City of Bellevue

MEMORANDUM

DATE: October 18, 2007

TO: Chair Robertson
Bellevue Planning Commission

FROM: Nicholas Matz AICP, Senior Planner 452-5371
nmatz@bellevuewa.gov
Paul Inghram AICP, Comprehensive Planning Manager 452-4070
pinghram@bellevuewa.gov

SUBJECT: Utilities Element Electrical Facilities Comprehensive Plan Amendment (CPA) and related Land Use Code (LUCA) amendments

INTRODUCTION

This agenda item continues the Electrical Facilities CPA work program. The October 24, 2007 study session will present drafts of proposed Comprehensive Plan Utilities Element text and map amendments, and proposed Land Use Code amendments. See Attachments 1, 2, and 3, respectively.

A review of the electric and magnetic field (EMF) report required by Policy UT-70 is also included here. See the report itself at Attachment 4.

The Planning Commission will be asked to set public hearings for the CPA and LUCA amendments.

BACKGROUND

The adoption of Resolution No. 7107 directed a work program of policy amendments to the Utilities Element of the Comprehensive Plan for the siting and/or expansion of electrical substation and transmission line facilities. With the direction established in Resolution No. 7107 the City Council seeks to balance two equally important objectives:

- Protection of residential neighborhoods from incompatible electrical facilities; and
- The needs of Puget Sound Energy (PSE) to provide sufficient electrical energy to service the growing demand of Downtown Bellevue and other commercial areas

At previous study sessions on February 28, May 9, June 20, and July 25, 2007 the Commission studied background on the GMA mandate for utilities elements, existing Bellevue Comprehensive Plan policy applicable to electrical facilities, a screening assessment of the existing electrical supply system plan in Bellevue to identify potential visual incompatibilities, and a new conceptual framework which included identifying, reviewing, and regulating electrical facilities expansions based on the city's GMA utilities element responsibilities.

ANALYSIS

Draft Comprehensive Plan policies and maps

These draft policies establish a new framework to clarify the roles and expectations for each of the city, PSE, and community, when siting electrical facilities. The process of siting such facilities remains a balancing act between neighborhood impacts and the need for adequate and reliable power.

The policies and new maps:

- Keep intact PSE's primary responsibility in implementing its electrical service system.
- Identify those new and expanded electrical facilities, proposed in sensitive locations.
- Introduce alternative siting analyses for these sensitive facilities.
- Support the development of regulations that address specific site mitigation.
- Continue a focus on meeting community needs through state-of-the-art reliability.

How the process would work:

1. PSE makes decisions about implementing its System Facility Plan
2. The city's GMA obligations identifying the locations and capacity of electrical utility facilities are realized in the Electrical Facilities maps in the Utilities Element
3. These maps identify existing and proposed electrical facilities in relation to the Comprehensive Plan. They further identify locations of planned new or expanded facilities with greater sensitivity*.
4. The LUC directs the type of permitting action based on the type of facility.
5. Once the permit application is made, conditional use or administrative conditional use permit review happens, and design and performance standards specific to electrical utility facilities are applied during review.
6. This sensitivity determines the degree of transparency in siting, as identified through an alternative siting analysis, as well as the permitting path and degree of site mitigation of impacts. Sensitive sites would require siting analysis.
7. The permit approval is conditioned to reflect its surrounding context.

*This sensitivity involves such factors as proximity to residential neighborhoods, visual access, and expansion within or beyond an existing facility border were considered in identifying potential incompatibilities. The early screening identifies a list of facilities that will require special siting scrutiny. The site assessment matrix includes facility-specific determinations.

Draft Land Use Code Amendments

These draft amendments are intended to implement the new framework established above by the policies. They include revised definitions of electrical utility facilities, the application of the permit review process to sensitive and non-sensitive facilities, and performance standards specific to electric utility facilities. See Attachment 3.

Electric and Magnetic Fields (EMF)

The Planning Commission earlier asked about the status of Policy UT-70—"Review periodically the state of scientific research on EMF and make changes to policies if the situation warrants." This is not the primary purpose of the current Utilities Element review, but is being conducted as an ancillary research matter.

The EMF assessment report required by Policy UT-70 has been completed by a 3rd party consultant familiar with research on the health effects of electrical emissions. The city's direction to Exponent, Inc. was to:

> "...prepare a summary of [1] the status of health research on electric and magnetic fields (EMF) in the frequency range associated with electrical transmission and distribution systems and to compare this current assessment to that contained in the EIS issued for the Bellevue Comprehensive Plan Amendment of the Utilities Element in 1993, to [2] review relevant...recommendations from scientific organizations, and to [3] conclude whether the policies in the existing Utilities Element are consistent with the current status of the science and recommendations for precautionary approaches."

The draft report submitted by the consultant focuses on those three areas:

1. Status of health research

   Conclusions

   - There has been a very large amount of scientific research that renders the 1993 summary of health research obsolete.
   - The current body of research does not suggest that there are any long-term, adverse health effects associated with exposure to electric or magnetic fields at the levels that the general public encounters on an everyday basis.
   - The research still suggests a weak association between childhood leukemia and estimates of long-term exposure to high, average magnetic fields; however, the research is not strong enough to conclude that this association is causal in nature.
   - The research continues to support precautionary measures that are based on current risk assessment, namely: a) additional research to seek to resolve uncertainty, b) establishing open communication programs, and c) employing low-cost methods for magnetic field exposure reductions.
   - Although no review panel can ever entirely rule out the possibility that EMF may have some adverse health effect, given the amount and quality of research that has been done so far, the report concludes that the research does not support the idea that EMF are a cause of long-term, adverse health effects.

2. Implications for public policy, including recommendations for precautionary measures

   Conclusions

   - The precautionary principle is a good tool as the basis for measures that can reflect the balance between uncertain health hazards, perceived level of risk, and cost and benefit trade-offs between the two.

- Prudent avoidance—a variant of the precautionary principle—can be realized in the form of "simple, easily achievable, low to modest cost measures to reduce individual or public EMF exposure, even in the absence of certainty that the measures would reduce risk." Examples of specific measures of potential application by local governments are shown in **bold** on pp. 20-21 of the report, and Exponent comments on those in Section 3 below.
- Measures should not normally lead to consideration of exposure limits:

> "There is scientific uncertainty as to whether chronic exposure to ELF magnetic fields causes an increased risk of childhood leukemia...it is unlikely that the implementation of an exposure limit based on the childhood leukemia data and aimed at reducing average exposure to ELF magnetic fields...would be of overall benefit to society."

3. Adequacy of the [Bellevue Comprehensive Plan] Utilities Element

Conclusions

- Existing policies contained in the Utilities Element are still consistent with both the status of scientific research regarding EMF and precautionary measures approaches recommended by the World Health Organization (WHO).
- Because the WHO review concluded that the current body of research does not suggest that there are any long-term, adverse health effects associated with exposure to electric or magnetic fields at the levels the general public encounters on an everyday basis, the types of existing transmission lines or even those proposed as far out into the future as 2030 would not be expected to produce field levels approaching scientific guidelines for setting public exposure levels.

COMMUNITY OUTREACH

Bellevue City Council

The City Council held a study session on July 30, 2007. The Council was presented with the latest policy framework discussion and the intent of the CPA work program to focus alternative siting analysis and site mitigation tools on what are now being called sensitive facilities. The Council also indicated a continued interest in stressing system reliability in light of the demands for reliable power for the Bellevue economy. Councilmembers agreed that the separate reliability study underway through the Transportation Department and expected to deliver a report sometime in 2008 will remain the primary focus on reliability.

Puget Sound Energy

Officials from PSE were briefed on October 15, 2007 about the latest developments in this work Staff feels it is fair to say that both the city and PSE representatives see the benefit in creating a more predictable and transparent siting/expansion process. Both are sensitive to issues of neighborhood character, as well as the need for a predictable electrical system that meets the community's growing needs. We expect to have PSE staff present at tonight's study session.

Continued community outreach

A second community open house will be held on October 24, 2007 from 4:30 to 6:00 p.m., just prior to the Planning Commission meeting. Notice and outreach was provided to neighborhood

leaders and associations, and stakeholders that have identified themselves during the course of this work program. Staff will report to the Planning Commission about this meeting.

ATTACHMENTS

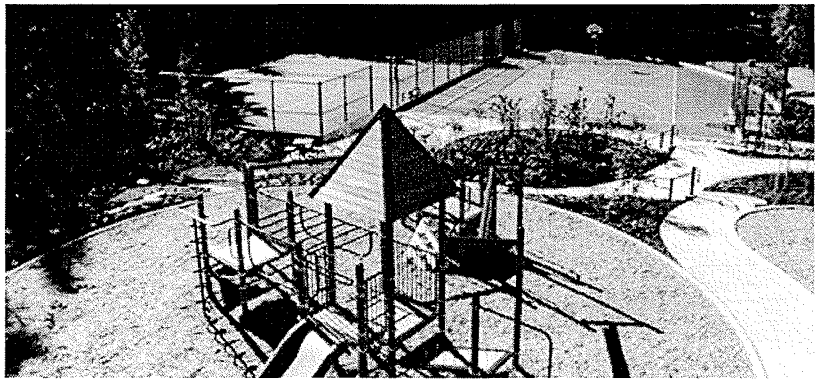
1. Draft electrical facilities Utilities Element text amendments, including new policies and amendments to existing non-policy text
2. Draft electrical facilities Utilities Element map amendments, including two new maps to replace existing Figure UT.5
3. Draft electrical utility facilities Land Use Code Amendments
4. October 8, 2007 Draft Report on the Status of Health Research on Electric and Magnetic Fields (EMF) and Implications for Public Policy

Utilities Element

GOALS:

1. **To facilitate the development and maintenance of all utilities at the appropriate levels of service to accommodate the City of Bellevue's projected growth.**
2. **To facilitate the provision of reliable utility service in a way that balances the public's concerns about safety and health impacts of utility infrastructures, consumers' interest in paying no more than a fair and reasonable price for the utility's product, Bellevue's natural environment and the impacts that utility infrastructures may have on it, and the community's desire that utility projects be aesthetically compatible with surrounding land uses.**
3. **To process permits and approvals for utility facilities in a fair and timely manner and in accord with development regulations which encourage predictability.**
4. **To encourage new technology that improves utility services while balancing health and safety, economic, aesthetics, and environmental factors.**

OVERVIEW



The Utilities Element contains policies and maps that guide the siting of utility facilities in the city. The main purpose of this element is to ensure that Bellevue will have utility capacity to adequately serve the Land Use Plan. Policies also address the quality, reliability, safety and regulation of the services provided. Other policies address environmental impacts, facilities location and construction, economics, and aesthetics in design and landscaping.

Non City-Managed Utilities

Authority

The Washington Utilities and Transportation Commission (WUTC) has the authority from longstanding state law to regulate the services and define the costs that a utility can recover, to ensure that the utility acts prudently and responsibly.

With the adoption of the 1990 Growth Management Act (GMA), current law now suggests that both the WUTC and Bellevue have jurisdiction over the activities of electric, gas, and telephone utilities within Bellevue's city limits.

The City of Bellevue has the authority to regulate land use and, under GMA, the requirement to consider the location of existing and proposed utilities and potential utility corridors in land use planning. The city must also plan for the adequate provision of utilities consistent with the goals and objectives of its Comprehensive Plan, taking into consideration the public service obligation of the utility involved.

The City of Bellevue is entitled to reasonable compensation for use of its rights-of-way, and leases of city owned property, structures and conduits.

The Telecommunications Act of 1996 established new responsibilities for the Federal Communications Commission (FCC) in licensing of personal wireless communication service providers. The licenses allow the right to use a block or blocks of the Radio Frequency Spectrum to provide wireless communication services.

Section 704(a)(7) of the Act recognizes the authority of state and local governments over decisions regarding siting of personal wireless communication service facilities, subject to certain limitations.

Electrical Service

While it is critically important to meet growing demand and further develop the reliability of Bellevue's electrical system, it is also important to ensure that new and expanding electrical facilities are sensitive to neighborhood character. Figure UT.5a identifies those planned facilities that have the potential to create significant incompatibilities with Bellevue neighborhoods. This figure resulted from an analysis of planned facility locations and manner of expansion anticipated by PSE's system plan. Such factors as proximity to residential neighborhoods, visual access, and expansion within or beyond an existing facility border were considered in identifying potential incompatibilities. The early screening identifies a list of facilities that will require special siting scrutiny. This is intended to increase

transparency of the siting process for PSE and the public, while also ensuring the utility's ability to meet system needs.

Puget Sound Energy (PSE) builds, operates, and maintains the electrical utility system serving the City of Bellevue. PSE is an ~~private,~~ investor-owned utility with the responsibility for providing service to over ~~750,000~~ 1,024,000 electric customers in a nine county service area. ~~The system serving~~ Bellevue is part of a larger service area called the "Greater Bellevue Area" which is roughly the ~~an~~ area between Lake Washington and Lake Sammamish. The ~~area~~ Greater Bellevue Area includes the entire cities of Bellevue, Beaux Arts, Medina, Hunts Point, Yarrow Point, and Clyde Hill~~,~~ ~~This area also includes~~ portions of Kirkland and Redmond and small portions of unincorporated King County.

PSE imports electrical energy from generation sources in Canada, on the Columbia River, and from other generation sites inside and outside of PSE's service territory.

~~Based on population and employment forecasts for the next 20-30 years as of 1993, PSE estimates that there will be a peak winter load of approximately 680 MVA (Mega or million volts amperes) in the Greater Bellevue Area. In comparison, the winter peak load in 1993 is 475 MVA. New facilities, including transmission lines and substations, may have to be constructed to meet this demand.~~
PSE's goals are to meet future customer needs for electrical service, enhance system reliability, and maintain safe facilities. As of the end of 2006, PSE served more than 57,200 electric customers within the City of Bellevue. During the winter of 2005-2006, peak electrical load (demand) in the Greater Bellevue Area was 500 MVA (Megavolt-amperes). Based on population, employment and development forecasts for the next twenty to thirty years as of 2006, PSE estimates that peak winter loads in the Greater Bellevue Area will be approximately 625 MVA in 2020 and 700 MVA in 2030. Actual load growth could vary from projections due to economic cycles, land use zoning changes and other drivers. While PSE's existing infrastructure is well positioned to meet City needs, several new system facilities including transmission lines and substations will need to be constructed to meet the projected increased demand for electrical service.

Natural Gas Service

Puget Sound Energy (PSE) builds, operates, and maintains the natural gas distribution system ~~facilities~~ serving the City of Bellevue. PSE is an investor-owned utility serving ~~nearly 650,761~~ more than 703,000 natural gas customers in ~~five western Washington counties including King, Snohomish, Pierce, Thurston, and Lewis counties~~in a six county service area. ~~There are approximately 30,697~~As of the end of 2006, PSE served more than 31,100 natural gas customers within the City of Bellevue.

~~Natural gas is delivered to a regional distribution network via an interstate pipeline system. Northwest Pipeline Corporation owns and operates the regional network that~~

~~supplies gas to the states of Washington, Oregon, and Idaho. The pipeline serving Bellevue consists of two pipelines running north and south, in an area east of Lake Sammamish.~~ The Pacific Northwest receives natural gas from widely disparate regions of the United States and Canada. Natural gas is transported throughout the states of Washington, Oregon and Idaho via a network of interstate transmission pipelines owned and operated by Northwest Pipeline Corporation. PSE takes delivery of natural gas from Northwest Pipeline east of Lake Sammamish and distributes the gas to customers via PSE's distribution system. The distribution system serving Bellevue consists of both high pressure and intermediate pressure mains.

~~Based on available population projections for the next 20 years as of 1993, PSE does not foresee a need for major new distribution facilities in Bellevue in the next 20 years.~~

PSE's goals are to meet future customer needs for gas service, enhance system performance, and maintain safe facilities. As of 2006, PSE's natural gas distribution system has sufficient capacity to serve existing demand for gas service in Bellevue. However, system capacity enhancements will be required in next few years to provide service to new development within the Bellevue Downtown area. Additional high pressure mains will need to be extended into the downtown area and additional intermediate pressure mains will be needed to serve specific developments. Thereafter, the need for additional system improvements will be driven by future development.

Telecommunication Services

Telecommunications is the transmission of sound, images and/or data by wire, radio, optical cable, electromagnetic, or other similar means. Telecommunications include but are not limited to, telephone, personal wireless services, microwave, and cable.

Bellevue's central location and significant employment concentration will continue to attract new and evolving technologies in the field of telecommunications. The city supports increased availability of improved telecommunications services in Bellevue. The city encourages new telecommunications technology that balances the costs and benefits of the following factors: health and safety, aesthetics, environmental, and economic.

In most cases, these telecommunications services will use existing utility corridors, public rights-of-way and city owned properties other than right-of-way, and will be able to provide services to all parts of the city. Bellevue encourages the shared use of space consistent with the city's service mission for telecommunication infrastructure projects within the street right-of-way and for telecommunication infrastructure opportunities on city property other than street right-of-way.

Bellevue's infrastructure investment and aesthetic quality should be protected from unnecessary degradation caused by the construction of telecommunications infrastructure.

Telecommunication Service - Telephone

Approximately 80 percent of the telephone customers in the City of Bellevue are served by one provider. A second provider serves the northern portion of the city, serving approximately 20 percent of Bellevue's telephone customers. Additionally, local telephone service is now being offered by the cable companies. It is anticipated that additional upgraded telephone facilities will be needed to handle a growing demand for advanced telecommunications services.

Telecommunication Service – Personal Wireless

Personal wireless facility communication services use radio waves to transmit voice and/or data using the radio frequency spectrum. These services include but are not limited to commercial mobile services (e.g. cellular), unlicensed wireless services, and common carrier wireless exchange services.

Personal wireless facility communication services use ground-based directional receivers (antennae) which may be located on freestanding poles and towers or on buildings and structures. Each antenna has ancillary power and radio equipment.

Policies

General Non City-Managed Utilities

POLICY UT-32. Defer to the serving utility the implementation sequence of utility plan components.

POLICY UT-33. Coordinate with the appropriate jurisdictions and governmental entities in the planning and implementation of multi-jurisdictional utility facility additions and improvements.

POLICY UT-34. Require effective and timely coordination of all public and private utility trenching activities.

POLICY UT-35. For infrastructure projects within street public rights-of-way, assist in the coordination between telecommunications providers to ensure that all interested parties are given the opportunity to install facilities in common trenches.

POLICY UT-36. Limit the amount of disturbance to city infrastructure by encouraging co-location of telecommunications conduit in the public right-of-way.

POLICY UT-37. Routinely inform telecommunications companies authorized to provide services within Bellevue about the schedules for projects within the city's Capital Investment Program which offer an opportunity to install telecommunications infrastructure during the construction of the city's projects.

POLICY UT-38. Require notification to the city prior to a utility's maintenance or removal of vegetation in city right-of-way.

POLICY UT-39. Require the undergrounding of all new electrical distribution and communication lines except that interim installation of new aerial facilities may be allowed if accompanied by a program to underground through coordination with the city and other utilities. Require the undergrounding of all existing electrical distribution and communication lines where a change in use or intensification of an existing use occurs, unless delayed installation is approved as part of a specific program to coordinate undergrounding of several utilities or in conjunction with an undergrounding program for several sites or when related to street improvements. Interim facilities should be limited to the aerial installation of a new line of 1/2" diameter or less.

POLICY UT-40. Require the reasonable screening and/or architecturally compatible integration of all new above ground utility facilities.

POLICY UT-41. Protect Bellevue's aesthetic quality and infrastructure investment from unnecessary degradation caused by the construction of telecommunication infrastructure.

POLICY UT-42. Encourage directional pruning of trees and phased replacement of improperly located vegetation planted in the right-of-way. Perform pruning and trimming of trees in an environmentally sensitive and aesthetically acceptable manner and according to professional arboricultural specifications and standards.

POLICY UT-43. Encourage consolidation on existing facilities where reasonably feasible and where such consolidation leads to fewer impacts than would construction of separate facilities.

Discussion: Examples of facilities which could be shared are towers, electrical, telephone and light poles, antenna, substation sites, trenches, and easements.

POLICY UT-44. Encourage the use of utility corridors as nonmotorized trails.

Discussion: The city and utility company should coordinate the acquisition, use, and enhancement of utility corridors for pedestrian, bicycle and equestrian trails and for wildlife corridors and habitat.

POLICY UT-45. Avoid, when reasonably possible, locating overhead lines in greenbelt and open spaces as identified in the Parks, Recreation, and Open Space Plan.

POLICY UT-46. Facilitate the conversion to cost-effective and environmentally sensitive alternative technologies and energy sources.

POLICY UT-47. Facilitate and encourage conservation of resources.

Discussion: Items the city should consider in implementing this policy include conserving the use of electric energy in its own facilities, and adopting practical and cost-effective energy building codes.

POLICY UT-48. Encourage cooperation with other jurisdictions in the planning and implementation of multi-jurisdictional utility facility additions and improvements. Decisions made regarding utility facilities shall be made in a manner consistent with, and complementary to, regional demand and resources, and shall reinforce an interconnected regional distribution network.

POLICY UT-49. Encourage communication among the city, the WUTC, and utilities regulated by the WUTC about the distribution of costs for existing and proposed utility facilities; especially requirements for the undergrounding of transmission, distribution, and communication lines exceeding statewide norms.

POLICY UT-50. Encourage system practices intended to minimize the number and duration of interruptions to customer service.

POLICY UT-51. Prior to seeking city approval for facilities, encourage utilities service providers to solicit community input on the siting of proposed facilities which may have a significant adverse impact on the surrounding community.

POLICY UT-52. Encourage utility providers to erect limited on-site signage on all sites purchased for future major utility facilities to indicate the utility's intended use of the site.

POLICY UT-53. Require all utility equipment support facilities to be aesthetically compatible with the area in which they are placed by using landscape screening and/or architecturally compatible details and integration.

POLICY UT-54. Support federal or state actions that would preserve local government authority to regulate time, manner and place of construction in the right-of-way.

Non City-Managed Utilities - Additional Wireless Facilities Policies

POLICY UT-55. Require the placement of personal wireless communication facilities in a manner that minimizes the adverse impacts on adjacent land uses.

POLICY UT-56. Encourage permit applicants to submit an area wide plan that demonstrates the lowest land use impacts consistent with telecommunication customer needs.

POLICY UT-57. Allow exchanges ("swaps") between providers of permitted wireless communication facilities sites, to encourage industry cooperation and coordination.

POLICY UT-58. Require wireless equipment constructed in the public rights of way in residential areas to be under 30 inches high.

POLICY UT-59. Recognize that personal wireless communication facilities will be deployed in all areas of the city to provide coverage and capacity consistent with the changing use of wireless technology. Minimize the attendant impacts, particularly the visual impacts of, personal wireless communication facility towers, lattice towers and structures by utilizing criteria for the design and location of such facilities that appropriately balance the need for wireless services and the impacts of the necessary facilities.

Discussion: Remaining policies illustrate the techniques appropriate to balancing the need for wireless services and the impacts of the necessary facilities.

POLICY UT-60. Minimize visual impacts of personal wireless communication facilities by encouraging deployment in land use districts in the following preferred and descending order when possible, considering the provider's coverage needs: 1) Nonresidential land use districts, except Transition Areas; 2) Transition Areas; 3) Multifamily (R-20 and R-30) districts; and 4) and Park sites and Residential districts.

POLICY UT-61. Minimize visual impacts of personal wireless communication facilities by encouraging system designs in the following preferred and descending order: 1) attached to public facility structures, building mounted, or integrated with utility poles, light standards, and signal supports; 2) co-located on utility poles, light standards, signal supports; and 3) free standing towers.

POLICY UT-62. Upgrade wireless communication facilities as improvements in telecommunications technology create smaller and less visually intrusive facilities by requiring removal of abandoned facilities.

POLICY UT-63. New freestanding facility towers and structures should only be considered when no feasible alternative exists or when visual intrusion is less than associated with placing the facility on an existing structure or building.

POLICY UT-64. Encourage the use of utility poles and towers on public rights of way to install wireless equipment compatible with other utility functions.

POLICY UT-65. Encourage the use of sites developed with utility facilities to install wireless equipment compatible with other utility functions.

POLICY UT-66. For infrastructure opportunities on city property, other than street rights-of-way, encourage the use of appropriate city owned properties for lease to install wireless communications equipment that is compatible with existing city uses of the sites and consistent with land use requirements.

POLICY UT-67. Encourage the co-location of telecommunications equipment on city sites which reduce total impact of antennas on the community.

Non City-Managed Utilities - Additional Electrical Facilities Policies

POLICY UT-68. Encourage the public to conserve electrical energy through public education.

POLICY UT-69. Encourage city and utility involvement with regional or statewide agencies when and if they are developing policies regarding exposure to electric and magnetic fields (EMF) or other utility issues.

POLICY UT-70. Review periodically, the state of scientific research on EMF and make changes to policies if the situation warrants.

POLICY UT-71. Require in the planning, siting, and construction of all electrical facilities, systems, lines, and substations that the electrical utility strike a reasonable balance between potential health effects and the cost and impacts of mitigating those effects by taking reasonable cost-effective steps.

POLICY UT-7X. Work with Puget Sound Energy to implement the electrical service system serving Bellevue in such a manner that new and expanded transmission and substation facilities are compatible and consistent with the land use pattern established in the Comprehensive Plan.

Discussion: Where feasible, electrical facilities should be sited within the area requiring additional service. Electrical facilities primarily serving commercial and mixed use areas should be located in commercial and mixed use areas, and not in areas that are primarily residential. Further, the siting and design of these facilities should incorporate measures to mitigate the visual impact on nearby residential areas. These considerations must be balanced with the community's need to have an adequate and reliable power supply.

POLICY UT-7X. Require siting analysis through the development review process for new and expanded sensitive facilities, including a consideration of alternative sites.

Discussion: Sensitive facilities are those new facilities and existing facilities proposed to be expanded where located in or in close proximity to residentially-zoned districts such that there is potential for visual impacts absent appropriate siting and mitigation. The city will update Figure UT.5a to the extent needed to stay current with changes in PSE's system planning.

POLICY UT-7X. Avoid, minimize and mitigate the impacts of new or expanded electrical facilities through the use of land use regulations and performance standards

that address siting considerations, architectural design, site screening, landscaping, maintenance, best available technologies, and other appropriate measures.

POLICY UT-7X. Work with and encourage Puget Sound Energy to plan, site, build and maintain an electrical system that meets the needs of existing and future development, and provides state-of-the-art reliability for Bellevue customers.

Additional Resources

- City of Bellevue Comprehensive Drainage Plan 1994
- City of Bellevue Comprehensive Wastewater Plan 2002
- City of Bellevue Water Comprehensive Plan 1998
- King County Solid Waste Management Plans
- Puget Sound Energy, Bellevue, Washington
- Local cable and broadband service providers
- Local wireless telecommunications service providers
- City of Bellevue: mapped wireless telecommunication facility sites with issued permits

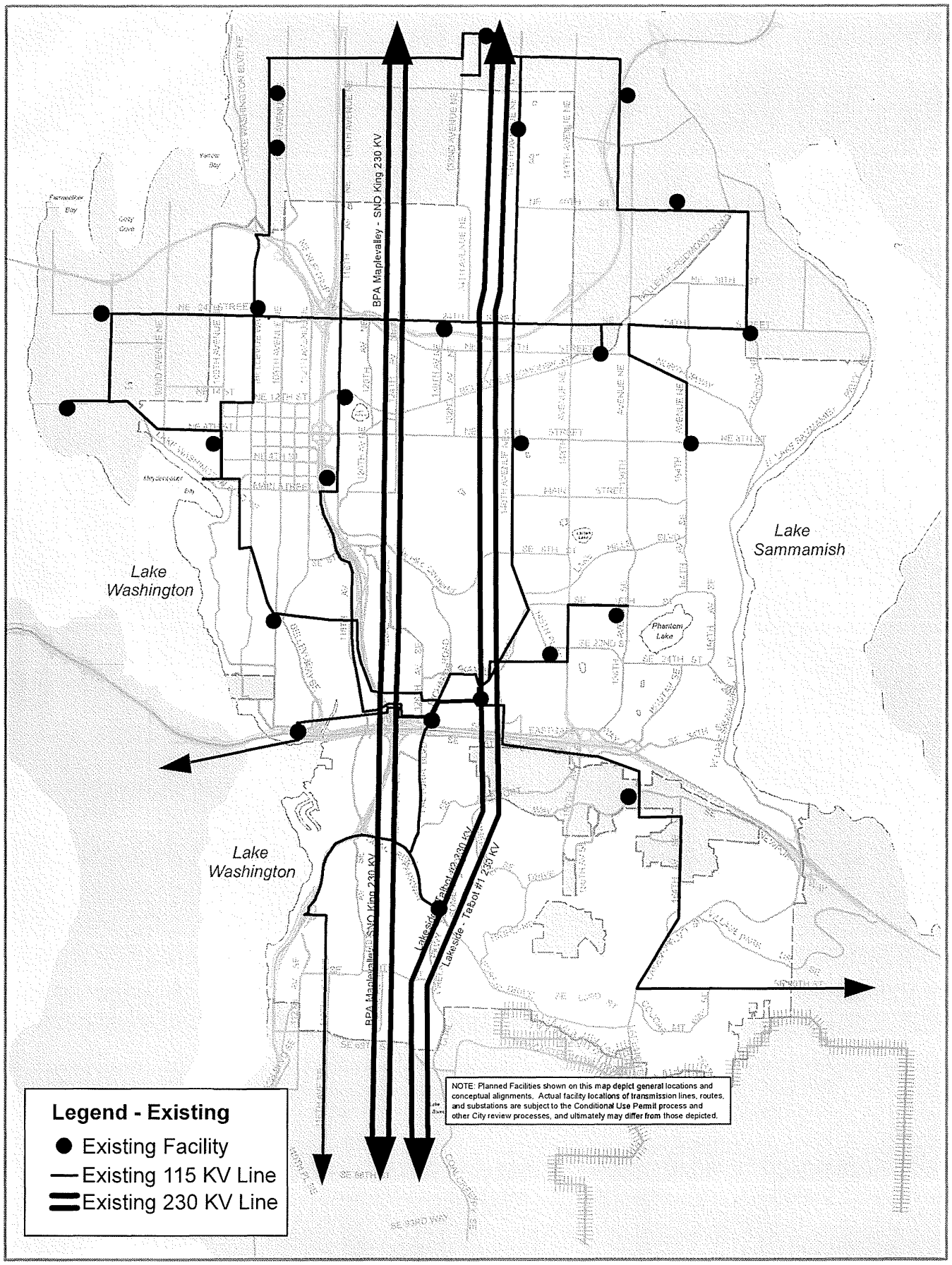


FIGURE UT.5

Existing Electrical Facilities

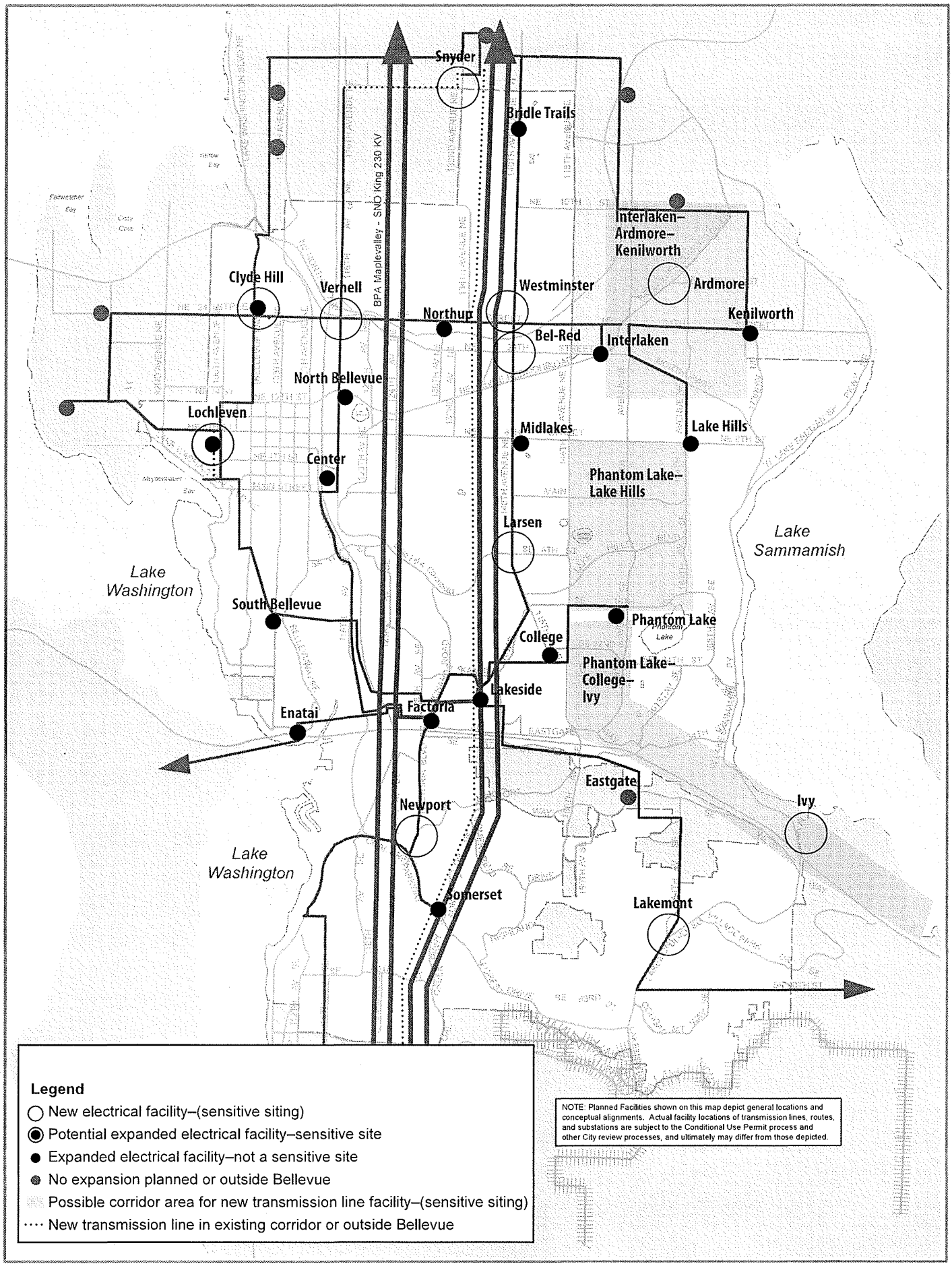


FIGURE UT.5a

New or Expanded Electrical Facilities

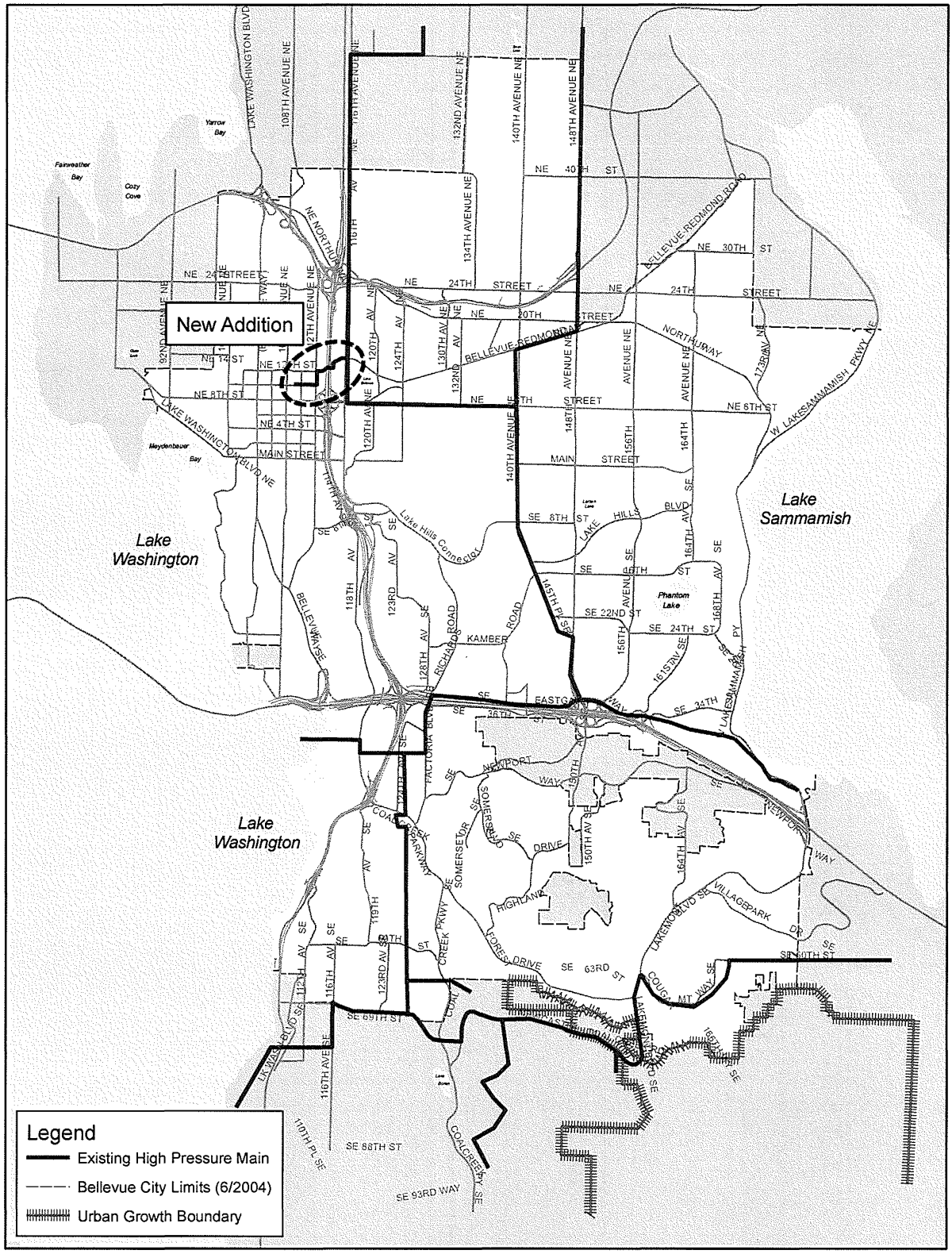


FIGURE UT.7

PSE Natural Gas Mains

Attachment 3

20.50.018 E Definitions.

~~Electrical Distribution Substation~~Electrical Utility Facility. ~~An assembly of equipment design to receive energy from a high voltage distribution supply system to convert it to a form suitable for local distribution and to distribute the energy to feeders through switching equipment designed to protect the service from the effect of faults.~~ A distribution substation, transmission station, transmission switching station, or transmission line that is built, installed, or established for a specific purpose, including: (a) Distribution Substations – A facility, at which electric power is taken from a transmission line, reduced in voltage and sent out through distribution circuits and lines to serve customers in a local area; (b) Transmission Stations – A facility for which transmission system voltage is decreased or increased using one or more transformers. Transmission stations generally reduce transmission system voltage and connect to lower voltage transmission lines used to move electric power to distribution substations; (c) Transmission Switching Station – A facility at which multiple transmission lines interconnect through using a system of busses and breakers. Switching stations provide the ability to change the configuration of the transmission system as operational needs may require; and (d) Transmission Line – An electrical line of at least 115kV that distributes electrical power to and from transmission switching and transmission stations to and from distribution substations, and which link generators to such stations.

20.50.032 L Definitions

Local Utility System. A utility system other than a Regional Utility System, LUC 20.50.044. For the definition of Electrical Utility Facility, see LUC 20.50.018 and for reference to applicable development regulations, see LUC 20.20.255.

20.50.032 U Definitions

Utility Facility. Public utility buildings, telephone exchanges, sewage pumping stations, gas, water and electrical distribution substations, regional storm drainage detention facilities and similar facilities located on a specific site and necessary for the operation of a public utility. Administrative offices and physically dispersed utility systems are not included. For the definition of Electrical Utility Facility, see LUC 20.50.018 and for reference to applicable development regulations, see LUC 20.20.255.

20.20.650 Public Utilities – Design and Performance Standards.

D. For the design and performance standards relating to Electrical Utility Facility as defined in LUC 20.50.018, see LUC 20.20.255.

20.20.520(F)(2)(a) Landscape development.

2. Planting Requirements for Specific Uses. Notwithstanding the provisions of paragraph F.1 of this section, the uses listed in this paragraph require specific landscaping as follows:

a. Subject to paragraph F.6 of this section, the following uses require 15 feet of Type I landscaping on all sides when located above ground and not housed within a building or accessory to another use; and if located outside of a public right-of-way:

i. ~~Utility~~ Electrical utility facility~~substation~~;
ii. Sewage pumping station;
iii. Water distribution facility.

Alternative landscaping may be approved by the Director of Planning and Community Development if the requirements of subsection J of this section are met, and if visibility is essential to safety, security, or maintenance access.

20.10.440 Land Use Charts

Chart 20.10.440

STD LAND USE CODE REF	LAND USE CLASSIFICATION	Transportation and Utilities – Residential Districts										
		R-1	R-1.8	R-2.5	R-3.5	R-4	R-5	R-7.5*	R-10	R-15	R-20	R-30
4	Transportation, Communications and Utilities											
41	Rail Transportation: Right-of-Way, Yards, Terminals, Maintenance Shops	C	C	C	C	C	C	C	C	C	C	C
42 4291	Motor Vehicle Transportation: Bus Terminals, Taxi Headquarters											
4214 422	Motor Vehicle Transportation: Maintenance Garages and Motor Freight Services											
43	Aircraft Transportation: Airports, Fields, Terminals, Heliports, Storage and Maintenance	C 11	C 11	C 11	C 11	C 11	C 11	C 11	C 11	C 11	C 11	C 11
	Accessory Parking (6)	P 3	P 3	P 3	P 3	P 3	P 3	P 3	P 3	P 3	P 3	P 3
46	Auto Parking: Commercial Lots and Garages											
	Park and Ride (5)	C	C	C	C	C	C	C	C	C	C	C
475	Radio and Television Broadcasting Studios											
485	Solid Waste Disposal (19)											

	Highway and Street Right-of-Way	P	P	P	P	P	P	P	P	P	P	P
	Utility Facility	C	C	C	C	C	C	C	C	C	C	C
	Local Utility System	P	P	P	P	P	P	P	P	P	P	P
	Regional Utility System	C	C	C	C	C	C	C	C	C	C	C
	On-Site Hazardous Waste Treatment and Storage Facility (7)											
	Off-Site Hazardous Waste Treatment and Storage Facility (8)											
	Essential Public Facility (20)	C	C	C	C	C	C	C	C	C	C	C
	Wireless Communication Facility (WCF): (without WCF Support Structures)	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21
	Communication, Broadcast and Relay Towers Including WCF Support Structures (Freestanding)	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16
	Satellite Dishes (18)	P	P	P	P	P	P	P	P	P	P	P
	Electrical Utility Facility (22)	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22

Chart 20.10.440

		Transportation and Utilities – Nonresidential Districts									
STD LAND USE CODE REF		Professional Office	Office	Office/Limited Business	Light Industry	General Commercial	Neighborhood Business	Community Business	Factoria Land Use District 1	Factoria Land Use District 2	Factoria Land Use District 3
	LAND USE CLASSIFICATION	PO	O	OLB	LI	GC	NB	CB	F1	F2	F3
4	Transportation, Communications and Utilities										
41	Rail Transportation: Right-of-Way, Yards, Terminals, Maintenance Shops	C	C	C	C	C	C	C	C	C	C
42 4291	Motor Vehicle Transportation: Bus Terminals,				P	P		P	P		

	Taxi Headquarters										
4214 422	Motor Vehicle Transportation: Maintenance Garages and Motor Freight Services				P	C					
43	Aircraft Transportation: Airports, Fields, Terminals, Heliports, Storage and Maintenance	C 11	C	C	C	C	C 11	C	C	C	C
	Accessory Parking (6)	P	P	P	P	P	P	P	P	P	P
46	Auto Parking Commercial Lots and Garages			C	C	C		C	C	C	C
	Park and Ride (5)	C	C	C	C	C	C	C	C	C	C
475	Radio and Television Broadcasting Studios	P	P	P	P 10	P 10		P	P	P	P
485	Solid Waste Disposal (19)				C						
	Highway and Street Right-of-Way	P	P	P	P	P	P	P	P	P	P
	Utility Facility	C	C	C	C	C	C	C	C	C	C
	Local Utility System	P	P	P	P	P	P	P	P	P	P
	Regional Utility System	C	C	C	C	C	C	C	C	C	C
	On-Site Hazardous Waste Treatment and Storage Facility (7)			A	A	A	A	A	A	A	A
	Off-Site Hazardous Waste				C						

	Treatment and Storage Facility (8)										
	Essential Public Facility (20)	C	C	C	C	C	C	C	C	C	C
	Wireless Communication Facility (WCF): (without WCF Support Structures)	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21
	Communication, Broadcast and Relay Towers Including WCF Support Structures (Freestanding)	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16
	Satellite Dishes (18)	P	P	P	P	P	P	P	P	P	P
	Electrical Utility Facility (22)	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22

Chart 20.10.440

		Transportation and Utilities – Downtown Districts					
STD LAND USE CODE REF		**Downtown Office District 1**	**Downtown Office District 2**	**Downtown Mixed Use District**	**Downtown Residential District**	**Downtown Old Bellevue District**	**Downtown Office and Limited Business District**
	LAND USE CLASSIFICATION	**DNTN O-1**	**DNTN O-2**	**DNTN MU**	**DNTN R**	**DNTN OB**	**DNTN OLB**
4	Transportation, Communications and Utilities						
41	Rail Transportation: Right-of-Way, Yards, Terminals, Maintenance Shops						
42 4291	Motor Vehicle Transportation: Bus Terminals, Taxi Headquarters	A	A	A			A
4214	Motor Vehicle	S	S	S			S

422	Transportation: Maintenance Garages and Motor Freight Services						
43	Aircraft Transportation: Airports, Fields, Terminals, Heliports, Storage and Maintenance	A/C 2,12	A/C 2,12	A/C 12			A/C 2,12
	Accessory Parking (6)	P 4	P 4	P 4	P 4	P 4	P 4
46	Auto Parking Commercial Lots and Garages	P 13	P 13	P 13	A	P 13	P 13
	Park and Ride (5)			A			A
475	Radio and Television Broadcasting Studios	P	P	P		P	P
485	Solid Waste Disposal (19)						
	Highway and Street Right-of-Way	P	P	P	P	P	P
	Utility Facility	C	C	C	C	C	C
	Local Utility System	P	P	P	P	P	P
	Regional Utility System	C	C	C	C	C	C
	On-Site Hazardous Waste Treatment and Storage Facility (7)	A	A	A	A	A	A
	Off-Site Hazardous Waste Treatment and Storage Facility (8)						
	Essential Public Facility (20)	C	C	C	C	C	C
	Wireless Communication Facility (WCF): (without WCF Support Structures)	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21	14, 16, 21
	Communication, Broadcast and Relay Towers Including WCF Support Structures (Freestanding)	14, 16	14, 16	14, 16	14, 16	14, 16	14, 16
	Satellite Dishes (18)	P	P	P	P	P	P
	Electrical Utility Facility (22)	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22	A/C 22

Notes: Uses in land use districts – Transportation and Utilities

Note (22) For the definition of Electrical Utility Facility, see LUC 20.50.018 and for reference to applicable development regulations relating to Electrical Utility Facilities or the expansion thereof, see LUC 20.20.255. For Electrical Utility Facilities considered to be sensitive as described by the Utilities Element of the City's Comprehensive Plan, the applicant shall obtain conditional use approval under LUC Part 20.30B and complete an alternative siting analysis as described in LUC 20.20.255(D). For all other Electrical

Utility Facilities, the applicant shall obtain administrative conditional use under LUC Part 20.30E.

20.20.255 Electrical Utility Facilities.

A. Purpose. The purpose of this section is to regulate new and expanding Electrical Utility Facilities and to minimize the visual and noise related impacts of Electrical Utility Facilities on surrounding areas through siting, design, screening, and fencing requirements.

B. Applicability. This section applies to all new Electrical Utility Facilities or the expansion of an existing Electrical Utility Facilities beyond an existing fence or site landscaping as defined in LUC 20.50.018. This section does not apply to other public utilities or other utility facilities which are regulated under LUC 20.20.650.

C. Required Review.

1. Conditional Use Permit. For new Electrical Utility Facilities or the expansion of existing Electrical Utility Facilities beyond an existing fence or site landscaping considered sensitive as referenced in the Utilities Element of the City's Comprehensive Plan, the applicant shall obtain conditional use approval under LUC Part 20.30B. In addition to the requirements set forth in LUC Part 20.30B and LUC Part 20.25B (if applicable), for all proposed locations on sensitive sites, the applicant shall complete and otherwise comply the following:

a. An alternative siting analysis set forth in LUC 20.20.255(D);

b. An informational/public meeting prior to the public hearing held before the Hearing Examiner required by LUC 20.35.137, which is in addition to the informational public meeting requirement set forth in LUC 20.35.100 and LUC 20.35.127; and

c. All development and design standards set forth this section.

2. Administrative Conditional Use. For new Electrical Utility Facilities or the expansion of existing Electrical Utility Facilities beyond an existing fence or site landscaping on sites not considered sensitive in the Utilities Element of the City's Comprehensive Plan, the applicant shall obtain administrative conditional use under LUC Part 20.30E. In addition to the requirements set forth in LUC Part 20.30E, the applicant shall comply with all development and design standards set forth in this section, provided the applicant is not required to complete the alternative siting analysis set forth in subsection D of this section

D. Alternative Siting Analysis. In addition to the requirements set forth in LUC Part 20.30B, LUC Part 20.25B (if applicable), and the development and design standards set

forth in this section, for sensitive facilities as referenced in the Utilities Element of the City's Comprehensive Plan, prior to locating a new Electrical Utility Facility or expanding such facility beyond an existing fence or site landscaping on said sensitive site, the applicant shall conduct the following analysis and otherwise submit the following material to the City:

1. Information regarding all practical or feasible alternative sites considered for the proposed Electrical Utility Facility or expansion thereof, including analysis relating to why the alternative sites were not selected. Included in this analysis, the applicant shall provide or demonstrate the following:

a. provide a map depicting the location or proximity of the new or expanding Electrical Utility Facility with respect to Neighborhood Business Land Use Districts, Residential Land Use Districts, and Transition Areas.

b. demonstrate that the new or expanding Electrical Utility Facility, if located in a Neighborhood Business Land Use District, Residential Land Use District, and/or Transition Area is a consequence of needs or demands from customers located within said district or area;

c. demonstrate that the new or expanding Electrical Utility Facility if located in a Neighborhood Business Land Use District, Residential Land Use District and/or Transition Area is not a consequence of needs or demands from customers located within said district or area, provide an explanation relating to what, if any, operational need(s) exist relating to said location or expansion.

2. Information relating to whether the new Electrical Utility Facility or expansion thereof utilizes best available technology and whether the new or expanding facility provides state-of-the-art reliability to customers served. Included in this analysis, the applicant shall address issues relating to system reliability and whether the proposed technology has the least visual, aesthetic, or noise related impact to surrounding properties.

3. Provision of an affidavit stating all methods of community outreach or involvement conducted prior to selecting a location for the Electrical Utility Facility or expansion thereof.

E. Development Standards. In addition to the requirements set forth in LUC Part 20.30B, Part 20.30E, Part 20.25B (if applicable), and other pertinent provisions of this section, prior to locating a new Electrical Utility Facility or expanding an Electrical Utility Facility beyond an existing fence or site landscaping, the applicant shall meet the following development standards:

1. The location, design, or expansion thereof, as determined by the City, is consistent with Puget Sound Energy's System Plan;

2. The design, use, and operation of the Electrical Utility Facility or expansion thereof complies with any applicable guidelines, rules, regulations or statutes adopted by state law, or any agency or jurisdiction with authority;

3. For location of an Electrical Utility Facility or expansion thereof, the applicant shall demonstrate that an operational need exists that requires locating or expanding the facility in said location, provided this subsection only applies to sites required to obtain administrative conditional use approval under LUC Part 20.30E;

4. The Electrical Utility Facility or expansion thereof minimizes adverse impacts on properties located near the facility, specifically including all visual, aesthetic, and noise related impacts to surrounding properties, including properties for which the system passes through;

5. The Electrical Utility Facility or expansion thereof provides mitigation sufficient to eliminate or minimize long-term impacts to surrounding properties; and

6. The Electrical Utility Facility or expansion thereof is necessary for the effective functioning of the utility.

D. Design Standards. Prior to locating a new Electrical Utility Facility or the expansion thereof beyond an existing fence or site landscaping, the applicant shall meet the following standards:

1. Site Landscaping. All new Electrical Utility Facility or the expansion of a facility beyond the footprint of an existing fence or site landscaping shall be sight-screened as specified in LUC 20.20.520(F)(2) or as required for the applicable land use district. Alternatively, the provisions of LUC 20.20.520(J) may be used, provided this subsection does not apply to transmission lines as defined in LUC 20.50.018.

2. Fencing.

a. All new Electrical Utility Facilities or facilities expanding beyond the footprint of an existing fence or site landscaping shall be entirely screened by a site-obscuring fence not less than eight-feet in height, unless the City determines that the site is adequately screened by topography or existing vegetation or the facility is located entirely within a structure or otherwise fully enclosed, provided this subsection does not apply to transmission lines as defined in LUC 20.50.018. To the maximum extent possible, all Electrical Utility Facility components, excluding transmission lines, shall be screened by either a site-obscuring fence or alternative screening;

b. Electrical Utility Facilities or any expansion thereof shall not be screened by barbed wire, electric, chain link fences, or any type of fencing that visually exposes the substation from view.

3. Required Setback. New or expanding Electrical Utility Facilities (and required fencing and site landscaping) shall conform to the setback requirement for structures in the land use district for which the facility is located. The minimum side setback for an Electrical Utility Facility and required fencing located in a Residential Land Use District is 20 feet.

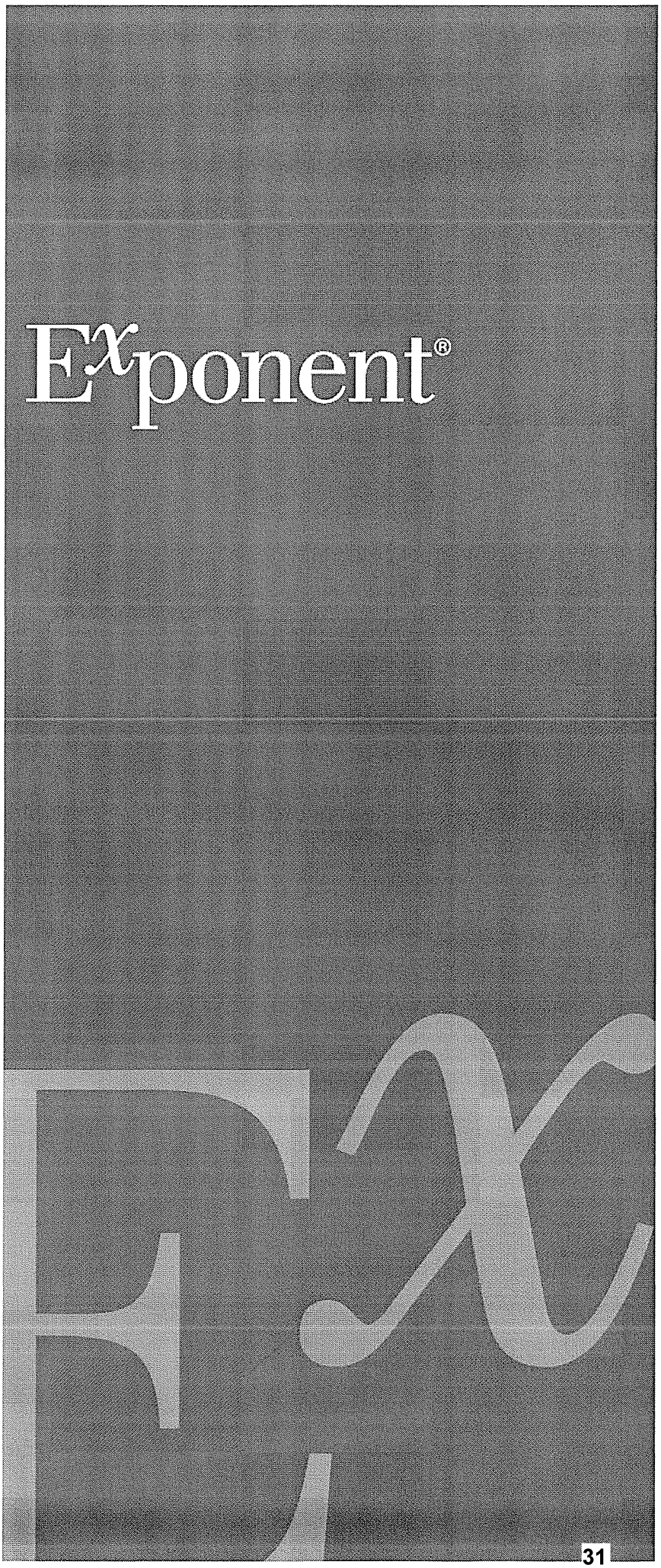
4. Height Limitations. For all Electrical Utility Facility components, including transmission lines, the City may approve a request to exceed the height limit for the underlying land use district if the applicant demonstrates that:

a. The requested increase is the minimum necessary for the effective functioning of the Electrical Utility Facility; and

b. Visual, aesthetic, and noise related impacts associated with the Electrical Utility Facility or expansion thereof have been mitigated to the greatest extent technically and visually feasible.

E. Mitigation Measures. For all new or expanding Electrical Utility Facilities, the City may impose conditions relating to the location, development, design, use, or operation of the facility within the scope of the City's authority to mitigate identified environmental, public safety, or other identifiable impacts. Mitigation measures may include, but are not limited to, natural features that may serve as buffers, or other site design elements such as fencing and site landscaping as provided for in subsection D. Should the City determine that the Electrical Utility Facility or expansion thereof is potentially dangerous to human life, appropriate protective measures may be required.

G. Independent Technical Review. The City may require the applicant pay for independent technical review, by a consultant retained by the City, of materials submitted to demonstrate compliance with the provisions of this section.



Health Sciences

Draft

Status of Health Research on Electric and Magnetic Fields (EMF) and Implications for Public Policy

Draft

Status of Health Research on Electric and Magnetic Fields (EMF) and Implications for Public Policy

Prepared for:

City of Bellevue
Department of Planning and Development
450 110th Ave. NE
P.O. Box 90012
Bellevue, WA 98009

Prepared by:

Exponent
420 Lexington Avenue, Suite 1740
New York, NY 10170

October 8, 2007

NY10644.000 A0T0 1007 MEW1

Contents

1 Introduction

The City of Bellevue is in the process of reviewing and updating (if necessary) the Electric Utilities Element of its Comprehensive Plan. As part of this review, the Planning Department contracted with Exponent, Inc. to prepare a summary of the status of health research on electric and magnetic fields (EMF) in the frequency range associated with electrical transmission and distribution systems and to compare this current assessment to that contained in the Environmental Impact Statement (EIS) issued for the Bellevue Comprehensive Plan Amendment of the Utilities Element in 1993[1], to review relevant exposure standards and precautionary recommendations from scientific organizations, and to conclude whether the policies in the existing Utilities Element are consistent with the current status of the science and recommendations for precautionary approaches. This review is called for under Policy UT-70, i.e., to "[r]eview periodically, the state of scientific research on EMF and make changes to policies if the situation warrants" (p. 110) and to provide input to policies affecting operations of non-city managed electric utilities.[2]

The Utilities Element is focused on achieving four goals. The second goal is pertinent to public health and safety issues:

> To facilitate the provision of reliable utility service in a way that balances the public's concerns about safety and health impacts of utility infrastructures, consumers' interest in paying no more than a fair and reasonable price for the utility's product, Bellevue's natural environment and the impacts that utility infrastructures may have on it, and the community's desire that utility projects be aesthetically compatible with surrounding land uses" (p. 95).

[1] City of Bellevue. Environmental Impact Statement. Comprehensive Plan Amendment. Utilities Element. Electrical Utility. March 1993.

[2] http://www.bellevuewa.gov/pdf/PCD/CompPlan_Vol_1_06.UtilitiesElement.pdf

The assessment of EMF research under Policy UT-70 potentially has implications for the other general policies supported in the Utilities Element, including UT-39, UT-44, UT-47, UT-69, and UT-71.

The policies for addressing EMF in the 1993 Utilities Element were developed based upon a summary of the research contained in Appendix D: EMF Technical Study[3] to the 1992 Draft EIS, which was subsequently edited without changing the major conclusions in the 1993 Final EIS. This summary of EMF health research up to 1992 is now obsolete given the publication of hundreds of papers on EMF and health in the following 15 years. Moreover, even at the time it was prepared, the 1993 EMF Technical Study was not a critical and comprehensive evaluation of the research literature; rather, the goal was limited to a summary and description of recently published research.

Subsequent to the 1992 review, many national and international agencies have commissioned multidisciplinary panels of scientists to perform critical scientific evaluations of the burgeoning literature. These reviews have provided guidance to utilities and governments at the national, state, and local levels. The most recent of these reviews is the Environmental Health Criteria report commissioned by the World Health Organization (WHO) and published in June 2007. Since it is an up-to-date and comprehensive evaluation of the EMF health research, the WHO review was chosen to characterize the current state of knowledge and as the basis for considering possible updates to the City of Bellevue's Utilities Element policies.

Section 2 of this report briefly summarizes the methods used to evaluate research, the conclusions of the WHO report, and how the current state of knowledge differs from the research knowledge in 1993. Section 3 discusses the implications of EMF health research for public policies on exposure standards and other precautionary measures, including what scientific agencies have recommended and what other governmental bodies have done at the national and state level. Finally, Section 4 discusses the

[3] EMF Technical Study. Prepared by Energetics for the City of Bellevue, Washington under contract no. 18096. November 27,1992.

adequacy of Bellevue's existing planning policies in light of the latest scientific and regulatory developments.

2 EMF Health Research Assessment

2.1 Research methods

Sound policies and recommendations about possible health risks are based on conclusions from the scientific process referred to as risk assessment. Risk assessment consists of several steps, as described on p. 91 of the 1992 EMF Technical Study. The process starts with systematically evaluating the body of research and identifying any possible risks associated with an exposure (*hazard identification*). A follow-up question to hazard identification is, "if the exposure does cause any health risks, at what level do they occur?" (*dose-response assessment*). A risk assessment then characterizes the exposure circumstances of the population (*exposure assessment*). Finally, using the findings from the hazard identification and dose-response assessment, a summary evaluation is provided about the nature and extent of possible risks (*risk characterization*). Standards and guidelines to limit exposures to agents such as EMF should be based on possibly hazardous exposure levels identified through the risk assessment process.

Hazard identification begins with a systematic review of published, peer-reviewed scientific research, which is often referred to as a weight-of-evidence review.[4] Scientific organizations and regulatory agencies use the weight-of-evidence approach worldwide to assess the possible health risks associated with exposures and, if conducted using sound scientific methods, it is these reviews that inform the scientific community and the public regarding the current state of the science. Since the publication of the 1993 EIS, numerous national and international organizations responsible for public health have convened multidisciplinary panels of scientists to conduct weight-of-evidence reviews and arrive at conclusions about the possible risks associated with EMF. The most important weight-of-evidence reviews on EMF and health effects include the following:

[4] While many scientific reviews are not explicitly referred to as "weight-of-evidence reviews", the term is used in this report to describe reviews that were conducted by a multidisciplinary group of scientists that used a structured and systematic process to weigh both the laboratory and epidemiologic evidence and provide a conclusion about causality.

- In the United States, the **National Institute for Environmental Health Sciences (NIEHS)** assembled a 30-person Working Group to review the cumulative body of epidemiologic and experimental data and provide conclusions and recommendations to the US government (NIEHS, 1998, 1999). This report was published at the conclusion of the US Department of Energy's EMF Research and Public Information Dissemination (EMF RAPID) Program, which was formed by a government mandate in 1992 in response to public concern about the safety of magnetic fields. This program included more than 100 animal and laboratory studies.

- The **International Agency for Research on Cancer (IARC)** completed a full carcinogenic evaluation of magnetic fields in 2002 as part of its standard program for evaluating the carcinogenicity of chemicals and other agents. The IARC is the division of the WHO with responsibility to coordinate and conduct research on the causes of human cancer and the mechanisms of carcinogenesis and to develop scientific strategies for cancer control.

- The **International Commission on Non-Ionizing Radiation Protection (ICNIRP)** published a weight-of-evidence review in 2003. The ICNIRP is the formally recognized organization for providing guidance on the safety of non-ionizing radiation for the WHO.

- The **National Radiological Protection Board (NRPB)**[5] of the United Kingdom issued full evaluations of the research in 1992, 2001a and 2004, with supplemental updates (1993, 1994a) and topic-specific reports (1994b; 2001b; 2006) published in the interim.

- Finally, the **WHO** released a review in June 2007 as part of its International EMF Program.

[5] The NRPB merged with the Health Protection Agency (HPA) in April 2005 to form its new Radiation Protection Division.

As discussed above, this report focuses on the conclusions of the 2007 WHO report since this publication is up-to-date and represents the most recent review of the literature by a national or international multidisciplinary scientific panel. The following discussion provides additional detail on the process used by the WHO and other agencies conducting weight-of-evidence reviews.

Weight-of-evidence reviews evaluate research in three disciplines: epidemiology, animal studies (*in vivo*), and studies in cells and tissues (*in vitro*). Studies vary widely in terms of the sophistication and validity of their methods and, therefore, the amount of information they can provide to the overall assessment. Each study from each discipline must be critically evaluated, and a final conclusion is reached by considering the cumulative weight of the evidence individually within each area of research and then collectively from all three disciplines (epidemiology, *in vivo* and *in vitro* studies).

Risk assessment requires that each type of research study be carefully evaluated since each provides a distinct and valuable piece of information; it is only when the entire body of research is evaluated together, however, that conclusions can be generated. Epidemiologic investigations enroll people into studies and measure their exposures as they go about their daily routines to determine whether people with specific exposures develop diseases more often than those without the exposure, or whether people with a certain disease have a history of a selected exposure more often than people without that disease. Such studies are designed to quantify and evaluate the statistical associations between reported exposures to environmental factors and health outcomes.[6] Since epidemiologists do not have control over the many other factors to which people are exposed (e.g., diet, pollution, infections, etc.) and diseases are caused by the complex interaction of many factors, the results of epidemiologic studies must be interpreted carefully. A single epidemiologic study is rarely unequivocally supportive or non-supportive of causation; rather, a weight is assigned to the study based on the validity of its methods. Epidemiologic support for causality is based on high-quality studies reporting consistent and strong results in a dose-response fashion across many different populations and study designs.

[6] A statistical association in an epidemiology study measures the degree to which the exposure and disease vary together, with positive associations meaning they tend to occur together more often than one would expect because of chance and negative associations meaning they tend to occur apart more often than one would expect because of chance.

Additional considerations for causality include biological plausibility, coherence, temporality and specificity, as defined by Bradford Hill's criteria outlined on pp. 78-87 of the 1992 EMF Technical Study.

Because of the inherent limitations of observational epidemiology, scientists also consider experimental studies in animals and in cells and tissues. *In vivo* studies expose laboratory animals to very high levels of a chemical or physical agent to determine whether exposed animals develop cancer at higher rates than unexposed animals, while tightly controlling for all other factors that could possibly affect disease rates (e.g., diet, genetics, etc.). *In vitro* studies are also important because they study how the exposure (e.g., magnetic fields) could initiate the disease process at the cellular level. Thus, the risk assessment process requires support from several layers of questioning. First, does the exposure cause a response in cells or tissues that could lead to a disease process? Second, do we observe this process in highly-controlled experimental studies of animals? And, finally, do we observe that people with the exposure have higher rates of the disease? It is the comprehensive consideration of these questions that leads to a valid risk assessment.

The conclusion of a health risk assessment always involves some uncertainty because scientific research cannot *prove* the absence of a health risk. Furthermore, scientific knowledge is an evolutionary process that gains certainty as more and more research is conducted to either support or refute the findings from previous studies. At different points in the evolution of the research, different questions remain unanswered and, in many cases, unconfirmed.

At the time of the publication of the 1993 EIS, the research related to EMF and health effects was relatively immature. It consisted largely of epidemiology studies, particularly of childhood leukemia because the first suggestive study on EMF was related to children with leukemia. No long-term chronic exposure studies in animals had been initiated at that time, and there were hints and hypotheses of potential mechanisms to explain the contribution of EMF to carcinogenic processes, but no firm conclusions. There has since been a very large amount of epidemiologic, *in vitro* and *in vivo* research that renders the conclusions of the 1993 EIS obsolete. The following sections discuss the current state of the science as summarized by the 2007 WHO risk assessment and the major advancements since the 1993 EIS.

2.2 Current state of the science

A summary of the 2007 WHO risk assessment is provided below to characterize the current state of the science, since this publication is the most recent review of the literature by a national or international multidisciplinary scientific panel. The WHO risk assessment was released as part of its International EMF Project and Environmental Health Criteria (EHC) Programme. The WHO is a scientific organization within the United Nations system whose mandate includes providing leadership on global health matters, shaping the health research agenda, and setting norms and standards. The WHO established the International EMF Project in 1996, in response to public concerns about exposures to EMF and possible adverse health effects. The Project's membership includes eight international organizations, eight collaborating institutions and over 54 national authorities. The overall purpose of the Project is to assess health and environmental effects of exposure to static and time varying EMF in the frequency range 0-300 Gigahertz (GHz). A key objective is to evaluate the scientific literature and make a status report on health effects, to be used as the basis for a coherent international response. Additional objectives of the Project are relevant to this report and will be discussed in later sections, including the following:

- "Facilitate the development of internationally acceptable standards limiting EMF exposure,

- Provide information on the management of EMF protection programmes for national and other authorities, including monographs on EMF risk perception, communication and management, and

- Provide advice to national authorities, other institutions, the general public and workers, about any hazards resulting from EMF exposure and any needed mitigation measures." (http://www.who.int/peh-emf/project/EMF_Project/en/index1.html)

The Monograph used standard scientific procedures, as outlined in the Preamble, to conduct its risk assessment. The Task Group responsible for the report's overall conclusions consisted of 21 scientists from around the world with expertise in a wide range of disciplines. The Task

Group relied on the conclusions of previous weight-of-evidence reviews, where possible, and (with regard to cancer) mainly focused on evaluating studies published after the IARC review in 2002.

The overwhelming majority of health research related to EMF has focused on the possibility of a relationship with cancer, including leukemia, lymphoma, breast cancer, and brain cancer, although the WHO also reviewed research related to reproductive effects and neurodegenerative diseases. *In vivo* studies in this field exposed rodents to high levels of magnetic fields (up to 50,000 milligauss [mG]) over the course of their entire lifetime to observe whether exposed animals had higher rates of cancer than unexposed animals. Some of these studies exposed animals to magnetic fields in tandem with a known carcinogen to test whether magnetic field exposure promoted carcinogenesis. Since there is relatively low energy associated with extremely low frequency (ELF) EMF, researchers believe it is highly unlikely that electric or magnetic fields can directly damage DNA. Therefore, *in vitro* studies in this field have largely focused on investigating whether ELF EMF could promote damage from other known carcinogens or cause cancer through a pathway other than DNA damage (e.g., hormonal or immune effects or alterations in signal transduction).

Since the WHO report uses the IARC conclusions from their 2002 review on cancer as a foundation for their risk assessment, the IARC's methods and conclusions are discussed briefly here for context. The IARC has a standard method for classifying exposures based on the strength of the scientific research in support of carcinogenicity. Categories include (from highest to lowest risk): carcinogenic to humans, probably carcinogenic to humans, possibly carcinogenic to humans, unclassifiable, and probably not carcinogenic to humans. As a result of two "pooled analyses" published in 2000, the epidemiology data was classified by the IARC as providing "limited evidence of carcinogenicity"[7] in relation to childhood leukemia. In these pooled analyses, researchers combined the data from previously published epidemiology studies

[7] Each type of evidence is categorized based on the strength of the evidence in support of carcinogenicity. The categories include: sufficient evidence of carcinogenicity, limited evidence of carcinogenicity, inadequate evidence of carcinogenicity, and evidence suggesting lack of carcinogenicity. If a positive association between an exposure and cancer is found (although factors such as chance, bias and confounding cannot be ruled out with reasonable confidence), the epidemiologic evidence is rated as "limited evidence of carcinogenicity." If chance, bias and confounding can be ruled out with reasonable confidence, then the evidence is classified as "sufficient evidence of carcinogenicity." The *in vivo* studies are ranked using a similar system, and the totality of the evidence is then considered to reach a conclusion about a particular exposure's carcinogenicity.

of magnetic fields and childhood leukemia that met specified criteria (Ahlbom et al., 2000; Greenland et al., 2000). In both pooled analyses, a weak association was reported between childhood leukemia and estimates of average magnetic field exposures greater than 3-4 mG. With regard to all other cancer types, the epidemiology evidence was classified as inadequate. The IARC panel also reported that there was "inadequate evidence of carcinogenicity" in studies of experimental animals. Overall, magnetic fields were evaluated as "possibly carcinogenic to humans." The IARC usage of "*possible*" denotes an exposure in which epidemiologic evidence points to a statistical association, but other explanations cannot be ruled out as the cause of that statistical association (e.g., bias and confounding)[8] and experimental evidence does not support a cause-and-effect relationship. Thus, the IARC conclusion in 2002 that magnetic fields are a possible carcinogen was based largely on the results of two pooled analyses, which reported a statistical association between childhood leukemia and exposure to magnetic fields at levels greater than 3-4 mG.

The WHO reviewed the research since the IARC review in 2002 and arrived at the following overall conclusions:

- The current body of research does not suggest that there are any long-term, adverse health effects associated with exposure to electric or magnetic fields at the levels that the general public encounters on an everyday basis.
- The only known health effects associated with electric and magnetic fields are short-term shock-like effects that occur at high field levels not encountered by the general public. These high field levels induce electric fields and currents in the body that can cause nerve and muscle stimulation and changes in nerve cell excitability in the central nervous system. Section 3 discusses these effects further in the context of standards and guidelines.
- The research still suggests a weak association between childhood leukemia and estimates of long-term exposure to high, average magnetic field levels (i.e.,

[8] Bias refers to any systematic error in the design, implementation or analysis of a study that results in a mistaken estimate of an exposure's effect on the risk of disease. A confounder is something that is related to both the disease under study and the exposure of interest such that we cannot be sure what causes the observed association - the confounder or the exposure of interest.

≥3-4 mG). However, considering the lack of consistent findings from animal and laboratory studies and the limitations of epidemiology, the research is not strong enough to conclude that this association is causal in nature. Several factors (aside from causation) might be fully, or partially, responsible for the consistent association observed between high, average magnetic fields and childhood leukemia, including misclassification of magnetic field exposure due to poor exposure assessment methods, confounding from unknown risk factors, and selection bias.

- Currently, the highest priority in the field of EMF research is reconciling the epidemiologic data on childhood leukemia and the negative experimental findings through innovative research.
- Overall, the animal studies have not reported an increase in cancer among animals exposed to high levels of electric or magnetic fields. The evidence that magnetic field exposure can enhance cancer development in combination with known carcinogens is inadequate.[9]
- No accepted biological mechanism has been discovered in laboratory studies that would explain how electric or magnetic fields could initiate disease, including cancer.
- The conclusion that magnetic fields are a possible carcinogen remains.
- A number of other diseases aside from childhood leukemia were considered, including other childhood cancers, cancers in adults, cardiovascular disorders, reproductive dysfunction, developmental disorders, and neurodegenerative disease. The scientific evidence supporting a relationship between exposure to magnetic fields and any of these diseases is weaker than for childhood leukemia.

---

[9] Specific terms were used by the Task Group to describe the strength of the evidence in support of causality. *Limited evidence* describes a body of research where the findings are inconsistent or there are outstanding questions about study design or other methodological issues that preclude making strong conclusions. *Inadequate evidence* describes a body of research where it is unclear whether the data is supportive or unsupportive of causation because there is a lack of data or there are major quantitative or qualitative issues.

In the case of cardiovascular disease and breast cancer, the evidence is sufficient to give confidence that magnetic fields do not cause the disease. The findings related to adult leukemia, adult brain cancer, reproductive and developmental effects, and neurodegenerative diseases were characterized as inadequate.

- The following precautionary measures are warranted based on the findings of the risk assessment: the promotion of research in certain unresolved areas to reduce uncertainty, the establishment of open communication programs, and the employment of low-cost methods for magnetic field exposure reductions. The research findings only justify exposure limits at high electric and magnetic field levels to protect against acute effects (see Section 3 for additional detail on precautionary measures).

These conclusions are emphasized in the following quote from the WHO:

> Acute biological effects have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low-intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted. (p. 355)

Because of the inherent limitations of scientific investigation, no review panel can ever completely rule out the possibility that EMF might have some adverse effect. The absence of a clear adverse effect after continued testing, however, increases the certainty that there are no adverse effects, or that any risk associated with the exposure is small. Furthermore, given the amount and quality of the research that has been conducted thus far, the opinion is strong that

there is not a cause-and-effect link between EMF and adverse health effects. The existing body of research is certainly much more robust and much higher in quality relative to what was available at the time of the 1993 EIS to offer the conclusion that the research does not support the idea that EMF are a cause of long-term, adverse health effects.

2.3 Research developments 1992 – 2007

As discussed above, the body of research at the time of the 1993 EIS was methodologically immature and inconsistent. The research consisted mainly of epidemiology studies on childhood leukemia and adult cancers in the occupational setting. At that time, a number of organizations including the Electric Power Research Institute (EPRI), the NIEHS, and the US Department of Energy (DOE) were funding experimental research programs on EMF, the results of which are available today. The following overall conclusion was provided in the 1992 EMF Technical Study:

> The body of scientific evidence regarding the health effects from EMF exposure remains unclear. While there are biological effects associated with exposure, there is no definitive indication that EMF exposure does or does not cause adverse human health effects. Such a definitive indication may not be forthcoming for several years. (p.108)

A "definitive indication" is not possible, however, the large amount of research currently available means that scientists have more confidence in their conclusions about the possible effects of EMF than they did in 1992. Readers are encouraged to focus on the conclusions from the cumulative body of research as outlined in Section 2.3, rather than the developments since 1993, since there have been an innumerable number of advancements. A few, important developments are discussed below, however, to highlight some major differences in conclusions and provide a reference for whether changes to the Utilities Element are required.

- Specific to childhood leukemia, the draft 1992 EIS concluded "there is evidence of a relationship between wiring code and leukemia" and "little support for a relationship

between measured magnetic field exposure and leukemia risk" (p. III-41). The status of the research has changed quite dramatically; the research currently does not support an association with wire codes, but does support an association with measured magnetic field levels greater than 3-4 mG. At the time of the 1993 EIS, studies were just beginning to estimate magnetic field levels, however, they were restricted to calculated field levels or spot measurements. Later studies actually measured magnetic fields over a long period of time to estimate a person's long-term exposure. Of note, the largest epidemiology studies of childhood leukemia that actually measured personal magnetic field exposure did not report evidence to support a causal relationship (Linet et al., 1997; McBride et al., 1999; UKCCS, 1999).

- Studies of occupational magnetic exposures at the time of the 1993 EIS were largely positive, although they were criticized for major flaws in their design. In particular, their exposure assessment was based solely on job title (e.g., electrical workers). More advanced exposure assessments were used in later studies to link job titles to actual exposure measurements.

- The authors of the 1992 EMF Technical Study discussed a biological mechanism by which magnetic fields could cause carcinogenic effects via the hormone melatonin. They reported on some initial positive findings. This mechanism, referred to as the melatonin hypothesis, has been extensively studied since 1993, and the WHO concluded that the evidence is inadequate to support this hypothesis.

- In terms of *in vivo* research, the results indicated in 1993 that there may be effects on cancer initiation or promotion, but the evidence was not clear. Since that time, four major animal studies were conducted. The WHO reported that these large-scale, long-term studies of rodents exposed to magnetic fields over the course of their lifetime did not report increases in any type of cancer (Mandeville et al., 1997; Yasui et al., 1997; Boorman et al., 1999; McCormick et al., 1999).

These developments demonstrate the evolving nature of research. The following sections discuss standards, guidelines and precautionary measures that are currently recommended by scientific and governmental bodies, in light of the results of the scientific research.

3 Implications for Public Policy

Decision-makers at the international, national and local levels develop policies to reduce possible health risks. Risk management is a complex and iterative process involving the evaluation of a range of factors, including the acceptability of risk, societal costs and benefits, and cultural preferences. Given the uncertainties in the research on EMF and the qualitative and political nature of risk management, decision-makers can theoretically chose from a wide range of strategies. Hazard identification, however, is the most important input to the development of precautionary measures and should form the basis of any standards or guidelines on exposure limits. The public's perception of risk is not always the same as the risk defined in the hazard identification process; therefore, some policies and statements, usually from non-governmental or non-scientific organizations, may be over-precautionary if compared to recommendations based on scientific findings.

One approach to developing policies related to uncertain health risks is based on the precautionary principle. The precautionary principle refers to the idea that, when it is uncertain whether an exposure is a hazard but risk is perceived, precautionary measures should be taken that are proportional to the perceived level of risk, with science as the basis for defining that risk. A key element of precautionary approaches is the recognition that a real risk from the exposure may not exist and, as such, any actions taken to reduce exposures may be without benefit. The societal challenge in developing precautionary policies is to decide what is the appropriate trade-off between the costs and benefits of any actions.

The precautionary principle is embedded in both European and US regulatory actions and expressed in a variety of ways as a legal principle. The European Commission (EC) prepared a report to clarify what became known as "the precautionary principle" because it had been subject to controversy and variability in interpretation.[10] The EC report explained that the precautionary principle should be based on a complete scientific evaluation and the range of actions taken should depend on the extent of the risk and the degree of uncertainty surrounding

[10] Commission of the European Communities, Communication on the Precautionary Principle, Brussels 03 February 2000 [http://europa.eu.int/comm./off/com/health_consumer/precaution.htm]

the occurrence of adverse effects. The EC provided guidelines for the application of the precautionary principle as five general principles: proportionality, non-discrimination, consistency, examination of costs and benefits of actions, and examination of scientific developments.[11]

A variant of the precautionary principle called "prudent avoidance" was developed specifically as a policy option for EMF and has been applied by some national, state, and local governments. The WHO describes prudent avoidance as "using simple, easily achievable, low to modest (prudent) cost measures to reduce individual or public EMF exposure, even in the absence of certainty that the measure would reduce risk" (WHO, 2002). Other precautionary policies include:

- passive regulatory action which "advocates educating the public on ways to reduce personal exposure, rather than setting up actual measures to reduce exposure," (WHO, 2007)
- emission control from devices,
- and precautionary exposure limits.

Many different variants of these precautionary policies have been adopted worldwide, as described in Table 86 of the WHO 2007 report. The following sections describe the WHO's recommendations for precautionary measures related to EMF; existing standards and guidelines; and, finally, policies instituted by regulatory bodies in the US.

---

[11] Proportionality: "Measures...must not be disproportionate to the desired level of protection and must not aim at zero risk."

Nondiscrimination: "comparable situations should not be treated differently and... different situations should not be treated in the same way, unless there are objective grounds for doing so."

Consistency: "measures...should be comparable in nature and scope with measures already taken in equivalent areas in which all the scientific data are available."

Examination of the benefits and costs of action or lack of action: "This examination should include an economic cost/benefit analysis when this is appropriate and feasible. However, other analysis methods...may also be relevant."

Examination of scientific developments: "The measures must be of a provisional nature pending the availability of more reliable scientific data"... "Scientific research shall be continued with a view to obtaining more complete data."

3.1 WHO recommendations for precautionary measures

Using the conclusions of their risk assessment as the basis for defining the potential for risk, the WHO evaluated, in general, the uncertainty of the risks associated with EMF and any costs and benefits to precautionary advice. They offered the following evaluation,

> There is scientific uncertainty as to whether chronic exposure to ELF magnetic fields causes an increased risk of childhood leukemia. In addition, given the small estimated effect resulting from such a risk, the rarity of average exposures higher than 0.4 uT and the uncertainty in determining the relevant exposure metric ..., it is unlikely that the implementation of an exposure limit based on the childhood leukaemia data and aimed at reducing average exposure to ELF magnetic fields to below 0.4 uT, would be of overall benefit to society. (p. 362)

Basic conclusions regarding appropriate risk management strategies from other scientific organizations that conducted weight-of-evidence reviews are provided in Table 1 and are broadly consistent with the evaluation by the WHO.

Table 1. Recommendations for precautionary measures

Scientific organization	Recommendations for precautionary measures
Health Council of the Netherlands, 2000	"The Committee feels that on the basis of the present scientific views described in this advisory report there is no reason to recommend to take measures in order to limit residence near overhead power lines or working under circumstances involving increased ELF EMF field exposure. It does recommend, however, to continue following the scientific developments in this field." (p. 48)
National Radiological Protection Board, 2004	"In the context of possible adverse health effects from EMFs, the conclusions of published expert scientific reviews have identified only one reasonably consistent epidemiological finding of an adverse health outcome associated with exposure to EMFs at levels lower than exposure guidelines: that is an apparent increased risk of childhood leukaemia with time-weighted average exposure to power frequency magnetic fields above 0.4 μT. It is the view of NRPB that the epidemiological evidence that prolonged exposure to power frequency magnetic fields above 0.4 μT is associated with a small absolute raised risk of leukaemia in children... is, at present, an observation for which there is no sound scientific explanation... Thus, any judgments developed on the assumption that the association is causal would be subject to a very high level of uncertainty... Public concern about possible risks from exposure to power frequency magnetic fields is also important and must be addressed... Because of the uncertainty cited above, and in the absence of a 'dose response' relationship, NRPB has concluded that the data concerning childhood leukaemia cannot be used to derive quantitative guidance on restricting exposure. NRPB concludes that it is important to consider the possible need for precautionary measures with respect to exposure of children to power frequency magnetic fields." (p. 133)
National Institute of Environmental Health Sciences, 1999	"The NIEHS suggests that the level and strength of evidence supporting ELF-EMF exposure as a human health hazard are insufficient to warrant aggressive regulatory actions; thus, we do not recommend actions such as stringent standards on electric appliances and a national program to bury all transmission and distribution lines. Instead, the evidence suggests passive measures such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. NIEHS suggests that the power industry continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards. We also encourage technologies that lower exposures from neighborhood distribution lines provided that they do not increase other risks, such as those from accidental electrocution or fire." (NIEHS, 1999, pp. 37-38).

In light of their evaluation, the WHO recommended the following precautionary measures (the recommendations that are particularly relevant to local authorities are in bold):

- Countries are encouraged to adopt international science-based guidelines.

- Provided that the health, social, and economic benefits of electric power are not compromised, implementing very low-cost precautionary procedures to reduce exposures is reasonable and warranted.

- **Policy-makers and community planners should implement very low-cost measures when constructing new facilities and designing new equipment including appliances.**

- **Changes to engineering practice to reduce ELF exposure from equipment or devices should be considered, provided that they yield other additional benefits, such as greater safety or involve little or no cost**

- **When changes to existing ELF sources are contemplated, ELF field reduction should be considered alongside safety, reliability, and economic aspects**

- **Local authorities should enforce wiring regulations to reduce unintentional ground currents when building new or rewiring existing facilities, while maintaining safety. Proactive measures to identify violations or existing problems in wiring would be expensive and unlikely to be justified**

- National authorities should implement an effective and open communication strategy to enable informed decision-making by all

stakeholders; this should include information on how individuals can reduce their own exposure.

- **Local authorities should improve planning of ELF EMF-emitting facilities, including better consultation between industry, local government, and citizens when siting major ELF EMF-emitting sources.**

- Government and industry should promote research programmes to reduce the uncertainty of the scientific evidence on the health effects of ELF field exposure. (adapted from pp. 372-373, WHO 2007)

In summary, the WHO recommends "very low cost" measures to reduce exposures from facilities, such as the use of good engineering design practices. Other recommendations include the enforcement of wiring code regulations and improved planning of EMF-emitting facilities.

3.2 Standards and guidelines

Following a thorough review of the research, scientific agencies develop exposure standards and guidelines to protect against known health effects. The major purpose of the dose-response evaluation in a risk assessment is to identify the lowest exposure level below which no health hazards have been found (i.e., a threshold). Exposure limits are then set well below the threshold level to account for any individual variability or sensitivities that may exist.

Several scientific organizations have published guidelines for exposure to EMF based on acute health effects that can occur at very high field levels. Table 2 summarizes the most frequently cited limits for fields at 60 Hertz (Hz). The ICNIRP reviewed the epidemiologic and experimental evidence through 1997 and concluded that there was insufficient evidence to warrant the development of standards or guidelines on the basis of hypothesized long-term adverse health effects such as cancer; rather, the guidelines put forth in their 1998 document set limits to protect against acute health effects (i.e., the stimulation of nerves and muscles) that

occur at much higher field levels. The ICNIRP recommends a residential screening value of 833 mG and an occupational exposure screening value of 4,200 mG (ICNIRP, 1998). If exposures exceed these screening values, then additional dosimetry evaluations are needed to determine whether basic restrictions on induced current densities are exceeded.

The International Committee on Electromagnetic Safety (ICES) also recommends limiting magnetic field exposures at high levels because of the risk of acute effects, although their guidelines are higher than ICNIRP's guidelines; the ICES recommends a residential exposure limit of 9,040 mG and an occupational exposure limit of 27,100 mG (ICES, 2002).

The ICNIRP and ICES guidelines provide guidance to national agencies and only become legally binding if a country adopts them into legislation. Most countries in Europe have legally adopted the ICNIRP guidelines, and agencies and organizations in other countries (such as the US) use them, but they have not been adopted into these nations' legislation. The WHO strongly recommends that countries adopt the ICNIRP guidelines, or use a scientifically sound framework for formulating any new guidelines (WHO, 2006).

There are no national or state standards in the United States limiting exposures to ELF fields based on long-term adverse health effects, such as cancer. Some states have adopted standards and guidelines for EMF associated with transmission lines for other reasons (see Table 3). For electric fields, the goal of these standards and guidelines is to minimize field perception and prevent contact shocks, particularly from large ungrounded vehicles parked under the conductors. The two states (Florida and New York) that enacted standards for magnetic fields thoroughly examined health and safety issues regarding fields from transmission lines, but did not conclude that they pose a public health risk. Instead, the basis for limiting magnetic fields from transmission lines was to maintain the 'status quo,' so that fields from new transmission lines would be no higher those produced by existing transmission lines.

Table 2. 60 Hz EMF Exposure Guidelines and Recommendations of Selected Organizations

	ICNIRP[1] (1998)	EC[2] (1999)	SSI[3] (2001)	ICES[4] (2002)	ACGIH[5] (2003)	NRPB[6] (2004)
Controlled Environment						
Magnetic Field	0.42 mT (4,200 mG)	-	-	2.71 mT (27,100 mG)	1 mT (10,000 mG)	0.42 mT (4,200 mG)
Electric Field	8.3 kV/m	-	-	20 kV/m	25 kV/m	8.3 kV/m
Contact Current	1.0 mA	-	-	1.5 mA	1.0 mA	1.0 mA
General Public						
Magnetic Field	0.083 mT (830 mG)	83.3 µT (833 mG)	0.083 mT (830 mG)	0.904 mT (9,040 mG)	-	0.083 mT (830 mG)
Electric Field	4.2 kV/m	4.2 kV/m	4.2 kV/m	5 kV/m[4]	-	4.2 kV/m
Contact Current	0.5 mA	-	-	0.5 mA	0.5 mA	0.5 mA

0.1 mT = 1G or 1,000 mG

1 microTesla (µT) = 10 milliGauss (mG)

kV/m = kilovolt per meter. One kilovolt = 1,000 volts.

[1] Countries that have adopted the ICNIRP standards include Belgium, The Netherlands, Germany, Sweden, France, Spain, Switzerland, Czech Republic, South Africa, Japan, United Kingdom, Australia, and New Zealand.

[2] Adopted ICNIRP (1998) guidelines but applied subject to: "This recommendation has as its objective the protection of the health of the public and it therefore applies, in particular, to relevant areas where members of the public spend significant time in relation to the effects covered by this recommendation" (p. 60, EC, 1999).

[3] SSK= Swedish Commission on Radiological Protection. Adopted ICNIRP (1998) guidelines

[4] Within power line rights-of-way, the maximum permissible exposure (MPE) limit for the general public is 10 kV/m under normal load conditions.

[5] ACGIH = American Conference of Governmental Industrial Hygienists

[6] Adopted ICNIRP (1998) guidelines

Table 3. State Transmission Line Standards and Guidelines

State	Year Published	Electric Field		Magnetic Field	
		On R.O.W.*	Edge R.O.W.	On R.O.W.	Edge R.O.W.
California	1992	-	1.6 kV/m	-	-
Florida	1989; 1996	8 kV/m[a] 10 kV/m[b]	2 kV/m	-	150 mG[a] (max. load) 200 mG[b] (max. load) 250 mG[c] (max. load)
Minnesota	-**	8 kV/m	-	-	-
Montana	1996	7 kV/m	1 kV/m[e]	-	-
New York	1978; 1990	11.8 kV/m 11.0 kV/m[f] 7.0 kV/m[d]	1.6 kV/m	-	200 mG (max. load)
North Dakota	-**	9 kV/m	-	-	-
Oregon	1980	9 kV/m	-	-	-

*R.O.W. = right-of-way (or in the Florida standard, certain additional areas adjoining the right-of-way).
**Original citation not found
kV/m = kilovolt per meter. One kilovolt = 1,000 volts.
[a] For lines of 69-230-kV.
[b] For 500-kV lines.
[c] For 500-kV lines on certain existing R.O.W.
[d] Maximum for highway crossings.
[e] May be waived by the landowner.
[f] Maximum for private road crossings.

3.3 Risk management approaches in the United States

As described in Table 1, the general risk management approach for EMF recommended to the US Government by the Director of the NIEHS in 1999 is passive regulatory action. The Director indicated that there is only marginal scientific support that exposure to ELF EMF are a health hazard and, in this context, recommended voluntary activities to reduce exposures of the public to EMF, such as education of the public and the reduction of EMF exposures through the design and siting of transmission lines.

Two states formally require utility companies to take steps to reduce EMF exposures from their facilities. These policies are described below. Both of these policies encourage responses and expenditures that are proportionate to the degree of scientific evidence that there might be risk.

California

In California, the Public Utilities Commission (PUC) began an evaluation in 1991 to consider the PUC's potential role in mitigating health effects of EMFs created by electrical facilities. The evaluation found that there was a lack of scientific evidence with regard to potential health effects of EMF. The PUC adopted seven interim measures in 1993 and, in January 2006, these seven measures were re-affirmed. The measures include the following (as stated verbatim from the PUC's website[12]):

- **No-cost and low-cost steps to reduce EMF levels:** When regulated utilities design new projects or upgrade existing facilities, approximately 4% of the project's budget may be used for reducing EMFs. The PUC did not set specific reduction levels for EMFs. It was inappropriate to set a specific numerical standard until a scientific basis for doing so exists.
- **New designs to reduce EMF levels:** The PUC's Advisory and Compliance Division and Safety Division held workshops for utilities to develop EMF design guidelines for new and rebuilt facilities. The guidelines incorporate alternative sites, increase the size of rights-of-way, place facilities underground, and use other suggested methods for reducing EMF levels at transmission, distribution and substation facilities
- **Measurement of EMFs:** Uniform residential and workplace EMF measurement programs were also designed in the workshops; they are available to utilities and their customers. Other utilities are also encouraged to use them.
- **Education and Research:** The PUC wants the public and groups having a financial or basic interest in EMFs to become involved in developing education and research programs; these programs are established and managed by the DHS. PUC-regulated utilities and municipal utilities use

[12] http://www.cpuc.ca.gov/static/energy/environment/electromagnetic+fields/action.htm

ratepayer funds to pay for their share of development costs for the following programs:

- **EMF Education:** This $1.49 million program will provide credible, meaningful, consistent, and timely EMF information to electric utility customers, employees, and the public. DHS will coordinate a uniform EMF education program to supplement, but not duplicate, those that most electric utilities already have. Utilities without programs should implement one as soon as possible.
- **EMF Research:** A $5.6 million four-year non-experimental research program will be directed by DHS. This program will provide utility participation in state, national, and international research to be pursued to the extent that it benefits ratepayers.
- **Other Research:** Utilities are authorized to contribute to federal experimental research conducted under the National Energy Policy Act of 1992.

Connecticut

In Connecticut, the Siting Council published Best Management Practices (BMPs) for utilities to address EMF in 1993. The BMPs were designed to recognize the latest information concerning potential health effects of EMF and to prompt utilities to make assessments of EMF associated with proposed transmission projects, and incorporate technologies and management techniques on a project-specific basis to minimize EMF levels consistent with maximizing the efficiency of the electric generation, transformation, and transmission industry.

4 Conclusions Regarding the Adequacy of the Utilities Element

The Utilities Element provides policies for considering proposed utility facilities. These policies explicitly weigh costs against tangible and intangible benefits, including benefits to public health and safety (p. 96). The policies in the Utilities Element that most directly bear upon EMF are UT-69, UT-70, and UT-71.

Policy UT-69

This policy is appropriate and requires no discussion. To our knowledge, there are no pending statewide or regional initiatives in which the city and utilities need to participate. Proactive discussions and planning of the city, utility, and residents, however, regarding the need for local electrical facilities and the best and most cost-effective means of meeting that need should be encouraged as called for in Policy UT-33. The WHO recommends these proactive discussions (see p. 21 of this report).

Policy UT-70

The review of scientific research in this report is a response to Policy UT-70, which calls for periodic reviews of the state of scientific research on EMF. The frequency of such reviews need not be often as the field of research is now quite mature and, despite continued research, the assessments by national and international agencies have been quite consistent over the past decade. The WHO review concluded that the current body of research does not suggest that there are any long-term, adverse health effects associated with exposure to electric or magnetic fields at the levels the general public encounters on an everyday basis.

Policy UT-71

Policy UT-71 is consistent with the general goal of the Utilities Element and, as shown from the discussion of precautionary approaches to address EMF in this report, is also consistent with approaches recommended by the WHO, NIEHS, and other health agencies that have offered

science-based conclusions with regard to precautionary approaches for EMF (see Table 1). The state regulatory agencies in Connecticut and California have also applied precautionary approaches that appear consistent with these recommendations. Given the current state of the science, the appropriate planning response involves simultaneously balancing multiple and competing concerns about electrical safety, health, cost, environmental impacts, and reliability, which are also the subject of Utilities Element policies.

Policy UT-71 is consistent with the WHO's recommendations regarding precautionary measures such as the balancing of the factors described above, and would support no or low cost means of avoiding or minimizing EMF levels around new electrical facilities. It is also consistent with the NIEHS recommendation that the power industry continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce magnetic fields around transmission and distribution lines without creating new hazards. The Utilities Element also contains polices to underground distribution lines (UT-39) and conserve resources (UT-47) that serve to minimize EMF exposures and the need for additional facilities. Technical means of minimizing EMF exposure have been summarized in the 1993 EIS, including an excerpt of the report, *Electric and Magnetic Field Reduction: Research Needs.*[13] Those technical means have not changed over the years, but more recent comparisons of the costs to implement various line configurations at 115-kV have been summarized elsewhere.[14]

Another WHO recommendation for open communication programs is laudable, and could be implemented under the aegis of the existing Utilities Element policies.

The WHO also recommends that national agencies adopt limits on EMF to protect against acute effects of very high exposures. While this could possibly be discussed at the state level in Washington, such limits have little practical relevance for the City of Bellevue. According to the 1993 EIS for the Bellevue Comprehensive Plan and the latest planned system

[13] Electric Transmission Research Needs Task Force, Electric and Magnetic Field Reduction: Research Needs, Washington State Health Department, submitted to Washington State Legislature January 15, 1992.

[14] Connecticut Siting Council. Life Cycle 2007: Connecticut Siting Council Investigation into the Life Cycle Costs of Electric Transmission Lines, February 2007.

improvements,[15] the existing transmission lines or even those proposed as far out into the future as 2030 would not be expected to produce field levels approaching the ICNIRP or ICES guidelines for public exposure.

In summary, the policies contained in the Utilities Element, including UT-69, UT-70, and UT-71, are still consistent with both the status of scientific research regarding EMF and precautionary approaches recommended by the WHO.

[15] Puget Sound Energy (PSE). City of Bellevue Comprehensive Plan Utilities Element Update. Puget Sound Energy Electrical Utility System, November 2006.

Puget Sound Energy (PSE). Bellevue Comprehensive Plan Update: Electrical System Basics and Planning Considerations White Paper, January 2007.

References

Ahlbom A, Day N, Feychting M, Roman E, Skinner J, Dockerty J, Linet M, Michealis J, Olsen JH, Tynes T, Verkasalo PK. A pooled analysis of magnetic fields and childhood leukemia. Br J Cancer. 83:692-698, 2000.

American Conference of Government Industrial Hygienists (ACGIH). Documentation of the threshold limit values and biological exposure indices, 7th edition. Publication No. 0100. Cincinnati, OH: American Conference of Government Industrial Hygienists. 2001.

Boorman GA, Anderson LE, Morris JE, Sasser LB, Mann PC, Grumbein SL, Hailey JR, McNally A, Sills RC, Haseman JK. Effect of 26 week magnetic field exposures in a DMBA initiation-promotion mammary gland model in Sprague-Dawley rats. Carcinogenesis. 20:899-904, 1999.

European Commission (EC). 1999. Council Recommendation on 12 July 1999 on the Limitation of Exposure of the General Public to Electromagnetic Fields (0 Hz to 300 GHz). Official Journal of the European Communities, 199: pp 59-70.

Greenland S, Sheppard AR, Kelsh MA, Kaune WT. A pooled analysis of magnetic fields, wire codes, and childhood leukemia. Epidemiology. 11:624-634, 2000.

Health Protection Agency (HPA). Power Frequency Electromagnetic fields, Melatonin and the Risk of Breast Cancer: Report of an Independent Advisory Group on Non-ionising Radiation. Doc HPA. Serious B: Radiation, Chemical and Environmental Hazards. RCE-1, 2006.

International Agency for Research on Cancer (IARC). IARC monographs on the evaluation of carcinogenic risks to humans. Volume 80: Static and extremely low-frequency (ELF) electric and magnetic fields. IARC Press, Lyon, France, 2002.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). Health Phys. 74:494-522, 1998.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Exposure to static and low frequency electromagnetic fields, biological effects and health consequences (0-100 kHz) – review of the scientific evidence on dosimetry, biological effects, epidemiological observations, and health consequences concerning exposure to static and low frequency electromagnetic fields (0-100 kHz). Matthes R, McKinlay AF, Bernhardt JH, Vecchia P, Beyret B (eds.). International Commission on Non-Ionizing Radiation Protection, 2003.

International Committee on Electromagnetic Safety (ICES). IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields 0 to 3 kHz C95. 6-2002. Piscataway, NJ: IEEE, 2002.

Linet MS, Hatch EH, Kleinerman A, Robinson LL, Kaune WT, Friedman DR, Severson RK, Haines CM, Hartsock CT, Niwa S, Wachholder S, and Tarone RE. Residential exposure to magnetic fields and acute lymphoblastic leukemia in children. N Engl J Med. 337:1-7, 1997.

McBride ML, Gallagher RP, Thériault G, Armstrong BG, Tamaro S, Spinelli JJ, Deadman JE, Fincham S, Robson D, Choi W. Power-frequency electric and magnetic fields and risk of childhood leukemia in Canada. Am J Epidemiol. 149:831-842, 1999.

McCormick DL, Boorman GA, Findlay JC, Hailey JR, Johnson TR, Gauger JR, Pletcher JM, Sills RC, and Haseman JK. Chronic toxicity/oncogenicity evaluation of 60 Hz (power frequency) magnetic fields in B6C3F1 mice. Toxicol Pathol 27 (3):279-85, 1999.

Mandeville R et al. Evaluation of the potential carcinogenicity of 60 Hz linear sinusoidal continuous-wave magnetic fields in Fisher F344 rats. FASEB-J, 11:1127-1136, 1997.

National Institute of Environmental Health Sciences (NIEHS). Assessment of health Effects from exposure to power-line frequency electric and magnetic fields: working group report. NIH Publication No. 98-3981. Research Triangle Park, NC: National Institute of Environmental Health Sciences of the US National Institutes of Health, 1998.

National Institute of Environmental Health Sciences (NIEHS). Health effects from exposure to power line frequency electric and magnetic fields. NIH; National Institute of Health; NIH No. 99-4493; Research Triangle Park, NC, 1999.

National Radiological Protection Board (NRPB). Electromagnetic fields and the risk of cancer. Report of an advisory group on non-ionising radiation. National Radiological Protection Board. 3:1-138, 1992.

National Radiological Protection Board (NRPB). Electromagnetic fields and the risk of cancer. Supplementary report by the advisory group on non-ionising radiation. National Radiological Protection Board. 4:65-69, 1993.

National Radiological Protection Board (NRPB). Electromagnetic fields and the risk of cancer. Supplementary report by the advisory group on non-ionising radiation. National Radiological Protection Board. 5:77-81, 1994a.

National Radiological Protection Board (NRPB). Health effects related to the use of visual display units. Report of an advisory group on non-ionising radiation. National Radiological Protection Board. 5:1-75, 1994b.

National Radiological Protection Board (NRPB). ELF electromagnetic fields and the risk of cancer: Report of an advisory group on non-ionising radiation. National Radiological Protection Board. Volume 12, No 1, 2001a.

National Radiological Protection Board (NRPB). ELF electromagnetic fields and neurodegenerative disease. National Radiological Protection Board. Volume 12, No 4, 2001b.

National Radiological Protection Board (NRPB). Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300 GHz) National Radiological Protection Board, Volume 15, No 3, 2004.

United Kingdom Childhood Cancer Study Investigators (UKCCS). Exposure to power frequency magnetic fields and the risk of childhood cancer. The Lancet. 353:1925-1931, 1999.

World Health Organization (WHO). WHO Handbook on: Establishing a dialogue on risks from electromagnetic fields. World Health Organization, 2002.

World Health Organization (WHO). Framework for Developing Health-Based Standards. Geneva, Switzerland: World Health Organization, 2006.

World Health Organization (WHO). Environmental Health Criteria 238: Extremely Low Frequency (ELF) Fields. WHO, Geneva, Switzerland, ISBN 978-92-4-157238-5, 2007.

Yasui M et al. Carcinogenicity test of 50 Hz sinusoidal magnetic fields in rats. Bioelectromagnetics, 18:531-540, 1997.