

# PSE on bainbridge island

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*Transmission Line Routing Community Sounding Board*

Information Meeting #2  
Electromagnetic Fields &  
Undergrounding Transmission lines

September 17, 2020

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We'll begin at 5:00pm—all participants will be muted.  
Technical difficulties? Please call or text Darcy Edmunds, [REDACTED]

An aerial photograph of a coastal town, likely Bainbridge Island, Washington. The town is nestled at the base of green, forested hills. In the foreground, there's a mix of residential houses and larger industrial or commercial buildings, including what appears to be a shipyard or industrial facility. A large marina filled with many sailboats and small boats is visible in the middle ground, extending towards the water. The water is a deep blue, and in the far distance, more land and mountains are visible under a clear sky.

# Welcome Community Sounding Board Members





PUGET  
SOUND  
ENERGY

# Safety Moment

# Safety Moment: Air Quality

Air Quality Index

Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	100 to 151	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.

# Panelist Screen Controls



- *Use the microphone icon to unmute*
- *Use the camera icon to manage your video*
- *Use the person icon to manage other settings.*
- *Slides appear in the main window.*

A screenshot of the Cisco Webex Events interface. The main window displays four large circular icons with letters: "DE" (top left), "FH" (top right), "NG" (bottom center), and "Nyles Green" (bottom left). Below the main window is a toolbar with icons for microphone, camera, person, and other controls. In the top right corner, there's a participant list titled "Participants (5)" showing "Panelist: 4". The participants listed are SH (Susan Hayman, me), DE (Darcy Edmunds, Host), FH (Faiza Hassan), and NG (Nyles Green). A message indicates "Attendee: 1 (0 displayed)" and a link to "View all attendees...". The top bar includes standard menu options: File, Edit, Share, View, Communicate, Participant, Event, Help, along with connection status indicators.

# For today

Darcy Edmunds  
is our meeting host.

Please text/call  
Darcy if you have  
technical difficulties:

- Attendees are in listen-only mode.
- A brief public comment opportunity will be available at the end of the meeting.
- CSB members:
  - Listen to and appreciate the diversity of views and opinions.
  - Actively participate in the group.
  - Behave constructively and courteously towards all participants.
  - Respect the role of the facilitator to guide the group process.

# Meeting Agenda

Time	Item	Presenter(s)
5:00 p.m.	<b>Opening</b> <ul style="list-style-type: none"> <li>• Welcome and safety moment</li> <li>• Agenda overview</li> <li>• Meeting conduct</li> <li>• Introduction of presenters</li> </ul>	<b>Kierra Phifer, PSE</b> <b>Susan Hayman, Facilitator</b>
5:10 p.m.	<b>Presentation: Electromagnetic fields</b> <b>Q&amp;A, discussion</b>	<b>Drew Thatcher, Consulting Health Physicist</b>
5:50 p.m.	<b>Break</b>	
6:00 p.m.	<b>Presentation: Undergrounding transmission lines</b> <b>Q&amp;A, discussion</b>	<b>Lowell Rogers, P.E., Infrastructure Development Advisor</b> <b>Andy Swayne, PSE</b>
6:50 p.m.	<b>Observer comment</b>	<b>Susan Hayman, Facilitator</b>
6:55 p.m.	<b>Wrap up, next steps</b>	<b>Susan Hayman, Facilitator</b>
7:00 p.m.	<b>Adjourn</b>	

# Electromagnetic frequencies

Andrew H. Thatcher  
Certified Health Physicist

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COMMUNITY SOUNDING BOARD, INFO SESSION #2  
MURDEN COVE – WINSLOW “MISSING LINK” TRANSMISSION LINE  
SEPTEMBER 2020

# Overview

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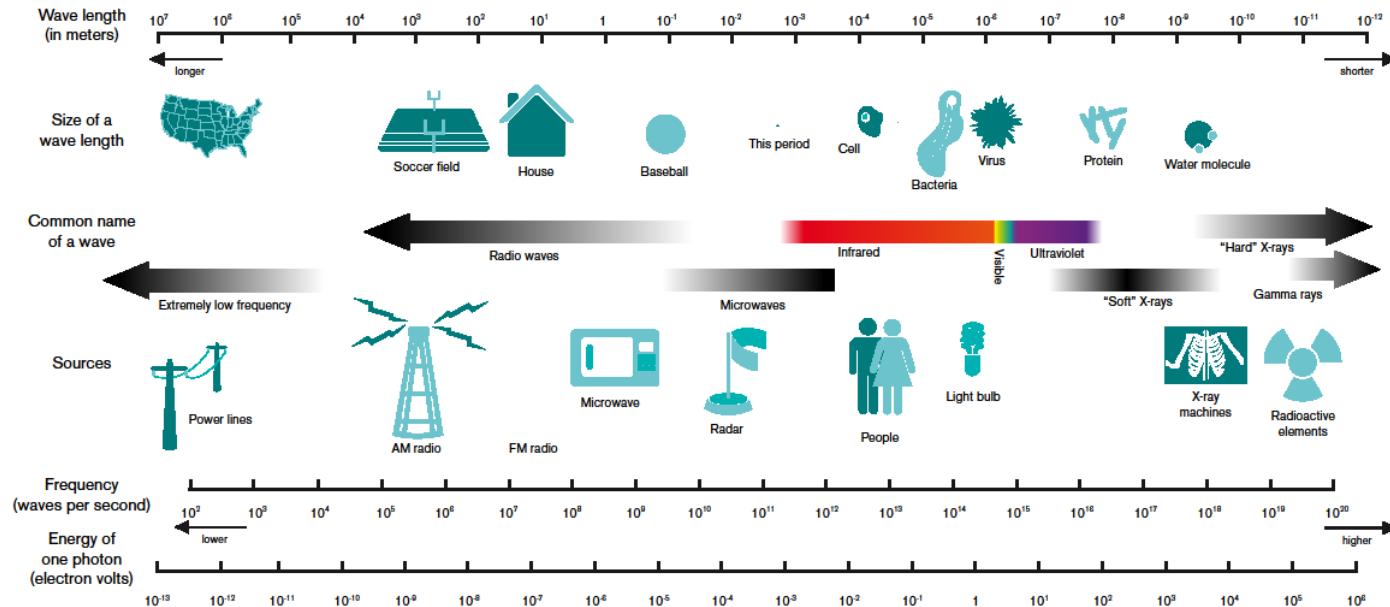
Establish a basis for understanding of the frequency and the fields

Review the science and studies related to ELF 60 Hz magnetic field exposures and health

Conclusions

# What is EMF?

## The Electromagnetic Spectrum



# What is EMF?

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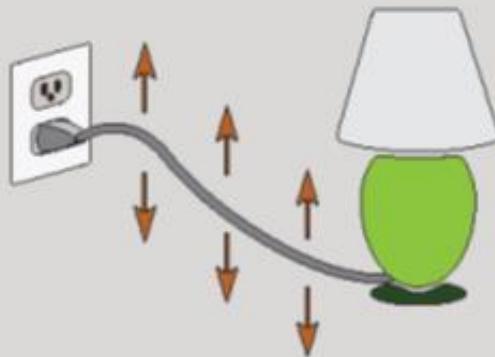
- EMF refers to two types of fields:
  - Electric fields
  - Magnetic fields



# A Comparison of Electric and Magnetic Fields

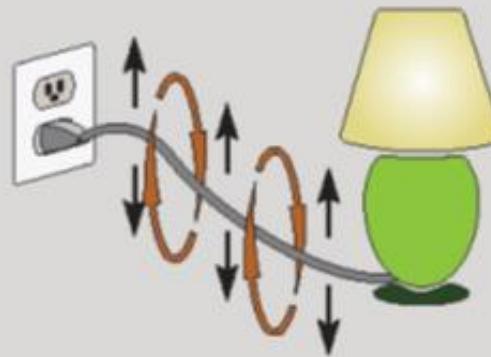
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**Electric Fields**



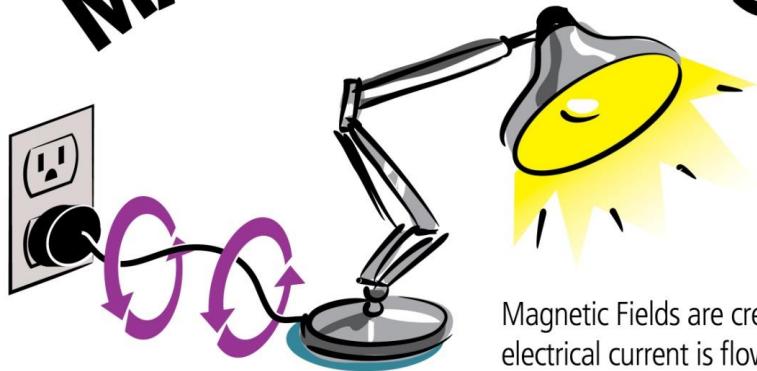
*Lamp plugged in but turned off.  
Voltage produces an electric field.*

**Magnetic Fields**



*Lamp plugged in and turned on.  
Current now produces a magnetic  
field also.*

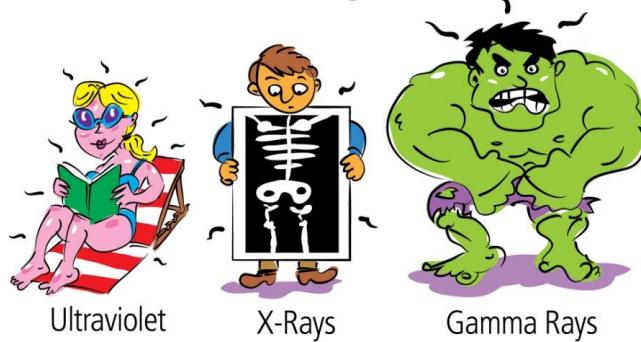
# What Are **MAGNETIC FIELDS?**



Magnetic Fields are created when electrical current is flowing.

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## What are they NOT?



Ultraviolet

X-Rays

Gamma Rays

## WHERE are they?



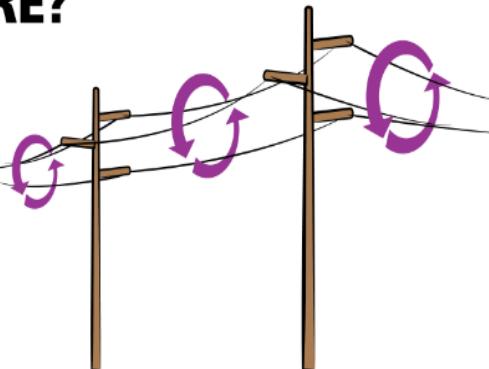
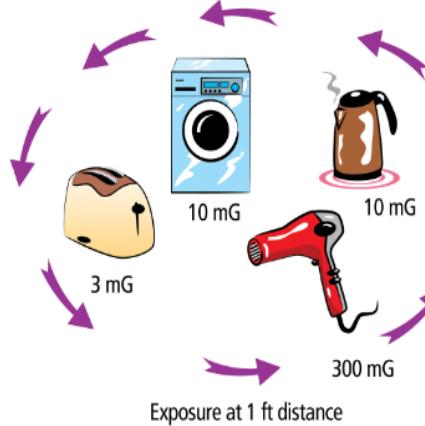
Anywhere electricity is used.

# How do they COMPARE?



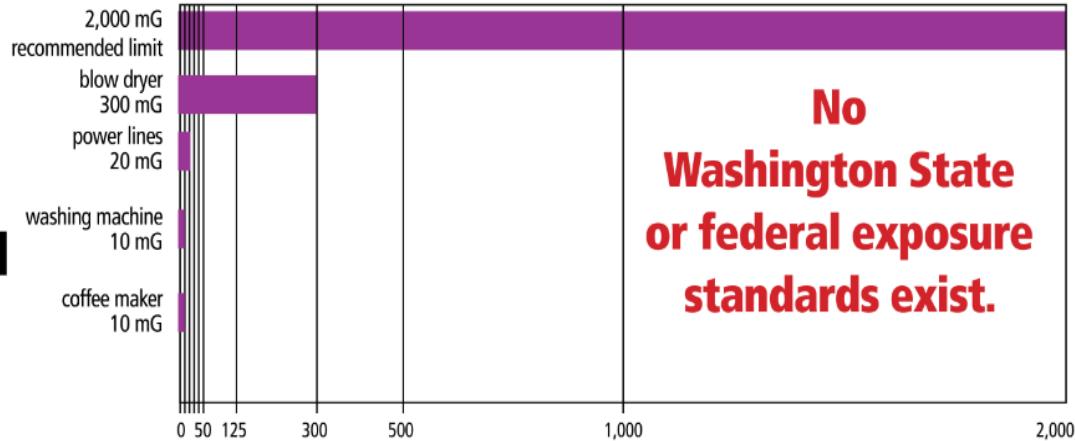
550 mG, static field

mG = milliGauss



115 kV Power Line:  
at 50 feet the magnetic field is ~6 mG  
at 100 feet the magnetic field is ~2.5 mG

## How do exposures compare to international guidelines?



# Background on EMF Studies

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Epidemiology – the study of exposures to humans

Animal and laboratory studies

Is there a plausible biological explanation

# Background on EMF Studies

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## How it all started....

- A study in 1979 that identified a slight excess risk based on wire code classification.
- Subsequent detailed analysis in the 1990s (Linet 1997), (McBride 1999) provided little support for the association of childhood leukemia and power frequency EMF
- Greenland (2000) pooled analysis from 15 studies identifies an OR of 1.7 for results greater than 3 mG
- In total, over 35 epidemiological studies have been performed over the years.

# Some Recent Studies

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Pedersen et al (2014): Relatively large Danish epidemiology study

- No evidence of higher risk of leukemia in children

Elliott et al (2013): UK study on adult cancers near high voltage power lines

- Study does not show any association between adult cancers and residential magnetic fields close to power lines

Feychtung (2013): Commentary following a study by Li et al (2013) on breast cancer and ELF magnetic fields

- A consistently negative association and greater confidence that ELF magnetic fields do not cause breast cancer

# Some Recent Studies

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Bunch et al (2016): Follow up to Draper UK (2005) study.

- Study found a declining risk over time (higher leukemia risk in the 1960s (4.5 RR) with a lower risk in the 2000s (0.7 RR). 1.12 RR overall.

Amoon et al (2018): Proximity to overhead power lines and childhood leukemia: an international pooled analysis.

- Among children living within ~150' of HV powerlines, the OR was 1.33, so no material association.

Kheifets et al (2017): CA case control study. Found a “risk deficit” in two intermediate exposure groups and a small (OR=1.5) excess risk in the highest exposure group.

However, pooled analysis by Ahlboom, Greenland and Kheifets all show a weak but consistent association between magnetic fields and childhood leukemia

# Results of Interest

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No association for ELF exposures and:

- Breast Cancer
- Amyotrophic Lateral Sclerosis (ALS)
- Parkinson's disease

# Results of Interest

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However:

- ELF magnetic fields given before damaging chemical or physical treatment is able to reduce the induced damage.
- Behavioral and cognitive disturbances in animal studies were observed in the 1 mT (10 Gauss) range
- preventative effect of 0.5 mT (5G) exposure to ELF magnetic fields was observed in an Alzheimer disease (AD) mouse model.

# WHO Summary Statement

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“Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields.”

# Epidemiological Studies: A Summary

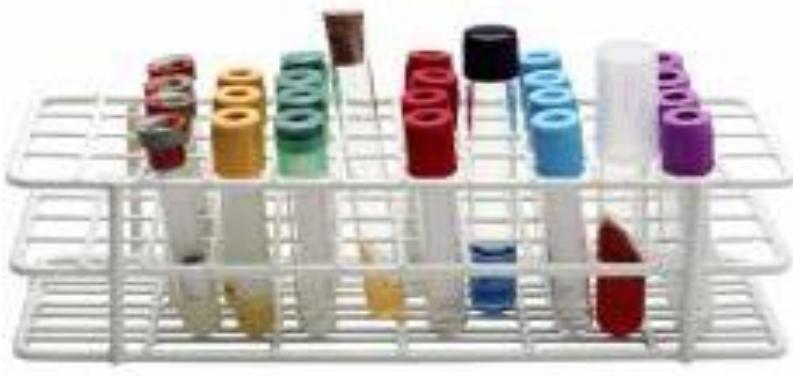
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Takeaways from epidemiological studies:

- 60 Hz power frequency magnetic fields have shown a weak but relatively consistent pattern an increase in childhood leukemia for exposures greater than 3 to 4 mG.
- However, the epi studies are weakened by methodological problems associated with selection and reporting biases. This highlights the need to use laboratory studies to support such claims.
- Epidemiology is like a weathervane that points us in the direction to devote further laboratory research to determine whether the epi finding is supported.

# Laboratory Test

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# Animal Studies

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## Why conduct animal studies?

The reason why all almost major scientific review organizations have failed to conclude that the possible risk from exposures and childhood leukemia is real is because animal and cellular studies have consistently failed to demonstrate any reproducible effects that show that magnetic field exposures cause or promote cancer.

Animal and cellular studies had consistently been negative in regard to magnetic field exposures and possible genetic effects with a small caveat.

- We now have rat strains that mimic the leukemia found in humans. The initial study results using these strains have also failed to find an association.

# Lab Data and Biological Basis for Effects

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More than 1,000 lab studies have been conducted on EMF exposure.

Most studies have used exposures greater than 1,000 mG.

Both cellular and animals have consistently shown a lack of replicated health effects.

Magnetic fields can affect the body through interactions at the cellular level

Minimum magnetic field densities for effects are on the order of the earth's background magnetic field.

# How the Evidence Stacks Up for Adverse Health Effects

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Weak but somewhat consistent epidemiological data regarding childhood leukemia and magnetic field exposures.

No supporting evidence from animal or cellular studies.

No dose response relationship

No plausible biological mechanism

# Arguments Against Carcinogenicity

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There has never been a carcinogen known to humans that does not also leave other tell tales signs of an impact.

For example: causes skin cancers but also causes sunburn in short term acute exposures, loss of elasticity, freckles, nevi, fibrous tissue, etc

# Electromagnetic Hypersensitivity

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What is it, what are the symptoms?

Does exposure to magnetic or electric fields cause this?

- Not according to the WHO – double blind studies showed that symptoms were not correlated with EMF exposures

This does not mean that EHS is not real, it is, but electric or magnetic field exposures are not the cause

# What is considered a safe exposure level?

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From ICNIRP for the general public, a whole body magnetic field of 2,000 mG to limit an induced current in the body of  $\sim 2 \text{ mA/m}^2$

Since magnetic fields penetrate the body without attenuation we would expect similar findings of effects throughout the body and in different species, which we are not.

# Conclusions

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Over 40 years of research on EMF

\$500 million spent on research in the United States alone

About 2,900 studies conducted to date related to cancer

- Very large amount of scientific knowledge

World Health Organization concluded that:

- “The current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields”

The international public exposure limits:

- 2,000 mG - International Commission on Non-Ionizing Radiation Protection
- 9,040 mG - Institute of Electrical and Electronic Engineers

# Public Health Summary

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EMF is a consequence of using power in our lives

WHO concludes that magnetic fields and health risks are not established nor are they supported by laboratory studies

The public exposure limit is 2,000 mG and exposures are more than 100 times less than the recommended exposure limits

# Questions?

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# Overview of Underground Transmission Line Construction

Presented to PSE Community Sounding  
Board Information Session #2

Lowell Rogers, P.E.

September 17, 2020



# Transmission

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Transmission lines form the backbone of the electrical system. The vast majority of this transmission system is made up of lines that are overhead. With proper vegetation clearances and maintenance, these lines are very reliable.

In some areas where overhead lines are not feasible due to insufficient right of way space, height limitations, or visual concerns, it may be preferred to construct the transmission lines underground rather than routing the line around the area of concern.



# Differences Between Transmission and Distribution

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In PSE's service area, distribution circuits are 34.5kV and lower whereas transmission circuits are 115kV and above.



12kV Distribution Line



115kV Transmission Line



# Materials

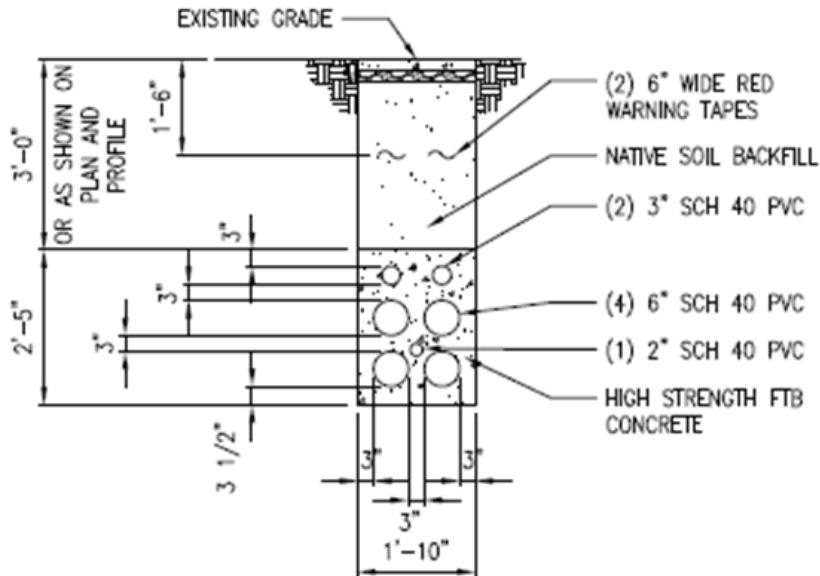
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Overhead conductor relies on the surrounding air to provide electrical insulation and cooling.

Underground cable is insulated internally and the heat that is generated is dissipated by the surrounding earth.



# Duct Bank Configuration



Typical 115kV duct bank cross section.

# Underground Transmission Construction Techniques

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Cable Duct Bank Excavation



Cable Duct Bank

# Underground Transmission Construction Techniques

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Cable splice vault

About 8 ft wide  
by 20 ft long by 9  
ft tall

Spaced every  
1,500-2,000 ft  
along the route.



# Underground Transmission Construction Techniques

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Cable Installation  
Approximately 2,000 ft  
cable lengths)



Cable Splicing within vault



# Underground Transmission Construction Techniques

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Underground to overhead transition structures.



# Technical Feasibility

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There are situations where an underground transmission line isn't feasible.

- The required capacity of the line cannot be provided by underground cables.
- The length of the line is too great for conventional underground equipment.



# Project Specific Feasibility

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Where the length and capacity requirements are feasible using underground configurations, there are additional factors to consider:

- Do construction impacts cause unmitigable impacts?
- Are there local regulations that prevent overhead construction?
- Is the cost of underground prohibitive?
- Does the location of the line allow access for repair when damaged?
- Can the service area tolerate a lengthy outage if the line is damaged?



# Routing

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The route of an underground transmission line can be limited by the following:

- Steep slopes
- Ravines
- Geology (e.g. rock)
- Wetlands, bodies of water
- Environmentally sensitive or protected habitat
- Available space for the duct bank and splice vaults, particularly in areas with other underground utilities.

These factors will significantly increase the cost of underground transmission lines if they cannot be avoided.



# Environmental Impacts

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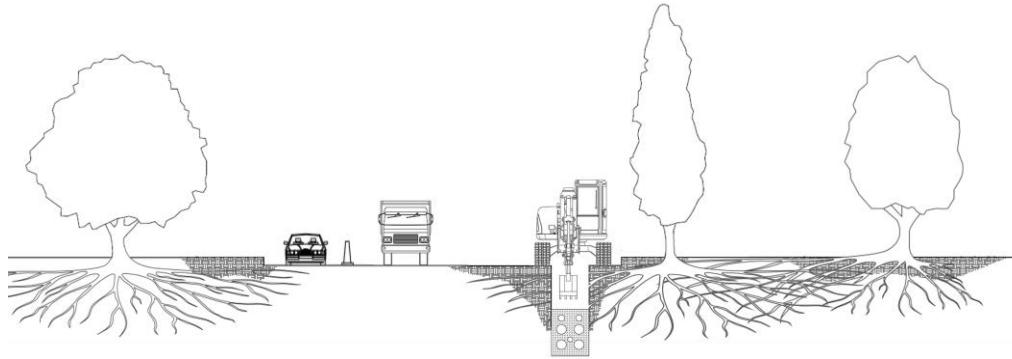
Underground lines require a cleared right-of-way for the entire length in order to trench excavation and line installation.

As compared to overhead lines, which have the ability to span areas of concern, underground transmission line construction has more direct impact to the environment.



# Environmental Impacts

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Underground lines require a cleared right-of-way for the entire length in order to trench excavation and line installation. This can significantly impact environmentally sensitive areas such as wetlands and sensitive habitats.

This clearing will require vegetation removal, grading, and contouring of the ground.



# Ongoing Right-of-Way Maintenance

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Once constructed, the right of way will need to remain clear of vegetation (e.g., trees and shrubs) that have root systems that could damage the duct bank.



# Cost Range of Underground Transmission

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Underground construction is much more expensive than overhead construction; generally 2.5-7 times for a 115kV single circuit transmission line.

- Example: For a similar overhead line that is estimated to be \$2.5million per mile for construction, that line may cost \$5-\$17million per mile in an underground configuration.



# Cost Range of Underground Transmission (continued)

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The range reflects the large number of variables that an underground project faces; such as:

- Type of soils to be excavated
- Number of existing underground facilities that need to be protected/avoided.
- Access constraints
- Road closure requirements
- Stream, freeway, or other crossings
- Permitting cost
- Right of way costs

Together these variable can significantly influence costs. In order to determine specific costs for an underground project; the route needs to be identified and a preliminary design completed.



# Questions

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Any questions?

Thank you for your  
interest.



# Observer Comment

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# Next steps

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- CSB Meeting #4: Route Segments, October 12, 5-7:30 p.m.

*Remember:* Resource materials for the CSB and overall project are available on PSE's website

# Adjourn

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# Thank you!

