	–	Live
Orlando, FL	Live	–	–	–
Panama City, FL	–	–	–	Live
Phoenix, AZ	–	Live	–	Live
Providence, RI	–	–	–	Live
Raleigh, NC	Live	–	–	–
Saint Paul, MN	–	–	–	Live
Salt Lake City, UT	–	–	–	Planned
San Antonio, TX	Live	–	–	–
San Diego, CA	Live	–	–	Planned
San Francisco, CA	Live	–	–	–
San Jose, CA	Live	–	–	–
Waco, TX	Live	–	–	–
Washington, D.C.	–	Live	–	Live

Sources: att.com, sprint.com, t-mobile.com, verizon.com [28]

4.11 Future

As technology advances, older devices will inevitably reach end-of-life. Much in the same way that the digital switchover occurred for over-the-air TV broadcasts, older mobile networks are actively being dismantled to free spectrum for LTE and 5G networks. [3]

In the US, AT&T disabled its 2G network on January 1, 2017, rendering countless phones unusable. Verizon plans to disable its legacy 2G and 3G networks by the end of 2019, which will render most older smartphones unusable, as well as IoT devices such as water meters. End-of-life plans for the 2G networks of Sprint and T-Mobile have not been publicly disclosed. [3]

When 5G is used to deliver wireless broadband on a broader scale, wireline broadband providers will face competition as the two-services approach feature parity. With many people using smartphones

both as their primary computing device and for tethering a traditional computer to the internet, the extra cost of a traditional wireline network connection may become unnecessary for some people, and enable those outside the reach of traditional wireline networks to have affordable access to high-speed broadband for the first time. [3]

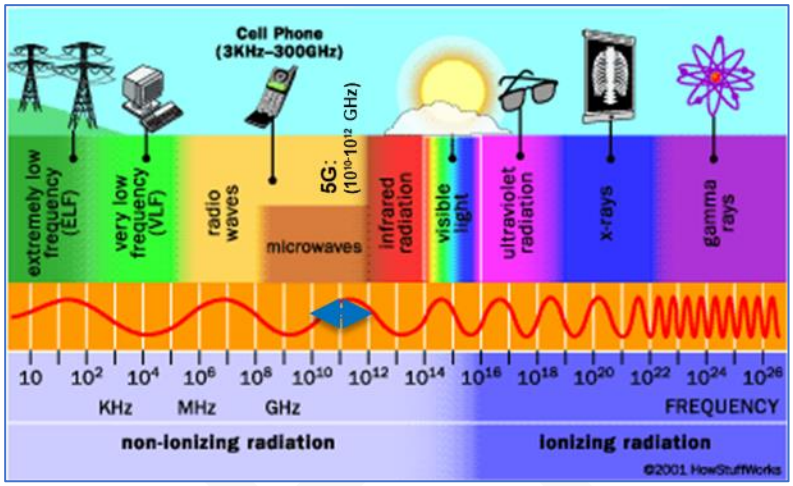
5G's low-power and low-latency attributes are expected to spark a revolution in IoT deployments. 5G will enable the deployment of billions of IoT devices by 2020, leading to the creation of the "industrial internet," which will affect a number of industries. This will also make 5G well suited for applications that require continuous response and data analysis, such as self-driving cars and traffic control. [3]

5. Ionizing vs Non-ionizing

5.1 Electromagnetic Radiation

Radiation is broken down into two types: non-ionizing and ionizing:

- ***Ionizing radiation*** contains enough energy to strip electrons from atoms and molecules within tissue and alter chemical reactions in the body, causing radiation burns and/or long term, mutations which can result in cancer. [17]
- ***Non-ionizing radiation*** is typically considered safe. It causes some heating effect at low power levels usually not enough to cause any type of long-term damage to tissue. ***Cell phones emit this type of radiation.*** [17]



Radio signals can be transmitted both omni-directionally or directionally. The power levels, frequency, and distance of radio signals, when combined, are often thought to be the most important factors when considering long term and short-term health effects.

6. Maximum Permissible Exposure

The FCC is required by the National Environmental Policy Act of 1969, among other things, to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. Several organizations, such as the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers, Inc. (IEEE),and the National Council on Radiation Protection and Measurements (NCRP) have issued recommendations for human exposure to RF electromagnetic fields. The potential hazards associated with RF electromagnetic fields are discussed in OET Bulletin No. 56, *"Questions and Answers About the Biological Effects and Potential Hazards of Radio frequency Electromagnetic Fields."* [58]

On August 1, 1996, with the adoption and release of Report and Order, FCC 96-623, the Commission adopted the NCRP's recommended Maximum Permissible Exposure limits for field strength and power density for the transmitters operating at frequencies of 300 kHz to 100 GHz. In addition, the Commission adopted the specific absorption rate (SAR) limits for devices operating within close proximity to the body as specified within the ANSI/IEEE C95.1-1992 guidelines. The Commission's requirements are detailed in Parts 1 and 2 of the FCC's Rules and Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093]. [55]

The FCC states that certain applicants are required to routinely perform an environmental evaluation with respect to determining compliance with the Commission's exposure limits. In the event that an applicant determines the site is not within compliance, the submission of an Environmental Analysis is required. The SAR limits for portable and mobile devices became effective August 7, 1996. The Commission's limits for field strength and power density became effective October 15, 1997 for all services except the Amateur Radio Service. The new limits became effective for the Amateur Radio Service on January 1, 1998. As of September 1, 2000, all FCC licensees were required to be in compliance with the FCC's RF exposure limits (See 47 C.F.R. 1.1307(b)(5)). [55]

The Commission says that the following services and devices are generally required to routinely perform an environmental evaluation. However many transmitters licensed under these service categories may be excluded from routine evaluation if they meet certain height and power thresholds (see OET Bulletin 65 for exclusion criteria). [55]

- Experimental Radio Service - Part 5
- Radio Frequency Devices - Part 15
- Multipoint Distribution Service - Part 21, subpart K
- Paging and Radiotelephone Service - Part 22, subpart E
- Cellular Radiotelephone Service - Part 22, subpart H
- Personal Communications Services - Part 24
- Satellite Communications - Part 25
- General Wireless Communications Service - Part 26
- Wireless Communications Service - Part 27
- Radio Broadcast Services - Part 73
- Experimental, auxiliary, and special broadcast and other program distributional services - Part 74
- Stations in the Maritime Service - Part 80

- Private Land Mobile, Paging Operations - Part 90
- Private Land Mobile, "covered" Specialized Mobile Radio - Part 90
- Amateur Radio Service - Part 97
- Local Multipoint Distribution service - Part 101, subpart L

Mobile and portable devices used as follows [55]:

- Cellular Radio Service
- Personal Communications Service
- Satellite Communications Branch
- General Wireless Communications Service
- Wireless Communications Service
- Maritime Service
- "Covered" Specialized Mobile Radio Service
- Unlicensed PCS and millimeter wave devices

The Commission issued a *Second Memorandum Opinion and Order* on August 25, 1997 to address petitions regarding the adoption of new exposure limits. OET revised OST Bulletin No. 65, to provide guidance on acceptable methods of determining compliance with the Commission's new exposure limits. The revised bulletin, OET Bulletin 65, *Evaluating Compliance With FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields* was issued simultaneously with the release of the *Second MO&O*. [55]

6.1 FCC 96-326

On August 1, 1996, the Commission adopted and released the Report and Order, FCC 96-326 – *Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*. In the introduction of the Report and Order, the FCC states: "By this action, we are amending our rules to adopt new guidelines and methods for evaluating the environmental effects of radiofrequency (RF) radiation from FCC-regulated transmitters. We are adopting Maximum Permissible Exposure (MPE) limits for electric and magnetic field strength and power density for transmitters operating at frequencies from 300 kHz to 100 GHz. We are also adopting limits for localized ("partial body") absorption that will apply to certain portable transmitting devices. We believe that the guidelines we are adopting will protect the public and workers from exposure to potentially harmful RF fields." [59]

In the Report and Order, the FCC goes on to state that in reaching their decision on the adoption of RF exposure guidelines they carefully considered the comments submitted by the U.S. Environmental Protection Agency (EPA), the Food and Drug Administration (FDA) and other federal health and safety agencies. The FCC believes that adopted guidelines are based substantially on the recommendations of those agencies, and the FCC believes that the guidelines represent a consensus view of the federal agencies responsible for matters relating to the public safety and health. [59]

According to the FCC, the MPE limits adopted in the Report and Order are based on exposure criteria quantified in terms of specific absorption rate (SAR), a measure of the rate of RF energy absorption. The basis for these limits, as well as the basis for the 1982 ANSI limits that the Commission previously specified in FCC rules, is an SAR limit of 4 watts per kilogram. The new MPE limits are derived by incorporating safety factors that lead, in some cases, to limits that are more conservative than the limits

specified by ANSI in 1982. The more conservative limits do not arise from a fundamental change in the RF safety criteria for SAR, but from a precautionary desire for more rigor in the derivation of factors which allow limits for MPE to be derived from SAR limits. [59]

In 1985, the FCC adopted a 1982 ANSI standard for use in evaluating the effects of RF radiation on the environment, noting that the ANSI standard was widely accepted and was technically and scientifically supportable. Since then the Commission has used this standard as its processing guideline for determining the potential environmental impact of RF emissions. The rules now require applicants for certain facilities to prepare an Environmental Assessment (EA) if the transmitter or facility under consideration could expose the general public or workers to levels of RF radiation that are in excess of the 1982 ANSI guidelines. [59]

In 1992, ANSI adopted a new standard for RF exposure, designated ANSI/IEEE C95.1-1992 to replace its 1982 standard. This new standard contains a number of significant differences from the 1982 ANSI standard. In some respects, the 1992 ANSI/IEEE standard is more restrictive in the amount of environmental RF exposure permitted, although for some situations recommended MPE levels are similar to the 1982 limits. The 1992 ANSI/IEEE standard also extends the frequency range under consideration to cover frequencies from 3 kHz to 300 GHz. The 1992 ANSI/IEEE standard specifies two tiers of exposure criteria, one tier for "controlled environments" (usually involving workers) and another, more stringent tier, for "uncontrolled environments" (usually involving the general public). The 1982 ANSI standard specified only one set of exposure limits, regardless of whether the individual exposed was a worker or a member of the general public. The 1992 ANSI/IEEE standard also, for the first time, includes specific restrictions on currents induced in the human body by RF fields. These restrictions apply to both "induced" currents and "contact" currents related to shock and burn hazards. [59]

The 1992 ANSI standard is generally more stringent in the evaluation of low-power devices, such as hand-held radios and cellular telephones, than the 1982 standard. That is, the 1982 ANSI standard permitted exclusion from compliance with the MPE limits if the localized specific absorption rate (SAR) of a low-power device could be shown to be 8 watts/kilogram (8 W/kg) or less, or if the input power of the radiating device at frequencies between 300 kHz and 1 GHz was 7 watts or less. The 1992 guidelines reduce the allowable localized SAR level for devices operating in "uncontrolled" environments by a factor of five to 1.6 W/kg, while maintaining the 8 W/kg limit for "controlled" environments. Further, the exclusion thresholds based on operating power are significantly reduced for devices that operate in uncontrolled environments and for devices that operate above 450 MHz in controlled environments. The 1992 ANSI/IEEE standard also prohibits the application of the power exclusion to hand-held devices where the radiating structure is maintained less than 2.5 centimeters (cm) from the body of the user. [59]

The 1992 ANSI/IEEE guidelines specify two sets of exposure limits based on the "environment" in which the exposure takes place. These environments are classified as either "controlled" or "uncontrolled." Controlled environments are defined as locations where "there is exposure that may be incurred by persons who are aware of the potential for exposure as a part of employment, by other cognizant persons, or as the incidental result of transient passage through areas where analysis shows the exposure levels may be above [the exposure and induced current levels permitted for uncontrolled environment but not those permitted for controlled environments]." Uncontrolled environments are defined as "locations where there is the exposure of individuals who have no knowledge or control of their exposure. The exposures may occur in living quarters or workplaces where there are no expectations that the exposure levels may exceed [the exposure and induced current levels permitted for uncontrolled environments]." [59]

Several federal agencies filed comments during the FCC's proceeding for the Report and Order expressing varying viewpoints on whether the FCC should adopt the ANSI/IEEE guidelines or some

alternative. Within the Federal Government, the EPA is generally responsible for investigating and making recommendations with regard to environmental issues. The FDA has general jurisdiction for protecting the public from potentially harmful radiation from consumer and industrial devices and in that capacity is expert in RF exposures that would result from consumer or industrial use of hand-held devices such as cellular telephones. The National Institute for Occupational Safety and Health (NIOSH), an agency of the U. S. Department of Health and Human Services, is responsible for performing research and analysis with respect to worker safety and health. The Occupational Safety and Health Administration (OSHA) has jurisdiction over Federal regulations dealing with worker safety and health.[59]

The FCC clarified that the adoption of FCC 96-326 satisfies the requirements of the Telecommunications Act of 1996. [59]

The Report and Order concludes by establishing a new FCC rule.

Part of the new FCC rule references Section 332(c)(7)(B)(iv) of the Telecommunications Act of 1996 which says that no State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the regulations contained in this chapter concerning the environmental effects of such emissions. For purposes of this paragraph:

(1) The term "personal wireless service" means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services;

(2) The term "personal wireless service facilities" means facilities for the provision of personal wireless services;

(3) The term "unlicensed wireless services" means the offering of telecommunications services using duly authorized devices which do not require individual licenses, but does not mean the provision of direct-to-home satellite services; and

(4) The term "direct-to-home satellite services" means the distribution or broadcasting of programming or services by satellite directly to the subscriber's premises without the use of ground receiving or distribution equipment, except at the subscriber's premises or in the uplink process to the satellite.

Part of the new FCC rule also created: *47 CFR 1.1310 - Radiofrequency radiation exposure limits*.

According to *47 CFR 1.1310*, the criteria listed in Table 1, shown below, shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation. [59]

Table 1. Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	($900/f^2$)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	($180/f^2$)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

NOTE 1: ***Occupational/controlled*** limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2: ***General population/uncontrolled*** exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

The FCC says that these limits are generally based on recommended exposure guidelines published by the National Council on Radiation Protection and Measurements (NCRP) in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86, Sections 17.4.1, 17.4.1.1, 17.4.2 and 17.4.3. In the frequency range from 100 MHz to 1500 MHz, exposure limits for field strength and power density are also generally based on guidelines recommended by the American National Standards Institute (ANSI) in Section 4.1 of "IEEE Standard for Safety Levels with Respect to

Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE C95.1-1992. [59]

According to the FCC, the exposure limits are generally applicable to all facilities, operations and transmitters regulated by the Commission. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation." [59]

6.2 FCC-13-39A1

On March 29, 2013, the FCC released FCC-13-39A1, which incorporated two Dockets. The first Docket, 13-84, is titled "*Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies*" and the second Docket, 03-137, is titled "*Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*". [60]

With the release of FCC-13-39A1, the FCC stated that periodic review of the government's rules and regulations to ensure they have kept pace with current knowledge and changing needs is an important characteristic of good government. In this document, the FCC advanced the process of providing a comprehensive review and modification, where appropriate, of the Commission's various rules pertaining to the implementation of the National Environmental Policy Act (NEPA) requirements for environmental reviews, specifically those reviews related to health and safety of radiofrequency (RF) emissions from radio transmitters. The FCC's actions were intended to ensure that the Commission's measures are compliant with its environmental responsibilities and requirements and that the public is appropriately protected from any potential adverse effects from RF exposure as provided by its rules, while avoiding any unnecessary burden in complying with these rules. [60]

FCC-13-39A1 is divided into three parts: a *Report and Order* (*Order*) and a *Further Notice of Proposed Rulemaking* (*Further Notice*) in Docket No. 03-137, and a *Notice of Inquiry* (*Inquiry*) in a new docket, Docket No. 13-84. In the *Order,* the FCC concluded several technical and semantic issues initiated in 2003 that revised and updated the FCC's regulations implementing NEPA; in the *Further Notice,* the FCC proposed to further update and revise their procedures and treat all services equally; and in the *Inquiry* the FCC requested comments to determine whether its RF exposure limits and policies need to be reassessed. The purpose of the *Order* and *Further Notice* was to advance ET Docket 03-137 with respect to how to demonstrate compliance with NEPA and FCC RF exposure limits, but that proceeding did not reach the issue of whether the FCC's exposure limits are appropriate. Since consideration of the limits themselves was explicitly outside of the scope of ET Docket 03-137, the FCC proposed with the *Inquiry* to open a new docket to consider those limits in light of more recent developments. The *Inquiry* was intended to open discussion on both the currency of FCC RF exposure limits and possible policy approaches regarding RF exposure. [60]

In the *Order*, the FCC resolved several issues regarding compliance with its regulations for conducting environmental reviews under NEPA as they relate to the guidelines for human exposure to RF electromagnetic fields. More specifically, the Order clarified evaluation procedures and references to determine compliance with FCC limits, including specific absorption rate (SAR) as a primary metric for compliance, consideration of the pinna (outer ear) as an extremity, and measurement of medical implant exposure. The FCC Order also elaborated on mitigation procedures to ensure compliance with its limits, including labeling and other requirements for occupational exposure classification, clarification of compliance responsibility at multiple transmitter sites, and labeling of fixed consumer transmitters.[60]

In the *Further Notice*, the FCC sought comment on new proposals developed in the course of the proceedings regarding compliance with its guidelines for human exposure to RF electromagnetic fields.

The FCC's proposals reflected an effort to provide more efficient, practical, and consistent application of evaluation procedures to ensure compliance with its guidelines limiting human exposure to RF energy from Commission-regulated transmitters and devices. The FCC proposed to broadly revise and harmonize the criteria for determining whether single or multiple fixed, mobile, or portable RF sources are subject to routine evaluation for compliance with the RF exposure limits or are exempted from such evaluations. Additionally, the FCC proposed clarifications of evaluation requirements for portable and medical implant devices. It also proposed to adopt specific new requirements for signs and barriers at fixed transmitter sites to ensure compliance with public and occupational exposure limits. Further, the FCC proposed a clarification of the definition of transient exposure for non-workers exposed at levels up to occupational limits. [60]

With the *Further Notice,* the FCC made proposals by which they sought to streamline and harmonize many procedures to achieve equal treatment of RF-emitting sources based on their physical properties rather than service categories. Thus, the Commission proposed establishing general exemptions from evaluation to determine compliance in place of existing service-specific "categorical exclusions." These proposed exemptions involve simple calculations to establish whether any further determination of compliance is necessary. Currently, routine evaluations are required for specific rule subparts meeting certain criteria. The new, general exemptions instead apply to all subparts authorizing RF sources, including some that were not previously listed. Given the trend toward opportunistic spectrum access to allow services to utilize multiple bands of frequencies with various power limits, inclusion of all services is necessary to better ensure compliance with FCC exposure limits. The FCC determined that simple calculations should reduce the likelihood of requiring unnecessary and burdensome evaluations for low-power portable devices. Additionally, the FCC sought to allow the computation of SAR for evaluation using any valid method to encourage technological development and greater competition in the computational software marketplace. [60]

The FCC initiated a new proceeding with a *Notice of Inquiry* to determine whether there is a need for reassessment of the Commission's radiofrequency (RF) exposure limits and policies. The *Inquiry* focused on three elements: the propriety of the FCC's existing standards and policies, possible options for precautionary exposure reduction, and possible improvements to the FCC's equipment authorization process and policies as they relate to RF exposure. The FCC adopted its present exposure limits in 1996, based on guidance from federal safety, health, and environmental agencies using recommendations published separately by the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers, Inc. (IEEE). Since 1996, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) has developed a recommendation supported by the World Health Organization (WHO), and the IEEE has revised its recommendations several times, while the NCRP has continued to support its recommendation as the FCC uses it in its current rules. In the *Inquiry*, the FCC asked whether its exposure limits remain appropriate given the differences in the various recommendations that have developed and recognizing additional progress in research subsequent to the adoption of its existing exposure limits. [60]

The FCC states that since it is not a health and safety agency, it defers to other organizations and agencies with respect to interpreting the biological research necessary to determine what levels are safe. As such, the Commission invited health and safety agencies and the public to comment on the propriety of its general present limits and whether additional precautions may be appropriate in some cases, for example with respect to children. The FCC recognizes its responsibility to both protect the public from established adverse effects due to exposure to RF energy and allow industry to provide telecommunications services to the public in the most efficient and practical manner possible. In the *Inquiry,* the FCC asked whether any precautionary action would be either useful or counterproductive,

given that there is a lack of scientific consensus about the possibility of adverse health effects at exposure levels at or below its existing limits. Further, if any action is found to be useful, the FCC inquired whether it could be efficient and practical.[60]

In the *Inquiry,* the FCC asked questions about several other issues related to public information, precautionary measures, and evaluation procedures. Specifically, it sought comment on the feasibility of evaluating portable RF sources without a separation distance when worn on the body to ensure compliance with its limits under present-day usage conditions. It asked whether the Commission should consistently require either disclosure of the maximum SAR value or other more reliable exposure data in a standard format – perhaps in manuals, at point-of-sale, or on a website. Additionally, the FCC sought comment on appropriate education and outreach to the public on low-level exposure to RF energy from fixed transmitters in the environment. The Commission also inquired about aspects of evaluation procedures to establish whether the standardization process can be improved considering the fast pace at which technology changes. [60]

The FCC also sought comments from the public, from any federal agency with jurisdiction by law or expertise over the environmental impact of human exposure to RF energy, and from expert organizations, regarding the potential environmental impacts, including any cumulative impacts, of the rule changes proposed in the *Further Notice*. Finally, the FCC proposed that any NEPA evaluation is premature at the time with respect to the *Inquiry,* which merely sought to determine whether there is a basis to reevaluate the Commission's RF exposure limits and policies. The FCC determined that such impact would be considered and the need for an environmental assessment (EA) would be evaluated at that time if it decides in the future to adopt new rules in the course of the new docket initiated by the *Inquiry*. [60]

6.3 FCC DOC-358968A1

On August 8, 2019, the Federal Communications Commission Chairman Ajit Pai shared with his colleagues a proposal that would continue to ensure the health and safety of workers and consumers of wireless technology. According to the Chairman, following more than six years of public input and review, the proposal would maintain the Commission's existing radiofrequency (RF) exposure limits. According to the FCC, the United States' RF exposure limits for handheld devices are among the most stringent in the world. [56]

The proposal would also establish a uniform set of guidelines for ensuring compliance with the limits regardless of the service or technology, replacing the Commission's current inconsistent patchwork of service-specific rules. In addition, Chairman Pai proposed that the Commission seek comment on establishing rules formalizing its existing methods of determining compliance with the RF exposure standard for high-frequency devices. [56]

According to the FCC's Office of Engineering and Technology (OET), the FCC sets radiofrequency limits in close consultation with the FDA and other health agencies. OET stated that after a thorough review of the record and consultation with these agencies, it finds it appropriate to maintain the existing radiofrequency limits, which are among the most stringent in the world for cell phones. [56]

The Food and Drug Administration's Center for Devices and Radiological Health, also stated that the available scientific evidence to date does not support adverse health effects in humans due to exposures at or under the current limits. The FDA went on to state that no changes to the current standards are warranted at this time. [56]

The FCC's draft proposal includes these main components:

- *Maintaining the current standard*: The item would maintain the existing RF exposure limits and thus resolve the Commission's 2013 Notice of Inquiry that sought public input on whether to strengthen or relax its existing RF exposure limits. [56]
- *Establishing uniform rules for determining compliance with RF standards*: The item would establish a uniform set of guidelines, agnostic to the service or technology, using science-based metrics around frequency, distance, and power, to determine how entities assess whether they are in compliance with RF standards. [56]
- *Formalizing the application of the existing standard to certain frequencies*: The item would seek comment on establishing a rule to formalize the Commission's existing methods of determining compliance with the RF exposure standard for devices operating at high frequencies. [56]

7. Food and Drug Administration

The United States Food and Drug Administration (FDA) has general jurisdiction for protecting the public from potentially harmful radiation from consumer and industrial devices and in that capacity is viewed as the expert in RF exposures that would result from consumer or industrial use of hand-held devices such as cellular telephones. [59]

The FDA states that according to current data, the weight of scientific evidence does not show an association between exposure to radiofrequency from cell phones and adverse health outcomes. However, according to the FCC, radiation can damage human tissue if it is exposed to high levels of RF radiation. The FCC states that RF radiation has the ability to heat human tissue, much like the way microwave ovens heat food. [18]

According to the FDA, the science is undecided because different studies have different results. Some say that cell phones are linked to higher occurrences of cancer and other ailments. Other studies report that cell-phone users have no higher rate of cancer than the population as a whole. The FDA states that there is consensus that additional research is warranted to address gaps in knowledge. [18]

7.1 Health Issues

The FDA says that many people are concerned that cell phone radiation will cause cancer or other serious health hazards. The Agency goes on to say that the weight of scientific evidence has not linked cell phones with any health problems. [61]

Cell phones emit low levels of radiofrequency energy (RF). According to the FDA, over the past 15 years (2002 to 2017), scientists have conducted hundreds of studies looking at the biological effects of the radiofrequency energy emitted by cell phones. While some researchers have reported biological changes associated with RF energy, these studies have failed to be replicated. The majority of studies published have failed to show an association between exposure to radiofrequency from a cell phone and health problems. [61]

The low levels of RF cell phones emit while in use are in the microwave frequency range. They also emit RF at substantially reduced time intervals when in the stand-by mode. The FDA states that whereas high levels of RF can produce health effects (by heating tissue), exposure to low level RF that does not produce heating effects causes no known adverse health effects. [61]

The FDA maintains that the biological effects of radiofrequency energy should not be confused with the effects from other types of electromagnetic energy. [61]

Very high levels of electromagnetic energy, such as is found in X-rays and gamma rays can ionize biological tissues. Ionization is a process where electrons are stripped away from their normal locations in atoms and molecules. It can, according to the FDA, permanently damage biological tissues including DNA, the genetic material. [61]

The FDA believes that the energy levels associated with radiofrequency energy, including both radio waves and microwaves, are not great enough to cause the ionization of atoms and molecules. Therefore, RF energy is a type of non-ionizing radiation. Other types of non-ionizing radiation include visible light, infrared radiation (heat) and other forms of electromagnetic radiation with relatively low frequencies. [61]

The FDA states that while RF energy doesn't ionize particles, large amounts can increase body temperatures and cause tissue damage. Two areas of the body, the eyes and the testes, are particularly

vulnerable to RF heating because there is relatively little blood flow in them to carry away excess heat. [61]

7.2 Interference with Pacemakers and Other Medical Devices

According to the FDA, radiofrequency energy (RF) from cell phones can interact with some electronic devices. This type of interference is called electromagnetic interference (EMI). For this reason, the FDA helped develop a detailed test method to measure EMI of implanted cardiac pacemakers and defibrillators from cell phones. This test method is now part of a standard sponsored by the Association for the Advancement of Medical Instrumentation (AAMI). According to the FDA, this standard will allow manufacturers to ensure that cardiac pacemakers and defibrillators are safe from cell phone EMI. [62]

The FDA continues to monitor the use of cell phones for possible interactions with other medical devices. Should harmful interference be found to occur, the FDA will conduct testing to assess the interference and work to resolve the problem. [62]

If EMI were to occur, it could affect a pacemaker in one of three ways [62]:

- Stopping the pacemaker from delivering the stimulating pulses that regulate the heart's rhythm
- Causing the pacemaker to deliver the pulses irregularly
- Causing the pacemaker to ignore the heart's own rhythm and deliver pulses at a fixed rate

Based on current research, the FDA believes that cell phones would not seem to pose a significant health problem for the vast majority of pacemaker wearers. Still, the FDA states that people with pacemakers may want to take some simple precautions to be sure that their cell phones don't cause a problem. [62]

- Hold the phone to the ear opposite the side of the body where the pacemaker is implanted to add some extra distance between the pacemaker and the phone
- Avoid placing a turned-on phone next to the pacemaker implant (e.g. don’t carry the phone in a shirt or jacket pocket directly over the pacemaker)

7.3 Children and Cell Phones

The FDA says that the scientific evidence does not show a danger to any users of cell phones from RF exposure, including children and teenagers. The FDA goes on to suggest some steps adults can take to reduce RF exposure apply to children and teenagers as well. [63]

- Reduce the amount of time spent on the cell phone
- Use speaker mode or a headset to place more distance between the head and the cell phone.

The FDA clarifies that some groups sponsored by other national governments have advised that children be discouraged from using cell phones at all. For example, the FDA mentions The Stewart Report from the United Kingdom that made such a recommendation in December 2000. In this report a group of independent experts noted that no evidence exists that using a cell phone causes brain tumors or other ill effects. The FDA states that their recommendation to limit cell phone use by children was strictly precautionary; it was not based on scientific evidence that any health hazard exists. [63]

7.4 Current Research Results

The FDA states that the results of most studies conducted to date indicate that there is not a connection between certain health problems and exposure to radiofrequency fields via cell phone use. In addition,

the agency says that attempts to replicate and confirm the few studies that did show a connection have failed. [18]

The FDA believes that the weight of current scientific evidence does not show an association between exposure to radiofrequency from cell phones and adverse health outcomes. Still, there is consensus that additional research is warranted to address gaps in knowledge, such as the effects of cell phone use over the long-term and on pediatric populations. [18]

7.5 World Health Organization's IARC

The International Agency for Research on Cancer (IARC), through the *Monographs* program, seeks to identify environmental factors that can increase the risk of cancer in humans. IARC uses the following categories to classify environmental agents [18]:

Group 1: Carcinogenic to humans.

Group 2A: Probably carcinogenic to humans.

Group 2B: Possibly carcinogenic to humans.

Group 3: Not classifiable as to its carcinogenicity to humans.

Group 4: Probably not carcinogenic to humans.

On May 31, 2011, the IARC classified radiofrequency fields in Group 2B, *possibly carcinogenic to humans*. [18]

IARC interprets the 2B classification as meaning there is limited evidence showing radiofrequency carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals.[18]

For perspective, IARC has classified the following other agents as "possibly carcinogenic to humans"[18]:

- Coffee
- Extremely low frequency electromagnetic fields (power line frequency)

A complete list of agents classified by IARC Monographs Vol. 1 – 122 can be found at https://monographs.iarc.fr/monographs-available/

7.6 Ongoing Studies

The FDA if monitoring the following studies.

International Cohort Study on Mobile Phone Users (COSMOS)

The COSMOS study aims to conduct long-term health monitoring of a large group of people to determine if there are any health issues linked with long-term exposure to radiofrequency energy from cell phone use. The COSMOS study will follow approximately 300,000 adult cell phone users in Europe for 20 to 30 years. Additional information about the COSMOS study can be found at http://www.ukcosmos.org/ [18]

Risk of brain cancer from exposure to radiofrequency fields in childhood and adolescence (MOBI-KIDS)

MOBI-KIDS is an international study investigating the relationship between exposure to radiofrequency energy from communication technologies, including cell phones, and brain cancer in young people. This is an international, multi-center study involving 14 European and non-European countries. Additional

information about the MOBI-KIDS study can be found at https://cordis.europa.eu/result/rcn/193614_en.html [18]

Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute

The SEER Program of the National Cancer Institute (NCI) actively follows cancer statistics in the United States. If cell phones play a role in increasing the risk of brain cancer, rates would be expected to increase. However, between 1987 and 2008, SEER data shows that despite the sharp increase in heavy cell phone use in the U.S., the overall age-adjusted incidence of brain cancer did not increase. Additional information about SEER can be found at http://seer.cancer.gov/. [18]

7.7 Reducing Exposure

If there is a risk from being exposed to radiofrequency energy (RF) from cell phones--and at this point the FDA does not state that there is--it is probably very small. But the FDA says that if cell phone users are concerned about avoiding even potential risks, they can take a few simple steps to minimize their RF exposure. [64]

- Reduce the amount of time spent using their cell phone
- Use speaker mode or a headset to place more distance between their head and the cell phone.

Hand-free kits may include audio or Bluetooth headsets and various types of body-worn accessories such as belt-clips and holsters. Combinations of these can be used to reduce RF energy absorption from cell phone. [64

The FDA promotes that headsets can substantially reduce exposure since the phone is held away from the head in the user's hand or in approved body-worn accessories. The FDA believes that cell phones marketed in the U.S. are required to meet RF exposure compliance requirements when used against the head and against the body. [64]

The FDA states that since there are no known risks from exposure to RF emissions from cell phones, there is no reason to believe that hands-free kits reduce risks. The agency goes on to say that hands-free kits can be used for convenience and comfort. They are also required by law in many states if cell phone users want to use their phone while driving. [64]

7.8 Cell Phone Industry Actions

The FDA believes that existing scientific data does not support a change in its regulation of cell phones, but it has urged the cell phone industry to take a number of steps, including [18]:

- Support additional research on possible biological effects of radiofrequency fields for the type of signal emitted by cell phones;
- Improve cell phone design by minimizing radiofrequency exposure to the user; and
- Cooperate in providing cell phone users with the latest scientific information on health concerns caused by radiofrequency exposure.

7.9 Safety Standards

The FDA is working with voluntary standard setting bodies such as the Institute of Electrical and Electronics Engineers (IEEE), the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and others to assure that safety standards continue to adequately protect the public. [18]

8. Municipal Case Studies

On September 27, 2018, the Federal Communications Commissions (FCC) adopted a Declaratory Ruling and Third Report and Order, titled "Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment" (the Order). The Order establishes fees, "shot clocks," and provides limits on local governments' control of small wireless infrastructure.

The FCC Order also includes Section 332(c)(7)(B)(iv) of the Telecommunications Act of 1996 which says that *no State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with FCC regulations concerning the environmental effects of such emissions*. Courts have interpreted environmental effects to include any potential effects on health.

While this part of the FCC Order limits a local government's ability to deny the sitting of a small cell facility in the public right-of-way based on the environmental effects of RF emissions, it opens the door for local governments to establish ways to ensure that the RF emissions from small wireless facilities were in compliance with FCC MPE limits. Since the release of the Order, local governments have created various regulations to address this compliance concern, including RF emissions testing and the submission of a non-ionizing electromagnetic radiation report.

8.1 RF Emissions Testing

In an effort to ensure that wireless facilities, such as small cell facilities, are in compliance with the MPE limits specified by the FCC, some local governments are requiring RF emissions testing of a wireless facility prior to unattended operations of the facility and some local governments are also requiring that these tests be performed annually.

One example of that is the City of Redlands in California, which included language in their Municipal Code that establishes RF emissions testing procedures for wireless facilities. In August of 2019, the Redlands' City Council voted to add Chapter 12.60, entitled "Wireless Facilities in Public Rights-Of-Way," to the Redlands Municipal Code.

Included in section *12.60.30* of the Chapter there is a paragraph that addresses *RF Exposure Compliance*. The paragraph states: "*All facilities must comply with all standards and regulations of the FCC and any other state or federal government agency with the authority to regulate RF exposure standards. After transmitter and antenna system optimization, but prior to unattended operations of the facility, permittee or its representative must conduct on-site post-installation RF emissions testing to demonstrate actual compliance with the FCC OET Bulletin 65 RF emissions safety rules for general population/uncontrolled RF exposure in all sectors. For this testing, the transmitter shall be operating at maximum operating power, and the testing shall occur outwards to a distance where the RF emissions no longer exceed the uncontrolled/general population limit. The Permittee shall submit documentation of this testing within ninety (90) days after installation of the facility*."

8.2 NIER Report

The ever-expanding use of wireless technology, such as small cell facilities (SCF), has led some people to speculate that the use of these wireless technologies is causing significant risks to human health. [55] In response to these concerns, some local governments are requiring that a small cell facility applicant submit a site specific ***non-ionizing electromagnetic radiation*** (NIER) report for the small cell facility equipment type and model that is part of the small cell facility application.

The following is an example of the language that some local governments are including in their small cell facilities code regarding a requirement to submit a NIER Report.

Certification of compliance with applicable FCC regulations, which includes a site specific non-ionizing electromagnetic radiation (NIER) report for the small cell facility (SCF) equipment type and model endorsed by a radiofrequency engineer acceptable to the city, including a certification that the SCF complies with all radiation and electromagnetic standards. The report shall specify approach distances to the general public and occupational workers at the ground and antenna centerline levels. The report shall include instructions regarding powering off the equipment or contact information for a person who can power off the equipment. No significant changes to the power, location, RF emission patterns and/or emitting frequencies may be made without prior notification and approval. However, non-substantive changes, for example, in-kind replacements of transmitters of the same frequency, radiation patterns and power are permitted. The city retains the right to independently verify the RF patterns as installed.

9. McKinney Citizen Concerns

Some of the citizens of the City of McKinney have brought their concerns regarding health effects of radiofrequency emissions to the attention of city officials. This group has indicated their opposition to the installation of small cell / 5G facilities in their community based on a number of studies, reports, articles, letters, etc. that share information about the potential health impacts of these and other cellular technologies.

As mentioned in the Executive Summary and detailed in Sections 6 and 7 of this report, there is also a large body of scientific information that shows no adverse health effects, and highlights steps industry has taken to develop this technology to reduce emissions and stay within the FCC guidelines.

Perhaps mirroring the disparity of opinions, speakers at the McKinney Town Hall listening session held February 12, 2020, spoke in approximately equal numbers who were in opposition to 5G and in support of this technology.

As part of this study, a catalogue of documents received in both opposition to and in support of 5G has been developed and included in this report in Appendix A, and has been provided to the City of McKinney. Below is a discussion of some of the most referred to studies that were referenced in citizen concern documents. Included is information that clarifies the findings of the studies and points out the difficulty in applying their results too broadly.

9.1 NTP Study

The National Toxicology Program (NTP) carried out extensive rodent toxicology and carcinogenesis studies of radiofrequency radiation (RFR) at frequencies and modulations used in the US telecommunications industry. NTP conducted toxicology studies in rats and mice to help clarify potential health hazards, including cancer risk, from exposure to RFR used in 2G and 3G cell phones. 2G and 3G networks were standard when the studies were designed. [65] A November 2018 Fact Sheet about the studies states that the $30 million NTP studies took more than 10 years to complete.

In the Fact Sheet, the U.S. Food and Drug Administration (FDA) selected RFR for study by the NTP, due to widespread human exposure and limited information about the potential health effects of long-term use of cell phones. The NTP is a federal, interagency program, headquartered at the National Institute of Environmental Health Sciences, which is part of the National Institutes of Health. [65]

The NTP conducted two-year toxicology studies in rats and mice to help clarify potential health hazards, including cancer risk, from exposure to RFR like that used in 2G and 3G cell phones which operate within a range of frequencies from about 700–2700 megahertz (MHz). These were published as Technical Reports in November 2018. [65]

The NTP studies found that high exposure to RFR (900 MHz) used by cell phones was associated with [65]:

- Clear evidence of tumors in the hearts of male rats. The tumors were malignant schwannomas.
- Some evidence of tumors in the brains of male rats. The tumors were malignant gliomas.
- Some evidence of tumors in the adrenal glands of male rats. The tumors were benign, malignant, or complex combined pheochromocytoma.

It was unclear if tumors observed in the studies were associated with exposure to RFR in female rats (900 MHz) and male and female mice (1900MHz). [65]

The results are based on NTP's four categories of evidence that a substance may cause cancer: clear evidence (highest), some evidence, equivocal evidence, no evidence (lowest). [65]

As a follow-up, NTP submitted a manuscript accepted for publication in October 2019 that evaluated DNA damage in three regions of the brain, the liver, and in blood cells in rats and mice that were removed at an earlier time point from the ongoing 2-year toxicology study. DNA damage, if not repaired, can potentially lead to tumors. This work was also included in NTP's published Technical Reports, but this study includes analyses of the data in the supporting information not included in the Technical Reports. [65]

NTP scientists found that RFR exposure was associated with an increase in DNA damage. Specifically, they found RFR exposure was linked with significant increases in DNA damage in [65]:

- the frontal cortex of the brain in male mice,
- the blood cells of female mice, and
- the hippocampus of male rats.

The NTP stated that there are many factors that influence whether damaged DNA will lead to tumors. The NTP plans to conduct additional studies to learn more about how RFR might cause DNA damage. [65]

The NTP says that it is currently evaluating the existing literature on the higher frequencies intended for use in the 5G network and is working to better understand the biological basis for the cancer findings reported in earlier studies on RFR with 2G and 3G technologies. [65]

This is an important and often cited study, but it is also important to keep the context of what was being determined. In simplified terms, the main question was whether RFR could cause damage – not were current acceptable levels causing damage.

Quoting a senior member of the research team: "The exposures used in the studies cannot be compared directly to the exposure that humans experience when using a cell phone," said John Bucher, Ph.D., NTP senior scientist. "In our studies, rats and mice received radio frequency radiation across their whole bodies. By contrast, people are mostly exposed in specific local tissues close to where they hold the phone. In addition, the exposure levels and durations in our studies were greater than what people experience."

The lowest exposure level used in the studies was equal to the maximum local tissue exposure currently allowed for cell phone users. This power level rarely occurs with typical cell phone use. The highest exposure level in the studies was four times higher than the maximum power level permitted. [66]

9.2 BioInitiative 2012 Report

The BioInitiative Report was first posted in August of 2007 and subsequently updated in December of 2012. A press release from the BioInitiative Working Group states it is a report by 29 independent scientists and health experts from around the world regarding the possible risks from wireless technologies and electromagnetic fields. [66]

According to the BioInitiative Working Group, the report documents the science, public health, public policy and global response to the growing health issue of chronic exposure to electromagnetic fields and radiofrequency radiation in the daily life of billions of people around the world. It covers brain tumor risks from cell phones, damage to DNA and genes, effects on memory, learning, behavior, attention; sleep disruption and cancer and neurological diseases like Alzheimer's disease. It also covers the effects on sperm and miscarriage (fertility and reproduction), effects of wireless on the brain development of the fetus and infant, and effects of wireless classrooms on children and adolescents. Additionally, the

report discusses the mechanisms for biological action and public health responses in other countries. It also addresses the therapeutic use of very low intensity electric and magnetic fields (EMF), and radio frequency radiation (RFR). [67]

The BioInitiative Working Group stated that the 2012 update covers about 1800 new studies reporting bioeffects and adverse health effects of electromagnetic fields (powerlines, electrical wiring, appliances and hand-held devices) – and wireless technologies (cell and cordless phones, cell towers, WI-FI, wireless laptops, wireless routers, baby monitors, surveillance systems, wireless utility meters ('smart meters'), etc. [66]

The Working Group says that the BioInitiative 2012 Report was prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs. Ten of 29 authors are from the USA. They worked alongside authors from Sweden (6), India (2), Italy (2), Greece (2), Canada (2), Denmark (1), Austria (2), Slovac Republic (1), and Russia (1). [66]

The following is a list of the high-level conclusions from the BioInitiative 2012 Report. [66] Additional details regarding each of these conclusions can be found at: https://bioinitiative.org/conclusions/

- Bioeffects are clearly established
- Bioeffects with chronic exposures can reasonably be presumed to result in adverse health effects
- Low exposure levels are associated with bioeffects and adverse health effects at cell tower RFR exposure levels
- Evidence for fertility and reproduction effects: human sperm and their DNA are damaged
- Evidence that children are more vulnerable
- Fetal and neonatal effects of EMF
- EMF/RFR as a plausible biological mechanism for autism (ASD)
- The blood-brain barrier is at risk
- Epidemiological studies consistently show elevations in risk of brain cancers
- Evidence for genetic effects
- Evidence for neurological effects
- Evidence for childhood cancers (leukemia)
- Decreased melatonin production (Breast Cancer and Alzheimer's Disease)
- Stress proteins and DNA as a fractal antenna for RFR
- Evidence for disruption of the modulating signal human stem cell DNA does not adapt or repair
- Effects of weak-field interactions on non-linear biological oscillators and synchronized neural activity
- EMF and RFR make chemical toxins more harmful
- EMF is successfully used in healing and disease treatments
- ELF-EMF and RFR are classified as possible cancer-causing agents – why are governments not acting?
- New safety limits must be established – health agencies should act now
- Scientific benchmarks for harm plus safety margin = new safety limits that are valid
- Sensitive populations must be protected
- Protecting new life – infants and children
- Standard of evidence for judging the science
- Wireless warnings for all
- EMF and RFR are preventable toxic exposures
- Defining a new 'effect level' for RFR

To point out how difficult it can be to distinguish between science and bias, the Health Council of the Netherlands, in making their report to their parliament made these comments about the BioInitiative Report:

> "In an advisory report, the Electromagnetic Fields Committee of the Health Council now gives its opinion as to the scientific value of the BioInitiative report. The Committee concludes that this report is not an objective and balanced reflection of the current state of scientific knowledge and does not provide any grounds for revising the current views as to the risks of exposure to electromagnetic fields."
>
> From their website: https://www.healthcouncil.nl/documents/advisory-reports/2008/09/02/bioinitiative

9.3 5G: Great risk for EU, U.S. and International Health

On May 17, 2018, Martin L. Pall, PhD, a Professor Emeritus of Biochemistry and Basic Medical Sciences at Washington State University published a report titled: *5G: Great risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them*. [69]

According to author, this is a 90-page, seven-chapter document on EMF effects, how they are produced in the body and the corruption of the international science. [69]

In the report, Dr, Pall states that there is a massive amount of literature, providing a high level of scientific certainty, for each of eight pathophysiological effects caused by non-thermal microwave frequency EMF exposures. [69]

Dr. Pall says that such EMFs:

1. Attack our nervous systems including our brains leading to widespread neurological/neuropsychiatric effects and possibly many other effects. This nervous system attack is of great concern. [69]
2. Attack our endocrine (that is hormonal) systems. In this context, the main things that make us functionally different from single celled creatures are our nervous system and our endocrine systems – even a simple planaria worm needs both of these. Thus, the consequences of the disruption of these two regulatory systems is immense, such that it is a travesty to ignore these findings. [69]
3. Produce oxidative stress and free radical damage, which have central roles in essentially all chronic diseases. [69]
4. Attack the DNA of our cells, producing single strand and double strand breaks in cellular DNA and oxidized bases in our cellular DNA. These in turn produce cancer and also mutations in germ line cells which produce mutations in future generations. [69]
5. Produce elevated levels of apoptosis (programmed cell death), events especially important in causing both neurodegenerative diseases and infertility. [69]
6. Lower male and female fertility, lower sex hormones, lower libido and increased levels of spontaneous abortion and, as already stated, attack the DNA in sperm cells. [69]
7. Produce excessive intracellular calcium and excessive calcium signaling. [69]
8. Attack the cells of our bodies to cause cancer. Such attacks are thought to act via 15 different mechanisms during cancer causation. [69]

The author goes on to state that there is also a substantial literature showing that EMFs also cause other effects including life threatening cardiac effects. In addition, substantial evidence suggests EMF causation of very early onset dementias, including Alzheimer's, digital and other types of dementias; and there is evidence that EMF exposures in utero and shortly after birth can cause ADHD and autism. [69]

Dr. Pall says that each of these effects is produced via the main mechanism of action of microwave/lower frequency EMFs, activation of voltage-gated calcium channels (VGCCs). Each of them is produced via what are called downstream effects of VGCC activation. It follows from this that we have a good understanding not only that these effects occur, but also how they can occur. The extraordinary sensitivity of the VGCC voltage sensor to the forces of the EMFs tells us that the current safety guidelines allow us to be exposed to EMF levels that are something like 7.2 million times too high. That sensitivity is predicted by the physics. Therefore, the physics and the biology are each pointing to the same mechanism of action of non-thermal EMFs. [69]

He states that the different effects produced are obviously very deep concerns. They become much deeper and become existential threats when one considers that several of these effects are both cumulative and eventually irreversible. There is substantial evidence for the cumulative nature and eventual irreversibility of the neurological/neuropsychiatric effects, of the reproductive effects, the mutational DNA effects, the cardiac effects, of some but not other of the hormonal effects; any causation of ADHD and autism may add additional concerns. [69]

According to Dr. Pall, over 60% of the 90-page report, is focused on the failures of statements from the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), the telecommunications industry, the U.S. FCC and the U.S. FDA to reflect the science. He goes on to state that their statements repeatedly omit much, often all of the most important science. He says that their statements are rife not only with omissions, but also with easily demonstrable falsehoods and with false logic. [69]

The author also says that there are also possible concerns about individual industry-linked research studies. All wireless communication devices put out polarized EMFs that carry information via pulsations. Both the pulsations and the polarization make these EMFs much more biologically active. There are three other factors that also influence the production of effects. Several industry-linked studies may have used these factors, along with using very tiny numbers of individual animals in their studies, to produce studies which may have been designed to fail. [69]

A common critique of Dr. Pall is that he most relies on study reviews (as opposed to his own research) and his compilations are susceptible to confirmation bias. For example, in a peer review article Foster and Moulder point out this criticism in Dr. Pall's work on the dangers of WiFi:

> "Confirmation bias and cherry picking: Selective use of sources, colloquially known as cherry picking, is a major fallacy in public debate. Pall does not state his criteria for including or excluding studies from his Table 1 or for evaluating the studies. It appears that he selected studies reporting biological effects of some kind while disregarding negative studies. He is hypercritical of "negative" studies that we cited (which were generally superior in their methodological quality despite limitations including small size) and far less critical of the "positive" studies that we or Pall cited in our respective reviews." (From their article "Response to Pall, "Wi-Fi is an important threat to human health" Kenneth R. Foster, John E. Moulder in Environmental Research October 2018).

These are examples of works that are often cited as "proving" health concerns. The corresponding questions and critiques show the difficulty interpreting this massive body of information.

10. McKinney Recommendations

As stated in the Executive Summary, at the most summary level, the consultant recommendation to the City of McKinney is:

> As the Mayor has stated, there is a baseline established by the FCC that communities are bound by. The City of McKinney could challenge, in court, the FCC's Declaratory Ruling and subsequent statements concerning the health risks of 5G. In a complete review of the documents and studies available to us and presented to the City, it appears to us that the FCC had access to those same studies (referencing them and having them catalogued in their public comments). Thus, at this point, there is nothing new that is substantial to add to the discussion of the FCC guidelines. So, we are not attorneys, but it is our opinion that challenging the FCC's ruling in court is a low probability, high risk effort. We recommend the City focus on the ways to manage and monitor this new technology – to control the concerns as much as possible and maximize the benefits.

There are federal rules and regulations that the City of McKinney must use as guides regarding how to address the potential radiofrequency (RF) emissions health concerns of its citizens. The Federal Communications Commission (FCC) has the authority granted to it by various federal laws including the Telecommunications Act of 1996 to promulgate these rules and regulations. Many of these rules and regulations pre-empt state and local laws.

For example, the FCC is required by the National Environmental Policy Act of 1969, among other things, to evaluate the effect of emissions from FCC-regulated transmitters on the quality of the human environment. Several organizations, such as the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers, Inc. (IEEE),and the National Council on Radiation Protection and Measurements (NCRP) have issued recommendations for human exposure to RF electromagnetic fields. [55]

On August 1, 1996, with the adoption and release of Report and Order, FCC 96-623, the Commission adopted the NCRP's recommended Maximum Permissible Exposure limits for field strength and power density for the transmitters operating at frequencies of 300 kHz to 100 GHz. In addition, the Commission adopted the specific absorption rate (SAR) limits for devices operating within close proximity to the body as specified within the ANSI/IEEE C95.1-1992 guidelines. [55]

On August 8, 2019, the Federal Communications Commission Chairman Ajit Pai shared with his colleagues a proposal that would continue to ensure the health and safety of workers and consumers of wireless technology. According to the Chairman, following more than six years of public input and review, the proposal would maintain the Commission's existing radiofrequency (RF) exposure limits, which were established in 1996 with the adoption and release of Report and Order, FCC 96-623. [56]

Another example of FCC rules and regulations that will impact the City's decision making about RF emissions health concerns can be found in Section 332(c)(7)(B)(iv) of the Telecommunications Act of 1996. This section states that *no State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with FCC regulations concerning the environmental effects of such emissions*.

Many of the FCC's ruling since the passage of the Act in 1996, have referenced this section of the Act. This includes the FCC's September 27, 2018, Declaratory Ruling and Third Report and Order, titled "Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment" (The Order).

While this part of the FCC Order limits McKinney's ability to deny the sitting of a small cell facility in the public right-of-way based on the environmental effects of RF emissions, which, according to the courts, includes health effects, it opens the door for McKinney to establish ways to ensure that the RF emissions from small cell facilities are in compliance with FCC MPE limits. Since the release of the Order, local governments, like McKinney, have created various regulations to address this compliance concern, including RF emissions testing and the submission of a non-ionizing electromagnetic radiation report.

It is important to point out that some of the FCC's rules and regulations are being challenged by local governments in federal courts. The City may want to track these cases to learn about any rulings that might impact its policies regarding how to address RF emissions health concerns.

10.1 RF Emissions Testing

In an effort to ensure that wireless facilities, such as small cell facilities, are in compliance with the MPE limits specified by the FCC, it is recommended that McKinney include in its small cell policies a requirement for RF emissions testing of a wireless facility prior to unattended operations of the facility and that these tests are performed annually.

An example of the code that could be included in the City's policies is:

RF Exposure Compliance. *The wireless provider shall comply with all applicable FCC, state, and local codes, provisions, or regulations that concern public safety. WCFs must not result in human exposure to radio frequency radiation in excess of applicable safety standards specified in 47 CFR Rule 1.1307(b), or as specifically amended by the FCC. After transmitter and antenna system optimization, but prior to unattended operations of the facility, the wireless provider or its representative must conduct on-site post-installation RF emissions testing to demonstrate actual compliance with the FCC OET Bulletin 65 RF emissions safety rules for general population/uncontrolled RF exposure in all sectors. For this testing, the transmitter shall be operating at maximum operating power, and the testing shall occur outwards to a distance where the RF emissions no longer exceed the uncontrolled/general population limit. The wireless provider shall submit documentation of this testing to the City within ninety (90) days after installation of the facility. RF emissions testing shall be conducted annually.*

10.2 NIER Report

The ever-expanding use of wireless technology, such as small cell facilities (SCF), has led some people to speculate that the use of these wireless technologies is causing significant risks to human health. [55] In response to these concerns, it is recommended that McKinney provide as much regulatory oversight as allowed to it under current FCC regulations. It is our recommendation that McKinney require that a small cell facility applicant submit a site specific ***non-ionizing electromagnetic radiation*** (NIER) report for the small cell facility equipment type and model that is part of the small cell facility application.

McKinney could include in its small cell facilities code regarding a requirement to submit a site specific NIER Report. For example:

Certification of compliance with applicable FCC regulations, *which includes a site specific non-ionizing electromagnetic radiation (NIER) report for the small cell facility (SCF) equipment type and model endorsed by a radiofrequency engineer acceptable to the city, including a certification that the SCF complies with all radiation and electromagnetic standards. The report shall specify approach distances to the general public and occupational workers at the ground and antenna centerline levels. The report shall include instructions regarding powering off the equipment or contact information for a person who can power off the equipment. No significant changes to the power, location, RF emission patterns and/or emitting frequencies may be made without prior notification and approval. However, non-substantive*

changes, for example, in-kind replacements of transmitters of the same frequency, radiation patterns and power are permitted. The city retains the right to independently verify the RF patterns as installed

10.3 Legal Challenges

Shortly after the FCC's Declaratory Ruling and Third Report and Order was released in September 2018 it was challenged by a coalition of local government entities and wireless carriers, including AT&T, Verizon, and Sprint. These organizations filed appeal petitions requesting federal courts to review the FCC Order.

Local government entities filed suit against the FCC claiming that the Order is a federal overreach. For instance, the CEO and Executive Director of the U.S. Conference of Mayors stated that the Order "misapplies federal law to federalize local public property" and "needlessly introduce[s] increased risk of right-of-way and other public safety hazards." On the other hand, several wireless carriers filed suit against the FCC claiming that the FCC did not go far enough, arguing that the Order should have included a "deemed granted" provision automatically approving applications after the shot clocks expire. [26]

The United States Judicial Panel on Multidistrict Litigation designated the U.S. Court of Appeals for the Tenth Circuit as the court in which to consolidate the various petitions for review. [26]

The Tenth Circuit on January 10, 2019 turned down a motion to stay the FCC's revised rules related to the rollout of small-cell 5G technologies. The Court concluded that the cities' motion to stay the ruling did not adequately demonstrate that they would suffer irreparable harm without putting the ruling on hold. [23]

Also, on January 10, 2019, the Tenth Circuit, granted a motion to transfer the various petitions for review to the United States Court of Appeals for the Ninth Circuit. To date, these challenges remain ongoing in the Ninth Circuit Court. [23]

In a separate legal challenge, filed by the United Keetoowah Band of Cherokee Indians in Oklahoma, individually and on behalf of all other Native American Indian Tribes and Tribal Organizations, as well as the National Association of Tribal Historic Preservation Officers, the petition for review focused on a portion of the FCC Order that "exempted most small cell construction from two kinds of previously required review: historic-preservation review under the National Historic Preservation Act (NHPA) and environmental review under the National Environmental Policy Act (NEPA)." NHPA and NEPA reviews assess the effects of new construction on, among other things, sites of religious and cultural importance to federally recognized Indian Tribes. The FCC Order also effectively reduced Tribes' role in reviewing proposed construction of macrocell towers and other wireless facilities that remain subject to cultural and environmental review. The petition was filed with the United States Court of Appeals for the District of Columbia Circuit, where arguments regarding it took place on March 15, 2019. [25]

On August 9, 2019, the three-judge panel of the US Court of Appeals for the District of Columbia Circuit issued a unanimous ruling. In their ruling the judges stated *"We grant in part the petitions for review because the Order does not justify the Commission's determination that it was not in the public interest to require review of small cell deployments. In particular, the Commission failed to justify its confidence that small cell deployments pose little to no cognizable religious, cultural, or environmental risk, particularly given the vast number of proposed deployments and the reality that the Order will principally affect small cells that require new construction. The Commission accordingly did not, pursuant to its public interest authority, 47 U.S.C. § 319(d), adequately address possible harms of deregulation and benefits of environmental and historic-preservation review. The Order's deregulation of small cells is thus arbitrary and capricious. We do not reach the alternative objections to the elimination of review on small cell construction. We deny the petitions for review on the remaining grounds."* [25]

To summarize, the consolidated petitions for review for the coalition of local government entities and wireless carriers are currently under consideration in the United States Court of Appeals for the Ninth Circuit. While the US Court of Appeals for the District of Columbia Circuit has granted the petition filed on behalf of all Native American Indian Tribes and Tribal Organizations, which reinstated the requirements for a NHPA and NEPA review of small cell facilities.

It is recommended that the City track these cases as well as other cases involving FCC rules and regulations to learn about any rulings that might impact its policies regarding how to address RF emissions health concerns.

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Appendix A: Rating System for Studies and Articles

In this age of immediate information, it can be important to develop standards by which the true science of a document or study can be evaluated. Some of those criteria can depend on what type of research is being done. For the purposes of measuring 5G/Small Cell documents, the consultant and City of McKinney developed four criteria to evaluate the relevance and reliability of studies which both supported and questioned the health impacts of 5G:

- The researcher or research team
- The methods used in the research
- The replicability of study results
- Peer review of the methods and results

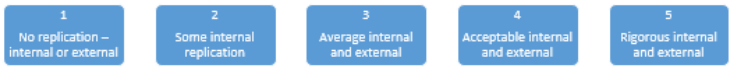
Because there are multiple criteria that can apply to the evaluation of a document, we recommend a scoring system that rates each criterion. Thus, the lower the score, the less reliable the document is and, conversely, the higher the score, the more the document could weigh in decisions.

Below is a "scorecard" that could be used for each document:

Researcher: Authoritative scientific experience and reputation in the specific field of the study

Methods: Published methods that are academically accepted for the study and results and that show the academic rigor necessary for unbiased results

Results: There are results that are replicable internally within the study and externally (preferably by other similarly credentialed researchers (to guard against bias))



Peer review: The study must be of a caliber and importance that it has peer review that validates the findings – having professional scrutiny, critique and replication

The maximum score would be twenty, which would indicate a document that is deemed important to the conversation. The lowest score is five – and, although it might be worth reading to see if there is any interesting information or ideas in it, it should not be included in the body of documents used to make decisions.

Appendix B: Literature Rating Worksheet

City of McKinney, Texas

5G Health Risks Literature Classification and Evaluation

Last Updated: June 9, 2020

Researcher Rating	Methods Rating	Results Rating	Peer Review Rating
1 = Non Authoritative 2 = Somewhat Authoritative 3 = Average Authority 4 = Respected Authority 5 = Very Authoritative	1 = Unknown or Questionable 2 = Vague Methods 3 = Average Methods 4 = Known and Acceptable Methods 5 = Clear, Rigorous and Unbiased Methods	1 = No Replication - Internal or External 2 = Some Internal Replication 3 = Average Internal and External 4 = Acceptable Internal and External 5 = Reigorous Internal and External	1 = No Credible Peer Review 2 = Some Credible Peer Review 3 = Average, Acceptable Peer Review 4 = Good, Credible Peer Review 5 = Rirorous, Credible Peer Review

Type	File Name	Article Name	Author	Publication	Date	Source	Comments	Researcher	Methods	Results	Peer Review	TOTAL
Article	https://childrenshealthdefense.org/news/robert-f-kennedy-jr-s-childrens-health-defense-submitted-historic-case-against-u-s-government-for-wireless-harms/	Robert F. Kennedy, Jr.'s Children's Health Defense Submitted Historic Case Against U.S. Government for Wireless Harms	Children's Health Defense	Cision PR Newswire	2/3/2020	Citizen	Article - not research	1	1	1	1	4
Study	https://books.google.com/books?hl=en&lr=&id=WSkEwt3AmE0C&oi=fnd&pg=PA1&dq=Vladimir+N.+Binhi+magnetobiology&ots=Jwc5RnnFo1&sig=xsrBTe5zH5dGbS16787HiQsmjaQ#v=onepage&q=Vladimir%20N.%20Binhi%20magnetobiology&f=false	Book - Magnetobiology: Underlying Physical Problems	Vladimir N. Binhi		2002	Citizen	From 2002 - new field, didn't try to explain everything (conflicting results) & allowed for tech ways to improve	4	4	2	2	12
Article	https://nasms.online/	The best tool to prevent disease is knowledge!	Dr. Carlos Ritter (EMF Knights)	NASMS.online		Citizen	Sleep medicine webpage with anectotal stories	1	1	1	1	4
Article	https://www.witnessnext.com/	5G Radiation At Your Service		NextGFree (McKinney based blog site)			Blog-not research	1	1	1	1	4
Article	https://childrenshealthdefense.org/news/5g-airgig-what-is-it-and-should-you-be-worried/	5G AirGig: What is It and Should You Be Worried?	Dafna Tachover, Director CHD's Stop 5G and Wireless Harms Project	Children's Health Defense	3/17/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org/news/seeking-justice-around-the-globe-lawsuit-to-stop-5g-filed-in-the-netherlands/	Seeking Justice Around the Globe: Lawsuit to Stop 5G Filed in the Netherlands	Susan Foster & Martine Vriens	Children's Health Defense	3/10/2020	Citizen	Member news / fundrasie	1	1	1	1	4
Article	https://childrenshealthdefense.org	"The 5G Trojan Horse" Documentary	Derrick Broze, TMU	Children's Health Defense	3/5/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	CHD's Dafna Tachover, Talks About 5G Dangers With RT America	Dafna Tachover, Director CHD's Stop 5G and Wireless Harms Project	Children's Health Defense	1/30/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Join Dafna Tachover, Esq. to Stop 5G	Dafna Tachover, Director CHD's Stop 5G and Wireless Harms Project	Children's Health Defense	1/13/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	The 5G Crisis: Awareness & Accountability	RFK, Jr.	Children's Health Defense	12/21/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Sounding the Alarm About Wireless Radiation and 5G	The Children's Health Defense Team	Children's Health Defense	12/20/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Children's Health Defense Appoints Dafna Tachover to Spearhead 5G and Wireless Radiation Efforts	Press Release	Children's Health Defense	12/17/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	5G and Wireless Technology Health Effects	Dafna Tachover, Contributing Writer	Children's Health Defense	10/15/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Resistance to 5G: Roadblock to a High Tech Future or Warning of a Serious Health Risk?	Conan Milner, Epoch Times	Children's Health Defense	10/13/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Studies, Papers, Reports and Articles on Glyphosate, GMOs, Pesticides, 5G, and Other Environmental Harms	Zen Honeycutt, Founder and Executive Director of CHD Coalition Partner, Moms Across America	Children's Health Defense	9/23/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	5G - The Global Human Experiment without Consent	Debra Greene, PhD, Guest Contributor	Children's Health Defense	7/11/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	5G: Coming To A Lamppost Near You	Guest Editorial Susan McFie, Hastings Independent Press	Children's Health Defense	7/7/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	5G: The Big Picture	Jeremy Naydler, Ph.D., Author and Philosopher	Children's Health Defense	4/25/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	The Dangers of 5G to Children's Health	The Children's Health Defense Team	Children's Health Defense	2/13/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	5G/Electromagnetic Fields / Wireless Technologies		Children's Health Defense		Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Scientists warn of potential serious health effects of 5G		Children's Health Defense	4/18/2017	Citizen	Article - not research	1	1	1	1	4

Type	File Name	Article Name	Author	Publication	Date	Source	Comments	Researcher	Methods	Results	Peer Review	TOTAL
Article	https://childrenshealthdefense.org	Meet Taylor, CHD's First EMF Child Ambassador	Dafna Tachover, Director, Stop 5G and Wireless Harms Project	Children's Health Defense	2/25/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Robert F. Kennedy, Jr.'s Children's Health Defense Submitted Historic Case Against U.S. Government for Wireless Harms		Children's Health Defense	2/3/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	CHD v the Federal Communication Commission (FCC)	Press Release	Children's Health Defense	2/3/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Six Italian Courts Have Ruled that Cell Phones Cause Brain Tumors	Martine Vriens and Dafna Tachover	Children's Health Defense	1/21/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Robert Kennedy, Jr.'s Legal Team Sues FCC over Wireless Health Guidelines		Children's Health Defense	1/21/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Healthy Lifestyles with Tom Lankering and Robert F. Kennedy Jr.	Host Tom Lankering talks w/ Robert F. Kennedy Jr.	Children's Health Defense	1/7/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Empowered Parenting Event Hawaii	Lawrence Palevsky, MD - Keynote Speaker	Children's Health Defense	1/18/2020	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	CHD Needs Your Help	Robert F. Kennedy, Jr., Chairman of Children's Health Defense	Children's Health Defense	11/20/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Legal Efforts		Children's Health Defense		Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Infant and Child Mortality in the U.S. - Nothing to Brag About	The Children's Health Defense Team	Children's Health Defense	9/26/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	More Evidence that Fluoride Lowers IQ: Will the CDC Keep Ignoring It?	The Children's Health Defense Team	Children's Health Defense	8/27/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	U.S. Births Are at Record - Low Levels - Why Aren't We Asking Why?	The Children's Health Defense Team	Children's Health Defense	7/31/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Pertussis: Vaccine Failure, Not Failure to Vaccinate	The Children's Health Defense Team	Children's Health Defense	5/31/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Written Testimony for HB 1638 - 2019 - 20 Madam Chair and Members of the Committee	Eric Ranger, 2004 United States Naval Academy Graduate, Washington (WA) resident of 10 years	Children's Health Defense	2/8/2019	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Incidence of Childhood Cancers Skyrockets: Is Modern Life Destroying the Health of Our Children?	The Children's Health Defense Team	Children's Health Defense	8/28/2018	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Contributing Writers	Robert F. Kennedy, Jr.	Children's Health Defense		Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	Directors Emeritus	Ryan Blair	Children's Health Defense		Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	The Association Between Thimerosal Exposure and Tics - The Advisory Committee on Childhood Vaccines (ACCV) Machinations	Brian S. Hooker, Ph.D., P.E.	Children's Health Defense	1/11/2018	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	FDA's 'CBER': Asleep at the Switch Again - An Ongoing Saga	Lyn Redwood, RN, MSN, Executive Director	Children's Health Defense	11/15/2017	Citizen	Article - not research	1	1	1	1	4
Article	https://childrenshealthdefense.org	CDC Whistleblower		Children's Health Defense		Citizen	Article - not research	1	1	1	1	4
Info	Electromagnetic Spectrum.png	The Electromagnetic Spectrum					General Information	3	3	1	2	9
Info	https://history.nih.gov/research/downloads/nuremberg.pdf	1947 Nrembergar Tribunal Ruling	The Nuremberg Code	Trails of War Criminals before the Nuremberg Military Tribunals under Control Council Law No. 10, Vol. 2	1949	US HHS	General Information (Human research)	4	2	2	2	10
Info	https://www.ohchr.org/en/professionalinterest/pages/crc.aspx	Convention on the Rights of the Child	General Assembly Resolution 44/25	United Nations Human Rights Office of the High Commissioner	September 1990	UN website	General guidelines for Children's rights	4	2	2	2	10
Article	https://www.healmindbody.com/how-5g-emf-radiation-impact-your-health/	How 5G & EMF Radiation Impact Your Health - The Nuremberg Code	Nick "The EMF Guy" Pineault	N & G Media Inc. 2019	2019		Article - not research	2	1	1	1	5
Article	https://whatis5g.info/	What are 5G and the Internet of Things? Includes "Nine ways 5G and the IoT will harm humans, the environment, and Earth"		5G?IoT	2018	5G?IoT website	Article - not research	1	1	1	1	4
Article	https://www.wired.com/story/worried-5g-health-effects-dont-be/	Worried About 5G's Health Effects? Don't Be	Klint Finley	Wired	12/18/2019		Article - not research	1	1	2	1	5
Info	https://www.governing.com/topics/transportation-infrastructure/govtech-5g-court-local-government-regulation.html	Rolling Back Local Government 5G Regulation Power, Court Rules in Favor of FCC	Skip Descant	Government Technology	1/15/2019	Website article	About FCC ruling	2	1	1	1	5

Type	File Name	Article Name	Author	Publication	Date	Source	Comments	Researcher	Methods	Results	Peer Review	TOTAL
Article	https://whatis5g.info/health/	Wireless The Biggest Health and Environmental Crisis of Our Times		5G?IoT	2018	5G?IoT website	Article - not research	1	1	1	1	4
Article	https://www.yahoo.com/lifestyle/dangerous-conspiracy-theory-linking-covid-111500959.html	Women's Health magazine: A Dangerous Conspiracy Theory Is Linking COVID-19 To 5G Networks	Korin Miller	Women's Health Magazing	4/11/2020		Article - not research (Covid-19 and 5G)	1	1	1	1	4
Article	https://ehtrust.org/	Several articles on environmental health					Article - not research	1	1	1	1	4
Article	http://freiburger-appell-2012.info/media/International_Doctors_Appeal_2012_Nov.pdf	International Doctors Appeal 2012		Physicians of the Competence Initiative for the Protection of Humanity, the Environment and Democracy e.V.	11/12		Not a research document - a summary appeal for certain actions and research	3	1	2	1	7
Article	https://www.researchgate.net/publication/298533689_International_Appeal_Scientists_call_for_protection_from_non-ionizing_electromagnetic_field_exposure	International Appeal: Scientists Call for Protection from Non-ionizing Electromagnetic Field Exposure	Scientists	EMFscientist.org	12/15		Not a research document - a summary appeal for certain actions and research	3	1	2	1	7
Article	https://www.mercurynews.com/2017/10/16/california-gov-jerry-brown-vetoes-bill-easing-permits-on-cell-phone-towers/	California: Gov. Jerry Brown vetoes bill easing permits on cell phone towers	Tracy Seipel	Bay Area News Group	10/16/2017		Brown's reason: city/county control	1	1	1	1	4
Article	http://media.withtank.com/b82e88dd4d.pdf	An open letter to Edmund Stoiber	Dr. Cornelia Waldmann-Selsam	www.mast-victims.org	10/7/2005		Requesting research	2	1	1	1	5
Article	http://www.ca4safertech.com/worldwide-experts-opposition-sb-649/	Letter to Governor Brown	Experts Worldwide in Opposition to SB 649		9/19/2017		Article - not research	2	1	1	1	5
Article	http://nebula.wsimg.com/afb8593d7b37e3c9abd164a7349bb792?AccessKeyId=C501C49FC54756FE9C7A&disposition=0&alloworigin=1	Martha Herber's Letter to LA School District	Martha R. Herbert, Ph.D., M.D.	Transcend	2/8/2013		Letters asking for wired instead of wireless	4	3	2	1	10
Article	https://www.counterpunch.org/2019/06/11/prime-minister-of-poland-signs-global-appeal-to-stop-5g/	Prime Minister of Poland Signs Global Appeal to Stop 5G	Julian Rose	Counterpunch	6/11/2019		Article - not research	1	1	1	1	4
Article	https://www.5gspaceappeal.org/the-appeal	International Appeal Stop 5G on Earth and in Space	Arthur Firstenberg, Appeal Administrator	International Appeal	5/24/2019		Article - not research	1	1	1	1	4
Article	https://wearetheevidence.org/	"We Are the Evidence", Those Injured by Wireless	We Are The Evidence Wireless Technology Injured Advocacy Group				Article - not research	1	1	1	1	4
Info	https://docs.fcc.gov/public/attachments/DOC-356362A1.pdf	Joint Opposition of Petitioners City of San Jose, Et Al. City of Austin, Texas, Et Al., and Intervenors National Association of Telecommunication Officers, City of New York, and Other Local Governments, to the Federal Communications Commission's Motion to Hold in Abeyance and Defer Filing of the Record	United States Court of Appeals for the Ninth Circuit	Ninth Circuit Court	3/7/2019	FCC	Court case challenging FCC Declaratory Ruling	1	1	1	1	4
Study	https://bioinitiative.org/	Bioinitiative 2012 A Rationale for Biologically-Based Exposure Standards for Low-Intensity Electromagnetic Radiation	Biolinitiative Working Group 2012	BioInitiative 2012	12/31/2012		Sections of this 2012 report (and updtaes)	3	2	3	1	9
Study	https://bioinitiative.org/	Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure (Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)		BioInitiative 2012			Sections of this 2012 report (and updtaes)	3	2	3	1	9
Study	https://bioinitiative.org/	Section 2 - Statement of the Problem	Cindy Sage, MA Sage Associates, USA	BioInitiative 2012	August 2007		Sections of this 2012 report (and updtaes)	3	2	3	1	9
Study	https://bioinitiative.org/	Section 3 - The Existing Public Exposure Standards	Cindy Sage, MA Sage Associates, USA	BioInitiative 2012	August 2007		Sections of this 2012 report (and updtaes)	3	2	3	1	9
Article	https://www.brusselstimes.com/brussels/55052/radiation-concerns-halt-brussels-5g-for-now/	Radiation Concerns Halt Brussels 5G Development, for Now		The Brussels Times	4/1/2019		Figuring out testing and proceed distribution	1	1	1	1	4
Article	https://www.telecompaper.com/news/brussels-digital-minister-calls-for-5g-test-zone--1327326	Brussels digital minister call for 5G test zone		telecompaper	2/20/2020		Staying competitive, testing, figure out proceed distribution	1	1	1	1	4
Article	https://thetruthrevolution.net/firefighters-suffer-neurological-damage-after-contact-with-5g-cell-towers/	Firefighters Suffer Neurological Damage After Contact with 5G Cell Towers		Several	2017		Article - not research	1	1	1	1	4
Article	https://leadstories.com/hoax-alert/2019/03/fake-news-firefighters-suffer-neurological-damage-with-5g-cell-towers.html	Fake News: Firefightes DID NOT Suffer Neurological Damage After Contact with 5G Cell Towers	Alan Duke	LeadStories.com and others	8/4/2018		Article - not research	1	1	1	1	4
Article	https://www.thenewstribune.com/news/local/community/gateway/article230384554.html	Gig Harbor Committee to Study Safety of 5G. Many in the City Oppose the New Technology	Jake Gregg, Contributing Writer	The News Tribune	5/14/2019		Article - not research	1	1	1	1	4
Study	https://www.ncbi.nlm.nih.gov/pubmed/28678737	Corrigendum to: Functional Brain MRI in Patients Complaining of Electrohypersensitivity After Long Term Exposure to Electromagnetic Fields	Gunnar Heuser and Sylvia A. Heuser	DE Gruyter	2017		10 patients. Had other head trauma and mold exposure. Determining EHS vulnerability.	4	3	3	2	12
Article	https://theconsciousresistance.com/louisiana-becomes-first-state-to-call-for-study-on-health-impacts-of-5g/	Louisiana Becomes First State to Call for Study on Health Impacts of 5G	Derrick Broze, TMU	Waking Times	6/7/2019		Article - not research	1	1	1	1	4
Article	https://www.fox8live.com/2020/01/23/tech-companies-begin-installing-g-poles-new-orleans/	Tech companies begin installing 5G poles in New Orleans	Rilwan Balogun	Fox New 8	1/23/2020		Article - not research	1	1	1	1	4
Article	https://medium.com/@reinettesenum/how-a-telecom-bill-is-about-to-strip-local-authority-in-california-1f88e9a9f96f	How a Telecom Bill is About to Strip Local Authority	Reinette Senum	Blog	4/14/2017		Article - not research	1	1	1	1	4
Article	https://www.nevadacityca.gov/files/documents/CityCouncilPacket10-23-19075827101819PM1329.pdf	Nevada City Council Meeting Packet	City	City Website	10/23/2019		City approved rates, reference policy they passed	1	1	1	1	4
Article	https://www.cnet.com/news/5g-is-coming-but-not-everyone-is-happy-about-it/	5G is Coming, but Not Everyone is Happy About It	Kent German	c/net	10/19/2018		Article - not research	1	1	1	1	4

Type	File Name	Article Name	Author	Publication	Date	Source	Comments	Researcher	Methods	Results	Peer Review	TOTAL
Article	https://www.counterpunch.org/2019/06/11/prime-minister-of-poland-signs-global-appeal-to-stop-5g/	Prime Minister of Poland Signs Global Appeal to Stop 5G	Julian Rose	Counterpunch	6/11/2019		Article - not research	1	1	1	1	4
Article	poland-5g/poland-to-work-with-telecoms-companies-to-develop-5g-	Poland to work with telecoms companies to develop 5G	Anna Koper	Reuters	10/28/2019		Play is doing their own deals	1	1	1	1	4
Article	https://www.modbee.com/news/article228295829.html	Ripon Parents Upset About One Cell Tower. What About 200? Here Comes 5G	Ken Carlson	www.modbee.com	2/22/2019		Article - not research	1	1	1	1	4
Article	file:///C:/Users/kdemlow/Downloads/2019-04-09%20City%20Council%20-%20Full%20Agenda-1193.pdf	Ripon City Council passes 5G/Small Cell guidelines	City	City Website	4/9/2019	The City	Council minutes - passed guidelines	1	1	1	1	4
Article	https://globalpossibilities.org/san-rafael-residents-take-pre-emptive-strike-against-5g-installations/	San Rafael Residents Pre-Emptive Strike	Group Stop5G Whynotnews	stop5g.whynotnews.eu	August 2018		Article - not research	1	1	1	1	4
Article	https://storage.googleapis.com/proudcity/sanrafaelca/uploads/2019/07/FY-2019-20-Goals-and-Strategies.pdf	San Rafael policy adopted that meets guidelines	City of San Rafael	City documents	12/2018	The City	City Plan	1	1	1	1	4
Article	https://www.pressdemocrat.com/news/8401923-181/santa-rosa-continues-pause-on	Santa Rosa Continues 'Pause' on Verizon Small-Cell Project	Kevin McCallum	The Press Democrate	6/6/2018		Article - initial response in 2018	1	1	1	1	4
Article	https://www.pressdemocrat.com/news/10440922-181/santa-rosa-to-reconsider-rollout	Santa Rosa to reconsider rollout of small-cell wireless technology	WILL SCHMITT	The Press Democrate	12/9/2019		Article-coordination of rollout in 2019	1	1	1	1	4
Article	https://www.kxan.com/news/texas-cities-fear-loss-of-millions-as-5g-becomes-reality/amp/	Texas Cities Fear Loss of Millions as 5G Becomes Reality	Phil Prazan	kxan.com	5/16/2017		Article-fee caps	1	1	1	1	4
Article	https://www.citylab.com/life/2019/05/fast-internet-wireless-service-provider-wifi-5g-boxes-fcc/587269/	Communities Are Fighting 5G, Permit by Permit	Sarah Holder	City Lab	5/15/2019		Mainly about awsthetics - article, not research	1	1	1	1	4
Article	https://www.researchgate.net/publication/335801195_5G_Wireless_Communication_and_Health_Effects-A_Pragmatic_Review_Based_on_Available_Studies_Regarding_6_to_100_GHz	5G Wireless Communication and Health Effects—A Pragmatic Review Based on Available Studies Regarding 6 to 100 GHz	Myrtill Simko and Mats-Olof Mattsson	Study	9/1/2019		Analysis of existing studies - summary on P. 16	3	3	3	1	10
Info	https://ecfsapi.fcc.gov/file/1410690001.pdf	Berkshire-Litchfield Environmental Council Letter to FCC	The Berkshire-Litchfield Environmental Council (BLEC)	FCC	7/12/2018		Letter to FCC against Delaratory Ruling	1	1	1	1	4
Info	http://wireless.fcc.gov/fact1.pdf	FCC Fact Sheet - New National Wireless Tower Siting Policies	Wireless Telecommunications Bureau	FCC	4/23/1996		FCC 5G background information	1	1	1	1	4
Info	https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf	FCC - Questions and Answers About Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields	OET Bulletin 56 Forth Edition	FCC Office of Engineering & Technology	August 1999		FCC 5G background information	1	1	1	1	4
Info	https://www.fcc.gov/5G	The FCC's 5G Fast Plan		FCC			FCC Document					
Info	https://docs.fcc.gov/public/attachments/DOC-354283A5.pdf	Dissenting Statement of Commissioner Jessica Rosenworcel RE: Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment, WT Docket No. 17-79	Jessica Rosenworcel, Commissioner				Supporst 5G - Dissent - focuses on ways to improve rule - mainly states and cities	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-acts-speed-deployment-next-gen-wireless-infrastructure/clyburn-statement	Dissenting Statement of Commissioner Mignon. L Clyburn RE: Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment, WT Docket No. 17-79	Mignon. L Clyburn, Commissioner				Supports 5G - dissent about the process	1	1	1	1	4
Info	https://www.federalregister.gov/documents/2018/10/15/2018-22234/accelerating-wireless-and-wireline-broadband-deployment-by-removing-barriers-to-infrastructure	Federal Communications Commission - Accelerating Wireline and Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment		FCC	8/2/2018		FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-facilitates-wireless-infrastructure-deployment-5g	FCC Acts to Facilitate Deployment of 5G and Wireless Broadband Infrastructure		FCC	3/22/2018		FCC background information	1	1	1	1	4
Info	https://docs.fcc.gov/public/attachments/FCC-18-133A3.pdf	Concurring Statement of Commiissionoer Michael O'Rielly RE: Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment, WT Docket No. 17-79	Michael O'Rielly, Commissioner	FCC			FCC background information	1	1	1	1	4
Info	https://docs.fcc.gov/public/attachments/FCC-18-133A4.pdf	Concurring Statement of Commiissionoer Brendan Carr RE: Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment, WT Docket No. 17-79	Brendan Carr, Commissioner	FCC			FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/chairman-pais-letters-congress	Letters and Responses Incl. New Jersey Congressman's Letter to Pai, Chairman of FCC	Andy Kim	Congress of the United States House of Representatives	3/28/2019		FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-facilitates-wireless-infrastructure-deployment-5g	Federal Communications Commission - Accelerating Wireline and Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment - website for comments		FCC	9/26/2018		FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies	FCC Takes Steps to Open Spectrum Horizons for New Services and Technologies	Neil Grace	FCC News	3/15/2019		FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies	Statement of Commissioner Michael O'Rielly RE: Spectrum Horizons, ET Docket No. 18-21; James Edwin Whedbee Petition for Rulemaking to Allow Unlicensed Operation in the 95-1,000 GHz Band, RM-11795 (proceeding terminated).	Michael O'Rielly, Commissioner				FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies	Statement of Chairman Ajit Pai RE: Spectrum Horizons, ET Docket No. 18-21; James Edwin WhedbeePetition for Rulemaking to Allow Unlicensed Operation in the 95-1, 000 GHz Band, RM-11795 (proceeding terminated).	Ajit Pai, Chairman				FCC background information	1	1	1	1	4

Type	File Name	Article Name	Author	Publication	Date	Source	Comments	Researcher	Methods	Results	Peer Review	TOTAL
Info	https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies	Statement of Commissioner Jessica Rosenworcel RE: Spectrum Horizons, ET Docket No. 18-21; James Edwin Whedbee Petition for Rulemaking to Allow Unlicensed Operation in the 95-1, 000 GHz Band, RM-11795 (proceeding terminated).	Jessica Rosenworcel, Commissioner				FCC background information	1	1	1	1	4
Info	https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies	Federal Communications Commission - Spectrum Horizons James Edwin Whedbee Petition for Rulemaking to Allow Unlicesed Operation in the 95-1, 000 GHz Band		FCC	3/15/2019		FCC background information	1	1	1	1	4
Info	Susan Clarke's Letter to FCC on Spectrum Frontiers.pdf	Stop 5G Harm to All Living Beings: The Science is Conclusive	Susan Clarke		7/14/2016		Not available					
Info	https://capitol.texas.gov/tlodocs/85R/billtext/pdf/SB01004F.pdf	Texas Senate Bill 1004 Relating to the Deployment of Network Nodes in Public Right-of-Way; Authorizing Fees		LegiScan Bringing People to the Process	9/1/2017		State law	1	1	1	1	4
Study	https://ieeexplore.ieee.org/document/1133316	Absorption of Millimeter Waves by Human Beings and Its Biological Implications	OM P. Gandhi, Fellow, IEEE and Abbas Riazi	IEEE Transactions on Microwave Theory and Techniques, Vol. MTT 34, No. 2	February 1986		1986 - followed up by other IEEE studies in this list	2	2	1	1	6
Info	https://apps.dtic.mil/dtic/tr/fulltext/u2/750271.pdf	Naval Medical Research Institute Bibliography of Reported Biological Phenomena ('Effects') and Clinical Manifestations Attributed	Zorach R. Glaser, Ph.D.	Naval Medical Research Institute	10/4/1971		1972 Bilbliography	1	1	1	1	4
Study	https://ntp.niehs.nih.gov/whatwestudy/topics/cellphones/index.html	Report of Partial Findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley SD Rats (Whole Body Exposures)		NTP	5/19/2016		Looked at cell phone use. There is a note about 5G and how the emissions differ from cell phones	4	4	2	3	13
Study	https://ntp.niehs.nih.gov/whatwestudy/topics/cellphones/index.html	NTP study - FAQ's - how this translates to humans		NTP	5/19/2016		2% of rats, may not relate to humans and constant cell phone exposure over whole body	4	1	1	1	7
Article	https://kompetenzinitiative.com/wp-content/uploads/2019/08/KI_Brochure-6_K_Hecht_web.pdf	Health Implications of Long-Term Exposure to Electrosmog	Karl Hecht	kompetenzinitiative.com	August 2016		Article	2	1	1	1	5
Article	https://einarflydal.files.wordpress.com/2018/04/pall-to-eu-on-5g-harm-march-2018.pdf	5G: Great Risk for EU, U.S. and International Health! Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them	Martin L. Pall, PhD, Professor Emeritus of Biochemistry and Basic Medical Sciences	Washington State University	5/17/2018		No research - compilatoin	3	1	1	1	6
Article	https://betweenrockandhardplace.wordpress.com/2019/06/28/cautionary-words-on-martin-palls-claim-that-vgcc-is-the-sole-target-and-mechanism-for-all-emf-effects/	Cautionary words on Martin Pall's claim that VGCC is the sole target and mechanism for all EMF effects		BRHP	6/28/2019		Article - not research	1	1	1	1	4
Article	https://ieeexplore.ieee.org/document/8732419	Wireless Communication and Applications Above 100 GHz: Opportunities and Challenges for 6G and Beyond	Theodore (Ted) S. Rappaport	NYU Wireless	3/15/2019		Article - not research	2	1	1	1	5
Article	https://www.nytimes.com/2019/07/16/science/5g-cellphones-wireless-cancer.html	The 5G Health Hazard That Isn't	William J. Broad	The New York Times	7/16/2019		Article - not research	1	1	1	1	4
Article	https://zero5g.com/wp-content/uploads/2018/07/5-G-wireless-telecommunications-expansion-Public-health-and-environmental-implications-Cindy-L.-russell.pdf	5 G Wireless Telecommunications Expansion: Public Health and Environmental Implications	Cindy L. Russell	Elsevier Environmental Research	10/3/2017		Article - not research	1	1	1	1	4
Article	https://mdsafetech.org/problems/5g/	Citation of Dr. Cindy Russell potential bias (as a scientist) - the group she works for	Cindy L. Russell employer website	Website	Current		Article - not research	1	1	1	1	4
Article	https://www.bbc.com/news/world-europe-48616174	Does 5G Pose health Risks (evidence doesn't show it does)	Reality Check Team	BBC News	7/15/2019		Article - not research	1	1	1	1	4
Article	https://ehs.cornell.edu/resources/rf-and-microwave-safety-program	RF and Microwave Safety Program		Cornell University	Current		Safety Program	1	1	1	1	4
Article	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4629874/	Safe for Generations to Come (studies don't show health risk)	Ting Wu, Theodore S. Rappaport & Christopher M. Collins	IEEE Microw Mag.	2/5/2015		Article - with some research	2	2	2	1	7
Study	https://www.researchgate.net/publication/273957446_The_Human_Body_and_Millimeter-Wave_Wireless_Communication_Systems_Interactions_and_Implications	The Human body and Millimeter-Wave Wireless Communication Systems: Interactions and Implications	Ting Wu, Theodore S. Rappaport & Christopher M. Collins	NYU Wireless	June 2015		Mathmatecal way to evaluate skin heat	2	2	2	1	7
Article	https://www.ncbi.nlm.nih.gov/pubmed/29402696	Towards 5G Communication Systems: Are There Health Implications?	Agostino Di Ciaula	International Journal of Hygiene and Environmental Health	1/20/2018		Reviewed studies	2	1	1	1	5
Info	https://dallascityhall.com/departments/publicworks/DCH%20Documents/Public%20Works/pdf/Small_Cell%20Design_Manual.pdf	City of Dallas Design Manual	City of Dallas	Promulgated Pursuant to Dallas City Code Chapter 43 Article VIII	7/2/2018		Code Example	1	1	1	1	4
Info	https://library.municode.com/tx/houston/codes/code_of_ordinances?nodeId=COOR_CH42SUDEPL_ARTIIIPLST_DIV5EA	Article XXL - Facilities in the Public Right-of-Way	City of Houston	Sec. 40-481. - Definitions	8/30/2017		Code Example	1	1	1	1	4
Info	https://statutes.capitol.texas.gov/Docs/LG/htm/LG.284.htm	Design Manual for the Installation of Network Nodes and Node Support Poles pursuant to Texas Local. Government Code, Chapter 284.	State of TX				Code Example	1	1	1	1	4