BOARD of ADJUSTMENT

Joe Bazzoli
Commission Chair

boa@ci.moscow.id.us

~Agenda~

Leah Carlson
Staff Liaison

208.883.7095

https://www.ci.moscow.id.us/354/Board-of-Adjustment

Tuesday **November 13th, 2018**	**7:00 PM**	**Council Chambers** **206 E 3rd Street**

Call to order

1. **Approval of Minutes from October 2nd, 2018**
   ACTION: Approve minutes as presented; approve minutes with amendments; or provide staff further direction.

2. **Public Hearing: Proposal for Conditional Use Permit for a Wireless Communication Facility located at 1400 E. 7th Street – LUP2018-0023**
   Conditional Use Permit application for a Wireless Communication Facility located at 1400 E. 7th Street. The applicant is proposing to construct an 80' Wireless Communication Facility to accommodate three carriers within a fully enclosed 800 sf lease area that will be a stealth style tower intended to resemble a tree located at 1400 E. 7th Street.
   ACTION: Conduct the public hearing for the proposed Conditional Use Permit and upon consideration of any testimony presented, approve Conditional Use Permit without conditions and direct Staff to prepare a reasoned statement of relevant criteria and standards; or approve the Conditional Use Permit with conditions as recommended by staff and direct Staff to prepare a reasoned statement of relevant criteria and standards; or deny the Conditional Use Permit and direct Staff to prepare a reasoned statement of relevant criteria and standards; or take other action as deemed appropriate.

3. **Board Communications**

4. **Other Business**

Adjournment

NOTICE: Moscow City Council Commission meetings can be televised, videotaped and/or recorded. Individuals attending the meeting who require special assistance to accommodate physical, hearing, or other impairments, please contact the City Clerk, at (208) 883-7015 or TDD 883-7019, as soon as possible so that arrangements may be made.

BOARD of ADJUSTMENT

Joe Bazzoli
Commission Chair

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Leah Carlson
Staff Liaison

208.883.7095

~Meeting Minutes~
October 11, 2018

http://www.ci.moscow.id.us/354/Board-of-Adjustment

The meeting was called to order at 5:31 PM

MEMBERS PRESENT: Mark Monson, Vice Chair; Annette Bieghler, Steve Bush

MEMBERS ABSENT: Joe Bazzoli, Marshall Comstock, Laurene Sorenson, Tim Thomson

STAFF IN ATTENDANCE: Leah Carlson, Anne Peterson

1. Approval of Minutes from October 2, 2018.

Bieghler moved approval of the minutes as presented.

RESULT:	**ACCEPTED [UNANIMOUS]**
MOVER:	Bieghler
SECONDER:	Bush

Motion carried by acclamation.

2. Approval of Relevant Criteria and Standards for Property Located at 212 Rodeo Drive – LUP2018-0028

Bieghler moved approval of the Relevant Criteria and Standards as presented.

RESULT:	**APPROVED [UNANIMOUS]**
MOVER:	Bieghler
SECONDER:	Bush

Motion carried by acclamation.

3. Board Communications

None.

Adjournment

The meeting adjourned at 5:34pm.

___________________________ ________________

Mark Monson, Vice Chair Date

NOTICE OF PUBLIC HEARING

Proposal for Conditional Use Permit at 1400 E. Seventh Street
Permit Application LUP2018-0023

A public hearing at which you may be present and speak will be conducted before the Board of Adjustment of the City of Moscow at which time the following proposals will be considered:

> Conditional Use Permit application for a proposed 80' Wireless Communication Facility (WCF). The WCF will accommodate three carriers within a fully enclosed 800 sf lease area and will be a stealth style tower intended to resemble a tree.

HEARING DATE: Tuesday, November 13th, 2018

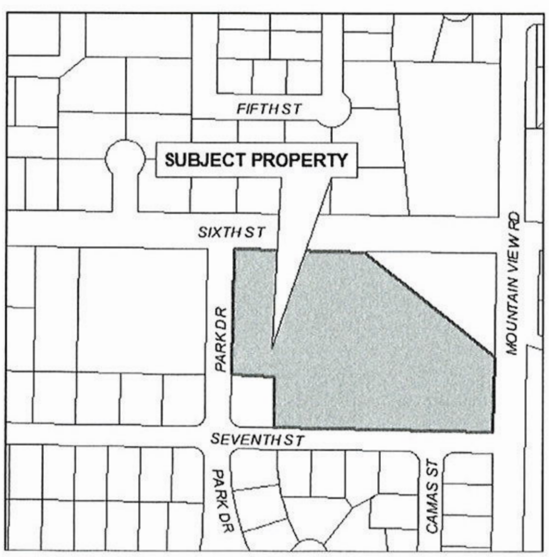
HEARING LOCATION: Council Chambers on the Second Floor of Moscow City Hall
206 East Third Street, Moscow, Idaho

MEETING TIME: 7:00pm

Note: Meeting start time is not necessarily indicative of hearing start time for the proposal advertised in this notice. Multiple hearings and/or agenda items may make it difficult to determine hearing start time, which could occur late in the meeting.

The file containing information on this matter is available for public review at the Community Development Department located in the Paul Mann Building at 221 East Second Street, Moscow, Idaho. Call 883-7035 for a meeting agenda and further information about the matter.

Verbal testimony at the hearing is generally limited to three (3) minutes time. Minor amounts of written materials (less than two (2) pages) may be submitted to the hearing body at any time prior to the close of comments, as determined by the hearing body. More in-depth written materials require at least five (5) calendar days for review prior to the hearing. You may obtain further information about the public hearing process and procedures on the City's Website at: http://id-moscow.civicplus.com/593/Public-Hearing-Notices.



Laurie Hopkins, Moscow City Clerk

Anne Peterson

Anne Peterson, Deputy City Clerk

Publish: Saturday, September 8th, 2018

COMMUNITY DEVELOPMENT DEPARTMENT
STAFF REPORT

HEARING DATE: Tuesday, November 13th, 2018

GENERAL INFORMATION

Hearing Body: Board of Adjustment

Subject: 1400 E 7th Street – A Conditional Use Permit application to allow the construction of a wireless telecommunications tower/facility within the Neighborhood Business (NB) Zoning District.

Attachments:
A. Public Hearing Notice – published in the Moscow-Pullman Daily News on Saturday, September 8th, 2018

B. Conditional Use Permit Application

C. Project description

D. Site Plan

E. Elevation Plans

F. Antenna Details

G. Relevant Criteria and Standards Worksheet

Prepared by: Leah Carlson, Planner I

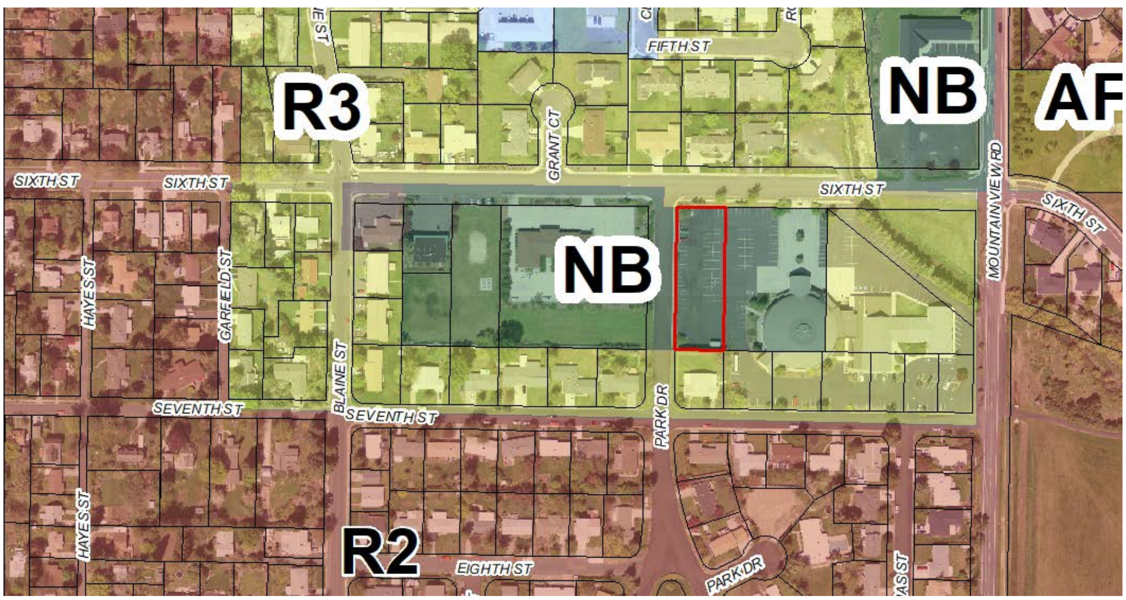
STAFF REVIEW

Proposal: The applicant, ProLand LLC, is requesting a Conditional Use Permit (CUP) to allow the construction of an 80' Wireless Communication Facility (WCF) located at 1400 East 7th Street. The proposed facility would be located on the property of the Church of the Nazarene and would accommodate three carriers within a fully enclosed 800 square foot lease area. The facility would be a stealth-style monopine tower intended to resemble a tree. The subject property is located within the Neighborhood Business Zoning District where Antenna Towers are only permitted with a Conditional Use Permit.

Site and Area Land Use: The subject property is an approximately 231,678 sq. ft. in size. Despite being split up into eleven (11) parcels, the site itself, which occupies an entire city block, is completely owned by the Church of the Nazarene.

The 800 square foot subject property, 20’ x 40’ in size, sits on the southwest corner of the block. Adjacent land uses include residential properties to the north and south of the site, while the Church of the Nazarene lies to the east and Short’s Funeral Home to the west.

Aerial



Zoning Map

Zoning: The subject property is located within the Neighborhood Business (NB) Zoning District. Adjacent properties to the east and west are also within the NB Zoning District. Adjacent properties to the north and south are within the Medium-Density Residential (R-3) Zoning District. Section 4-3-5(4)(b) of Moscow City Code establishes that the installation of antenna towers in excess of thirty five (35) feet in height requires the issuance of a Conditional Use Permit (CUP). The proposed tower is eighty (80) feet in height. The Zoning Code also requires the following development standards:

1. ***Setbacks: No antenna towers that exceed sixty feet (60') in height shall be located within 500 feet from the State Highway 8 and 95 rights of way.***
   The proposed tower, located within the Neighborhood Business (NB) Zoning District, would be located approximately 3,480 feet north of the State Highway 8 right-of-way.

2. ***Security: Every telecommunications facility shall be protected from unauthorized access by appropriate security measures.***
   The proposed site is enclosed by a six foot (6') high fence and the ancillary facilities are fully enclosed within proposed site.

3. ***Lighting: Every antenna and antenna tower shall not be lighted unless required by the Federal Aviation Administration or other state or federal agency having such authority, and such lighting shall not be more than the minimum required by such agency. Antenna tower site security lighting shall be designed and installed so as not to glare or trespass onto neighboring lands or roads, and shall be provided only as approved by the Zoning Administrator or Board of Adjustment.***
   The submitted plans do not show any lighting on the new antenna tower.

4. ***Noise Reduction: In any SR, R-1, R-2, R-3, or R-4 Zoning District, and in all other Zoning Districts when the adjacent property is zoned SR, R-1, R-2, R-3, or R-4 or occupied by a dwelling, hospital, school, library, or nursing home or similar use, noise generating equipment shall be sound-buffered by means of baffling, barriers, or other suitable means to reduce sound level measured at the property line to forty five decibels (45 dB).***
   The subject property is located adjacent to Medium Density Residential Zoning District (R-3). Construction will create some noise, but the noise is temporary and will last approximately one month. There is a proposed diesel generator that is double contained and will be used in the event of a power outage. The generator will run once a week for approximately one hour for maintenance. If noise becomes a problem, then a decibel reading will be taken at the property line and Staff will take corrective action if the reading is too high.

5. ***Signage: The placement of signage on antenna towers is prohibited, except for the placement of security signage, which shall not exceed six (6) square feet on each side of the antenna tower and shall not be located higher than six feet (6') above grade. Additionally, one security sign not to exceed one (1) square foot may be provided on each fifty feet (50') of wall or fence enclosing the facility.***
   There is no proposed signage on the antenna tower.

6. ***Antenna towers shall be separated from the property line of any adjacent property zoned SR, R-1, R-2, R-3, or R-4 at least a distance equal to the height of the antenna tower, and shall be separated from all other adjacent property lines at least a distance equal to one-half (1/2) the height of the antenna tower.***
   The height of the proposed tower is approximately eighty feet (80’), therefore the tower must be separated at least forty feet (40’) from adjacent properties zoned SR, R-1, R-2, R-3, or R-4. The only adjacent property outside of the Church of the Nazarene campus that is Zoned R-3 is located on the corner of Park Drive and Seventh Street. This property is approximately 100’ from the proposed site.

7. ***Aesthetic Considerations: Antennas and cables shall be of a color identical to or closely compatible with that of the structure to which they are attached. Telecommunications facilities shall be surrounded by a minimum 6 foot tall wall or solid or slatted fence.***
   The tower is proposed to be a monopine design that is meant to improve aesthetic compatibility within the surrounding area. Current plans show a six foot (6’) cedar fence surrounding the site. Staff recommends that the Board require the fence design to be changed to a decorative wall constructed of brick, stone, or textured concrete that is at least six feet (6’) in height, as is required per Section 4-3-5 (G)(III) of Moscow City Code. Staff also recommends that the Board require a Type A Landscape Buffer Yard on the western side of the proposed site that will shield the site from Park Drive, as is required per Section 4-3-5 (G)(III) of Moscow City Code. All other development standards under this section of the Code shall be met as part of the permitting process.

8. ***Any new or relocated antenna tower eighty feet (80’) or greater in height shall be designed and constructed to accommodate at least two (2) additional users unless a larger number of users needs to be accommodated as indicated by the response to the Notice provisions herein. As an alternative, a smaller tower may be approved if the tower owner commits in writing to “swap out” to a larger tower when needed to allow co-location space for additional service providers. A notarized written commitment to shared use as specified in subsection F.1 above shall be submitted to the Zoning Administrator by the antenna tower applicant. The failure of the owner of an antenna tower built with a capacity for shared use to negotiate in good faith with potential users shall be unlawful and shall be a violation of this Ordinance and, among other remedies of the City, shall be just cause for the withholding of the issuance of future antenna tower permits to such an owner as well as revocation of antenna tower permits for any antenna tower on which co-location is refused or unreasonably hindered.***
   The proposed facility is designed to accommodate three (3) carriers. Staff recommends that the applicant enter into a co-location agreement as required by City Code, subject to City Staff approval.

Comprehensive Plan: Chapter 2, Community Character and Land Use, designates the subject property as Public and Semi-Public. Public and Semi-Public designated areas provide for government buildings and properties, as well as semi-public or institutional uses such as churches, schools, and the hospital.

Chapter 3, Community Mobility, identifies Seventh Street and Park Drive both as local neighborhood streets.

A goal of Chapter 6 is to, "Enhance and strengthen the regional economy utilizing the strengths and assets of the region."

Streets and Access: The subject property is surrounded by the property of the Church of the Nazarene. The closest access point to the WCF will be from Park Drive, just north of the house located on the southwest corner of the property.

Input from Other Departments/Entities: No comments from any Departments/Entities

RELEVANT CRITERIA AND STANDARDS

1. **The proposed use (is/is not) a conditionally permitted use within the Zoning District.**

2. **The character of the proposed use (will/will not) be in harmony with the neighborhood and surrounding land uses.**

3. **The proposed use as approved, or as approved with conditions, (will/will not) generate nuisances that would be injurious or detrimental to the adjoining properties or the neighborhood (including, but not limited to, noise, dust, glare, vibrations, odors, and the like).**

4. **The location, design, and size of the proposed use (will/will not) be adequately served by existing streets, public facilities and services.**

5. **The proposed use (will/will not) endanger the public health or safety if located where proposed?**

6. **Proposed use (meets/does not meet) all applicable development standards of the Zoning Code.**

7. **The propose use (will/will not) be in conflict with the Comprehensive Plan.**

In addition to Relevant Criteria and Standards, four additional criteria are required to be fulfilled before the issuance of a Conditional Use Permit for an antenna tower. These criteria include:

1. **No existing antenna towers or antenna support structures within the necessary geographic area for the applicant's antenna tower meet the applicant's requirements considering: a) height, b) structural integrity, or c) that there are other prohibitive conditions that render existing antenna towers or antenna support structure within the applicant's required geographic area unsuitable.**

2. **That the design of the antenna tower, including the antennas and ancillary facilities, minimizes visual impact and other complies with provisions and intent of this Section.**

3. **That the proposed antenna tower location minimizes the number and/or size of antenna towers or antenna support structure that will be required in the area.**

4. **That the applicant has not previously failed to take advantage of reasonably available shared use opportunities or procedures provided by this Ordinance or otherwise.**

RECOMMENDATION

Staff recommends **approval** for the application for a Conditional Use Permit at 1400 E 7th Street for a proposed 80' Wireless Communication Facility (WCF) with three conditions:

1. The applicant shall construct a six-foot (6') high decorative wall constructed of brick, stone, or textured concrete block surrounding the telecommunications facility, as is required per MCC 4-3-5 (G)(iii).

2. The applicant shall implement a 12' wide Type A Buffer yard on the western side of the proposed facility, as is required per MCC 4-3-5 (G)(iii).

3. The applicant shall enter into a co-location agreement as required by City Code, subject to City staff approval.

Board shall direct staff to prepare Relevant Standards and Criteria to be reviewed at an upcoming meeting.

CITY OF MOSCOW
COMMUNITY DEVELOPMENT
Ph: 208-883-7035
Fax: 208-883-7033
apeterson@ci.moscow.id.us

For City Use Only			
	Date Received	7-30-18	
Dept	Fee Type	Fees	Paid
CD	Application Fee	$410	7-30-18
	Receipt Number	LUP 2018-0023	

APPLICATION FOR CONDITIONAL OR SPECIAL USE PERMIT

(Please type or print plainly with blue ink.)

GENERAL INFORMATION

1. **Applicant**

Name: **Lend Lease** Telephone: **509-939-6202**

ProLand, LLC
Attn. Derek Budig
PO Box 8436
Spokane WA 99203

(Office address)

Relationship to affected property (please check one):

Owner ☐ Purchaser ☐ **Lessee** ■ Other ☐ (explain below)

2. **Owner of Affected Property** (if other than applicant)

Name: Church of Nazarene Telephone: 509.939.6202

1400 7TH Street, Moscow, ID 83823

(home address)

3. **Location of Affected Property**: 1400E 7TH Street

Legal Description: See legal Description located on Sheet T-1 of the zoning drawings.

If described by Metes and Bounds, please attach deed on a separate sheet.

4. **Proposal**: The applicant proposes the following use and/or construction for the above-described property:

LendLease proposed a new 80' Wireless Communication Facility (WCF) that will be stealth to look like a tree. The ground equipment will be fully enclosed within a 800 square foot lease area with a 6' high cedar fence that will be fully screened bend in with the surrounding environment. The WCF will be designed to accommodate 3 carriers. See zoning drawings for additional information.

The proposed activities and use shall be shown on an attached site plan drawn to a standard engineer's or architect's scale. The site plan shall show, label and dimension all property lines and easements, existing and proposed buildings, parking lot and driveway(s), fencing and landscaping. A site topography map shall be provided when appropriate.

Received 7/30/18

5. **Authorization**: Section 12-4 of the Moscow Zoning Ordinance authorizes the proposed use, subject to a Conditional Use Permit.

6. **Operating Characteristics**: Detail the operating characteristics of the proposed use. In other words, provide specific information which describes and defines how the proposed use will be conducted and what will be involved in the day to day operations of the proposed use. Applicable information may include hours of operation, number of people (employees, customers, students, etc.) involved, traffic and/or delivery information, services provided, equipment or machinery which may be involved, or any other information which helps describe and define the proposed use and impacts which it may have.
The proposed WCF is an un-maned structure. A technician may visit the facility periodically for maintenance post construction (estimate 6-8 times per year). The WCF will provide needed wireless cellular coverage and service to the residential, commercial, motorists, pedestrians and public surrounding uses. The WCF will provide coverage for essential E911 services. All associated equipment will be located within the proposed 800 square foot leased area that will be fenced and screened from the public view.

7. *Before the Moscow Board of Adjustment may issue a Conditional Use Permit, the Board must first make findings of compliance with the following seven relevant criteria and standards. Please indicate in the spaces provided below what you believe to be justification showing compliance with each of the relevant criteria and standards.*

Criteria #1. THE PROPOSED USE IS A CONDITIONALLY OR SPECIALLY PERMITTED USE WITHIN THE ZONING DISTRICT.
Justification and compliance with criteria #1: In Section 2-7 of the Zoning Code the proposed WCF is located within the R-3 zoning district and is permitted as a Condition Use Permit.

Criteria #2. THE CHARACTER OF THE PROPOSED USE WILL BE IN HARMONY WITH THE NEIGHBORHOOD AND SURROUNDING LAND USES.
Justification and compliance with criteria #2: The character of the proposed use will be in harmony with the neighboring and surrounding uses. The WCF is proposed to be stealth as a tree to blend in with the existing natural environment. All ground equipment will be fully screened with existing landscaping and a new cedar fence. There are no residential uses that abut the parcel. The WCF is located on a city block owned entirely by the Church of Nazarene. The surrounding uses are mixed use with a dentist office to the north, baseball field to the east and multiple commercial uses to the west. The WCF is necessary to support the existing and future growth of the surrounding commercial and residential uses.

Criteria #3. THE PROPOSED USE AS APPROVED, OR AS APPROVED WITH CONDITIONS, WILL NOT GENERATE NUISANCES THAT WOULD BE INJURIOUS OR DETRIMENTAL TO ADJOINING PROPERTIES OR THE NEIGHBORHOOD (INCLUDING BUT NOT LIMITED TO NOISE, DUST, GLARE, VIBRATIONS, ODORS AND THE LIKE).
Justification and compliance with criteria #3: The proposed WCF is un-maned. A technician will visit the site once a month for maintenance. Construction will create some noise, but is temporary and will last approximately one month. There is a proposed diesel generator that is double contained and will be used in the event of a power outage. The generator will run once a week for approximately one hour for maintenance. There are no direct adjacent residential uses that will be affected any nuisance that that the WCF may cause.

Received 7/30/18

Criteria #4. THE LOCATION, DESIGN, AND SIZE OF THE PROPOSED USE WILL BE ADEQUATELY SERVED BY EXISTING STREETS, PUBLIC FACILITIES AND SERVICES.
Justification and compliance with criteria #4: The proposed WCF is located on a parcel that has access on all four sides of the property line. A new access is proposed off Park Drive. Public services proposed are power and telephone and are existing.

Criteria #5. THE PROPOSED USE WILL NOT ENDANGER THE PUBLIC HEALTH OR SAFETY IF LOCATED WHERE PROPOSED.
Justification and compliance with criteria #5: There are no known health risks associated with this technology, as regulated by the Federal Government/FCC. Further, the proposed site meets all applicable ANSI/IEEE C95.1-1992 exposure levels, as adopted by the FCC requirements and the equipment we use meets the following safety/regulatory standards: FCC Part 15 & Part 24, UL 1950, 3rd Edition, CSA C22.2 #234, UL 50-Type 3R, Transmit Spurious Emissions: IS-95B, FCC Part 15 & Part 24.

6. THE PROPOSED USE MEETS ALL APPLICABLE DEVELOPMENT STANDARDS OF THE ZONING CODE.
Justification and compliance with criteria #6: The proposed WCF is in compliance with Section 12-4 of the Zoning Code.

Criteria #7. THE PROPOSED USE WILL NOT BE IN CONFLICT WITH THE COMPREHENSIVE PLAN.
Justification and compliance with criteria #7: The proposed use will not be in conflict with the Comprehensive Plan. The WCF will support emergency services and provided needed service, where a significant gap in coverage exists, to the adjoining landuses and residences while meeting current and future community desires and needs. The WCF will help support sustainable growth that will boost, enhance and promote the local economy. The zoning district is Medium Density Residential and a new WCF is supported by a Conditional Use Permit. The proposed WCF will be stealth, as a monopine type tree structure and this will preserve the character of the community and blend in harmoniously with the natural environment.

Received 7/30/18

CONDITIONS OF APPROVAL

The Board of Adjustment may impose conditions including, but not limited to, those (1) minimizing adverse impact on other development; (2) controlling the sequence and timing of development; (3) controlling the duration of development; (4) assuring that development is maintained properly; (5) designating the exact location and nature of development; (6) requiring the provision for onsite or offsite public facilities or services; (7) requiring more restrictive standards than those generally required in an ordinance; and/or (8) requiring mitigation of effects of the proposed development upon service delivery by any political subdivision, including school districts, providing services within the planning jurisdiction.

COMPLIANCE

1. In the event of failure to comply with the plans proof by the Board of Adjustment, or with any conditions imposed upon the Conditional Use Permit, the permit shall be immediately revoked and shall be automatically null and void.
2. Where plans are submitted and approved as part of the application for a Conditional Use Permit, modifications of the original plans may be required by the Board as a condition of approval.
3. Where plans approved by the Board of Adjustment are modified following such approval, such plan modifications must be submitted to and determined by City staff to be in substantial conformance with the plans approved by the Board. If plan modifications are not in substantial conformance, the plan modifications must be resubmitted to the Board for an additional public hearing as an amendment to the Conditional Use Permit application.

Received 7/30/18

REVOCATIONS

If a Building Permit and/or Certificate of Occupancy pertaining to the Conditional Use Permit is not obtained for the subject property of the Conditional Use Permit within one year from the date of the Board of Adjustment's final decision, the Conditional Use Permit shall be immediately revoked and shall be automatically null and void. If the use and/or occupancy for which the Conditional Use Permit is approved ceases for a period of twelve consecutive months, unless otherwise provided for in the Conditional Use Permit, then the Conditional Use Permit shall be immediately revoked and shall be automatically null and void.

Application Submittal:

This application must be completed and submitted with the below described items to the Moscow Community Development Director at least twenty-one days prior to the hearing at which the application is to be considered by the Board or the application will not be processed.

The following items must be submitted with this application before it will be processed:
1. Application Fee
2. Site Plan, drawn to scale
3. Floor Plans, drawn to scale
4. Elevation Drawings, drawn to scale (for new construction only)

Derek Budig | 7/18/18

Applicant's Signature | Date

Per section 4. Attorney in Fact and Cooperation, this has been granted by Owner, per the attached Ground Land Lease Agreement

Owner's Signature | Date

Received 7/30/18

Before a Conditional Use Permit for an antenna tower may be issued, the applicant must demonstrate, and the Zoning Board of Adjustment must find compliance with all of the following per MCC 4-3-5(8):

Criteria A: No existing antenna towers or antenna support structures within the necessary geographic area for the applicant's antenna tower meet the applicant's requirements considering (a) height, (b) structural integrity, or (c) that there are other prohibitive conditions that render existing antenna towers or antenna support structures within the applicant's required geographic area unsuitable.

None are available or exist in this geographic area, the jurisdiction has not brought any existing towers to the applicant's attention, nor are any visible in the immediate area, the City has provided no other alternative. See attached ASR which demonstrates there are none existing - the only ASR is for this proposed tower. Per the attached ASR there are no registered support structures within 1 mile of this proposed facility. Existing water tank approx 1/2 mile east on Hathaway Street was submitted to City by T Mobile a few years back, but failed for structural reasons. Rotary Park Tower is not in this geographic search area, but is being pursued by the applicant to cover another geographic coverage area to the north. Per the attached RF Letter a facility at this location is needed to meet the coverage objective for the applicants tenant.

Criteria B: That the design of the antenna tower, including the antennas and ancillary facilities, minimizes visual impact and otherwise complies with provisions and intent of this Section.

Facility is of stealth design, a monopine which is designed to look like a tree and will blend in harmoniously with the surrounding landscape. In addition the support structure is engineered for additional carriers to prevent the need for a proliferation of towers in this dense geographic area where a significant gap in coverage for T Mobile, the applicant's tenant exists.

Criteria C: That the proposed antenna tower location minimizes the number and/or size of antenna towers or antenna support structures that will be required in the area.

Antenna tower is designed for multiple wireless carriers and is an area where an existing water tank structure hosts a competitor, but for structural reasons has no available space. Said water tank was denied to applicant by City of Moscow a few years back. Per the attached ASR there are no registered support structures within 1 mile of this proposed facility.

Criteria D: That the applicant has not previously failed to take advantage of reasonably available shared use opportunities or procedures provided by this Ordinance or otherwise.

Existing water tank meets T Mobile's needs, but was denied to the applicant in 2012. Said water tank approx 1/2 mile east on Hathaway Street was submitted to City by T Mobile a few years back, but failed for structural reasons. Rotary Park Tower is not in this geographic search area, but is being pursued by applicant to cover another geographic coverage area to the north. Per the attached ASR there are no registered support structures within 1 mile of this proposed facility.

T-Mobile, USA Spokane Market
601 W. 1st Ave, Suite 1442
Spokane, WA 99201

September 7, 2018

City of Moscow Land-use Department – Zoning approval

Ref: T-Mobile Site #: SP01120H (Moscow Residential)
Site Address: 1400 E. 7th Street, Moscow, Idaho 83823
Supporting Documentation; Site Needs, Improved Throughput and Subscriber Growth, Support for Student Population University of Idaho, Moscow Idaho.

Dear Board Members and Council Members:

The proposed Tower addition in the Southeastern area of the City Moscow, located at 1400 E. 7th Street, will support T-Mobile's expansion and improvements in the City of Moscow and the Student population of the University of Idaho.

First Point, this site will provide **indoor and improved outdoor coverage** to our existing 500+ subscribers which are forced to use **"Wi-Fi"** calling in their residences in the Southeastern part of City of Moscow.

Second Point, with an additional site near this residential neighborhood, it will improve signal quality, allow the use of newly purchased low-band spectrum which will improve Internet throughput immensely for our existing subscribers and potential new subscribers.

Thirdly, this site due to it's proximity to the Southeastern residential area will provide your constituents with another option for Service with an additional Mobile service provider.

Thank you for your cooperation with this request. Should you have any questions, please contact Donald Blenker at **(1) 509-230-0010** or via email at don.blenker@t-mobile.com. Thank you for your cooperation in this matter as T-Mobile continues to improve our wireless network.

Sincerely,

Donald E Blenker

Donald E. Blenker
RF Engineer, Spokane Market
T-Mobile, USA

ASR Registration Search

Registration 1307885

Map Registration

Registration Detail

Reg Number	1307885	Status	Granted
File Number	A1114168	Constructed	
EMI	No	Dismantled	
NEPA			

Antenna Structure

Structure Type	MTOWER - Monopole		
Location (in NAD83 Coordinates)			
Lat/Long	46-43-45.6 N 116-58-56.9 W	Address	1400 E. 7th St.
City, State	Moscow , ID		
Zip	83823	County	LATAH
Center of AM Array		Position of Tower in Array	

Heights (meters)

Elevation of Site Above Mean Sea Level	Overall Height Above Ground (AGL)
791.8	25.9
Overall Height Above Mean Sea Level	Overall Height Above Ground w/o Appurtenances
817.7	25.9

Painting and Lighting Specifications

None

FAA Notification

FAA Study	2018-ANM-1746-OE	FAA Issue Date	06/12/2018

Owner & Contact Information

FRN	0023395601	Owner Entity Type	Limited Liability Company

Owner

PI Tower Development, LLC co LendLease Americas LLC Attention To: Brandon Olsen 2320 Cascade Point Blvd Suite 300 Charlotte , NC 28208	P: (503)951-7515 F: E: brandon.olsen@lendlease.com

Contact

Olsen , Brandon Attention To: Brandon Olsen 2320 Cascade Point Blvd Suite 300 Charlotte , NC 28208	P: (503)951-7515 F: E: brandon.olsen@lendlease.com

Last Action Status

Status	Granted	Received	10/22/2018
Purpose	Amendment	Entered	10/22/2018
Mode	Interactive		

Related Applications	
10/22/2018	A1114168 - Amendment (AM)

Comments
Comments
None

History	
Date	**Event**
10/23/2018	Registration Printed

Automated Letters	
10/23/2018	Authorization, Reference

CLOSE WINDOW

Site Name: ID-Moscow-Residential

Site Number: PIID003

GROUND LEASE AGREEMENT

THIS GROUND LEASE AGREEMENT (the "Lease") is made this 10th day of July, 2018 (the "Commencement Date"), by and between **"CHURCH OF THE NAZARENE" OF MOSCOW, IDAHO**, an Idaho Corporation ("Lessor"), and **PI TOWER DEVELOPMENT LLC**, a Delaware limited liability company ("Lessee").

1. **Leased Premises**. Lessor hereby leases to Lessee and Lessee hereby leases from Lessor under the terms and conditions set forth in this Lease a portion of that certain parcel of real property, located at 1400 E 7th Street, Moscow, Idaho 83843 ("Site"), as more particularly described on **Exhibit "A"** and the survey or site plan shown on **Exhibit "A-1"** attached hereto and made a part hereof ("Leased Premises"), together with an easement, or easements, for ingress, egress, utilities, fiber, and any other easements required by the local governing authorities, including, without limitation, a landscape buffer or "Fall Zone" (if applicable), for the duration of the lease on the property which is more particularly described on **Exhibit "B"** attached hereto and made a part hereof ("Easement(s)"). The easement rights herein granted include the right and authority of Lessee to grant or assign to third parties all or some of the easement rights granted to Lessee herein without additional consideration paid to Lesser. Lessor agrees and acknowledges that Lessee may, at Lessee's sole cost and expense, have a metes and bounds survey prepared of the Leased Premises and the Easement(s), and that the legal description of the Leased Premises and the Easement(s), as shown on the survey, shall thereafter become the legal description of the Leased Premises and the Easement(s). Lessor represents and warrants that Lessor has good and marketable title to the Leased Premises and the Easement(s) free and clear of all liens and encumbrances, other than those liens and encumbrances shown on **Exhibit "C"** attached hereto and made a part hereof. Lessor further represents and warrants that there are no easements, licenses, rights of use or other encumbrances on the Leased Premises or the Easement(s) which will interfere with or constructively prohibit Lessee's Intended Use (as herein defined) of the Leased Premises.

2. **Lessor's Representations and Warranties**. Lessor represents and warrants that Lessee's intended use of the Leased Premises as a site for the transmission and receipt of wireless communication signals and for the construction and maintenance of towers, antennas or buildings and related facilities ("Intended Use") is not prohibited by any covenants, restrictions, reciprocal easements, servitudes, subdivision rules or regulations. Lessor further represents and warrants that (i) the execution of this Lease by Lessor will not cause a breach or an event of default of any other agreement to which Lessor is a party, (ii) there are no pending or threatened administrative actions, including bankruptcy or insolvency proceedings under the state or federal law, suits, claims or causes of action against Lessor or which may otherwise affect the Leased Premises and the Easement(s), (iii) the Leased Premises and the Easement(s) are not presently subject to an option, lease or other contract which may adversely affect Lessor's ability to fulfill its obligations under this Lease, and (iv) Lessor shall not grant an option or enter any contract which will affect the Leased Premises or the Easement(s) until this Lease expires or is terminated by Lessee.

3. **Lessee's Due Diligence Period**.

(a) Within twenty (20) business days following the Commencement Date, Lessee shall pay to Lessor the amount of [redacted] (the "Due Diligence Fee"), which Due Diligence Fee shall be nonrefundable to Lessee. Provided that construction of the Tower Facilities (as hereinafter defined) has not commenced, it is understood that Lessee shall have the right to terminate this Lease for any reason or no reason at all, without any further liability or obligation to Lessor except those obligations which specifically survive the expiration or termination of this Lease, by delivery of written notice of termination to Lessor prior to the Rent Commencement Date.

(b) Lessee shall have the right, at its cost and expense, to have the Leased Premises

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and the Easement(s) surveyed and to obtain a title report or commitment for a leasehold title policy covering the Leased Premises and the Easement(s) from the title insurance company of its choice prior to the Rent Commencement Date. Lessor shall remove any survey or title defects, which will adversely affect Lessee's leasehold title or its ability to mortgage its leasehold interest. In the event Lessor shall fail to cure any such defects, Lessee shall have the right to terminate this Lease upon written notice to Lessor.

(c) In the event of a termination of the Lease pursuant to subparagraph 3(a) or 3(b) above or Paragraph 8 below, within thirty (30) days of such termination Lessee will file a release or other appropriate instrument with the local recording office to remove the Memorandum of Lease from the title record. If said removal is not performed by Lessee within such thirty (30) day period, Lessee appoints Lessor, as Lessee's agent and at Lessee's cost and expense, to file the necessary release or other instrument to cause the Memorandum of Lease to be released from title.

4. Attorney-In-Fact and Cooperation. Lessor hereby irrevocably appoints Lessee or Lessee's agent as Lessor's agent to file such applications on behalf of Lessor with federal, state and local governmental authorities which relate to Lessee's Intended Use of the Leased Premises, including, but not limited to, land use and zoning applications. Lessor agrees to cooperate with Lessee in obtaining, at Lessee's expense, all licenses and permits required for Lessee's use of the Leased Premises (the "Governmental Approval").

5. Use. The Leased Premises may be used by Lessee for the transmission and receipt of wireless communication signals in any and all frequencies and the construction and maintenance of a communications tower, antennas, buildings, and related facilities and activities, and all other uses permitted under applicable zoning regulations. Lessee may construct additional improvements, demolish and reconstruct improvements, or restore, replace and reconfigure improvements at any time during the Term (as herein defined) of this Lease.

6. Initial Term. The initial term of this Lease shall be **five (5) years** commencing on the Commencement Date and terminating on the fifth (5th) anniversary of the Commencement Date ("Initial Term"). The parties agree that a memorandum of lease in the form attached hereto as **Exhibit "D"**, evidencing the Commencement Date and other matters, shall be executed and recorded.

7. Renewal Terms. Lessee shall have the right to extend the Initial Term of this Lease for **five (5) additional five (5) year terms** ("Renewal Terms"). Each Renewal Term shall be on the same terms and conditions as set forth in this Lease. This Lease shall automatically be renewed for each successive Renewal Term unless Lessee notifies Lessor of Lessee's intention not to renew the Lease at least thirty (30) days prior to the expiration of the Initial Term or the Renewal Term which is then in effect. The Initial Term and each Renewal Term shall collectively be referred to herein as the "Term".

8. Rent.

(a) Commencing on the Rent Commencement Date, during the Term of this Lease, Lessee shall pay to Lessor an annual rental amount of [redacted] ("Rent"), which shall be deemed to include any applicable State, County or local sales or use tax. Rent shall be payable on or before the fifteenth (15th) day of each calendar month, and shall be remitted to the address shown for Lessor in this Lease, or such other address as Lessor may direct by written notice to Lessee. Lessor acknowledges the first such payment of Rent will be made within thirty (30) days of the Rent Commencement Date. Lessee shall have no obligation to make any Rent payments until such time as Lessee receives a completed Internal Revenue Service W-9 form from Lessor, setting forth the Federal tax identification number of Lessor or the person or entity to whom the Rent checks are to be made payable as directed in writing by Lessor (the "**Tax Credentials**"). From time to time during the Term and within fourteen (14) days of a written request from Lessee, Lessor agrees to provide updated Tax Credentials in a form reasonably acceptable to Lessee. The Tax Credentials shall be provided to Lessee in accordance with the provisions of, and at the address given in, Section 21 below. Within fifteen (15) days of obtaining an interest in the Property or this Lease, any assignee(s) or transferee(s) of Lessor shall provide to Lessee

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Lessor shall not disclose any of the terms hereof to any third party, except with Lessee's prior written consent. Notwithstanding the foregoing, Lessor is permitted to disclose the terms of this Lease to its attorneys, financial consultants, accountants and lenders.

(SIGNATURE PAGES FOLLOWING)

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IN WITNESS WHEREOF, the parties hereto have executed this Lease as of the date first written above.

LESSOR:

"CHURCH OF THE NAZARENE" OF MOSCOW, IDAHO, an Idaho Corporation

WITNESS: John C. Miller
John C. Miller
Print Name

David A. Evans
Print Name

By: Ed Eby
Print Name: Ed Eby
Title: Chairman
Date: 5/21/18

LESSEE:

PI TOWER DEVELOPMENT LLC,
a Delaware limited liability company

WITNESS: Megan Evans
Megan Evans
Print Name
Nancy Venturelli
Nancy Venturelli
Print Name

By: RE Bitt
Print Name: Ron Bittner
Title: Vice President
Date: 7/19/18

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EXHIBIT "A"

Description of Real Property (Leased Premises)

A **20' by 40'** parcel of land for the tower compound being located around the base of the tower, all being a portion of the parent tract (see attached warranty deed for legal description of parent tract, if available). The legal description of the Leased Premises shall be determined by survey and shall thereafter replace this **Exhibit "A"**.

Tax Parcel I.D. # of parent tract:	RPM0260002001A
Physical Address of parent tract:	1400 E 7th Street Moscow, ID 83843

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EXHIBIT "A-1"

Survey or Site Plan

Location of the Leased Premises shall be determined by survey, and upon completion shall replace this **Exhibit "A-1"**.

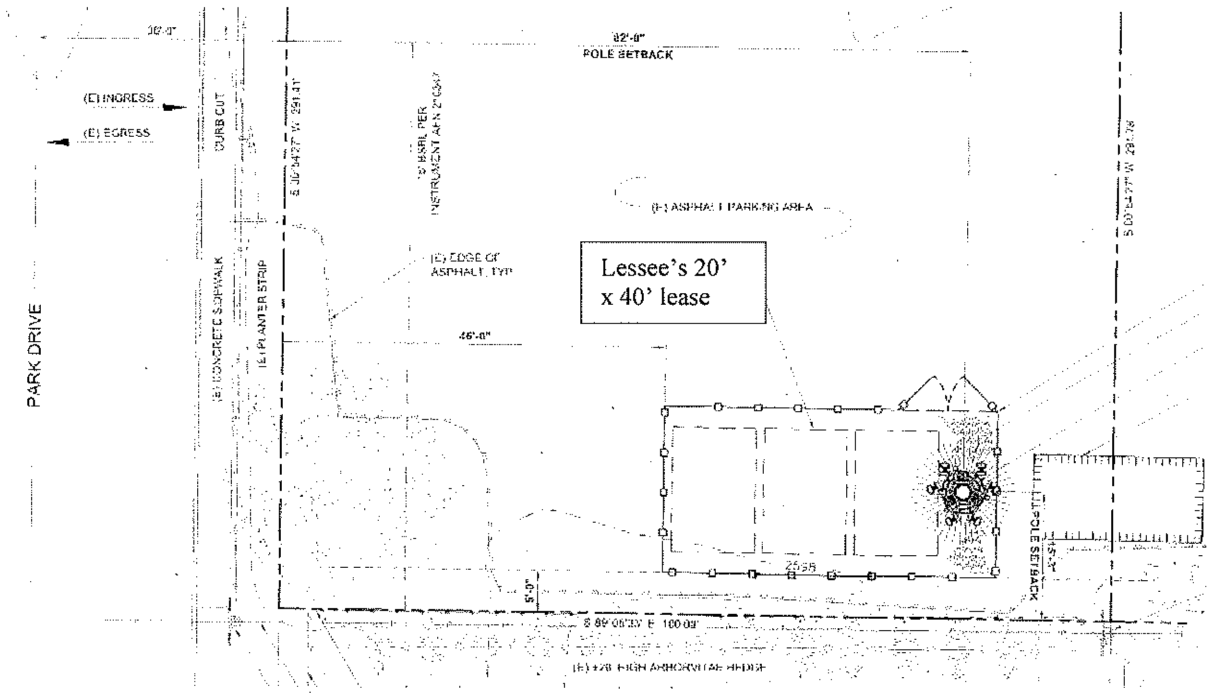

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EXHIBIT "B"

Easement(s)

(i) An easement from the Leased Premises to an open and improved public road in a minimum width of either 20 feet or the minimum width necessary to comply with any applicable governmental requirements, whichever is greater, to allow for ingress to and egress from the Leased Premises by vehicle;

(ii) An easement as may be required to provide utilities and/or fiber to the Leased Premises from the utility providers' preferred connection point;

(iii) if required by governmental authorities, an easement for a "Fall Zone" centered on the location of the Lessee's tower and extending outward in a circle for the number of feet as may be required by local zoning authorities (typically equal to the height of the Lessee's tower but could be more); and

(iv) if required by governmental authorities, an easement for a landscape buffer zone or any such additional easement(s) as may be required by local zoning authorities, each to be determined by survey, and upon completion of survey, shall replace this **Exhibit "B"**.

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Lendlease (US) Telecom Holdings LLC
c/o PI TOWER DEVELOPMENT LLC

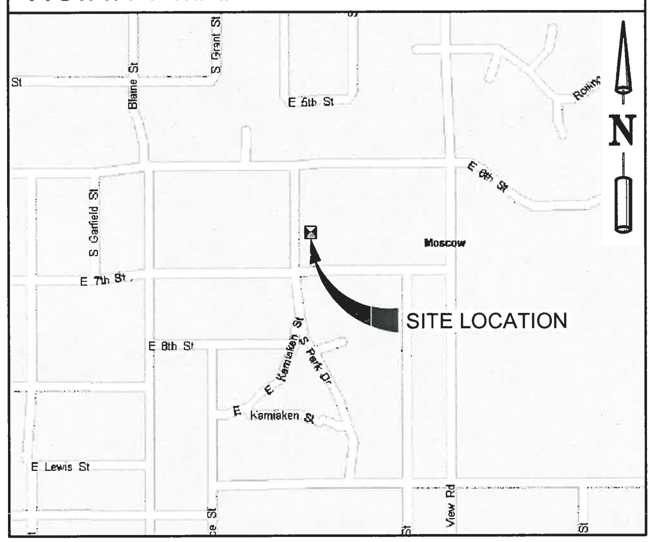
ID MOSCOW RESIDENTIAL

1400 E 7TH STREET
MOSCOW, ID 83823
LATAH COUNTY

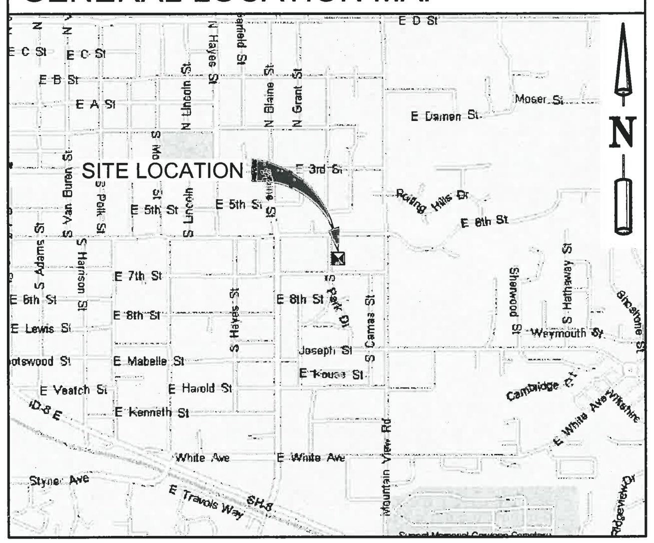
LEGAL DESCRIPTION

PARCEL I: (TAX PARCEL NO. RPM0260002001A)
THE WEST 100 FEET OF LOT 1, BLOCK 2, EASTGATE ADDITION TO THE CITY OF MOSCOW, AS SHOWN BY THE RECORDED PLAT THEREOF.
PARCEL II: (TAX PARCEL NO. RPM0260002001B)
LOT 1, BLOCK 2, EASTGATE ADDITION TO THE CITY OF MOSCOW, AS SHOWN BY THE RECORDED PLAT THEREOF;
EXCEPTING THEREFROM THE WEST 100 FEET OF SAID LOT 1, BLOCK 2.
PARCEL III: (TAX PARCEL NO. RPM02600020020)
LOT 2, BLOCK 2, EASTGATE ADDITION TO THE CITY OF MOSCOW, AS SHOWN BY THE RECORDED PLAT THEREOF.

VICINITY MAP



GENERAL LOCATION MAP



PROJECT TEAM

APPLICANT / LESSEE:
LENDLEASE (US) TELECOM HOLDINGS LLC
c/o PI TOWER DEVELOPMENT LLC
909 LAKE CAROLYN PARKWAY
IRVING, TX 75039
CONTACT: BRANDON OLSEN
(503) 951-7515
brandon.olsen@lendlease.com

PROJECT CONSULTANT:
PARALLEL INFRASTRUCTURE
909 LAKE CAROLYN
IRVING, TX 75039
(904) 450-4830

PROJECT ENGINEER:
CORNERSTONE ENGINEERING, INC.
16928 WOODINVILLE-REDMOND RD N.E. STE 210
WOODINVILLE, WA 98072
MARK W OLSON, P.E.
(425) 487-1732

PROPERTY OWNER:
CHURCH OF THE NAZARENE
1400 7TH STREET
MOSCOW, ID 83823

PROJECT MANAGER:
DEREK BUDIG
(509) 939-6202
dbudig@prolandllc.com

SITE AQUISITION:
DEREK BUDIG
(509) 939-6202
dbudig@prolandllc.com

ZONING:
DEREK BUDIG
(509) 939-6202
dbudig@prolandllc.com

CONSTRUCTION COORDINATOR:
TECHNOLOGY ASSOCIATES
PAUL HERBERT
(503) 549-0001

DRAWING INDEX

DWG	DESCRIPTION
T-1	TITLE SHEET
A-1	SITE PLAN
A-1.1	ENLARGED SITE PLAN
A-1.2	EXISTING ENLARGED COMPOUND SITE PLAN
A-1.3	PROPOSED ENLARGED COMPOUND SITE PLAN
A-2	PROPOSED NORTH ELEVATION

APPROVAL/SIGN OFF OF DRAWINGS

CONSULTANT	DATE	SIGNATURE
PROJECT MANAGER		
CONSTRUCTION MANAGER		
SITE ACQUISITION		
LANDLORD'S REPRESENTATIVE		

CARRIER	DATE	SIGNATURE
PROJECT MANAGER		
CONSTRUCTION MANAGER		
RF ENGINEER		
INTERCONNECT		
OPERATIONS		
COMPLIANCE		

REVIEWERS SHALL **CLEARLY PLACE INITIALS** ADJACENT TO EACH REDLINE NOTE AS DRAWINGS ARE BEING REDLINED

DRIVING DIRECTIONS

STARTING AT SPOKANE INTERNATIONAL AIRPORT:
TAKE I-90 EAST / US-2 EAST TOWARD SPOKANE
AT EXIT 279, TAKE RAMP RIGHT FOR US-195 SOUTH TOWARD COLFAX / PULLMAN
TAKE RAMP RIGHT FOR WA-271 SOUTH TOWARD OAKESDALE / ROSALIA
TURN LEFT ONTO WA-271
KEEP STRAIGHT ONTO WA-27 / 1ST ST
TURN LEFT TO STAY ON WA-27 / E STEPTOE AVE
KEEP RIGHT TO STAY ON WA-27
KEEP STRAIGHT ONTO WA-27 / BRIDGE ST S
TURN LEFT ONTO WA-66 / W ALMOTA RD
ROAD NAME CHANGES TO ID-66
TURN RIGHT ONTO US-95
TURN LEFT ONTO E D ST
TURN RIGHT ONTO N MOUNTAIN VIEW RD
ROAD NAME CHANGES TO S MOUNTAIN VIEW RD
TURN RIGHT ONTO E 7TH ST
ARRIVE AT 1400 E 7TH ST

UTILITY COMPANIES

POWER COMPANY:
AVISTA UTILITIES
(509) 773-4833

FIBER COMPANY:
TBD

PROJECT INFORMATION

CODE INFORMATION:
ZONING CLASSIFICATION: R3 (RESIDENTIAL)
BUILDING CODE: IBC 2015
CONSTRUCTION TYPE: V-B
OCCUPANCY: GROUP U
JURISDICTION: CITY OF MOSCOW, ID
PROPOSED BUILDING USE: TELECOMM

PARCEL NUMBER:
RPM0260002001A

AREA OF PARCEL:
±29,159 SQ. FT. (±0.67 ACRES)

PROJECT AREA:
±800 SQ. FT. (LEASE AREA)

NEW IMPERVIOUS AREA:
±800 SQ. FT. (LEASE AREA)

SITE LOCATION (BASED ON NAD 83):
LATITUDE: 46° 43' 45.59" N (46.729330)
LONGITUDE: 116° 58' 57.03" W (-116.982508)
TOP OF STRUCTURE: ±80.0' AGL (MONOPINE POLE)
BASE OF STRUCTURE: ±2597.8' AMSL

GENERAL INFORMATION:
1. PARKING REQUIREMENTS ARE UNCHANGED. (NON ASSIGNED TECH PARKING)
2. TRAFFIC IS UNAFFECTED.
3. SIGNAGE IS PROPOSED.

PROJECT DESCRIPTION

NEW TELECOMMUNICATION FACILITY WHICH INCLUDES A 20'x40' LEASE AREA CONTAINING A 6'-0" HIGH CEDAR FENCE. A ±80.0' MONOPINE POLE WITH (3) CARRIER LOCATIONS CONSISTING OF (6) PANEL ANTENNAS W/ EQUIPMENT. (1) RELOCATED PORTABLE SHED

Lendlease (us) Telecom Holdings LLC
c/o PI TOWER DEVELOPMENT LLC

PLANS PREPARED BY:
CORNERSTONE ENGINEERING, INC.
16928 WOODINVILLE-REDMOND RD NE, SUITE 210
WOODINVILLE, WA 98072
PHONE: 425.487.1732
WWW.CORNERSTONE-ENGR.COM

PROJECT INFO:
ID MOSCOW RESIDENTIAL
1400 E 7TH STREET
MOSCOW, ID 83823
LATAH COUNTY

ISSUED FOR:
ZONING

REV:	DATE:	ISSUED FOR:	BY:
0	04-09-18	FINAL	DMO
B	12-28-17	ADD MONOPINE	DMO
A	12-12-17	PRELIMINARY	DMO

DRAWN BY:	CHK.:	APV.:
DMO	MWO	MWO

CURRENT ISSUE DATE:
04-09-18

LICENSURE:
PROFESSIONAL ENGINEER
REGISTERED
11663
STATE OF IDAHO
MARK W. OLSON
4/9/18

JURISDICTIONAL APPROVAL:

PROPRIETARY INFORMATION:
DO NOT SCALE DRAWINGS. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND ADVISE CONSULTANTS OF ANY ERRORS AND OMISSIONS. ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED BY THE LATEST REVISION. THE INFORMATION CONTAINED IN THIS SET OF DOCUMENTS IS PROPRIETARY BY NATURE. ANY USE OR DISCLOSURE OTHER THAN WHICH IS RELATED TO NAMED CLIENT IS STRICTLY PROHIBITED.

DRAWING TITLE:
TITLE SHEET

DRAWING NUMBER:
T-1 | 0

CEI JOB NUMBER: NSB 17-55052

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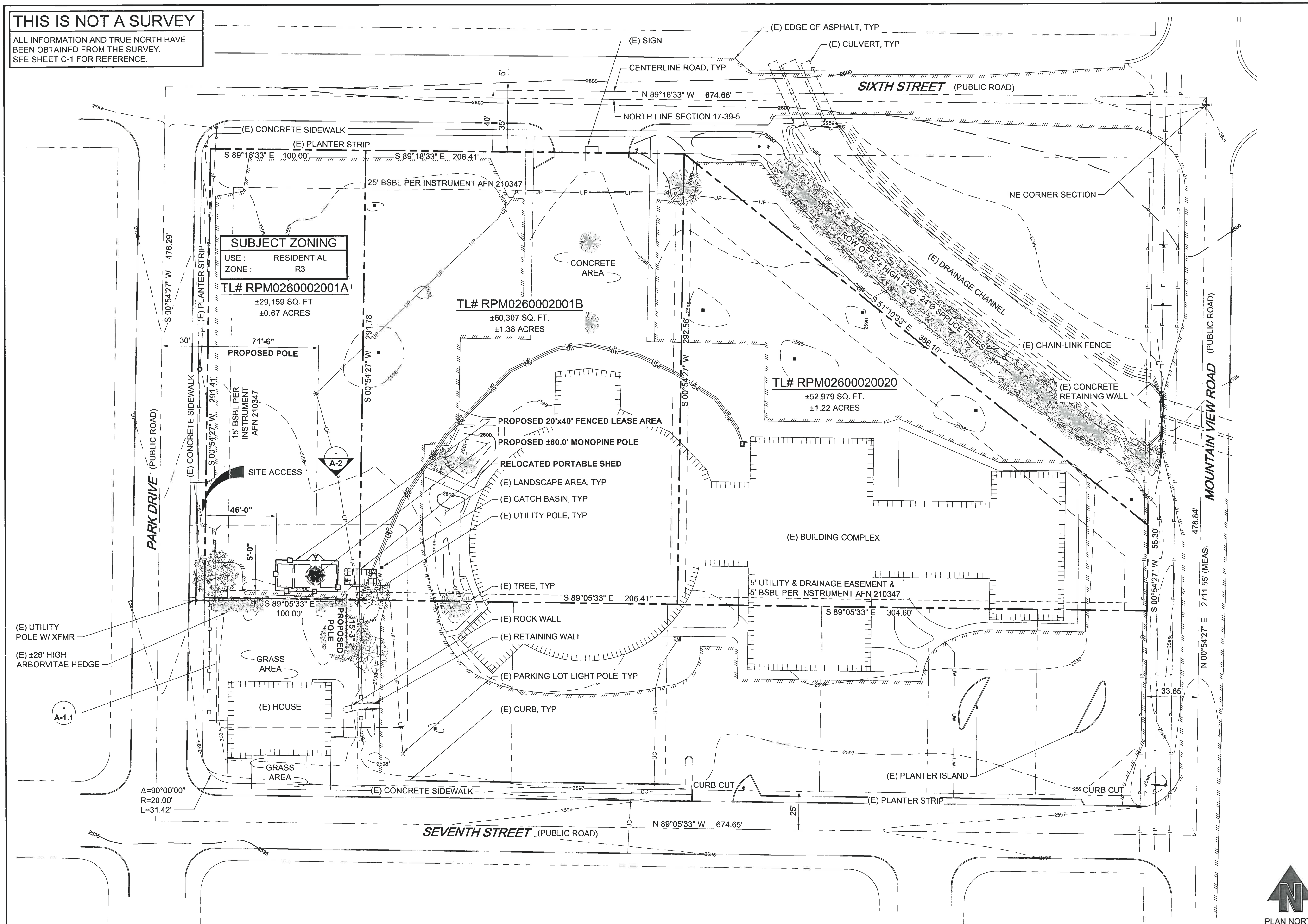
LUP018-0023



SITE PLAN

22x34 SCALE: 1" = 30'-0" | 11x17 SCALE: 1" = 60'-0"

1

lendlease

Lendlease (us) Telecom Holdings LLC
c/o PI TOWER DEVELOPMENT LLC

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DMO	MWO	MWO

CURRENT ISSUE DATE:

04-09-18

LICENSURE:

PROFESSIONAL ENGINEER REGISTERED 11663 STATE OF IDAHO MARK W. OLSON

4/9/18

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DRAWING TITLE:

SITE PLAN

DRAWING NUMBER:

A-1 | 0

CEI JOB NUMBER: 17-052

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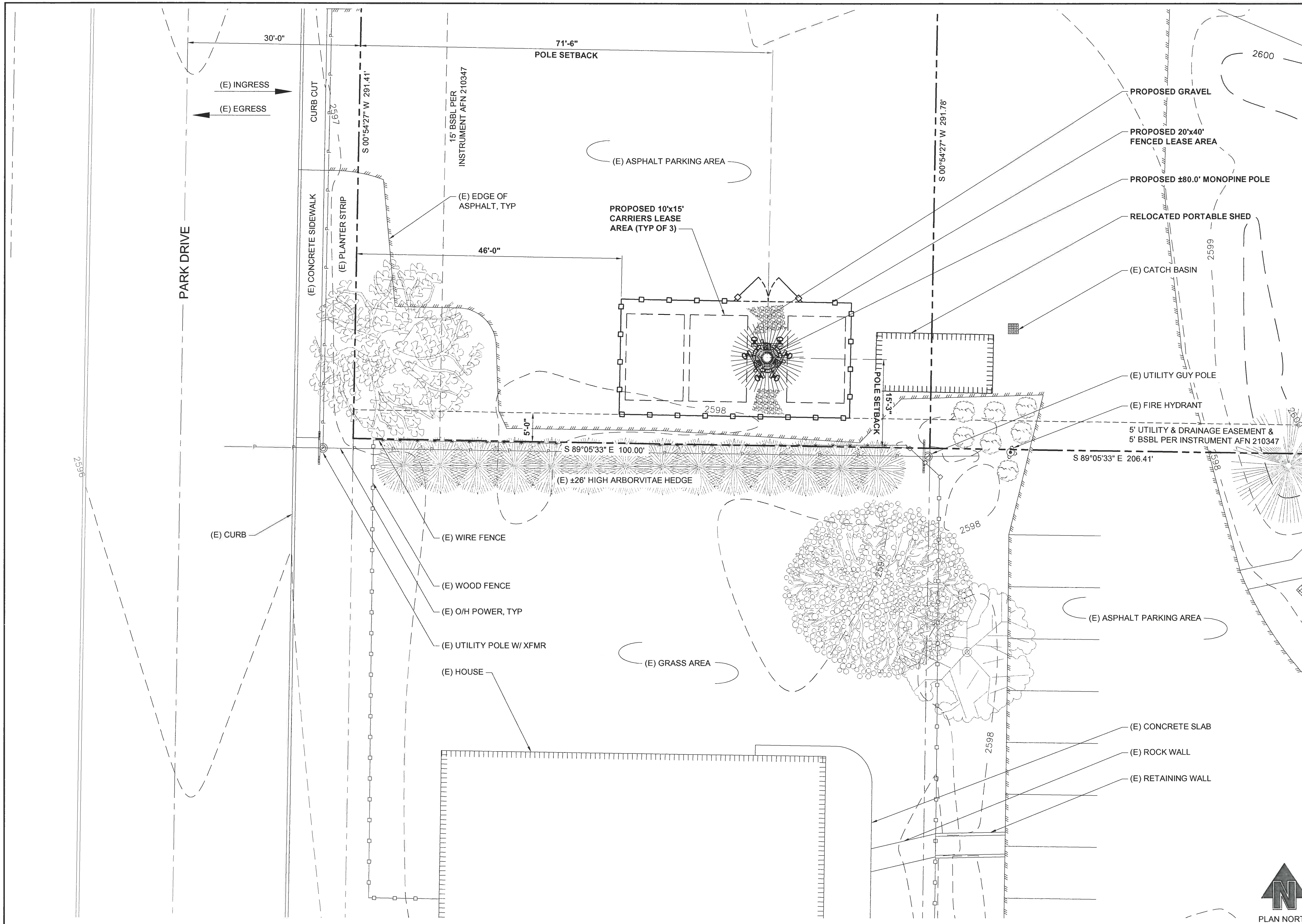

ENLARGED SITE PLAN

22x34 SCALE: 1/8" = 1'-0" | 11x17 SCALE: 1/16" = 1'-0"

1

lendlease

Lendlease (us) Telecom Holdings LLC
c/o PI TOWER DEVELOPMENT LLC

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WWW.CORNERSTONE-ENGR.COM

PROJECT INFO:

ID MOSCOW RESIDENTIAL

1400 E 7TH STREET
MOSCOW, ID 83823
LATAH COUNTY

ISSUED FOR:

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DMO	MWO	MWO

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DRAWING TITLE:

ENLARGED SITE PLAN

DRAWING NUMBER:

A-1.1 | 0

CEI JOB NUMBER: NSB 17-55052

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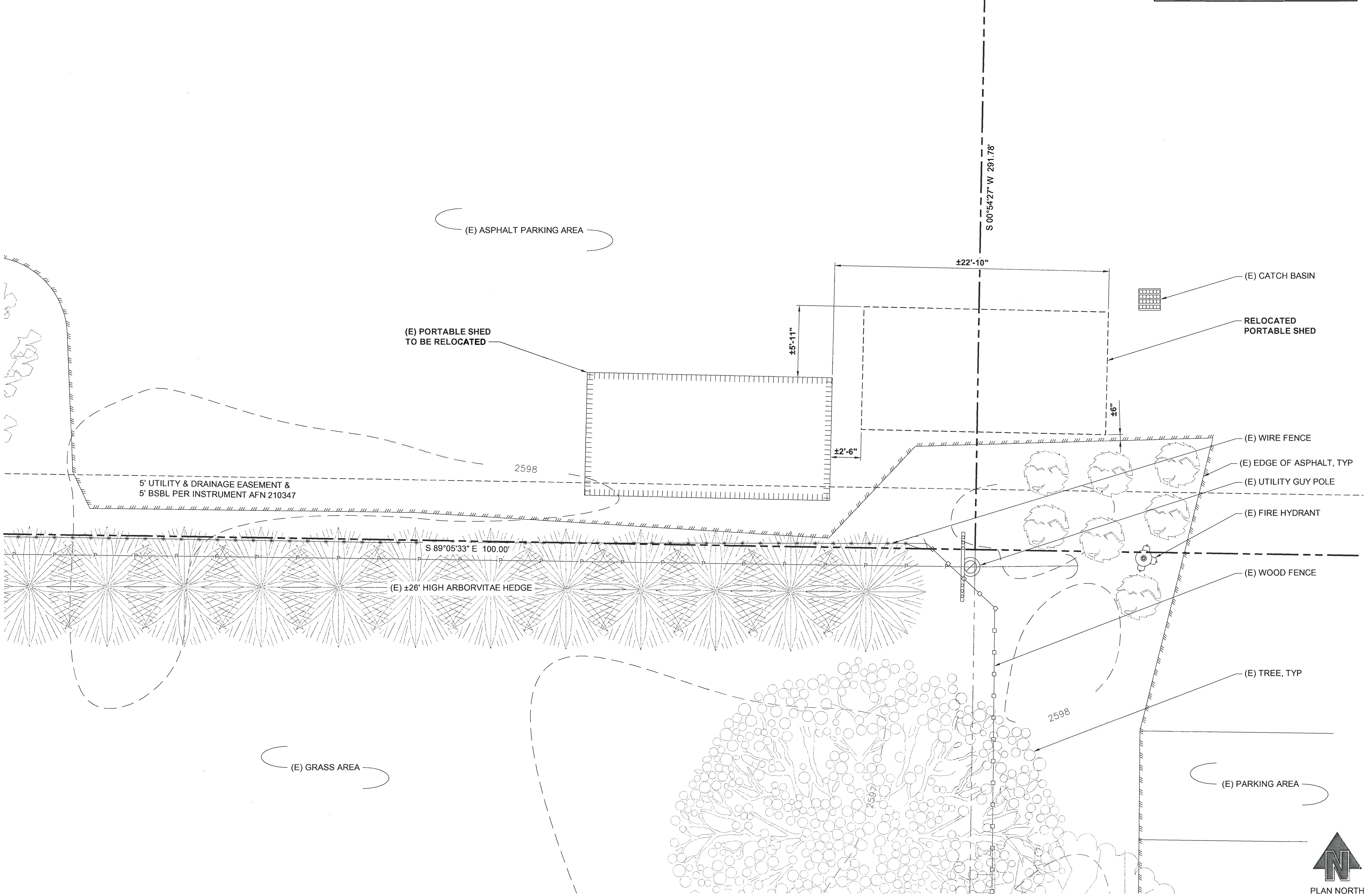
NOTE:
EXACT LOCATION OF PROPOSED 20'x40' LEASE AREA & RELOCATED PORTABLE SHED TO BE DETERMINED AFTER CLIENT REVIEW



EXISTING ENLARGED COMPOUND SITE PLAN

22x34 SCALE: 1/4" = 1'-0" | 11x17 SCALE: 1/8" = 1'-0"

1

lendlease

Lendlease (us) Telecom Holdings LLC
c/o PI TOWER DEVELOPMENT LLC

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1400 E 7TH STREET
MOSCOW, ID 83823
LATAH COUNTY

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DRAWN BY:	CHK.:	APV.:
DMO	MWO	MWO

CURRENT ISSUE DATE:

04-09-18

LICENSURE:

PROFESSIONAL ENGINEER REGISTERED 11663 STATE OF IDAHO MARK W. OLSON

4/9/18

JURISDICTIONAL APPROVAL:

PROPRIETARY INFORMATION:

DRAWING TITLE:

EXISTING ENLARGED COMPOUND SITE PLAN

DRAWING NUMBER:

A-1.2 | 0

CEI JOB NUMBER: NSB 17-56052

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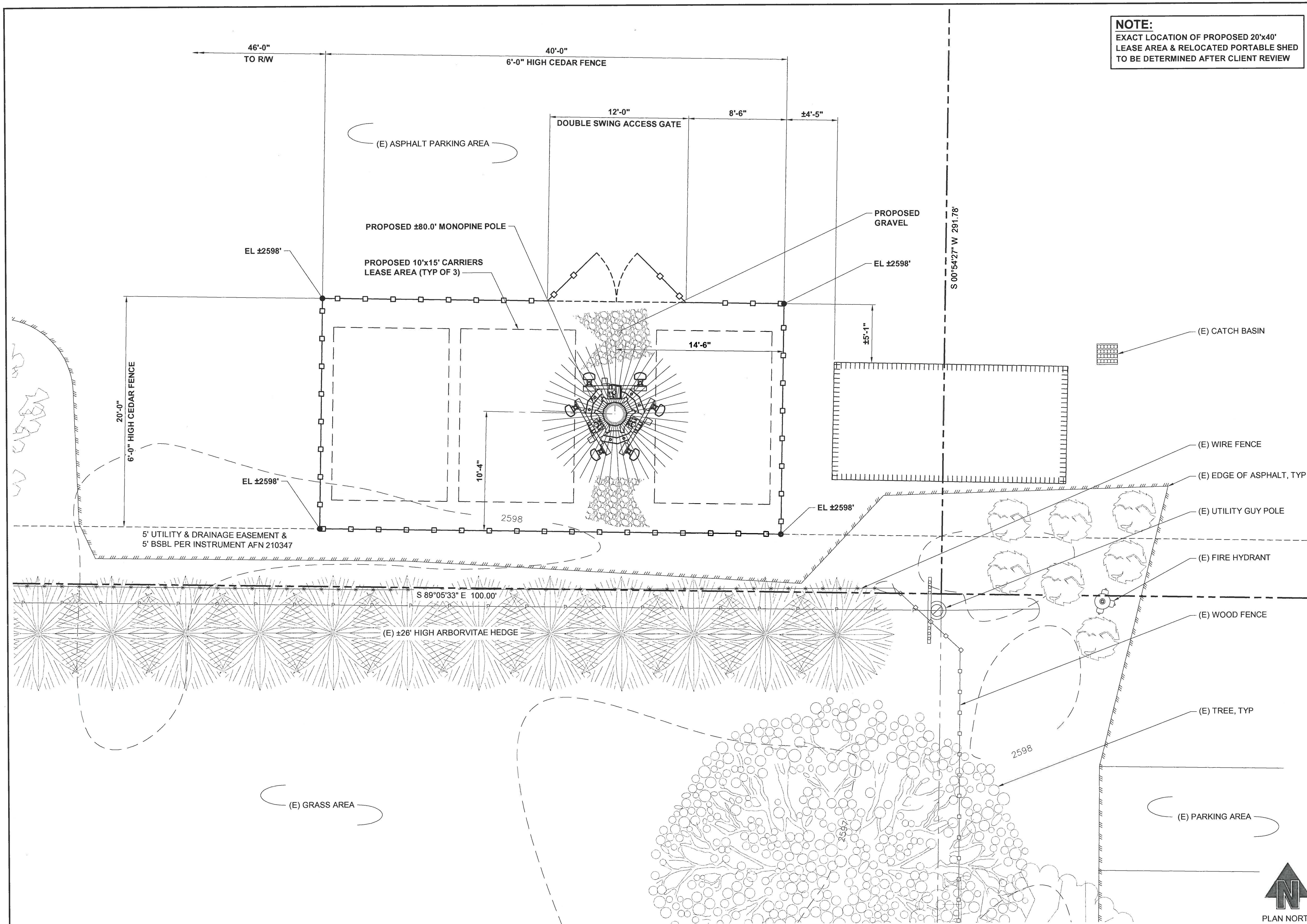

PROPOSED ENLARGED COMPOUND SITE PLAN

22x34 SCALE: 1/4" = 1'-0" | 11x17 SCALE: 1/8" = 1'-0"

1

lendlease

Lendlease (us) Telecom Holdings LLC
c/o PI TOWER DEVELOPMENT LLC

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DMO	MWO	MWO

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LICENSURE:

PROFESSIONAL ENGINEER REGISTERED 11663 STATE OF IDAHO MARK W. OLSON
4/9/18

JURISDICTIONAL APPROVAL:

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DRAWING TITLE:

PROPOSED ENLARGED COMPOUND SITE PLAN

DRAWING NUMBER:

A-1.3 | 0

CEI JOB NUMBER: NSB 17152052

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CORNERSTONE ENGINEERING, INC.

ID MOSCOW RESIDENTIAL

PICTURE LOCATION MAP

verizon

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CORNERSTONE ENGINEERING, INC.

ID MOSCOW RESIDENTIAL

EXISTING NORTHEAST ELEVATION

verizon

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ID MOSCOW RESIDENTIAL
PROPOSED NORTHEAST ELEVATION

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LUP018-0023

ID MOSCOW RESIDENTIAL
EXISTING SOUTHEAST ELEVATION

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LUP018-0023

CORNERSTONE ENGINEERING, INC.

ID MOSCOW RESIDENTIAL
PROPOSED SOUTHEAST ELEVATION

verizon

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LUP018-0023

CORNERSTONE ENGINEERING, INC.

ID MOSCOW RESIDENTIAL
EXISTING SOUTHWEST ELEVATION

verizon

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CORNERSTONE ENGINEERING, INC.

ID MOSCOW RESIDENTIAL

PROPOSED SOUTHWEST ELEVATION

verizon

Received 7/30/18

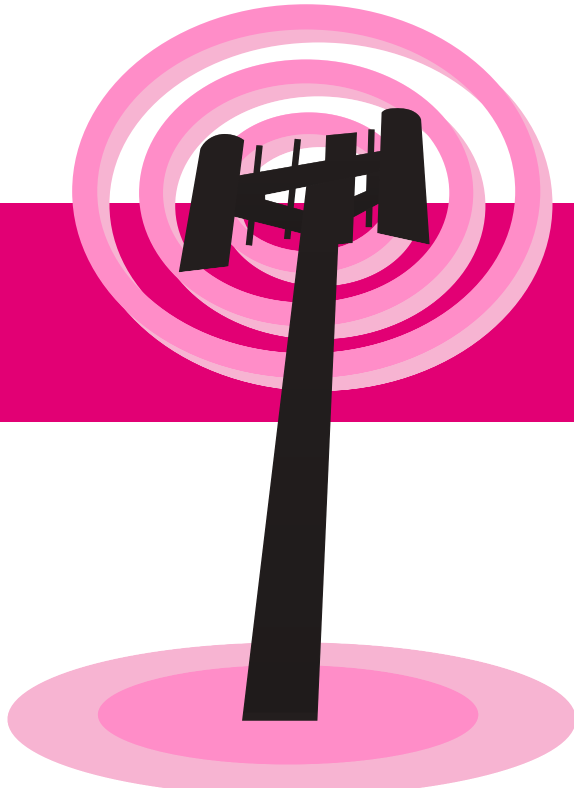
LUP018-0023

T · · Mobile ·

SP01120H – Moscow Residential – Coverage

Spokane RF Engineering

Received 7/30/18



Existing Coverage (Without New Site)

Spokane RF Engineering, T-Mobile USA

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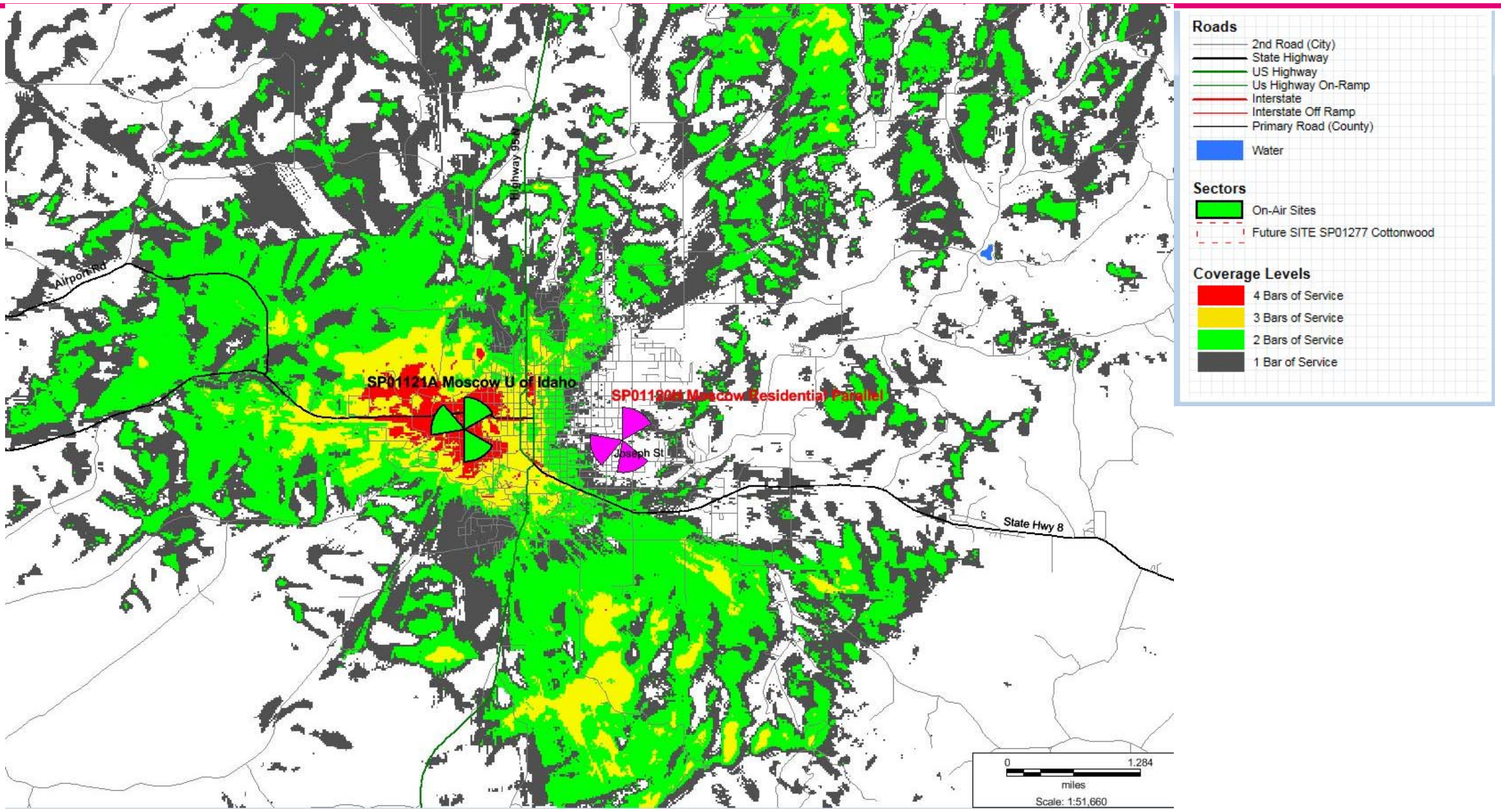

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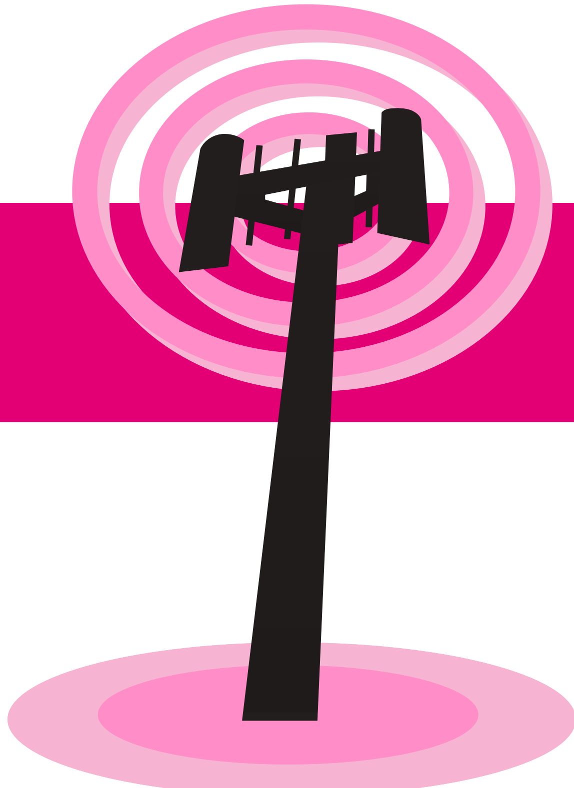
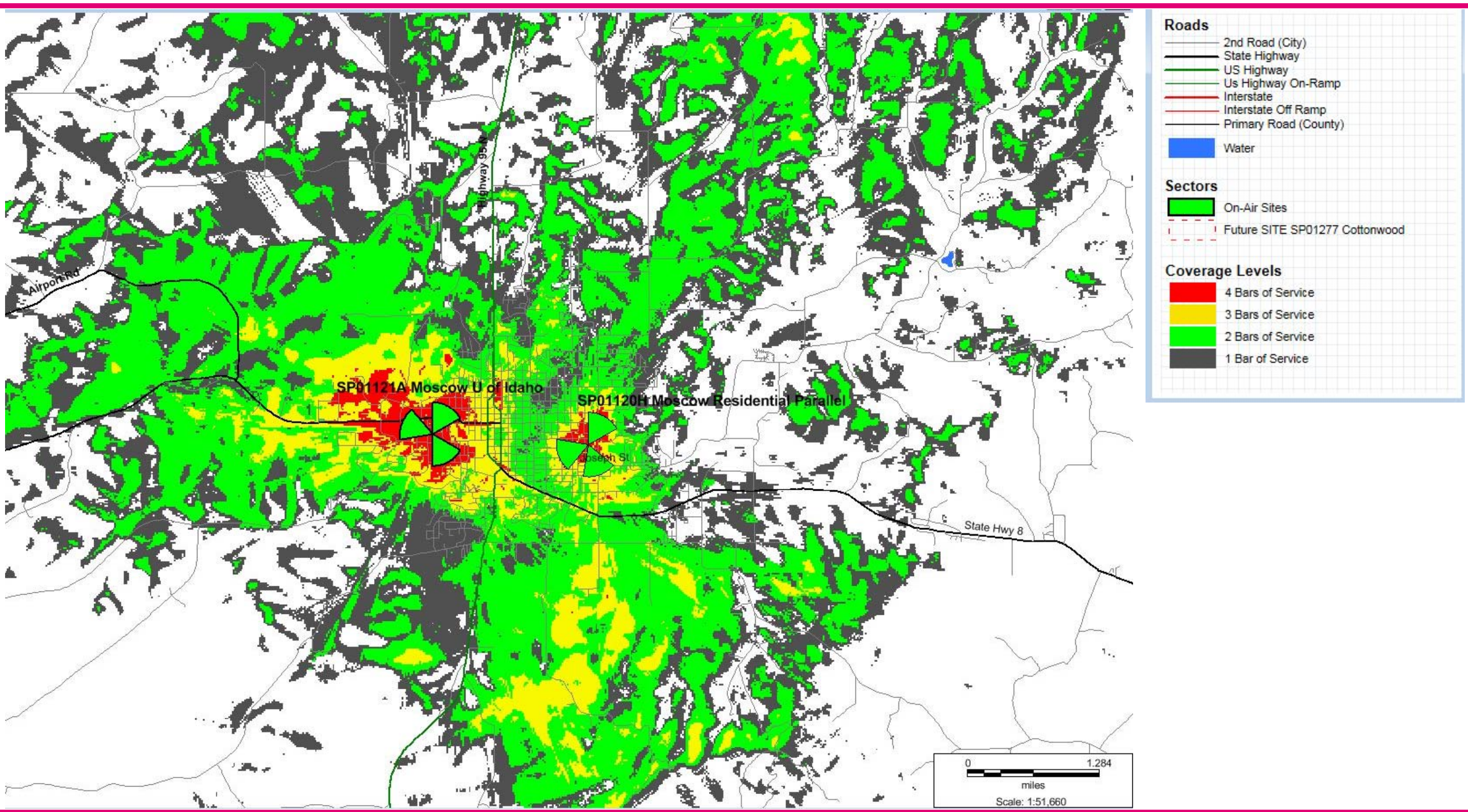
T-Mobile



New Coverage (With New Site)

Spokane RF Engineering, T-Mobile USA

Received 7/30/18



Received 7/30/18

Received 7/30/18

ProLand, LLC
Derek Budig
Site Acquisition – Zoning – Project Management

Attention Wireless Providers

This letter is to notify you of an application for the installation of a new wireless telecommunications facility within the City of Moscow, ID and within your licensed area. Attached is the application and a description of the proposed wireless facility. Please provide any comments you have, including your desire to collocate within 10 days receipt of this notice to:

Derek Budig
509-939-6202
Dbudig@prolandllc.com

Or via mail to the address listed below:

T-MOBILE USA, INC.
12920 SE 38TH ST
BELLEVUE WA 98006

INLAND TELEPHONE CO
PO BOX 171
ROSLYN WA 98941

VERIZON WIRELESS
1095 AVENUE OF THE
AMERICAS
NEW YORK, NY 10036

SPRINT PCS
6200 SPRINT PARKWAY
OVERLAND PARK KS 66251

CRICKET WIRELESS LLC
575 MOROSGO DR NE
ATLANTA, GA 30324

AT&T WIRELESS
208 S AKARD ST
DALLAS, TX 75202

US CELLULAR
8410 W BRYN MAWR
SUITE 700
CHICAGO, IL 60631

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3.
- Print your name and address on the reverse so that we can return the card to you.
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CRICKET WIRELESS LLC
575 MOROSGO DR NE
ATLANTA, GA 30324

9590 9402 3704 7335 7420 78

2. Article Number (Transfer from service label)

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8410 W BRYN MAWR Suite 700
CHICAGO, IL 60631

9590 9402 1828 6104 4824 48

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VERIZON WIRELESS
1095 AVE of the AMERICANS
NEW YORK, 10036

9590 9402 1828 6104 4824 55

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INLAND TELEPHONE CO
PO BOX 171
ROSLYN WA 98941

9590 9402 1828 6104 4824 31

2. Article Number (Transfer from service label)

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AT&T WIRELESS
208 S. AKARD ST
DALLAS, TX 75202

9590 9402 1828 6104 4824 17

2. Article Number (Transfer from service label)

7017 2400 0000 5685 3734

PS Form 3811, July 2015 PSN 7530-02-000-9053

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Domestic Return Receipt

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T-MOBILE USA, INC
12920 SE 38th ST
BELLEVUE WA 98006

9590 9402 3704 7335 7420 85

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PS Form 3811, July 2015 PSN 7530-02-000-9053

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Domestic Return Receipt

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SPRINT PCS
6200 SPRINT PARKWAY
OVERLAND PARK KS 66251

9590 9402 1828 6104 4824 24

2. Article Number *(Transfer from service label)*

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☐ Addressee

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PS Form 3811, July 2015 PSN 7530-02-000-9053

Domestic Return Receipt

From: Shane Niemela <Shane.Niemela@itd.idaho.gov>
Sent: Thursday, August 2, 2018 3:34 PM
To: Anne Peterson
Cc: Jared Hopkins
Subject: RE: [EXTERNAL] cell tower application for your review

Hi Anne,
ITD has not concerns about this CUP.
Thank you,
Shane Niemela

From: Anne Peterson [mailto:apeterson@ci.moscow.id.us]
Sent: Thursday, August 02, 2018 2:58 PM
To: Greg Bailey; James Fry; Jared Hopkins; Jesse Flowers; Mia Vowels; NANCY BECKER (nbecker@phd2.idaho.gov); Shane Niemela
Subject: [EXTERNAL] cell tower application for your review

--- This email is from an external sender. Be cautious and DO NOT open links or attachments if the sender is unknown. ---

The attached Conditional Use Permit application for an 80-foot cell tower at 1400 East 7th St is sent for your information and review. Please reply with any comments by August 17. Thank you!

Anne Peterson
Admin Asst/Deputy City Clerk
E | apeterson@ci.moscow.id.us
P | 208-883-7035
F | 208-883-7033
CITY OF MOSCOW IDAHO

Public Comment:

The following documents contain input from citizens regarding the Conditional Use Permit for the proposed Wireless Communication Facility (WCF) located at 1400 E 7th Street.

1. Letter from Maury Wiese – Received October 31, 2018

2. Email from Faris Paxton – Received November 6, 2018

3. Email from Jon Hill – Received November 6, 2018

October 31, 2018

Board of Adjustment
City of Moscow

RE: LUP 2018-0023

I write in opposition to the "tower disguised as a tree" proposed to be constructed near 7th and Park in Moscow. I ask that this project not be approved because

- A tower, especially an 80-ft tower even "disguised as a tree," is gaudy and unsightly. At this proposed location near 7th and Park, the tower will be an eye sore since nearby trees and residences are generally less than 30-ft tall.

- My residence at 711 Park Drive originally offered an attractive view of Moscow Mountain. This view was severely compromised by the eventual construction of the Nazarene Church and would certainly be obstructed further by the proposed gaudy tower.

- If this tower provides a service to the community, I would argue that this service could be provided as well at any other site within a 1-2 mile radius from the Nazarene Church and the intersection of 7th and Park.

Please consider the negative practical and esthetic impacts this tower will have on the residential area surrounding 7th and Park and deny this proposal.

MVWiese

Maury Wiese
711 Park Drive

From: Faris Paxton <faris.paxton@gmail.com>
Sent: Tuesday, November 6, 2018 1:57 PM
To: Leah Carlson
Subject: Material concerning the proposed Cell Tower at 1400 7th Street, Moscow, ID 83823

Leah Carlson,

Thanks so much for talking with me earlier concerning the proposed Cell Tower on the Nazarene Church property.
https://www.ci.moscow.id.us/DocumentCenter/View/10251/11-13-18-Conditional-Use-Permit-1400-7th-Street

Below is a sample of available studies that I think could be worthy of the council's attention before the meeting on Tuesday, November 13, 2018. I'm planning to attend this meeting and discuss some of these items in person.

ATTACHMENT 1

National Institutes of Health
High exposure to radio frequency radiation linked to tumor activity in male rats

ATTACHMENT 2

Significant Decrease of Clinical Symptoms after Mobile Phone Base Station Removal

ATTACHMENT 3

"The present U.S. guidelines for RFR exposure are not up to date."
Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

ATTACHMENT 4

Impact of radio frequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations.

Thanks,

Faris Paxton
824 Park Dr.
Moscow ID, 83843

ATTACHMENT 1

NEWS RELEASES

Friday, February 2, 2018

High exposure to radiofrequency radiation linked to tumor activity in male rats

High exposure to radiofrequency radiation (RFR) in rodents resulted in tumors in tissues surrounding nerves in the hearts of male rats, but not female rats or any mice, according to draft studies from the National Toxicology Program (NTP). The exposure levels used in the studies were equal to and higher than the highest level permitted for local tissue exposure in cell phone emissions today. Cell phones typically emit lower levels of RFR than the maximum level allowed. NTP's draft conclusions were released today as two technical reports, one for rat studies and one for mouse studies. NTP will hold an external expert review of its complete findings from these rodent studies March 26-28.

The incidence of tumors, called malignant schwannomas, that were observed in the heart increased in male rats as they were exposed to increasing levels of RFR beyond the allowable cell phone emissions. Researchers also noted increases in an unusual pattern of cardiomyopathy, or damage to heart tissue, in exposed male and female rats. Overall, there was little indication of health problems in mice related to RFR.

The reports also point out statistically significant increases in the number of rats and mice with tumors found in other organs at one or more of the exposure levels studied, including the brain, prostate gland, pituitary gland, adrenal gland, liver, and pancreas. However, the researchers determined that these were equivocal findings, meaning it was unclear if any of these tumor increases were related to RFR.

"The levels and duration of exposure to RFR were much greater than what people experience with even the highest level of cell phone use, and exposed the rodents' whole bodies. So, these findings should not be directly extrapolated to human cell phone usage," said John Bucher, Ph.D., NTP senior scientist. "We note, however, that the tumors we saw in these studies are similar to tumors previously reported in some studies of frequent cell phone users."

To conduct the studies, NTP built special chambers that exposed rats and mice to different levels of RFR for up to two years. Exposure levels ranged from 1.5 to 6 watts per kilogram (W/kg) in rats, and 2.5 to 10 W/kg in mice. The low power level for rats was equal to the highest level permitted for local tissue exposures to cell phone emissions today. The animals were exposed for 10-minute on, 10-minute off increments, totaling just over 9 hours each day. The studies used 2G and 3G frequencies and modulations still used in voice calls and texting in the United States. More recent 4G, 4G-LTE, and 5G networks for streaming video and downloading attachments use different cell phone signal frequencies and modulations than NTP used in these studies.

The NTP studies also looked for a range of noncancer health effects in rats and mice, including changes in body weight, evidence of tissue damage from RFR-generated heating, and genetic damage. Researchers saw lower body weights among newborn rats and their mothers, especially when exposed to high levels of RFR during pregnancy and lactation. Yet, these animals grew to normal size.

"These studies were complex and technically challenging, but they provide the most comprehensive assessment, to date, of health effects in rats and mice from exposure to RFR," said Bucher. "Cell phone technologies are constantly changing, and these findings provide valuable information to help guide future studies of cell phone safety."

The U.S. Food and Drug Administration nominated cell phone radiofrequency radiation for study by NTP because of widespread use of cell phones. FDA and the Federal Communications Commission are jointly responsible for regulating wireless communication devices.

About the National Toxicology Program (NTP): NTP is a federal, interagency program headquartered at NIEHS, whose goal is to safeguard the public by identifying substances in the environment that may affect human health. For more information about NTP and its programs, visit ntp.niehs.nih.gov.

About the National Institute of Environmental Health Sciences: NIEHS supports research to understand the effects of the environment on human health and is part of NIH. For more information on environmental health topics, visit www.niehs.nih.gov. Subscribe to one or more of the NIEHS news lists to stay current on NIEHS news, press releases, grant opportunities, training, events, and publications.

About the National Institutes of Health (NIH): NIH, the nation's medical research agency, includes 27 Institutes and Centers and is a component of the U.S. Department of Health and Human Services. NIH is the primary federal agency conducting and supporting basic, clinical, and translational medical research, and is investigating the causes, treatments, and cures for both common and rare diseases. For more information about NIH and its programs, visit www.nih.gov.

NIH...Turning Discovery Into Health®

###

Institute/Center

National Institute of Environmental Health Sciences (NIEHS)

Contact

Virginia Guidry, NIEHS
919-541-1993

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ATTACHMENT 2

Electromagnetic Fields

Original scientific publication

Significant Decrease of Clinical Symptoms after Mobile Phone Base Station Removal – An Intervention Study

Tetsuharu Shinjyo and Akemi Shinjyo

This research was undertaken to investigate the validity of concerns about whether chronic exposure to radiofrequency electromagnetic fields (RF-EMFs) emitted from mobile phone base station antennas could cause adverse health effects. The aim of this study was to identify possible adverse health effects among the residents of a condominium on which a mobile phone base station with sets of antennas operating at two different frequencies had been mounted. This research was conducted without outside funds in order to maintain neutrality and avoid pressures from external sources.

Methods: We investigated possible adverse effects on the health of condominium inhabitants who were exposed from 1998 to 2009 to the radiation from mobile phone base station antennas installed on top of their condominium. To accomplish this, in January and November 2009, 107 of 122 inhabitants were interviewed and underwent medical examinations. The first examination was carried out while the base station was in operation, the second examination three months after the base station antennas were removed once and for all. Based on the health examination results, the residents' health and its changes during the operation of the antennas and after their removal were compared.

Results: In several cases, significant effects on the inhabitants' health could be proven. The health of these inhabitants was shown to improve after the removal of the antennas, and the researchers could identify no other factors that could explain this health improvement. These examinations and interviews suggest that there are possible adverse health effects related to RF-EMF exposure among people living under mobile phone base stations.

Conclusions and recommendations: The results of these examinations and interviews indicate a connection between adverse health effects and electromagnetic radiation from mobile phone base stations. Further research and studies are recommended regarding the possible adverse health effects of RF-EMFs. These results lead us to question the construction of mobile phone base stations on top of buildings such as condominiums or houses.

Key words: mobile phone, base station, radiofrequency (RF), electromagnetic field (EMF), health problems, residents.

Signifikanter Rückgang klinischer Symptome nach Senderabbau – eine Interventionsstudie

Tetsuharu Shinjyo and Akemi Shinjyo

Hintergrund der vorliegenden Arbeit waren Befürchtungen, dass die chronische Exposition hochfrequenter elektromagnetischer Strahlung (HFS -EMF), die von den Sendeantennen von Mobilfunkbasisstationen ausgehen, negative Auswirkungen auf die Gesundheit haben könnte.

Ziel war es, die möglichen negativen Auswirkungen auf die Gesundheit der Bewohner einer Wohnanlage festzustellen, auf deren Dach zwei Mobilfunkbasisstationen montiert worden waren.
Aus Gründen der Neutralität und um äußeren Druck zu vermeiden, wurde diese Studie ohne Drittmittel durchgeführt.

Methode: Untersucht wurden mögliche negative Auswirkungen auf die Gesundheit der Bewohner einer Wohnanlage, die von 1998 bis 2009 der Strahlung zweier auf dem Dach befindlichen Mobilfunksendeantennen ausgesetzt waren. Dazu wurden 107 der 122 Bewohner im Januar und November 2009 befragt und ärztlich untersucht, wobei die erste Untersuchung während des Sendebetriebes und die zweite Untersuchung drei Monate nach dem endgültigen Abbau der Sendeantennen stattfand. Basierend auf den Ergebnissen der Gesundheitsuntersuchung wurden der Gesundheitszustand der Bewohner und dessen Änderungen während und nach dem Sendebetrieb verglichen.

Ergebnis: In mehreren Fällen konnten signifikante gesundheitliche Auswirkungen nachgewiesen werden. Der Gesundheitszustand dieser Bewohner besserte sich nach Senderabbau, wobei von den Untersuchern keine anderen Faktoren erkannt werden konnten, die diese Verbesserung hatte erklären können. Diese Untersuchungen mit Interviews legen den Schluss nahe, dass auf HFS- EMF zurückzuführende Auswirkungen auf die Gesundheit bei Menschen möglich sind, die unter Mobilfunkbasisstationen wohnen.

Schlussfolgerungen und Empfehlungen: Die Ergebnisse dieser Untersuchungen mit Interviews legen den Schluss nahe, dass es einen Zusammenhang gibt zwischen einer Verschlechterung des Gesundheitszustandes und Mobilfunkbasisstationen. Es wird empfohlen, weitere Forschungen und Studien bezüglich negativer Auswirkungen von HFS-EMF auf die Gesundheit durchzuführen. Diese Ergebnisse lassen uns die Installation von Mobilfunkbasisstationen auf Wohnhäusern in Frage stellen.

Schlüsselwörter: Mobilfunk, Basisstation, Hochfrequenzstrahlung (HFS), elektromagnetisches Feld (EMF), gesundheitliche Probleme, Bewohner, Anwohner.

Introduction

In 2011, the International Agency for Research on Cancer (IARC), a subsidiary body of the World Health Organization (WHO), officially declared radiofrequency electromagnetic fields (RF-EMFs) as possibly carcinogenic and a potential risk factor for gliomas and acoustic neuromas (IARC 2011). Moreover, it recommended taking precautionary measures to reduce exposure during mobile phone use, such as texting and the use of hands-free devices instead of holding the mobile phone next to the ear when talking.

However, the WHO has not issued any recommendation yet regarding adverse health effects of RF-EMFs emitted from mobile phone base stations. If there are health problems related to RF-EMF emitted from mobile phones, would the RF-EMFs from a mobile phone base station have the same effect? Mobile phone base stations constantly send signals to many mobile phones. Because of that, people living near base stations can be exposed to RF-EMFs 24 hours a day all the year (Khurana 2009). Today, there are a number of published studies concerning the impact of RF-EMFs emitted by base stations (Berg-Beckhoff et al. 2009, Blettner et al. 2009, Abdel-Rassoul 2007, Hutter et al. 2006, Eger et al. 2004, Wolf & Wolf 2004, Navarro et al. 2003, Santini et al. 2003). Some of these studies indicate possible health hazard to those living close to base stations (Berg-Beckhoff 2009, Blettner et al. 2009, Navarro et al. 2003, Santini et al. 2003). Some show a higher incidence of cancer (Eger et al. 2004, Wolf & Wolf 2004) or a higher cancer mortality (Dode et al. 2011). Hutter et al. (2006) reported that the stronger the RF-EMFs are, the higher the incidence of headaches and attention deficit disorders. Reduced cognition has also been documented (Abdel-Rassoul et al. 2007).

However, when studies like these are conducted on base stations, biases such as low frequency radiation (LF-EMF) and RF-EMF from the domestic living environment arise. Therefore, the more meticulous the research methodology is, the less significant the results indicated by the research. To get more precise results, it is necessary to eliminate biases as much as possible and to use double-blind procedures. However, conducting such research is difficult in reality.

The Situation in Japan

In Japan, there is presently little concern about the possibility of adverse health effects from mobile phones and mobile phone base stations. With the exception of a small number of cases, existing worries about mobile phones and mobile phone base stations have been ignored there (Sato et al. 2011). The reasons for this lack of attention are:

In Japan, the Ministry of Internal Affairs and Communications does not recognise any non-thermal effects from non-ionising radiation.

Furthermore, the possibility of adverse health effects is not accepted by that Ministry when power densities are below 1000 μW/cm^2 (1.8-5 GHz) (MIC 2011).
There are no official reports on the possible adverse health effects of RF-EMF emitted from mobile phone base stations in Japan. Risks and hazardous effects associated with these stations are not officially recognised in Japan. Reports about the risks of mobile phone base stations are seldom in the Japanese print and

broadcast media. A reason for this could be the mobile phone companies' media sponsorship.

Materials and Method

In 1998, a mobile phone base station was installed for the first time on the roof of the condominium in Naha City, Okinawa, Japan that is being investigated. Its antennas had an 800 MHz operational frequency [800 MHz code division multiple access (CDMA One)]. At the end of 2007, a further set of antennas with an operational frequency of 2 GHz (CDMA 2000) was installed. These were activated in March 2008. Figures 1A-D show the antenna installations on the condominium roof from different perspectives.

After the company owning the condominium withdrew its consent, the base station had to be removed. In June 2009, the 800 MHz installation was deactivated. It had been in operation for 11 years. The 2 GHz (CDMA 2000) antennas were deactivated in February 2009. They had an RF-EMF emission period of 11 months. The final removal of both the 0.8 and the 2 GHz antennas took place in August 2009. So there are two comparable time periods for comparing the symptoms before and after the residents' exposure to the 2 GHz radiation.

Figure 2 shows the chronological sequence from the erection of the base station to the removal of both sets of antennas and the timings of the medical examinations.

In January 2009, the first medical examinations and interviews with the inhabitants were carried out whilst the base station was fully operational. A second set of examinations was conducted in August 2009 after the removal of the base station. These examinations and interviews compared the health of 107 residents during the base station's operation and after its removal. The residents had no prior knowledge about possible adverse health effects of RF-EMFs.

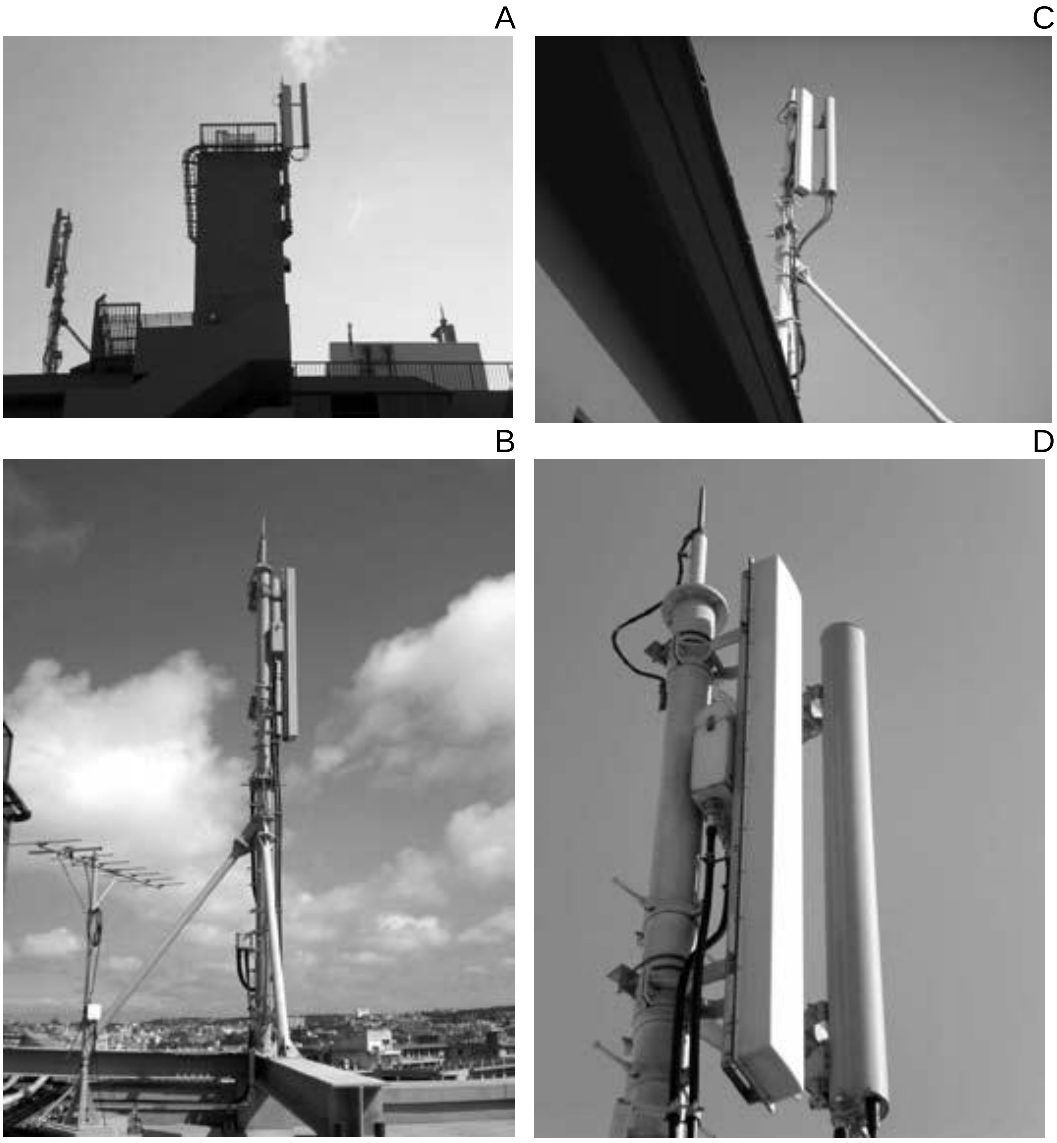


Figure 1: Close-up and overview photographs of the three transmitter masts on the roof of the condominium in Naha City, Okinawa, Japan. Each mast had an 800 MHz antenna and a 2 GHz antenna.

(A) Overview shot of all antennas, with corresponding housing for the base station's ancillary operational equipment.

(B) Antenna on the highest point of the building.

(C) View of the base stations from the balcony.

(D) Close-up of the 800 MHz (CDMA One) antennas and the 2 GHz (CDMA2000) antennas. The cylindrical antennas emit 2 GHz radiation, whereas the rectangular antennas emit 800 MHz radiation.

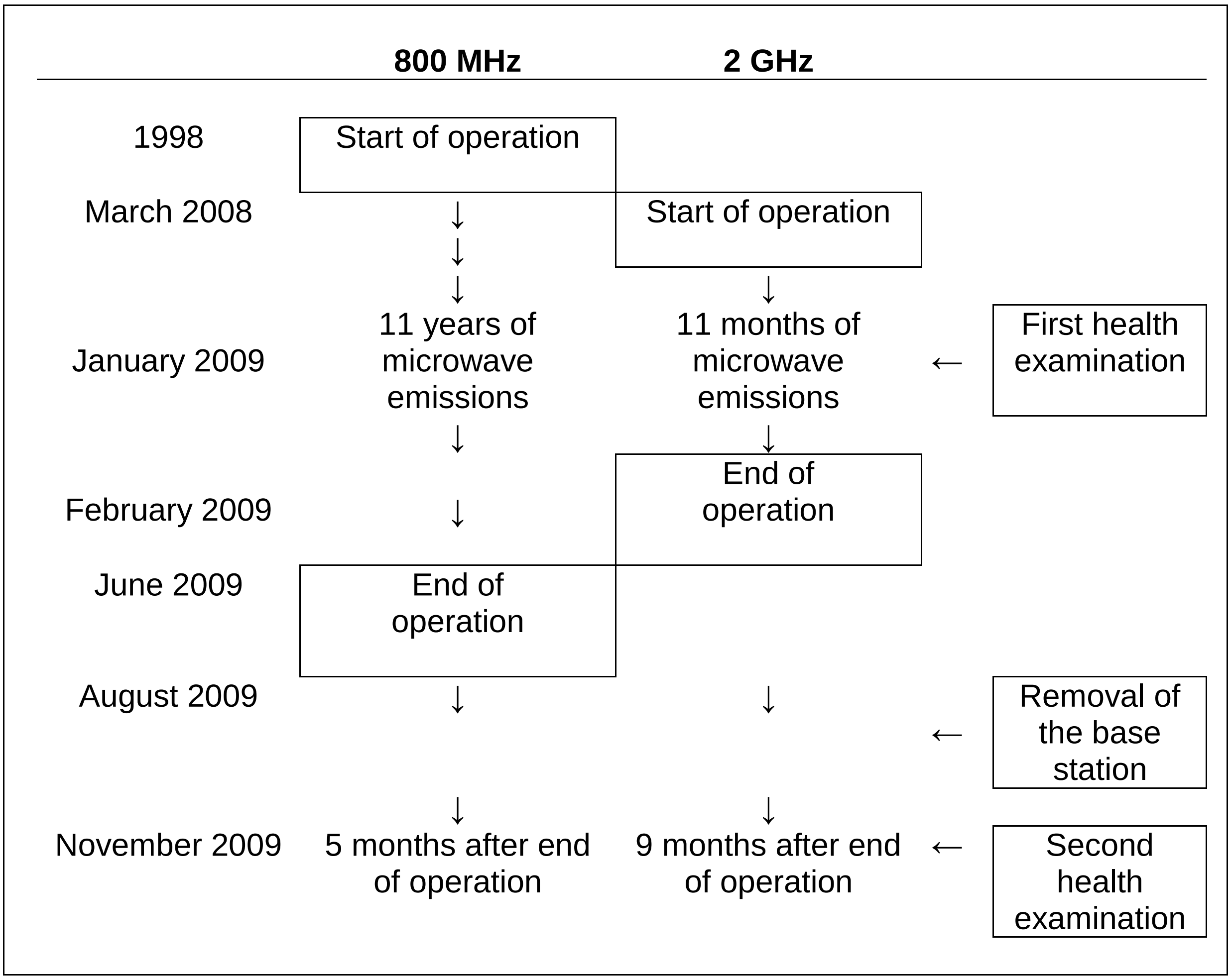


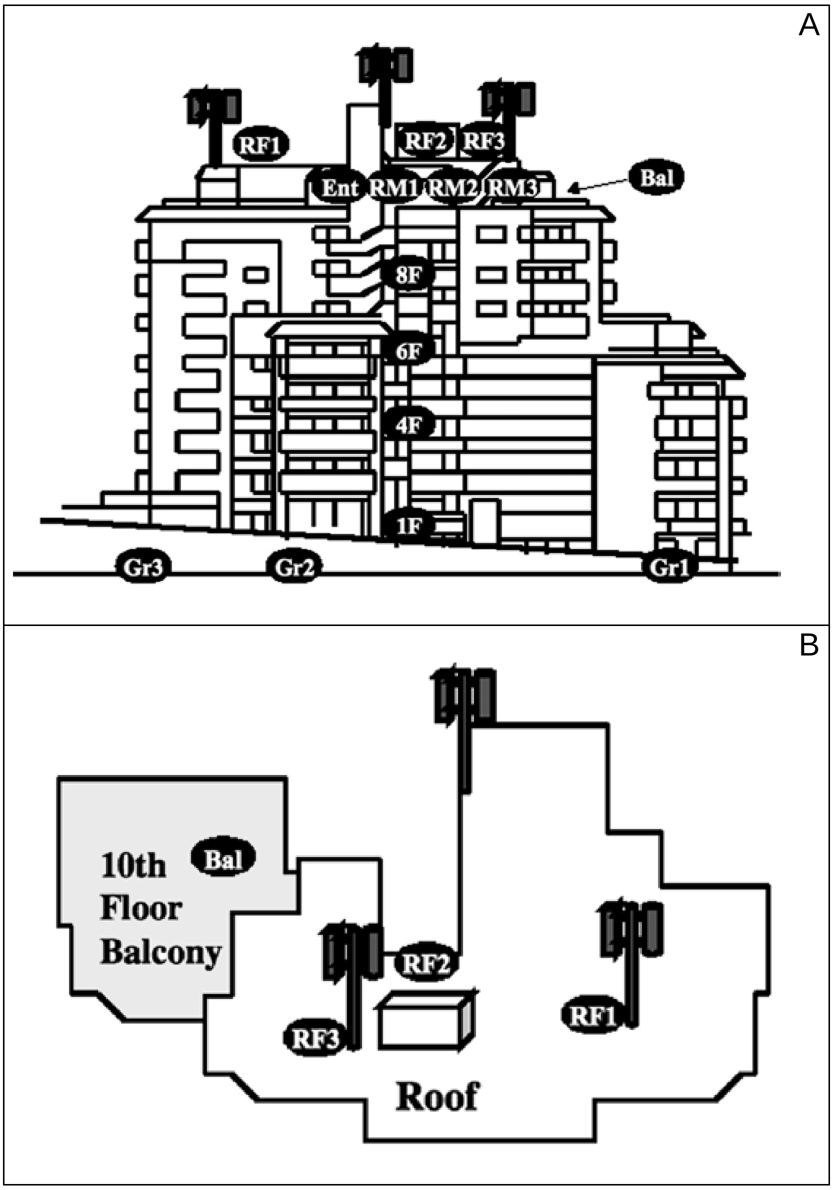
Fig. 2: Chronological overview of erection, activation, deactivation and removal of the 800 MHz and 2 GHz antennas together with the time of the health examinations.

Examination of the Condominium Residents' Health Problems

A physician and a nurse, who had both more than 20 years of clinical experience, conducted face-to-face health examinations. Before the interviews, the residents had filled out health questionnaires distributed by the physician. Inhabitants of 39 out of 47 apartments participated. Vacant apartments and inhabitants who refused to participate were excluded from the study. 107 out of the 122 individuals who answered the questionnaires were interviewed. When interviewing the inhabitants about symptoms, the time of the first appearance of symptoms was taken into account. Health problems appearing between 1998 and March 2008, shortly before the installation of the 2 GHz antennas, were recorded as symptoms associated with radiation emitted from the 800 MHz antennas. Health problems appearing after the activation of the 2 GHz antennas, i.e. after March 2008 until the first examination in January 2009, were recorded as symptoms possibly affected by radiation emitted from the 2 GHz antennas.

Measurement of the Mobile Phone Base Station Power Density

After receiving a request from the condominium association board members, the mobile phone company operating the antennas undertook power density measurements of the RF-EMFs emitted by the mobile phone base station. Two technicians employed by the mobile phone company conducted the measurements. The measuring device was an SRM-3000 (Narda Safety Test Solutions GmbH, Sandwiesenstrasse, Pfullingen, Germany). The technicians did not explain in detail to the residents how the measurements were taken. Figure 3 shows the 15 places where power density was measured. Three locations were assessed on the roof of the condominium and one on the balcony of the top (tenth) floor. Three rooms and the entrance area on that floor were also assessed, as were the entrance areas of rooms on the 8th, 6th, 4th, and 1st floor, the ground floor entrance area of the condominium and two locations within the parking lot. Before each measurement, the technicians called the operation centre. A few days later, the results of the measurements were sent to the board members of the condominium association.



Figures 3A and 3B: Measurement points used to assess the RF-EMFs emitted from the base station on 24th December 2008; elevation view (A) and plan view (B). For an explanation of the abbreviations used refer to Table 1.

Results of power density measurements taken to assess the RF-EMFs emitted by the base station			
		Power density ($\mu W/cm^2$)	
Place of measurement		**2 GHz**	**800 MHz**
Roof 1	(RF1)	0.01520	0.00336
Roof 2	(RF2)	0.00278	0.00029
Roof 3	(RF3)	0.02086	0.00258
Room 1 – 10th floor	(RM1)	0.00055	0.00028
Room 2 – 10th floor	(RM2)	0.00036	0.00031
Room 3 – 10th floor	(RM3)	0.00010	0.00060
Balcony – 10th floor	(Bal)	0.00316	0.00025
Entrance – 10th floor	(Ent)	0.00051	0.00016
8th floor	(8F)	0.00030	0.00060
6th floor	(6F)	0.00043	0.00051
4th floor	(4F)	0.00014	0.00093
1st floor	(1F)	0.00050	0.00014
Ground floor 1	(Gr1)	0.00074	0.00057
Ground floor 2	(Gr2)	0.00111	0.00011
Ground floor 3	(Gr3)	0.00246	0.00007

Table 1: Measurements taken at the locations shown in Figures 3A and 3B.

Results

Measurement of RF-EMF Emissions from the Mobile Phone Base Station

Two technicians from the mobile phone company measured the power densities at 15 different locations around the condominium to assess RF-EMF emissions from the mobile phone station on 24th December 2008 (Figures 3A and 3B). The RF-EMFs from the 800 MHz and 2 GHz antennas were measured and recorded separately. Table 1 shows the results of the measurements, which were between 0.0001 and 0.0286 $\mu W/cm^2$ (equivalent to 0.02 to 0.28 V/m).

The measurements taken at RF1 and RF3 indicated a relatively high power density. Interestingly, the power density measurements for the 2 GHz antennas showed lower values on the roof (RF2: 0.00278 $\mu W/cm^2$) than on the balcony (Bal: 0.00316 $\mu W/cm^2$). The distance between balcony and antenna was only slightly greater than the distance between RF2 and antenna. This result could be attributed to the fact that RF2 was behind the location of the base station's ancillary operational equipment.

	Frequency	Male	Female	Total
Number of residents		65	57	122
Number of respondents		56	51	107
Mean age of respondents		37.2	38.6	
(standard deviation)		(22.7)	(20.9)	
Mean exposure period	800 MHz	5.60	6.64	years
(standard deviation)		(3.10)	(2.92)	
	2 GHz	11	11	months

Table 2: Overview of the residents' age and gender distribution, as well as exposure time period.

Symptoms	Removal of the 800 MHz antennas Before	After	P-value
Tinnitus	13	4	<0.05
Myodesopsia	7	2	>0.05
Arthralgia, shoulder stiffness	7	1	<0.05
Headache	5	1	>0.05
Hypertension	4	1	>0.05
Nasal bleeding	4	0	>0.05
Tumours (lymphoma, tongue cancer, bladder cancer)	3	1	>0.05
Insomnia, sleep problems, sleep disturbances	3	1	>0.05
Dizziness, vertigo	3	1	>0.05
Eye pain, ocular infection, dry eyes	3	0	>0.05
Astigmatism, deteriorated eyesight	2	0	>0.05
Palpitation (tachycardia), arrhythmia	2	0	>0.05
Tremor	1	1	>0.05
Glaucoma	1	0	>0.05
Hearing loss	1	0	>0.05
Rhinitis (nasal discharge)	1	0	>0.05
Otitis media	1	0	>0.05
Invertebral disc hernia	1	0	>0.05
Numbness	1	0	>0.05
Skin problems	1	0	>0.05
Angina pectoris	1	0	>0.05
Complex regional pain syndrome (CRPS)	1	0	>0.05
Total	**66**	**13**	

Table 3: Health comparison before and after the removal of the 800 MHz antennas. The statistical evaluation was carried out using Fisher's exact test and the chi-square test.
Symptoms appearing during the operation of both the 800 MHz antennas and the 2 GHz antennas are printed in bold letters.

Symptoms	**Removal of the 2 GHz antennas**		
	Before	**After**	**P-value**
Fatigue, loss of motivation	21	0	<0.01
Eye pain, ocular infection, dry eyes	14	0	<0.01
Insomnia, sleep problems, sleep disturbances	11	2	<0.01
Dizziness, vertigo, Menière's disease	11	0	<0.01
Jitteriness	11	0	<0.01
Astigmatism, deteriorated eyesight	10	6	>0.05
Headache	9	1	<0.01
Impaired consciousness	8	0	<0.01
Arthralgia, shoulder stiffness	7	3	>0.05
Tinnitus	7	1	<0.05
Nasal bleeding	6	0	<0.05
Palpitation (tachycardia), arrhythmia	5	2	>0.05
Numbness	5	0	<0.05
Dyspnoea, shortness of breath	3	1	>0.05
Tumours (colon polyp, vocal chord polyp)	3	0	>0.05
Skin problems	3	0	>0.05
Memory loss	3	0	>0.05
Hyperthyroidism and hypothyroidism	2	2	>0.05
Lack of concentration	2	0	>0.05
Hypertension	2	0	>0.05
Mental confusion	2	0	>0.05
Rhinitis (nasal discharge)	2	0	>0.05
Gastritis	2	0	>0.05
Cataract	1	0	>0.05
Angina pectoris	1	0	>0.05
Facial nerve palsy	1	0	>0.05
Facial flushing	1	0	>0.05
Sweating	1	0	>0.05
Taste disorder	1	0	>0.05
Hearing loss	1	0	>0.05
Slurred speech	1	0	>0.05
Drowsiness	1	0	>0.05
Total	**158**	**18**	

Table 4: Comparison of the symptoms appearing during and after operation of the 2 GHz antennas. The statistical evaluation was carried out using Fisher's exact test and the chi-square test.
Symptoms appearing during the operation of both the 800 MHz antennas and the 2 GHz antennas are printed in bold letters.

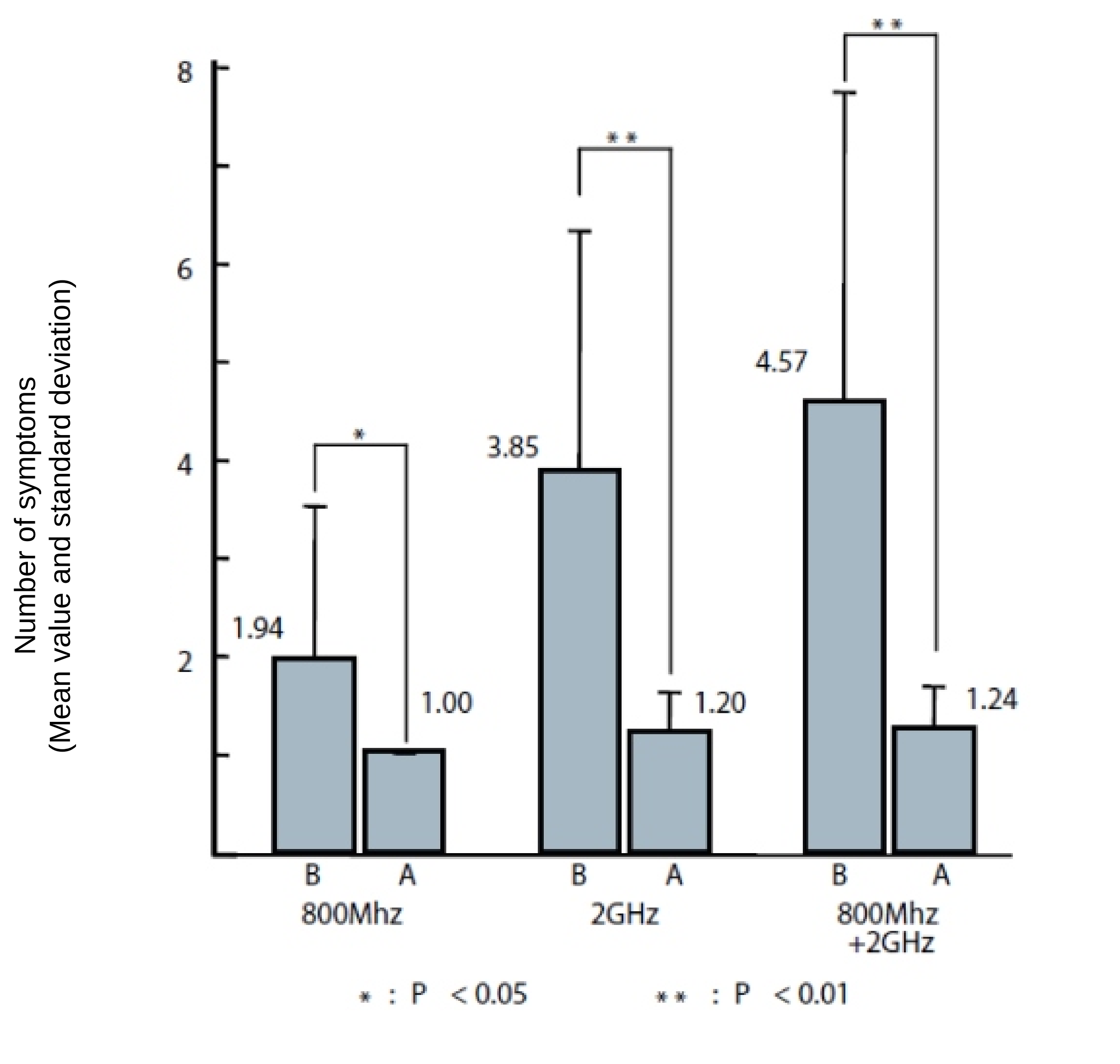


Figure 4: Comparison of symptoms before (B) and after (A) removal of the base station. The first examination (B) was conducted in January 2009 during antenna operation, the second (A) in November 2009 after removal of the base station. The Figure shows the average number of symptoms per inhabitant.

The pair of bars on the left refers to the symptoms appearing only during the operation of the 800 MHz antennas. The pair of bars in the centre refers to the time period from March 2008 to January 2009, when the 2 GHz base antennas were activated. The pair of bars on the right is the sum of both of those pairs of bars. The statistical evaluation was carried out using Student's t-test and analysis of covariance (ANCOVA).
* = P < 0.05, ** = P < 0.01.

Frequency	**Base station removal** **Before**	**After**	**χ^2**	**P-Value**	**OR [95%CI]**
	N=107 (%)	N=107 (%)			
800 MHz	34 (31.8)	13 (12.1)	10.9	< 0.001	3.37 [1.67-6.78]
2 GHz	41 (38.3)	15 (14.0)	15.1	< 0.001	3.81 [1.96-7.40]
800 MHz + 2 GHz	49 (45.8)	25 (23.4)	10.9	< 0.001	2.77 [1.54-4.97]

Table 5: Statistical comparison of the number of inhabitants with health problems before and after base station removal using the chi-square test.

Subjects of the Health Examination

The health examinations were conducted twice – in January 2009 and in November 2009 – among 107 out of 122 residents. This represented a participation rate of 87.7 %. 56 participants were male and 51 female. The average age was 37.2 years for male and 38.6 years for female participants. The average time period of RF-EMF exposure from the 800 MHz antennas was 5.60 years for the males and 6.64 years for the females. Regarding the 2 GHz RF-EMF exposure, the average exposure period was 11 months for both male and female residents. Table 2 provides an overview of the residents' age and gender distributions, as well as the periods of exposure time.

Health problems of the residents after installation of the 800 MHz antennas

34 residents said they had health problems after the 800 MHz antennas had been installed. They mentioned 66 individual symptoms, which are listed in Table 3. The health problem symptoms included: tinnitus, myodesopsia, arthralgia, shoulder stiffness, headache, and nasal bleeding. For tinnitus and arthralgia, the difference was shown to be statistically significant.

Health problems of the residents after installation of the 2 GHz antennas

After installation of the 2 GHz antennas, 41 individuals showed symptoms. 26 of these 41 participants had already exhibited symptoms after installation of the 800 MHz antennas. The subjects mentioned a total of 158 cases of symptoms. These are documented in Table 4. The most frequent symptoms were fatigue and loss of motivation, eye pain, astigmatism, deteriorated eyesight, insomnia, sleep problems, sleep disturbances, dizziness, jitteriness, tachycardia, palpitation, numbness and others. The number of these symptoms – except for astigmatism, deteriorated eyesight, tachycardia, and palpitations – decreased significantly after the removal of the mobile phone station. The symptoms that were recognised during the operation of both the 800 MHz and the 2 GHz antennas are printed in bold font. Health problems that appeared after the installation of the 2 GHz antennas were greater in number than those appearing after installation of the 800 MHz antennas. A comparison of the number of symptoms before and after removal of the mobile phone base station shows significant differences.

Comparison of the number of residents with health problems before and after removal of the mobile phone base station

A total of 34 residents suffered from health problems after installation of the 800 MHz antennas. Three months after their removal this number decreased to 13. There were 41 residents who had health problems after installation of the 2 GHz antennas, and this number decreased to 15 after removal of the 2 GHz antennas. In total 49 residents suffered from health problems during operation of both the 800 MHz and the 2 GHz antennas. However, this number decreased to 25 after removal of both sets of antennas.

These results showed significant differences using the chi-square test (Table 5).

Discussion

The power density values read by the mobile phone company are extremely low, suspiciously low, compared with measurements taken near other base stations (Abdel-Rassoul et al. 2006). Furthermore, the power density was measured only once by the mobile phone company, whereas this kind of measurement should be conducted several times. Although the power density, as measured by the mobile phone company, was too low to be considered relevant in aggravating the health problems experienced by residents, we have used these measurements as reference levels in this case study.

The RF-EMF values were highest at RF1 and RF3, two locations adjacent to the antennas. The RF-EMF power density values at RF2 were lower. It is possible that RF2's location behind the shelter accounts for these lower values. The power density of Bal, the balcony on the 10th floor, was higher than the power density at RF2. Theoretically, the RF-EMFs emitted from the antennas are not directed vertically downwards. However, it is likely that RF-EMFs were emitted downwards in the form of a side lobe. The power density measurement values clearly indicated that the 2 GHz antennas gave off more energy than the 800 MHz antennas. The number of individual health problems the residents suffered from after installation of the 800 MHz antennas was 66, and rose to 158 after installation of the 2 GHz antennas. It is possible that the health problems the residents suffered from after installation of the 2 GHz antennas were related to their high power output.

This health investigation diagnosed 34 residents with health problems appearing during operation of the 800 MHz antennas; out of these residents, 26 suffered even worse health problems after the installation of the 2 GHz antennas. Considering the fact that these residents had already recognised their health problems as related to the 800 MHz antennas, they could possibly have become more sensitive to RF-EMFs emitted from the 2 GHz antennas. Hypersensitisation could have occurred among these residents. The incidence of health problems among 26 residents out of 34 is apparently more frequent than that of electromagnetic hypersensitivity (EHS) patients (Hillert et al. 2002, Johansson 2006, Kato & Johansson 2012, Levallois et al. 2002, Schreier et al. 2006, Schröttner & Leitgeb 2008).

Moreover, it is considered that the acute symptoms could have occurred whilst those residents were exposed to the higher energy of RF-EMFs emitted by the 2 GHz antennas.

Recent studies suggest that the pattern and angle of radiation emission, the effects of modulation and the power density all need to be taken into account. An experiment using baboons revealed that the melatonin concentration in the pineal gland decreased significantly while the baboons were exposed to different modulations of EMF in a sudden onset/offset environment (Rogers et al. 1995). Furthermore, a report examining the stress hormone levels of residents living close to a mobile phone base station showed that an abnormal amount of stress hormones was secreted over the period of one year (Buchner & Eger 2011). Because of such findings, it is important to conduct longitudinal studies on stress hormone secretion under the influence of RF-EMFs. Our research examines symptoms from the installation of the 800 MHz RF-EMF emitting antennas up to the period after their removal, a total time of 11 years. Examining long-term changes of the residents' health problems has enabled us to prove that the residents' health showed significant differences before and after the removal of the mobile phone base station.

In 2000, the European Commission decided to adopt a precautionary approach as a basic principle in environmental issues. In this decision, the EU pledged to take precautionary measures to deal with environmental issues, so that irreversible consequences could be anticipated even if the risk was not scientifically proven European Union (2010). However, the Japanese Government has issued an Electromagnetic Wave Protection Guidance which states that RF-EMFs do not affect health if they are below 1000 μW/cm^2 in the 1800 MHz to 5 GHz frequency range. (MIC 2011). The value 800 MHz range permitted by the Japanese Government is 530 μW/cm2 calculated by the following formula: f (MHz)/1500 (between the frequency is 800 to 1500 MHz) (MIC 2000). As a result, an increasing number of mobile phone towers and base stations have been erected, without any regulation, on the roofs of condominium buildings. Moreover, media coverage of non-ionising radiation is in Japan much rarer than in Europe and the USA. Because of this, it is difficult for this issue to be recognised by the Japanese general public.

Summary

Our intention was to examine whether there were health impacts on residents from RF-EMFs emitted by the mobile phone base station erected on the roof of their condominium building. We conducted thorough research on whether there were any other factors to account for the improvements of the residents' health other than the removal of the base station.

The results of this case report indicate that health problems of the residents were associated with the operation of the mobile phone base station and that these problems improved after its removal. Although this report is not a double-blind study, it can be used as an example indicating the potential effects of RF-EMFs emitted from mobile phone base stations erected on the roofs of condominium buildings on human health. It is imperative that further detailed research is conducted regarding the impact of RF-EMFs on human health.

Note
This research and the corresponding data collection were conducted without outside funds in order to maintain neutrality and avoid pressures from external sources.
The original translation into the German language was made possible by a donation from the registered association "Netzwerk Risiko Mobilfunk Oberfranken e.V. (NRMO)" (= "Network Risk of Mobile Telephony in Upper Franconia") (for further information please refer to: www.mobilfunk-oberfranken.de).

Editor's Note

This article is marked as an **original scientific publication** and has been subject to a special peer-review procedure by the Scientific Advisory Board of Umwelt-Medizin-Gesellschaft.

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ATTACHMENT 3

Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

B. Blake Levitt and Henry Lai

Abstract: The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed. Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations. The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted. Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.

Key words: radiofrequency radiation (RFR), antenna arrays, cellular phone base stations, microwave sickness, nonionizing electromagnetic fields, environmental pollution.

Résumé : La localisation des stations de base pour téléphones cellulaires et autres infrastructures cellulaires, comme les installations d'antennes sur les toitures, surtout dans les quartiers résidentiels, constitue un sujet litigieux d'utilisation du territoire. La résistance locale de la part des résidents et propriétaires fonciers limitrophes repose souvent sur les craintes d'effets adverses pour la santé, en dépit des réassurances venant des fournisseurs de services de télécommunication, à l'effet qu'ils appliquent les standards internationaux d'exposition. En plus de rapports anecdotiques, certaines études épidémiologiques font état de maux de tête, d'éruption cutanée, de perturbation du sommeil, de dépression, de diminution de libido, d'augmentations du taux de suicide, de problèmes de concentration, de vertiges, d'altération de la mémoire, d'augmentation du risque de cancers, de trémulations et autres effets neurophysiologiques, dans les populations vivant au voisinage des stations de base. Les auteurs révisent ici les études existantes portant sur les gens, vivant ou travaillant près d'infrastructures cellulaires ou autres études pertinentes qui pourraient s'appliquer aux expositions à long terme à la radiation de radiofréquence de faible intensité « RFR ». Bien que la recherche épidémiologique spécifique dans ce domaine soit rare et contradictoire, et que de telles expositions soient difficiles à quantifier compte tenu des degrés croissants du bruit de fond des RFR provenant de produits de myriades de consommateurs personnels, il existe certaines recherches qui justifient la prudence dans l'installation des infrastructures. Les futures études épidémiologiques sont nécessaires afin de prendre en compte la totalité des expositions à la RFR ambiante. Les symptômes rapportés jusqu'ici pourraient correspondre à la maladie classique des micro-ondes, décrite pour la première fois en 1978. Les champs électromagnétiques non-ionisants constituent les formes de pollution environnementale croissant le plus rapidement. On peut effectuer certaines extrapolations à partir de recherches autres qu'épidémiologiques concernant les effets biologiques d'expositions à des degrés bien au-dessous des directives internationales.

Mots-clés : radiofréquence de faible intensité « RFR », les installations d'antennes, des stations de base pour téléphones cellulaires, la maladie classique des micro-ondes, les champs électromagnétiques non-ionisants, pollution environnementale.

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1. Introduction

Wireless technologies are ubiquitous today. According to the European Information Technology Observatory, an industry-funded organization in Germany, the threshold of 5.1 billion cell phone users worldwide will be reached by the end of 2010 — up from 3.3 billion in 2007. That number is expected to increase by another 10% to 5.6 billion in 2011, out of a total worldwide population of 6.5 billion.[2] In 2010, cell phone subscribers in the U.S. numbered 287 million, Russia 220 million, Germany 111 million, Italy 87 million, Great Britain 81 million, France 62 million, and Spain 57 million. Growth is strong throughout Asia and in South America but especially so in developing countries where landline systems were never fully established.

The investment firm Bank of America Merril-Lynch estimated that the worldwide penetration of mobile phone customers is twice that of landline customers today and that America has the highest minutes of use per month per user.[3] Today, 94% of Americans live in counties with four or more wireless service providers, plus 99% of Americans live in counties where next generation, 3G (third generation), 4G (fourth generation), and broadband services are available. All of this capacity requires an extensive infrastructure that the industry continues to build in the U.S., despite a 93% wireless penetration of the total U.S. population.[4]

Next generation services are continuing to drive the build-out of both new infrastructure as well as adaptation of preexisting sites. According to the industry, there are an estimated 251 618 cell sites in the U.S. today, up from 19 844 in 1995.[4] There is no comprehensive data for antennas hidden inside of buildings but one industry-maintained Web site (www.antennasearch.com), allows people to type in an address and all antennas within a 3 mile (1 mile = 1.6 km) area will come up. There are hundreds of thousands in the U.S. alone.

People are increasingly abandoning landline systems in favor of wireless communications. One estimate in 2006 found that 42% of all wireless subscribers used their wireless phone as their primary phone. According to the National Center for Health Statistics of the U.S. Centers for Disease Control (CDC), by the second half of 2008, one in every five American households had no landlines but did have at least one wireless phone (Department of Health and Human Services 2008). The figures reflected a 2.7% increase over the first half of 2008 — the largest jump since the CDC began tracking such data in 2003, and represented a total of 20.2% of the U.S. population — a figure that coincides with industry estimates of 24.50% of completely wireless households in 2010.[5] The CDC also found that approximately 18.7% of all children, nearly 14 million, lived in households with only wireless phones. The CDC further found that one in every seven American homes, 14.5% of the population, received all or almost all of their calls via wireless phones, even when there was a landline in the home. They called these “wireless-mostly households.”

The trend away from landline phones is obviously increasing as wireless providers market their services specifically toward a mobile customer, particularly younger adults who readily embrace new technologies. One study (Silke et al. 2010) in Germany found that children from lower socioeconomic backgrounds not only owned more cell phones than children from higher economic groups, but also used their cell phones more often — as determined by the test groups’ wearing of personal dosimetry devices. This was the first study to track such data and it found an interesting contradiction to the assumption that higher socioeconomic groups were the largest users of cell services. At one time, cell phones were the status symbol of the wealthy. Today, it is also a status symbol of lower socioeconomic groups. The CDC found in their survey discussed above that 65.3% of adults living in poverty or living near poverty were more likely than higher income adults to be living in households with wireless only telephones. There may be multiple reasons for these findings, including a shift away from cell phone dialogues to texting in younger adults in higher socioeconomic categories.

In some developing countries where landline systems have never been fully developed outside of urban centers, cell phones are the only means of communication. Cellular technology, especially the new 3G, 4G, and broadband services that allow wireless communications for real-time voice communication, text messaging, photos, Internet connections, music and video downloads, and TV viewing, is the fastest growing segment of many economies that are in otherwise sharp decline due to the global economic downturn.

There is some indication that although the cellular phone markets for many European countries are more mature than in the U.S., people there may be maintaining their landline use while augmenting with mobile phone capability. This may be a consequence of the more robust media coverage regarding health and safety issues of wireless technology in the European press, particularly in the UK, as well as recommendations by European governments like France and Germany[6] that citizens not abandon their landline phones or wired computer systems because of safety concerns. According to OfCom’s 2008 *Communications Market Interim Report* (OfCom 2008), which provided information up to December 2007, approximately 86% of UK adults use cell phones. While four out of five households have both cell phones and landlines, only 11% use cell phones exclusively, a total down from 28% noted by this group in 2005. In addition, 44% of UK adults use text messaging on a daily basis. Fixed landline services fell by 9% in 2007 but OfCom notes that landline services continue to be strong despite the fact that mobile services also continued to grow by 16%. This indicates that people are continuing to use both landlines and wireless technology rather than choosing one over the other in the UK. There were 51 300 UK base station sites in

[2] http://www.eito.com/pressinformation_20100811.htm. (Accessed October 2010.)
[3] http://www.ctia.org/advocacy/research/index.cfm/AID/10377. (Accessed October 2010.)
[4] http://www.ctia.org/advocacy/research/index.cfm/AID/10323. (Accessed October 2010.)
[5] http://www.ctia.org/advocacy/research/index.cfm/AID/10323. (Accessed October 2010.)
[6] http://www.icems.eu/docs/deutscher_bundestag.pdf and http://www.icems.eu/docs/resolutions/EP_EMF_resolution_2APR09.pdf. (Accessed October 2010.)

the beginning of 2009 (two-thirds installed on existing buildings or structures) with an estimated 52 900 needed to accommodate new 3G and 4G services by the end of 2009.

Clearly, this is an enormous global industry. Yet, no money has ever been appropriated by the industry in the U.S., or by any U.S. government agency, to study the potential health effects on people living near the infrastructure. The most recent research has all come from outside of the U.S. According to the CTIA – The Wireless Association, "If the wireless telecom industry were a country, its economy would be bigger than that of Egypt, and, if measured by GNP (gross national product), [it] would rank as the 46th largest country in the world." They further say, "It took more than 21 years for color televisions to reach 100 million consumers, more than 90 years for landline service to reach 100 million consumers, and less than 17 years for wireless to reach 100 million consumers."[7]

In lieu of building new cell towers, some municipalities are licensing public utility poles throughout urban areas for Wi-Fi antennas that allow wireless Internet access. These systems can require hundreds of antennas in close proximity to the population with some exposures at a lateral height where second- and third-storey windows face antennas. Most of these systems are categorically excluded from regulation by the U.S. Federal Communications Commission (FCC) or oversight by government agencies because they operate below a certain power density threshold. However, power density is not the only factor determining biological effects from radiofrequency radiation (RFR).

In addition, when the U.S. and other countries permanently changed from analog signals used for television transmission to newer digital formats, the old analog frequencies were reallocated for use by municipal services such as police, fire, and emergency medical dispatch, as well as to private telecommunications companies wanting to expand their networks and services. This creates another significant increase in ambient background exposures.

Wi-Max is another wireless service in the wings that will broaden wireless capabilities further and place additional towers and (or) transmitters in close proximity to the population in addition to what is already in existence. Wi-Max aims to make wireless Internet access universal without tying the user to a specific location or "hotspot." The rollout of Wi-Max in the U.S., which began in 2009, uses lower frequencies at high power densities than currently used by cellular phone transmission. Many in science and the activist communities are worried, especially those concerrned about electromagnetic-hypersensitivity syndrome (EHS).

It remains to be seen what additional exposures "smart grid" or "smart meter" technology proposals to upgrade the electrical powerline transmission systems will entail regarding total ambient RFR increases, but it will add another ubiquitous low-level layer. Some of the largest corporations on earth, notably Siemens and General Electric, are involved. Smart grids are being built out in some areas of the U.S. and in Canada and throughout Europe. That technology plans to alter certain aspects of powerline utility metering from a wired system to a partially wireless one. The systems require a combination of wireless transmitters attached to homes and businesses that will send radio signals of approximately 1 W output in the 2.4000–2.4835 GHz range to local "access point" transceivers, which will then relay the signal to a further distant information center (Tell 2008). Access point antennas will require additional power density and will be capable of interfacing with frequencies between 900 MHz and 1.9 GHz. Most signals will be intermittent, operating between 2 to 33 seconds per hour. Access points will be mounted on utility poles as well as on free-standing towers. The systems will form wide area networks (WANs), capable of covering whole towns and counties through a combination of "mesh-like" networks from house to house. Some meters installed on private homes will also act as transmission relays, boosting signals from more distant buildings in a neighborhood. Eventually, WANs will be completely linked.

Smart grid technology also proposes to allow homeowners to attach additional RFR devices to existing indoor appliances, to track power use, with the intention of reducing usage during peak hours. Manufacturers like General Electric are already making appliances with transmitters embedded in them. Many new appliances will be incapable of having transmitters deactivated without disabling the appliance and the warranty. People will be able to access their home appliances remotely by cell phone. The WANs smart grids described earlier in the text differ significantly from the current upgrades that many utility companies have initiated within recent years that already use low-power RFR meters attached to homes and businesses. Those first generation RFR meters transmit to a mobile van that travels through an area and "collects" the information on a regular billing cycle. Smart grids do away with the van and the meter reader and work off of a centralized RFR antenna system capable of blanketing whole regions with RFR.

Another new technology in the wings is broadband over powerlines (BPL). It was approved by the U.S. FCC in 2007 and some systems have already been built out. Critics of the latter technology warned during the approval process that radiofrequency interference could occur in homes and businesses and those warnings have proven accurate. BPL technology couples radiofrequency bands with extremely low frequency (ELF) bands that travel over powerline infrastructure, thereby creating a multi-frequency field designed to extend some distance from the lines themselves. Such couplings follow the path of conductive material, including secondary distribution lines, into people's homes.

There is no doubt that wireless technologies are popular with consumers and businesses alike, but all of this requires an extensive infrastructure to function. Infrastructure typically consists of freestanding towers (either preexisting towers to which cell antennas can be mounted, or new towers specifically built for cellular service), and myriad methods of placing transceiving antennas near the service being called for by users. This includes attaching antenna panels to the sides of buildings as well as roof-mountings; antennas hidden inside church steeples, barn silos, elevator shafts, and any number of other "stealth sites." It also includes camouflaging towers to look like trees indigenous to areas where they are placed, e.g., pine trees in northern climates, cacti

[7] CTIA website: http://www.ctia.org/advocay/research/index.cfm/AID/10385. (Accessed 9 December 2008.)

in deserts, and palm trees in temperate zones, or as chimneys, flagpoles, silos, or other tall structures (Rinebold 2001). Often the rationale for stealth antenna placement or camouflaging of towers is based on the aesthetic concerns of host communities.

An aesthetic emphasis is often the only perceived control of a municipality, particularly in countries like America where there is an overriding federal preemption that precludes taking the "environmental effects" of RFR into consideration in cell tower siting as stipulated in Section 704 of *The Telecommunications Act of 1996* (USFCC 1996). Citizen resistance, however, is most often based on health concerns regarding the safety of RFR exposures to those who live near the infrastructure. Many citizens, especially those who claim to be hypersensitive to electromagnetic fields, state they would rather know where the antennas are and that hiding them greatly complicates society's ability to monitor for safety.[8]

Industry representatives try to reassure communities that facilities are many orders of magnitude below what is allowed for exposure by standards-setting boards and studies bear that out (Cooper et al. 2006; Henderson and Bangay 2006; Bornkessel et al. 2007). These include standards by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) used throughout Europe, Canada, and elsewhere (ICNIRP 1998). The standards currently adopted by the U.S. FCC, which uses a two-tiered system of recommendations put out by the National Council on Radiation Protection (NCRP) for civilian exposures (referred to as uncontrolled environments), and the International Electricians and Electronics Engineers (IEEE) for professional exposures (referred to as controlled environments) (U.S. FCC 1997). The U.S. may eventually adopt standards closer to ICNIRP. The current U.S. standards are more protective than ICNIRP's in some frequency ranges so any harmonization toward the ICNIRP standards will make the U.S. limits more lenient.

All of the standards currently in place are based on RFRs ability to heat tissue, called thermal effects. A longstanding criticism, going back to the 1950s (Levitt 1995), is that such acute heating effects do not take potentially more subtle non-thermal effects into consideration. And based on the number of citizens who have tried to stop cell towers from being installed in their neighborhoods, laypeople in many countries do not find adherence to exisitng standards valid in addressing health concerns. Therefore, infrastructure siting does not have the confidence of the public (Levitt 1998).

2. A changing industry

Cellular phone technology has changed significantly over the last two decades. The first wireless systems began in the mid-1980s and used analog signals in the 850–900 MHz range. Because those wavelengths were longer, infrastructure was needed on average every 8 to 10 miles apart. Then came the digital personal communications systems (PCS) in the late 1990s, which used higher frequencies, around 1900 GHz, and digitized signals. The PCS systems, using shorter wavelengths and with more stringent exposure guidelines, require infrastructure approximately every 1 to 3 miles apart. Digital signals work on a binary method, mimicking a wave that allows any frequency to be split in several ways, thereby carrying more information far beyond just voice messages.

Today's 3G network can send photos and download music and video directly onto a cell phone screen or iPod. The new 4G systems digitize and recycle some of the older frequencies in the 700 to 875 MHz bands to create another service for wireless Internet access. The 4G network does not require a customer who wants to log on wirelessly to locate a "hot spot" as is the case with private Wi-Fi systems. Today's Wi-Fi uses a network of small antennas, creating coverage of a small area of 100 ft ($\sim$30 m) or so at homes or businesses. Wi-fi can also create a small wireless computer system in a school where they are often called wireless local area networks (WLANs). Whole cities can make Wi-Fi available by mounting antennas to utility poles.

Large-scale Wi-Fi systems have come under increasing opposition from citizens concerned about health issues who have legally blocked such installations (Antenna Free Union[9]). Small-scale Wi-Fi has also come under more scrutiny as governments in France and throughout Europe have banned such installations in libraries and schools, based on precautionary principles (REFLEX Program 2004).

3. Cell towers in perspective: some definitions

Cell towers are considered low-power installations when compared to many other commercial uses of radiofrequency energy. Wireless transmission for radio, television (TV), satellite communications, police and military radar, federal homeland security systems, emergency response networks, and many other applications all emit RFR, sometimes at millions of watts of effective radiated power (ERP). Cellular facilities, by contrast, use a few hundred watts of ERP per channel, depending on the use being called for at any given time and the number of service providers co-located at any given tower.

No matter what the use, once emitted, RFR travels through space at the speed of light and oscillates during propagation. The number of times the wave oscillates in one second determines its frequency.

Radiofrequency radiation covers a large segment of the electromagnetic spectrum and falls within the nonionizing bands. Its frequency ranges between 10 kHz to 300 GHz; 1 Hz = 1 oscillation per second; 1 kHz = 1000 Hz; 1 MHz = 1 000 000 Hz; and 1 GHz = 1 000 000 000 Hz.

Different frequencies of RFR are used in different applications. Some examples include the frequency range of 540 to 1600 kHz used in AM radio transmission; and 76 to 108 MHz used for FM radio. Cell-phone technology uses frequencies between 800 MHz and 3 GHz. The RFR of 2450 MHz is used in some Wi-Fi applications and microwave cooking.

Any signal can be digitized. All of the new telecommunications technologies are digitized and in the U.S., all TV is

[8] See, for example, www.radiationresearch.org. (Accessed October 2010.)
[9] http://www.antennafreeunion.org/. (Accessed October 2010.)

broadcast in 100% digital formats — digital television (DTV) and high definition television (HDTV). The old analog TV signals, primarily in the 700 MHz ranges, will now be recycled and relicensed for other applications to additional users, creating additional layers of ambient exposures.

The intensity of RFR is generally measured and noted in scientific literature in watts per square meter (W/m^2); milliwatts per square centimetre (mW/cm^2), or microwatts per square centimetre ($\mu W/cm^2$). All are energy relationships that exist in space. However, biological effects depend on how much of the energy is absorbed in the body of a living organism, not just what exists in space.

4. Specific absorption rate (SAR)

Absorption of RFR depends on many factors including the transmission frequency and the power density, one's distance from the radiating source, and one's orientation toward the radiation of the system. Other factors include the size, shape, mineral and water content of an organism. Children absorb energy differently than adults because of differences in their anatomies and tissue composition. Children are not just "little adults". For this reason, and because their bodies are still developing, children may be more susceptible to damage from cell phone radiation. For instance, radiation from a cell phone penetrates deeper into the head of children (Gandhi et al. 1996; Wiart et al. 2008) and certain tissues of a child's head, e.g., the bone marrow and the eye, absorb significantly more energy than those in an adult head (Christ et al. 2010). The same can be presumed for proximity to towers, even though exposure will be lower from towers under most circumstances than from cell phones. This is because of the distance from the source. The transmitter is placed directly against the head during cell phone use whereas proximity to a cell tower will be an ambient exposure at a distance.

There is little difference between cell phones and the domestic cordless phones used today. Both use similar frequencies and involve a transmitter placed against the head. But the newer digitally enhanced cordless technology (DECT) cordless domestic phones transmit a constant signal even when the phone is not in use, unlike the older domestic cordless phones. But some DECT brands are available that stop transmission if the mobile units are placed in their docking station.

The term used to describe the absorption of RFR in the body is specific absorption rate (SAR), which is the rate of energy that is actually absorbed by a unit of tissue. Specific absorption rates (SARs) are generally expressed in watts per kilogram (W/kg) of tissue. The SAR measurements are averaged either over the whole body, or over a small volume of tissue, typically between 1 and 10 g of tissue. The SAR is used to quantify energy absorption to fields typically between 100 kHz and 10 GHz and encompasses RFR from devices such as cellular phones up through diagnostic MRI (magnetic resonance imaging).

Specific absorption rates are a more reliable determinant and index of RFR's biological effects than are power density, or the intensity of the field in space, because SARs reflect what is actually being absorbed rather than the energy in space. However, while SARs may be a more precise model, at least in theory, there were only a handful of animal studies that were used to determine the threshold values of SAR for the setting of human exposure guidelines (de Lorge and Ezell 1980; de Lorge 1984). (For further information see Section 8). Those values are still reflected in today's standards.

It is presumed that by controlling the field strength from the transmitting source that SARs will automatically be controlled too, but this may not be true in all cases, especially with far-field exposures such as near cell or broadcast towers. Actual measurement of SARs is very difficult in real life so measurements of electric and magnetic fields are used as surrogates because they are easier to assess. In fact, it is impossible to conduct SAR measurements in living organisms so all values are inferred from dead animal measurements (thermography, calorimetry, etc.), phantom models, or computer simulation (FDTD).

However, according to the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) *Health Effects of Exposure to EMF*, released in January of 2009:

> . . . recent studies of whole body plane wave exposure of both adult and children phantoms demonstrated that when children and small persons are exposed to levels which are in compliance with reference levels, exceeding the basic restrictions cannot be excluded [Dimbylow and Bloch 2007; Wang et al. 2006; Kuhn et al., 2007; Hadjem et al., 2007]. While the whole frequency range has been investigated, such effects were found in the frequency bands around 100 MHz and also around 2 GHz. For a model of a 5-year-old child it has been shown that when the phantom is exposed to electromagnetic fields at reference levels, the basic restrictions were exceeded by 40% [Conil et al., 2008]. . .. Moreover, a few studies demonstrated that multipath exposure can lead to higher exposure levels compared to plane wave exposure [Neubauer et al. 2006; Vermeeren et al. 2007]. It is important to realize that this issue refers to far field exposure only, for which the actual exposure levels are orders of magnitude below existing guidelines. (p. 34–35, SCENIHR 2009)

In addition to average SARs, there are indications that biological effects may also depend on how energy is actually deposited in the body. Different propagation characteristics such as modulation, or different wave-forms and shapes, may have different effects on living systems. For example, the same amount of energy can be delivered to tissue continuously or in short pulses. Different biological effects may result depending on the type and duration of the exposure.

5. Transmission facilities

The intensity of RFR decreases rapidly with the distance from the emitting source; therefore, exposure to RFR from transmission towers is often of low intensity depending on one's proximity. But intensity is not the only factor. Living near a facility will involve long-duration exposures, sometimes for years, at many hours per day. People working at home or the infirm can experience low-level 24 h exposures. Nighttimes alone will create 8 h continuous exposures. The current standards for both ICNIRP, IEEE and the NCRP (adopted by the U.S. FCC) are for whole-body exposures averaged over a short duration (minutes) and are based on results from short-term exposure studies, not for long-term, low-level exposures such as those experienced by people living or working near transmitting facilities. For such populations, these can be involuntary exposures, unlike cell phones where user choice is involved.

There have been some recent attempts to quantify human SARs in proximity to cell towers but these are primarily for occupational exposures in close proximity to the sources and questions raised were dosimetry-based regarding the accuracy of antenna modeling (van Wyk et al. 2005). In one study by Martínez-Búrdalo et al. (2005) however, the researchers used high-resolution human body models placed at different distances to assess SARs in worst-case exposures to three different frequencies — 900, 1800, and 2170 MHz. Their focus was to compute whole-body averaged SARs at a maximum 10 g averaged SAR inside the exposed model. They concluded that for

> . . . antenna–body distances in the near zone of the antenna, the fact that averaged field values are below reference levels, could, at certain frequencies, not guarantee guidelines compliance based on basic restrictions.
> (p. 4125, Martínez-Búrdalo et al. 2005)

This raises questions about the basic validity of predicting SARs in real-life exposure situations or compliance to guidelines according to standard modeling methods, at least when one is very close to an antenna.

Thus, the relevant questions for the general population living or working near transmitting facilities are: Do biological and (or) health effects occur after exposure to low-intensity RFR? Do effects accumulate over time, since the exposure is of a long duration and may be intermittent? What precisely is the definition of low-intensity RFR? What might its biological effects be and what does the science tell us about such exposures?

6. Government radiofrequency radiation (RFR) guidelines: how spatial energy translates to the body's absorption

The U.S. FCC has issued guidelines for both power density and SARs. For power density, the U.S. guidelines are between 0.2–1.0 mW/cm^2. For cell phones, SAR levels require hand-held devices to be at or below 1.6 W/kg measured over 1.0 g of tissue. For whole body exposures, the limit is 0.08 W/kg.

In most European countries, the SAR limit for hand-held devices is 2.0 W/kg averaged over 10 g of tissue. Whole body exposure limits are 0.08 W/kg.

At 100–200 ft ($\sim$30–60 m) from a cell phone base station, a person can be exposed to a power density of 0.001 mW/cm^2 (i.e., 1.0 μW/cm^2). The SAR at such a distance can be 0.001 W/kg (i.e., 1.0 mW/kg). The U.S. guidelines for SARs are between 0.08–0.40 W/kg.

For the purposes of this paper, we will define low-intensity exposure to RFR of power density of 0.001 mW/cm^2 or a SAR of 0.001 W/kg.

7. Biological effects at low intensities

Many biological effects have been documented at very low intensities comparable to what the population experiences within 200 to 500 ft ($\sim$60–150 m) of a cell tower, including effects that occurred in studies of cell cultures and animals after exposures to low-intensity RFR. Effects reported include: genetic, growth, and reproductive; increases in permeability of the blood–brain barrier; behavioral; molecular, cellular, and metabolic; and increases in cancer risk. Some examples are as follows:

- Dutta et al. (1989) reported an increase in calcium efflux in human neuroblastoma cells after exposure to RFR at 0.005 W/kg. Calcium is an important component in normal cellular functions.
- Fesenko et al. (1999) reported a change in immunological functions in mice after exposure to RFR at a power density of 0.001 mW/cm^2.
- Magras and Xenos (1997) reported a decrease in reproductive function in mice exposed to RFR at power densities of 0.000168–0.001053 mW/cm^2.
- Forgacs et al. (2006) reported an increase in serum testosterone levels in rats exposed to GSM (global system for mobile communication)-like RFR at SAR of 0.018–0.025 W/kg.
- Persson et al. (1997) reported an increase in the permeability of the blood–brain barrier in mice exposed to RFR at 0.0004–0.008 W/kg. The blood–brain barrier is a physiological mechanism that protects the brain from toxic substances, bacteria, and viruses.
- Phillips et al. (1998) reported DNA damage in cells exposed to RFR at SAR of 0.0024–0.024 W/kg.
- Kesari and Behari (2009) also reported an increase in DNA strand breaks in brain cells of rats after exposure to RFR at SAR of 0.0008 W/kg.
- Belyaev et al. (2009) reported changes in DNA repair mechanisms after RFR exposure at a SAR of 0.0037 W/kg. A list of publications reporting biological and (or) health effects of low-intensity RFR exposure is in Table 1.

Out of the 56 papers in the list, 37 provided the SAR of exposure. The average SAR of these studies at which biological effects occurred is 0.022 W/kg — a finding below the current standards.

Ten years ago, there were only about a dozen studies reporting such low-intensity effects; currently, there are more than 60. This body of work cannot be ignored. These are important findings with implications for anyone living or working near a transmitting facility. However, again, most of the studies in the list are on short-term (minutes to hours) exposure to low-intensity RFR. Long-term exposure studies are sparse. In addition, we do not know if all of these reported effects occur in humans exposed to low-intensity RFR, or whether the reported effects are health hazards. Biological effects do not automatically mean adverse health effects, plus many biological effects are reversible. However, it is clear that low-intensity RFR is not biologically inert. Clearly, more needs to be learned before a presumption of safety can continue to be made regarding placement of antenna arrays near the population, as is the case today.

Table 1. List of studies reporting biological effects at low intensities of radiofrequency radiation (RFR).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Balmori (2010) (in vivo) (eggs and tadpoles of frog)	88.5–1873.6 MHz	Cell phone base station emission	2 months		3.25	Retarded development
Belyaev et al. (2005) (in vitro)	915 MHz	GSM	24, 48 h	0.037		Genetic changes in human white blood cells
Belyaev et al. (2009) (in vitro)	915 MHz, 1947 MHz	GSM, UMTS	24, 72 h	0.037		DNA repair mechanism in human white blood cells
Blackman et al. (1980) (in vitro)	50 MHz	AM at 16 Hz		0.0014		Calcium in forebrain of chickens
Boscol et al. (2001) (in vivo) (human whole body)	500 KHz–3 GHz	TV broadcast			0.5	Immunological system in women
Campisi et al. (2010) (in vitro)	900 MHz	CW (CW– no effect observed) AM at 50 Hz	14 days, 5, 10, 20 min per day		26	DNA damage in human glial cells
Capri et al. (2004) (in vitro)	900 MHz	GSM	1 h/day, 3 days	0.07		A slight decrease in cell proliferation when human immune cells were stimulated with mitogen and a slight increase in the number of cells with altered distribution of phosphatidylserine across the membrane
Chiang et al. (1989) (in vivo) (human whole body)	Lived and worked close to AM radio and radar installations for more than 1 year				10	People lived and worked near AM radio antennas and radar installations showed deficits in psychological and short-term memory tests
de Pomerai et al. (2003) (in vitro)	1 GHz		24, 48 h	0.015		Protein damages
D'Inzeo et al. (1988) (in vitro)	10.75 GHz	CW	30–120 s	0.008		Operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions
Dutta et al. (1984) (in vitro)	915 MHz	Sinusoidal AM at 16 Hz	30 min	0.05		Increase in calcium efflux in brain cancer cells
Dutta et al. (1989) (in vitro)	147 MHz	Sinusoidal AM at 16 Hz	30 min	0.005		Increase in calcium efflux in brain cancer cells
Fesenko et al. (1999) (in vivo) (mouse- wavelength in mm range)	From 8.15–18 GHz		5 h to 7 days direction of response depended on exposure duration		1	Change in immunological functions
Forgacs et al. (2006) (in vivo) (mouse whole body)	1800 MHz	GSM, 217 Hz pulses, 576 μs pulse width	2 h/day, 10 days	0.018		Increase in serum testosterone
Guler et al. (2010) (In vivo) (rabbit whole body)	1800 MHz	AM at 217 Hz	15 min/day, 7 days		52	Oxidative lipid and DNA damages in the brain of pregnant rabbits

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Table 1 (*continued*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Hjollund et al. (1997) (in vivo) (human partial or whole body)	Military radars				10	Sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems, were significantly lower compared to references
Ivaschuk et al. (1997) (in vitro)	836.55 MHz	TDMA	20 min	0.026		A gene related to cancer
Jech et al. (2001) (in vivo) (human partial body exposure-narcoleptic patients)	900 MHz	GSM— 217 Hz pulses, 577 µs pulse width	45 min	0.06		Improved cognitive functions
Kesari and Behari (2009) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Double strand DNA breaks observed in brain cells
Kesari and Behari (2010) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Reproductive system of male rats
Kesari et al. (2010) (in vivo) (rat whole body)	2450 MHz	50 Hz modulation	2 h/day, 35 days	0.11		DNA double strand breaks in brain cells
Kwee et al. (2001) (in vitro)	960 MHz	GSM	20 min	0.0021		Increased stress protein in human epithelial amnion cells
Lebedeva et al. (2000) (in vivo) (human partial body)	902.4 MHz	GSM	20 min		60	Brain wave activation
Lerchl et al. (2008) (in vivo) (hamster whole body)	383 MHz 900 and 1800 MHz	TETRA GSM	24 h/day, 60 days	0.08		Metabolic changes
Magras and Xenos (1997) (in vivo) (mouse whole body)	"Antenna park"	TV and FM-radio	Exposure over several generations		0.168	Decrease in reproductive function
Mann et al. (1998) (in vivo) (human whole body)	900 MHz	GSM pulse-modulated at 217 Hz, 577 µs width	8 h		20	A transient increase in blood cortisol
Marinelli et al. (2004) (in vitro)	900 MHz	CW	2–48 h	0.0035		Cell's self-defense responses triggered by DNA damage
Markovà et al. (2005) (in vitro)	915 and 905 MHz	GSM	1 h	0.037		Chromatin conformation in human white blood cells
Navakatikian and Tomashevskaya (1994) (in vivo) (rat whole body)	2450 MHz 3000 MHz	CW (no effect observed) Pulse-modulated 2 µs pulses at 400 Hz	Single (0.5–12hr) or repeated (15–60 days, 7–12 h/day) exposure, CW–no effect	0.0027		Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin
Nittby et al. (2008) (in vivo) (rat whole body)	900 MHz,	GSM	2 h/week, 55 weeks	0.0006		Reduced memory functions
Novoselova et al. (1999) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time – 16 ms reverse, 5 h		1	Functions of the immune system
Novoselova et al. (2004) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time16 ms reverse, 1.5 h/day, 30 days		1	Decreased tumor growth rate and enhanced survival

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Table 1 (*continued*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Panagopoulos et al. (2010) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		1–10	Reproductive capacity and induced cell death
Panagopoulos and Margaritis (2010*a*) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		10	'Window' effect of GSM radiation on reproductive capacity and cell death
Panagopoulos and Margaritis (2010*b*) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	1–21 min/day, 5 days		10	Reproductive capacity of the fly decreased linearly with increased duration of exposure
Pavicic and Trosic (2008) (in vitro)	864 and 935 MHz	CW	1–3 h	0.08		Growth affected in Chinese hamster V79 cells
Pérez-Castejón et al. (2009) (in vitro)	9.6 GHz	90% AM	24 h	0.0004		Increased proliferation rate in human astrocytoma cancer cells
Persson et al. (1997) (in vivo) (mouse whole body)	915 MHz	CW and pulse-modulated (217 Hz, 0.57 ms; 50 Hz, 6.6 ms)	2–960 min; CW more potent	0.0004		Increase in permeability of the blood–brain barrier
Phillips et al. (1998) (in vitro)	813.5625 MHz 836.55 MHz	iDEN TDMA	2, 21 h 2, 21 h	0.0024		DNA damage in human leukemia cells
Pologea-Moraru et al. (2002) (in vitro)	2.45 GHz		1 h		15	Change in membrane of cells in the retina
Pyrpasopoulou et al. (2004) (in vivo) (rat whole body)	9.4 GHz	GSM (50 Hz pulses, 20 µs pulse length)	1–7 days postcoitum	0.0005		Exposure during early gestation affected kidney development
Roux et al. (2008*a*) (in vivo) (tomato whole body)	900 MHz				7	Gene expression and energy metabolism
Roux et al. (2008*b*) (in vivo) (plant whole body)	900 MHz				7	Energy metabolism
Salford et al. (2003) (in vivo) (rat whole body)	915 MHz	GSM	2 h	0.02		Nerve cell damage in brain
Sarimov et al. (2004) (in vitro)	895–915 MHz	GSM	30 min	0.0054		Human lymphocyte chromatin affected similar to stress response
Schwartz et al. (1990) (in vitro)	240 MHz	CW and sinusoidal modulation at 0.5 and 16 Hz, effect only observed at 16 Hz modulation	30 min	0.00015		Calcium movement in the heart
Schwarz et al. (2008) (in vitro)	1950 MHz	UMTS	24 h	0.05		Genes in human fibroblasts
Somosy et al. (1991) (in vitro)	2.45 GHz	CW and 16 Hz square-modulation, modulated field more potent than CW		0.024		Molecular and structural changes in cells of mouse embryos

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Table 1 (*concluded*).

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density (μW/cm^2)	Effects reported
Stagg et al. (1997) (in vitro)	836.55 MHz	TDMA duty cycle 33%	24 h	0.0059		Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division
Stankiewicz et al. (2006) (in vitro)	900 MHz	GSM 217 Hz pulses, 577 ms width		0.024		Immune activities of human white blood cells
Tattersall et al. (2001) (in vitro)	700 MHz	CW	5–15 min	0.0016		Function of the hippocampus
Velizarov et al. (1999) (in vitro)	960 MHz	GSM 217 Hz square-pulse, duty cycle 12%	30 min	0.000021		Decrease in proliferation of human epithelial amnion cells
Veyret et al. (1991) (in vivo) (mouse whole body)	9.4 GHz	1 μs pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz, response only with AM, direction of response depended on AM frequency		0.015		Functions of the immune system
Vian et al. (2006) (in vivo) plant	900 MHz				7	Stress gene expression
Wolke et al. (1996) (in vitro)	900, 1300, 1800 MHz 900 MHz	Square-wave modulated at 217 Hz CW, 16 Hz, 50 Hz, and 30 KHz modulations		0.001		Calcium concentration in heart muscle cells of guinea pig
Yurekli et al. (2006) (in vivo) (rat whole body)	945 MHz	GSM, 217 Hz pulse-modulation	7 h/day, 8 days	0.0113		Free radical chemistry

Note: These papers gave either specific absorption rate, SAR, (W/kg) or power density (μW/cm^2) of exposure. (Studies that did not contain these values were excluded). AM, amplitude-modulated or amplitude-modulation; CW, continuous wave; GSM, global system for mobile communication; iDEN, integrated digital enhanced network; TDMA, time division multiple access, TETRA, terrestrial trunked radio; UMTS, universal mobile telecommunications system.

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8. Long-term exposures and cumulative effects

There are many important gaps in the RFR research. The majority of the studies on RFR have been conducted with short-term exposures, i.e., a few minutes to several hours. Little is known about the effects of long-term exposure such as would be experienced by people living near telecommunications installations, especially with exposures spanning months or years. The important questions then are: What are the effects of long-term exposure? Does long-term exposure produce different effects from short-term exposure? Do effects accumulate over time?

There is some evidence of cumulative effects. Phillips et al. (1998) reported DNA damage in cells after 24 h exposure to low-intensity RFR. DNA damage can lead to gene mutation that accumulates over time. Magras and Xenos (1997) reported that mice exposed to low-intensity RFR became less reproductive. After five generations of exposure the mice were not able to produce offspring. This shows that the effects of RFR can pass from one generation to another. Persson et al. (1997) reported an increase in permeability of the blood–brain barrier in mice when the energy deposited in the body exceeded 1.5 J/kg (joule per kilogram) — a measurement of the total amount of energy deposited. This suggests that a short-term, high-intensity exposure can produce the same effect as a long-term, low-intensity exposure, and is another indication that RFR effects can accumulate over time.

In addition, there is some indication that test animals become more sensitive to radiation after long-term exposure as seen in two of the critical experiments that contributed to the present SAR standards, called the "behavior–disruption experiments" carried out in the 1980s.

In the first experiment, de Lorge and Ezell (1980) trained rats on an auditory observing-response task. In the task, an animal was presented with two bars. Pressing the right bar would produce either a low-pitch or a high-pitch tone for half a second. The low-pitch tone signaled an unrewarded situation and the animal was expected to do nothing. However, when the high-pitch tone was on, pressing the left bar would produce a food reward. Thus, the task required continuous vigilance in which an animal had to coordinate its motor responses according to the stimulus presented to get a reward by choosing between a high-pitch or low-pitch tone. After learning the task, rats were then irradiated with 1280 MHz or 5620 MHz RFR during performance. Disruption of behavior (i.e., the rats could not perform very well) was observed within 30–60 min of exposure at a SAR of 3.75 W/kg for 1280 MHz, and 4.9 W/kg for 5620 MHz.

In another experiment, de Lorge (1984) trained monkeys on a similar auditory observing response task. Monkeys were exposed to RFR at 225, 1300, and 5800 MHz. Disruption of performance was observed at 8.1 mW/cm^2 (SAR 3.2 W/kg) for 225 MHz; at 57 mW/cm^2 (SAR 7.4 W/kg) for 1300 MHz; and at 140 mW/cm^2 (SAR 4.3 W/kg) for 5800 MHz. The disruption occurred when body temperature was increased by 1°C.

The conclusion from these experiments was that "... disruption of behavior occurred when an animal was exposed at an SAR of approximately 4 W/kg, and disruption occurred after 30–60 minutes of exposure and when body temperature increased by 1°C" (de Lorge 1984). Based on just these two experiments, 4 W/kg has been used in the setting of the present RFR exposure guidelines for humans. With theoretical safety margins added, the limit for occupational exposure was then set at 0.4 W/kg (i.e., 1/10 of the SAR where effects were observed) and for public exposure 0.08 W/kg for whole body exposures (i.e., 1/5 of that of occupational exposure).

But the relevant question for establishing a human SAR remains: Is this standard adequate, based on so little data, primarily extrapolated from a handful of animal studies from the same investigators? The de Lorge (1984) animal studies noted previously describe effects of short-term exposures, defined as less than one hour. But are they comparable to long-term exposures like what whole populations experience when living or working near transmitting facilities?

Two series of experiments were conducted in 1986 on the effects of long-term exposure. D'Andrea et al. (1986*a*) exposed rats to 2450 MHz RFR for 7 h a day, 7 days per week for 14 weeks. They reported a disruption of behavior at an SAR of 0.7 W/kg. And D'Andrea et al. (1986*b*) also exposed rats to 2450 MHz RFR for 7 h a day, 7 days per week, for 90 days at an SAR of 0.14 W/kg and found a small but significant disruption in behavior. The experimenters concluded, "... the threshold for behavioral and physiological effects of chronic (long-term) RFR exposure in the rat occurs between 0.5 mW/cm^2 (0.14 W/kg) and 2.5 mW/cm^2 (0.7 W/kg)" (p. 55, D'Andrea et al. 1986*b*).

The previously mentioned studies show that RFR can produce effects at much lower intensities after test animals are repeatedly exposed. This may have implications for people exposed to RFR from transmission towers for long periods of time.

Other biological outcomes have also been reported after long-term exposure to RFR. Effects were observed by Baranski (1972) and Takashima et al. (1979) after prolonged, repeated exposure but not after short-term exposure. Conversely, in other work by Johnson et al. (1983), and Lai et al. (1987, 1992) effects that were observed after short-term exposure disappeared after prolonged, repeated exposure, i.e., habituation occurred. Different effects were observed by Dumansky and Shandala (1974) and Lai et al. (1989) after different exposure durations. The conclusion from this body of work is that effects of long-term exposure can be quite different from those of short-term exposure.

Since most studies with RFR are short-term exposure studies, it is not valid to use their results to set guidelines for long-term exposures, such as in populations living or working near cell phone base stations.

9. Effects below 4 W/kg: thermal versus nonthermal

As described previously, current international RFR exposure standards are based mainly on the acute exposure experiments that showed disruption of behavior at 4 W/kg. However, such a basis is not scientifically valid. There are many studies that show biological effects at SARs less than 4 W/kg after short-term exposures to RFR. For example, since the 4 W/kg originated from psychological and (or) behavioral experiments, when one surveys the EMF literature on behavioral effects, one can find many reports on behavioral effects observed at SARs less than 4 W/kg, e.g., D'Andrea et al. (1986*a*) at 0.14 to 0.7 W/kg; DeWitt et al. (1987) at 0.14 W/kg; Gage (1979) at 3 W/kg ; King et al. (1971) at 2.4 W/kg; Kumlin et al. (2007) at 3 W/kg; Lai et al. (1989) at 0.6 W/kg; Mitchell et al. (1977) at 2.3 W/kg (1977); Navakatikian and Tomashevskaya (1994) at 0.027 W/kg; Nittby et al. (2008) at 0.06 W/kg; Schrot et al. (1980) at 0.7 W/kg; Thomas et al. (1975) at 1.5 to 2.7 W/kg; and Wang and Lai (2000) at 1.2 W/kg.

The obvious mechanism of effects of RFR is thermal (i.e., tissue heating). However, for decades, there have been questions about whether nonthermal (i.e., not dependent on a change in temperature) effects exist. This is a well-discussed area in the scientific literature and not the focus of this paper but we would like to mention it briefly because it has implications for public safety near transmission facilities.

Practically, we do not actually need to know whether RFR effects are thermal or nonthermal to set exposure guidelines. Most of the biological-effects studies of RFR that have been conducted since the 1980s were under nonthermal conditions. In studies using isolated cells, the ambient temperature during exposure was generally well controlled. In most animal studies, the RFR intensity used usually did not cause a significant increase in body temperature in the test animals. Most scientists consider nonthermal effects as established, even though the implications are not fully understood.

Scientifically, there are three rationales for the existence of nonthermal effects:

1. Effects can occur at low intensities when a significant increase in temperature is not likely.
2. Heating does not produce the same effects as RFR exposure.
3. RFR with different modulations and characteristics produce different effects even though they may produce the same pattern of SAR distribution and tissue heating.

Low-intensityeffects have been discussed previously (see Section 7.). There are reports that RFR triggers effects that are different from an increase in temperature, e.g., Wachtel et al. (1975); Seaman and Wachtel (1978); D'Inzeo et al. (1988). And studies showing that RFR of the same frequency and intensity, but with different modulations and waveforms, can produce different effects as seen in the work of Baranski (1972); Arber and Lin (1985); Campisi et al. (2010); d'Ambrosio et al. (2002); Frey et al. (1975); Oscar and Hawkins (1977); Sanders et al. (1985); Huber et al. (2002); Markkanen et al. (2004); Hung et al. (2007); and Luukkonen et al. (2009).

A counter-argument for point 1 is that RFR can cause micro-heating at a small location even though there is no measurement change in temperature over the whole sample. This implies that an effect observed at low intensities could be due to localized micro-heating, and, therefore, is still considered thermal. However, the micro-heating theory could not apply to test subjects that are not stationary, such as in the case of Magras and Xenos (1997) who reported that mice exposed to low-intensity RFR became less reproductive over several generations. "Hot spots" of heating move within the body when the subject moves in the field and, thus, cannot maintain sustained heating of certain tissue.

The counter argument for point 2 is that heating by other means does not produce the same pattern of energy distribution as RFR. Thus, different effects would result. Again, this counter argument does not work on moving objects. Thus, results supporting the third point are the most compelling.

10. Studies on exposure to cell tower transmissions

From the early genesis of cell phone technology in the early 1980s, cell towers were presumed safe when located near populated areas because they are low-power installations in comparison with broadcast towers. This thinking already depended on the assumption that broadcast towers were safe if kept below certain limits. Therefore, the reasoning went, cell towers would be safer still. The thinking also assumed that exposures between cell and broadcast towers were comparable. In certain cities, cell and broadcast tower transmissions both contributed significantly to the ambient levels of RFR (Sirav and Seyhan 2009; Joseph et al. 2010).

There are several fallacies in this thinking, including the fact that broadcast exposures have been found unsafe even at regulated thresholds. Adverse effects have been noted for significant increases for all cancers in both men and women living near broadcast towers (Henderson and Anderson 1986); childhood leukemia clusters (Maskarinec et al. 1994; Ha et al. 2003; Park et al. 2004); adult leukemia and lymphoma clusters, and elevated rates of mental illness (Hocking et al. 1996; Michelozzi et al. 2002; Ha et al. 2007); elevated brain tumor incidence (Dolk et al. 1997*a*, 1997*b*); sleep disorders, decreased concentration, anxiety, elevated blood pressure, headaches, memory impairment, increased white cell counts, and decreased lung function in children (Altpeter et al. 2000); motor, memory, and learning impairment in children (Kolodynski and Kolodynski 1996), nonlinear increases in brain tumor incidence (Colorado Department of Public Health 2004); increases in malignant melanoma (Hallberg and Johansson 2002); and nonlinear immune system changes in women (Boscol et al. 2001). (The term "nonlinear" is used in scientific literature to mean that an effect was not directly proportional to the intensity of exposure. In the case of the two studies mentioned previously, adverse effects were found at significant distances from the towers, not in closer proximity where the power density exposures were higher and therefore presumed to have a greater chance of causing effects. This is something that often comes up in low-level energy studies and adds credence to the argument that low-level exposures could cause qualitatively different effects than higher level exposures.)

There is also anecdotal evidence in Europe that some communities have experienced adverse physical reactions after the switch from analog TV broadcast signals to the new digital formats, which can be more biologically complex

Three doctors in Germany, Cornelia Waldmann-Selsam, MD, Christine Aschermann, MD, and Markus Kern, MD, wrote (in a letter to the U.S. President, entitled *Warning — Adverse Health Effects From Digital Broadcast Television*)[10], that on 20 May 2006, two digital broadcast television stations went on the air in the Hessian Rhoen area. Prior to that time that area had low radiation levels, which included that from cell phone towers of which there were few. However, coinciding with the introduction of the digital signals, within a radius of more than 20 km, there was an abrupt onset of symptoms for constant headaches, pressure in the head, drowsiness, sleep problems, inability to think clearly, forgetfulness, nervousness, irritability, tightness in the chest, rapid heartbeat, shortness of breath, depression, apathy, loss of empathy, burning skin, sense of inner burning, leg weakness, pain in the limbs, stabbing pain in various organs, and weight gain. They also noted that birds fled the area. The same symptoms gradually appeared in other locations after digital signals were introduced. Some physicians accompanied affected people to areas where there was no TV reception from terrestrial sources, such as in valleys or behind mountain ranges, and observed that many people became symptom free after only a short time. The digital systems also require more transmitters than the older analog systems and, therefore, somewhat higher exposure levels to the general population are expected, according to the 2009 SCENIHR Report (SCENIHR 2009).

Whether digital or analog, the frequencies differ between broadcast and cell antennas and do not couple with the human anatomy in whole-body or organ-specific models in the same ways (NCRP 1986; ICNIRP 1998). This difference in how the body absorbs energy is the reason that all standards-setting organizations have the strictest limitations between 30–300 MHz — ranges that encompass FM broadcast where whole body resonance occurs (Cleveland 2001). Exposure allowances are more lenient for cell technology in frequency ranges between 300 MHz and 3 GHz, which encompass cellular phone technology. This is based on the assumption that the cell frequencies do not penetrate the body as deeply and no whole-body resonance can occur.

There are some studies on the health effects on people living near cell phone towers. Though cell technology has been in existence since the late 1980s, the first study of populations near cell tower base stations was only conducted by Santini et al. (2002). It was prompted in part by complaints of adverse effects experienced by residents living near cell base stations throughout the world and increased activism by citizens. As well, increasing concerns by physicians to understand those complaints was reflected in professional organizations like the ICEMS (International Committee on Electromagnetic Safety) Catania Resolution[11], the Irish Doctors Environmental Association (IDEA)[12], and the Freiburger Appeal[13].

Santini conducted a survey study of 530 people (270 men, 260 women) on 18 nonspecific health symptoms (NSHS) in relation to self-reported distance from towers of <10 m, 10 to 50 m, 50 to 100 m, 100 to 200 m, 200 to 300 m, and >300 m. The control group compared people living more than 300 m (approximately 1000 ft) or not exposed to base stations. They controlled for age, presence of electrical transformers (<10 m), high tension lines (<100 m), and radio/TV broadcast transmitters (<4 km), the frequency of cell phone use (>20 min per day), and computer use (>2 h per day). Questions also included residents' location in relation to antennas, taking into account orientations that were facing, beside, behind, or beneath antennas in cases of roof-mounted antenna arrays. Exposure conditions were defined by the length of time living in the neighborhood (<1 year through >5 years); the number of days per week and hours per day (<1 h to >16 h) that were spent in the residence.

Results indicated increased symptoms and complaints the closer a person lived to a tower. At <10 m, symptoms included nausea, loss of appetite, visual disruptions, and difficulty in moving. Significant differences were observed up through 100 m for irritability, depressive tendencies, concentration difficulties, memory loss, dizziness, and lower libido. Between 100 and 200 m, symptoms included headaches, sleep disruption, feelings of discomfort, and skin problems. Beyond 200 m, fatigue was significantly reported more often than in controls. Women significantly reported symptoms more often than men, except for libido loss. There was no increase in premature menopause in women in relation to distance from towers. The authors concluded that there were different sex-dependent sensitivities to electromagnetic fields. They also called for infrastructure not to be sited <300 m (~1000 ft) from populations for precautionary purposes, and noted that the information their survey captured might not apply to all circumstances since actual exposures depend on the volume of calls being generated from any particular tower, as well as on how radiowaves are reflected by environmental factors.

Similar results were found in Egypt by Abdel-Rassoul et al. (2007) looking to identify neurobehavioral deficits in people living near cell phone base stations. Researchers conducted a cross-sectional study of 85 subjects: 37 living inside a building where antennas were mounted on the rooftop and 48 agricultural directorate employees who worked in a building ($\sim$10 m) opposite the station. A control group of 80 who did not live near base stations were matched for age, sex, occupation, smoking, cell phone use, and educational level. All participants completed a questionnaire containing personal, educational, and medical histories; general and neurological examinations; a neurobehavioral test battery (NBTB) involving tests for visuomotor speed, problem solving, attention, and memory, in addition to a Eysenck personality questionnaire (EPQ).

Their results found a prevalence of neuropsychiatric complaints: headaches, memory changes, dizziness, tremors, depressive symptoms, and sleep disturbance were significantly higher among exposed inhabitants than controls. The NBTB indicated that the exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory (paced auditory

[10] http://www.notanotherconspiracy.com/2009/02/warning-adverse-health-effects-from.html. (Accessed October 2010.)
[11] http://www.icems.eu/resolution.htm
[12] http://www.ideeaireland.org/emr.htm
[13] http://www.laleva.cc/environment/freiburger_appeal.html

serial addition test (PASAT)). Also, the inhabitants opposite the station exhibited a lower performance in the problem-solving test (block design) than those who lived under the station. All inhabitants exhibited a better performance in the two tests of visuomotor speed (digit symbol and Trailmaking B) and one test of attention (Trailmaking A) than controls.

Environmental power-density data were taken from measurements of that building done by the National Telecommunications Institute in 2000. Measurements were collected from the rooftop where the antennas were positioned, the shelter that enclosed the electrical equipment and cables for the antennas, other sites on the roof, and within an apartment below one of the antennas. Power-density measurements ranged from 0.1–6.7 μW/cm^2. No measurements were taken in the building across the street. The researchers noted that the last available measurements of RFR in 2002 in that area were less than the allowable standards but also noted that exposures depended on the number of calls being made at any given time, and that the number of cell phone users had increased approximately four times within the 2 years just before the beginning of their study in 2003. They concluded that inhabitants living near mobile phone base stations are at risk for developing neuropsychiatric problems, as well as some changes in the performance of neurobehavioral functions, either by facilitation (over-stimulation) or inhibition (suppression). They recommended the standards be revised for public exposure to RFR, and called for using the NBTB for regular assessment and early detection of biological effects among inhabitants near base stations (Abdel-Rassoul et al. 2007).

Hutter et al. (2006) sought to determine cognitive changes, sleep quality, and overall well-being in 365 rural and urban inhabitants who had lived for more than a year near 10 selected cell phone base stations. Distance from antennas was 24 to 600 m in rural areas, and 20 to 250 m in the urban areas. Field strength measurements were taken in bedrooms and cognitive tests were performed. Exposure to high-frequency EMFs was lower than guidelines and ranged from 0.000002 to 0.14 μW/cm^2 for all frequencies between 80 MHz and 2 GHz with the greater exposure coming from mobile telecommunications facilities, which was between 0.000001 and 0.14 μW/cm^2. Maximum levels were between 0.000002 and 0.41 μW/cm^2 with an overall 5% of the estimated maximum above 0.1 μW/cm^2. Average levels were slightly higher in rural areas (0.005 μW/cm^2) than in urban areas (0.002 μW/cm^2). The researchers tried to ascertain if the subjective rating of negative health consequences from base stations acted as a covariable but found that most subjects expressed no strong concerns about adverse effects from the stations, with 65% and 61% in urban and rural areas, respectively, stating no concerns at all. But symptoms were generally higher for subjects who expressed health concerns regarding the towers. The researchers speculated that this was due to the subjects with health complaints seeking answers and consequently blaming the base station; or that subjects with concerns were more anxious in general and tended to give more negative appraisals of their body functions; and the fact that some people simply give very negative answers.

Hutter's results were similar to those of Santini et al. (2002) and Abdel-Rassoul et al. (2007). Hutter found a significant relationship between symptoms and power densities. Adverse effects were highest for headaches, cold hands and feet, cardiovascular symptoms, and concentration difficulties. Perceptual speed increased while accuracy decreased insignificantly with increasing exposure levels. Unlike the others, however, Hutter found no significant effects on sleep quality and attributed such problems more to fear of adverse effects than actual exposure. They concluded that effects on well-being and performance cannot be ruled out even as mechanisms of action remain unknown. They further recommended that antenna siting should be done to minimize exposure to the population.

Navarro et al. (2003) measured the broadband electric field (E-field) in the bedrooms of 97 participants in La Nora, Murcia, Spain and found a significantly higher symptom score in 9 out of 16 symptoms in the groups with an exposure of 0.65 V/m (0.1121 μW/cm^2) compared with the control group with an exposure below 0.2 V/m (0.01061 μW/cm^2), both as an average. The highest contributor to the exposure was GSM 900/1800 MHz signals from mobile telecommunications. The same researchers also reported significant correlation coefficients between the measured E-field and 14 out of 16 health-related symptoms with the five highest associations found for depressive tendencies, fatigue, sleeping disorders, concentration difficulties, and cardiovascular problems. In a follow up work, Oberfeld et al. (2004) conducted a health survey in Spain in the vicinity of two GSM 900/1800 MHz cell phone base stations, measuring the E-field in six bedrooms, and found similar results. They concluded that the symptoms are in line with "microwave syndrome" reported in the literature (Johnson-Liakouris 1998). They recommended that the sum total for ambient exposures should not be higher than 0.02 V/m — the equivalent of a power density of 0.00011 μW/cm^2, which is the indoor exposure value for GSM base stations proposed by the Public Health Office of the Government of Salzburg, Austria in 2002[14].

Eger et al. (2004) took up a challenge to medical professionals by Germany's radiation protection board to determine if there was an increased cancer incidence in populations living near cell towers. Their study evaluated data for approximately 1000 patients between the years of 1994 and 2004 who lived close to cell antennas. The results showed that the incidence of cancer was significantly higher among those patients who had lived for 5 to 10 years at a distance of up to 400 m from a cell installation that had been in operation since 1993, compared with those patients living further away, and that the patients fell ill on an average of 8 years earlier than would be expected. In the years between 1999 and 2004, after 5 years operation of the transmitting installation, the relative risk of getting cancer had tripled for residents in proximity of the installation compared with inhabitants outside of the area.

Wolf and Wolf (2004) investigated increased cancer incidence in populations living in a small area in Israel exposed

[14] http://www.salzburg.gv.at/umweltmedizin. (Accessed October 2010.)

to RFR from a cell tower. The antennas were mounted 10 m high, transmitting at 850 MHz and 1500 W at full-power output. People lived within a 350 m half circle of the antennas. An epidemiologic assessment was done to determine whether the incidence of cancer cases among individuals exposed to the base station in the south section of the city of Netanya called Irus (designated area A) differed from expected cancer rates throughout Israel, and in the town of Netanya in general, as compared with people who lived in a nearby area without a cell tower (designated area B). There were 622 participants in area A who had lived near the cell tower for 3 to 7 years and were patients at one health clinic. The exposure began 1 year before the start of the study when the station first came into service. A second cohort of individuals in area B, with 1222 participants who received medical services at a different clinic located nearby, was used as a control. Area B was closely matched for environment, workplace, and occupational characteristics. In exposure area A, eight cases of different types of cancer were diagnosed in a period of 1 year, including cancers of the ovary (1), breast (3), Hodgkins lymphoma (1), lung (1), osteoid osteoma (1), and hypernephroma (1). The RFR field measurements were also taken per house and matched to the cancer incidents. The rate of cancers in area A was compared with the annual rate of the general population (31 cases per 10 000) and to incidence for the entire town of Netanya. There were two cancers in area B, compared to eight in area A. They also examined the history of the exposed cohort (area A) for malignancies in the 5 years before exposure began and found only two cases in comparison to eight cases 1 year after the tower went into service. The researchers concluded that relative cancer rates for females were 10.5 for area A, 0.6 for area B, and 1.0 for the whole town of Netanya. Cancer incidence in women in area A was thus significantly higher (p <0.0001) compared with that of area B and the whole city. A comparison of the relative risk revealed that there were 4.15 times more cases in area A than in the entire population. The study indicated an association between increased incidence of cancer and living in proximity to a cell phone base station. The measured level of RFR, between 0.3 to 0.5 $\mu W/cm^2$, was far below the thermal guidelines.

11. Risk perception, electrohypersensitivity, and psychological factors

Others have followed up on what role risk perception might play in populations near cell base stations to see if it is associated with health complaints.

Blettner et al. (2008) conducted a cross-sectional, multiphase study in Germany. In the initial phase, 30 047 people out of a total of 51 444, who took part in a nationwide survey, were also asked about their health and attitudes towards mobile phone base stations. A list of 38 potential health complaints were used. With a response rate of 58.6%, 18.0% were concerned about adverse health effects from base stations, 10.3% directly attributed personal adverse effects to them. It was found that people living within 500 m, or those concerned about personal exposures, reported more health complaints than others. The authors concluded that even though a substantial proportion of the German population is concerned about such exposures, the observed higher health complaints cannot be attributed to those concerns alone.

Kristiansen et al. (2009) also explored the prevalence and nature of concerns about mobile phone radiation, especially since the introduction of new 3G–UMTS (universal mobile telecommunications system) networks that require many more towers and antennas have sparked debate throughout Europe. Some local governments have prohibited mobile antennas on public buildings due to concerns about cancer, especially brain cancer in children and impaired psychomotor functions. One aim of the researchers was risk assessment — to compare people's perceptions of risk from cell phones and masts to other fears, such as being struck by lightening. In Denmark, they used data from a 2006 telephone survey of 1004 people aged 15+ years. They found that 28% of the respondents were concerned about exposure to mobile phone radiation and 15% about radiation from masts. In contrast, 82% of respondents were concerned about other forms of environmental pollution. Nearly half of the respondents considered the mortality risk of 3G phones and masts to be of the same order of magnitude as being struck by lightning (0.1 fatalities per million people per year), while 7% thought it was equivalent to tobacco-induced lung cancer (approximately 500 fatalities per million per year). Among women, concerns about mobile phone radiation, perceived mobile phone mortality risk, and concerns about unknown consequences of new technologies, increased with educational levels. More than two thirds of the respondents felt that they had not received adequate public information about the 3G system. The results of the study indicated that the majority of the survey population had little concern about mobile phone radiation, while a minority is very concerned.

Augner et al. (2009) examined the effects of short-term GSM base station exposure on psychological symptoms including good mood, alertness, and calmness as measured by a standardized well-being questionnaire. Fifty-seven participants were randomly assigned to one of three different exposure scenarios. Each of those scenarios subjected participants to five 50 min exposure sessions, with only the first four relevant for the study of psychological symptoms. Three exposure levels were created by shielding devices, which could be installed or removed between sessions to create double-blinded conditions. The overall median power densities were 0.00052 $\mu W/cm^2$ during low exposures, 0.0154 $\mu W/cm^2$ during medium exposures, and 0.2127 $\mu W/cm^2$ during high-exposure sessions. Participants in high- and medium-exposure scenarios were significantly calmer during those sessions than participants in low-exposure scenarios throughout. However, no significant differences between exposure scenarios in the "good mood" or "alertness" factors were found. The researchers concluded that short-term exposure to GSM base station signals may have an impact on well-being by reducing psychological arousal.

Eltiti et al. (2007) looked into exposures to the GSM and UMTS exposures from base stations and the effects to 56 participants who were self-reported as sensitive to electromagnetic fields. Some call it electro-hypersensitivity (EHS) or just electrosensitivity. People with EHS report that they suffer negative health effects when exposed to electromagnetic fields from everyday objects such as cell phones, mobile phone base stations, and many other common things in modern societies. EHS is a recognized functional impairment in Sweden. This study used both open provocation and double-blind tests to determine if electrosensitive and control individuals experienced more negative health effects when exposed to base-station-like signals compared with sham exposures. Fifty-six electrosensitive and 120 control participants were tested first in an open provocation test. Of these, 12 electrosensitive and six controls withdrew after the first session. Some of the electrosensitive subjects later issued a statement saying that the initial exposures made them too uncomfortable to continue participating in the study. This means that the study may have lost its most vulnerable test subjects right at the beginning, possibly skewing later outcomes. The remainder completed a series of double-blind tests. Subjective measures of well-being and symptoms, as well as physiological measures of blood-volume pulse, heart rate, and skin conductance were obtained. They found that during the open provocation, electrosensitive individuals reported lower levels of well-being to both GSM and UMTS signals compared with sham exposure, whereas controls reported more symptoms during the UMTS exposure. During double-blind tests the GSM signal did not have any effect on either group. Electrosensitive participants did report elevated levels of arousal during the UMTS condition, but the number or severity of symptoms experienced did not increase. Physiological measures did not differ across the three exposure conditions for either group. The researchers concluded that short-term exposure to a typical GSM base-station-like signal did not affect well-being or physiological functions in electrosensitive or control individuals even though the electrosensitive individuals reported elevated levels of arousal when exposed to a UMTS signal. The researchers stated that this difference was likely due to the effect of the order of the exposures throughout the series rather than to the exposure itself. The researchers do not speculate about possible data bias when one quarter of the most sensitive test subjects dropped out at the beginning.

In follow-up work, Eltiti et al. (2009) attempted to clarify some of the inconsistencies in the research with people who report sensitivity to electromagnetic fields. Such individuals, they noted, often report cognitive impairments that they believe are due to exposure to mobile phone technology. They further said that previous research in this area has revealed mixed results, with the majority of research only testing control individuals. Their aim was to clarify whether short-term (50 min) exposure at 1 $\mu W/cm^2$ to typical GSM and UMTS base station signals affects attention, memory, and physiological endpoints in electrosensitive and control participants. Data from 44 electrosensitive and 44 matched-control participants who performed the digit symbol substitution task (DSST), digit span task (DS), and a mental arithmetic task (MA), while being exposed to GSM, UMTS, and sham signals under double-blind conditions were analyzed. Overall, the researchers concluded that cognitive functioning was not affected by short-term exposure to either GSM or UMTS signals. Nor did exposure affect the physiological measurements of blood-volume pulse, heart rate, and skin conductance that were taken while participants performed the cognitive tasks. The GSM signal was a combined signal of 900 and 1800 MHz frequencies, each with a power flux density of 0.5 $\mu W/cm^2$, which resulted in combined power flux density of 1 $\mu W/cm^2$ over the area where test subjects were seated. Previous measurements in 2002 by the National Radiological Protection Board in the UK, measuring power density from base stations at 17 sites and 118 locations (Mann et al. 2002), found that in general, the power flux density was between 0.001 $\mu W/cm^2$ to 0.1 $\mu W/cm^2$, with the highest power density being 0.83 $\mu W/cm^2$. The higher exposure used by the researchers in this study was deemed comparable by them to the maximum exposure a person would encounter in the real world. But many electrosensitive individuals report that they react to much lower exposures too. Overall, the electrosensitive participants had a significantly higher level of mean skin conductance than control subjects while performing cognitive tasks. The researchers noted that this was consistent with other studies that hypothesize sensitive individuals may have a general imbalance in autonomic nervous system regulation. Generally, cognitive functioning was not affected in either electrosensitives or controls. When Bonferroni corrections were applied to the data, the effects on mean skin conductance disappeared. A criticism is that this averaging of test results hides more subtle effects.

Wallace et al. (2010) also tried to determine if short-term exposure to RFR had an impact on well-being and what role, if any, psychological factors play. Their study focused on “Airwave”, a new communication system being rolled out across the UK for police and emergency services. Some police officers have complained about skin rashes, nausea, headaches, and depression as a consequence of using Airwave two-way radio handsets. The researchers used a small group of self-reported electrosensitive people to determine if they reacted to the exposures, and to determine if exposures to specific signals affect a selection of the adult population who do not report sensitivity to electromagnetic fields. A randomized double-blind provocation study was conducted to establish whether short-term exposure to a terrestrial trunked radio (TETRA) base station signal has an impact on health and well-being in individuals with electrosensitivity and controls. Fifty-one individuals with electrosensitivity and 132 age- and gender-matched controls participated first in an open provocation test, while 48 electrosensitive and 132 control participants went on to complete double-blind tests in a fully screened semi-anechoic chamber. Heart rate, skin conductance, and blood pressure readings provided objective indices of short-term physiological response. Visual analogue scales and symptom scales provided subjective indices of well-being. Their results found no differences on any measure between TETRA and sham (no signal) under double-blind conditions for either control or electrosensitive participants and neither group could detect the presence of a TETRA signal above chance (50%). The researchers noted, however, that when conditions were not double-blinded, the electrosensitive individuals did report feeling worse and experienced more severe symptoms during TETRA compared with sham exposure. They concluded that the adverse symptoms experienced by electrosensitive individuals are caused by the belief of harm from TETRA base stations rather than because of the low-level EMF exposure itself.

It is interesting to note that the three previously mentioned studies were all conducted at the same Electromagnetics and Health Laboratory at the University of Essex, Essex, UK, by the same relative group of investigators. Those claiming to be electrosensitive are a small subgroup in the population, often in touch through Internet support groups. In the first test, many electrosensitives dropped out because they found the exposures used in the study too uncomfortable. The drop-out rate decreased with the subsequent studies, which raises the question of whether the electrosensitive participants in the latter studies were truly electrosensitive. There is a possibility that a true subgroup of electrosensitives cannot tolerate such study conditions, or that potential test subjects are networking in a way that preclude their participation in the first place. In fact, researchers were not able to recruit their target numbers for electrosensitive participants in any of the studies. The researchers also do not state if there were any of the same electrosensitive participants used in the three studies. Nor do they offer comment regarding the order of the test methods possibly skewing results.

Because of uncertainty regarding whether EMF exposures are actually causing the symptoms that electrosensitives report, and since many electrosensitives also report sensitivities to myriad chemicals and other environmental factors, it has been recommended (Hansson Mild et al. 2006) that a new term be used to describe such individuals — idiopathic environmental intolerance with attribution to electromagnetic fields (IEI-EMF).

Furubayashi et al. (2009) also tried to determine if people who reported symptoms to mobile phones are more susceptible than control subjects to the effect of EMF emitted from base stations. They conducted a double-blind, cross-over provocation study, sent questionnaires to 5000 women and obtained 2472 valid responses from possible candidates. From those, they were only able to recruit 11 subjects with mobile phone related symptoms (MPRS) and 43 controls. The assumption was that individuals with MPRS matched the description of electrosensitivity by the World Health Organization (WHO). There were four EMF exposure conditions, each of which lasted 30 min: (*i*) continuous, (*ii*) intermittent, (*iii*) sham exposure with noise, and (*iv*) sham exposure without noise. Subjects were exposed to EMF of 2.14 GHz, 10 V/m (26.53 μW/cm^2) wideband code division multiple access (W-CDMA), in a shielded room to simulate whole-body exposure to EMF from base stations, although the exposure strength they used was higher than that commonly received from base stations. The researchers measured several psychological and cognitive parameters immediately before and after exposure, and monitored autonomic functions. Subjects were asked to report on their perception of EMF and level of discomfort during the experiment. The MPRS group did not differ from the controls in their ability to detect exposure to EMF. They did, however, consistently experience more discomfort in general, regardless of whether or not they were actually exposed to EMF, and despite the lack of significant changes in their autonomic functions. The researchers noted that others had found electrosensitive subjects to be more susceptible to stress imposed by task performance, although they did not differ from normal controls in their personality traits. The researchers concluded that the two groups did not differ in their responses to real or sham EMF exposure according to any psychological, cognitive or autonomic assessment. They said they found no evidence of any causal link between hypersensitivity symptoms and exposure to EMF from base stations. However, this study, had few MPRS participants.

Regel et al. (2006) also investigated the effects of the influence of UMTS base-station-like signals on well-being and cognitive performance in subjects with and without self-reported sensitivity to RFR. The researchers performed a controlled exposure experiment in a randomized, double-blind crossover study, with 45 min at an electric field strength of 0 V/m, 1.0 V/m (0.2653 μW/cm^2), or 10.0 V/m (26.53 μW/cm^2), incident with a polarization of 45° from the left-rear side of the subject, at weekly intervals. A total of 117 healthy subjects that included 33 self-reported sensitive subjects and 84 nonsensitive subjects, participated in the study. The team assessed well-being, perceived field strength, and cognitive performance with questionnaires and cognitive tasks and conducted statistical analyses using linear mixed models. Organ-specific and brain-tissue-specific dosimetry, including uncertainty and variation analysis, was performed. Their results found that in both groups, well-being and perceived field strength were not associated with actual exposure levels. They observed no consistent condition-induced changes in cognitive performance except for two marginal effects. At 10 V/m (26.53 μW/cm^2) they observed a slight effect on speed in one of six tasks in the sensitive subjects and an effect on accuracy in another task in nonsensitive subjects. Both effects disappeared after multiple endpoint adjustments. They concluded that they could not confirm a short-term effect of UMTS base-station-like exposure on well-being. The reported effects on brain functioning were marginal, which they attributed to chance. Peak spatial absorption in brain tissue was considerably smaller than during use of a mobile phone. They concluded that no conclusions could be drawn regarding short-term effects of cell phone exposure or the effects of long-term base-station-like exposures on human health.

Siegrist et al. (2005) investigated risk perceptions associated with mobile phones, base stations, and other sources of EMFs through a telephone survey conducted in Switzerland. Participants assessed both risks and benefits associated with nine different sources of EMF. Trust in the authorities regulating these hazards was also assessed. Participants answered a set of questions related to attitudes toward EMF and toward mobile phone base stations. Their results were: high-voltage transmission lines are perceived as the most risky source of EMF; and mobile phones and base stations received lower risk ratings. Trust in authorities was positively associated with perceived benefits and negatively associated with perceived risks. Also, people who use their mobile phones frequently perceived lower risks and higher benefits than people who use their mobile phones infrequently. People who believed they lived close to a base station did not significantly differ in their perceived level of risks associated with mobile phone base stations from people who did not believe they lived close to a base station. A majority of participants favored limits to exposures based on worst-case scenarios. The researchers also correlated perceived risks with other beliefs and found that belief in paranormal phenomena is related to level of perceived risks associated with

EMF. In addition, people who believed that most chemical substances cause cancer also worried more about EMF than people who did not believe that chemical substances are harmful. This study found the obvious — that some people worry more about environmental factors than others across a range of concerns.

Wilen et al. (2006) investigated the effects of exposure to mobile phone RFR on people who experience subjective symptoms when using mobile phones. Twenty subjects with MPRS were matched with 20 controls without MPRS. Each subject participated in two experimental sessions, one with true exposure and one with sham exposure, in random order. In the true exposure condition, the test subjects were exposed for 30 min to an RFR field generating a maximum SAR (1 g) in the head of 1 W/kg through an indoor base station antenna attached to signals from a 900 MHz GSM mobile phone. Physiological and cognitive parameters were measured during the experiment for heart rate and heart rate variability (HRV), respiration, local blood flow, electrodermal activity, critical flicker fusion threshold (CFFT), short-term memory, and reaction time. No significant differences related to RFR exposure conditions and no differences in baseline data were found between subject groups with the exception for reaction time, which was significantly longer among the test subjects than among the controls the first time the test was performed. This difference disappeared when the test was repeated. However, the test subjects differed significantly from the controls with respect to HRV as measured in the frequency domain. The test subjects displayed a shift in the low/high frequency ratio towards a sympathetic dominance in the autonomous nervous system during the CFFT and memory tests, regardless of exposure condition. They interpreted this as a sign of differences in the autonomous nervous system regulation among persons with MPRS and persons with no such symptoms.

12. Assessing exposures

Quantifying, qualifying, and measuring radiofrequency (RF) energy both indoors and outdoors has frustrated scientists, researchers, regulators, and citizens alike. The questions involve how best to capture actual exposure data — through epidemiology, computer estimates, self-reporting, or actual dosimetry measurements. Determining how best to do this is more important than ever, given the increasing background levels of RFR. Distance from a generating source has traditionally been used as a surrogate for probable power density but that is imperfect at best, given how RF energy behaves once it is transmitted. Complicated factors and numerous variables come into play. The wearing of personal dosimetry devices appears to be a promising area for capturing cumulative exposure data.

Neubauer et al. (2007) asked the question if epidemiology studies are even possible now, given the increasing deployment of wireless technologies. They examined the methodological challenges and used experts in engineering, dosimetry, and epidemiology to critically evaluate dosimetric concepts and specific aspects of exposure assessment regarding epidemiological study outcomes. They concluded that, at least in theory, epidemiology studies near base stations are feasible but that all relevant RF sources have to be taken into account. They called for pilot studies to validate exposure assessments and recommended that short-to-medium term effects on health and well-being are best investigated by cohort studies. They also said that for long-term effects, groups with high exposures need to be identified first, and that for immediate effects, human laboratory studies are the preferred approach. In other words, multiple approaches are required. They did not make specific recommendations on how to quantify long-term, low-level effects on health and well-being.

Radon et al. (2006) compared personal RF dosimetry measurements against recall to ascertain the reliability of self-reporting near base stations. Their aim was to test the feasibility and reliability of personal dosimetry devices. They used a 24 h assessment on 42 children, 57 adolescents, and 64 adults who wore a Maschek dosimeter prototype, then compared the self-reported exposures with the measurements. They also compared the readings of Maschek prototype with those of the Antennessa DSP-090 in 40 test subjects. They found that self-reported exposures did not correlate with actual readings. The two dosimeters were in moderate agreement. Their conclusion was that personal dosimetry, or the wearing of measuring devices, was a feasible method in epidemiology studies.

A study by Frei et al. (2009) also used personal dosimetry devices to examine the total exposure levels of RFR in the Swiss urban population. What they found was startling — nearly a third of the test subjects' cumulative exposures were from cell base stations. Prior to this study, exposure from base stations was thought to be insignificant due to their low-power densities and to affect only those living or working in close proximity to the infrastructure. This study showed that the general population moves in and out of these particular fields with more regularity than previously expected. In a sample of 166 volunteers from Basel, Switzerland, who agreed to wear personal exposure meters (called exposimeters), the researchers found that nearly one third of total exposures came from base stations. Participants carried an exposimeter for 1 week (2 separate weeks in 32 participants) and also completed an activity diary. Mean values were calculated using the robust regression on order statistics (ROS) method. Results found a mean weekly exposure to all RFR and (or) EMF sources was 0.013 $\mu W/cm^2$ (range of individual means 0.0014–0.0881 $\mu W/cm^2$). Exposure was mainly from mobile phone base stations (32.0%), mobile phone handsets (29.1%), and digital enhanced cordless telecommunications (DECT) phones (22.7%). People owning a DECT phone (total mean 0.015 $\mu W/cm^2$) or mobile phone (0.014 $\mu W/cm^2$) were exposed more than those not owning a DECT or mobile phone (0.010 $\mu W/cm^2$). Mean values were highest in trains (0.116 $\mu W/cm^2$), airports (0.074 $\mu W/cm^2$), and tramways or buses (0.036 $\mu W/cm^2$) and were higher during daytime (0.016 $\mu W/cm^2$) than nighttime (0.008 $\mu W/cm^2$). The Spearman correlation coefficient between mean exposure in the first and second week was 0.61. Another surprising finding of this study contradicted Neubauer et al. (2008) who found that a rough dosimetric estimate of a 24 h exposure from a base station (1–2 V/m) (i.e., 0.2653–1.061 $\mu W/cm^2$) corresponded to approximately 30 min of mobile phone use. But Frei et al. (2009) found, using the exposimeter, that cell phone use was 200 times higher than the average base station exposure contribution in self-selected volunteers (0.487 versus 0.002 μW/cm²). This implied that at the belt, backpack, or in close vicinity to the body, the mean base station contribution corresponds to about 7 min of mobile phone use (24 h divided by 200), not 30 min. They concluded that exposure to RFR varied considerably between persons and locations but was fairly consistent for individuals. They noted that cell phones, base stations, and cordless phones were important sources of exposure in urban Switzerland but that people could reduce their exposures by replacing their cordless domestic phones with conventional landlines at home. They determined that it was feasible to combine diary data with personal exposure measurements and that such data was useful in evaluating RFR exposure during daily living, as well as helpful in reducing exposure misclassification in future epidemiology studies.

Viel et al. (2009) also used personal exposure meters (EME SPY 120 made by Satimo and ESM 140 made by Maschek) to characterize actual residential exposure from antennas. Their primary aim was to assess personal exposures, not ambient field strengths. Two hundred randomly selected people were enrolled to wear measurement meters for 24 h and asked to keep a time–location–activity diary. Two exposure metrics for each radiofrequency were then calculated: the proportion of measurements above the detection limit of 0.05 V/m (0.0006631 μW/cm²) and the maximum electric field strength. Residential addresses were geocoded and distances from each antenna were calculated. They found that much of the time-recorded field strength was below the detection level of 0.05 V/m, with the exception of the FM radio bands, which had a detection threshold of 12.3%. The maximum electric field was always lower than 1.5 V/m (0.5968 μW/cm²). Exposure to GSM and digital cellular system (DCS) frequencies peaked around 280 m in urban areas and 1000 m from antennas in more suburban/rural areas. A downward trend in exposures was found within a 10 km distance for FM exposures. Conversely, UMTS, TV3, and TV 4 and 5 signals did not vary with distance. The difference in peak exposures for cell frequencies were attributed to microcell antennas being more numerous in urban areas, often mounted a few meters above ground level, whereas macrocell base stations in less urban areas are placed higher (between 15 and 50 m above ground level) to cover distances of several kilometres. They concluded that despite the limiting factors and high variability of RF exposure assessments, in using sound statistical technique they were able to determine that exposures from GSM and DCS cellular base stations actually increase with distance in the near source zone, with a maximum exposure where the main beam intersects the ground. They noted that such information should be available to local authorities and the public regarding the siting of base stations. Their findings coincide with Abdel-Rassoul et al. (2007) who found field strengths to be less in the building directly underneath antennas, with reported health complaints higher in inhabitants of the building across the street.

Amoako et al. (2009) conducted a survey of RFR at public access points close to schools, hospitals, and highly populated areas in Ghana near 50 cell phone base stations. Their primary objective was to measure and analyze field strength levels. Measurements were made using an Anritsu model MS 2601A spectrum analyzer to determine the electric field level in the 900 and 1800 MHz frequency bands. Using a GPS (global positioning system), various base stations were mapped. Measurements were taken at 1.5 m above ground to maintain line of sight with the RF source. Signals were measured during the day over a 3 h period, at a distance of approximately 300 m. The results indicated that power densities for 900 MHz at public access points varied from as low as 0.000001 μW/cm² to as high as 0.001 μW/cm². At 1800 MHz, the variation of power densities was from 0.000001 to 0.01 μW/cm². There are no specific RFR standards in Ghana. These researchers determined that while their results in most cites were compliant with the ICNIRP standards, levels were still 20 times higher than values typically found in the UK, Australia, and the U.S., especially for Ghana base stations in rural areas with higher power output. They determined that there is a need to reduce RFR levels since an increase in mobile phone usage is foreseen.

Clearly, predicting actual exposures based on simple distance from antennas using standardized computer formulas is inadequate. Although power density undoubtedly decreases with distance from a generating source, actual exposure metrics can be far more complex, especially in urban areas. Contributing to the complexity is the fact that the narrow vertical spread of the beam creates a low RF field strength at the ground directly below the antenna. As a person moves away or within a particular field, exposures can become complicated, creating peaks and valleys in field strength. Scattering and attenuation alter field strength in relation to building placement and architecture, and local perturbation factors can come into play. Power density levels can be 1 to 100 times lower inside a building, depending on construction materials, and exposures can differ greatly within a building, depending on numerous factors such as orientation toward the generating source and the presence of conductive materials. Exposures can be twice as high in upper floors than in lower floors, as found by Anglesio et al. (2001).

However, although distance from a transmitting source has been shown to be an unreliable determinant for accurate exposure predictions, it is nevertheless useful in some general ways. For instance, it has been shown that radiation levels from a tower with 15 nonbroadcast radio systems will fall off to hypothetical natural background levels at approximately 1500 ft (~500 m) (Rinebold 2001). This would be in general agreement with the lessening of symptoms in people living near cell towers at a distance over 1000 ft (~300 m) found by Santini et al. (2002) .

The previously mentioned studies indicate that accuracy in both test design and personal dosimetry measurements are possible in spite of the complexities and that a general safer distance from a cell tower for residences, schools, daycare centers, hospitals, and nursing homes might be ascertained.

13. Discussion

Numerous biological effects do occur after short-term exposures to low-intensity RFR but potential hazardous health effects from such exposures on humans are still not well established, despite increasing evidence as demonstrated throughout this paper. Unfortunately, not enough is known about biological effects from long-term exposures, especially as the effects of long-term exposure can be quite different from those of short-term exposure. It is the long-term, low-intensity exposures that are most common today and increasing significantly from myriad wireless products and services.

People are reporting symptoms near cell towers and in proximity to other RFR-generating sources including consumer products such as wireless computer routers and Wi-Fi systems that appear to be classic "microwave sickness syndrome," also known as "radiofrequency radiation sickness." First identified in the 1950s by Soviet medical researchers, symptoms included headache, fatigue, ocular dysfunction, dizziness, and sleep disorders. In Soviet medicine, clinical manifestations include dermographism, tumors, blood changes, reproductive and cardiovascular abnormalities, depression, irritability, and memory impairment, among others. The Soviet researchers noted that the syndrome is reversible in early stages but is considered lethal over time (Tolgskaya et al. 1973).

Johnson-Liakouris (1998) noted there are both occupational studies conducted between 1953 and 1991 and clinical cases of acute exposure between 1975 and 1993 that offer substantive verification for the syndrome. Yet, U.S. regulatory agencies and standards-setting groups continue to quibble about the existence of microwave sickness because it does not fit neatly into engineering models for power density, even as studies are finding that cell towers are creating the same health complaints in the population. It should be noted that before cellular telecommunications technology, no such infrastructure exposures between 800 MHz and 2 GHz existed this close to so many people. Microwave ovens are the primary consumer product utilizing a high RF intensity, but their use is for very brief periods of time and ovens are shielded to prevent leakage above 1000 μW/cm^2 — the current FDA standard. In some cases, following the U.S. Telecommunications Act of 1996 preemption of local health considerations in infrastructure siting, antennas have been mounted within mere feet of dwellings. And, on buildings with roof-mounted arrays, exposures can be lateral with top floors of adjacent buildings at close range.

It makes little sense to keep denying health symptoms that are being reported in good faith. Though the prevalence of such exposures is relatively new to a widespread population, we, nevertheless, have a 50 year observation period to draw from. The primary questions now involve specific exposure parameters, not the reality of the complaints or attempts to attribute such complaints to psychosomatic causes, malingering, or beliefs in paranormal phenomenon. That line of argument is insulting to regulators, citizens, and their physicians. Serious mitigation efforts are overdue.

There is early Russian and U.S. documentation of long-term, very low-level exposures causing microwave sickness as contained in *The Johns Hopkins Foreign Service Health Status Study* done in 1978 (Lilienfield et al. 1978; United States Senate 1979). This study contains both clinical information, and clear exposure parameters. Called the Lilienfield study, it was conducted between 1953 and 1976 to determine what, if any, effects there had been to personnel in the U.S. Embassy in Moscow after it was discovered that the Soviet government had been systematically irradiating the U.S. government compound there.

The symptoms reported were not due to any known tissue heating properties. The power densities were not only very low but the propagation characteristics were remarkably similar to what we have today with cell phone base stations. Lilienfield recorded exposures for continuous-wave, broadband, modulated RFR in the frequency ranges between 0.6 and 9.5 GHz. The exposures were long-term and low-level at 6 to 8 h per day, 5 days per week, with the average length of exposure time per individual between 2 to 4 years. Modulation information contained phase, amplitude, and pulse variations with modulated signals being transmitted for 48 h or less at a time. Radiofrequency power density was between 2 and 28 μW/cm^2 — levels comparable to recent studies cited in this paper.

The symptoms that Lilienfield found included four that fit the Soviet description for dermographism — eczema, psoriasis, allergic, and inflammatory reactions. Also found were neurological problems with diseases of peripheral nerves and ganglia in males; reproductive problems in females during pregnancy, childbearing, and the period immediately after delivery (puerperium); tumor increases (malignant in females, benign in males); hematological alterations; and effects on mood and well-being including irritability, depression, loss of appetite, concentration, and eye problems. This description of symptoms in the early literature is nearly identical to the Santini, Abdel-Rassoul, and Narvarro studies cited earlier, as well as the current (though still anecdotal) reports in communities where broadcast facilities have switched from analog to digital signals at power intensities that are remarkably similar. In addition, the symptoms in the older literature are also quite similar to complaints in people with EHS.

Such reports of adverse effects on well-being are occurring worldwide near cell infrastructure and this does not appear to be related to emotional perceptions of risk. Similar symptoms have also been recorded at varying distances from broadcast towers. It is clear that something else is going on in populations exposed to low-level RFR that computer-generated RFR propagation models and obsolete exposure standards, which only protect against acute exposures, do not encompass or understand. With the increase in so many RFR-emitting devices today, as well as the many in the wings that will dramatically increase total exposures to the population from infrastructure alone, it may be time to approach this from a completely different perspective.

It might be more realistic to consider ambient outdoor and indoor RFR exposures in the same way we consider other environmental hazards such as chemicals from building materials that cause sick building syndrome. In considering public health, we should concentrate on aggregate exposures from multiple sources, rather than continuing to focus on individual source points like cell and broadcast base stations. In addition, whole categorically excluded technologies must be included for systems like Wi-Fi, Wi-Max, smart grids, and smart metering as these can greatly increase ambient radiation levels. Only in that way will low-level electromagnetic energy exposures be understood as the broad environmental factor it is. Radiofrequency radiation is a form of energetic air pollution and it should be controlled as such. Our current predilection to take this one product or service at a time does not encompass what we already know beyond reasonable doubt. Only when aggregate exposures are better understood by consumers will disproportionate resistance to base station siting bring more intelligent debate into the public arena and help create safer infrastructure. That can also benefit the industries trying to satisfy customers who want such services.

Safety to populations living or working near communications infrastructure has not been given the kind of attention it deserves. Aggregate ambient outdoor and indoor exposures should be emphasized by summing up levels from different generating source points in the vicinity. Radiofrequency radiation should be treated and regulated like radon and toxic chemicals, as aggregate exposures, with appropriate recommendations made to the public including for consumer products that may produce significant RFR levels indoors. When indoor consumer products such as wireless routers, cordless/DECT phones, leaking microwave ovens, wireless speakers, and (or) security systems, etc. are factored in with nearby outdoor transmission infrastructure, indoor levels may rise to exposures that are unsafe. The contradictions in the studies should not be used to paralyze movement toward safer regulation of consumer products, new infrastructure creation, or better tower siting. Enough good science exists regarding long-term low-level exposures — the most prevalent today — to warrant caution.

The present U.S. guidelines for RFR exposure are not up to date. The most recent IEEE and NCRP guidelines used by the U.S. FCC have not taken many pertinent recent studies into consideration because, they argue, the results of many of those studies have not been replicated and thus are not valid for standards setting. That is a specious argument. It implies that someone tried to replicate certain works but failed to do so, indicating the studies in question are unreliable. However, in most cases, no one has tried to exactly replicate the works at all. It must be pointed out that the 4 W/kg SAR threshold based on the de Lorge studies have also not been replicated independently. In addition, effects of long-term exposure, modulation, and other propagation characteristics are not considered. Therefore, the current guidelines are questionable in protecting the public from possible harmful effects of RFR exposure and the U.S. FCC should take steps to update their regulations by taking all recent research into consideration without waiting for replication that may never come because of the scarcity of research funding. The ICNIRP standards are more lenient in key exposures to the population than current U.S. FCC regulations. The U.S. standards should not be "harmonized" toward more lenient allowances. The ICNIRP should become more protective instead. All standards should be biologically based, not dosimetry based as is the case today.

Exposure of the general population to RFR from wireless communication devices and transmission towers should be kept to a minimum and should follow the "As Low As Reasonably Achievable" (ALARA) principle. Some scientists, organizations, and local governments recommend very low exposure levels — so low, in fact, that many wireless industries claim they cannot function without many more antennas in a given area. However, a denser infrastructure may be impossible to attain because of citizen unwillingness to live in proximity to so many antennas. In general, the lowest regulatory standards currently in place aim to accomplish a maximum exposure of 0.02 V/m, equal to a power density of 0.0001 $\mu W/cm^2$, which is in line with Salzburg, Austria's indoor exposure value for GSM cell base stations. Other precautionary target levels aim for an outdoor cumulative exposure of 0.1 $\mu W/cm^2$ for pulsed RF exposures where they affect the general population and an indoor exposure as low as 0.01 $\mu W/cm^2$ (Sage and Carpenter 2009). In 2007, *The BioInitiative Report, A rationale for a biologically based public exposure standard for electromagnetic fields (ELF and RF)*, also made this recommendation, based on the precautionary principle (Bioinitiative Report 2007).

Citizens and municipalities often ask for firm setbacks from towers to guarantee safety. There are many variables involved with safer tower siting — such as how many providers are co-located, at what frequencies they operate, the tower's height, surrounding topographical characteristics, the presence of metal objects, and others. Hard and fast setbacks are difficult to recommend in all circumstances. Deployment of base stations should be kept as efficient as possible to avoid exposure of the public to unnecessary high levels of RFR. As a general guideline, cell base stations should not be located less than 1500 ft ($\sim$500 m) from the population, and at a height of about 150 ft ($\sim$50 m). Several of the papers previously cited indicate that symptoms lessen at that distance, despite the many variables involved. However, with new technologies now being added to cell towers such as Wi-Max networks, which add significantly more power density to the environment, setback recommendations can be a very unpredictable reassurance at best. New technology should be developed to reduce the energy required for effective wireless communication.

In addition, regular RFR monitoring of base stations should be considered. Some communities require that ambient background levels be measured at specific distances from proposed tower sites before, and after, towers go online to establish baseline data in case adverse effects in the population are later reported. The establishment of such baselines would help epidemiologists determine what changed in the environment at a specific point in time and help better assess if RFR played a role in health effects. Unfortunately, with so much background RFR today, it is almost impossible to find a clean RFR environment. Pretesting may have become impossible in many places. This will certainly be the case when smart grid technologies create a whole new blanket of low-level RFR, with millions of new transceivers attached to people's homes and appliances, working off of centralized RFR hubs in every neighborhood. That one technology alone has the ability to permanently negate certain baseline data points.

The increasing popularity of wireless technologies makes understanding actual environmental exposures more critical with each passing day. This also includes any potential effects on wildlife. There is a new environmental concept taking form — that of "air as habitat" (Manville 2007) for species such as birds, bats, and insects, in the same way that water is considered habitat for marine life. Until now, air has been considered something "used" but not necessarily "lived in" or critical to the survival of species. However, when air is considered habitat, RFR is among the potential pollutants with an ability to adversely affect other species. It is a new area of inquiry deserving of immediate funding and research.

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ATTACHMENT 4

Journal

Electromagnetic Biology and Medicine ›

Volume 36, 2017 - Issue 3

Articles

Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations

Zothansiama, Mary Zosangzuali, Miriam Lalramdinpuii & Ganesh Chandra Jagetia

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ABSTRACT

Radiofrequency radiations (RFRs) emitted by mobile phone base stations have raised concerns on its adverse impact on humans residing in the vicinity of mobile phone base stations. Therefore, the present study was envisaged to evaluate the effect of RFR

on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes (HPBLs) of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls. The study groups matched for various demographic data including age, gender, dietary pattern, smoking habit, alcohol consumption, duration of mobile phone use and average daily mobile phone use. The RF power density of the exposed individuals was significantly higher ($p < 0.0001$) when compared to the control group. The HPBLs were cultured and the DNA damage was assessed by cytokinesis blocked micronucleus (MN) assay in the binucleate lymphocytes. The analyses of data from the exposed group ($n = 40$), residing within a perimeter of 80 m of mobile base stations, showed significantly ($p < 0.0001$) higher frequency of micronuclei when compared to the control group, residing 300 m away from the mobile base station/s. The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione (GSH) concentration ($p < 0.01$), activities of catalase (CAT) ($p < 0.001$) and superoxide dismutase (SOD) ($p < 0.001$) and rise in lipid peroxidation (LOO) when compared to controls. Multiple linear regression analyses revealed a significant association among reduced GSH concentration ($p < 0.05$), CAT ($p < 0.001$) and SOD ($p < 0.001$) activities and elevated MN frequency ($p < 0.001$) and LOO ($p < 0.001$) with increasing RF power density.

KEYWORDS: Antioxidants, genotoxicity, humans, micronucleus, power density

Additional information

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A cross-sectional case control study on genetic damage in individuals residing in the vicinity of a mobile phone base station

Gursatej Gandhi et al.

Electromagnetic Biology and Medicine
Volume 34, 2015 - Issue 4

Published online: 9 Jul 2014

From: Jon Hill <hill.jon.m@gmail.com>

Sent: Tuesday, November 6, 2018 3:13 PM

To: Leah Carlson

Subject: Proposed Cell Phone Tower near Nazarene Church

Hello,

My name is Jon Hill. My wife Kensington and I live at 721 Park Drive - right across the street from the Nazarene church.

I strongly urge the council to not allow a cell phone tower to be placed so near a residential area. There have been a number of studies which prove that the EMF pollution from cell phone towers causes adverse affects in living creatures. Examples:

ATTACHMENT 1

1) A 1998 study of the effects of a cell tower on a herd of dairy cattle was conduced by the Bavarian state government in Germany. The tower caused adverse health effects in the cows, resulting in a measurable drop in milk yield. Relocating the cattle restored the milk yield and moving them back to the pasture recreated the problem. Please see the entire study here: https://emwatch.com/wp-content/uploads/2013/11/dairycowstudy.pdf?0c6aef&0c6aef

ATTACHMENT 2

2) A human study in 2007 measured blood levels of serotonin and melatonin before and after the activation of a new cell tower site. For the 25 participants who lived within 300 meters of the tower, the study found alarmingly unfavorable changes in their hormone levels. Please see the entire study here:
https://unidoc.wiltshire.gov.uk/UniDoc/Document/File/MTcvMDE0OTcvUE5URUwsOTU4NzA3

ATTACHMENT 3

3) A study performed by doctors in Naila, Germany monitored 1000 residents who lived in an area around two cell phone towers for 10 years. Those who lived within 400 meters of either tower had a newly-diagnosed cancer rate three times higher than those who lived further away.

Please see the entire study here: https://emwatch.com/wp-content/uploads/2013/11/Naila_study.pdf?0c6aef&0c6aef

In addition to the 3 studies I have listed, there are many others that support these findings. It is worth nothing that the USA has extremely lax policies on EMF levels. The current legal limit for cell site radiation in the US is 1000 microwatts per square centimeter. Other countries have set limits as low as 1 microwatt per square centimeter. Switzerland, Italy, China, and many other countries impose a limit of 10 microwatts per square centimeter.

The bottom line is that towers such as these should never be placed within 400 meters of residential areas. The harmful effects of the radiation are much more pronounced within this distance. I urge the council to take the safe approach. Adding a new tower is fine, but make sure it's more than 400 meters from any residential areas.

Respectfully,

Jon Hill

ATTACHMENT 1 - JON HILL

From the Institute of Pharmacology, Toxicology and Pharmacy at the Veterinary Faculty of Hannover (Director: Prof. Dr. W. Löscher) and the Scientific Institute of Electronics and Radar at the University of the German Federal Armed Forces (Prof. G. Käs)

Conspicuous behavioural abnormalities in a dairy cow herd near a TV and Radio transmitting antenna

W. Löscher and G. Käs (Authors)

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SUMMARY: In addition to a considerable reduction of milk yield and increasing occurences of health problems, behavioural abnormalities that have not yet been examined, have been observed over the last two years in a herd of dairy cows maintained in close proximity to a TV and Radio transmitting antenna. The evaluation of possible factors which could explain the abnormalities in the livestock did not disclose any factors other than the measurable high-frequency electromagnetic fields. An experiment in which a cow with abnormal behaviour was brought to a stable in a different area resulted in normalisation of the cow within five days. The symptoms returned, however, when the cow was brought back to the stable in close proximity to the antenna in question. In view of the previously known effects of electromagnetic fields it may be possible that the observed abnormalities are related to the electromagnetic field exposure.

Key words: transmitting antennas, electromagnetic fields, milk yield, behaviour, cow.

Introduction

Because of the ubiquitous usage of electric power and the increasing spread of high-frequency transmitters for mobile communication and TV & Radio broadcasting, humans and animals in highly industrialized countries are these days exposed to electrical and magnetic fields to a degree which exceeds the natural tension levels of relevant fields by a magnitude and presents a new influencing quantity in the evolutionary history of humans and animals (Katalyse 1994). For a long time the possibility of an influence of weak electrical and magnetic fields on the well-being of humans and animals has simply been ignored. The limits were only relating to acute cases of health impairment which can occur at some workplaces under extremely high exposure rates. The ever increasing knowledge of the biological effects of even weak electrical and magnetic fields as well as numerous epidemiological studies with the focus on a possible increase in the risk of cancer through field exposure have, however, led in the last ten to fifteen years to an altered discussion of the possible risk potential of such fields (Adey 1993; Hendee and Boteler 1994; Katalyse 1994; Meinert and Michaelis 1996; Robert 1993; Savitz 1995; Shaw and Croen 1993; Sobel et al. 1996; Wertheimer and Leeper 1994). As one can be protected well from electrical fields in contrast to magnetic fields, the effects of such fields on human and animal health are rarely the focus of scientific research. In comparison, low-frequency magnetic fields can practically penetrate any matter without being slowed down, and high-frequency electromagnetic fields and waves can cause biological effects - even in greater distance from their source – which are possibly connected to health risks (Katalyse 1994). Fields of this type which are a necessity of civilisation and have certain health effects are commonly known as "Electrosmog".

The question of a possible risk of cancer which today cannot be discounted mainly because of numerous findings based on experiments with animals (Liburdy and Löscher 1997;

Löscher and Mevissen 1994), occupies the foreground of public debate about possible health risks through exposure to low-frequency magnetic or high-frequency electromagnetic fields. In addition, there are extensive indications of interactions of magnetic fields with the hormonal balance, biorhythm, immune system, nervous system, behavioural patterns and psychological functions, interactions which can have a detrimental effect on health (Katalyse 1994; Liburdy u. Löscher 1997; Löscher u. Liburdy 1998). In this connection it is often forgotten that not only humans but also pets and farm animals who are exposed can suffer such impairments to their health because of field exposure, for example in the vicinity of high tension pylons or transmitting antennas (Marks et al. 1995). Similarly to epidemiological studies on humans with field exposed workplaces the risk of breast cancer for hundreds living in apartments with high flux densities of low-frequency (60 Hertz) magnetic fields was seven times higher in comparison with animals that were not exposed (Reif et al. 1995), a finding that can be explained by the "Melatonin Hypothesis" of magnetic field effects (Löscher and Mevissen 1997).

A series of earlier studies looked at the effect of magnetic fields on farm animals. Lee et al. (1997) discovered that sheep which had been grazing in close proximity to a high tension mast, showed an impaired immune system. Examinations of dairy cows that had been exposed to magnetic fields resulted in inconsistent findings which ranged from no influence at all to a reduction in milk yield, changed milk composition and fertility problems (Algen and Hultgren 1985a, b, 1987; Amstutz and Miller 1980; Angell et al. 1990; Burchard et al. 1996; Marks et al. 1995; Martin et al. 1986). The predominant share of the examinations on dairy cows was conducted under exposure to low-frequency (50 or 60 Hertz) fields, whereas only few studies deal with the effect of high-frequency electromagnetic fields, for example in the vicinity of transmitting antennas.
A recently publicized study discovered a significant increase of micronuclei in erythrocyte in the blood of cattle grazing on a farm near a transmitting facility. This is an indication of a genotoxic effect of the exposure (Balode 1996).

In the case described by this study a farmer asked a veterinary department for help after he had experienced major problems with his herd of dairy cows since the previous year. The farm is situated in close proximity to a transmitting tower with several transmitters (see Table 1 and Figure 1). The problems with the herd described in the following started after several transmitters for mobile radio communication had been installed in addition to the already existing TV transmitting antennas. As the farmer himself and his family were experiencing considerable health problems since the additional transmitters were installed, and none of the medical tests conducted had shed any light on the source of these health problems, the farmer came to the conclusion that the high-frequency electromagnetic fields that were produced by these transmitters had to be the cause of the problems including the problems experienced by his dairy cow herd. The relevant veterinary department then conducted observational studies and research which were complemented by measurements of the electromagnetic fields, with its focus on the dairy cow herd.

Table 1: Transmitting antennas in close proximity of the farm (all installed in the TV tower of Figure 1)

Transmitting Antenna	Frequency	Performance
39 directional radio transmitters (Mean)	2.2 – 18.7 GHz	124 W
C-Net	461 MHz	34 W
D-Net	935 MHZ	25 W
B-Net	160 MHz	20 W
Cityruf	460 MHz	50 W
Eurosignal	87,361 MHz	2 kW
TV-Channel 2	510 MHZ	20 kW
TV-Channel 3	734 MHZ	20 kW
Modacom	427 MHz	15 kW

Ground Plan for Measurements outdoors

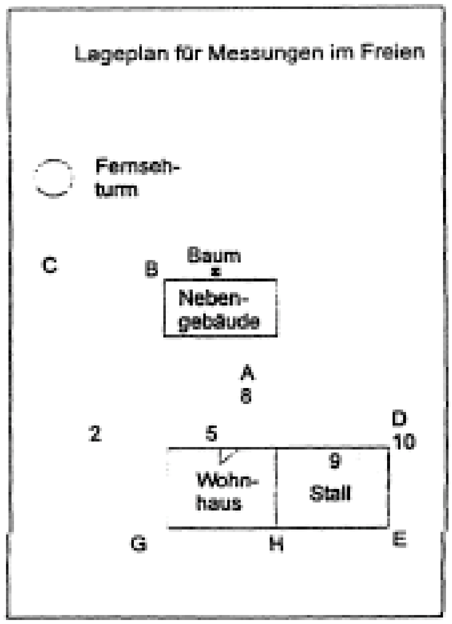

Figure 1: Ground plan for the measurements of electromagnetic fields in the vicinity of the transmitting antennas (for examples re the measurements see Table 2 and 3).

Observations of the dairy cow herd

Many of the biological effects and discussed health risks of electromagnetic fields are similar to the effects of chronic stress pressure (Blank 1995; Smith 1996). Apart from apparent problems caused by stress such as increased aborting without detectable causes, frequent fertility disorders in the form of an acyclic tendency and reduction in milk yield all of which have already been observed in herds grazing in close proximity to high tension lines (see overview in Burchard et al. 1996), the following abnormalities occurred in the affected dairy cow herd:

Most of the cows in this herd displayed conjunctivitis with heavy flood of tears (continuously wet cheeks) and itching (some cows rubbed their eye areas continuously against items in the stable within reach as well as against neighbouring cows).

Several animals were pushing their heads against the chest area of neighbouring cows turning their heads in the same direction (away from the transmitting antenna).
One cow showed very conspicuous behaviour by shuffling backwards and forwards moving her head continuously (Weaving). Resting phases alternated with the described behaviour which often lasted more than 30 minutes.

Cows in calf as well as dry cows that were put out on pasture land close to the farm, only grazed for a few minutes each time then taking "cover" from the transmitting tower in or behind an outbuilding.

Cows that have calved three or four times showed rapid decline. When these cows tried to get up their hind legs showed trembling and over time they found getting up increasingly difficult. The decline continued and led to their death after only a few weeks.

Conducted Examinations

1. Fodder analysis and feeding calculation

To exclude that a feeding fault had caused any metabolic disorders which in turn could be responsible for causing other health problems, a fodder analysis and feeding calculation was initiated by the relevant agricultural authority. The research and calculation yielded that the fodder was of high quality and that the amount of feed stuffs administered by the farmer was in relation to the performance of the dairy cows.

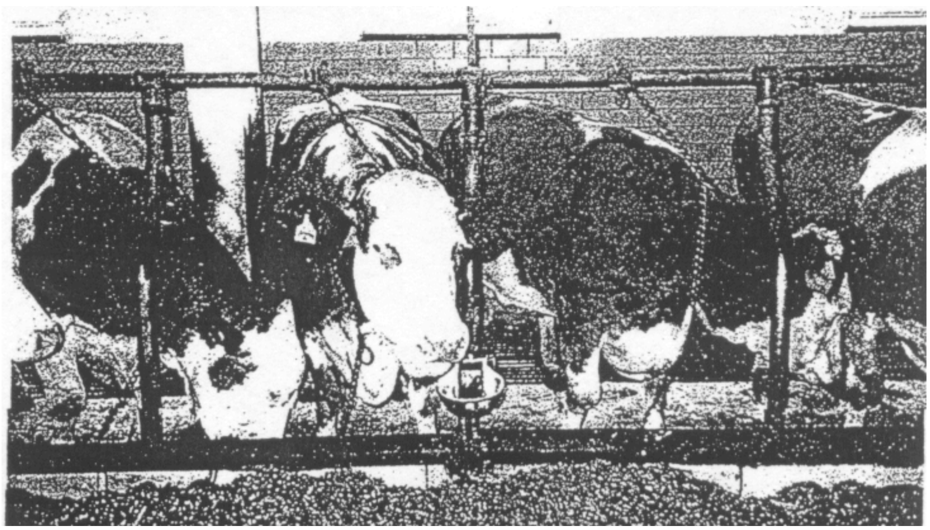

Figure 2: Typical turning of the head (away from the transmitting antennas) displayed by cows of the herd in question (see detailed description in text).

2. Autopsy of a perished dairy cow

The autopsy of a four-year-old cow that had died in the stable building and had previously displayed symptoms of the same illness as described above, provided the following result: Death from acute heart & circulatory collapse with bleeding from several organs. No indication as to the cause, in particular no acute or chronic inflammatory changes to organs. The autopsy was kindly performed by Dr. Geisel, Institute of Animal Pathology at the University of Munich.

3. Examination of aborted foetal material

The examination of aborted foetal material at the Landesuntersuchungsamt für das Gesundheitswesen Südbayern (Federal Examination Authority for the Health Service of Southern Bavaria) did not disclose any indication of pathogenic causes for aborting the foetus based on the microscopic and cultural examination and on the serological tests performed.

4. Switching stables

To obtain further indications with regard to the causes for the behavioural changes the dairy cow which displayed very obvious changes in behaviour and which was described under 3 in the section Observations of the dairy cow herd, and another dairy cow were separated from the original herd and joined another dairy cow herd in an identically partitioned stable which was approx. 20 kilometres away from the original location. After five days in the new stable the affected dairy cow did not show any of the conspicuous behavioural abnormalities any more. Both cows were relocated to the original stable after approximately two weeks. The previously affected cow displayed the described conspicuous behavioural abnormalities again after only a few days.

5. Measurement of the electromagnetic fields

Measurements of the electromagnetic fields in front of and on the farm property itself were conducted by the Bundesamt für Post und Telekommunikation (Federal Office for Postal Services and Telecommunication) and by the Abteilung für Elektronik und Radar der Universität der Bundeswehr München (Department of Electronics and Radar of the University of the German Federal Armed Forces in Munich). The most important results of these measurements are displayed in Table 2 and 3. The measurement values are considerably below the limits set out in the 26. Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes (Verordnung über elektromagnetische Felder; 26. BImSchV) (26. Ordnance/Decree** for the Implementation of the Federal Air Pollution Laws (Ordnance/Decree for electromagnetic fields; 26. BImSchV (Abbreviation for 26th Bundes-Immissionsschutzgesetz)) dated 16. December 1996.

Discussion

The health disorders and behavioural abnormalities described in this paper as well as the results of the conducted examinations point to the electromagnetic tension as the cause of the occurrences in the affected herd of dairy cows. The main problem in conducting an definitive assessment is the constant change in circumstances/ conditions because the farmer is forced to continue to run his farm and to keep the losses as small as possible. Therefore he tries to have cows which display the first signs of being affected such as worsening general condition after calving, either slaughtered early or taken to alternative grazing paddocks which are situated about 10 kilometres away from his farm. The relocation and exchange of dairy cows continuously creates a new situation because every cow reacts to the electromagnetic tension in an individual manner. Only a scientifically structured test of the affected dairy cow herd with set parameters could provide more definite findings in this case. Such a test of the affected herd is planned to clarify the causes of the observed behavioural abnormalities and health problems further. A causal relation could best be determined in this case by switching off the transmitting antennas for the mobile radio communication temporarily.

Table 2: Measurements of the electromagnetic field output in the attic storey of the farm house

Attic window	Frequency	Signal	Level (dBm)	Power density (µW/cm2)
closed	512.2	TV-2	- 12.8	0.044
closed	464.2	C-Network	- 43	0.00003
closed	936.2	D-Network	- 46.8	0.000051
closed	735.7	TV-3	- 15.8	0.04
open	511.4	TV-2	- 13.2	0.035
open	735.7	TV-3	- 7.6	0.26

Table 3: Measurements of the electromagnetic field output at different sites in the vicinity of and in the stable and living area (see Figure 1 for the measurement locations). The measurements were predominantly conducted at one frequency (512 MHz) because all other signals can be put in relation to the measurements inside the farm house (see Table 2) if we assume that the attenuation values through the wall of the building will not differ much within the relatively narrow frequency band (see Figure 1).

Measurement	Location	Frequency (MHz)	Level (dBm)	Power density (µW/cm2)
In the stable	Entrance (10)	512	- 9.6	0.08
In the stable	Middle part	512	- 24	0.003
In the stable	Rear part	512	- 26	0.002
Surrounding area	A	512	- 10.6	0.06

Surrounding area	B	512	0	0.7
Surrounding area	C	512	- 3.2	0.35
Surrounding area	F	512	- 10.8	0.06
In front of stable	D	512	- 3.8	0.36
Beside the stable	E	512	- 22.4	0.004
Beside the house	G	512	- 2	0.46
Behind the stable	H	512	- 13.4	0.03
Inside the house		735.7	- 15.8	0.04
In front of the house	5	88.8	- 4.8	0.006

Should the scheduled examination confirm the correlation described above between exposure to magnetic fields and health disorders or behavioural abnormalities then this would provide further indications that the limits set out in the 26. BlmSchV (Abbreviation for 26th Bundes-Immissionsschutzgesetz = 26th Federal Air Pollution Laws) are too high and require correction (see Karus u. Nießen 1996). In this case one has to take into consideration that even though the measurements for the different electromagnetic fields turned out to be below the limits set out in the 26. BlmSchV, interactions between the fields when animals and humans were exposed to them cannot be excluded because of the multitude of existing fields with different frequencies. Synergic interactions between electromagnetic fields with different frequencies have already been described on a cellular level (Löscher and Liburdy, 1998) and should not be neglected in future discussions regarding any limits of this kind.

After the above case had been published by the media and agricultural magazines more farmers have come forward describing similar cases. The above case description is mainly intended to alert the Veterinary Association to the obvious possibility of behavioural abnormalities and health problems caused by electromagnetic field exposure of animals.

Expression of Thanks
We would like to thank Prof. Klee (Veterinary Faculty of the Ludwig-Maximilians-University Munich) for the critical checking of this paper's manuscript.

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ATTACHMENT 2 - JON HILL

From: Caroline Brown
Sent: 24 March 2017 09:11
To: Taylor, James

Subject: Supporting research information missing from various objections - 17/01497/PNTEL

Dear James,

A number of the people who spoke at the BOA town council meeting have asked me to point out that certain articles of research and photos were missing from their objections letters online, following the attendance of BOA town council meeting.

I would be very grateful if you could add the following to their particular submissions.

Many thanks

Caroline

Gisela Norman submission for 23/3/17

http://weepnews.blogspot.co.uk/2008/07/kempten-west-study-2007-english-version.html

Kempten West Study 2007 - English version

This is a very important study which shows the adverse health effects caused soon after a cell phone transmitter commenced operation.
Margaret

Mobile Telecommunications in Kempten West

Blood levels alarmingly altered

The Citizens Initiative Kempten West , which was established after the installation of the T-Mobile transmitter on the bank building (in Lindauerstraße) is now able to present the first results of the blood tests. Unfortunately, the results confirm the fears of the Initiative.

The initial blood samples were taken in November 2006 before the transmitter commenced operation (Dec. 2006). The second set of blood samples were taken in May 2007, 5 months after the transmitter commenced normal operation.

All 28 participating residents had already removed DECT-Telephones and WLAN from their homes weeks before the first blood sampling took place and also reduced their mobile phone use to a few conversations outside home. Furthermore, 6 families had the electromagnetic exposure in their houses measured by technician Herr W. Jogschies, Wildpoldsried, both before and also after the installation of the transmitter mast. The second test results showed a several fold increase in the electromagnetic RF radiation exposure (the medical team has the measurements).

At the suggestion of Dr. med. M. Kern, the initiator of the `Allgäuer Doctor's Initiative', and of alternative practitioner E. Strodl, the citizen's initiative decided to investigate the effects of the telecommunications mast on diverse laboratory parameters. At the same time, this series of analyses is part of a German-wide investigation into the effects of mobile telecommunications on humans (Dr. med. Hans-C. Scheiner in Munich (München). The organisation, implementation and medical supervision of the project Suburb and the first summary of the results were handled by physician Anna Blanz.

The following laboratory values were established:

o The differential blood picture using whole-blood

o Serotonin daytime level from the blood serum (8 a.m. -9:00 a.m.)

o Melatonin and from the blood serum (daytime level)

o Determination of the nocturnal maximum melatonin excretion through determination of the melatonin metabolite
6-Hydroxy-Melatonin-Sulphate (6-OH-M-S) in the nocturnal total collected urine.

It is established that both, the "mood hormone" serotonin and also the "sleep-" and "immune defence hormone" melatonin is formed in the pineal gland of the brain, whereby serotonin represents a precursor of melatonin.

In healthy conditions a maximum of the sleep hormone melatonin is formed from serotonin during the night, whilst, during the daytime, the 'mood hormone' serotonin is shown to be clearly increased, at the expense of the then severely reduced amount of the 'sleep hormone', melatonin.

In addition, undisturbed melatonin excretion synchronises various biological and hormonal rhythms in the human body and ensures deep revitalising sleep.

At the same time, melatonin represents one of the most important immune enhancing substances of our body and, as a free radical scavenger, it protects all body- and brain cells against genetic damage considered as a precursor to cancer.

Serotonin acts especially as a messenger for the nervous system and in the brain as a mood hormone. A reduction of the serotonin level is therefore associated with depression, lethargy and listlessness, inner agitation and many psychiatric disturbances.

The evaluation/analysis of 25 study participants (13 women, 9 men, 3 young people) who all live within a radius of 15-300 metres of the telecommunications mast produced the following results:

Melatonin in the Urine:

Only 8 out of 25 participants (28%) at the initial testing exhibited initial blood levels which were in the region considered to be normal. It was therefore a group of people that had already been pre-exposed.

For 14 of 25 participants (56 %), there was a decrease for the 6-OH-M-S in the collected nocturnal urine.

For 7 of 25 participants (28%), there was an increase, in most cases, within a region considered to be severely pathological.

Only one out of 25 participants (4 %) with normal initial level exhibited an increased level of 6-OH-M-S at the 2nd [blood] test.

Daytime melatonin in the blood serum:

As a rule, the daytime melatonin level in the blood serum is very much lower than the nocturnal maximum melatonin level.

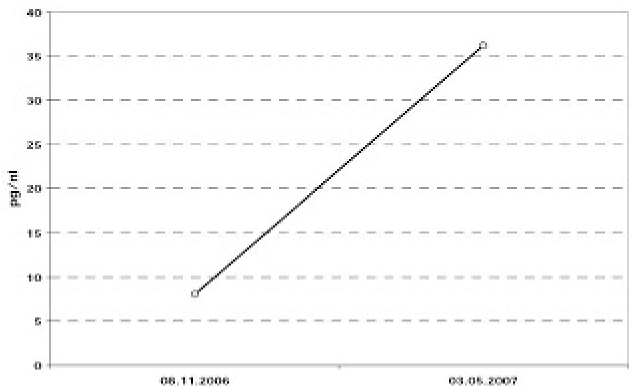
The paradox increase in the daytime melatonin levels reflects the general tendency to marked daytime tiredness of people exposed to radiation.

Melatonin levels clearly increased on average by about 4.5 times of the initial level for all 25 participants.

This effect is shown below based on the mean value (of 25 participants).

Graph

Melatonin in the serum



Serotonin in the blood:

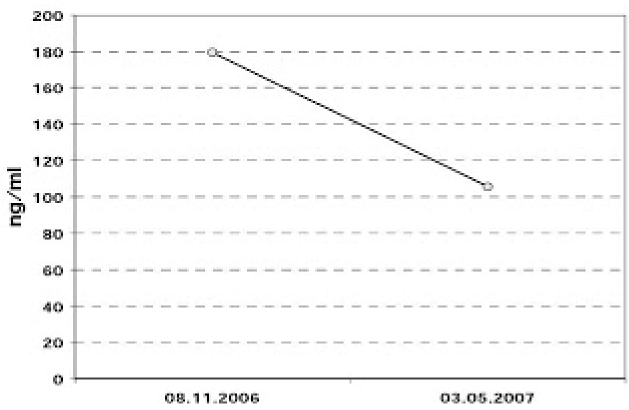
At the second measurement 21 of 25 participants (=84%)presented a reduction of the ‘mood hormone’ serotonin (in the daytime blood serum) by an average of 46.3%.

Of these, 10 participants showed a decrease of about 50% and above, with a maximum serotonin decrease of up to 68 %. For 3 participants it remained unchanged, for 1 participant the level was slightly increased.

The following graph shows this change based on the mean value of 21 participants:

Graph 2

Serotonin in the Serum



Summary Evaluation of the Results:

Especially alarming is the fact, that 84 % of participants, almost the whole group, reacted with a massive decrease in the serotonin level (average 46%) following increased exposure from the operation of the newly erected telecommunications mast.

The clear increase in depressive mood disturbances, lethargy and listlessness, appetite disturbances, inner agitation and reduced quality of life experienced by nearly all nearby residents must be acknowledged by orthodox medicine

Alarming is also the fairly steep nightly melatonin decrease in the presence of increasing telecommunication signal exposure, which is nearly half of the normal level for more than half of the group (56%). Even the slow increased tendency of nearly one third (28%)represents ultimately, despite a slight increase, only an upturn within a mainly deeply lowered pathological region.

We therefore have to expect considerable sleep disturbance and immune deficiencies in 84% (28 plus 56%). Since, from the medical viewpoint, sleep disturbance is increasingly seen as a cancer promoting risk factor, these numbers must be considered as alarming

The increase of the daytime melatonin level, that is also normally substantially lower in comparison to the nocturnal melatonin peak, also indicates a displacement of the flattened nocturnal distribution graph in the morning direction. Normally, the level increases about 1-2 hours after going to bed, it reaches a maximum between 2 a.m. and 3 a.m. and then drops off again steeply until the morning hours.

The blood sampling took place in the morning between 8 a.m. and 9 a.m. All participants went to bed the night before at the latest by 11 p.m. This increase indicates, in addition to the nocturnal melatonin reduction, also a displacement of melatonin excretion in the morning direction.
That means:

1. relative melatonin deficiency at night with shortened phases of deep sleep. This is indicated by restless sleep with frequency awakening and

2. increased melatonin level at the tine of arising from bed. It is symptomatic of this, that one has difficulty getting out of bed in the morning and feels “absolutely whacked”. During the day, consecutive symptoms appear, such as tiredness, irritability, loss of concentration etc. Actually, 16 participants complained about sleep disturbances, 6 complained that they were regularly awakened between 2 a.m. and 4 a.m. and that they then had difficulty getting off to sleep again.

Since the group of participants had no other obvious change in their living conditions, apart from the operation of the mobile telecommunications mast with the measured, appreciably increased radiation exposure, it must be assumed that there is a direct relationship.

Conclusion:

Since the medically conducted tests carried out on residents living in the vicinity of the commissioned operational telecommunications mast proves a drastically increased health risk, immediate action by political and regulatory authorities , at the municipal, provincial- and federal level are demanded.

In order to prevent further endangerment of the health of residents, the medical point of view is that the operation of the telecommunications mast must immediately be stopped!

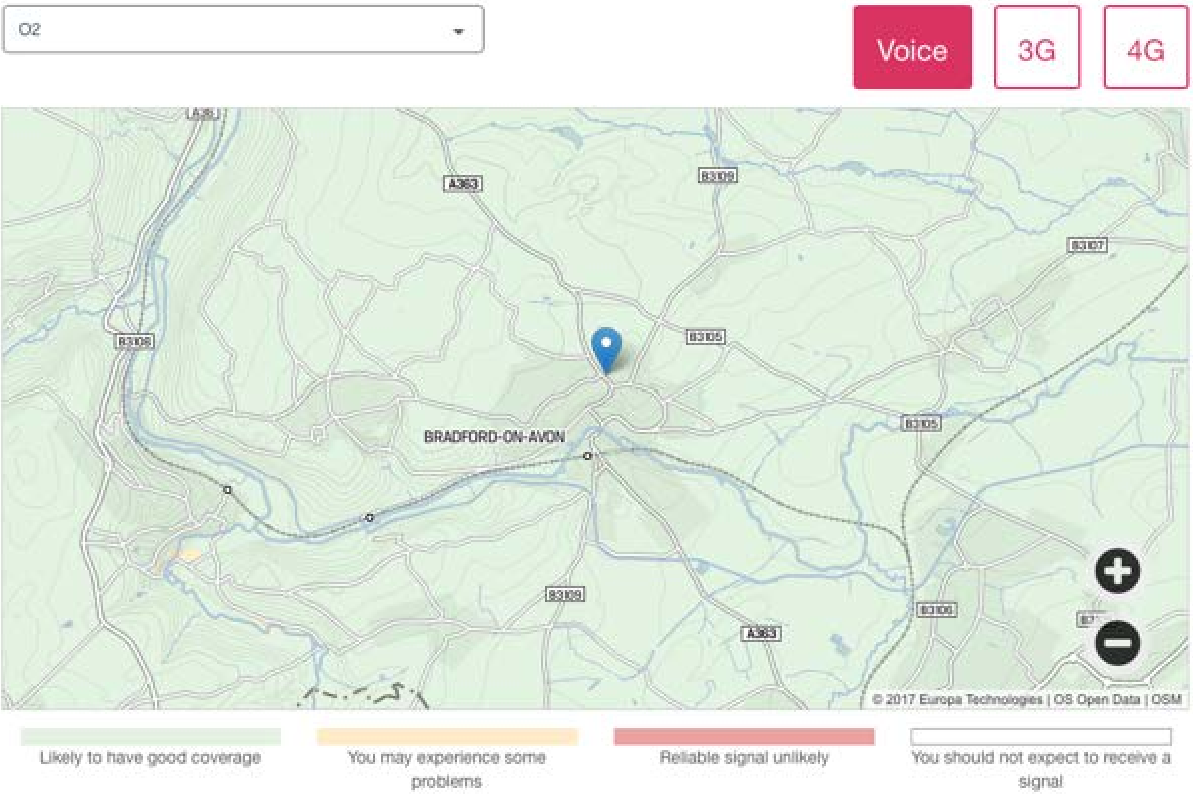
Dr Anna Blanz, -Dr. med. Markus Kern -Dr. med. Hans-C. Scheiner

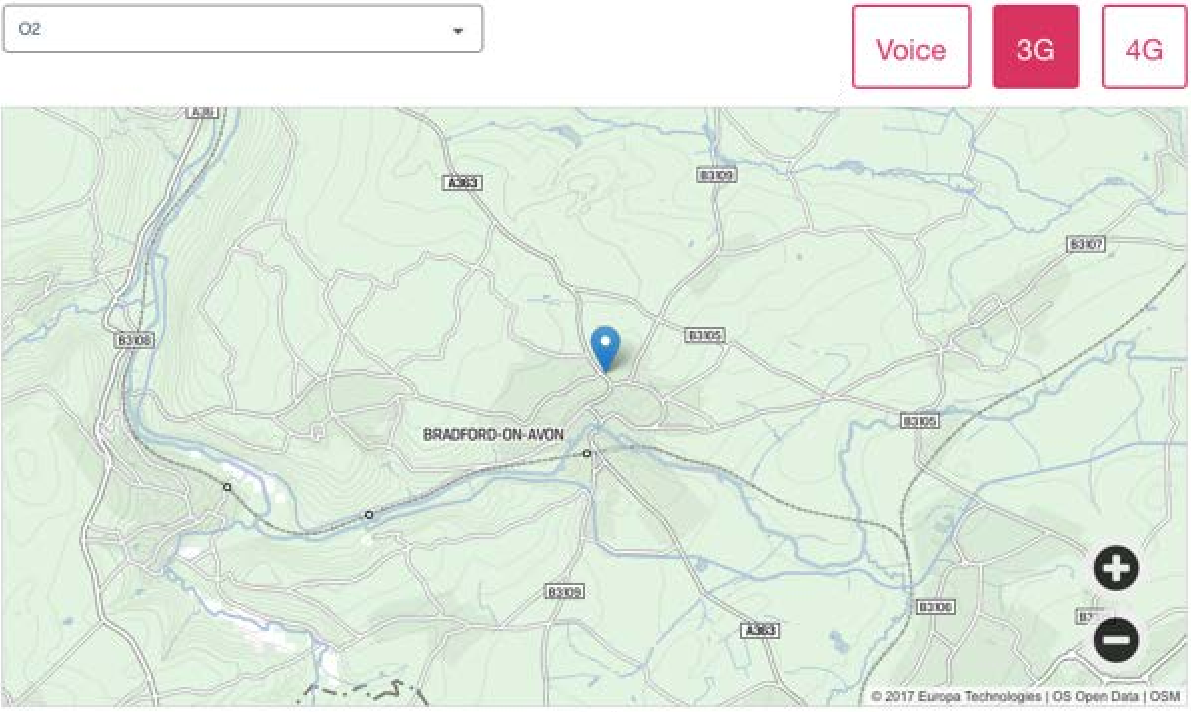
Amanda Braha submission for 23/3/17

Caroline Brown submission for 23/3/17

Bradford on Avon Conservation Areas 1 & 2
Proposed Boundary Changes

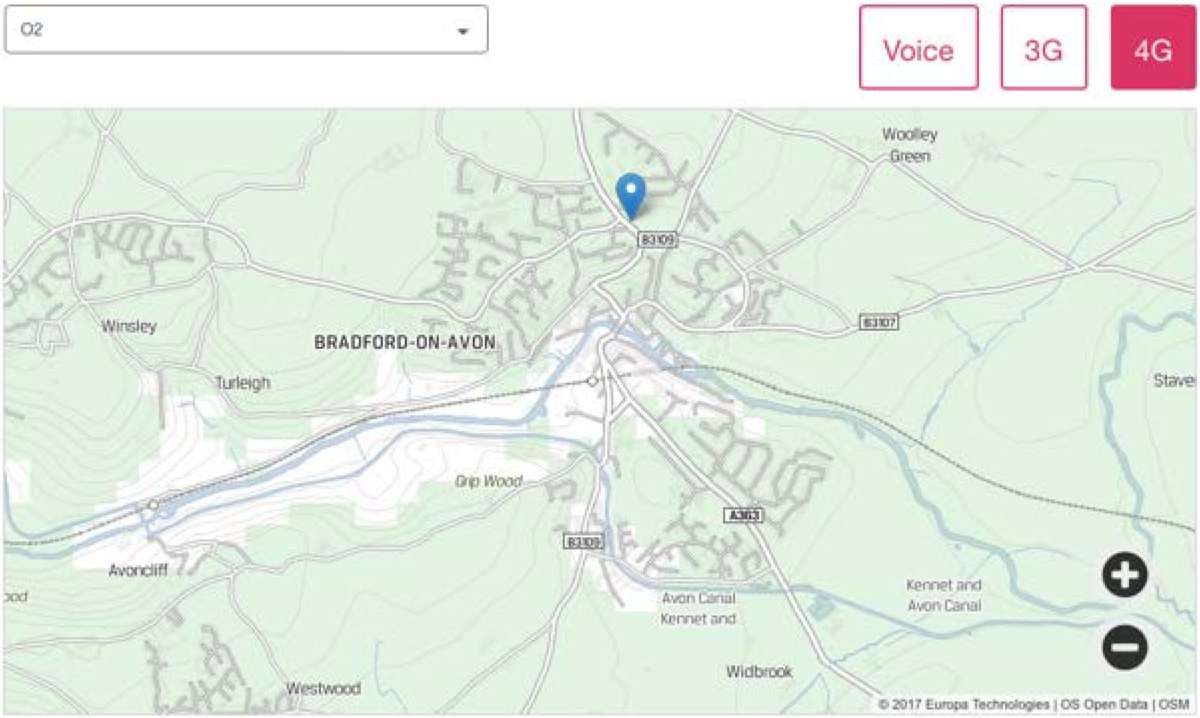
Proposed Microwave Mast





In green areas you are likely to be able to use 3G services reliably

In white areas you are unlikely to be able to use 3G services reliably



In green areas you are likely to be able to use 4G services reliably

In white areas you are unlikely to be able to use 4G services reliably

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Sarah J. Starkey*

Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation

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Abstract: The Advisory Group on Non-ionising Radiation (AGNIR) 2012 report forms the basis of official advice on the safety of radiofrequency (RF) electromagnetic fields in the United Kingdom and has been relied upon by health protection agencies around the world. This review describes incorrect and misleading statements from within the report, omissions and conflict of interest, which make it unsuitable for health risk assessment. The executive summary and overall conclusions did not accurately reflect the scientific evidence available. Independence is needed from the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the group that set the exposure guidelines being assessed. This conflict of interest critically needs to be addressed for the forthcoming World Health Organisation (WHO) Environmental Health Criteria Monograph on Radiofrequency Fields. Decision makers, organisations and individuals require accurate information about the safety of RF electromagnetic signals if they are to be able to fulfil their safeguarding responsibilities and protect those for whom they have legal responsibility.

Keywords: AGNIR; brain; cognition; development; EEG; electromagnetic; fertility; genotoxicity; health; ICNIRP; immune; membranes; misleading; oxidative stress; proteins; Public Health England (PHE); symptoms; tumours; wireless; WHO.

Introduction

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) set international exposure guidelines for radiofrequency (RF) electromagnetic fields in 1998 (1). Conclusions from subsequent ICNIRP reviews have supported the guidelines. Within the United Kingdom (UK), Public Health England (PHE) commission scientific reviews by the Advisory Group on Non-ionising Radiation (AGNIR) to assess the safety of RF fields. AGNIR reviews, along with PHE in-house assessments of exposures, form the basis of PHE's advice on the safety of RF signals. This guides the UK government, organisations and decision makers when assessing the safety of wireless devices and infrastructure. The latest AGNIR review (2) has also been relied upon by health protection agencies around the world, including the Australian Radiation Protection and Nuclear Safety Agency (3) and Health Canada (4).

The majority of the global population absorb RF radiation on a daily basis from smartphones, tablet computers, body-worn devices, Wi-Fi and Bluetooth transmitters, cordless phones, base stations, wireless utility meters and other transmitters. For public health to be protected, decisions need to be based on accurate information. The AGNIR report is considered here for conflicts of interest and scientific accuracy.

Conflicts of interest

PHE stated, "*The 2012 AGNIR report considered whether there was evidence for health effects occurring in relation to exposures below the ICNIRP levels*" (5). At the time of writing the report, the chairman of AGNIR was also chair of the ICNIRP standing committee on epidemiology. Currently, six members of AGNIR and three members of PHE or its parent organisation, the Department of Health (DH), are or have been part of ICNIRP (Table 1). When the group charged with assessing whether there is evidence of health effects occurring at exposures below current ICNIRP values have members who are responsible for setting the guidelines, it introduces a conflict of interest. How can AGNIR report that the scientific literature contains evidence of harmful effects below the current guidelines when several of them are responsible for those guidelines? PHE provide

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the official advice on the safety of wireless signals within the UK, but having members in ICNIRP introduces a conflict of interest which could prevent them from acknowledging adverse effects below ICNIRP guidelines.

PHE (the then Health Protection Agency) responded to the report with "*The Health Protection Agency welcomes this comprehensive and critical review of scientific studies prepared by the independent Advisory Group on Non-ionising Radiation*" (6). The implication was that an independent group had produced the report and presented it to PHE. However, at the time of writing, 43% of those in AGNIR were from PHE or the DH (2) (Table 1). PHE had misleadingly welcomed the report which they were involved in preparing.

Scientific accuracy

The executive summary of the AGNIR report included "*Taken together, these studies provide no evidence of health effects of RF field exposures below internationally accepted guideline levels*" [page 3 of the report (2)] and "*the evidence considered overall has not demonstrated any adverse health effects of RF field exposures below internationally accepted guideline levels*" [page 4 (2)]. Accuracy is vital when most people only read the executive summary and overall conclusions from a 348-page report and national and international public health decisions and exposures are based on them. These conclusions did not accurately reflect the evidence, as described in examples below.

(a) Studies were omitted, included in other sections but without any conclusions, or conclusions left out; (b) evidence was dismissed and ignored in conclusions; (c) there were incorrect statements. Terms such as 'convincing' or 'consistent' were used to imply that there was no evidence. Some examples fall into more than one category.

(a) Studies omitted, included in other sections but without any conclusions, or conclusions left out

Only 7 studies were included in the section on reactive oxygen species [ROS; page 94 (2); Figure 1]. These were summarised by "*production of reactive oxygen species (ROS) were increased in some studies, but not others*" [page 106 (2)]. At least a further 30 studies relevant to ROS or the possible resulting damaging state of oxidative stress were included throughout the report, but with no reference to ROS or oxidative stress within the main text for 16 of these (listed in Supplementary Information, SI) and no mention of this subject in any other summaries or conclusions. At least 40 studies were omitted (using AGNIR restriction to the English language; identified from PubMed and EMF-Portal databases or references within the papers; SI). If these had been included, 79% of studies (61 out of 77) would have demonstrated evidence of significantly increased ROS or oxidative stress in response to

Table 1: AGNIR in 2012 and 2016 and membership of ICNIRP, PHE or DH.

AGNIR 2012		AGNIR 2016	
Swerdlow A.J. (Chair)	ICNIRP Chair of standing committee on epidemiology	Swerdlow A.J. (Chair)	formerly ICNIRP
Conney S.W.	DH	Conney S.W.	DH
Coulton L.A.		Coulton L.A.	
Duck F.A.		Duck F.A.	ICNIRP
Feychting M.	ICNIRP	Feychting M.	Vice-Chair ICNIRP
Haggard P.		Haggard P.	
Lomas D.J.		Lomas D.	
Noble D.			
Mann S.M.	HPA	Mann S.M.	ICNIRP, PHE
Maslanyj M.P.	HPA	Maslanyj M.P.	PHE
Meara J.R.	HPA	Meara J.R.	PHE
		O'Hagan J.O.	ICNIRP, PHE
Peyman A.	HPA	Peyman A.	PHE
		Powers H.	
		Rhodes L.	
Rubin G.J.		Rubin G.J.	
Sienkiewicz Z.J.	ICNIRP, HPA	Sienkiewicz Z.J.	ICNIRP, PHE
		Tedstone A.	PHE
		Young A.	

PHE was formerly known as the Health Protection Agency, HPA. PHE is part of the Department of Health, DH.

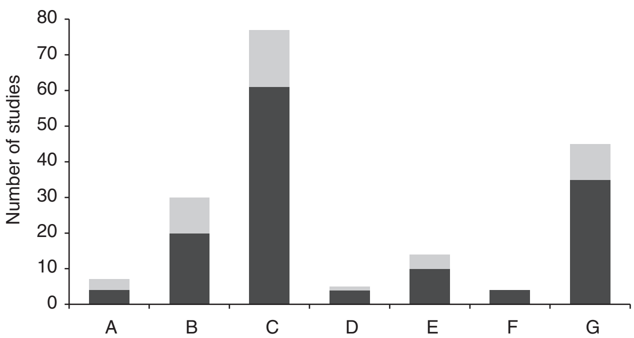

Figure 1: Comparison of the number of studies included in the AGNIR report with those that could have been, for ROS, oxidative stress or male fertility.
(A) studies included in the ROS section; (B) studies scattered throughout the report on ROS or oxidative stress (but with no summary or conclusion); (C) studies which could have been included for ROS or oxidative stress; (D) studies included on male fertility in the cellular studies chapter; (E) studies included on male fertility in animal studies; (F) studies included on male fertility in humans (in vivo); (G) studies which could have been included for male fertility. Dark shading indicates evidence of significant increase of ROS or oxidative stress, adverse effect on male fertility or altered male testosterone concentrations in response to a radiofrequency field; light shading indicates no significant increase of ROS or oxidative stress, adverse effect on male fertility or altered male testosterone concentrations. Studies are listed in SI.

RF fields (Figure 1; SI). By only including a few of the available studies, not referring to many scattered throughout the report and not mentioning ROS or oxidative stress in any conclusions or the executive summary, this important area of research was misrepresented. Oxidative stress is a toxic state which can lead to cellular DNA, RNA, protein or lipid damage (7, 8), is accepted as a major cause of cancer (7), as well as being implicated in many reproductive, central nervous system, cardiovascular, immune and metabolic disorders (7–14).

The conclusion for male fertility studies in animals was "*A substantial number of studies have investigated the effects of RF fields on testicular function, principally in rats, and most report large, obvious effects. However, these results are largely uninterpretable due to inadequate dosimetry or other shortcomings in the studies, and thus are unsuitable for the purposes of health risk assessment. One well-conducted study reported no effects on testicular function in rats exposed to 848 MHz CDMA signals*" [page 191 (2)]. For male fertility in humans (in vivo), it was concluded, "*The evidence on the effect of RF fields on sperm quality is still weak and the addition of the two new studies does not allow reliable evaluation of the presence or absence of a health effect. Some suggestive positive results, although not convincing, give justification for further studies with improved methods. The evidence on effects on male subfertility is very limited, and allows no conclusions*".

At least 22 studies on male fertility were omitted (AGNIR restriction to the English language; identified from PubMed or EMF-Portal databases or references within the papers; listed in SI). Considering those identified as included throughout the report (excluding three subsequently retracted, SI), 78% of studies (18 out of 23) described significant adverse effects on sperm, male reproductive organs or changes in male testosterone concentrations (SI). If the 22 references identified as omitted had also been included, this would have been 35 out of 45, 78% (Figure 1; SI). Isolating small samples of evidence in chapters on cells, animals or humans (Figure 1) may have made it easier to dismiss significant effects on male reproductive health. Inaccurately, in the overall and executive summaries, the evidence for adverse effects on male fertility disappeared: "*Despite many studies investigating effects on male fertility, there is no convincing evidence that low level exposure results in any adverse outcomes on testicular function*" [page 192 (2)] and for humans, in vivo, "*The limited available data on other non-cancer outcomes show no effects of RF field exposure*" [page 4 (2)]. The term 'convincing' is subjective and can erroneously imply that there is no evidence. The human data on male fertility did not show "*no effects of RF field exposure*".

Some studies, mostly those which had tested signals from real mobile devices, were dismissed as uninterpretable because they had not described the dosimetry, the process of determining internal electromagnetic quantities relating to exposure in tissues, in enough detail. Limited descriptions restrict possible interpretations, but do not make them uninterpretable. If the question is 'do mobile phone signals damage male fertility?', real phone signals are highly relevant because they allow possible effects of the complex patterns of fields to which humans are exposed to be investigated. ICNIRP only accept thermal effects of RF fields and focus on average energy absorbed. Highly controlled, simulated signals with descriptions of overall specific absorption rates (SARs) are suited to the assessment of temperature rises in cells or tissues. Real signals make it more difficult to measure average energy, but have characteristics which controlled, simulated signals lack. The complex field patterns, with variable peak field strengths and intervals between transmissions, may influence biology in ways that controlled, simulated patterns cannot, but they are not represented by time-averaged, duty factor reductions of described energy absorption. Responses to RF fields can be greater for intermittent exposures than continuous

(15, 16) and depend upon the pulse characteristics for the same average power (17). Effects can be dependent on frequency, modulation, signal strength (intensity windows), durations of exposure and polarisation (18, 19). For the nervous system, complex signals from real devices may modulate neuronal activity, similar to endogenous electric field ephaptic (non-synaptic) coupling in the brain (20). There is evidence that endogenous electric fields feedback to modulate neuronal activity (21). Fields with amplitudes similar to those found in vivo, applied to neocortical brain slices, modulated and entrained neuronal spiking activity (21). Irregular patterns of fields with complex dynamics, which mimicked in vivo fluctuations, entrained neuronal activity more strongly than sine waves (21). There are valid reasons for testing the effects of signals from real mobile devices, and dismissing these limited and misrepresented the evidence.

The summary for neurocognitive effects in humans stated, "*Studies of cognitive function and human performance do not suggest acute effects of exposure to RF fields from mobile phones and base stations*" [page 226 (2)]. But acute detrimental effects on cognition were omitted from the report (22–25) or mentioned in different sections (26–29). Increased errors during a memory task (26), slowed performance (27) or decreased accuracy in a cognitive test (28) were reported in the electroencephalogram (EEG) section [pages 209–213 (2)]; slowed performance in cognitive tests (29) were reported under sleep [page 215 (2)]. Omitting the studies which found effects in the relevant section led to an incorrect conclusion.

For symptoms in humans, "*Sufferers differ in terms of the type of symptoms that they report, the speed with which symptoms develop and the types of electromagnetic field that appear to be problematic*" [page 232 (2)]. Acute provocation studies in humans expose all subjects to the same short electromagnetic signal to see whether they all respond with the same immediate symptoms. If the speed with which symptoms develop and types of trigger differ between individuals, then in a group overall a lack of significance might be expected for identical acute provocations, but this does not mean that some individuals cannot respond to certain fields given adequate exposure durations, intervals between provocations and low background electromagnetic fields, as has been reported (30, 31). The executive summary concluded, "*The evidence suggests that RF field exposures below guideline levels do not cause acute symptoms in humans*" [page 3 (2)], without explaining limitations.

Many of the longer-term observational studies described significant associations of RF exposures with symptoms, albeit with limitations in study designs: "*While some, though by no means all, of the studies reviewed above appear to suggest an association between mobile phone use and symptoms*…" [page 245 (2)], followed by "*almost all of the studies share a fundamental methodological problem which makes it difficult to draw any firm conclusions from them: these studies relied upon the participants' own descriptions of their mobile phone usage as the exposure variable for their analysis and on self-description of symptoms while knowing exposure status*" (2). Longer-term studies on symptoms were omitted from the executive summary.

No mention was made of the World Health Organization (WHO) International Agency for Research on Cancer (IARC) classification of RF fields as a possible human carcinogen in 2011, which was based on limited evidence supporting carcinogenicity below ICNIRP guideline values (32).

(b) Evidence dismissed and ignored in conclusions

For in vitro membrane effects, the report showed that all studies included (seventeen (33–49); non-blood-brain barrier (BBB)) described significant responses to RF signals except for one, which had tested extremely high powers, far greater than ICNIRP guidelines, that heated the tissue [250–3600 W/kg time-averaged SAR (50); pages 102 and 103 (2)]. This heating study had reported an effect, an in vitro recoverable decrease in population spike amplitude in the hippocampus in response to the RF signal, but no effect on long-term potentiation (50). The report text also mentioned that Falzone et al. had found no changes to the cell membrane [(51), page 101 (2)], but they had measured markers of apoptosis, programmed cell death, not direct effects on membranes; this paper was not included in the table of studies on membrane effects. The membrane studies were weakly dismissed: "*In general, most studies report finding effects on cell membranes when exposures are made at mobile phone frequencies. However, the effects reported are varied and, although the majority find effects, neither is this unanimous nor does it necessarily provide supporting evidence of a consistent effect. The variety of cellular systems and exposures makes comparisons of the effects on the cell membrane problematic and without independent replication it is difficult to assess the robustness or even the validity of the findings*." Studies had looked at a range of effects and all, below high power heating, reported significant changes, strengthening the validity of the findings.

For direct effects on proteins, 15 out of 16 studies listed found significant effects of RF fields [pages 103–105 (2); (52–67) effect; (53) no effect]. The conclusion was "*In general, most of the studies that have investigated changes* *in protein function or structure due to exposure to RF fields have found effects. However, at the present time the effects have not been demonstrated to be robust by independent replication; so although the concept of a direct effect of RF field exposure on protein structure is interesting, further research is needed to establish if this is a real phenomenon.*" Ninety-four percent of the studies listed on direct effects on proteins, from 14 different groups, found significant effects, but the conclusion was turned around to imply that these may not be real.

"*Where replications have been undertaken they do not support the original findings. This continued lack of robust evidence makes the possibility of an effect of RF fields on cells more unlikely*" [page 105 (2)]. An effect on cells is not unlikely when there were significant effects in all of the relevant studies on membranes (excluding BBB), all of the studies except one on direct protein effects, the majority of the studies on oxidative stress or male fertility, all of the included in vitro genotoxicity studies on epithelial cells [see c; page 84 (2)] and 47% of in vitro genotoxicity studies which could have been included in the report (see c; SI).

"*Studies on cell membranes and direct effects on proteins mostly found effects of RF field exposure. However, no conclusions can be made as there are no common patterns of exposure conditions or types of effects caused by the exposure*" [page 106 (2)]. Out of 33 studies on direct effects on proteins or cell membranes, 32 described significant effects of RF signals below high power heating, but these disappeared in the conclusions.

By the end of the report, the conclusion on cellular studies had incorrectly become "*There are now several hundred studies in the published literature that have looked for effects on isolated cells or their components when exposed to RF fields. None has provided robust evidence for an effect*" [page 318 (2)].

A summary for human brain EEG recordings stated, "*the EEG studies published since 2003 do provide some evidence that RF fields could influence brain function, and this should remain an area of interest*" [page 226 (2)]. Many EEG studies (awake or asleep subjects) reported changes in electrical field potential oscillations, evoked responses or interhemispheric coupling, but these were dismissed: "*it remains unclear whether these RF effects, if they exist, are material to human health or not*". Electrical field potential oscillations can synchronise activity of local networks (21) or propagate signals over large regions, controlling brain developmental processes, including neurogenesis, apoptosis, neuronal migration, differentiation and network formation (68). Oscillations have been linked with active processing or inhibition of cognitive functions (69) and cyclic modulations of neuronal excitability (21). References available at the time of the report describing behavioural problems (70–72) and changed psychomotor performance (73) associated with pre-natal or childhood RF exposures, cell death and reduced cell numbers in the brain (74–83) and cognitive inhibition (22–29, 78, 79, 84–88) supported the possibility that RF-induced changes in electrical activity could contribute to altered brain development or cognition.

The executive summary included "*There has been no consistent evidence of effects on the brain, nervous system or the blood-brain barrier, on auditory function, or on fertility and reproduction*" [page 3 (2)]. The term 'consistent' dismissed areas for which the majority of studies had found adverse effects, such as male fertility. Of the studies included in the report on pregnancy and development, which quantified effects of pre-natal or early neonatal RF exposures on neuronal cell numbers in the developing brain [pages 184–187 (2)], four found significant decreases: pyramidal cells in the rat hippocampus (74), granule cells in the rat dentate gyrus (75), Purkinje cells in the mouse cerebellum (76) and a transient increase in neurogenesis of the subventricular zone following 8 h of RF exposure over 2 days, but a long-lasting decrease in neurogenesis following a 24 h exposure over 3 days (77), measured from proliferating cells in the rat rostral migratory stream. One study described no effect on neuronal numbers in the mouse hippocampus (89). Whilst not all reported effects, the studies supported RF exposures decreasing neuronal numbers in the brain during pre-natal and early neonatal development at least in some circumstances (74–77). The executive summary misleadingly implied that because not all studies reported the same effects, RF signals have no effect.

The AGNIR report suggested that symptoms in humans may be caused by people's perception of being exposed, rather than the actual electromagnetic fields [page 246 (2)]. Imagining a signal to be present is unlikely to explain all responses, particularly symptoms reported in response to RF signals under blind or double-blind conditions (30, 31, 90). Many other studies support biological responses being related to the electromagnetic signal, including evidence from cultured cells, in vitro preparations, animals, plants or asleep humans, none of which reacted with significant changes because they imagined that RF signals were present. That living things can respond to low power RF signals is now supported by a large body of research.

(c) Incorrect statements

For child development [page 260 (2)], maternal mobile phone use during pregnancy was associated with behavioural problems in children at the age of 7 (70, 71) and lower psychomotor performance was described for children of mothers who had the highest mobile phone use during pregnancy (73). The report said, "*these results are only suggestive of an effect, rather than being conclusive evidence of one*". Increased conduct problems were reported in 8–17-year-olds with the highest quartile of RF exposures (72) [page 250 (2)]. As studies suggested an effect on child development, the executive summary incorrectly stated, "*data on other non-cancer outcomes show no effects of RF field exposure*" [page 4 (2)].

For risks of brain tumours or acoustic neuromas in humans, "*the similar results of all investigators except the Hardell group, with no methodological inferiorities in these other investigators' studies overall, suggest that the results of the Hardell group are the problematic ones*" [page 308 (2)]. However, some significantly increased risks of brain tumours or acoustic neuromas were described in Hardell and non-Hardell studies [pages 282–306 (2), (91)], although non-Hardell significant data were omitted from the data tables and only mentioned in the text. For example, for gliomas with an ipsilateral mobile phone use of ≥ 1640 cumulative hours (ages 30–59), the international Interphone study reported a significant odds ratio (95% confidence interval) of 1.96 (1.22–3.16) and Hardell et al. reported a significant odds ratio of 2.32 (1.14–4.73) (91). Had the data tables included results for ipsilateral exposures, duration of use and more detail of the pooled Interphone studies, it would have been clearer that significantly increased risks had been reported. "*With no methodological inferiorities in these other investigators' studies*" was incorrect. The Interphone study did not take cordless phone use into account in the analysis for mobile phones (91); the Danish cohort study misclassified corporate mobile phone users as non-users, as well as those who took subscriptions out after 1995 (92).

The comment in the executive summary, "*the accumulating evidence on cancer risks, notably in relation to mobile phone use, is not definitive, but overall is increasingly in the direction of no material effect of exposure*" [page 4 (2)], was misleading. Significant risks were most common for ipsilateral exposures, latencies of 10 years or more since first use or the highest cumulative hours of use (2), (91). If anything, as use increased, the evidence increasingly pointed towards possible risks.

The executive summary stated for cells in vitro: "*In particular, there has been no convincing evidence that RF fields cause genetic damage or increase the likelihood of cells becoming malignant*" [page 3 (2)] and in the chapter on cellular studies: "*Results from studies using other cell types are also contradictory. Epithelial cells exposed to …*" [page 86 (2)]. However, all in vitro studies included on epithelial cells [four, one retracted, page 84 (2), (93–95)], from more than one laboratory, found damage to DNA or chromosomal aberrations in response to RF signals. Forty-six percent of genotoxicity studies identified as included in the report (36 out of 78; SI) described evidence for genotoxicity in response to RF fields, but at least 40 genotoxicity studies were omitted (SI). If these had been included, 52% (61 out of 118) of genotoxicity studies overall and 47% of in vitro (36 out of 76) would have described evidence for genotoxicity (SI; AGNIR restriction to the English language; identified from PubMed and EMF-Portal databases). AGNIR found the genotoxicity evidence unconvincing, but a more accurate conclusion could have been that RF signals appear to be genotoxic under certain circumstances, but not others.

For the immune system [page 174 (2)], a Russian study was included (96), which mostly replicated earlier Russian studies and a French one which did not (97). The conclusion was "*it is clear that the results of the original Soviet studies have not been confirmed*". It was not clear, as the report also referred to the Russian study with "*These results do not appear to be identical to the original, although they do show the same tendency. Results of ELISA reinforced this conclusion. Grigoriev and colleagues also reported that very few pregnant animals receiving serum from exposed animals gave birth to live animals (4 out of 12), which is also supportive of the previous results*".

The report described cognitive performance of RF-exposed and sham-exposed Alzheimer's disease-like transgenic mice (98) [pages 144–147 (2)]. However, there were no shams in the study, as controls were housed in a separate room without a Faraday cage; exposed mice (two 1 h exposures per day, 918 MHz, SAR 0.25 W/kg) were continuously housed within a Faraday cage for up to 9 months (98). Cognitive improvements in the exposed groups compared to controls may have been the result of long-term protection from environmental electromagnetic fields by the Faraday cage. Because background man-made electromagnetic fields may alter experimental results and are often present in experimental environments, they ought to be described in the Methods section for all biological studies, but are often omitted, as in this paper. The AGNIR report conclusions [page 318 (2)] described this as a well-performed study, whilst other effects of RF signals on cognition were dismissed as inconsistent. Varied responses might indicate dependency upon physiological or experimental conditions and do not automatically justify ignoring evidence.

Conclusions

Decisions about involuntary, continuous and widespread RF exposures in schools, hospitals, workplaces and public and private spaces in the UK and around the world have been made based upon inaccurate conclusions of the AGNIR report. Published in 2012, it continues to be used to justify RF exposures and dismiss concerns about possible adverse effects on health, well-being or development.

The denial of the existence of adverse effects of RF fields below ICNIRP guidelines in the AGNIR report conclusions is not supported by the scientific evidence. Studies have, as described as examples in this review, reported damage to male reproductive health, proteins and cellular membranes, increased oxidative stress, cell death and genotoxicity, altered electrical brain activity and cognition, increased behavioural problems in children and risks of some cancers. For future official RF reports, it is important to check that conclusions accurately reflect available evidence before decisions which impact on public health are made based on the executive summary and overall conclusions.

The involvement of ICNIRP scientists in the misleading report calls into question the basis and validity of the international exposure guidelines. To protect public health, we need accurate official assessments of whether there are adverse effects of RF signals below current international ICNIRP guidelines, independent of the group who set the guidelines.

The anticipated WHO Environmental Health Criteria Monograph on Radiofrequency Fields, due in 2017, is being prepared by a core group and additional experts (99), with 50% of those named, being, or having been, members of AGNIR or ICNIRP (Table 2). Considering the importance of the Monograph for worldwide public health and the inaccuracies described here, independence from AGNIR would increase confidence in the report findings. Independence from ICNIRP is necessary to remove the conflict of interest when effects below ICNIRP exposure guidelines are being assessed.

Schools, hospitals, employers, organisations and individuals have legal responsibilities to safeguard the health, safety, well-being and development of children, employees and members of the public. But they are unable to fulfil their legal responsibilities when they have been provided with inaccurate information and the evidence of possible harm has been covered up.

Individuals and organisations who/that have made decisions about the often compulsory exposures of others to wireless RF communication signals may be unaware of the physical harm that they may have caused, and may still be causing, because they have not been accurately informed of the risks. This has been a safeguarding failure and the health of some children or adults may have been damaged as a result. To prevent further possible harm, restrictions on exposures are required, particularly for children, pregnant women and individuals with medical conditions. All children in schools and care environments need protection from the potential harmful effects of RF exposures and not, as is now often the case, a compulsory use of wireless devices in the classroom. Children may unjustly face losing their human right to an education if they do not want to absorb RF fields every day at school and no alternative environments are available. Attention also needs to be given to the provision of safe working environments for employees and safe public spaces, particularly where exposures are involuntary.

PHE and AGNIR had a responsibility to provide accurate information about the safety of RF fields. Unfortunately, the report suffered from an incorrect and misleading executive summary and overall conclusions,

Table 2: Named contributors to the WHO Environmental Health Criteria Monograph on Radiofrequency Fields [(99), in preparation] and membership of ICNIRP or AGNIR.

Core group	
Feychting M.	Vice-Chair ICNIRP, AGNIR
Mann S.M.	ICNIRP, AGNIR
Oftedal G.	ICNIRP
van Rongen E.	Chair ICNIRP
Scarfi M.R.	
Zmirou D.	
Additional experts	
Aicardi G.	
Challis L.	Formerly AGNIR
Curcio G.	
Hug K.	
Juutilainen J.	ICNIRP
Lagorio S.	
Loughran S.	ICNIRP
Marino C.	ICNIRP
McNamee J.	
Naarala J.	
Peyman A.	AGNIR
Röösli M.	ICNIRP
Rubin G.J.	AGNIR
Schoemaker M.	
Selmaoui B.	
de Sèze R.	ICNIRP
Sienkiewicz Z.J.	ICNIRP, AGNIR
Simko M.	
Vijaylaxmi	
Zeni O.	

inaccurate statements, omissions and conflict of interest. Public health and the well-being of other species in the natural world cannot be protected when evidence of harm, no matter how inconvenient, is covered up.

Conflict of interest statement: The author states no conflict of interest.
Ethical approval: The conducted research is not related to either human or animal use.

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How Exposure to Base-station Radiation can Adversely Affect Humans*

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The claim made by the Mobile Phone Industry that the microwave emissions from the antennae of a GSM or TETRA Base-station are many times lower (by at least a factor of 1000) than the limit to which the UK Government's Statutory Body – the National Radiological Protection Board (NRPB) – maintains it is safe for us to be exposed to, is perfectly true.

The current exposure limits, set by the International Commission for Non-ionising Radiation Protection (ICNIRP), are, however, purely thermally based - *i.e.* they simply limit the intensity of the radiation to ensure that the amount of tissue heating by the absorption of microwaves is not in excess of what the body can cope with. If heating were the only effect of the radiation, existing guidelines would afford adequate protection; unfortunately, however, this is not the case. For microwaves are, after all, waves, and, as such, have properties other than solely intensity. In particular, the pulsed microwave radiation used in the GSM and TETRA systems of mobile telephony has certain rather well defined frequencies, which facilitate its discernment by the alive human organism, and *via* which the organism can, in turn, be affected in a purely *non-thermal* way. This is so because the alive human organism (and only the alive one) itself supports a variety of oscillatory electrical biological activities, each characterised by a specific frequency, *some of which happen be close to those used in GSM and TETRA*. Thus, the frequencies of the microwaves (particularly the higher ones used in GSM) that carry the voice information by means of appropriate modulations are close to those characterising the highly organised electrical activities that are involved in the control of certain biological processes in living organisms at the cellular level (including processes as fundamental as cell division), whilst the somewhat lower frequencies used in TETRA facilitate deeper penetration of this radiation. On the other hand, the rates at which the microwaves are emitted in distinct groups of flashes (or pulses) are close to the frequencies of some of the brain's own electrical and electrochemical rhythms, which this makes them particularly vulnerable to interference (or even entrainment) by the radiation. [The basic 'flash rate' is 217Hz, but the flashes are emitted in groups of 25 at the rate of 8.34Hz. With increasing call traffic, the 217Hz pulsing gradually disappears, leaving only the ELF pulsation at 8.34Hz, which is in the range of the alpha brain wave activity!] It is to be stressed that unlike heating, such non-thermal influences are possible only when the organism is alive: the Dead have no electrical brain activity with which an external electromagnetic field can interfere!

What the Industry and the various regulatory bodies (such as the NRPB and ICNIRP) dispute is that the very weak, pulsed microwave radiation used in GSM and TETRA can **non**-thermally affect these various biological (electrical) activities in ways that can provoke adverse health reactions. Their difficulty in accepting this reality is due to an out-dated 'linear' mentality, within which forces the conclusion that exposure to weak radiation can entail only correspondingly weak effects, and *vice versa*. Whilst this is true in the case of inanimate systems and dead organisms, it is certainly not so either for energised electronic equipment, or for **living organisms**. For the latter, in consequence of their *vitality*, are themselves **electromagnetic instruments of great and exquisite sensitivity**, and thereby vulnerable to interference by weak external electromagnetic fields whose frequencies are close to those found in the alive organism. The situation is not dissimilar to the way in which the reception of a (turned-on) radio that is tuned to a particular frequency can be interfered with by a signal that is slightly off-station. In both cases, it is more a question of the 'information' content of a given (interfering) signal, rather than how much energy it contains (or equivalently, its ability to heat tissue). Whilst the importance of ensuring *non-thermal* electromagnetic compatibility between mobile phone radiation and energised electronic equipment (in aircraft and hospitals, and with heart pacemakers, for example) is accepted and generally respected, the same, unfortunately, does not yet obtain in the case of the alive human organism!

Despite persistent claims to the contrary by the Mobile Phone Industry, the existence of non-thermal effects of low intensity, pulsed microwave radiation is established beyond dispute, on the basis of many replicated experiments that have been performed over the last 30 years on a variety of living organisms. The results of these experiments have been published in international, peer reviewed scientific journals, and are endorsed by the 16 signatories (of international standing) to the 1998 Vienna Resolution, the only non-signatory being the head of the WHO Project on Electromagnetic Fields!

Of particular relevance is the way in which this radiation affects *brain function* – specifically, its electrical activity (EEG), its electro-chemistry, and the blood/ brain barrier - and degrades the *immune system*. For these established influences are of a kind that are ***consistent*** with the nature of adverse health reactions reported both by some users of mobile phones and by some people (involuntarily) subject to long-term exposure to the radiation from Base-stations. For example, the radiation is known to affect the dopamine-opiate system of the brain and to increase the permeability of the blood brain barrier, both of which are medically considered to underlie headache – one of the most persistently reported adverse health effects. Similarly, the duration of REM sleep is shortened by exposure to radio-frequency radiation, whilst nocturnal secretion of melatonin is partly inhibited, both of which are consistent with reports of sleep disruption. Furthermore, the fact that microwave radiation has been discovered to target the hippocampal region of the brain is consistent with reports of memory problems and, in some epileptic children, with an increase in the frequency of seizures. The latter finding is not at all unreasonable, given the known ability of a visible light (such as a stroboscope) flashing at a rate somewhere between 15-20 times per second to provoke seizures in the 5% minority of epileptics who are photosensitive. For visible light and microwaves are both simply different realisations of electromagnetic radiation, and the microwave radiation used in GSM and TETRA similarly 'flashes' in a way that the brain is able to recognise, as has already been mentioned; unlike visible light, however, pulsed microwaves can penetrate the skull directly. Of particular concern is that the flash frequency of the TETRA signals is not only within to the range where photoepilepsy can be provoked, but is also very close to the frequency that causes the maximum loss of calcium from brain cells, thereby potentially undermining the integrity of the nervous system.

It should be noted that although microwave radiation is non-ionising – *i.e.* does not have enough energy to break chemical bonds, particularly in DNA – exposure can still cause interference with the natural DNA *repair* process, and produce chromosome aberrations and micronuclei. Such effects are consistent with the finding that exposure to pulsed microwave radiation (at intensities comparable to those realised during use of a mobile phone) promotes the development of cancer in mice that have been genetically engineered to have a predisposition to cancer, and also with the 2-fold increase in the incidence of a rare form of cancer in the periphery of the human brain (where the radiation from the handset most easily penetrates) - the laterality of which correlates with that of handset use - which has been found in a recent nationwide epidemiological study in the US. The relevance of these disturbing findings to the less intense, but often more prolonged, exposure to Base-station radiation is at present unknown, but the increasing number of reports of serious adverse effects in animals exposed to such radiation could well be valuable warning portents that should not be ignored.

It is essential to appreciate, however, that because the possibility of non-thermal influences is dependent on the organism being alive, it necessarily follows that **not everyone will be equally susceptible**, even under the same exposure conditions - susceptibility depending on the physiological state of the individual when irradiated, such as the stability of the brain's electrical activity and the person's level of stress prior to exposure. Whilst this admittedly makes the occurrence of non-thermal effects more difficult to predict than is the case with thermal effects – and hence to regulate against – *it does not mean that they can be safely ignored, or that they cannot provoke adverse health reactions in some people*, the severity of which will again vary from person to person, according to the robustness of their immune system. It is probably true to say that if the same degree of risk and uncertainty as to subjective noxiousness obtained in the case of a new drug or foodstuff, they would never be licensed. In connection with the biological noxiousness of low intensity microwave radiation, it should not be forgotten that during the 'Cold War', such radiation was used (rather successfully) by the Soviets to induce serious adverse health effects in the staff of Western Embassies in Eastern bloc countries, as well as in their children!

Quite apart from their weaker immune systems, children are particularly vulnerable because of the increased rate at which their cells divide (which makes them more susceptible to genetic damage) and their still developing nervous system - the size of their heads and the thinness of their skulls causing them to absorb more radiation than do adults. Particularly vulnerable to interference by the pulses of microwaves, is their electrical brain-wave activity, which does not settle into a stable pattern until about the age of 11 or 12 years. The use of mobile phones by pre-adolescent children is thus to be strongly discouraged, and the siting of Base-station masts in the vicinity of schools and nurseries resisted: financial gain must not be allowed to be the overriding consideration! It must be appreciated that whilst the intensity to which the Public is normally exposed in the vicinity of a Base-station is indeed very much lower than that encountered during use of a mobile phone, the **information** content of the signals is the **same**, so that they are equally potentially noxious.

To cite the examples of radio and television transmission in an attempt to support the claim that exposure to the (much less intense) radiation used in mobile telephony is flawed, on account of *(i)* the occurrence, in any case, of certain health problems that correlate with exposure to the radiation from these installations, *(ii)* the fact that, *unlike the radiation used in GSM and some TETRA installations*, this radiation is **not** emitted as pulses, in patterns that the brain can recognise, and *(iii)* the fact that the lower frequency carriers used in radio and TV are somewhat less biologically active than are higher microwave carrier frequencies used in GSM.

In conclusion, it can hardly be disputed that to enjoy an acceptable quality of life requires more than simply an absence of terminal disease. Adverse health effects in humans of the kinds already consistently reported worldwide – such as headaches, sleep disruption, impairment of short–term memory, *etc.* - whilst maybe not life-threatening in themselves, do nevertheless have a debilitating effect that undoubtedly undermines the general well-being of those affected, and which in the case of some children could well undermine their neurological and academic development. It should, of course, be stressed that the apparent absence to date of life threatening adverse effects on a global scale attributable to exposure to GSM or TETRA Base-station radiation is no guarantee of immunity in the long-term. For exposure to this kind of radiation is still in its 'early days' in comparison to the much longer (10-15 years) latency period of the kinds of cancers that could well be promoted or initiated in certain people.

REFERENCE: G.J. Hyland, 'On the Inadequacy of Existing Safety Guidelines' – *ww.tassie.net.au/emfacts/mobiles/hyland2.html*

The GSM and TETRA systems deployed in Europe are similar to PCS/Digital in the United States.
In the U.S. human exposure to RF/MW radiation is regulated by the Federal Communications Commission (FCC) based on standards developed by the private organizations American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE). The status of the non-ionzing radiation committee at the National Council on Radiation Protection and Measurement (NCRP),

ATTACHMENT 3 - JON HILL

The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer

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'Einfluss der räumlichen Nähe von Mobilfunksendeanlagen auf die Krebsinzidenz'

Summary

Following the call by Wolfram König, President of the Bundesamt für Strahlenschutz (Federal Agency for radiation protection), to all doctors of medicine to collaborate actively in the assessment of the risk posed by cellular radiation, the aim of our study was to examine whether people living close to cellular transmitter antennas were exposed to a heightened risk of taking ill with malignant tumors.

The basis of the data used for the survey were PC files of the case histories of patients between the years 1994 and 2004. While adhering to data protection, the personal data of almost 1,000 patients were evaluated for this study, which was completed without any external financial support. It is intended to continue the project in the form of a register.

The result of the study shows that the proportion of newly developing cancer cases was significantly higher among those patients who had lived during the past ten years at a distance of up to 400 metres from the cellular transmitter site, which has been in operation since 1993, compared to those patients living further away, and that the patients fell ill on average 8 years earlier.

In the years 1999-2004, *ie* after five years' operation of the transmitting installation, the relative risk of getting cancer had trebled for the residents of the area in the proximity of the installation compared to the inhabitants of Naila outside the area.

Key words: cellular radiation, cellular transmitter antennas, malignant tumours

The rapid increase in the use of mobile telephony in the last few years has led to an increasing number of cell phone transmission masts being positioned in or near to residential areas. With this in mind, the president of the German governmental department for protection against electromagnetic radiation (Bundesamtes für Strahlenschutz) Wolfram König, has challenged all doctors to actively help in the work to estimate the risks from such cell phone masts. The goal of this investigation was therefore to prove whether on not people living near to cell phone masts have a higher risk of developing cancerous tumours.

The basic data was taken from the medical records held by the local medical authority (Krankenkasse) for the years 1994 to 2004. This material is stored on computer. In this voluntary study the records of roughly 1,000 patients from Naila (Oberfranken) were used, respecting the associated data protection laws. The results from this study show a significantly increased likelihood of developing cancer for the patients that have lived within 400 metres of the cell phone transmission mast (active since 1993) over the last ten years, in comparison to those patients that live further away. In addition, the patients that live within 400 metres tend to develop the cancers at a younger age. For the years 1999 to 2004 (*ie* after five or more years of living with the cell phone transmission mast), the risk of developing cancer for those living within 400 metres of the mast in comparison to those living outside this area, was three times as high.

Introduction

A series of studies available before this investigation provided strong evidence of health risks and increased cancer risk associated with physical proximity to radio transmission masts. Haider *et al.* reported in 1993 in the Moosbrunn study frequent psychovegetive symptoms below the current safety limit for electromagnetic waves (1). In 1995, Abelin *et al.* in the Swiss- Schwarzenburg study found dose dependent sleep problems (5:1) and depression (4:1) at a shortwave transmitter station that has been in operation since 1939 (2).

In many studies an increased risk of developing leukaemia has been found; in children near transmitter antennas for Radio and Television in Hawaii (3); increased cancer cases and general mortality in the area of Radio and Television transmitter antennas in Australia (4); and in England, 9 times more leukaemia cases were diagnosed in people who live in a nearby area to the Sutton Coldfield transmitter antennas (5). In a second study, concentrating on 20 transmitter antennas in England, a significant increased leukaemia risk was found (6). The Cherry study (7) indicates an association between an increase in cancer and living in proximity to a transmitter station. According to a study of the transmitter station of Radio Vatican, there were 2.2 times more leukaemia cases in children within a radius of 6 km, and adult mortality from leukaemia also increased (8).

In 1997 Goldsmith published the Lilienfeld-study that indicated 4 times more cancer cases in the staff of the American Embassy in Moscow following microwave radiation during the cold war. The dose was low and below the German limit (9).

The three studies of symptoms indicated a significant correlation between illness and physical proximity to radio transmission masts. A study by Santini *et al.* in France resulted in an association between irritability, depression, dizziness (within 100m) and tiredness within 300m of a cell phone transmitter station (10).

In Austria there was an association between field strength and cardiovascular symptoms (11) and in Spain a study indicates an association between radiation, headache, nausea, loss of appetite, unwellness, sleep disturbance, depression, lack of concentration and dizziness (12).

The human body physically absorbs microwaves. This leads to rotation of dipole molecules and to inversion transitions (13), causing a warming effect. The fact that the human body transmits microwave radiation at a very low intensity means that since every transmitter represents a receiver and transmitter at the same time, we know the human body also acts as a receiver.

In Germany, the maximum safe limit for high frequency microwave radiation is based on purely thermal effects. These limits are one thousand billion times higher than the natural radiation in these frequencies that reaches us from the sun.

The following study examines whether there is also an increased cancer risk close to cellular transmitter antennas in the frequency range 900 to 1800 MHz. Prior to this study there were no published results for long-term exposure (10 years) for this frequency range and its associated effects to be revealed. So far, no follow-up monitoring of the state of health of such a residential population has been systematically undertaken.

Materials and Methods

Study area

In June 1993, cellular transmitter antennas were permitted by the Federal Postal Administration in the Southern German city of Naila and became operational in September 1993.

The GSM transmitter antenna has a power of 15 dbW per channel in the 935MHz frequency range. The total

Fig. 1: Schematic plan of the antenna sites

transmission time for the study period is ca. 90,000 hours. In December 1997 there followed an additional installation from another company. The details are found in an unpublished report, appendix page 1-3 (14).

To compare results an 'inner' and 'outer' area were defined. The inner area covered the land that was within a distance of 400 metres from the cellular transmitter site. The outer area covered the land beyond 400 metres. The average distance of roads surveyed in the inner area (nearer than 400m) was 266m and in the outer area (further than 400m) 1,026m. Fig. 1 shows the position of the cellular transmitter sites I and 2, surrounded by circle of radius 400 metres. The geographical situation shows the transmitter sites (560m) are the highest point of the landscape, which falls away to 525m at a distance of 450m. From the height and tilt angle of the transmitter it is possible to calculate the distance where the transmitter's beam of greatest intensity strikes the ground (see Fig. 2).

The highest radiation values are in areas of the main

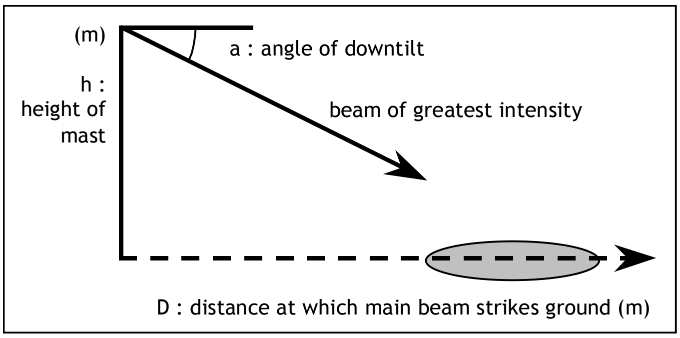

Fig. 2: From the mast height h and the downtilt angle a, the distance D at which the main beam reaches ground is given by $D = \tan(90-a) \times h$

beam where it hits the ground and from the expected associated local reflection; from this point the intensity of radiation falls off with the square of the distance from the transmitter.

In Naila the main beam hits the ground at 350m with a beam angle of 6 degrees (15). In the inner area, additional emissions are caused by the secondary lobes of the transmitter; this means in comparison that from purely mathematical calculations the outer area has significantly reduced radiation intensity.

The calculations from computer simulations and the measurements from the Bavaria agency for the environmental protection, both found that the intensity of radiation was a factor of 100 higher in the inner area as compared to the outer area. The measurements of all transmitter stations show that the intensity of radiation from the cell phone transmitter station in Naila in the inner area was higher than the other measurement shown in the previous studies of electromagnetic fields from radio, television or radar (14).

The study StSch 4314 from the ECOLOG Institute indicates an association between a vertical and horizontal distance from the transmitter station and expected radiation intensity on the local people (16). The reason for setting a distance of 400m for the differentiation point is partly due to physical considerations, and partly due to the study of Santini *et al.* who chose 300m (10).

Data Gathering
Similar residential streets in the inner area and outer areas were selected at random. The large old people's home in the inner area was excluded from the study because of the age of the inhabitants. Data gathering covered nearly 90% of the local residents, because all four GPs in Naila took part in this study over 10 years. Every team researched the names of the patients from the selected streets that had been ill with tumours since 1994. The condition was that all patients had been living during the entire observation time of 10 years at the same address.

The data from patients was handled according to data protection in an anonymous way. The data was evaluated for gender, age, tumour type and start of illness. All cases in the study were based on concrete results from tissue analysis. The selection of patents for the study was always done in exactly the same way. Self-selection was not allowed. Also the subjective opinion of patients that the radio mast detrimentally affected their health has not affected this study. Since patients with cancer do not keep this secret from GPs, it was possible to gain a complete data set.

Population study

In the areas where data was collected 1,045 residents were registered in 31.12.2003. The registration statistics for Naila at the beginning of the study (1.1.1994) show the number of old people in the inner and outer areas, as shown in Table 1. The average age at the beginning of the study (1.1.1994) in both the inner and outer areas was 40.2 years. In the study period between 1994-2004, 34 new cases of cancer where documented out of 967 patients (Table 3). The study covered nearly 90% of local residents.

	female	male	total
Inner area	41.48	38.70	40.21
Outer area	41.93	38.12	40.20
Naila total	43.55	39.13	41.45

Table 1 : Overview of average ages at the beginning of the study in 1994

1994	inner 22.4%	outer 2.8%	Naila total 24.8%
2004	inner 26.3%	outer 26.7%	

Table 2 : Proportion of patients aged over 60

The average age of the residents in Naila is one year more than that of the study due to the effects of the old people's home. From the 9,472 residents who are registered in Naila, 4,979 (52.6%) are women and 4,493 (47.4%) are men. According to the register office, in 1.1.1994 in the outer area, the percentage was 45.4% male and 54.5% female, and in the inner area 45.3% male and 54.6% female. The number of people who are over 60 years old is shown in Table 2.

The social differences in Naila are small. Big social differences like in the USA do not exist here. There is also no ethnic diversity. In 1994 in Naila the percentage of foreigners was 4%. Naila has no heavy industry, and in the inner area there are neither high voltage cable nor electric trains.

Results

Results are first shown for the entire 10 year period from 1994 until 2004. Secondly, the last five-year period 1999 to 2004 is considered separately.

Period 1994 to 2004
As a null hypothesis it was checked to see if the physical distance from the mobile transmission mast had no effect on the number cancer cases in the selected population, *ie* that for both the group nearer than 400 metres and the group further than 400 metres the chance of developing cancer was the same. The relative frequencies of cancer in the form of a matrix are shown in Table 3. The statistical test method used on this data was the chi-squared test with Yates's correction. Using this method we obtained the value of 6.27, which is over the critical value of 3.84 for a

Period 1994-2004	Inner area	Outer area	total
new cases of cancers	18	16	34
with no new cancer	302	631	933
total	320	647	967

Table 3 : numbers of patients with and without cancers, 1994-2004

statistical significance of 0.05).

This means the null hypothesis that both groups within the 400-metre radius of the mast and beyond the 400 metre radius, have the same chance of developing cancer, can be rejected with a 95% level of confidence. With a statistical significance of 0.05, an even more significant difference was observed in the rate of new cancer cases between the two groups.

Calculating over the entire study period of 1994 until 2004, based on the incidence matrix (Table 3) we arrive at a relative risk factor of 2.27 (quotient of proportion for each group, *eg* 18/320 in the strongly exposed inner area, against 16/647 in the lower exposed comparison group). If expressed as an odds ratio, the relationship of the chance of getting cancer between strongly exposed and the less exposed is 2.35.

The following results show clearly that inhabitants who live close to transmitter antennas compared to inhabitants who live outside the 400m zone, double their risk of developing cancer. In addition, the average age of developing cancer was 64.1 years in the inner area whereas in the outer area the average age was 72.6 years, a difference of 8.5 years. That means during the 10 year study that in the inner area (within 400 metres of the radio mast) tumours appear at a younger age.

In Germany the average age of developing cancer is approximately 66.5 years, among men it is approximately 66 and among women, 67 (18).

Over the years of the study the time trend for new cancer cases shows a high annual constant value (Table 4). It should be noted that the number of people in the inner area is only half that of the outer area, and therefore the absolute numbers of cases is smaller.

Table 7 shows the types of tumour that have developed in the cases of the inner area.

Period 1994 to 1999

No. of cases of tumours per year of study	inner area: of the 320 people		outer area: of the 647 people	
	total cases	per 1,000	total cases	per 1,000
1994	–	–	I	1.5
1995	–	–	–	–
1996	II	6.3	I	1.5
1997	I	3.1	III	4.6
1998	II	6.3	III	4.6
1999	II	6.3	I	1.5
2000	IIIII	15.6	I	1.5
2001	II	6.3	II	3.1
2002	II	6.3	II	3.1
2003-3/2004	II	6.3	II	3.1

Table 4 : Summary of the total tumours occurring per year (no. and per thousand)

Period 1994-1999	Inner area	Outer area	total
new cases of cancers	5	8	13
with no new cancer	315	639	954
total	320	647	967

Table 5 : numbers of patients with and without cancers, 1994-1999

For the first five years of the radio transmission mast operation (1994-1998) there was no significant increased risk of getting cancer within the inner area as compared to the outer area (Table 5).

Period 1999 to 2004

Under the biologically plausible assumption that cancer caused by detrimental external factors will require a time of several years before it will be diagnosed, we now concentrate on the last five years of the study between 1999 and 2004. At the start of this period the transmitter had been in operation for 5 years. The results for this period are shown in Table 6. The chi-squared test result for this data (with Yates's correction) is 6.77 and is over the critical value of 6.67 (statistical significance 0.01). This means, with 99% level of confidence, that there is a statistically proven difference between development of cancer between the inner group and outer group. The relative risk of 3.29 revealed that there was 3 times more risk of developing cancer in the inner area than the outer area during this time period.

Period 1999-2004	Inner area	Outer area	total
new cases of cancers	13	8	31
with no new cancer	307	639	946
total	320	647	967

Table 6 : numbers of patients with and without cancers, 1999-2004

The odds-ratio 3.38 (VI 95% 1.39-8.25, 99% 1.05-10.91) allows us with 99% confidence to say that the difference observed here is not due to some random statistical effect.

Discussion

Exactly the same system was used to gather data in the inner area and outer areas. The medical chip card, which has been in use for 10 years, enables the data to be processed easily. The four participating GPs examined the illness of 90% of Naila's inhabitants over the last 10 years. The basic data for this study were based on direct examination results of patients extracted from the medical chip cards, which record also the diagnosis and treatment. The study population is (in regards to age, sex and cancer risk) comparable, and therefore statistically neutral. The study deals only with people who have been living permanently at the same address for the entire study period and therefore

Type of tumour (organ)	no. of tumours found	total expected	incidence per 100,000	ratio inner: outer
breast	8	5.6	112	5:3
ovary	1	1.1	23	0:1
prostate	5	4.6	101	2:3
pancreas	m 3 f 2	0.6 0.9	14 18	2:1 1:1
bowel	m 4 f 0	3.7 4.0	81 81	2:2 0:0
skin melanoma	m 1 f 0	0.6 0.7	13 14	1:0 0:0
lung	m 3 f 0	3.6 1.2	79 24	2:1 0:0
kidney	m 2 f 1	1.0 0.7	22 15	1:1 1:0
stomach	m 1 f 1	1.2 1.1	27 23	0:1 0:1
bladder	m 1 f 0	2.0 0.8	44 16	0:1 0:0
blood	m 0 f 1	0.6 0.7	14 15	0:0 1:0

Table 7 : Summary of tumours occurring in Naila, compared with incidence expected from the Saarland cancer register

have the same duration of exposure regardless of whether they are in the inner area or outer area.

The result of the study shows that the proportion of newly developing cancer cases was significantly higher ($p<0.05$) among those patients who had lived during the past ten years within a distance of 400 metres from the cellular transmitter site, which has been in operation since 1993, in comparison to people who live further away. Compared to those patients living further away, the patients developed cancer on average 8.5 years earlier. This means the doubled risk of cancer in the inner area cannot be explained by an average age difference between the two groups. That the transmitter has the effect that speeds up the clinical manifestations of the illness and general development of the cancer cannot be ruled out.

In the years 1999-2004, *ie* after five years and more of transmitter operation, the relative risk of getting cancer had trebled for the residents of the area in the proximity of the mast compared to the inhabitants of Naila in the outer area ($p>0.01$). The division into inner area and outer area groups was clearly defined at the beginning of the study by the distance to the cell phone transmission mast. According to physical considerations people living close to cellular transmitter antennas were exposed to heightened transmitted radiation intensity.

Both calculated and empirical measurements revealed that the intensity of radiation is 100 times higher in the inner area compared to the outer area. According to the research StSch 4314 the horizontal and vertical position in regards to the transmitter antenna is the most important criterion in defining the radiation intensity area on inhabitants (16).

The layered epidemiological assessment method used in this study is also used in assessment of possible chemical environmental effects. In this case the layering is performed in regards to the distance from the cell phone transmitter station. Using this method it has been shown that there is a significant difference in probability of developing new cancers depending on the exposure intensity.

The number of patients examined was high enough according to statistical rules that the effects of other factors (such as use of DECT phones) should be normalised across the inner area and outer area groups. From experience the disruption caused by a statistical confounding factor is in the range between 20% and 30%. Such a factor could therefore in no way explain the 300% increase in new cancer cases. If structural factors such as smoking or excessive alcohol consumption are unevenly distributed between the different groups this should be visible from the specific type of cancers to have developed (*ie* lung, pharyngeal or oesophageal). In the study inner area there were two lung cancers (one smoker, one non-smoker), and one in the outer area (a smoker), but no oesophageal cancers. This rate of lung cancer is twice what is statistically to be expected and cannot be explained by a confounding factor alone. None of the patients who developed cancer was from a family with such a genetic propensity.

Through the many years experience of the GPs involved in this study, the social structures in Naila are well known. Through this experience we can say there was no significant social difference in the examined groups that might explain the increased risk of cancer.

The type and number of the diagnosed cancers are shown in Table 7. In the inner area the number of cancers associated with blood formation and tumour-controlling endocrine systems (pancreas), were more frequent than in the outer area (77% inner area and 69% outer area).

From Table 7, the relative risk of getting breast cancer is significantly increased to 3.4. The average age of patients that developed breast cancer in the inner area was 50.8 years. In comparison, in the outer area the average age was 69.9 years, approximately 20 years less. In Germany the average age for developing breast cancer is about 63 years. The incidence of breast cancer has increased from 80 per 100,000 in the year 1970 to 112 per 100,000 in the year 2000. A possible question for future research is whether breast cancer can be used as a 'marker cancer' for areas where there is high contamination from electromagnetic radiation. The report of Tynes *et al.* described an increased risk of breast cancer in Norwegian female radio and telegraph operators (20).

To further validate the results the data gathered were compared with the Saarland cancer register (21). In this register all newly developed cancers cases since 1970 are recorded for each Bundesland. These data are accessible via the Internet. Patents that suffer two separate tumours were registered twice, which increases the overall incidence up to 10%. In this

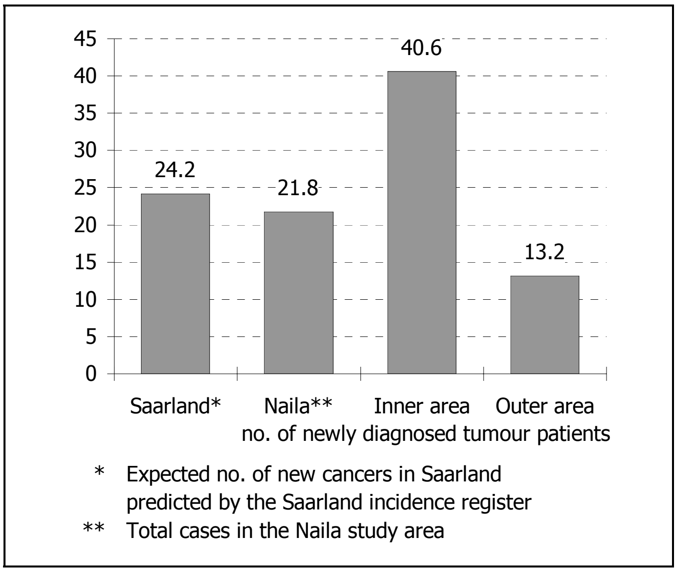

Fig. 3 : Number of new cancer cases 1999 to 2004, adjusted for age and gender, calculated for the 5,000 patient years

register there is no location-specific information, for instance proximity to cell phone transmission masts. The data in the cancer register therefore reflect no real control group but rather the effect of the average radiation on the total population.

From the Saarland cancer register for the year 2000 the incidence of new cancer cases was 498 per 100,000 for men and 462 per 100,000 for women. When adjusted for age and sex one would expect a rate of between 480 and 500 per 100,000 in Naila. For the years 1999 to 2004 there were 21 new cases of cancer among 967 patients. The expected number was 24 cases per 1,000 patients.

The results of the study are shown graphically in Fig. 3. The bars of the chart represent the number of new cancer cases per 1,000 patients in the separate areas, over the five years (bars 2 to 4). The first bar represents the expected number from the Saarland cancer register.

In spite of a possible underestimation, the number of newly developed cancer cases in the inner area is more than the expected number taken from the cancer register, which represents the total population being irradiated. The group who had lived during the past five years within a distance of 400 m from the cellular transmitter have a two times higher risk of developing cancer than that of the average population. The relative risk of getting cancer in the inner area compared with the Saarland cancer register is 1.7 (see to Table 7).

Conclusion

The result of this retrospective study in Naila shows that the risk of newly developing cancer was three times higher among those patients who had lived during past ten years (1994-2004), within a distance of 400m from the cellular transmitter, in comparison to those who had lived further away.

Cross-sectional studies can be used to provide the decisive empirical information to identify real problems. In the 1960s just three observations of birth deformities were enough to uncover what is today an academically indisputable Thalidomide problem.

This study, which was completed without any external financial support is a pilot project. Measurements of individual exposure as well as the focused search for further side effects would provide a useful extension to this work, however such research would need the appropriate financial support.

The concept of this study is simple and can be used everywhere, where there it a long-term electromagnetic radiation from a transmitting station.

The results presented are a first concrete epidemiological sign of a temporal and spatial connection between exposure to GSM base station radiation and cancer disease.

These results are, according to the literature relating to high frequency electromagnetic fields, not only plausible and possible, but also likely.

From both an ethical and legal standpoint it is necessary to immediately start to monitor the health of the residents living in areas of high radio frequency emissions from mobile telephone base stations with epidemiological studies. This is necessary because this study has shown that it is no longer safely possible to assume that there is no causal link between radio frequency transmissions and increased cancer rates.

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Footnotes

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