Exhibit DTW 14

WASATCH COUNTY

APPLICATION FOR CONDITIONAL USE PERMIT

SUPPLEMENTARY INFORMATION

Double Circuit 138 KV Transmission Line
West Side of Browns Canyon / South of Wasatch/Summit County Line
Section 36 Township 2 South Range 4 East

Submitted by:

ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP

September 9, 2015

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I. Project Summary

Overview

Rocky Mountain Power (the "*Company*") is a public utility regulated by the Public Service Commission of the state of Utah. Under state regulation, the Company has an affirmative legal duty to design, construct, and maintain facilities sufficient to provide safe, reliable, adequate, and efficient electric service to its customers. In furtherance of its legal duty, the Company is constructing a new 138 kV transmission line (the "*Project*") to accommodate the significant increased demand for electricity in Wasatch and Summit Counties due to commercial and residential growth and development. The Project consists of 74 miles of transmission line between Railroad Substation near Evanston, Wyoming and the Silvercreek substation near Park City, Utah. As proposed, the a small portion of the Project will have four (4) power poles located within Wasatch County near Browns Canyon Road and Highway 248. The Project is needed to be constructed and placed in service in Fall 2016 in order to accommodate customer demand. This Conditional Use Permit application (the "*CUP Application*") seeks approval only of a small segment of the Project that is located within Wasatch County.

Background

In 2007, the Company performed studies to determine the electrical needs in Utah's Wasatch and Summit Counties; both Wasatch and Summit Counties are popular winter tourism destinations which include several world class ski resorts and host large winter events. In 2007, the Company had approximately 25,000 customers in the combined Wasatch and Summit County area, including the rapidly growing Heber Valley. Heber Light and Power, which serves many additional customers in the area, receives its power directly from the Company.

Wasatch County experiences its peak electrical load during both summer and winter months, with the winter months being the higher of the two peak periods. Peak load was identified as load that exceeds 160 megavolts-amps. The studies also identified that, when the power supply to the Wasatch County experiences an N-1 occurrence (meaning that the system is not functioning optimally, due to any number of causes), Wasatch County has no reliable power transformer backup. Due to these factors and in order to protect the area's electrical system from experiencing a cascading event across the power grid, these areas are operated "radially," with each area being fed from a single source, which can cause what is referred to as "rolling brown outs." To clarify, Wasatch County is currently served by two transmission lines, one through Parleys Canyon and one from Provo Canyon. In the event one of those transmission lines was unavailable for service during peak load, the Company would be required to implement rolling brown outs in order to maintain service. Recent studies show peak load in the winter of 2013-2014 was 183 megavolts-amps, which is 114 percent of the winter limit of both major transmission feeds to the area. Following these studies, it was determined that the Company must take action to correct these issues and build a more reliable power supply for both Wasatch and Summit Counties. To be clear, the Company's actions are based on its obligations as a publicly regulated utility to provide safe, reliable, adequate, and efficient electric transmission service to its customers, and in response to increasing demand for electricity.

How to Correct the Problem

To correct these area-wide electrical issues and provide much needed reliability, the Company developed a systematic improvement plan. The first phase of this plan includes upgrading 74 miles of 46kV transmission line to 138kV line. This transmission line runs from the existing Railroad Substation (Evanston, Wyoming) to the Silvercreek Substation (Park City, Utah). The upgrade includes building a new transmission substation in Croydon, Utah, and expanding the Coalville Substation (Coalville, Utah), Silvercreek Substation (Park City, Utah) and Railroad Substation (Evanston, Wyoming). Work will also include the removal of three small substations located across the total transmission line project.

The second phase of the plan will consist of an 8 mile 138kV transmission line from the Midway Substation (Midway, Utah) to the Jordanelle Substation (North of Heber, Utah). Of these eight miles, approximately 3.5 miles are located within Wasatch County. When completed, these upgrades will eliminate the current reliability issues impacting customers (including Heber Light & Power as a wholesale customer) in Wasatch County, as well as Summit County and surrounding communities. The upgrade will also provide residents in Wasatch County with additional capacity for the future growth and development that has been documented and planned by Wasatch County in its general plan. Reliable electricity cannot be afforded to the future growth and development identified by Wasatch County without these transmission line improvements.

Benefits

Construction of the Project is necessary for the following reasons:

- Increased the safety, reliability, adequacy and efficiency of electric service to customers within Wasatch County , as well as service to the Company's customers in Summit County and surrounding counties.
- Elimination of cascading power outages in Wasatch County as well as Summit County and surrounding areas, and
- Allows for Wasatch County area load be returned to a reliable looped configuration during peak periods, rather than a radial feed.

Additional benefits include:

- Correct low voltage issues currently being experienced by both Wasatch and Summit County large industrial customers including Mountain Regional Water, Utlite, Weber Basin Water, and others.
- Upgrades will also benefit neighboring Morgan County and its customers.
- The upgrades align with the area master plan to provide a 138kV loop between the Ogden, Morgan County, Summit and Wasatch County areas which provides future increased reliability and load serving capabilities within Utah.
- The Project also allows an additional path for moving resources from electric-generation rich areas such as Wyoming to service areas within Utah, including Wasatch County as well as Summit County and surrounding areas.

Schedule and Timeline

Completed

- Railroad Substation (Evanston, Wyoming) – 2012
- Railroad to Devils Slide (Morgan, Utah) – 2013
- Devils Slide to Croydon (Morgan, Utah) – 2014

In Progress

- Croydon Substation – Scheduled in-service September 2015
- Coalville Substation (Coalville, Utah) to Croydon – Schedule In-service December 2015

In Permitting

- Coalville to Oakley Tap (Peoa, Utah) – Permitting underway, desired in-service Summer 2016
- Oakley Tap to Silvercreek (Park City, Utah) - Permitting underway, desired in-service Fall 2016

Conditional Use Application Background and Transmission Line Alignment Alternatives

On January 23, 2015, the Company submitted an application for a Conditional Use Permit (the "***Initial CUP Application***") to allow for the construction of a double circuit 138kV transmission line as depicted on a proposed Option 1 Plan (the "***Option 1 Plan***") (See Appendix 1). The Wasatch County Planning Staff (the "***Staff***") issued a Planning Commission Staff Report (the "***Staff Report***") (See Appendix 2) providing its recommendations and findings on the proposal, which was discussed at a hearing before the Planning Commission on March 12, 2015 (See Appendix 3). The proposal was continued to allow for further discussions among interested parties. Thereafter, the Company participated in several meetings with the County and interested stakeholders to present and discuss the need for the transmission line, alternative transmission line routes and concerns expressed by the County and interested parties. Through the course of these meetings, the Company thoroughly substantiated the need for the new transmission line to provide safe, reliable, adequate, and efficient delivery of electricity to the Company's customers, Wasatch County as well as Summit County and surrounding areas.

On August 13, 2015, the Company appeared before the Planning Commission and requested the hearing be continued to allow for further discussions with the County, to address what the Company believed were inaccuracies in the Staff Report, and to requested consideration and input from the County regarding alternative route alignments. Despite the Company's request, the Planning Commission moved for a vote on the Initial CUP Application without further discussion, at which point the Company elected to withdraw the application. The application was withdrawn with the express purpose of seeking additional opportunity find a mutually agreeable resolution.

As of the date hereof, the Company now files the CUP Application seeking the approval to construct a double circuit 138kV transmission line as depicted on the Option 1 Plan (See Appendix 1). Under the Option 1 Plan, four (4) power poles would be located within Wasatch County. The proposed route for the Option 1 Plan was selected by the Company through its normal and customary transmission line siting practices and procedures, after evaluating several alternative alignments, and represents the alignment and design the Company would construct in compliance with local regulations as imposed on similar land uses and which do not impair the ability of the Company to provide service to its customers in a safe, reliable, adequate and efficient manner. Utah Code Ann. § 54-14-103(9)(b). Therefore, the Option 1 Plan constitutes the measure for "standard cost" of the required facility. Utah Code Ann. § 54-14-103(9)(a). The estimated cost of the Option 1 Plan for the segment within Wasatch County is Five Hundred Thousand Dollars ($500,000.00).

In response to concerns expressed previously by the County regarding the Option 1 Plan, the Company has evaluated several alternative alignments for the proposed transmission line, and outlines three of those alignments in this application for the County's consideration.

The Option 2 Plan, as depicted in Appendix 4, follows the Option 1 alignment. Option 2 Plan takes into consideration comments provided by Staff during the Initial CUP Application process and complies with the Ridgeline Regulations, as interpreted by Staff, by not breaching the ridgeline. Option 2 preserves the initial proposed centerline, but adjusts the heights and configurations of the proposed pole schematics in order to remain below the ridgeline. While this option remains below the ridgeline it nevertheless imposes a greater base impact on the ground and increases the visual impact against elevation of the adjacent ridge. Furthermore, the Company notes that it will be required to work with the underlying property owner to seek a modification to the existing easement of record in order to accommodate the wider base of the proposed pole schematics.

The Option 3 Plan, as depicted on Appendix 5, provides for the underground of the 138 kV facilities through the area of Browns Canyon within Wasatch County. The underground facilities would replace the overhead facilities located within Wasatch County only. The adjoining overhead facilities located within Summit County will remain above ground. The estimated cost of the Option 3 Plan is Six Million Eight Hundred Thousand Dollars ($6,800,000.00). It is important to note that such estimate is based on preliminary data only and may increase depending geotechnical evaluation or other unknown conditions.

The Browns Canyon Road Option, as depicted in Appendix 6, provides for a transmission line alignment along Highway 248 and Browns Canyon Road. Similar to the undergrounding alternative, this option is not preferred. The Browns Canyon Road Option will require the installation of sixteen (16) power poles within the roadway rights-of-way along Highway 248 and Browns Canyon Road. The estimated cost of the Browns Canyon Road Option is Three Million Three Hundred and Fifty Thousand Dollars ($3,350,000), excluding any costs associated with rights-of-way acquisition, which may be significant.

This CUP Application is hereby submitted requesting approval of the Option 1 Plan. The Company, however, could also construct the Option 2 alternative within the scope of the proposed Project. The Option 3 Plan and the Browns Canyon Road Plan could both be constructed in compliance with the County's local land use regulations and ordinances, and would fulfill the need for the Project to provide safe, reliable, adequate, and efficient electric transmission service to the Company's customers. Therefore, the Company invites the County to evaluate whether the Option 3 Plan and the Browns Canyon Road Plan is preferred by the

County, with the understanding that the excess costs associated with either of these two alternative facilities over the "standard cost" of the Option 1 or Option 2 Plans will be the responsibility of the County. Utah Code Ann. § 54-14-201(2).

II. Wasatch County Local Regulatory Compliance

During the Initial CUP Application process, the Company demonstrated the Option 1 Plan's compliance with the County's local land use requirements, ordinances and General Plan, as well as compliance with the Company's obligation to provide safe, reliable, adequate and efficient electric service to its customers. The following information was previously submitted in support of the Initial CUP Application, and is herein resubmitted in support of this application.

<u>Ridgeline/View Shed Regulations and Impact Analysis</u>

The purpose of Wasatch County Ordinance Section 16.27.22 - Ridgeline/View Shed Regulations (the "Ridgeline Regulations") is to "…*protect the valuable views of the ridgelines of Wasatch County by providing regulations, which will limit the building of structures that protrude above primary and secondary ridgelines, or will mitigate the appearance of such structures if prevention is not possible." The application of these regulations is to "….all land use applications in Wasatch County for which any portion of a proposed structure protrudes above ridgelines when viewed from the designated viewing platforms…"*

In the Staff Report, an assertion was made that the Company's proposal violates the Ridgeline Regulations by "*protruding above significant ridgelines.*" The Company disagrees that there is a complete prohibition of any pole "protruding above [a] ridgeline." As written, the Ordinance merely states that its purpose is to "limit" the building of "structures" that protrude above the ridgeline. Limiting is not synonymous with prohibiting. Indeed, the Ordinance goes on to provide that in the event such protrusion is impossible to prevent, the County will mitigate the appearance of the protrusion. On its face this language acknowledges that there will be instances, as are currently instances in the County, when structures will protrude above ridgelines. Accordingly, the Company urges the Commission to reject any interpretation of the County ordinances which outright prohibits any and all construction of any kind above a ridgeline.

Furthermore, a broad application of the regulations by inclusion of a "utility pole" within the definition of "structure" does not appear to be consistent with the remaining language of this section. The Ridgeline Regulations, by their own terms, are designed to address subdivisions, housing projects, and large scale commercial infrastructure. Their terms speak of lot construction, "building envelope locations", and the like. The Ridgeline Regulations are silent as to electrical facilities, including poles. Clearly, it is not appropriate to include poles within the definition of a "structure."

As such, the Company disagrees with Staff's previous position during the Initial CUP Application process that the proposed Option 1 Plan violates the Ridgeline Regulations. While the Option 1 Plan does depict single pole line visibility above the ridgeline in four (4) isolated locations, the Company believes that the overall elevation of the ridgeline view shed is better preserved in the Option 1 Plan than in comparison with all other alternatives, including the Browns Canyon Road Option. As previously stated, the Company is also open to consider reasonable mitigation consistent with the purpose and intent of the language in the Ridgeline Regulations and in fact has designed the Project to use materials such as nonreflecting conductor, minimized pole height, etc., to mitigate and minimize the extent possible the visual effects of the line.

Notwithstanding the forgoing, and in an effort to respond to Staff's comments on the Initial CUP Application and the Option 1 Plan, the Company proposes the Option 2 Plan, the Option 3 Plan and the Browns Canyon Road Plan.

<u>Compliance with Ordinance and General Plan</u>

As provided in the Staff Report, Section 16.23.07 of the Ordinance requires the Planning Commission to find the following:

1. The application complies with all requirements of Title 16.

   The Company has provided four (4) plan options in compliance with the Ridgeline Regulations.

2. The business shall maintain a business license if required.

   Staff has noted in the Staff Report that this requirement is not applicable. Notwithstanding this position by Staff, the Company has the appropriate agreements in place for compliance with all state, county and municipal business regulations.

3. The use will be compatible with surrounding structures in use, location, scale, mass, design and circulation.

   Staff previously suggested that the proposal may not be compatible with the adjacent development due to the visibility of the poles above the residential structures. The Company disagrees with Staff's recommendation to the Planning Commission on this issue. While the height of the poles will be visible above the residential structures, the Company notes that the visibility of utility poles above residential structures is a standard physical occurrence in developments around Wasatch County and throughout the state. Also, the placement of the poles along open space corridors is also not only an industry standard, but a development standard nationally. More importantly, the pole height is necessary to meet industry and state safety, reliability and efficiency standards, and regulations, with which the Company must comply. In the Company's view, the Staff's recommendation on this point is not only unreasonable and impractical, but unrealistic and unsustainable.

Considering existing development within the County, the proposed use is consistent with the scale of pole heights and distances adjacent to other residential developments within the County. As a reference, there is a development across Hwy 248 being constructed adjacent to existing double circuit 138kV and 46kV transmission lines at a distance of approximately 130 feet from the corner transmission line structure. The Stillwater development and Fox Bay condominium developments are also similar in distance and scale to adjacent pole structures. (<u>See Appendix 7</u>) Lastly, the Company has previously offered and is willing to incorporate strategic vegetation in an effort to mitigate the visual impact and provide compatibility with the adjacent residential development. To date, all of the Company's offers to provide additional mitigation have been rejected by the County.

4. The visual or safety impacts caused by the proposed use can be adequately mitigated with conditions.

   All three options proposed by the Company provide alternative options in mitigating visual impacts, which also meet the County's Ridgeline Regulations. The Company is also willing to discuss material, color and vegetation treatments to further mitigate any visual impacts. The proposed use meets all safety regulations and standards within the industry.

5. The use is consistent with the Wasatch County General Plan.

   The Company has provided three (3) plans to consider for a proposed use that are each consistent with the mission statement of the General Plan in seeking to enhance the quality of life for County residents, visitors and the business community by providing required electrical infrastructure and reliability. The General Plan addresses various public facilities and services such as water, sewer and other types of development infrastructure; however, it is silent on specific criteria relative to electrical infrastructure. In promoting development consistent with the General Plan, safe, efficient and reliable power and electricity is necessary. The Project is being provided to support the local communities and will provide critical infrastructure and redundancy to support residents and citizens of the County, as well as surrounding counties and the state of Utah. The proposed use, as depicted in each option plan, is consistent with Section 1.1.2 of the General Plan as it preserves the ridge lines viewed from the State Roads or County arterial and collector roads. Option 1 preserves a greater width and base of the overall ridge view by using the fewest number of poles in the design and Option 2 provides a design that preserves the view of the ridgeline by keeping the structures from protruding above it.

6. The effects of any future expansion in use or scale can be and will be mitigated through conditions.

The Company understands that any change or expansion to the proposed use would require a new conditional use permit application and be subject to the Planning Commission's approval. This project has been designed to meet the current and projected needs of Summit and Wasatch Counties. The Company notes that no future expansion is anticipated at this time based upon current projected population and development within the County and surrounding areas.

7. All issues of lighting, parking, the location and nature of the proposed use, the character of the surrounding development, the traffic capacities of adjacent and collector streets, the environmental factors, such as drainage, erosion, soil stability, wildlife impacts, dust, odor noise and vibrations have been adequately mitigated through conditions.

   Staff has indicated in their Staff Report that compliance with the Ridgeline Regulations was the only issue relative to this requirement. The Company believes it has submitted plan options that are compliant with the Ridgeline Regulations. While Staff has not raised any other concerns of compliance with this requirement, the Company notes that any relative noise would be compatible with adjacent development. (See Appendix 8)

   The Company has reviewed the impact of the proposed use on the environment, wildlife and soils. A copy of the Geotechnical Report that was initially provided to the Planning Director in January of 2015 is provided as a formal supplement to the application. (See Appendix 9)

8. The use will not place an unreasonable financial burden on the County or place significant impacts on the County or surrounding properties without adequate mitigation of those impacts.

   A large scale study review by CH2MHill shows minimal initial impacts and no long term detrimental impacts to property values. In some cases there is a positive impact when transmission lines are adjacent to a development. (See Appendix 10)

   The Company notes that without electrical infrastructure property could actually be valued less. Safe, reliable power supplied to developments and residents impacts the overall tax base for the County and complies with the goals and policies of the County General Plan.

9. The use will not adversely affect the health, safety or welfare of the residents and visitors of Wasatch County.

   Staff suggests in the Staff Report potential negative effects of power lines on adjacent residential homes due to presence of electromagnetic fields.

   The magnetic fields that are present around proposed transmission line wires are insignificant, due in part to their distance from people on the ground. The weak magnetic *fields decay quickly with distance from the wire. According to national studies, the proposed use is far below recommended exposure limits for the general public. Indeed, this particular project will have fields only 1/10th of the allowed recommended limits. On page 47 of the included EMF RAPID report generated by the National Institute of Environmental Health Sciences and the National Institutes of Health, the general public exposure limit is 833mG. (*See Appendix 11*) Yet, the anticipated initial loading is projected to create a field of only 64mG. To reach the higher limit would take several years of load growth and even at that point the calculated maximum load, considering direct proximity adjacent to the pole, would be 78mG -- well below 1/10th of the exposure threshold. Accordingly, the Company believes that the proposed use would not adversely affect the health, safety or welfare as the anticipated limits are significantly less than the regulated limit of the industry.*

In addition, the proposed use meets the strict criteria of the National Electric Safety Code, which is published by the International Electrical and Electronic Engineering society (IEEE) in conjunction with other institutes like American National Standards Institute (ANSI) that have developed several standards and design criteria that govern the electrical equipment industry including the equipment utilities use. The proposed use also meets the requirements of the Western Electricity Coordinating Council (WECC) Standards for reliability. The WECC is an approved corporation by the Federal Energy Regulatory Commission to maintain reliability of the western interconnection area.

Community Coordination / Meeting Efforts

Throughout the Initial CUP Application process, the Company was in continual communication with interested parties, including Summit and Wasatch Counties and adjacent landowners. A timeline of events and summary of minutes and meeting efforts by the Company during the Initial CUP Application process is included with this supplemental information. (See Appendix 12).

Additionally, on July 29, 2015, the Company submitted mailing envelopes to re-notice property owners of the Company's plans regarding the Project. In response to a request from adjacent concerned parties, the Company expanded such notice to include all property owners in attendance at the May 2015 Planning Commission hearing, though not required by local or state law. (See Appendix 13). The Company will continue to communicate and work closely with interested parties, including the Counties, throughout the current CUP Application process and during construction of the Project.

Significantly, the Company has also obtained a letter of support from Heber Light & Power Company, highlighting the importance of the Project for Wasatch County. (See Appendix 14).

III. Conclusion

The Company has an affirmative legal duty to design, construct, and maintain facilities sufficient to provide safe, reliable, adequate, and efficient electric service to its customers within Wasatch County and throughout the state of Utah. In addition, as a regulated utility, the Company must meet minimum reliability standards for its electrical service. Due to increasing electricity demand in Wasatch and surrounding areas, the Project must be constructed to maintain the reliability of the Company's system in these areas, and to provide safe, adequate and efficient electric service to the Company's customers. With this need in mind, the Company has thoughtfully and carefully planned and designed the Project to meet the demand and load growth that has occurred in Wasatch County, and expected future load growth, while at the same balancing the interests of the environment, community and the Company's customers by minimizing the impact of the Project to the extent reasonably possible.

With the submittal of the CUP Application, including this supplemental filing, the Company believes the CUP Application is complete, and in full compliance with the County's requirements, ordinance, General Plan, and state land use law. Accordingly, the Company requests the County approve the CUP Application. The Company remains willing to meet with the County and interested parties to discuss additional reasonable mitigation stipulations that would allow for the approval of the CUP Application.

Finally, the Company thanks the Commission and its Staff for their time and efforts to understand the issues and needs surrounding the Project.

Appendix 1
Option 1 Plan

OPTION 1 SUBMITTED WITH PREVIOUS CONDITIONAL USE PERMIT

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK
138kV TRANSMISSION LINE

PHOTO SIMULATION OPTION 1
LOCATION MAP

Photo simulations are for discussion purposes only. Final design may change pending public and regulatory review.

OPTION 1 SUBMITTED WITH PREVIOUS CONDITIONAL USE PERMIT

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK
138kV TRANSMISSION LINE

PHOTO SIMULATION
OPTION 1

Appendix 2
Staff Report dated March 12, 2015

Wasatch County Planning Commission

March 12, 2015

Item #1

Rocky Mountain Power

Conditional Use

Wasatch County
Planning Commission Staff Report
March 12, 2015

ITEM: 1

Don Watts, representative for Rocky Mountain Power, is requesting a conditional use permit for a new double circuit 138 kv line with above grade pole heights that are between 74.5 – 85 feet. The proposal is on the west side of Browns Canyon south of the Wasatch/Summit County line in Section 36, Township 2 South Range 4 East in the Jordanelle Basin Overlay Zone (JBOZ).

BACKGROUND:

This proposal is for a new alignment of a 138 kv line which requires Conditional Use Permit (CUP) approval. The proposal is located south of the County boundary line on the west side of Browns Canyon Road. This is north and adjacent to a newly approved development referred to as Black Rock Ridge phases 4-7.

The power line currently runs through the middle of the Promontory development in Summit County. According to Rocky Mountain Power (RMP) the line needs to be upgraded and Promontory wanted the line moved out of that portion of their property. An easement agreement was reached between RMP and Promontory to relocate the power line into the new easement. As far as Planning Staff and Wasatch County administration is aware there were no discussions with Wasatch County at the time to see if the line and pole locations would be allowed. According to RMP, negotiations with Promontory to move the line outside of the new easement have not been well received.

The power line easement is adjacent to a medium density development that is either in the process of receiving approvals or under construction. Structures could be within 20-40’ of the power poles.

Below is the section of the code governing development on a ridgeline:

> *16.27.22 Purpose:*
>
> *A. It is the intent of this section to protect the valuable views of the ridgelines of Wasatch County by providing regulations, which will limit the building of structures that protrude above primary and secondary ridgelines, or will mitigate the appearance of such structures if prevention is not possible.*
>
> *B. Applicability: These regulations apply to all land use applications in Wasatch County for which any portion of a proposed structure protrudes above ridgelines when viewed from the designated viewing platforms as*

> *shown on the adopted viewing platform map. Any rezoning, proposed development or building permit shall be subject to compliance with these regulations, irrespective of whether specific reference to the regulations is made in this title. In the event of an overlapping or conflicting requirement of this chapter and other provisions or regulations in this code, the more restrictive provision shall apply. All proposals for development of preexisting lots of record or platted plots that may be located within the primary or secondary ridgeline areas are subject to conditional use approval.*

The viewing platform for this area is the intersection of Browns Canyon and Highway 248. The visual simulations are all from the above noted platform.

The poles are proposed to be wood structures (except for the corner pole) and it appears that there are 6 poles in the County. Poles are between 74.5 and 85 feet above grade.

All properties within 500' of the proposal have been sent a letter regarding this. The property to the south is very adamant that the proposal not violate the ridgeline.

ANALYSIS:

The comments in italicized represents Planning Staff's comments pertaining to compliance or lack of compliance with the findings the Planning Commission must make in considering this request. Section 16.23.07 requires specifically the Planning Commission to find that:

1. The application complies with all requirements of Title 16; *the applicant has provided photo simulations of the proposed poles that would be in Wasatch County and it appears that they will violate the county's ridgeline ordinance by protruding above significant ridgelines as viewed from the platform.*
2. The business shall maintain business license if required; *Not applicable*
3. The use will be compatible with surrounding structures in use, location, scale, mass, design and circulation; There are structures immediately south and will be structures adjacent to the east. The structures to the east have a 35' height maximum and the 17-plex structure to the south is around 40-45' high. *The poles will be visible above the residential structures and will not fit in with the neighborhood uses.*
4. The visual or safety impacts caused by the proposed use can be adequately mitigated with conditions; *the proposal would be a violation*

of the county's ridgeline ordinance and planning staff does not know of a way to mitigate the poles other than requiring the applicant to move poles to locations that do not violate the ordinance.

5. The use is consistent with the Wasatch County General Plan; *Policy 1.1.2 in the General Plan states: "Promote preservation of ridge lines from development as viewed from any State Roads or County arterial or collector road by keeping the roof lines of structures below the ridge line." The proposal would violate this policy by allowing multiple poles and lines to protrude above the ridgeline as viewed from the intersection of Browns Canyon and SR (State Road) 248.*
6. The effects of any future expansion in use or scale can be and will be mitigated through conditions; If this proposal is approved *any change or expansion in the use would require new conditional use approval.*
7. All issues of lighting, parking, the location and nature of the proposed use, the character of the surrounding development, the traffic capacities of adjacent and collector streets, the environmental factors such as drainage, erosion, soil stability, wildlife impacts, dust, odor, noise, and vibrations have been adequately mitigated through conditions; *The proposed poles violate the county ridgeline ordinance and the impacts have not been mitigated.*
8. The use will not place an unreasonable financial burden on the County or place significant impacts on the County or surrounding properties, without adequate mitigation of those impacts. *It may be argued that the poles could have a detrimental effect on property values.*
9. The use will not adversely affects the health, safety or welfare of the residents and visitors of Wasatch County. *I have not heard that there is conclusive proof of the negative effects of power lines adjacent to residential homes but that issue has been argued.*

POSSIBLE FINDINGS:

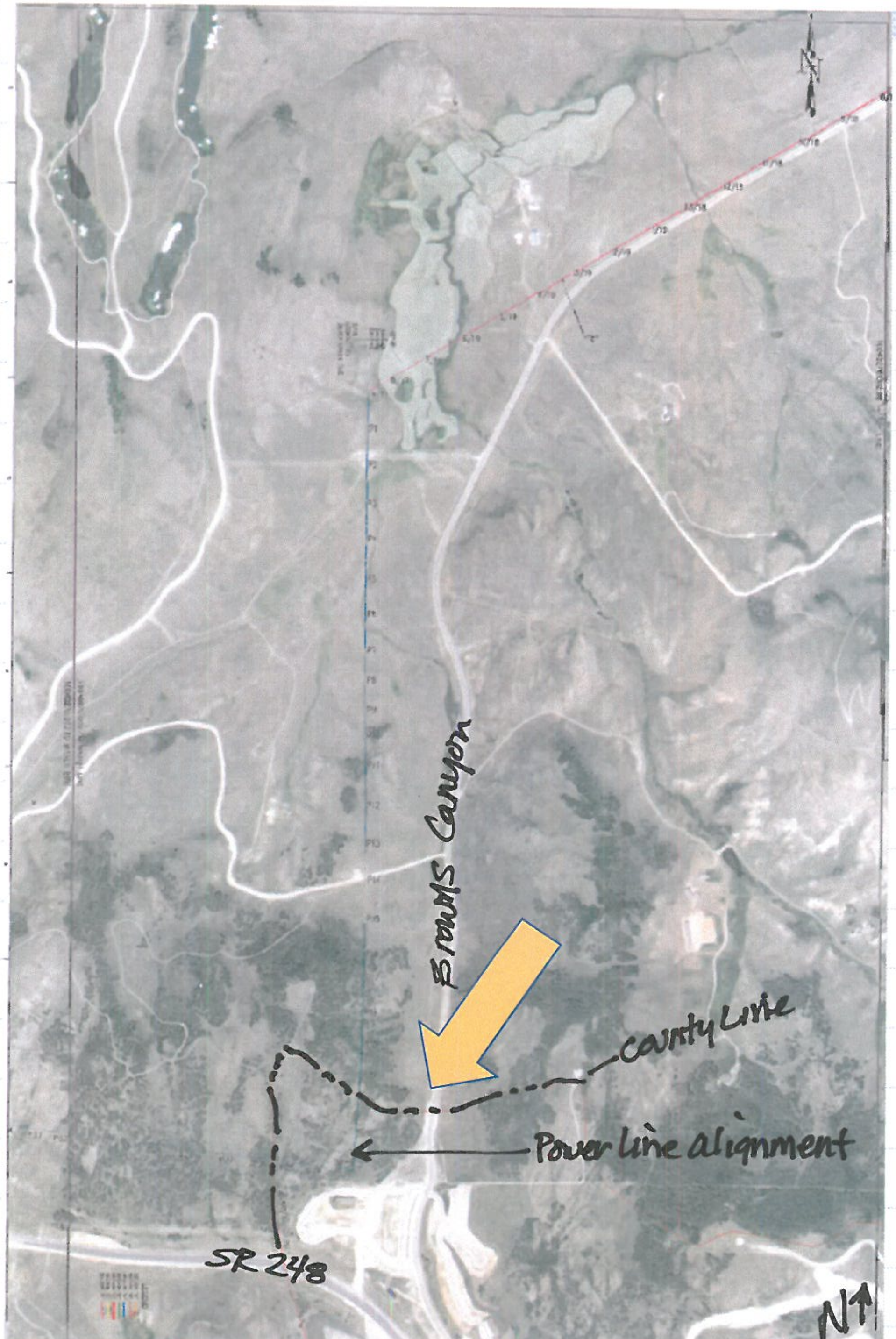
- The proposal does not comply with ridgeline ordinance as written in 16.27.22
- The proposal does not comply with policy 1.1.2 of the Wasatch County General Plan.
- The ridgeline ordinance refers to structures not dwellings.
- Wasatch County, as far as we are aware, was not consulted with the alignment of the newly purchased easement.

ALTERNATIVE ACTIONS:

1. Recommendation for denial. This action can be taken if the Planning Commission feels that the request does not meet the requirements of the ordinance.
2. Recommendation for conditional approval. This action can be taken if the Planning Commission feels that conditions placed on the approval can resolve any outstanding issues.
3. Recommendation for continuance. This action can be taken if the Planning Commission feels that there are unresolved issues.

PROPOSED CONDITIONS (if approved):

1. Poles must be wood if possible.
2. It must be demonstrated that the poles are at lowest height necessary.
3. If metal poles are used at corner locations they must be the rust colored metal.



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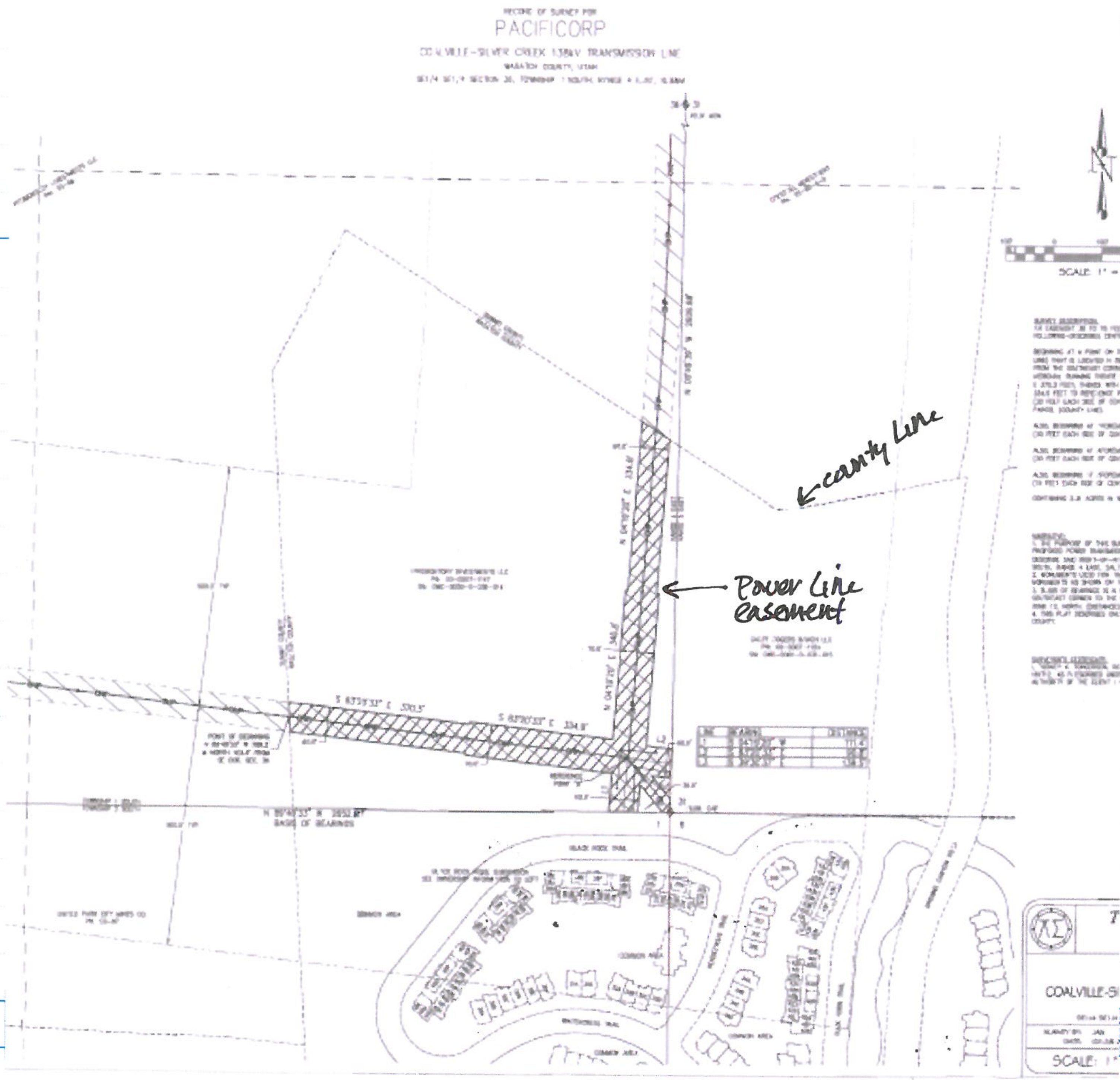
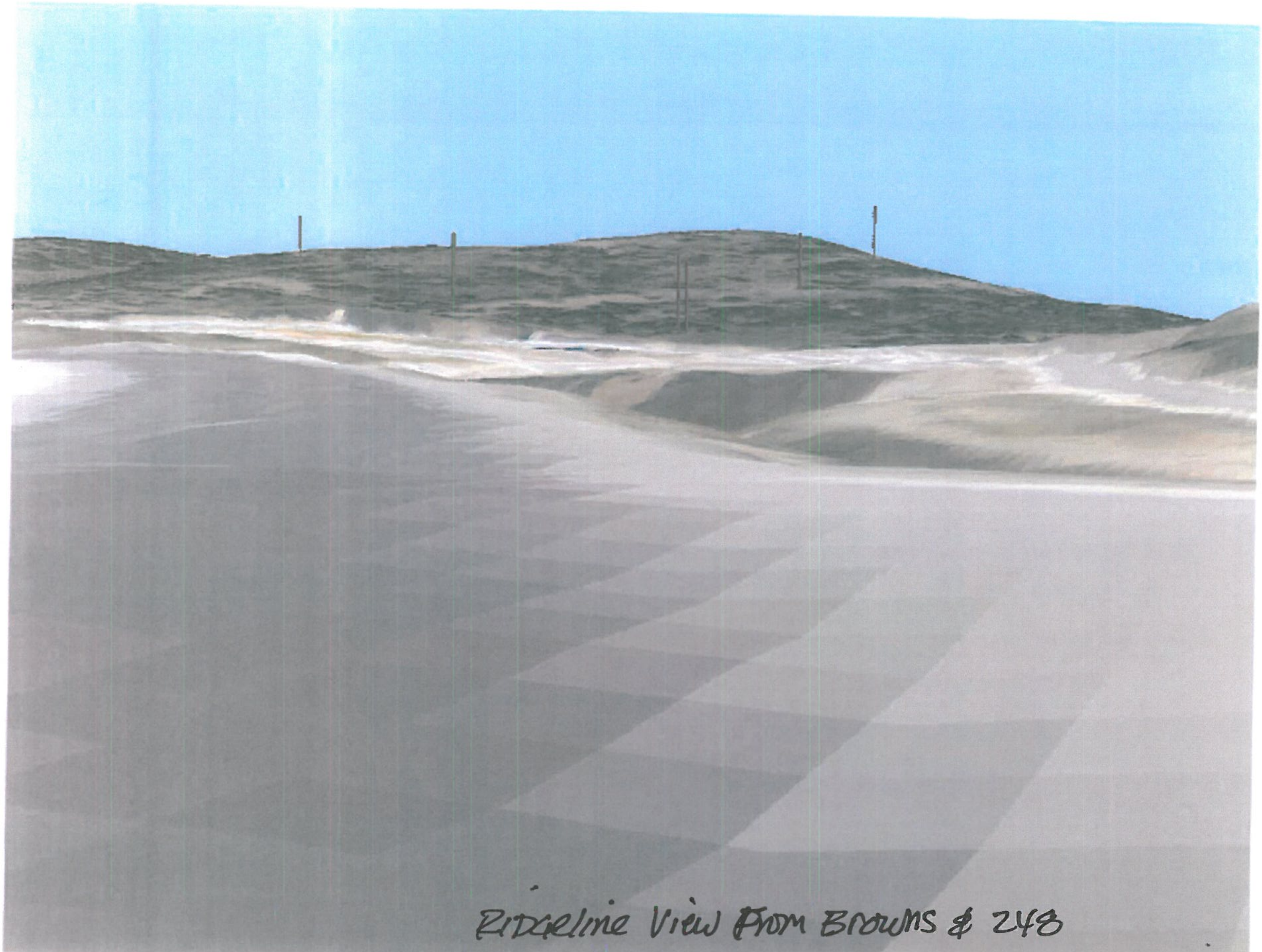
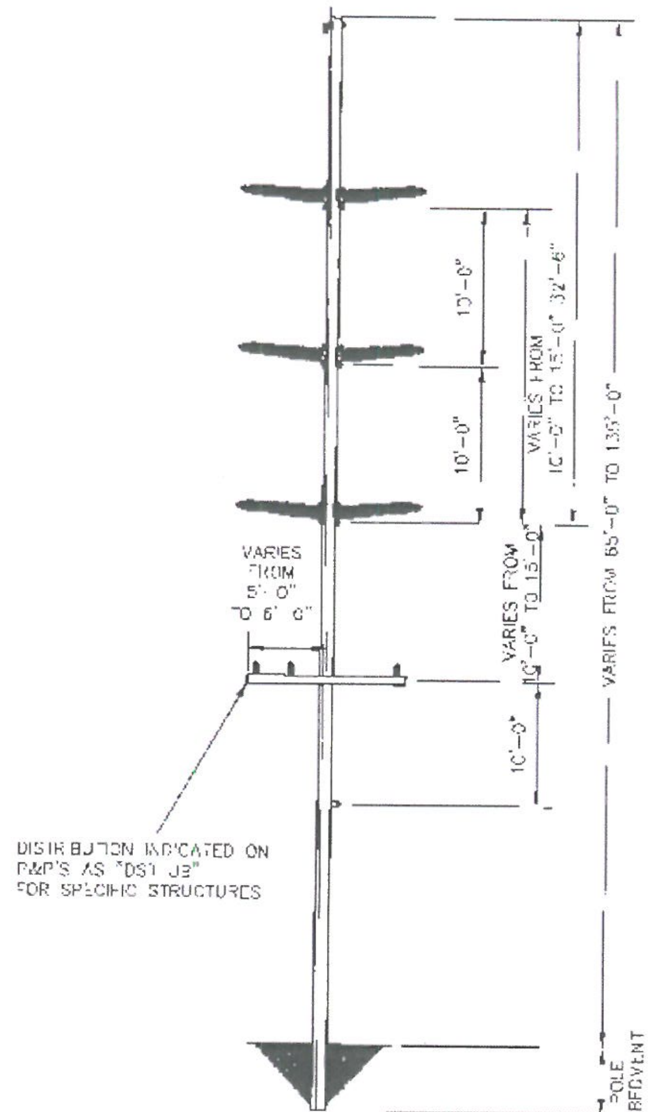


RECORD OF SURVEY FOR
PACIFICORP
COALVILLE-SILVER CREEK 138KV TRANSMISSION LINE
WASATCH COUNTY, UTAH
County Line
Power Line easement
S 83°33'33" E 370.5'
S 83°33'33" E 334.9'
N 04°10'20" E 334.9'
N 04°10'20" E 346.6'
N 89°41'33" W 2652.87'
BASIS OF BEARINGS
BLACK ROCK TRAIL
COMMON AREA
COALVILLE-SI
SCALE: 1"

Row #	Structure Number	STR TYPE	Line Angle (deg)	Stake Description	X Easting (ft)	Y Northing (ft)	Structure Height Above Ground
1	13/20	TG271	0	Structure Hub	1520011.238	14777204.39	95
2	14/20	TG271	1.52	Structure Hub	1520006.989	14776905.2	86
3	15/20	TG271	1.99	Structure Hub	1519995.473	14776622.47	72.5
4	16/20	TG271	0	Structure Hub	1519977.925	14776390.29	74.5
5	:7/20	TG271	0	Structure Hub	1519956.318	14776104.41	81.5
6	:8/20	252 (2 POL	92.34	Structure Hub Left	1519930.158	14775758.29	85
7	18/20	252 (2 POL	92.34	Structure Hub Right	1519911.072	14775781.44	85
8	1/21	TG271	0	Structure Hub	1519596.965	14775797.18	81.5
9	2/21	TG271	0	Structure Hub	1519349.506	14775826.06	74.5
10	3/21	TG271	0	Structure Hub	1519097.091	14775855.53	70

Heights


Ridgeline View From Browns & 248



NO.	DATE	REVISIONS	ENGINEER	DES./ DR.	CHECKED	APPROVED

TRANSMISSION

SW WYOMING TO SILVER CREEK
138kV TRANSMISSION LINE
SUMMIT COUNTY
TYPICAL STRUCTURE DRAWING

DISCIPLINE ENG. PROJ/ENG P.J. DATE
PROJECT ENG. DIR. DSGN
APPROVAL ENG. DR. CH
SCALE NONE
SHEET 1
TG271
REVISION

PACIFICORP

3/2/2015

Appendix 3
Planning Commission Minutes
dated March 12, 2015

NOTICE is hereby given that the WASATCH COUNTY PLANNING COMMISSION will hold a Public Hearing on March 12, 2015 at 7:00 p.m. in the Wasatch County Council Chambers, located at 25 North Main Street, Heber City, to consider the following items:

1. Don Watts, representative for Rocky Mountain Power, is requesting a conditional use permit for a new double circuit 138 kv line with above grade pole heights that are between 74.5 – 85 feet. The proposal is on the west side of Browns Canyon south of the Wasatch/Summit County line in Section 36, Township 2 South Range 4 East in the Jordanelle Basin Overlay Zone (JBOZ).

2. Donald and Debra Perry are requesting a plat amendment to Timber Lakes plat 16A, to combine lots 1721 and 1722 into one lot. The proposal is located at 9949 East and 9979 East Deer Creek Drive in Section 15, Township 4 South, Range 6 East in the M (Mountain) zone. **Recommendation by the Planning Commission on this item will be considered by the County Council as the Land Use Authority, at a Public Hearing on March 18, 2015**.

3. Jeff Graham, representative for VR Acquisitions LLC, is requesting a plat amendment to Plat A of Victory Ranch. The proposal is to remove plat notes 4 (maximum building square footage), 9 (restricting building heights to 28'), and 13 (removing the limits of disturbance note) and then add a note regarding enforcement of the CC&R's, Design Guidelines, and Bylaws of Victory Ranch. Plat A is located in Sections 31 and 32, Township 2 South, Range 6 East in the Jordanelle Basin Overlay Zone (JBOZ) **Recommendation by the Planning Commission on this item will be considered by the County Council as the Land Use Authority, at a Public Hearing on March 18, 2015**.

4. Lynn Russell is requesting a conditional use permit for a guest accessory dwelling unit. The request would allow the applicant to construct a guest dwelling on the second floor of a future accessory storage structure on his 5 acre parcel. The proposal is located at 1823 North Dutch Canyon Road in Section 23, Township 3 South, Range 4 East in the RA-1 (Residential Agricultural 1-acre) zone.

5. Paul Cook, representative for Wasatch Tank Lines, is requesting a conditional use permit and site plan approval for corporate offices in the former Western Traditions building and parking for up to six semi-trucks and trailers on the adjoining property to the north. The property formerly facilitated a log mill operation. The applicant is also proposing that the tanker trucks access the property off of 2400 North, through an access that is just east of the current Western Traditions building, rather than directly off of Highway 40. The proposal is located at 2383 South Highway 40 in the C (Commercial) zone.

6. Discussion and possible recommendation of ordinance 15-03 which is an amendment to 16.41 the Jordanelle Specially Planned Area (JSPA) to add Appendix A which is bylaws for the JSPA Planning Commission. **Recommendation by the Planning Commission on this item will be considered by the County Council as the Land Use Authority, at a Public Hearing on March 18, 2015**.

7. Discussion and possible recommendation of ordinance 15-02 which is an amendment to 16.21.44 (B,14) which could allow for free standing signs in residential zones for value added agriculture uses as a conditional use. **Recommendation by the Planning Commission on this item will be considered by the County Council as the Land Use Authority, at a Public Hearing on March 18, 2015**.

All interested persons are invited to attend.

A briefing will be held in the Council Chambers at 6:30 p.m. to review the evening's issues. This briefing will be for discussion purposes only between the Planning Staff and the Planning Commission. No action will be taken. The public may attend; however, no public testimony will be heard. For information, please call the Planning Department at 435-657-3205.

*County Council Public Hearings will be held at 6:00 p.m. in the County Council Chambers located at 25 North Main Street, Heber City on the date specified.

Pursuant to the Americans with Disabilities Act, individuals needing special accommodations during the meeting should notify the Wasatch County Planning Department prior to the meeting.

Publish 2-25-15
S. Lawrence
Wasatch County Planning & Zoning

This Notice has been posted in three public places within Wasatch County including the front and rear doors of the Wasatch County Administration Building, posted on the Wasatch County website as well as the State of Utah website, and delivered to the Editor of the Wasatch Wave to be published in compliance with the Utah Open and Public Meetings Act Utah Code ann. § 52-4-202 et. seq.

To view this notice online, go to the Wasatch County website: www.co.wasatch.ut.us or the State of Utah website: www.utah.gov.

MINUTES OF THE
WASATCH COUNTY PLANNING COMMISSION
MARCH 12, 2015

PRESENT:	Jon Jacobsmeyer, Gerald Hayward, Robert Gappmayer, Paul Probst.
COUNTY COUNCIL REP.	Councilman Kipp Bangerter
EXCUSED:	Commissioner Liz Lewis
STAFF:	Doug Smith, Planning Director; Luke Robinson, Planner; Craig Chambers, Deputy County Attorney.
OTHERS PRESENT:	On list attached to a supplemental file.
PRAYER:	Councilman Kipp Bangerter
PLEDGE OF ALLEGIANCE:	Commissioner Paul Probst

Chair Robert Gappmayer called the meeting to order at 7:00 p.m. and excused Commissioner Liz Lewis and then welcomed those present and called the first agenda item. Chair Gappmayer also indicated that it will take the vote of all the commissioners present for a matter to pass and if an applicant would like to wait until there are more Planning Commissioners present just let that be known.

APPROVAL OF THE MINUTES OF JANUARY 15, 2015

Motion

Commissioner Probst made a motion that we accept the minutes of the January 15, 2015 meeting as written.

Commissioner Jacobsmeyer seconded the motion.

The motion carries with the following vote:
AYE: Jon Jacobsmeyer, Gerald Hayward, Robert Gappmayer, Paul Probst.
NAY: None.

ITEM 1 DON WATTS, REPRESENTATIVE FOR ROCKY MOUNTAIN POWER, IS REQUESTING A CONDITIONAL USE PERMIT FOR A NEW DOUBLE CIRCUIT 138 KV LINE WITH ABOVE GRADE POLE HEIGHTS THAT ARE BETWEEN 74.5 – 85 FEET. THE PROPOSAL IS ON THE WEST SIDE OF BROWNS CANYON SOUTH OF THE WASATCH/SUMMIT COUNTY LINE IN SECTION 36, TOWNSHIP 2 SOUTH RANGE 4 EAST IN THE JORDANELLE BASIN OVERLAY ZONE (JBOZ).

Staff

Doug Smith, the Wasatch County Planning Director, addressed the Wasatch County Planning Commission and indicated that this proposal is for a new alignment of a 138 kv line which requires a Conditional Use Permit approval. Doug also indicated that the power line currently runs through the middle of the Promontory development in Summit County. Rocky Mountain Power indicated that the line needs to be upgraded and Promontory wanted the line moved out of that portion of their property. Doug indicated that as a result an easement agreement was reached between Rocky Mountain Power and Promontory to relocate the power line into the new easement and as far as the Wasatch County Planning Staff and Wasatch County administration is aware there were no discussions with Wasatch County at the time to see if the line and pole locations would be allowed. As a result Rocky Mountain Power indicated that the negotiations with Promontory to move the line outside of the new easement have not been well received.

Doug also indicated that the viewing platform for this area is the intersection of Browns' Canyon and Highway 248. Also the poles are proposed to be wood structures except for the corner pole and it appears that there are six poles in Wasatch County and the poles are between 74.5 and 85 feet above grade.

Doug also indicated that all the properties within 500 feet of the proposal have been sent a letter regarding this and the property to the south is very adamant that the proposal not violate the ridge line.

Doug indicated that the possible findings are:

1. The proposal does not comply with ridge line ordinance as written in 16.27.22.
2. The proposal does not comply with policy 1.1.2 of the Wasatch County General Plan.
3. The ridge line ordinance refers to structures not dwellings.
4. Wasatch County, as far as we are aware, was not consulted with the alignment of the newly purchased easement.

Doug indicated that the possible proposed conditions if approved are:

1. Poles must be wood if possible.
2. It must be demonstrated that the poles are at lowest height necessary.
3. If metal poles are used at corner locations they must be the rust colored metal.

Doug also indicated that it is the recommendation of the Wasatch County Planning Department that this matter be denied. Doug also indicated that if the voting is not unanimous, due to only four members being present, the matter will receive a denial by the Wasatch County Planning Commission because a conditional use permit does not go to the Wasatch County Council for their consideration.

Applicant

Don Watts, representative for Rocky Mountain Power, addressed the Wasatch County Planning Commission and indicated that they are willing to go forward tonight with their application with only four members being present. Don also indicated and asked the Wasatch County Planning Commission if there are further items that the Planning Commission feels would warrant a work session or tabling for further discussion would that be a possibility as well. Chair Gappmayer indicated that it sure would be a possibility from your recommendation before the Wasatch County Planning Commission voted.

Don Watts also indicated that this line is necessary to bring in additional power into the Silver Creek Substation and the Northern part of Wasatch County. Don also indicated that the poles have been lowered down as much as possible and the shine of the wire has been diminished as much as possible. Don also indicated that they are presently working with Heber Light and Power to tie onto the 138 kv system from Provo up through the Midway substation which is over by the Midway City Cemetery and then building out to where there is an existing 138 kv line just at the bottom of the Jordanelle Reservoir. Don also indicated that there were some discussions with Wasatch County about the easement and he could get the information to the Wasatch County Planning Commission.

Public Comment

Chair Gappmayer then asked if there was any public comment.

Jay Price, an ex-Wasatch County Councilman, who is a representative for Mark 25 LLC, who was the developer of the Black Rock Ridge, addressed the Wasatch County Planning Commission and indicated that they agree with the need for additional power and recognize that need. Jay also indicated that Wasatch County has always taken the position in supporting these types of things in an existing right-of-way. Jay indicated that there is an existing right-of-way on Promontory's property that has existing poles. Also that Wasatch County was not consulted on this relocation of these poles. As a result this is an item that needs to be worked out with Promontory which is to the total benefit of Promontory to move it out of their property and then move it to another private property which Mark 25 can't support that. Jay also indicated that this goes against the ordinance as stated. In order to be approved it can't be self-imposed. This is a departure from their existing right-of-way. Jay also indicated that this is an economic gain for a different developer, Promontory. Also the money being exchanged between Promontory and Rocky Mountain Power is not an economic gain to Wasatch County but an economic gain to the existing development where an existing right-of-way already exists. There needed to be discussions before this matter ever came before the Wasatch County Planning Commission and it is not appropriate to ask for a continuance at this time when no discussions have even taken place to see what can be worked out to solve this problem. Jay then indicated that with the reasons stated they would definitely recommend denial of this proposal.

Jason Norlin, General Manager of Heber Light and Power, addressed the Wasatch County Planning Commission and indicated that Heber Light and Power needs the additional electricity capacity, and Heber Light and Power has nothing to do with this problem. Jason also indicated that everybody needs to work together to solve these problems that have been mentioned. Jason also indicated that it doesn't matter which direction the added capacity comes from, just so Heber Light and Power receives the additional capacity. Also if this matter takes time and delays the matter then Heber Light and Power does have a concern. Jason also indicated that if the power line is taken underground Heber Light and Power is very much against that because it changes the way Rocky Mountain operates their transmission system.

Chair Gappmayer then closed the public comment period.

Don Watts, the applicant, then asked that this matter be continued to address the various concerns with the necessary parties and would ask for three months. Jay Price asked that Mark 25 be included in those discussions if granted. Commissioner Probst also indicated that if the matter is continued that all the necessary parties are made a part of those discussions. Commissioner Hayward indicated that he has a concern that Wasatch County was not notified of the changes that Promontory was asking for and financial arrangements were also made to take care of the changes without Wasatch County being made aware of that. Commissioner Hayward also indicated that the compliance of the ridge line ordinances is very important and should not be deviated from but upheld.

Doug Smith, the Wasatch County Planner, also indicated that after the matter has been discussed and comes back before the Wasatch County Planning Commission and the poles still violate the ridge line ordinance the recommendation for denial would still be the same from the Wasatch County Planning Department.

Jeff Richards, General Counsel for Rocky Mountain Power, addressed the Wasatch County Planning Commission and indicated that he appreciates the opportunity to present the item to Wasatch County and also to step back and discuss the matter with the various property owners.

Mr. Wolper, from Mark 25, indicated that he has a concern about the noticing process and all the necessary parties would be noticed that need to be made a part of the discussions.

Craig Chambers, Deputy Wasatch County Attorney, indicated that he would check into the obligation for the noticing to take place.

Councilman Kipp Bangerter, from the Wasatch County Council, asked that a member of the Wasatch County Council be made a part of the negotiations that could take place in work meetings.

Commissioner Probst also indicated that there needs to be some good progress shown by this continuation but it is obvious that the Wasatch County Planning Commission will not grant the Conditional Use Permit requested by Rocky Mountain Power.

Motion

Commissioner Jacobsmeyer made a motion that we continue this Item No. 1, Rocky Mountain Power's Conditional Use request until May 14, 2015 and have Rocky Mountain Power take care of the notifying of the necessary parties that need to be present in the discussions.

Commissioner Probst seconded the motion.

The motion carries with the necessary vote;
AYE: Jon Jacobsmeyer, Robert Gappmayer, Paul Probst, Gerald Hayward.
NAY: None.

ITEM 2 **DONALD AND DEBRA PERRY ARE REQUESTING A PLAT AMENDMENT TO TIMBER LAKES PLAT 16A, TO COMBINE LOTS 1721 AND 1722 INTO ONE LOT. THE PROPOSAL IS LOCATED AT 9949 EAST AND 9979 EAST DEER CREEK DRIVE IN SECTION 15, TOWNSHIP 4 SOUTH, RANGE 6 EAST IN THE M (MOUNTAIN) ZONE.** ****RECOMMENDATION BY THE PLANNING COMMISSION ON THIS ITEM WILL BE CONSIDERED BY THE COUNTY COUNCIL AS THE LAND USE AUTHORITY, AT A PUBLIC HEARING ON MARCH 18, 2015.***

<u>**Public Comments**</u>

Chair Gappmayer asked if there was anyone here opposing this matter if there was any public comment and there was none so the public comment period was closed.

<u>**Findings**</u>

1. Lot combinations assure less density, more open space, and fewer septic drain fields.
2. Based on the current zoning designation and its associated regulations, the applicant would forfeit the right for further subdivision of their property.
3. There are no public roads being vacated or amended as part of this plat amendment.
4. No objections have been received as of the writing on this report.
5. Utah law allows the County to approve a plat amendment if the County finds that (a) there is good cause for the vacation, alteration, or amendment; and (b) no public-street, right-of-way, or easement has been vacated or altered.
6. Staff believes that good cause exists for the plat amendment. The request complies with zoning and the County engineering department is in agreement. No public-street, right-of-way, or easement would be vacated or altered by the plat amendment. Therefore, Staff's position is that Utah law allows this plat amendment.

<u>**Conditions**</u>

1. Combined lots may continue to have water bond payments based on two lots.
2. Address for the proposed lot should be 9965 E. Deer Creek Drive.

<u>**Motion**</u>

Commissioner Jacobsmeyer made a motion that we accept this matter as a consent item and grant the plat amendment for the combining of Timber Lakes lots 1721 and 1722 and accept the findings and conditions and the staff report and recommend this matter to the Wasatch County Council for their approval.

Commissioner Hayward seconded the motion.

The motion carries with the following vote:
AYE: Robert Gappmayer, Jon Jacobsmeyer, Gerald Hayward, Paul Probst.
NAY: None.

ITEM 3 **JEFF GRAHAM, REPRESENTATIVE FOR VR ACQUISITIONS LLC, IS REQUESTING A PLAT AMENDMENT TO PLAT A OF VICTORY RANCH. THE PROPOSAL IS TO REMOVE PLAT NOTES 4 (MAXIMUM BUILDING SQUARE FOOTAGE), 9 (RESTRICTING BUILDING HEIGHTS TO 28'), AND 13 (REMOVING THE LIMITS OF DISTURBANCE NOTE) AND THEN ADD A NOTE REGARDING ENFORCEMENT OF THE CC&R'S, DESIGN GUIDELINES, AND BYLAWS OF VICTORY RANCH. PLAT A IS LOCATED IN SECTIONS 31 AND 32, TOWNSHIP 2 SOUTH, RANGE 6 EAST IN THE JORDANELLE BASIN OVERLAY ZONE (JBOZ)** ****RECOMMENDATION BY THE PLANNING COMMISSION ON THIS ITEM WILL BE CONSIDERED BY THE COUNTY COUNCIL AS THE LAND USE AUTHORITY, AT A PUBLIC HEARING ON MARCH 18, 2015.***

<u>**Public Comment**</u>

Chair Gappmayer asked if there was anyone here opposing this action and if there is any public comment and there was none so the public comment period was closed.

<u>**Findings**</u>

1. As of the writing of this report our office has received one verbal objection to removing the 6,700 sf of maximum floor area. According to the developer, between the time of the objection and the meeting the developer was able to resolve their concerns.
2. No public roads are being vacated as part of this plat amendment.
3. This proposed revision conforms to the Wasatch County development standards.
4. Utah law allows the County to approve a plat amendment if the County finds that (a) there is good cause for the vacation, alteration, or amendment, and (b) no public-street, right-of-way, or easement has been vacated or altered.
5. The request complies with zoning. No public street, right-of-way, or easement would be vacated or altered by the plat amendment. Therefore, Staff's position is that Utah Law allows this plat amendment.

Conditions

1. Add plat note stating that at the time of the building permit, applicants will need to identify whether they are building on slopes less than 30 percent but over 25 percent on their site plan. If they are, they will be required to do a site specific geotechnical evaluation and will need to comply with all recommendations of that report.

Motion

Commissioner Hayward made a motion that we accept Victory Ranch Plat A amendment and accept it as a consent item and adopt the findings and conditions and the staff report and forward it onto the Wasatch County Council.

Commissioner Probst seconded the motion.

The motion carries with the following vote:
AYE: Robert Gappmayer, Paul Probst, Jon Jacobsmeyer, Gerald Hayward.
NAY: None.

ITEM 4 LYNN RUSSELL IS REQUESTING A CONDITIONAL USE PERMIT FOR A GUEST ACCESSORY DWELLING UNIT. THE REQUEST WOULD ALLOW THE APPLICANT TO CONSTRUCT A GUEST DWELLING ON THE SECOND FLOOR OF A FUTURE ACCESSORY STORAGE STRUCTURE ON HIS 5 ACRE PARCEL. THE PROPOSAL IS LOCATED AT 1823 NORTH DUTCH CANYON ROAD IN SECTION 23, TOWNSHIP 3 SOUTH, RANGE 4 EAST IN THE RA-1 (RESIDENTIAL AGRICULTURAL 1-ACRE) ZONE.

Staff

Luke Robinson, Assistant Wasatch County Planner, addressed the Wasatch County Planning Commission and indicated that this request is for a conditional use approval of a proposed guest accessory dwelling unit above a proposed detached garage. Luke also indicated that the proposed Guest ADU would be located on the applicant's five acre parcel that has an existing dwelling in the RA-1 Zone. Luke also indicated that notice has been sent to property owners within 500 feet and no objections have been received as of the writing of the report. Also this matter ends with the Wasatch County Planning Commission and is not forwarded to the Wasatch County Council.

Luke also indicated that some proposed findings are:

1. The proposal complies with the Conditional Use 16.23.07 and Guest ADU 16.21.46 sections of the code.
2. Notice has been sent to the neighboring property owners within 500 feet of the lot and no objections have been received as of the writing of this report.

Luke also indicated that the conditions are:

1. Since this is an additional dwelling a deed restriction needs to be filed by the applicant on a form provided by the county that prohibits the rental, sale, condominiumization, subdivision, or separation of the guest ADU as a separate parcel of property an illegal subdivision of property. The applicant must provide the recorded deed restriction to the planning department prior to the building permit being issued.
2. Since county code allows for only one point of connection for water, sewer and electrical, applicant must size these utilities appropriately when the connection is made, to serve both the Guest ADU, and the residence and any other buildings. No additional connections to utilities will be allowed.
3. Will Serve letters must be provided by the applicant for electric and natural gas previous to them approving a building permit.
4. This approval is only granting the use of a Guest ADU. Applicant will need to obtain a building permit.
5. Applicant will need to deed restrict parcel #00-0014-3144 (5acres) so that it cannot be built on, unless an alternative septic system is installed to service the existing house and proposed Guest ADU parcel #00-0007-4034 or is connected to sewer.
6. Fire Marshal-Sprinklers and additional fire flow may be required.
7. Amend existing well permit #55-5805 to the name of the current owner of property and to include two ERUs.
8. Roll back taxes must be paid.

Applicant

Lynn Russell, the applicant, addressed the Wasatch County Planning Commission and indicated that they accept the conditions as outlined. Lynn also indicated that he has some questions about the roll back taxes because the ground has an agricultural use on it that is run by Grant Kohler of Midway, Utah. Lynn indicated that he hopes that will be clarified. Lynn also indicated that this will become our permanent residence.

Public Comment

Chair Gappmayer then asked if there is any public comment regarding this matter.

Terryl Miller, adjoining property owner, addressed the Wasatch County Planning Commission and indicated that he has no problem with what is being requested by Lynn Russell and would recommend to you that you give him his Conditional Use.

Chair Gappmayer then closed public comment.

Motion

Commissioner Probst made a motion that we grant a conditional use permit to Lynn Russell with the Dutch Canyon Property for a Guest House and accept the findings and conditions and also the staff report.

Commissioner Hayward seconded the motion.

The motion carries with the following vote:
AYE: Jon Jacobsmeyer, Paul Probst, Robert Gappmayer, Gerald Hayward.
NAY: None.

ITEM 5 PAUL COOK, REPRESENTATIVE FOR WASATCH TANK LINES, IS REQUESTING A CONDITIONAL USE PERMIT AND SITE PLAN APPROVAL FOR CORPORATE OFFICES IN THE FORMER WESTERN TRADITIONS BUILDING AND PARKING FOR UP TO SIX SEMI-TRUCKS AND TRAILERS ON THE ADJOINING PROPERTY TO THE NORTH. THE PROPERTY FORMERLY FACILITATED A LOG MILL OPERATION. THE APPLICANT IS ALSO PROPOSING THAT THE TANKER TRUCKS ACCESS THE PROPERTY OFF OF 2400 NORTH, THROUGH AN ACCESS THAT IS JUST EAST OF THE CURRENT WESTERN TRADITIONS BUILDING, RATHER THAN DIRECTLY OFF OF HIGHWAY 40. THE PROPOSAL IS LOCATED AT 2383 SOUTH HIGHWAY 40 IN THE C (COMMERCIAL) ZONE.

<u>Staff</u>

Luke Robinson, the Assistant Wasatch County Planner, addressed the Wasatch County Planning Commission and indicated that Wasatch Tank Lines is requesting a conditional use permit for corporate offices in the former Western Traditions building and parking for up to six semi-trucks and trailers on the adjoining property to the north. Luke also indicated that as part of the site plan and conditional use approval the applicant will be required to make certain site improvements in order to comply with the code as well as mitigate any possible negative impacts from the proposal. Also the commercial zone allows office space as a permitted use. Luke also indicated that the mill operations on the applicant's property will need to be cleaned up as a part of the conditional use approval. Also there are a number of storage and ancillary buildings on the site, some of which will be torn down, and two of which will remain erected on the portion that Mr. Cook will own. Luke also indicated that the potion that the applicant will own has an existing well and septic tank that may serve the needs of the proposed use, the applicant is working with the Health Department to obtain their approval. Luke also indicated that because of the change in access, the applicant will be required to make onsite and offsite improvements in order to allow the tankers to use that portion of the site for ingress and egress. Luke also presented and made a part of the record a letter from Craig Keyser who was concerned about the trucks possibly blocking traffic on 2400 South and hopefully the improvements should help address those concerns and let him know about that and haven't had a response back but just so that you are aware of that.

Luke indicated that some proposed findings are:

1. The zone requires a 50 foot setback from state and federal highways.
2. The applicant's property is located within the annexation boundary for Heber City.
3. Wasatch County's General Plan states that any development that is within Heber City's annexation boundary occur in accordance with their standards. Heber City Planning Anthony Kohler has provided a letter stating that they have no opposition to the proposal and that it addresses any concerns they may have had.
4. There is not a Corridor Access Management Agreement with UDOT for US 40 south of the US 189/US40 intersection but the intent would be to maintain the highway as a high capacity and high volume facility. Any further development that impacts Highway 40 should be coordinated with UDOT.
5. Currently the applicant does not possess an adequate easement to access Highway 40 directly from their property. According to UDOT they currently have a 16 foot wide agricultural and emergency access. The current property owner has been disputing that with UDOT, but the applicant will need to work with UDOT to resolve it if they intend to use an access onto Highway 40 for regular traffic.
6. The applicant has moved their primary entrance to 2400 South/Center Creek and has addressed all of the concerns from the county engineer and public works department. Both departments have approved the use of 2400 South and Mill Road for the applicant to access Highway 40.
7. The property is abutted on the east by the RA-1 residential zone which is currently being farmed. Property across Center Creek to the south is zoned RA-1 and primarily farmed as well.
8. The land use code requires all new commercial uses to be connected to a sewer system. There is a preexisting commercial use on the property that had a septic system. The Health Department is currently working with the applicant to verify that the septic tank is adequately sized for the proposed use.
9. The parking of up to six semi-trucks at any time may create impacts that may need to be mitigated. As part of the site plan approval, the applicant has been required to make improvements to bring the site up to current commercial standards and to help buffer some of the negative impacts.
10. The entrance off of 2400 South will be more than the 80 feet from the intersection of 2400 South and Highway 40 as required by 16.33.12. It will also be 20' from the east property line.
11. With change in use, the applicant is being required to make site improvements so that the site meets current zoning requirements.

Luke indicated that some conditions are:

1. Parking is only permitted for up to six tanker trucks at any given time.
2. Clean up debris and junk from log mill operations on applicant's property.
3. Grant easement to Mr. Sweat for access into the remaining portion of property.
4. Vehicular access will be relocated to 12400 South where improvements will be made to allow the tankers a means of ingress and egress without encumbering regular traffic.
5. The current access directly onto Highway 40 will be gated and locked until an agreement can be reached with UDOT regarding its use.

6. A six foot solid or vinyl fence will need to be installed along the east property line of the property where it abuts the RA-1 zone.
7. Enclose the trash container.
8. Trucks should not be left idling for extended periods of time, maintenance should not be performed on site, or storage of materials outside.
9. There will be a 10 foot landscape buffer with deciduous and evergreen trees at 25 foot spacing maximum installed along the east property line of the property where it abuts the RA-1 Zone.
10. A 30 foot landscaping buffer must be installed along street frontages except for along parking stalls where 15 foot will be permitted because of existing parking with deciduous and evergreens trees 2 inch caliper, 6 foot tall minimums at 50 foot maximum spacing.
11. All lighting should be dark sky compliant and meet the standards in 16.21.16.
12. Install new fire hydrant at south east corner of parcel per fire marshal requirements.
13. Address posted on the building should be 1057 East Center Creek.
14. The billboard on the property must comply with the approvals granted to it.

<u>Applicant</u>

Paul Cook, the applicant, addressed the Wasatch County Planning Commission and indicated that his company travels throughout six states. Paul indicated that they have been looking for a place that was adequate to have an office. This office will make it possible to have drivers of trucks located in Heber City and makes it possible to hire people in Heber City for our business. Paul also indicated that shift changes with the trucks often take place at night and early morning hours and possibly that may happen in the middle of the day. Paul indicated that if the trucks park it should be for a very short time. Paul indicated that half of the crew and fleet are stationed in Salt Lake City. Paul also indicated that they agree to comply with all the conditions listed by the Wasatch County Planning Commission but there is one request. The request is that as far as the landscaping and the fence on that east side because it is being required to be a solid fence because of the residential and would ask that we be given at least three years to complete that knowing that right now it isn't residential. If it goes residential any time between that point obviously we would comply.

<u>Public Comment</u>

Chair Gappmayer then opened the matter up for public comment.

Lew Giles, an adjoining neighbor to the east, addressed the Wasatch County Planning Commission and indicated that there is a power pole on the fence line and Lew was wondering how the power company will get to that pole because they have been entering his property to fix the power if need be. Lew indicated that probably Heber Light and Power should be contacted to see how they intend to take care of the power problems that are associated with that pole. Lew also indicated that needs to be addressed with the power company.

Councilman Kipp Bangerter, from the Wasatch County Council, addressed the Wasatch County Planning Commission and indicated that there will be no safety issue on the highway because by closing that gate and letting them turn which they are very capable making the turn in either direction into their driveway is one hundred times safer than trying to go through that gate. Also there will be no problem with the trucks idling because with the new trucks all that will be emitted is nitrogen and water.

<u>Motion</u>

Commissioner Probst made a motion that we grant a conditional use permit for 2383 South Highway 40 to Paul Cook, Wasatch Tank Lines with the findings listed and the conditions listed amending Condition No. 6 to three years or when residential building takes place and to check with Heber Light and Power regarding the concern that Lew Giles had. Also to accept the staff report.

Commissioner Jacobsmeyer seconded the motion.

The motion carries with the following vote:
AYE: Robert Gappmayer, Jon Jacobsmeyer, Gerald Hayward, Paul Probst.
NAY: None.

ITEM 6 DISCUSSION AND POSSIBLE RECOMMENDATION OF ORDINANCE 15-03 WHICH IS AN AMENDMENT TO 16.41 THE JORDANELLE SPECIALLY PLANNED AREA (JSPA) TO ADD APPENDIX A WHICH IS BYLAWS FOR THE JSPA PLANNING COMMISSION.
RECOMMENDATION BY THE PLANNING COMMISSION ON THIS ITEM WILL BE CONSIDERED BY THE COUNTY COUNCIL AS THE LAND USE AUTHORITY, AT A PUBLIC HEARING ON MARCH 18, 2015.

<u>Staff</u>

Doug Smith, the Wasatch County Planning Director, addressed the Wasatch County Planning Commission and indicated that this matter is in regards to having a separate Planning Commission for the JSPA, the Jordanelle Specially Planned Area. Since it is a separate Planning Commission there needs to be separate bylaws. Doug also indicated that the bylaws are the same as the Wasatch County Planning Commission except this language is added which states that members are required to re-apply when terms are up and are considered expired unless re-appointed or re-appointed on an interim basis by the Wasatch County Council. Craig Chambers, the Deputy Wasatch County Attorney, addressed the Wasatch County Planning Commission and indicated that he has an issue with regards to getting people to serve and with this language that Doug has put into the bylaws it eliminates the possibility for when a person's term expires that they continue to serve until somebody else is called and that is the way it works under the Wasatch County Planning Commission. Craig also indicated that his concern is a practical concern and probably can be with Mike Davis, the Wasatch County Manager, and get the concern taken care of.

Public Comment

Chair Gappmayer then asked if there was any public comment concerning the matter and there was none so the public comment period was closed.

Motion

> **Commissioner Hayward made a motion that we approve Item No. 6 and accept the changes to Ordinance No. 15-03 amendment and recommend this matter to the Wasatch County Council.**
>
> **Commissioner Probst seconded the motion.**
>
> **The motion carries with the following vote:**
> **AYE: Robert Gappmayer, Jon Jacobsmeyer, Paul Probst, Gerald Hayward.**
> **NAY: None.**

ITEM 7 DISCUSSION AND POSSIBLE RECOMMENDATION OF ORDINANCE 15-02 WHICH IS AN AMENDMENT TO 16.21.44 (B,14) WHICH COULD ALLOW FOR FREE STANDING SIGNS IN RESIDENTIAL ZONES FOR VALUE ADDED AGRICULTURE USES AS A CONDITIONAL USE. *RECOMMENDATION BY THE PLANNING COMMISSION ON THIS ITEM WILL BE CONSIDERED BY THE COUNTY COUNCIL AS THE LAND USE AUTHORITY, AT A PUBLIC HEARING ON MARCH 18, 2015.*

Staff

Doug Smith, the Wasatch County Planning Director, addressed the Wasatch County Planning Commission and indicated that this proposal would allow for free standing signs for value added agriculture uses on a countywide basis. Doug also indicated that this particular code amendment has been applied for by Heber Valley Artisan Cheese on River Road close to Midway. Also that the original code specifically did not allow free standing signs only attached signs. Also the original thought was that value added agriculture uses are located in residential zones and usually have residents in the immediate vicinity and free standing signs were not allowed so they would blend in better with the residential uses. Doug then indicated that home occupations allowed in residential zones are not allowed to have free-standing signs and the thought was to be consistent with all uses in Wasatch County.

Doug also indicated that said allowances should be made to allow advertising in a tasteful and un-obtrusive way and not impact the residential nature of the area.

Doug then went through and indicated the changes that will need to be made to 16.21.44 (B). The change is on 14-a. It says that freestanding signs are allowed if they are approved as a conditional use and are no larger than 32 square feet inclusive of the entire structure and no more than nine feet in height. Freestanding signs can only be illuminated if the course is external and directed downward. Signs should be earth tone in color and no flashing or bright lights are allowed. Freestanding signs shall be set back from the property lines a minimum of ten feet and that minimum set back has been added and also added the thirty-two square feet inclusive of the entire structure.

Doug also indicated that Mr. Grant Kohler will be in next month for the conditional use for the sign and to add an additional storage building behind his retail store.

Public Comment

Chair Gappmayer then asked if there was any public comment regarding the matter and there was none so the public comment period was closed.

Motion

> **Commissioner Jacobsmeyer made a motion that we pass Ordinance 15-02 amending 16.21.44(B, 14) of the Wasatch County Code and forward the matter to the Wasatch County Council.**
>
> **Commissioner Hayward seconded the motion.**
>
> **The motion carries with the following vote:**
> **AYE: Jon Jacobsmeyer, Robert Gappmayer, Paul Probst, Gerald Hayward.**
> **NAY: None.**

ADJOURNMENT

Motion

> **Commissioner Probst made a motion to adjourn.**
>
> **Commissioner Jacobsmeyer seconded the motion.**
>
> **The motion carries with the following vote:**
> **AYE: Paul Probst, Jon Jacobsmeyer, Robert Gappmayer, Gerald Hayward.**

NAY: None.

Meeting adjourned at 9:30 p.m.

____

ROBERT GAPPMAYER, CHAIRMAN

Appendix 4
Alternative Plan - Option 2

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK 138kV TRANSMISSION LINE

PHOTO SIMULATION OPTION 2

LOCATION MAP

Photo simulations are for discussion purposes only. Final design may change pending public and regulatory review.

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK
138kV TRANSMISSION LINE

PHOTO SIMULATION
OPTION 2

Appendix 5

Alternative Plan - Option 3

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK
138kV TRANSMISSION LINE

PHOTO SIMULATION OPTION 3
LOCATION MAP

Photo simulations are for discussion purposes only. Final design may change pending public and regulatory review.

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK
138kV TRANSMISSION LINE

PHOTO SIMULATION
OPTION 3

Appendix 6

Alternative Plan - Browns Canyon Road Option

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

POWER ENGINEERS

COALVILLE TO SILVER CREEK
138kV TRANSMISSION LINE

BROWN'S CANYON ROAD OPTION
VIEWPOINT 2 LOCATION MAP

Photo simulations are for discussion purposes only. Final design may change pending public and regulatory review.

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

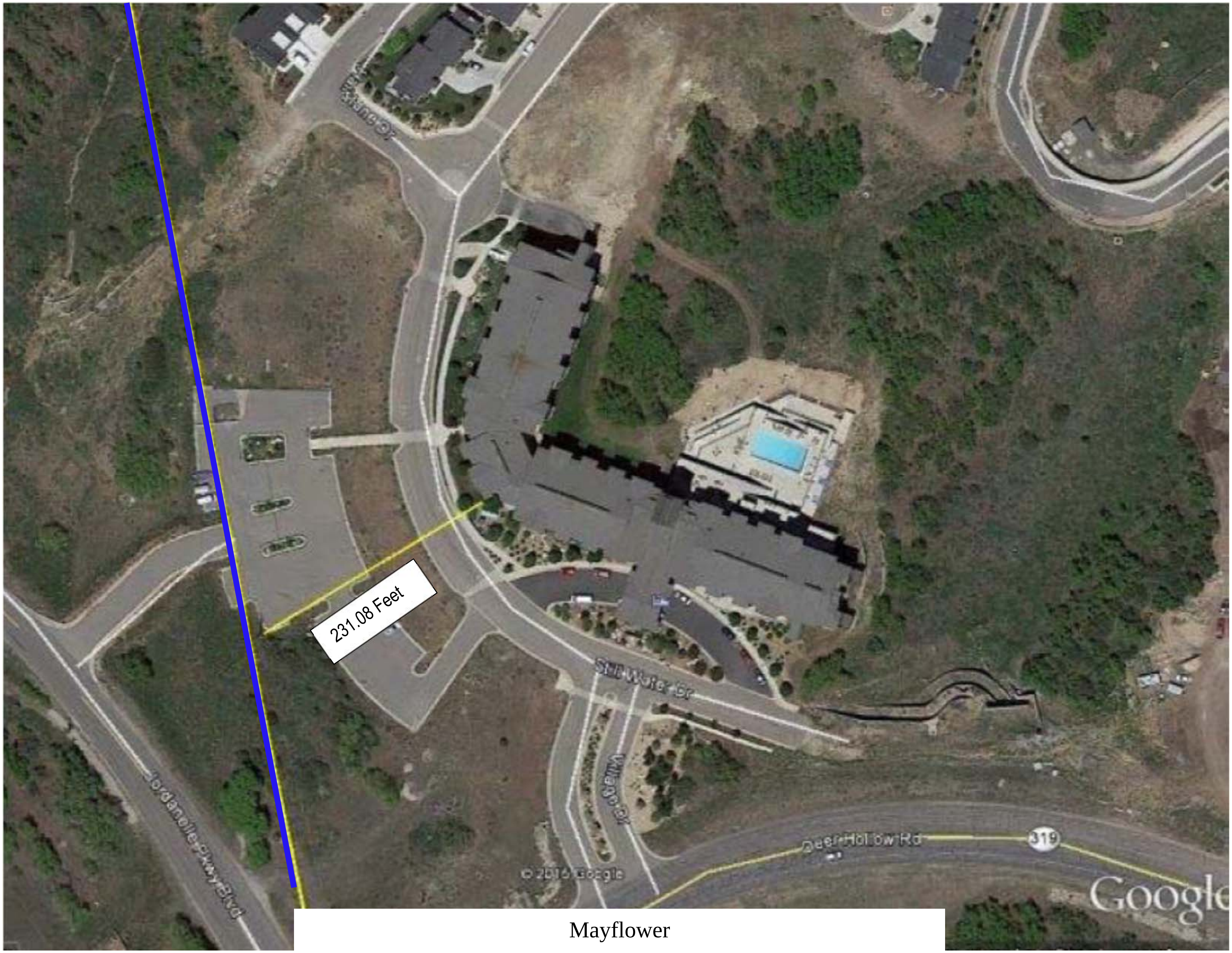
POWER ENGINEERS

COALVILLE TO SILVER CREEK 138kV TRANSMISSION LINE

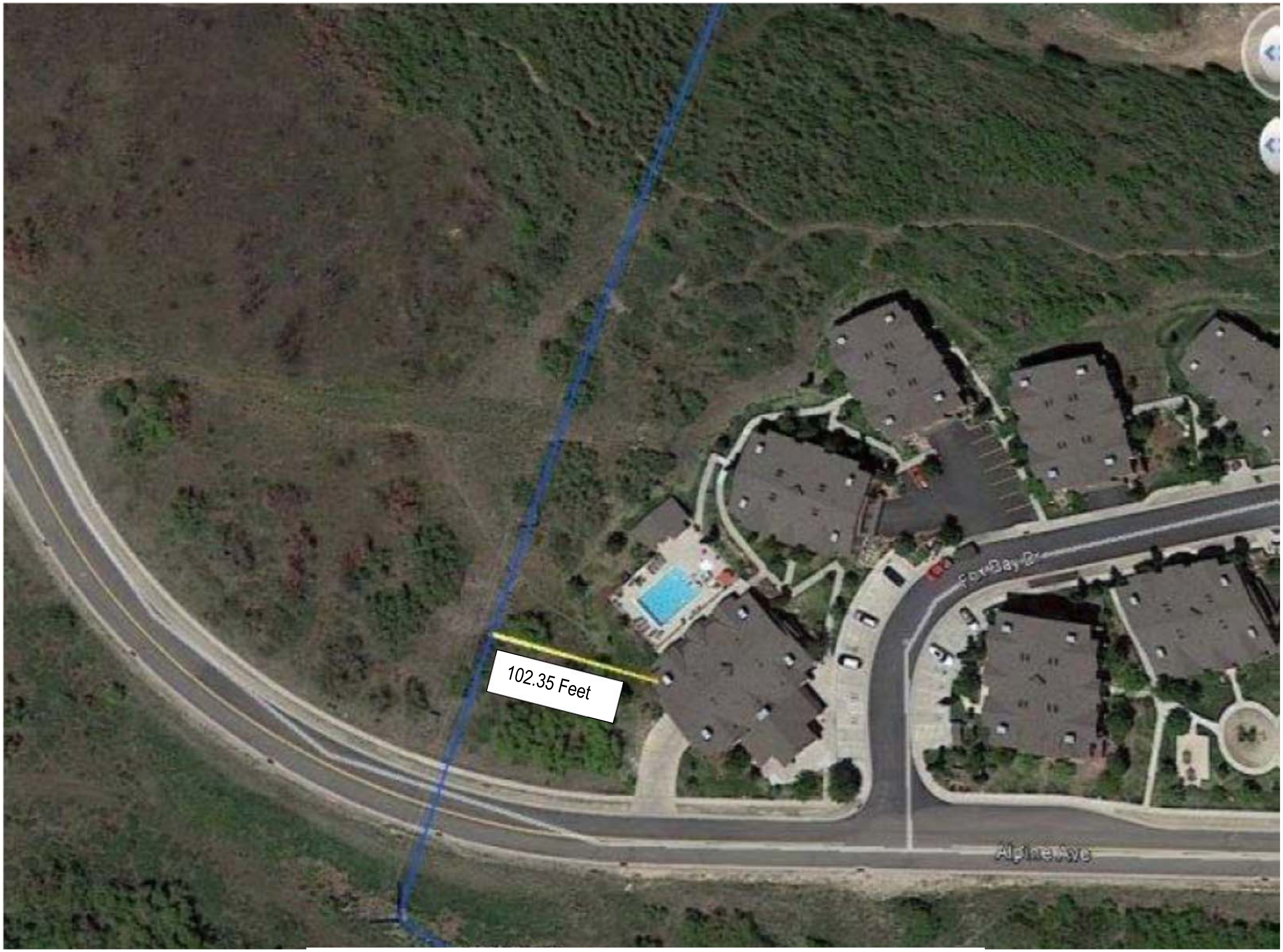
BROWN'S CANYON ROAD OPTION VIEWPOINT 2 PHOTO SIMULATION

Appendix 7
Comparable Existing Developments

Stillwater


231.08 Feet
Still Water Dr
Deer Hollow Rd
319
© 2016 Google
Google

Mayflower



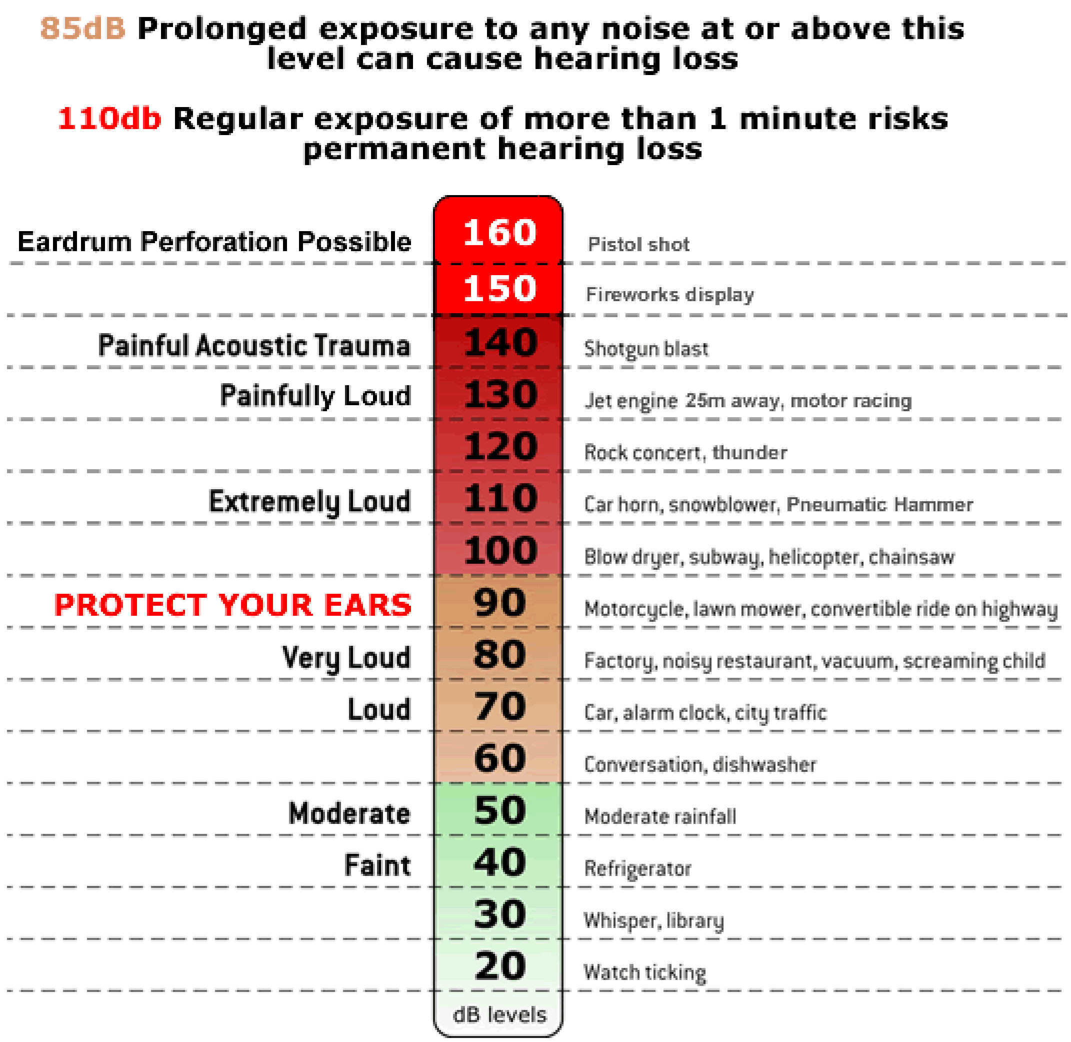
Foxhollow

Appendix 8
Noise Analysis and Articles

Calculated sound levels for double circuit transmission line

4 Pole Tangent structure:	28.3 dB (A)
2 Pole Angle Structure:	31.0 dB (A)
1 Pole Angle Structure:	30.7 dB (A)

From the www.edzearmuffs.com/Noise_Levels The chart shows typical noise levels in dB.



Appendix 9
Geotechnical Report

GEOTECHNICAL ENGINEERING REPORT

Southwest Wyoming to Silver Creek Transmission Line – Coalville to Silver Creek Segment

Property location:
NEAR EVANSTON, WYOMING TO PARK CITY, UTAH
PROJECT NO. 11173

Prepared for:
POWER ENGINEERS
ATT: MICHEL YBARRONDO
2041 SOUTH COBALT WAY
MERIDIAN, ID 83642

December 6, 2011

Chad P. Bhongir, PE
Geotechnical Engineer

David P. Wilding, PE
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
#157952
DAVID PRESTON WILDING
12/6/11
STATE OF UTAH

PREPARED BY:
WILDING ENGINEERING
14721 SOUTH HERITAGE CREST DRIVE
BLUFFDALE, UTAH 84065

LIST OF TABLES AND FIGURES

1.0. INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed Southwest Wyoming to Silver Creek Transmission Line, the Coalville to Silver Creek Segment from near Coalville, Utah to Park City, Utah. Wilding Engineering, Inc previously performed geotechnical investigations for the north and south segments of this transmission line and provided recommendations in the geotechnical engineering reports dated January 14, 2011, June 16, 2011, and August 3, 2011. The subsurface field investigations were performed in accordance with Wilding Engineering proposal dated October 28, 2011, and authorized by Mr. Michel Ybarrondo of Power Engineers.

2.0. PURPOSE AND SCOPE

The purpose of this geotechnical investigation was to gather pertinent information regarding the subsurface conditions at each site in order to develop opinions and recommendations regarding the geotechnical design and construction of the proposed transmission line. For this project, the following scope of services was performed:

- Contacted Blue Stakes of Utah and One Call of Wyoming at least 48 hours prior to drilling activities and coordinated access to property with Power/PacifiCorp Company Representative.
- Performed a site reconnaissance, reviewed the geologic, and surface conditions for each transmission line tower structure location.
- Subsurface conditions at the proposed site locations were evaluated using 21 borings, designated B-DP-228, BP-P-201, B-DP-202, B-203, B-204, B-DP-205, B-206 through B-208, B-DP-209, B-210, B-211, B-DP-212 through B-DP-215, B-DP-218, B-DP-219, B-DP-221, B-DP-222, and B-DP-224 as indicated on Figures A-1 through A-21 in Appendix A. Borings were advanced using a B-80 truck mounted drill rig equipped with ODEX drilling system to depths ranging from about 20 to 40 feet below existing site grades. The number, depth, and locations were selected by Power Engineers. The boring locations were marked in the field by a Wilding Engineering Geotechnical Engineer.
- A Boring Log for each test location describing the types of soil encountered and other pertinent information was prepared. Bore holes were backfilled using on-site soils to near original site grades. These logs are located in Appendix B.
- Select laboratory tests were performed to develop geotechnical engineering recommendations laboratory tests included: moisture content, unit weight, atterberg limits, sieve analyses, and chemical testing (soil pH, laboratory soil resistivity, water-soluble sulfates).

- Provide the following design parameters for each layer of soil encountered in the transmission line borings that will support structures:

  Properties for pier foundation design utilizing "CAISSON" by Power Line Systems, Inc.

  - Cohesive (Clay) or Cohesionless (Sand) Soil
  - Thickness
  - Soil Density (pcf)
  - Undrained Shear Strength (psf) for Cohesive Soils
  - Rankine Coefficient of Earth Pressure (Kp) for Cohesionless Soils
  - Skin friction

- In addition to providing the design parameters for CAISSON design software, we have provided the soil characteristics for the use of L-PILE design software by Ensoft, Inc.

  Properties for pier foundation design utilizing "LPILE" by Ensoft, Inc.

  - Soil Type, (p-y curve), for each layer
  - Properties of each soil layer
    - Effective Unit Weight
    - Consistency
    - Soil layer thickness
    - Effective Friction Angle, deg
    - P-y modulus, k
    - Strain Factor, ε_{50}
    - Undrained Cohesion, c
    - Young's Modulus, Er
    - Uniaxial Compressive Strength
    - RQD, %
    - K_rm
    - Skin Friction in compression and uplift
    - Maximum End Bearing

- Conducted a geotechnical engineering evaluation of the available data to provided recommendations regarding PLS-CAISSON drilled pier parameters, foundation type, groundwater conditions, seismic design criteria including site class definition and spectral acceleration values (S_s and S_1), liquefaction potential, and construction considerations.

3.0. SITE AND PROJECT INFORMATION

3.1 Proposed Project Description

Based upon the information provided, we understand that PacifiCorp is planning to construct a new transmission line from Southwest Wyoming to Silver Creek Substation. The proposed transmission line runs parallel to an existing transmission line. The transmission borings alignment for Coalville to Silver Creek Segment is shown on the "General Site Vicinity Maps" designated as A-1 through A-4 in Appendix A.

We anticipate that drilled pier foundations will be used to support transmission line tower structures. Based on the information provided, we understand that the computer programs such as CAISSONS by Powerline Systems, Inc and/or LPILE v 5.0 by Ensoft, Inc. will be used to design drilled pier foundations to support transmission line tower structures.

Recommendations presented in this report are based upon the available project information and the subsurface soil conditions described in this report. If any of the above noted information presented is incorrect or has changed, please inform Wilding Engineering in writing so that we may amend the recommendations presented in this report appropriately.

3.2 Existing Site Conditions

The existing conditions of the proposed transmission tower sites are unique to each structure location. The following subsections describe the conditions near each boring location. Table 3.2 lists the latitude and longitude for each boring.

Table 3.2: Boring Locations

Boring	Latitude	Longitude
B-DP-228	41.064	-111.522
B-DP-201	40.912	-111.407
B-DP-202	40.912	-111.405
B-203	40.875	-111.399
B-204	40.838	-111.401
B-DP-205	40.810	-111.405
B-206	40.809	-111.404
B-207	40.798	-111.410
B-208	40.773	-111.409
B-DP-209	40.768	-111.406
B-210	40.757	-111.401
B-211	40.757	-111.392
B-DP-212	40.737	-111.365
B-DP-213	40.737	-111.368
B-DP-214	40.736	-111.372
B-DP-215	40.736	-111.373
B-DP-218	40.723	-111.388
B-DP-219	40.717	-111.395
B-DP-221	40.716	-111.407
B-DP-222	40.702	-111.435
B-DP-224	40.684	-111.453

3.2.1 Exploration Site B-DP-228

Boring B-DP-228 is located approximately ½-mile southwest of the intersection of 6800 East Street and 1800 North Street in Croydon, Utah. The boring location is located just north of an existing transmission pole on the access road. The transmission pole is located near the bottom of an existing slope. The site generally slopes down to the north.

3.2.2 Exploration Site B-DP-201

Boring B-DP-201 is located approximately 0.1 miles southwest of the intersection of 100 South Street and I-80 Frontage Road in Coalville, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site is relatively flat gently sloping downward to the east.

3.2.3 Exploration Site B-DP-202

Boring B-DP-202 is located on the southwestern corner of the intersection of 100 South Street and I-80 Frontage Road in Coalville, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site is relatively flat gently sloping downward to the east.

3.2.4 Exploration Site B-203

Boring B-203 is located approximately 400 feet northwest of the intersection of West Hoytsville Road and Creamery Lane in Hoytsville, Utah. The boring location is located east of an existing transmission pole in the vacant land. At the time of our field investigation, the proposed site was vacant land vegetated with various grasses and weeds. The site generally slopes down to the east.

3.2.5 Exploration Site B-204

Boring B-204 is located approximately 1/3-mile southeast of the intersection of West Hoytsville Road and Valley View Drive near Wanship, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site is relatively flat gently sloping downward to the east.

3.2.6 Exploration Site B-DP-205

Boring B-DP-2058 is located approximately 300 feet southest of the intersection of 2100 South Street and 50 East Street in Wanship, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site is relatively flat slopes gently down to the east.

3.2.7 Exploration Site B-206

Boring B-206 is located approximately 0.2 miles east of Highway 32 and just south of I-80 in Wanship, Utah. The boring is located near an existing transmission pole structure. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site slopes downward to the east.

3.2.8 Exploration Site B-207

Boring B-207 is located approximately 0.15 miles southwest of the intersection of Highway 32 and Bridge Hollow Drive in Wanship, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site slopes downward to the east.

3.2.9 Exploration Site B-208

Boring B-208 is located approximately 0.15 miles northwest of the intersection of Highway 32 and Rockport Boulevard near Wanship, Utah. The boring location is located near the edge of an existing slope. At the time of the field investigation, the proposed site was vacant land used as a parking area. The site slopes downward to the west.

3.2.10 Exploration Site B-DP-209

Boring B-DP-209 is located approximately ½-mile south of the intersection of Highway 32 and Rockport Boulevard near Wanship, Utah. The boring location was drilled on the west side of Rockport Boulevard due to limited accessibility to the actual boring location. The site slopes downward to the east.

3.2.11 Exploration Site B-210

Boring B-210 is located approximately ½-mile west of the intersection of Highway 32 and Three Mile Canyon Road near Wanship, Utah. The boring is located in the landfill property just south of an existing transmission pole structure. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site slopes down to the south.

3.2.12 Exploration Site B-211

Boring B-211 is located approximately 1/3-mile south of the intersection of Highway 32 and Three Mile Canyon Road near Wanship, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site generally slopes down to the east.

3.2.13 Exploration Site B-DP-212

Boring B-DP-212 is located approximately 0.8 miles west of the intersection of Browns Canyon Road and Highway 32 near Peoa, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site is relatively flat sloping gently to the east.

3.2.14 Exploration Site B-DP-213

Boring B-DP-213 is located approximately 1 mile west of the intersection of Browns Canyon Road and Highway 32 near Peoa, Utah. The proposed boring location is near the bottom of an existing hillside. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site slopes downward to the east.

3.2.15 Exploration Site B-DP-214

Boring B-DP-214 is located approximately 1.15 miles west of the intersection of Browns Canyon Road and Highway 32 near Peoa, Utah. The proposed boring location is near the top of an existing hill. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site slopes downward to the east.

3.2.16 Exploration Site B-DP-215

Boring B-DP-214 is located approximately 1.2 miles west of the intersection of Browns Canyon Road and Highway 32 near Peoa, Utah. The proposed boring location is near an existing 3-pole structure. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site generally slopes downward to the south.

3.2.17 Exploration Site B-DP-218

Boring B-DP-218 is located approximately ¼-mile northeast of the intersection of Browns Canyon Road and Highview Road near Peoa, Utah. The proposed boring location is near an existing transmission pole structure. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site generally slopes downward to the south-southeast.

3.2.18 Exploration Site B-DP-219

Boring B-DP-219 is located approximately 1/3-miles southwest of the intersection of Browns Canyon Road and Highview Road near Peoa, Utah. The proposed boring location is near an existing transmission pole structure in a gravel pit property. At the time of the field investigation, the proposed site was vacant land used for staging purposes. The site generally slopes downward to the north.

3.2.19 Exploration Site B-DP-221

Boring B-DP-221 is located approximately 0.9 miles southwest of the intersection of Browns Canyon Road and Highview Road near Peoa, Utah. The proposed boring location on an existing gravel pit access road. The site generally slopes downward to the north-northwest.

3.2.20 Exploration Site B-DP-222

Boring B-DP-222 is located approximately 0.7 miles northwest of the Browns Canyon Road and Wright Sheep Road near Park City, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site is relatively flat sloping gently to the east-northeast.

3.2.21 Exploration Site B-DP-224

Boring B-DP-224 is located approximately 1/3-mile east of the intersection of Highway 248 and Old Highway 40 near Park City, Utah. At the time of the field investigation, the proposed site was vacant land with various grasses and shrubs. The site generally slopes downward to the south.

4.0. GENERAL GEOLOGY AND HYDROLOGY

4.1 Surficial Geology

Based on available geologic maps (Progress Report Geologic Map of the Ogden 30’ x 60’ Quadrangle, Utah and Wyoming – Year 3 of 3 by James C. Coogan and Jon K. King, 2001 utilized for this report), the boring locations are located in the geologic defined areas as follows: **Kwc** – B-DP-228; **Qal** – B-DP-201, B-DP-202, B-203, B-204, B-DP-205, B-206; **Keh** – B-207; **Kk** – B-208, B-DP-209, B-DP-212; **Jp** – B-210; **Kfo** – B-211; **Tkt** – B-DP-213, B-DP-214, B-DP-215, B-DP-218, B-DP-219, B-DP-221, B-DP-222; **Tkb** – B-DP-224.

- **Kwc** – Weber Canyon Conglomerate (Upper Cretaceous-Campanian/late Santonian) Red, gray and tan, boulder to cobble conglomerate with minor sandstone and mudstone interbeds; exposed above the buried Crawford thrust trace in Lost Creek drainage and along the Right Fork of South Ogden River east of Causey Dam; clasts are from the Tintic Quartzite, Weber Quartzite, Nugget Sandstone, Lodgepole Limestone, Park City Formation, and Twin Creek Limestone; contains progressive intraformational unconformities; at least 1,900 feet (580 m) thick near Devils Slide and forms cliffs.

- **Qal** – Stream alluvium, Holocene – Sand, silt, clay, and gravel in channels and floodplains; composition depends on source area; suffixes 1 and 2 indicate ages where they can be separated in the area of former Lake Bonneville, with 2 including low terraces.
- **Keh** – Hams Fork Member of the Evanston Formation (Upper Cretaceous) – Medium- to light-gray and greenish-gray siltstone and claystone, light-gray to yellowish-gray and brownish-gray sandstone, and basal pebble to cobble, locally boulder conglomerate. Sandstone contains reddish-brown-weathering concretions in places. Conglomerate contains clasts of Precambrian quartzite derived from the Willard thrust sheet to the north of the map area. Thickest section is about 800 m on northeast side of Cherry Canyon, east of Wanship in the central part of the quadrangle. Pollen indicate a late Campanian to early Maastrichtian age.
- **Kk** – Kelvin Formation (Lower Cretaceous), Upper Member – Yellowish-gray, grayish-red, and light- to moderate-red sandstone; gray, reddish-brown, and grayish-red siltstone and claystone; and conglomerate. Comglomerate beds thicker and more numerous west of East Canyon Creek; contains pebbles and cobbles of sandstone, siltstone, and minor amounts of limestone. Unit about 1,300 m thick in Turner Hollow area; thins of west and south. About 470 m thick near head of Parleys Canyon.
- **Jp** – Preuss Sandstone (Middle Jurassic) – Reddish-brown, grayish-red and light- to moderate-red silty sandstone, sandstone, and silty shale. Contains anhydrite and salt in the subsurface in the Chalk Creek area and east of Franklin Canyon (Lamerson, 1982). About 300 m thick, but locally has been thickened due to deformation and flowage of salt, anhydrite, and associated shales.
- **Kfo** – Oyster Ridge Sandstone Member – Light-yellow to gray marine sandstone and pebbly sandstone locally overlain by nonmarine sandstone, siltstone, and silty shale. Contains early middle Turonian ammonite, Collignoniceras woolgari (Cobban and Reeside, 1952). Thickness 60-100 m.
- **Tkt** - Tuff – Interbedded light-yellow and yellowish-gray, fine-grained tuff, lapilli tuff, volcanic gravel, and thin lahar. Internedded with intertonguing upwards into coarse breccia of unit Tkb. Contains early Oligocene vertebrates near Peoa (Nelson, 1972). Thickness as much as 250 m.
- **Tkb** – Light-gray to gray lahar, flow breccia, and tuff – Proportion of tuff increases with distances with distance from volcanic centers. Sandstone and conglomerate composed of volcanic clasts occur distal to volcanic centers. Zircon fission-track age of 35.3 Ma and biotite K-Ar age of 37.5 Ma obtained from flow breccias north of Salt Lake City (Van Horn, 1981). Thickness as much as 500 m in Keetley region.

4.2 Geologic Hazards

4.2.1. Faulting

The proposed transmission line alignment is located within the Middle Rocky Mountains physiographic province. As shown in Table 4.2.1, Boring B-DP-228 is located closest to the Morgan Fault, Central Section; Borings B-DP-201, BDP-202, B-203 are located closest to the East Canyon Fault, Southern East Canyon Section; Borings B-204, B-DP-20, B-206 through B-208, B-DP-209, B-210, B-212, B-DP-212 through B-DP-215 are located closest to the East Kamas Fault; and Borings B-DP-218, B-DP-219, B-DP-221, B-DP-222, B-DP-224 are located closest to the Frog Valley Fault. Table 4.2.1 indicates the approximate distance to the nearest fault.

Table 4.2.1: Approximate Distances to Faults

Boring Location	Nearest Fault	Distance to Fault (Miles)
B-DP-228	Morgan Fault, Central Section	7.7
B-DP-201	East Canyon Fault, Southern East Canyon Section	10.1
B-DP-202	East Canyon Fault, Southern East Canyon Section	10.2
B-203	East Canyon Fault, Southern East Canyon Section	11.0
B-204	East Kamas Fault	9.9
B-DP-205	East Kamas Fault	9.0
B-206	East Kamas Fault	8.9
B-207	East Kamas Fault	8.9
B-208	East Kamas Fault	8.3
B-DP-209	East Kamas Fault	8.1
B-210	East Kamas Fault	7.7
B-211	East Kamas Fault	7.2
B-DP-212	East Kamas Fault	5.7
B-DP-213	East Kamas Fault	5.8
B-DP-214	East Kamas Fault	6.0
B-DP-215	East Kamas Fault	6.1
B-DP-218	Frog Valley Fault	6.3
B-DP-219	Frog Valley Fault	5.7
B-DP-221	Frog Valley Fault	5.2
B-DP-222	Frog Valley Fault	3.5
B-DP-224	Frog Valley Fault	2.0

4.2.2. Liquefaction

Liquefaction is a condition that may occur during a seismic event where loose sandy soils lose shear strength due to sudden increase in pore water pressure. A physical change occurs to the soil transforming it "from solid ground capable of supporting a structure, to quicksand-like liquid with a greatly reduced ability to bear the weight of a structure." Liquefaction can induce ground settlement and lateral spreading, which can result in damage to structures. Further details on liquefaction are presented in section 7.5.2 of this report.

5.0. FIELD EXPLORATIONS

5.1 Subsurface Investigation

Subsurface conditions at the proposed site locations were evaluated using 21 borings, designated B-DP-228, BP-P-201, B-DP-202, B-203, B-204, B-DP-205, B-206 through B-208, B-DP-209, B-210, B-211, B-DP-212 through B-DP-215, B-DP-218, B-DP-219, B-

DP-221, B-DP-222, and B-DP-224 at approximate locations indicated on Figures A-1 through A-21 in Appendix A. Borings were advanced using a B-80 truck mounted drill rig equipped with ODEX drilling system to depths ranging from about 20 to 40 feet below existing site grades. Borings with designation B- were advanced to a depth of 20 feet, while borings with designation B-DP- were advanced to a depth of 40 feet below existing site grades. Stratigraphy and classification of the soils were logged under the direction of a Geotechnical Engineer.

Soil samples were obtained at about 2½ to 5 foot intervals in each boring. Disturbed samples were either obtained by driving a standard 2-inch outside diameter (OD) split-spoon sampler or a 2.42-inch (I.D.) Modified California sampler into the soil a distance of 18 inches using a 140-lb down hole safety hammer dropped from a height of 30 inches. The number of blows required to drive the sampler 12 inches is known as the standard penetration resistance or N-value. Blowcounts obtained from Modified California sampler were adjusted by a correction factor of 0.65 to obtain N-values (Burimister 1948). The N-values provide a measure of the relative density of granular soils, such as sand, and the relative consistency, or stiffness of cohesive soils, such as clay or silt.

Disturbed soil samples were taken at various depths and examined in the field. Representative portions were stored in sealed plastic bags. The samples were transported to Wilding Engineering's laboratory for further examination and testing. The borings were backfilled up to the ground surface with on-site soils. Sample types with depths are shown in detail in the Boring Logs included in Appendix B.

5.2 Subsurface Conditions

5.2.1 Soils

The subsurface profile descriptions below are a generalized interpretation provided to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for more specific information. The stratifications shown on the boring logs represent the conditions only at the boring log locations. The stratifications represent the approximate boundary between subsurface materials and the transition may be gradual.

- **Boring B-DP-228**

Boring B-DP-228 generally encountered a soil profile consisting of layers of dense to very dense Silty Sand (SM), very dense Poorly Graded Gravel with Sand (GP), very stiff Silt with Sand (ML), and hard Lean Clay (CL) to the maximum depth explored of 41 feet.

SPT blow counts recorded in the boring had N-values ranging from 20 to greater than 50 blows per foot in fine grained soils and ranged from 36 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 41 feet. For detailed description of the soil conditions encountered in Boring B-DP-228, please refer to boring log B-DP-228 in Appendix B.

- **Boring B-DP-201**

Boring B-DP-201 generally encountered a soil profile consisting of stiff Lean Clay (CL) underlain by layers of medium dense to very dense Silty Sand with Gravel (SM), dense to medium dense Poorly Graded Gravel with Sand (GP), very dense Poorly Graded Sand with Silt and Gravel (SP-SM), and hard Silt (ML) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranging from 12 to greater than 50 blows per foot in fine grained soils and ranged from 10 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-201, please refer to boring log B-DP-201 in Appendix B.

- **Boring B-DP-202**

Boring B-DP-202 generally encountered a soil profile consisting of stiff to hard Lean Clay to Sandy Lean Clay (CL) underlain by layers of dense to very dense Poorly Graded Sand (SP) with varying amounts of Gravel, and dense Poorly Graded Gravel with Sand (GP) to the maximum depth explored of 41 feet.

SPT blow counts recorded in the boring had N-values ranging from 9 to 29 blows per foot in fine grained soils and ranged from 49 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 41 feet. For detailed description of the soil conditions encountered in Boring B-DP-202, please refer to boring log B-DP-202 in Appendix B.

- **Boring B-203**

Boring B-203 generally encountered a soil profile consisting of medium stiff to hard Lean Clay to Sandy Lean Clay (CL) to the maximum depth explored of 21.5 feet.

SPT blow counts recorded in the boring had N-values ranging from 6 to 37 blows per foot the subsurface soils to a maximum depth explored of 21.5 feet. For detailed description of the soil conditions encountered in Boring B-203, please refer to boring log B-203 in Appendix B.

- **Boring B-204**

Boring B-204 generally encountered a soil profile consisting of layers of very stiff to hard Lean Clay (CL) with varying amounts of Sand and Gravel, very dense Poorly Graded Gravel with Silt and Sand (GP-GM), and very dense Poorly Graded Gravel with Sand (GP) to the maximum depth explored of 21.5 feet.

SPT blow counts recorded in the boring had N-values ranging from 18 to greater than 50 blows per foot in fine grained soils and were generally greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 21.5 feet. For detailed description of the soil conditions encountered in Boring B-204, please refer to boring log B-204 in Appendix B.

- **Boring B-DP-205**

Boring B-DP-205 generally encountered a soil profile consisting of layers of stiff to hard Lean Clay (CL) with varying amounts of Sand, loose Clayey Sand (SC), dense to very dense Poorly Graded Gravel with Sand (GP), and very dense Poorly Graded Sand with Silt and Gravel (SP-SM) to the maximum depth explored of 41 feet.

SPT blow counts recorded in the boring had N-values ranging from 9 to greater than 50 blows per foot in fine grained soils and ranged from 6 to greater than 50 blows per foot for the coarse grained soils to a maximum depth explored of 41 feet. For detailed description of the soil conditions encountered in Boring B-DP-205, please refer to boring log B-DP-205 in Appendix B.

- **Boring B-206**

Boring B-206 generally encountered a soil profile consisting of layers of loose to dense Silty Sand (SM) with varying amounts of Gravel, medium stiff to hard Lean Clay (CL) with varying amounts of Sand and Gravel, and very dense Poorly Graded Gravel with Silt and Sand (GP-GM) to the maximum depth explored of 21.5 feet.

SPT blow counts recorded in the boring had N-values ranging from 5 to greater than 50 blows per foot in fine grained soils and ranged from 4 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 21.5 feet. For detailed description of the soil conditions encountered in Boring B-206, please refer to boring log B-206 in Appendix B.

- **Boring B-207**

Boring B-207 generally encountered a soil profile consisting of very stiff to hard Lean Clay (CL) with varying amounts of Gravel and very dense Silty Gravel with Sand (GM) to the maximum depth explored of 21.5 feet.

SPT blow counts recorded in the boring had N-values ranging from 18 to greater than 50 blows per foot in fine grained soils and were greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 21.5 feet. For detailed description of the soil conditions encountered in Boring B-207, please refer to boring log B-207 in Appendix B.

- **Boring B-208**

Boring B-208 generally encountered a soil profile consisting of hard Lean Clay with Sand (CL) underlain by hard Fat Clay (CH) to the maximum depth explored of 21.5 feet.

SPT blow counts recorded in the boring had N-values generally greater than 50 blows per foot in the subsurface soils to a maximum depth explored of 21.5 feet. For detailed description of the soil conditions encountered in Boring B-208, please refer to boring log B-208 in Appendix B.

- **Boring B-DP-209**

Boring B-DP-209 generally encountered a soil profile consisting of layers of very stiff to hard Lean Clay (CL) with varying amounts of Sand, medium dense to very dense Silty Sand with Gravel (SM), and very dense Poorly Graded Sand with Silt and Gravel (SP-SM) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranging from 20 to greater than 50 blows per foot in fine grained soils and ranged from 25 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-209, please refer to boring log B-DP-209 in Appendix B.

- **Boring B-210**

Boring B-210 generally encountered a soil profile consisting of dense Silty Sand with Gravel (SM) underlain by layers of stiff to very stiff Lean Clay (CL) with varying amounts of Sand, stiff Sandy Silty Clay (CL-ML), and medium dense Silty Gravel with Sand (GM) to the maximum depth explored of 21.5 feet.

SPT blow counts recorded in the boring had N-values ranging from 10 to 18 blows per foot in fine grained soils and ranged from 12 to 40 blows per foot for the coarse grained soils to a maximum depth explored of 21.5 feet. For detailed description of the soil conditions encountered in Boring B-210, please refer to boring log B-210 in Appendix B.

- **Boring B-211**

Boring B-211 generally encountered a soil profile consisting of very stiff to hard Lean Clay (CL) underlain by layers of very dense Silty Gravel with Sand (GM), dense to very dense Poorly Graded Sand with Silt and Gravel (SP-SM), and very dense Clayey Gravel with Sand (GC) to the maximum depth explored of 20 feet.

SPT blow counts recorded in the boring had N-values ranging from 29 to greater than 50 blows per foot in fine grained soils and ranged from 49 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 20 feet. For detailed description of the soil conditions encountered in Boring B-211, please refer to boring log B-211 in Appendix B.

- **Boring B-DP-212**

Boring B-DP-212 generally encountered a soil profile consisting of layers of hard Lean Clay (CL) with varying amounts of Sand, dense to very dense Clayey Sand with Gravel (SC), very dense Poorly Graded Gravel with Silt and Sand (GP-GM), very dense Silty Sand with Gravel (SM), and very dense Poorly Graded Sand with Silt and Gravel (SP-SM) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranging from 48 to greater than 50 per foot in fine grained soils and ranged from 44 to greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-212, please refer to boring log B-DP-212 in Appendix B.

- **Boring B-DP-213**

Boring B-DP-213 generally encountered a soil profile consisting of hard Lean Clay with Sand (CL), very dense Clayey Gravel (GC) with varying amounts of Sand, very dense clayey Sand (SC) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values generally greater than 50 blows per foot in the subsurface soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-213, please refer to boring log B-DP-213 in Appendix B.

- **Boring B-DP-214**

Boring B-DP-214 generally encountered a soil profile consisting of very dense Poorly Graded Gravel with Silt and Sand (GP-GM) underlain by very dense Silty Sand (SM) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values were generally greater than 50 blows per foot in the subsurface soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-214, please refer to boring log B-DP-214 in Appendix B.

- **Boring B-DP-215**

Boring B-DP-215 generally encountered a soil profile consisting of hard Lean Clay with Sand (CL) underlain by layers of very dense Poorly Graded Gravel with Sand (GP) and by very dense Silty Sand with Gravel (SM) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values were generally greater than 50 blows per foot in the subsurface soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-215, please refer to boring log B-DP-215 in Appendix B.

- **Boring B-DP-218**

Boring B-DP-218 generally encountered a soil profile consisting of hard Lean Clay with Sand (CL) underlain by very dense Silty Sand with Gravel (SM) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranged from 46 to greater than 50 blows per foot in the subsurface soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-218, please refer to boring log B-DP-218 in Appendix B.

- **Boring B-DP-219**

Boring B-DP-219 generally encountered a soil profile consisting of layers of hard Lean Clay (CL) with varying amounts of Sand and Gravel, hard Sandy Fat Clay (CH), very dense Silty Sand (SM) with varying amounts of Gravel, and very dense Clayey Sand with Gravel (SC) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranging from 35 to greater than 50 blows per foot in fine grained soils and were generally greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-219, please refer to boring log B-DP-219 in Appendix B.

- **Boring B-DP-221**

Boring B-DP-221 generally encountered a soil profile consisting of layers of very dense Silty Sand with Gravel (SM), very stiff to hard Lean Clay with Sand (CL), very stiff Sandy Fat Clay (CH), and very dense Clayey Sand (SC) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranging from 15 to greater than 50 blows per foot in fine grained soils and were generally greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-221, please refer to boring log B-DP-221 in Appendix B.

- **Boring B-DP-222**

Boring B-DP-222 generally encountered a soil profile consisting of layers of hard Lean Clay with Sand (CL), very dense Clayey Sand with Gravel (SC), and very dense Silty Sand with Gravel (SM) to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values ranging from 36 to greater than 50 blows per foot in fine grained soils and were greater than 50 blows per foot in the coarse grained soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-222, please refer to boring log B-DP-222 in Appendix B.

- **Boring B-DP-224**

Boring B-DP-224 generally encountered a soil profile consisting of hard Lean Clay (CL) underlain by layers of very dense Poorly Graded Gravel with Silt and Sand (GP-GM), very dense Silty Gravel with Sand (GM) and very dense Silty Sand with Gravel (SM), and hard Shale bedrock to the maximum depth explored of 40 feet.

SPT blow counts recorded in the boring had N-values generally greater than 50 blows per foot in the subsurface soils to a maximum depth explored of 40 feet. For detailed description of the soil conditions encountered in Boring B-DP-224, please refer to boring log B-DP-224 in Appendix B.

5.2.2 Groundwater

Groundwater was encountered in the borings as at the depths indicated in Table 5.2.2.

Table 5.2.2: Groundwater Information

Boring Number	Drilling Depth (ft)	Depth to Ground Water (ft)
B-DP-228	41	20
B-DP-201	40	2
B-DP-202	41	7
B-203	21½	Not encountered
B-204	21½	Not encountered
B-DP-205	41	11½
B-206	21	6½
B-207	21½	Not encountered
B-208	21	Not encountered
B-DP-209	40	Not encountered
B-210	21½	Not encountered
B-211	21	Not encountered
B-DP-212	40	11
B-DP-213	40	5½
B-DP-214	40	Not encountered
B-DP-215	40	Not encountered
B-DP-218	40	Not encountered
B-DP-219	40	11
B-DP-221	40	12½
B-DP-222	40	10
B-DP-224	40	Not encountered

Stabilized groundwater levels may be slightly higher than the observed level at the time of drilling. It should be noted that it is possible for the ground water levels to fluctuate during the year depending on the season and climate. Additionally, discontinuous zones of perched water may exist at various locations and depths beneath the ground surface. This could result in encountering ground water conditions during construction which may be different than during our field investigation. If groundwater is encountered during construction at levels that are different from the levels indicated in the borings, Wilding Engineering must be notified to observe changing conditions and provide recommendations.

5.3 Field Reconnaissance

A field reconnaissance was conducted in the general vicinity of the borings to obtain information relative to surficial soils and rock outcrops. No rock outcrops were observed at the proposed transmission tower locations.

6.0. LABORATORY TESTING

Representative soil samples were tested to evaluate physical and engineering properties. Laboratory testing included: Natural Water Content, Unit Weight, Grain Size Analysis, Atterberg Limits, Soil Ph, Chemical Resistivity, and Water-Soluble Sulfate Ion. Lab results are presented on the Boring Logs in Appendix B and in the Summary of Lab Results in Appendix C.

7.0. RECOMMENDATIONS AND CONCLUSIONS

7.1 Geotechnical Discussion

Wilding Engineering, Inc. has provided the following geotechnical recommendations based on the information provided by the client and the soils encountered during our field investigation for the proposed construction. The transmission tower sites are suitable for construction if the recommendations of this report are adhered to. The primary geotechnical factors that will impact the proposed construction include potential difficulties in excavation of on-site soils, potential caving of granular soils, and drilled pier construction below groundwater levels. Further information is provided in the following sections of this report.

7.2 Excavation Consideration

All excavations shall be carefully supported, maintained, and protected during construction in accordance with OSHA Regulations as stated in 29 CFR Part 1926. It is solely the responsibility of the contractor to have safe working conditions. Temporary construction excavations should be properly sloped or shored, in compliance with current federal, state, and local requirements.

Wilding Engineering does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations. As stated in the OSHA regulations, “a competent person shall evaluate the soil exposed in the excavations as part of his/her safety procedures”. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

During wet conditions, earth berms, sand bags or other methods should be used to prevent surface water from entering foundation, utility trench, and drilled pier excavations. Surface water which does enter the foundation and utility trench excavations should be removed.

7.3 Direct Imbed Foundations

It is our understanding that PacifiCorp plans to use “direct imbed” foundations for the majority of the transmission poles in this Southwest Wyoming to Silver Creek Transmission Corridor. The pole heights are to be 80 to 100 feet tall and pole embedment depth will be 10 to 12 feet deep. Soil characteristics of the investigative borings are given in the “Deep Foundation Design Parameter tables in section 7.4.

These soil characteristics should be considered when designing direct imbed foundations.

7.4 Deep Foundations – Drilled Piers

We understand that PacifiCorp intends to support some of the proposed towers on drilled pier foundations. We have evaluated the soils with respect to their capacity to support the proposed structures according the typical loads. Tables 7.4a through 7.4u present the parameters needed to evaluate the capacity of these types of foundations using the computer programs L-Pile v 5.0 by Ensoft and Caissons by Powerline Systems.

Table 7.4a – Deep Foundation Design Parameters near Boring B-DP-228

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Sand/S	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Sand/S	6	137	42.1	5.1	0	253	169	35397	355	355	-
3	10	15	Silt/C-S	5	133	33.0	3.4	1250	775	517	46132	814	326	0.0057
4	15	20	Stiff Clay/C	5	138	0.0	1.0	4600	1727	1152	39231	1751	700	0.0040
5	20	25	Stiff Clay/C W/ FW	5	78	0.0	1.0	6960	2770	1847	356938	2725	1090	0.0031
6	25	35	Sand/S	10	75	42.1	5.1	0	2442	1628	52746	197	197	-
7	35	40	Sand/S	5	75	42.1	5.1	0	2364	1576	67502	197	197	-
8	40	41	Stiff Clay/C W/ FW	1	78	0.0	1.0	7500	2495	1664	67502	2906	1162	0.0029

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was stabilized at a depth of 20 feet in Boring B-DP-228 during our field investigation.

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Table 7.4b – Deep Foundation Design Parameters near Boring B-DP-201

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	2	Stiff Clay/C	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	2	4	Stiff Clay/C W/ FW	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	4	10	Sand/S	6	53	33.0	3.4	0	116	77	49934	33	33	-
4	10	15	Sand/S	5	59	36.7	4.0	0	191	127	117980	70	70	-
5	15	25	Sand/S	10	75	42.1	5.1	0	372	248	180985	197	197	-
6	25	35	Sand/S	10	75	42.1	5.1	0	551	367	212166	197	197	-
7	35	40	Silt/C-S	5	78	38.0	4.2	3750	1085	724	337012	2906	1162	0.0029
8	40	41	Sand/S	1	75	42.1	5.1	0	1098	732	346176	197	197	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was stabilized at a depth of 2 feet in Boring B-DP-201 during our field investigation.

Table 7.4c – Deep Foundation Design Parameters near Boring B-DP-202

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	7	Stiff Clay/C	3	129	0.0	1.0	1260	538	359	16472	318	127	0.0087
3	7	10	Stiff Clay/C W/ FW	3	71	0.0	1.0	2830	1224	816	95932	955	382	0.0053
4	10	15	Sand/S	5	68	40.0	4.6	0	1004	669	124221	155	155	-
5	15	20	Sand/S	5	75	42.1	5.1	0	946	631	139340	197	197	-
6	20	25	Sand/S	5	64	39.3	4.5	0	927	618	199568	133	133	-
7	25	35	Sand/S	10	71	40.9	4.8	0	983	655	333521	178	178	-
8	35	41	Sand/S	6	75	42.1	5.1	0	1049	700	385990	197	197	-

Notes:
1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was stabilized at a depth of 7 feet in Boring B-DP-202 during our field investigation.

Table 7.4d – Deep Foundation Design Parameters near Boring B-203

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Stiff Clay/C	6	122	0.0	1.0	750	449	300	19187	137	55	0.0119
3	10	15	Stiff Clay/C	5	133	0.0	1.0	2540	1144	763	17190	830	332	0.0057
4	15	21.5	Stiff Clay/C	6.5	132	0.0	1.0	1910	1375	917	17190	570	228	0.0067

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-203 during our field investigation.

Table 7.4e – Deep Foundation Design Parameters near Boring B-204

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	7.5	Sand/S	3.5	137	42.1	5.1	0	174	116	23170	355	355	-
3	7.5	12.5	Stiff Clay/C	5	133	0.0	1.0	2510	1106	737	30067	820	328	0.0057
4	12.5	15	Sand/S	2.5	137	42.1	5.1	0	1068	712	34201	355	355	-
5	15	21.5	Stiff Clay/C	6.5	136	0.0	1.0	3800	1889	1260	34201	1390	556	0.0044

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-204 during our field investigation.

Table 7.4f – Deep Foundation Design Parameters near Boring B-DP-205

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	7.5	Stiff Clay/C	3.5	130	0.0	1.0	1430	665	443	31293	379	151	0.0081
3	7.5	10	Sand/S	2.5	109	30.5	3.1	0	589	393	33707	20	20	-
4	10	11.5 ▽	Stiff Clay/C	1.5	140	0.0	1.0	7500	1489	992	34175	2906	1162	0.0029
5	11.5	15	Stiff Clay/C W/ FW	3.5	78	0.0	1.0	7500	2886	1924	201212	2906	1162	0.0029
6	15	20	Sand/S	5	75	42.1	5.1	0	2397	1598	244640	197	197	-
7	20	25	Sand/S	5	75	42.1	5.1	0	2130	1420	288207	197	197	-
8	25	35	Sand/S	10	75	42.1	5.1	0	1891	1261	374918	197	197	-
9	35	41	Sand/S	6	75	42.1	5.1	0	1858	1239	427259	197	197	-

Notes: 1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was stabilized at a depth of 11.5 feet in Boring B-DP-205 during our field investigation.

Table 7.4g – Deep Foundation Design Parameters near Boring B-206

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Sand/S	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	6.5	Sand/S	2.5	106	29.3	2.9	0	72	48	13824	11	11	-
3	6.5	12.5	Stiff Clay/C W/FW	6	70	0.0	1.0	2500	1235	823	136750	814	326	0.0057
4	12.5	21	Sand/S	8.5	75	42.1	5.1	0	1019	679	210724	197	197	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was stabilized at a depth of 6.5 feet in Boring B-206 during our field investigation.

Table 7.4h – Deep Foundation Design Parameters near Boring B-207

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	7.5	Sand/S	3.5	137	42.1	5.1	0	173	116	47741	355	355	-
3	7.5	12.5	Stiff Clay/C	5	139	0.0	1.0	5340	2234	1490	39601	2076	831	0.0036
4	12.5	20	Stiff Clay/C	7.5	140	0.0	1.0	5660	3514	2343	20700	2215	886	0.0035
5	20	21.5	Stiff Clay/C	1.5	132	0.0	1.0	2300	3433	2289	20700	729	292	0.0060

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-207 during our field investigation.

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Table 7.4i – Deep Foundation Design Parameters near Boring B-DP-208

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Stiff Clay/C	6	140	0.0	1.0	7500	4494	2996	66238	2906	1162	0.0029
3	10	15	Stiff Clay/C	5	140	0.0	1.0	7500	5486	3657	67502	2906	1162	0.0029
4	15	21.5	Stiff Clay/C	6.5	140	0.0	1.0	7500	6102	4068	67502	2906	1162	0.0029

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-208 during our field investigation.

Table 7.4j – Deep Foundation Design Parameters near Boring B-DP-209

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	7.5	Sand/S	3.5	122	37.4	4.1	0	140	93	43523	135	135	-
3	7.5	15	Stiff Clay/C	7.5	140	0.0	1.0	7500	3813	2542	234433	2906	1162	0.0029
4	15	25	Sand/S	10	137	42.1	5.1	0	2798	1866	394067	355	355	-
5	25	35	Sand/S	10	137	42.1	5.1	0	2539	1692	553794	355	355	-
6	35	40	Sand/S	5	137	42.1	5.1	0	2523	1682	633502	355	355	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-DP-209 during our field investigation.

Table 7.4k – Deep Foundation Design Parameters near Boring B-210

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Sand/S	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Stiff Clay/C	6	132	0.0	1.0	1850	1109	739	11589	544	218	0.0069
3	10	15	Stiff Clay/C	5	129	0.0	1.0	1260	1157	771	17276	318	127	0.0087
4	15	20	Sand/S	5	117	33.8	3.5	0	1070	713	20250	56	56	-
5	20	21.5	Stiff Clay/C	1.5	132	0.0	1.0	2250	1151	767	20250	708	283	0.0061

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was not encountered in Boring B-210 during our field investigation.

Table 7.4l – Deep Foundation Design Parameters near Boring B-211

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	12.5	Sand/S	8.5	137	42.1	5.1	0	362	242	130470	355	355	-
3	12.5	15	Sand/S	2.5	129	39.8	4.6	0	438	292	158648	268	268	-
4	15	20	Sand/S	5	131	40.3	4.7	0	591	394	209462	290	290	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-211 during our field investigation.

Table 7.4m – Deep Foundation Design Parameters near Boring B-DP-212

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	11	Sand/S	7	127	39.4	4.5	0	274	183	168819	240	240	-
3	11	20	Sand/S	9	75	42.1	5.1	0	525	350	38548	197	197	-
4	20	25	Sand/S	5	75	42.1	5.1	0	636	424	40381	197	197	-
5	25	30	Stiff Clay/C W/FW	5	78	0.0	1.0	7500	1777	1185	335987	2906	1162	0.0029
6	30	40	Sand/S	10	75	42.1	5.1	0	1723	1149	423304	197	197	-

Notes: 1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was stabilized at a depth of 11 feet in Boring B-DP-212 during our field investigation.

Table 7.4n – Deep Foundation Design Parameters near Boring B-DP-213

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	5.5	Stiff Clay/C	1.5	140	0.0	1.0	7500	2044	1363	39374	2906	1162	0.0029
3	5.5	10	Stiff Clay/C W/ FW	4.5	78	0.0	1.0	7500	4494	2996	33117	2906	1162	0.0029
4	10	15	Sand/S	5	75	42.1	5.1	0	3194	2129	44624	197	197	-
5	15	20	Stiff Clay/C W/ FW	5	78	0.0	1.0	7500	4272	2848	45998	2906	1162	0.0029
6	20	25	Sand/S	5	75	42.1	5.1	0	3621	2414	59422	197	197	-
7	25	35	Stiff Clay/C W/ FW	10	78	0.0	1.0	7500	4719	3146	50044	2906	1162	0.0029
8	35	40	Sand/S	5	75	42.1	5.1	0	4323	2882	67502	197	197	-
9	40	41	Stiff Clay/C W/ FW	1	78	0.0	1.0	7500	4390	2927	67502	2906	1162	0.0029

Notes: 1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was stabilized at a depth of 5.5 feet in Boring B-DP-213 during our field investigation.

Table 7.4o – Deep Foundation Design Parameters near Boring B-DP-214

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Sand/S	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Sand/S	6	137	42.1	5.1	0	268	179	159648	355	355	-
3	10	20	Sand/S	10	137	42.1	5.1	0	613	409	319296	355	355	-
4	20	30	Sand/S	10	137	42.1	5.1	0	941	627	478944	355	355	-
5	30	40	Sand/S	10	137	42.1	5.1	0	1264	843	638591	355	355	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was not encountered in Boring B-DP-214 during our field investigation.

Table 7.4p – Deep Foundation Design Parameters near Boring B-DP-215

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Sand/S	6	137	42.1	5.1	0	272	181	161193	355	355	-
3	10	20	Sand/S	10	137	42.1	5.1	0	618	412	320844	355	355	-
4	20	30	Sand/S	10	137	42.1	5.1	0	946	631	480504	355	355	-
5	30	40	Sand/S	10	137	42.1	5.1	0	1270	847	640148	355	355	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was not encountered in Boring B-DP-215 during our field investigation

Table 7.4q – Deep Foundation Design Parameters near Boring B-DP-218

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Sand/S	6	137	42.1	5.1	0	272	181	161193	355	355	-
3	10	20	Sand/S	10	137	42.1	5.1	0	618	412	320844	355	355	-
4	20	30	Sand/S	10	137	42.1	5.1	0	946	631	480504	355	355	-
5	30	40	Sand/S	10	137	42.1	5.1	0	1270	847	640148	355	355	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was not encountered in Boring B-DP-218 during our field investigation.

Table 7.4r – Deep Foundation Design Parameters near Boring B-DP-219

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	11	Stiff Clay/C	7	140	0.0	1.0	7500	4765	3176	44400	2906	1162	0.0029
3	11	15	Stiff Clay/C W/ FW	4	78	0.0	1.0	7500	5486	3657	37240	2906	1162	0.0029
4	15	20	Sand/S	5	75	42.1	5.1	0	4370	2914	47200	197	197	-
5	20	25	Stiff Clay/C W/ FW	5	78	0.0	1.0	7500	4986	3324	40993	2906	1162	0.0029
6	25	30	Sand/S	5	75	42.1	5.1	0	4374	2916	42821	197	197	-
7	30	35	Stiff Clay/C W/ FW	5	78	0.0	1.0	7500	4803	3202	393999	2906	1162	0.0029
8	35	40	Sand/S	5	75	42.1	5.1	0	4429	2953	437856	197	197	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was stabilized at a depth of 11 feet in Boring B-DP-219 during our field investigation.

Table 7.4s – Deep Foundation Design Parameters near Boring B-DP-221

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Sand/S	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Stiff Clay/C	6	133	0.0	1.0	2750	1648	1099	14789	922	369	0.0054
3	10	12.5	Stiff Clay/C	2.5	132	0.0	1.0	1850	1690	1126	34196	544	218	0.0069
4	12.5	15	Stiff Clay/C W/ FW	2.5	71	0.0	1.0	2740	1860	1240	56145	917	367	0.0054
5	15	25	Sand/S	10	75	42.1	5.1	0	1525	1017	40630	197	197	-
6	25	30	Stiff Clay/C W/ FW	5	78	0.0	1.0	7500	2518	1679	84498	2906	1162	0.0029
7	30	40	Sand/S	10	75	42.1	5.1	0	2286	1524	67502	197	197	-
8	40	41	Stiff Clay/C W/ FW	1	78	0.0	1.0	7500	2402	1602	67502	2906	1162	0.0029

Notes: 1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.

2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.

3. Ground water was stabilized at a depth of 12.5 feet in Boring B-DP-221 during our field investigation.

Table 7.4t – Deep Foundation Design Parameters near Boring B-DP-222

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Sand/S	6	137	42.1	5.1	0	269	179	159976	355	355	-
3	10	20	Sand/S	10	75	42.1	5.1	0	542	361	247074	197	197	-
4	20	30	Sand/S	10	75	42.1	5.1	0	749	499	334174	197	197	-
5	30	40	Sand/S	10	75	42.1	5.1	0	939	626	420979	197	197	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was stabilized at a depth of 10 feet in Boring B-DP-222 during our field investigation.

Table 7.4u – Deep Foundation Design Parameters near Boring B-DP-224

Soil Layer Number	Depth Below		LPILE/CAISSON Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle Φ' (°)	Rankine's Passive Earth Pressure K_p	Undrained Shear Strength C_u (S_u) (psf)	Ultimate Skin		Maximum End Bearing Pressure (psf)	p-y Parameters		
	Top of Layer (ft)	Bottom of Layer (ft)							Downward (psf)	Uplift (psf)		k_s (static) (E_s=k_x) (pci)	k_c (cyclic) (pci)	ε_{50}
1	0	4	Stiff Clay/C	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	4	10	Sand/S	6	137	42.1	5.1	0	272	181	161193	355	355	-
3	10	20	Sand/S	10	137	42.1	5.1	0	618	412	320844	355	355	-
4	20	30	Sand/S	10	137	42.1	5.1	0	946	631	480504	355	355	-
5	30	40	Sand/S	10	137	42.1	5.1	0	1270	847	640148	355	355	-

Notes:

1. Frost depth for this area should be considered to be 48 inches below the ground surface. Therefore, the top 4 feet should be ignored when calculating the capacity of deep foundations with respect to skin friction.
2. Capacity values are given as ULTIMATE values. A minimum factor of safety of 2.0 or a soil factor of 0.5 should be applied to calculate allowable values.
3. Ground water was not encountered in Boring B-DP-224 during our field investigation.

Drilled piers are shafts having a diameter of 24 inches or more. The shaft is filled with a steel reinforcing cage and concrete to the design depth. The axial load carrying capacity is taken as the sum of the skin friction, less any negative skin friction, and the point or tip bearing capacity of the shaft. Skin friction, should be neglected in the upper 4 feet of the pier, as this is the frost zone.

Deep foundations for tower structures for the transmission line shall be designed using parameters derived from borings using allowable ground line lateral deflections of up to 2 inches.

7.4.1 Drilled Pier Construction Considerations

Wilding Engineering recommends that the drilled pier excavation and construction be observed by a representative of the geotechnical engineer to ensure the soil parameters presented herein are consistent with those encountered in the field. Please note that the drilled pier excavations may be difficult in borings where dense to very dense granular soils as indicated on boring logs. Special drilling techniques and/or equipment may be required to achieve the design depths for drilled pier excavation. Steel casing may be required to mitigate caving conditions in the drilled pier excavations. The reinforcing steel and concrete should be placed immediately upon completion of the drilling and observation processes.

Please note that loose or flowing sand layers exist below groundwater levels in some soil borings as indicated on the boring logs. Special consideration should be given to the potential for in-flow of water and soils during construction of the drilled piers. We recommend the use of a temporary casing to prevent potential inflows. Concrete should be placed using a tremie for drilled pier construction. The casing shall be removed simultaneously with concrete placement. Sufficient head of concrete should be maintained inside the casing, during removal, to minimize intrusion of soil due to hydrostatic (if any) and lateral soil pressure. Due to the presence of loose granular soils below the groundwater table, we recommend the use of weighted drilling fluid during drilled pier excavations. Weighted drilling fluid will provide a medium through which the contractor can drill, to aid in equalization of overburden pressure and prevent caving, sloughing, or subsidence. We recommend an experienced mud engineer be consulted to properly design a suitable weighted drilling mud system. In all cases a qualified inspector shall observe and document the construction of the proposed drilled piers to ensure compliance with these specifications. The inspector shall relay information as appropriate to the Geotechnical Engineer should unanticipated conditions be encountered during construction.

Concrete placed in the pier excavations should have a slump in the range of 6 to 8 inches to reduce the potential of the formation of voids as the temporary casing is extracted. The concrete should have air entrainment of 6% +/- 1%. The contractor should consider the air entrainment requirement when pumping concrete into the excavation. Limiting the free fall drop of the concrete will keep the air entrained. The concrete mix should be designed to attain 28-day design strength of 4000 psi considering this slump and air entrainment requirement. The drilling contractor should submit their procedures for approval prior to beginning construction.

7.5 Seismic Information

7.5.1 Faulting

The International Building Code (IBC 2006), and the USGS National Earthquake Hazards Reduction Program (NEHRP) interpolated probabilistic ground motion, and design response spectrum values are shown in table 7.5.1.

Table 7.5.1 USGS Earthquake Hazards Estimated Horizontal Ground Acceleration Values[1]

Boring	Latitude	Longitude	2% PE in 50 Years (g)			S_S	S_1	F_a	F_v	S_{DS}	S_{D1}	Site Class
			PGA	1.0 sec	0.2 sec							
B-DP-228	41.064	-111.522	0.269	0.234	0.651	0.651	0.234	1.28	1.93	0.555	0.301	D
B-DP-201	40.912	-111.407	0.239	0.214	0.574	0.574	0.214	1.34	1.97	0.513	0.282	D
B-DP-202	40.912	-111.405	0.239	0.214	0.573	0.573	0.214	1.34	1.97	0.513	0.281	D
B-203	40.875	-111.399	0.240	0.215	0.575	0.575	0.215	1.34	1.97	0.514	0.282	D
B-204	40.838	-111.401	0.243	0.217	0.582	0.582	0.217	1.33	1.97	0.518	0.284	D
B-DP-205	40.810	-111.405	0.246	0.219	0.589	0.589	0.219	1.33	1.96	0.522	0.287	D
B-206	40.809	-111.404	0.246	0.219	0.589	0.589	0.219	1.33	1.96	0.522	0.286	D
B-207	40.798	-111.410	0.248	0.221	0.594	0.594	0.221	1.32	1.96	0.525	0.288	D
B-208	40.773	-111.409	0.250	0.222	0.598	0.598	0.222	1.32	1.96	0.527	0.289	D
B-DP-209	40.768	-111.406	0.250	0.221	0.597	0.597	0.221	1.32	1.96	0.527	0.289	D
B-210	40.757	-111.401	0.250	0.220	0.596	0.596	0.220	1.32	1.96	0.526	0.288	D
B-211	40.757	-111.392	0.249	0.219	0.592	0.592	0.219	1.33	1.96	0.524	0.286	D
B-DP-212	40.737	-111.365	0.247	0.216	0.586	0.586	0.216	1.33	1.97	0.520	0.283	D
B-DP-213	40.737	-111.368	0.247	0.216	0.587	0.587	0.216	1.33	1.97	0.521	0.284	D
B-DP-214	40.736	-111.372	0.248	0.217	0.589	0.589	0.217	1.33	1.97	0.522	0.284	D
B-DP-215	40.736	-111.373	0.248	0.217	0.589	0.589	0.217	1.33	1.97	0.522	0.285	D
B-DP-218	40.723	-111.388	0.252	0.220	0.599	0.599	0.220	1.32	1.96	0.527	0.288	D
B-DP-219	40.717	-111.395	0.253	0.222	0.603	0.603	0.222	1.32	1.96	0.530	0.290	D
B-DP-221	40.716	-111.407	0.256	0.225	0.610	0.610	0.225	1.31	1.95	0.534	0.292	D
B-DP-222	40.702	-111.435	0.264	0.232	0.631	0.631	0.232	1.29	1.94	0.545	0.299	D
B-DP-224	40.684	-111.453	0.269	0.238	0.648	0.648	0.238	1.28	1.93	0.554	0.305	D

7.5.2 Liquefaction Analysis

Three conditions must be present for liquefaction to occur, in soils:

- The soil must be susceptible to liquefaction, i.e., granular layers with less than fifteen percent fines, existing below the ground water table.
- The soil must be in a loose state.
- Ground shaking strong enough to cause liquefaction.

[1] Source: http://earthquake.usgs.gov/research/hazmaps/interactive/index.php

Transmission line borings were advanced to a depths ranging from about 20 to 41½ feet below existing ground surfaces. Ground water was encountered in borings B-DP-228, B-DP-201, B-DP-202, B-DP-205, B-206, B-DP-212, B-DP-213, B-DP-219, B-DP-221, and B-DP-222 as indicated in section 5.2.2 of this report. Based on our subsurface profiles encountered in the borings, the soils are not likely to liquefy.

7.6 Soil Corrosivity

Chemical reactivity tests of soil pH, resistivity, and water- soluble sulfate ion contents were performed in general accordance with AASHTO T 289-91, ASTM G57-78, and AASHTO T 290-95 procedures, respectively. Table 7.6 summarizes the results of laboratory tests performed on soil samples collected from the sites.

Table 7.6: Summary of Chemical Reactivity Tests

Boring ID	Depth (ft)	Sulfate (mg/kg-dry) ppm	Resistivity (ohm-cm)	Soil pH @ 25^0 C
B-DP-228	10	<6.02	6,640	8.78
B-DP-228	20	24.8	--	--
B-DP-228	35	19.5	--	--
B-DP-201	5	40.6	5,890	8.43
B-DP-201	15	35.9	--	--
B-DP-201	35	213	--	--
B-DP-202	10	26.6	4,950	8.40
B-DP-202	25	<5.0	--	--
B-203	5	41.2	12,300	7.72
B-203	20	21.9	--	--
B-204	7.5	33.9	21,700	7.80
B-204	20	35.2	--	--
B-DP-205	5	<6.08	8,350	8.63
B-DP-205	15	<5.0	--	--
B-DP-205	25	19.8	--	--
B-206	7.5	194	5,270	7.36
B-206	15	22.5	--	--
B-207	7.5	<28.5	4,980	9.50
B-208	7.5	<5.28	5,960	9.48
B-208	15	79.6	--	--
B-DP-209	5	<5.31	8,250	8.60
B-DP-209	12.5	138	--	--
B-DP-209	25	<5.0	--	--
B-210	7.5	192	574	8.31
B-211	7.5	<5.14	8,310	9.20
B-211	12.5	<5.21	--	--
B-DP-212	7.5	11.6	6,220	8.60
B-DP-212	15	97.2	--	--
B-DP-212	25	18.2	--	--
B-DP-213	7.5	16.1	8,510	9.12
B-DP-213	15	21.3	--	--
B-DP-213	30	22.8	--	--
B-DP-214	7.5	<5.03	22,700	8.68
B-DP-214	25	109	--	--
B-DP-214	40	7.43	--	--
B-DP-215	5	<5.22	12,500	8.99
B-DP-215	20	36.7	--	--

Boring ID	Depth (ft)	Sulfate (mg/kg-dry) ppm	Resistivity (ohm-cm)	Soil pH @ 25^0 C
B-DP-215	35	90.8	--	--
B-DP-218	10	7.52	14,300	6.97
B-DP-218	25	19.2	--	--
B-DP-218	35	<5.65	--	--
B-DP-219	7.5	84.4	2,160	8.25
B-DP-219	12.5	66.0	--	--
B-DP-219	30	90.0	--	--
B-DP-221	7.5	19.6	6,910	7.82
B-DP-221	15	15.6	--	--
B-DP-221	25	<6.74	--	--
B-DP-222	10	16.1	41,800	7.12
B-DP-222	20	86.5	--	--
B-DP-222	35	71.7	--	--
B-DP-224	7.5	<5.45	17,400	8.75
B-DP-224	15	10.7	--	--
B-DP-224	35	<5.45	--	--

Test results indicate the soil in the soil profiles contain a soluble sulfate concentration ranging from less than 5 ppm to 213 ppm. Based on the American Concrete Institute (ACI) Building Code, these concentrations represent a “negligible to moderate” degree of sulfate attack on concrete structures. It is recommended that Type II Portland Cement Concrete is used for concrete elements in contact with native or imported soils.

Soil resistivity has a direct impact on the degree of corrosion in underground steel structures. A decrease in resistivity relates to an increase in corrosion activity and therefore dictates the protective treatment to be used. Results from the laboratory resistivity tests indicate a range of resistivity from 574 to 41,800 ohm-cm. Based on the resistivity test results, the onsite soils are considered to be “noncorrosive” to “extremely corrosive”[2].

Results of the hydrogen ion concentration (pH) tests were between 6.97 and 9.50. Concentrations above 7 are considered basic and are less likely to contribute to corrosion attack on subsurface steel structures.

Underground steel structures (i.e., pipes, exposed steel) should be protected against corrosion.

8.0. LIMITATIONS AND PROFESSIONAL STATEMENT

This report has been prepared in accordance with generally accepted geologic and geotechnical engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the borings at the locations indicated on the site plan, laboratory results, data obtained from the U.S.G.S. Library, and previous reports and studies. Variations in the subsurface conditions may not become evident until additional

[2] Roberge, Pierre R., Handbook of Corrosion Engineering, McGraw-Hill; Publication Date: 2000; ISBN 007-076516-2, p150; 1140 pages

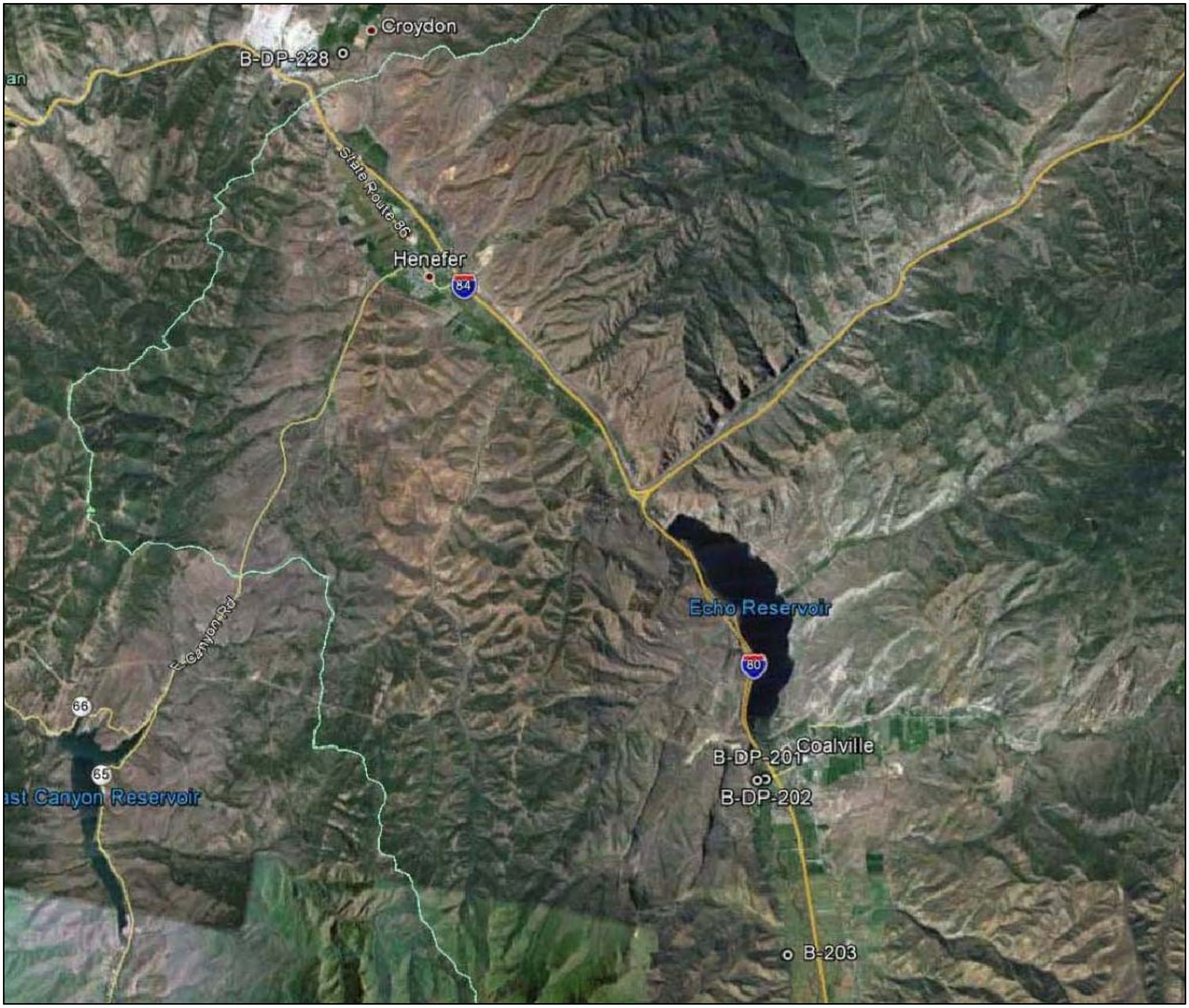
exploration or excavation is conducted. If the subsurface soil or ground water conditions are found to be significantly different than that which is described in this report, we should be notified so that we can re-evaluate recommendations.

We have correlated soil types and properties such as bearing pressure with U.S.G.S. surveys, the International Building Code, and surrounding investigations. Any assumptions made, based on these correlations, are conservative.

We appreciate the opportunity of providing this service for you. If you have any questions concerning this report or require additional information or services please contact us at 801-553-8112.

APPENDIX A

VICINITY MAP



(continued on A-2)

Courtesy: Google Earth

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME	SW WYOMING TO SILVER CREEK TRANSMISSION LINE
DATE	11/30/11
SCALE	NTS
DRAWN	CPB
CHECKED	DPW
PROJECT #	11173
SHEET	A-1
FILE NAME:	G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

VICINITY MAP

(continuation from A-1)

(continued on A-3)

Courtesy: Google Earth

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PROJECT #	11173
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SHEET	A-2

VICINITY MAP

(continuation from A-2)

(continued on A-4)

Courtesy: Google Earth

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PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE			DATE: 11/30/11
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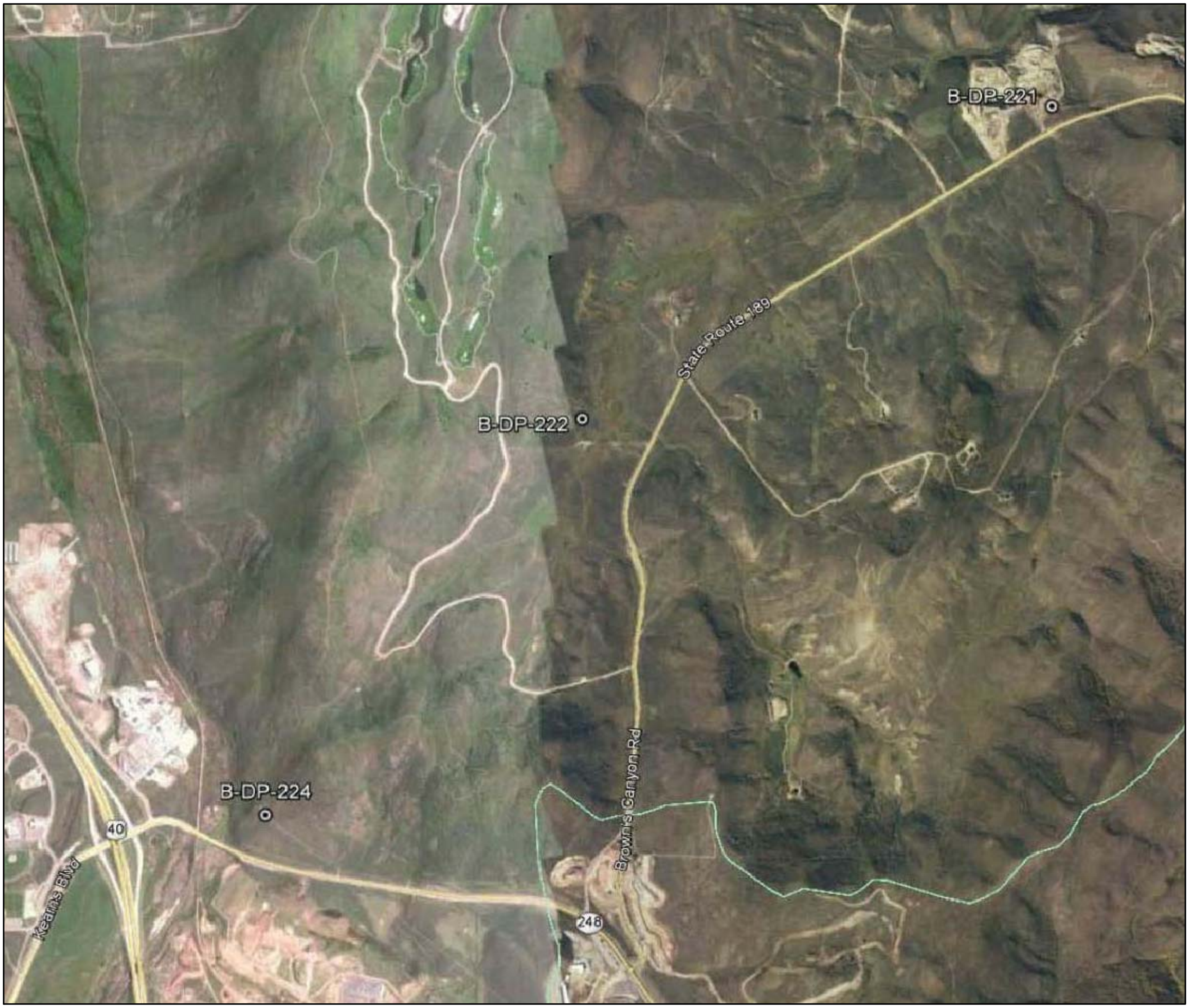
VICINITY MAP

(continuation from A-3)



Courtesy: Google Earth

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PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE		DATE: 11/30/11
		SCALE: NTS
DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173
FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg		SHEET: A-4

SITE MAP WITH BORING LOCATION B-DP-228

(see Sheet A-1)

N

Courtesy: Google Earth

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			SCALE: NTS
DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173	SHEET: A-5
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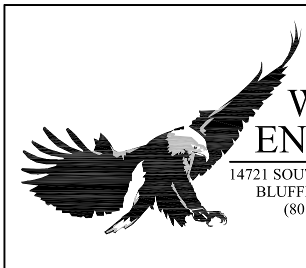
SITE MAP WITH BORING LOCATIONS B-DP-201 AND B-DP-202
(see Sheet A-1)

N

Courtesy: Google Earth



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PROJECT NAME			DATE
SW WYOMING TO SILVER CREEK TRANSMISSION LINE			11/30/11
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DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173	SHEET: A-6
FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg			

SITE MAP WITH BORING LOCATION B-203
(see Sheet A-1)

Courtesy: Google Earth

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PROJECT NAME	DATE
SW WYOMING TO SILVER CREEK TRANSMISSION LINE	11/30/11
	SCALE: NTS

DRAWN	CHECKED	PROJECT #	SHEET
CPB	DPW	11173	A-7

FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

SITE MAP WITH BORING LOCATION B-204

(see Sheet A-2)

Courtesy: Google Earth

WILDING ENGINEERING, INC 14721 SOUTH HERITAGE CREST WAY BLUFFDALE, UTAH 84065 (801)553-8112	PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE		DATE: 11/30/11
	DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173	SCALE: NTS
	FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg		SHEET: A-8

SITE MAP WITH BORING LOCATIONS B-DP-205 AND B-206

(see Sheet A-2)

Courtesy: Google Earth

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DRAWN	CPB
CHECKED	DPW
PROJECT #	11173
FILE NAME:	G:\Data\11173..\dwg\Vicinity and Site Maps.dwg
SHEET	A-9

SITE MAP WITH BORING LOCATION B-207
(see Sheet A-2)

N

Courtesy: Google Earth

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	DRAWN CPB	CHECKED DPW	PROJECT # 11173
	FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg		SHEET A-10

SITE MAP WITH BORING LOCATION B-208

(see Sheet A-2)

Courtesy: Google Earth

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			SCALE NTS
	DRAWN CPB	CHECKED DPW	PROJECT # 11173
	FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg		SHEET A-11

SITE MAP WITH BORING LOCATION B-DP-209

(see Sheet A-2)

Courtesy: Google Earth

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(801)553-8112

PROJECT NAME	DATE	SCALE	SHEET
SW WYOMING TO SILVER CREEK TRANSMISSION LINE	11/30/11	NTS	A-12

DRAWN	CHECKED	PROJECT #
CPB	DPW	11173

FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

SITE MAP WITH BORING LOCATION B-210

(see Sheet A-2)

Courtesy: Google Earth

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14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE		DATE: 11/30/11
		SCALE: NTS
DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173
FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg		SHEET: A-13

SITE MAP WITH BORING LOCATION B-211

(see Sheet A-2)

N

Courtesy: Google Earth

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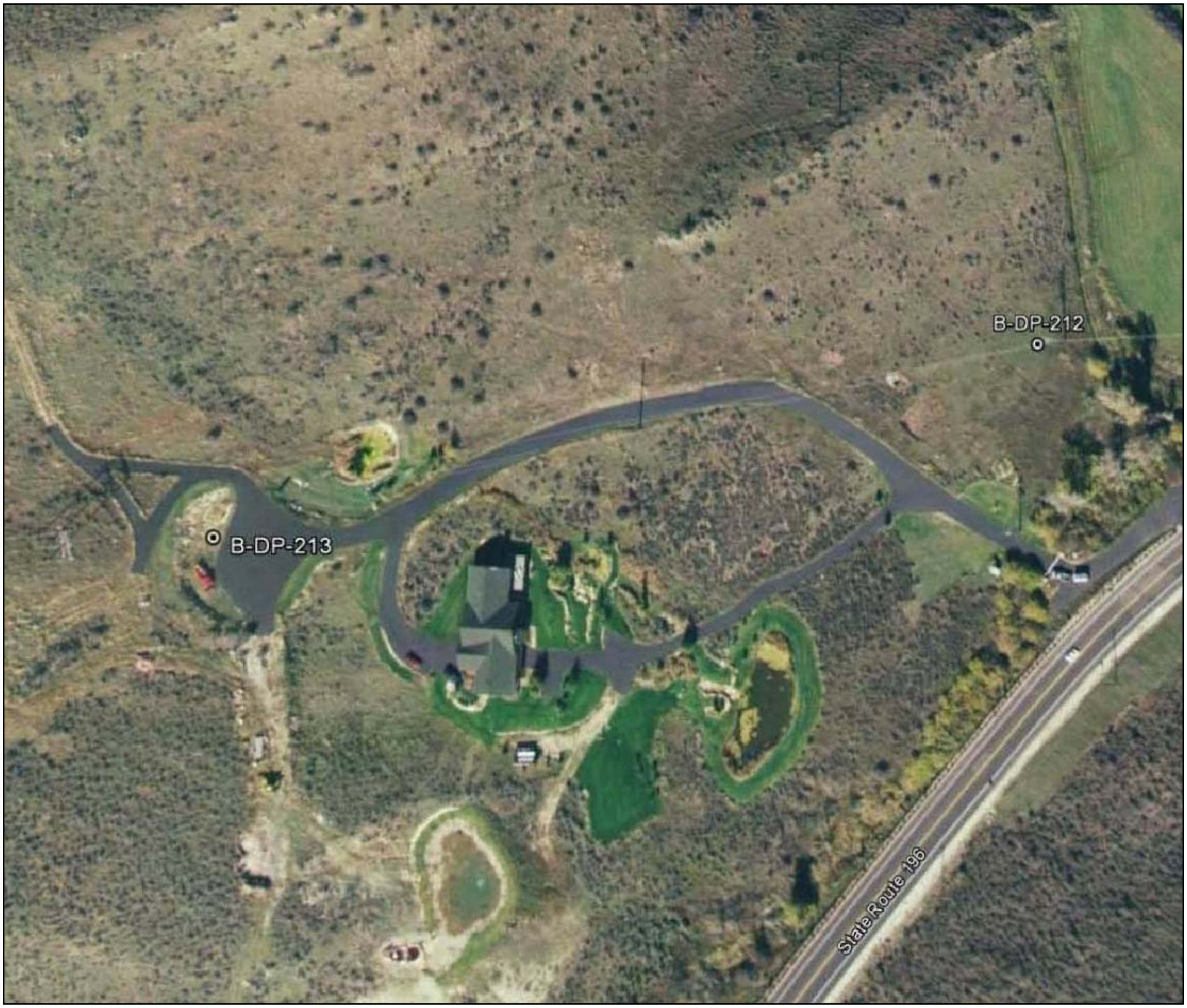
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE			DATE: 11/30/11
			SCALE: NTS
DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173	SHEET: A-14
FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg			

SITE MAP WITH BORING LOCATIONS B-DP-212 AND B-DP-213
(see Sheet A-3)

(see Sheet A-3)



Courtesy: Google Earth

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PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE		DATE: 11/30/11
DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173
SCALE: NTS	SHEET: A-15	
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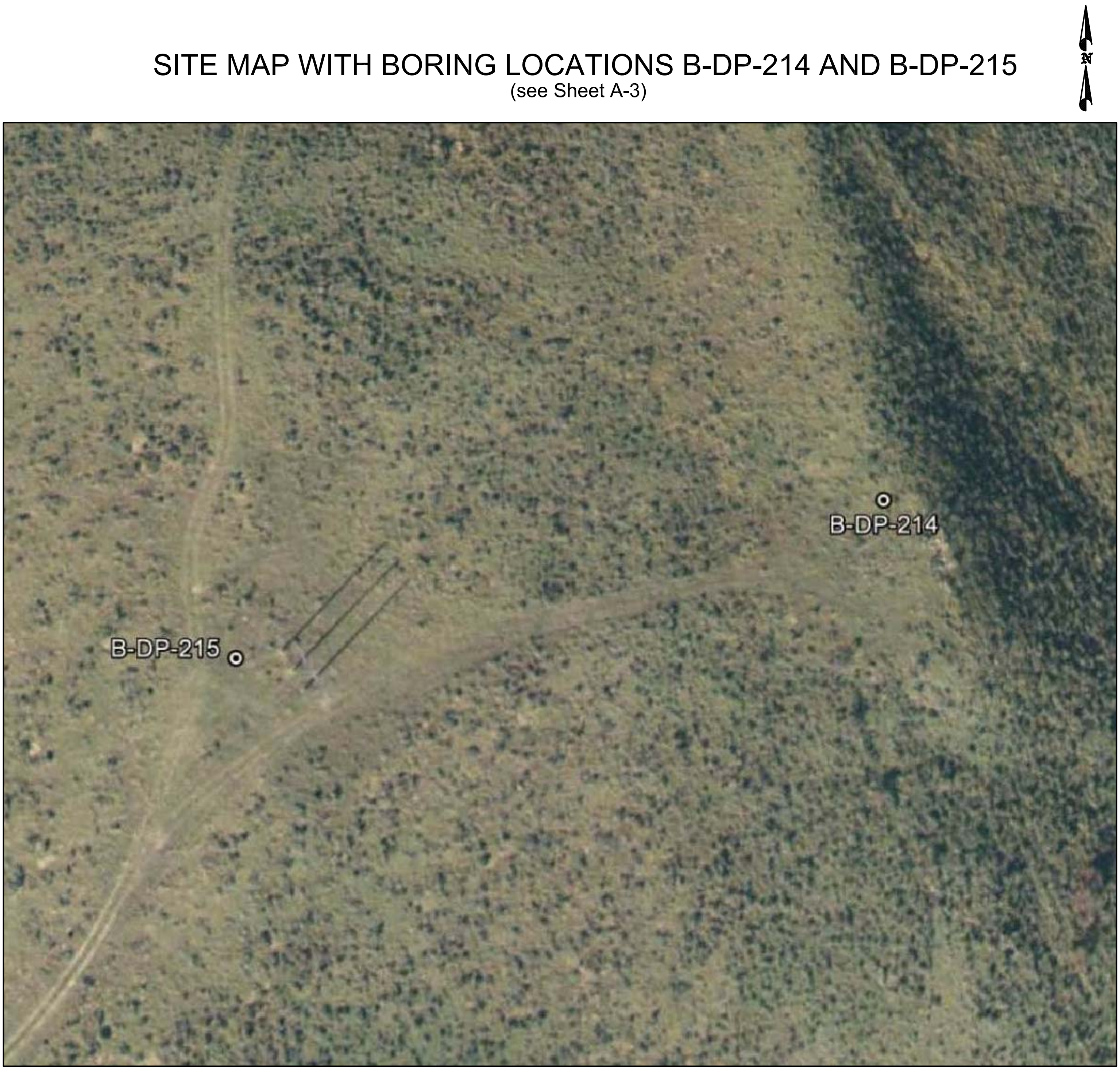
SITE MAP WITH BORING LOCATIONS B-DP-214 AND B-DP-215

(see Sheet A-3)



Courtesy: Google Earth

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PROJECT NAME	SW WYOMING TO SILVER CREEK TRANSMISSION LINE
DATE	11/30/11
SCALE	NTS
DRAWN	CPB
CHECKED	DPW
PROJECT #	11173
SHEET	A-16
FILE NAME:	G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

SITE MAP WITH BORING LOCATION B-DP-218
(see Sheet A-3)

Courtesy: Google Earth

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME	SW WYOMING TO SILVER CREEK TRANSMISSION LINE
DATE	11/30/11
SCALE	NTS
DRAWN	CPB
CHECKED	DPW
PROJECT #	11173
SHEET	A-17
FILE NAME:	G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

SITE MAP WITH BORING LOCATION B-DP-219

(see Sheet A-3)

Courtesy: Google Earth

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME: SW WYOMING TO SILVER CREEK TRANSMISSION LINE			DATE: 11/30/11
			SCALE: NTS
DRAWN: CPB	CHECKED: DPW	PROJECT #: 11173	SHEET: A-18
FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg			

SITE MAP WITH BORING LOCATION B-DP-221

(see Sheet A-4)

N

Courtesy: Google Earth

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME	SW WYOMING TO SILVER CREEK TRANSMISSION LINE
DRAWN	CPB
CHECKED	DPW
PROJECT #	11173
FILE NAME:	G:\Data\11173..\dwg\Vicinity and Site Maps.dwg
DATE	11/30/11
SCALE	NTS
SHEET	A-19

SITE MAP WITH BORING LOCATION B-DP-222
(see Sheet A-4)

Courtesy: Google Earth

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME	SW WYOMING TO SILVER CREEK TRANSMISSION LINE
DATE	11/30/11
SCALE	NTS
DRAWN	CPB
CHECKED	DPW
PROJECT #	11173
SHEET	A-20
FILE NAME:	G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

SITE MAP WITH BORING LOCATION B-DP-224
(see Sheet A-4)

Courtesy: Google Earth

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801)553-8112

PROJECT NAME	DATE	SCALE	SHEET
SW WYOMING TO SILVER CREEK TRANSMISSION LINE	11/30/11	NTS	A-21

DRAWN	CHECKED	PROJECT #
CPB	DPW	11173

FILE NAME: G:\Data\11173..\dwg\Vicinity and Site Maps.dwg

APPENDIX B

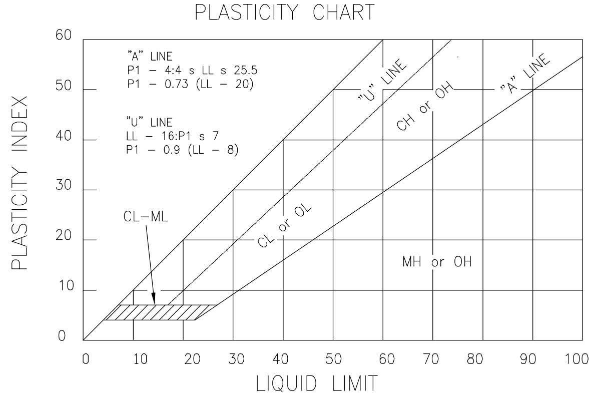
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified for engineering purposes by the Unified Soil Classification System. Grain-sized analyses and Atterberg Limits tests often are performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. Graphic symbols are used on boring logs presented on this report. For a more detailed description of the system, see "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)" ASTM Designation:2488-84 and "Standard Test Method for Classification of Soils for Engineering Purposes" ASTM Designation: 2487-85.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS Less than 50% passes No. 200 sieve	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No, 200 sieve)			GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, OR SAND -GRAVEL-COBBLE MIXTURES
					GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, OR SAND-GRAVEL-COBBLE MIXTURES
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Lines plot below "A" line & hatched zone on plasticity chart		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			Lines plot above "A" line & hatched zone on plasticity chart		GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	WELL GRADED SANDS, GRAVELLY SANDS
					SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Lines plot below "A" line & hatched zone on plasticity chart		SM	SILTY SANDS, SAND-SILT MIXTURES
			Lines plot above "A" line & hatched zone on plasticity chart		SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS (50% or more passes No. 200 sieve	SILTS Limited plot below "A" line & hatched zone on plasticity chart	SILTS OF LOW PLASTICITY (Liquid limit less than 50)			ML	INORGANIC SILTS, CLAYEY SILTS OF LOW TO MEDIUM PLASTICITY
		SILTS OF HIGH PLASTICITY (Liquid limit 50 or more)			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS, ELASTIC SILTS
	CLAYS Limited plot above "A" line & hatched zone on plasticity chart	CLAYS OF LOW PLASTICITY (Liquid limit less than 50)			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, AND SILTY CLAYS
		CLAYS OF HIGH PLASTICITY (Liquid limit 50 or more)			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS, SANDY CLAYS OF HIGH PLASTICITY
	ORGANIC SILTS AND CLAYS	ORGANIC SILTS AND CLAYS OF LOW PLASTICITY (Liquid limit less than 50)			OL	ORGANIC SILTS AND CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY ORGANIC SILTS AND CLAYS
		ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY (Liquid limit 50 or more)			OH	ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY, SANDY ORGANIC SILTS AND CLAYS
ORGANIC SOILS		PRIMARILY ORGANIC MATTER (dark in color and organic odor)			PT	PEAT

NOTE: Coarse-grained soils with between 5% and 12% passing thru No. 200 sieve and fine-grained soils with limit plotting in the hatched zone on the plasticity chart have dual classifications.

PLASTICITY CHART



DEFINITION OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 12 in.
Cobbles	12 in. to 3 in.
Gravel	3 in. to No. 4 sieve
Coarse Gravel	3 in. to 3/4 in.
Fine Gravel	3/4 in. to No. 4 sieve
Sand	No. 4 to No. 200 sieve
Coarse sand	No. 4 to No. 10 sieve
Medium sand	No. 10 to No. 40 sieve
Fine sand	No. 40 to No. 200 sieve
Fines(silt and clay)	Less than No. 200 sieve

DATE 10/24/2011

LOG OF BORING NO. B-DP-228

PROJECT: SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION: Evanston, Wyoming to Park City, Utah

BORING LOCATION: LAT: 41.0635 LONG: -111.5220

RIG TYPE: Mobile B-80

DRILLING METHOD: Odex

SURFACE ELEVATION: 5310 ft (from google earth)

FIELD ENGINEER: JP

DEPTH IN FEET	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0	1	T	22-19-17		44.4	9.1	SM	**SILTY SAND WITH GRAVEL:** dense, moist, reddish brown.	
	2	T	50/5"		0.0			-- very dense.	
5	3	T	50/5"		40.0		GP	**POORLY GRADED GRAVEL WITH SAND:** very dense, moist, brown, with cobbles and boulders.	
	4	T	29-47-50/5"	1	23.5	2.7			
10	5	T	6-13-14		27.8		ML	**SILT WITH SAND:** very stiff, moist, reddish brown.	
	6	M	5-7-13	78	100.0	20.6			Atterberg Limits @ 12.5-ft: LL=NP PL=NP PI=NP
15	7	T	11-13-24		100.0		CL	**LEAN CLAY WITH SAND:** hard, moist, reddish brown.	
20	8	T	18-25-31		66.7			-- wet.	
25	9	T	20-35-40	34	83.3	20.0	SM	**SILTY SAND:** very dense, wet, reddish brown.	Atterberg Limits @ 25-ft: LL=NP PL=NP PI=NP
30	10	T	29-50/5"		90.9				

Continued Next Page

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
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BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/24/2011

LOG OF BORING NO. B-DP-228

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 41.0635 LONG: -111.5220
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5310 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/5"		100.0			**SILTY SAND:** very dense, wet, reddish brown.	
40		12	T	30-50/5"		81.8	19.6	CL	**LEAN CLAY:** hard, wet, reddish brown.	
									BOTTOM OF BORING AT 40.9 FEET	-- Groundwater was encountered at 20 feet during drilling. -- Groundwater was stabilized at 20 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
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- H - HAND SAMPLE

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BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/24/2011

LOG OF BORING NO. B-DP-201

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.9117 LONG: -111.4072
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5603 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	5-5-7		100.0		CL	**LEAN CLAY:** stiff, moist, dark brown, with vegetation in upper 3 inches.	
		2	T	11-35-50/5"		105.9	12.6	SM	**SILTY SAND WITH GRAVEL:** very dense, wet, brown.	
5		3	T	7-11-21		22.2			-- dense.	
		4	T	8-5-5		5.6			-- medium dense.	
10		5	T	6-7-27	2	22.2	9.8	GP	**POORLY GRADED GRAVEL WITH SAND:** dense, wet, brown.	
		6	T	9-9-12		22.2			-- medium dense, with decreasing Sand.	
15		7	T	50/4"		100.0		SM	**SILTY SAND WITH GRAVEL:** very dense, wet, light brown.	
20		8	T	9-50/5"	2	100.0	17.5	SP-SM	**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, wet, light brown.	
25		9	T	29-50/1"		85.7				
30		10	T	37-40-40	3	83.3	13.2			

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
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BLUFFDALE, UTAH 84065
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DATE 10/24/2011

LOG OF BORING NO. B-DP-201

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.9117 LONG: -111.4072
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5603 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/4"		75.0		ML	**SILT:** hard, wet, yellowish brown.	
40		12	T	50/4"		100.0	22.7	SP-SM	**POORLY GRADED SAND WITH SILT:** very dense, wet, light brown.	
									BOTTOM OF BORING AT 40.3 FEET	-- Groundwater was encountered at 2 feet during drilling. -- Groundwater was stabilized at 2 feet after 24 hours after drilling..

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

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DATE 10/25/2011

LOG OF BORING NO. B-DP-202

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.9119 LONG: -111.4050
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 5593 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	21-18-11		5.6			**LEAN CLAY:** hard, moist, dark brown, with vegetation in upper 4 inches.	
		2	T	5-5-4		22.2			-- stiff.	
5		3	T	3-4-6	51	66.7	28.9	CL	-- Sandy Lean Clay, stiff, moist, brown.	Atterberg Limits @ 5-ft: LL=34 PL=19 PI=15
		4	M	7-9-14		0.0			-- very stiff.	
10		5	T	6-25-30		16.7			**POORLY GRADED SAND WITH GRAVEL:** very dense, wet, brown.	
		6	T	7-19-30	2	33.3	15.9		-- dense.	
15		7	T	30-50/5"		54.5		SP	-- very dense.	
20		8	T	11-18-26	2	33.3	9.9	GP	**POORLY GRADED GRAVEL WITH SAND:** dense, wet, brown.	
25		9	T	50/5"		60.0			**POORLY GRADED SAND WITH GRAVEL:** very dense, wet, brown.	
30		10	T	11-24-32	3	66.7	19.8	SP	-- with no Gravel.	

Continued Next Page

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

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DATE 10/25/2011

LOG OF BORING NO. B-DP-202

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.9119 LONG: -111.4050
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5593 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/5"		0.0		SP	**POORLY GRADED SAND:** very dense, wet, brown.	-- Obtained cuttings.
40		12	T	42-50/2"		0.0				-- Obtained cuttings.
									BOTTOM OF BORING AT 40.7 FEET	-- Groundwater was encountered at 10 feet during drilling. - Groundwater was stabilized at 7 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

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DATE 10/25/2011

LOG OF BORING NO. B-203

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.8754 LONG: -111.3990
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5691 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	22-15-17		16.7			**LEAN CLAY:** hard, moist, dark brown, with vegetation in upper 3 inches.	
		2	T	7-6-5		11.1	14.8		-- stiff, with Gravel, brown.	
5		3	T	3-2-4		66.7			-- medium stiff.	
		4	T	3-3-3		33.3				
10		5	M	3-10-10	63	66.7	19.9	CL	-- Sandy Lean Clay, very stiff, moist, brown.	Atterberg Limits @ 10-ft: LL=32 PL=14 PI=18
		6	T	10-12-15		100.0			-- reddish brown.	
15		7	T	3-5-6	86	66.7	20.6		-- stiff, with decreasing Sand.	Atterberg Limits @ 15-ft: LL=31 PL=15 PI=16
20		8	T	6-9-28		100.0			-- hard.	
									BOTTOM OF BORING AT 21.5 FEET	-- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

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DATE 10/25/2011

LOG OF BORING NO. B-204

PROJECT: SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION: Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.8384 LONG: -111.4008
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5969 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	20-50/2"		50.0		CL	**LEAN CLAY WITH GRAVEL:** hard, dry, brown.	
		2	T	50/4"		100.0		GP-GM	**POORLY GRADED GRAVEL WITH SILT AND SAND:** very dense, dry, light brown.	
5		3	T	35-36-50/5"	5	52.9	2.5			
		4	T	9-9-9		22.2		CL	**GRAVELLY LEAN CLAY:** very stiff, moist, brown.	
10		5	T	12-12-12	62	66.7	13.4			Atterberg Limits @ 10-ft: LL=27 PL=16 PI=11
		6	T	24-50/1"		57.1		GP	**POORLY GRADED GRAVEL WITH SAND:** very dense, dry, brown.	
15		7	T	10-11-15	68	83.3	17.3	CL	**SANDY LEAN CLAY:** very stiff, moist, brown.	Atterberg Limits @ 15-ft: LL=29 PL=14 PI=15
20		8	T	8-12-31		66.7			-- hard.	
									BOTTOM OF BORING AT 21.5 FEET	-- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

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(801) 553-8112

DATE 10/26/2011

LOG OF BORING NO. B-DP-205

PROJECT: SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION: Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.8101 LONG: -111.4055
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5862 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0	1	T	6-7-8		11.1		CL	**LEAN CLAY:** stiff, moist, brown, with vegetation in upper 4 inches.	
	2	T	3-4-5		66.7	18.2			
5	3	T	4-5-6		83.3				
	4	M	3-3-3	38	100.0	23.3	SC	**CLAYEY SAND:** loose, moist, brown.	Atterberg Limits @ 7.5-ft: LL=27 PL=17 PI=10
10	5	T	2-3-50/5"		70.6		CL	**LEAN CLAY WITH SAND:** hard, moist, brown.	
	6	T	50/5"		240.0				
15	7	T	22-50/3"		33.3		GP	**POORLY GRADED GRAVEL WITH SAND:** very dense, wet, brown.	
20	8	T	7-10-30	3	22.2	11.5		-- dense.	
25	9	T	14-31-50/5"		88.2		SP-SM	**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, wet, brown.	
30	10	T	12-50/4"		20.0	6.4		**POORLY GRADED GRAVEL WITH SAND:** very dense, wet, brown.	

Continued Next Page

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

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(801) 553-8112

DATE 10/26/2011

LOG OF BORING NO. B-DP-205

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.8101 LONG: -111.4055
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	5862 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	40-50/2"		25.0		GP	**POORLY GRADED GRAVEL WITH SAND:** very dense, wet, brown.	
40		12	T	19-50/4"		30.0	6.3			
									BOTTOM OF BORING AT 40.8 FEET	-- Groundwater was encountered at 14 feet during drilling. -- Groundwater was stabilized at 11.5 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/25/2011

LOG OF BORING NO. B-206

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.8091 LONG: -111.4045

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 5867 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	21-22-25		44.4	9.1	SM	**SILTY SAND WITH GRAVEL:** dense, moist, brown, with 3 inches of vegetation.	
		2	T	2-2-3		100.0		CL	**LEAN CLAY WITH SAND:** medium stiff, moist, brown.	
5		3	M	1-1-3	18	100.0	30.0	SM	**SILTY SAND:** loose, moist, brown.	Atterberg Limits @ 5-ft: LL=NP PL=NP PI=NP
		4	T	15-16-45		83.3		CL	**LEAN CLAY WITH SAND AND GRAVEL:** hard, moist, brown.	
10		5	T	8-9-10		33.3	30.3		-- very stiff, with decreasing Gravel.	
		6	T	46-50/5"	10	100.0	13.2	GP-GM	**POORLY GRADED GRAVEL WITH SILT AND SAND:** very dense, wet, light brown.	
15		7	T	16-35-40		33.3				
20		8	T	47-32-50/4"		37.5	10.9			
									BOTTOM OF BORING AT 21.3 FEET	-- Groundwater was encountered at 12 feet during drilling. -- Groundwater was stabilized at 6.5 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
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- H - HAND SAMPLE

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(801) 553-8112

DATE 10/31/2011

LOG OF BORING NO. B-207

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7977 LONG: -111.4104
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6003 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	20-22-33		11.1		CL	**LEAN CLAY:** hard, dry, brown.	
		2	T	29-32-39		22.2			-- light brown.	
5		3	T	43-41-32	28	33.3	6.9	GM	**SILTY GRAVEL WITH SAND:** very dense, dry, light brown.	
		4	T	16-25-24		66.7		CL	**LEAN CLAY WITH GRAVEL:** hard, moist, brown.	
10		5	T	16-16-27		27.8				
		6	T	24-24-24		22.2	13.9		-- with decreasing Gravel.	
15		7	T	9-21-21		66.7			-- with Gravel	
20		8	M	10-8-10	74	100.0	14.7		-- very stiff.	Atterberg Limits @ 20-ft: LL=25 PL=14 PI=11 -- Groundwater was not encountered during drilling.
									BOTTOM OF BORING AT 21.5 FEET	

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
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DATE 10/26/2011

LOG OF BORING NO. B-208

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7734 LONG: -111.4090
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 6105 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0									**3-INCHES ASPHALT**	
									LEAN CLAY WITH SAND: hard, dry, light brown.	
		1	T	50/5"		80.0				
5		2	T	50/3"		100.0	9.1			
		3	T	50/3"		100.0				
10		4	T	50/5"	82	80.0	6.2	CL		
		5	T	42-50/4"		100.0				
15		6	T	42-50/5"		72.7				
20		7	T	15-26-50/5"	91	88.2	30.9	CH	**FAT CLAY:** hard, dry, light brown.	Atterberg Limits @ 20-ft: LL=60 PL=23 PI=37
									BOTTOM OF BORING AT 21.4 FEET	-- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

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DATE 10/26/2011

LOG OF BORING NO. B-DP-209

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7682 LONG: -111.4063
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6367 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	18-22-26		33.3		CL	**LEAN CLAY:** hard, dry, light brown.	
		2	T	10-10-10		33.3	6.0		-- very stiff.	
5		3	T	10-11-14		33.3		SM	**SILTY SAND WITH GRAVEL:** medium dense, dry, brown.	
		4	T	15-38-50/4"	85	75.0	9.3	CL	**LEAN CLAY WITH SAND:** hard, dry, light gray.	Atterberg Limits @ 7.5-ft: LL=37 PL=17 PI=20
10		5	T	50/2"		0.0				
		6	T	50/4"		75.0				
15		7	T	50/1"		100.0	4.6	SM	**SILTY SAND WITH GRAVEL:** very dense, dry, light brown.	
20		8	T	50/5"	18	60.0	3.3			
25		9	T	50/4"		75.0		SP-SM	**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, dry, light brown.	
30		10	T	50/2"		0.0				

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/26/2011

LOG OF BORING NO. B-DP-209

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7682 LONG: -111.4063

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6367 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/2"		0.0	1.5		**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, dry, light brown.	-- Obtained cuttings.
40		12	T	50/2"		0.0			BOTTOM OF BORING AT 40.2 FEET	-- Obtained cuttings. -- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
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- T - 2" O.D. SPLIT SPOON
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DATE 10/27/2011

LOG OF BORING NO. B-210

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7567 LONG: -111.4008
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 6154 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	25-23-17		66.7	7.7	SM	**SILTY SAND WITH GRAVEL:** dense, moist, brown.	
		2	T	11-6-12		33.3		CL	**LEAN CLAY:** very stiff, moist, brown.	
5		3	T	9-9-9		66.7	11.7			
		4	T	7-7-7		44.4			-- stiff.	
10		5	M	7-7-7	53	100.0	10.3	CL-ML	**SANDY SILTY CLAY:** stiff, moist, brown.	Atterberg Limits @ 10-ft: LL=23 PL=16 PI=7
		6	T	8-5-5		83.3				
15		7	T	14-7-5	17	11.1	3.9	GM	**SILTY GRAVEL WITH SAND:** medium dense, moist, reddish brown.	
20		8	T	9-9-9		83.3		CL	**LEAN CLAY WITH SAND:** very stiff, moist, reddish brown.	
									BOTTOM OF BORING AT 21.5 FEET	-- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
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DATE 10/27/2011

LOG OF BORING NO. B-211

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7571 LONG: -111.3916

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6125 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	8-9-20		33.3	20.0	CL	**LEAN CLAY:** very stiff, dry, brown.	
		2	T	50/5"		40.0			-- hard.	
5		3	T	40-50/4"	34	80.0	6.8	GM	**SILTY GRAVEL WITH SAND:** very dense, dry, light brown.	
		4	T	50/5"		80.0				
10		5	T	50/0"						
		6	T	20-20-29		66.7		SP-SM	**POORLY GRADED SAND WITH SILT AND GRAVEL:** dense, moist, brown.	
15		7	T	33-27-25	45	66.7	12.2	GC	**CLAYEY GRAVEL WITH SAND:** very dense, moist, reddish brown.	Atterberg Limits @ 15-ft: LL=30 PL=14 PI=16
20		8	T	50/5"		60.0		SP-SM	**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, moist, yellowish brown. BOTTOM OF BORING AT 20.4 FEET	-- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
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DATE 10/27/2011

LOG OF BORING NO. B-DP-212

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7372 LONG: -111.3652

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6156 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	14-27-28		22.2		CL	**LEAN CLAY:** hard, dry, brown.	
		2	T	24-24-24		11.1				
5		3	M	14-27-31	38	100.0	13.4	SC	**CLAYEY SAND WITH GRAVEL:** very dense, moist, brown.	Atterberg Limits @ 5-ft: LL=38 PL=18 PI=20
		4	T	17-22-22		83.3			-- dense.	
10		5	T	19-33-41		83.3	10.6		-- very dense.	
		6	T	50/5"	6	60.0	3.6	GP-GM	**POORLY GRADED GRAVEL WITH SILT AND SAND:** very dense, dry, brown.	
15		7	T	50/5"		80.0			-- wet.	
20		8	T	50/5"	12	100.0	21.2	SM	**SILTY SAND WITH GRAVEL:** very dense, wet, brown.	
25		9	T	50/2"		100.0		CL	**LEAN CLAY WITH SAND:** hard, wet, brown.	
30		10	T	50/3"		33.3	14.0		**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, wet, brown.	

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
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DATE 10/27/2011

LOG OF BORING NO. B-DP-212

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7372 LONG: -111.3652
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6156 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/3"		0.0		SP-SM	**POORLY GRADED SAND WITH SILT AND GRAVEL:** very dense, wet, brown.	
40		12	T	50/3"		100.0				
									BOTTOM OF BORING AT 40.3 FEET	-- Groundwater was encountered at 15.5 feet during drilling. -- Groundwater was stabilized at 11 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

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DATE 11/1/2011

LOG OF BORING NO. B-DP-213

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7368 LONG: -111.3680
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6235 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	9-32-32		44.4	14.3		**LEAN CLAY WITH SAND:** hard, moist, reddish brown.	
		2	T	50/3"		100.0				
5		3	T	50/3"		100.0	11.8	CL		
		4	T	50/4"		100.0				
10		5	T	50/5"	30	100.0	8.6		**CLAYEY GRAVEL:** very dense, moist, reddish brown.	Atterberg Limits @ 10-ft: LL=36 PL=19 PI=17
		6	T	50/4"		100.0		GC		
15		7	T	50/5"		100.0			**LEAN CLAY WITH SAND:** hard, moist, reddish brown.	
								CL		
20		8	T	50/5"	27	100.0	13.4		**CLAYEY SAND:** very dense, wet, reddish brown.	Atterberg Limits @ 20-ft: LL=37 PL=19 PI=18
								SC		
25		9	T	50/3"		100.0			**LEAN CLAY WITH SAND:** hard, wet, reddish brown.	
30		10	T	50/5"		100.0		CL		

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
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(801) 553-8112

DATE 11/1/2011

LOG OF BORING NO. B-DP-213

PROJECT: SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION: Evanston, Wyoming to Park City, Utah

BORING LOCATION: LAT: 40.7368 LONG: -111.3680
RIG TYPE: Mobile B-80
DRILLING METHOD: Odex
SURFACE ELEVATION: 6235 ft (from google earth)
FIELD ENGINEER: JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/2"		50.0	19.8	GC	**CLAYEY GRAVEL WITH SAND:** very dense, wet, reddish brown.	
40		12	T	50/4"		100.0		CL	**LEAN CLAY WITH SAND:** hard, wet, reddish brown.	
									BOTTOM OF BORING AT 40.3 FEET	-- Groundwater was encountered at 20 feet during drilling. -- Groundwater was stabilized at 5.5 feet after 24 hours after drilling.

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
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14721 SOUTH HERITAGE CREST WAY
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DATE 10/28/2011

LOG OF BORING NO. B-DP-214

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7363 LONG: -111.3718

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6573 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0	1	T	41-50/4"		0.0			**POORLY GRADED GRAVEL WITH SILT AND SAND:** very dense, dry, light brown, with cobbles and boulders.	
	2	T	50/3"		66.7				
5	3	T	50/5"		40.0				
	4	T	50/3"		66.7				
10	5	T	14-50/5"	6	72.7	1.8	GP-GM		
	6	T	35-50/5"		0.0				
15	7	T	50/4"		0.0				
20	8	T	50/5"	18	100.0	16.6		**SILTY SAND:** very dense, moist, yellowish brown.	
25	9	T	50/5"		100.0				
30	10	T	41-50/5"	21	72.7	15.4	SM		

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/28/2011

LOG OF BORING NO. B-DP-214

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7363 LONG: -111.3718

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6573 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/5"		40.0			**SILTY SAND:** very dense, moist, yellowish brown.	
40		12	T	50/5"		80.0				
									BOTTOM OF BORING AT 40.4 FEET	-- Groundwater was not encoutnered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/28/2011

LOG OF BORING NO. B-DP-215

PROJECT: SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION: Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7361 LONG: -111.3731
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6617 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	13-21-50/4"		75.0		CL	**LEAN CLAY WITH SAND:** hard, moist, brown.	
		2	T	50/2"		150.0	2.1	GP	**POORLY GRADED GRAVEL WITH SAND:** very dense, dry, light brown, with cobbles and boulders.	
5		3	T	50/5"		80.0				
		4	T	50/3"	1	66.7	0.8			
10		5	T	50/4"		50.0				
		6	T	50/3"		66.7				
15		7	T	50-50/3"	15	88.9	14.4	SM	**SILTY SAND WITH GRAVEL:** very dense, moist, yellowish brown.	
20		8	T	50/4"		75.0				
25		9	T	50/4"		100.0				
30		10	T	50/5"	17	100.0	10.7			

Continued Next Page

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
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DATE 10/28/2011

LOG OF BORING NO. B-DP-215

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7361 LONG: -111.3731
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 6617 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/4"		100.0			**SILTY SAND WITH GRAVEL:** very dense, moist, yellowish brown.	
40		12	T	50/4"		25.0	6.5			
									BOTTOM OF BORING AT 40.3 FEET	-- Groundwater was not encoutnered during drilling.

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
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DATE 10/31/2011

LOG OF BORING NO. B-DP-218

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7234 LONG: -111.3879

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6560 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	10-15-31		44.4		CL	**LEAN CLAY WITH SAND:** hard, moist, brown.	
		2	T	50/3"		100.0	17.0	SM	**SILTY SAND WITH GRAVEL:** very dense, dry, brown, with cobbles and boulders.	
5		3	T	50/3"		100.0				
		4	T	50/4"	20	100.0	15.8			
10		5	T	50/3"		100.0				
		6	T	50/2"		50.0				
15		7	T	50/3"		100.0	9.7			
20		8	T	50/4"	17	100.0	14.6			
25		9	T	50/3"		66.7				
30		10	T	50/3"	14	100.0	12.0			

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
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DATE 10/31/2011

LOG OF BORING NO. B-DP-218

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7234 LONG: -111.3879

RIG TYPE Mobile B-80

DRILLING METHOD Odex

SURFACE ELEVATION 6560 ft (from google earth)

FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/4"		100.0			**SILTY SAND WITH GRAVEL:** very dense, dry, brown, with cobbles and boulders.	
40		12	T	50/4"		100.0	11.2			
									BOTTOM OF BORING AT 40.3 FEET	-- Groundwater was not encoutnered during drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/31/2011

LOG OF BORING NO. B-DP-219

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7174 LONG: -111.3952
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 6588 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	30-20-15		22.2		CL	**LEAN CLAY WITH GRAVEL** hard, dry, brown.	
		2	T	21-40-50		100.0				
5		3	T	31-42-50/4"	55	112.5	31.6	CH	**SANDY FAT CLAY:** hard, dry, brown.	Atterberg Limits @ 5-ft: LL=51 PL=25 PI=26
		4	T	21-30-50/4"		112.5				
10		5	T	50/5"		100.0	29.4			
		6	T	36-50/5"		100.0				
15		7	T	38-50/4"	27	100.0	34.3	SM	**SILTY SAND:** very dense, moist, brown.	Atterberg Limits @ 15-ft: LL=NP PL=NP PI=NP
20		8	T	35-50/5"		100.0		CL	**LEAN CLAY WITH SAND:** hard, wet, brown.	
25		9	T	50/5"	23	100.0	27.1	SM	**SILTY SAND WITH GRAVEL:** very dense, wet, brown.	
30		10	T	38-50/4"		100.0		CL	**LEAN CLAY WITH SAND:** hard, wet, brown.	

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 10/31/2011

LOG OF BORING NO. B-DP-219

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7174 LONG: -111.3952
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6588 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	29-50/5"	21	100.0	27.8	SM	**SILTY SAND:** very dense, wet, brown.	
40		12	T	50/5"		100.0		SC	**CLAYEY SAND WITH GRAVEL:** very dense, wet, brown.	
									BOTTOM OF BORING AT 40.4 FEET	-- Groundwater was encountered at 20 feet during drilling. -- Groundwater was stabilized at 11 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
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WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 11/1/2011-11/2/2011

LOG OF BORING NO. B-DP-221

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7163 LONG: -111.4068
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6596 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	35-42-25		66.7		SM	**SILTY SAND WITH GRAVEL:** very dense, moist, brown.	
		2	T	12-9-14		11.1		CL	**LEAN CLAY WITH SAND:** very stiff, moist, brown.	
5		3	T	7-9-13		66.7	28.0			
		4	T	9-12-13		100.0			-- with Gravel.	
10		5	M	8-6-9	55	100.0	34.8	CH	**SANDY FAT CLAY:** very stiff, moist, brown.	Atterberg Limits @ 10-ft: LL=52 PL=16 PI=36
		6	T	7-10-12		100.0				
15		7	T	50/3"		100.0		SM	**SILTY SAND WITH GRAVEL:** very dense, moist, brown.	
20		8	T	35-35-50/5"	31	100.0	40.2	SC	**CLAYEY SAND:** very dense, moist, light gray.	Atterberg Limits @ 20-ft: LL=79 PL=29 PI=50
25		9	T	38-50/4"		100.0		CL	**LEAN CLAY WITH SAND:** hard, wet, light gray.	
30		10	T	15-50/5"	19	100.0	40.8		**CLAYEY SAND:** very dense, wet, brown.	Atterberg Limits @ 30-ft: LL=74 PL=30 PI=44

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
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- M - MODIFIED CALIFORNIA
- T - 2" O.D. SPLIT SPOON
- H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

DATE 11/1/2011-11/2/2011

LOG OF BORING NO. B-DP-221

PROJECT SW Wyoming to Silver Creek Transmission Line
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.7163 LONG: -111.4068
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 6596 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/5"		100.0		SC	**CLAYEY SAND:** very dense, wet, brown. -- with Gravel.	
40		12	T	50/5"		100.0	54.6	CL	**LEAN CLAY:** hard, wet, brown. BOTTOM OF BORING AT 40.4 FEET	-- Groundwater was encountered at 25 feet during drilling. -- Groundwater was stabilized at 12.5 feet after 24 hours after drilling.

GROUNDWATER ELEVATION
- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD
- A - AUGER CUTTINGS
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DATE 11/3/2011

LOG OF BORING NO. B-DP-222

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.7022 LONG: -111.4346
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6609 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0	1	T	9-14-22		16.7			**LEAN CLAY WITH SAND:** hard, moist, brown.	
	2	T	50/5"		80.0	11.2	CL		
5	3	T	50/4"		100.0			**CLAYEY SAND WITH GRAVEL:** very dense, moist, brown.	
	4	T	30-44-50/5"	25	100.0	35.7		-- with decreasing Gravel.	Atterberg Limits @ 7.5-ft: LL=64 PL=28 PI=36
10	5	T	37-42-49		100.0				
	6	T	47-44-50/5"		100.0			-- with Gravel.	
15	7	T	46-38-50/4"	26	100.0	34.3	SC	-- with decreasing Gravel.	Atterberg Limits @ 15-ft: LL=66 PL=26 PI=40
20	8	T	41-48-50/5"		100.0				
25	9	T	40-50/5"	17	100.0	19.3		**SILTY SAND WITH GRAVEL:** very dense, moist, brown.	Atterberg Limits @ 25-ft: LL=47 PL=31 PI=16
30	10	T	50/5"		100.0		SM	-- wet.	

Continued Next Page

GROUNDWATER ELEVATION

- ▽ DURING DRILLING
- ▼ AFTER DRILLING
- ▼ 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
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- H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
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DATE 11/3/2011

LOG OF BORING NO. B-DP-222

PROJECT: SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION: Evanston, Wyoming to Park City, Utah

BORING LOCATION: LAT: 40.7022 LONG: -111.4346

RIG TYPE: Mobile B-80

DRILLING METHOD: Odex

SURFACE ELEVATION: 6609 ft (from google earth)

FIELD ENGINEER: JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/5"		100.0		SM	**SILTY SAND WITH GRAVEL**: very dense, wet, brown.	
40		12	T	50/4"		100.0	27.5			
									BOTTOM OF BORING AT 40.3 FEET	-- Groundwater was encountered at 30 feet during drilling. -- Groundwater was stabilized at 10 feet after 24 hours after drilling.

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

- A - AUGER CUTTINGS
- S - 3" O.D. THIN WALLED SHELBY TUBE
- M - MODIFIED CALIFORNIA
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WILDING ENGINEERING, INC
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(801) 553-8112

DATE 11/3/2011

LOG OF BORING NO. B-DP-224

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION	LAT: 40.6845 LONG: -111.4532
RIG TYPE	Mobile B-80
DRILLING METHOD	Odex
SURFACE ELEVATION	6725 ft (from google earth)
FIELD ENGINEER	JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
0		1	T	14-29-40		16.7	12.8	CL	**LEAN CLAY:** hard, moist, brown.	
		2	T	50/4"		100.0			-- with Gravel.	
5		3	T	50/4"	7	100.0	7.0	GP-GM	**POORLY GRADED GRAVEL WITH SILT AND SAND:** very dense, dry, light brown, with cobbles and boulders.	
		4	T	50/5"		80.0				
10		5	T	50/5"		100.0	5.6			
		6	T	34-34-42	24	83.3	13.6	GM	**SILTY GRAVEL WITH SAND:** very dense, dry, light brown, with cobbles and boulders.	
15		7	T	50/5"		100.0				
20		8	T	50/1"		0.0				
25		9	T	50/2"		50.0				
30		10	T	50/3"	16	100.0	7.4		**SILTY SAND WITH GRAVEL:** very dense, dry, brown.	

Continued Next Page

GROUNDWATER ELEVATION

- DURING DRILLING
- AFTER DRILLING
- 24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
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(801) 553-8112

DATE 11/3/2011

LOG OF BORING NO. B-DP-224

PROJECT SW Wyoming to Silver Creek Transmission Line

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

BORING LOCATION LAT: 40.6845 LONG: -111.4532
RIG TYPE Mobile B-80
DRILLING METHOD Odex
SURFACE ELEVATION 6725 ft (from google earth)
FIELD ENGINEER JP

DEPTH IN FEET	GRAPHICAL LOG	SAMPLE NUMBER	SAMPLE TYPE	PENETRATION RESISTANCE (per 6-inch)	% FINER THAN #200 SIEVE	% RECOVERY	% MOISTURE	UNIFIED SOIL CLASSIFICATION	VISUAL CLASSIFICATION	REMARKS
35		11	T	50/4"		100.0		SM	**SILTY SAND WITH GRAVEL:** very dense, dry, brown.	
40		12	T	50/2"		50.0	3.4		BOTTOM OF BORING AT 40.2 FEET	-- Groundwater was not encountered during drilling.

GROUNDWATER ELEVATION

DURING DRILLING

AFTER DRILLING

24 HOURS AFTER

SAMPLE METHOD

A - AUGER CUTTINGS
S - 3" O.D. THIN WALLED SHELBY TUBE
M - MODIFIED CALIFORNIA
T - 2" O.D. SPLIT SPOON
H - HAND SAMPLE

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
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APPENDIX C

SUMMARY OF LABORATORY TEST RESULTS

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
(801) 553-8112

Wilding Engineering Inc

CLIENT Power Engineers
PROJECT NAME SW Wyoming to Silver Creek Transmission Line
PROJECT NUMBER 11173
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

Borehole	Depth (ft)	Moisture (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%<#200 Sieve)	Classification
B-203	2.5	14.8								
B-203	10.0	19.9	109.6	32	14	18			63	CL
B-203	15.0	20.6		31	15	16			86	CL
B-204	5.0	2.5					68	27	5	
B-204	10.0	13.4		27	16	11			62	CL
B-204	15.0	17.3		29	14	15			68	CL
B-206	0.0	9.1								
B-206	5.0	30.0	92.3	NP	NP	NP	0	82	18	SM
B-206	10.0	30.3								
B-206	12.5	13.2					51	40	10	
B-206	20.0	10.9								
B-207	5.0	6.9					38	33	28	
B-207	12.5	13.9								
B-207	20.0	14.7	114.1	25	14	11			74	CL
B-208	5.0	9.1								
B-208	10.0	6.2					4	14	82	
B-208	20.0	30.9		60	23	37			91	CH
B-210	0.0	7.7								
B-210	5.0	11.7								
B-210	10.0	10.3	115.6	23	16	7	2	45	53	CL-ML
B-210	15.0	3.9					47	36	17	
B-211	0.0	20.0								
B-211	5.0	6.8					35	31	34	
B-211	15.0	12.2		30	14	16	38	17	45	GC
B-DP-201	2.5	12.6								
B-DP-201	10.0	9.8					66	32	2	GP
B-DP-201	20.0	17.5					17	82	2	SP
B-DP-201	30.0	13.2					40	57	3	SP
B-DP-201	40.0	22.7								
B-DP-202	5.0	28.9		34	19	15			51	CL
B-DP-202	12.5	15.9					41	57	2	SP
B-DP-202	20.0	9.9					61	38	2	GP
B-DP-202	30.0	19.8					4	93	3	SP
B-DP-205	2.5	18.2								
B-DP-205	7.5	23.3	102.2	27	17	10			38	SC
B-DP-205	20.0	11.5					57	40	3	GP
B-DP-205	30.0	6.4								
B-DP-205	40.0	6.3								
B-DP-209	2.5	6.0								
B-DP-209	7.5	9.3		37	17	20			85	CL
B-DP-209	15.0	4.6								
B-DP-209	20.0	3.3					20	62	18	
B-DP-209	35.0	1.5								

Wilding Engineering Inc

SUMMARY OF LABORATORY TEST RESULTS

CLIENT Power Engineers

PROJECT NAME SW Wyoming to Silver Creek Transmission Line

PROJECT NUMBER 11173

PROJECT LOCATION Evanston, Wyoming to Park City, Utah

Borehole	Depth (ft)	Moisture (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%<#200 Sieve)	Classification
B-DP-212	5.0	13.4	103.5	38	18	20	23	39	38	SC
B-DP-212	10.0	10.6								
B-DP-212	12.5	3.6					67	27	6	
B-DP-212	20.0	21.2					42	47	12	
B-DP-212	30.0	14.0								
B-DP-213	0.0	14.3								
B-DP-213	5.0	11.8								
B-DP-213	10.0	8.6		36	19	17	35	34	30	GC
B-DP-213	20.0	13.4		37	19	18	9	64	27	SC
B-DP-213	35.0	19.8								
B-DP-214	10.0	1.8					65	29	6	
B-DP-214	20.0	16.6					13	69	18	
B-DP-214	30.0	15.4					14	65	21	
B-DP-215	2.5	2.1								
B-DP-215	7.5	0.8					98	2	1	GP
B-DP-215	15.0	14.4					21	64	15	
B-DP-215	30.0	10.7					29	54	17	
B-DP-215	40.0	6.5								
B-DP-218	2.5	17.0								
B-DP-218	7.5	15.8					17	63	20	
B-DP-218	15.0	9.7								
B-DP-218	20.0	14.6					31	51	17	
B-DP-218	30.0	12.0					29	57	14	
B-DP-218	40.0	11.2								
B-DP-219	5.0	31.6		51	25	26	8	36	55	CH
B-DP-219	10.0	29.4								
B-DP-219	15.0	34.3		NP	NP	NP	6	67	27	SM
B-DP-219	25.0	27.1					33	44	23	
B-DP-219	35.0	27.8					0	79	21	
B-DP-221	5.0	28.0								
B-DP-221	10.0	34.8	84.7	52	16	36	3	41	55	CH
B-DP-221	20.0	40.2		79	29	50			31	SC
B-DP-221	30.0	40.8		74	30	44	12	69	19	SC
B-DP-221	40.0	54.6								
B-DP-222	2.5	11.2								
B-DP-222	7.5	35.7		64	28	36	14	61	25	SC
B-DP-222	15.0	34.3		66	26	40	11	62	26	SC
B-DP-222	25.0	19.3		47	31	16	27	56	17	SM
B-DP-222	40.0	27.5								
B-DP-224	0.0	12.8								
B-DP-224	5.0	7.0					60	33	7	
B-DP-224	10.0	5.6								
B-DP-224	12.5	13.6					39	38	24	

WILDING ENGINEERING, INC
14721 SOUTH HERITAGE CREST WAY
BLUFFDALE, UTAH 84065
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Wilding Engineering Inc

CLIENT Power Engineers
PROJECT NAME SW Wyoming to Silver Creek Transmission Line
PROJECT NUMBER 11173
PROJECT LOCATION Evanston, Wyoming to Park City, Utah

Borehole	Depth (ft)	Moisture (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%<#200 Sieve)	Classification
B-DP-224	30.0	7.4					15	69	16	
B-DP-224	40.0	3.4								
B-DP-228	0.0	9.1								
B-DP-228	7.5	2.7					93	6	1	GP
B-DP-228	12.5	20.6	106.7	NP	NP	NP			78	ML
B-DP-228	25.0	20.0		NP	NP	NP			34	SM
B-DP-228	40.0	19.6								

GRAIN SIZE DISTRIBUTION

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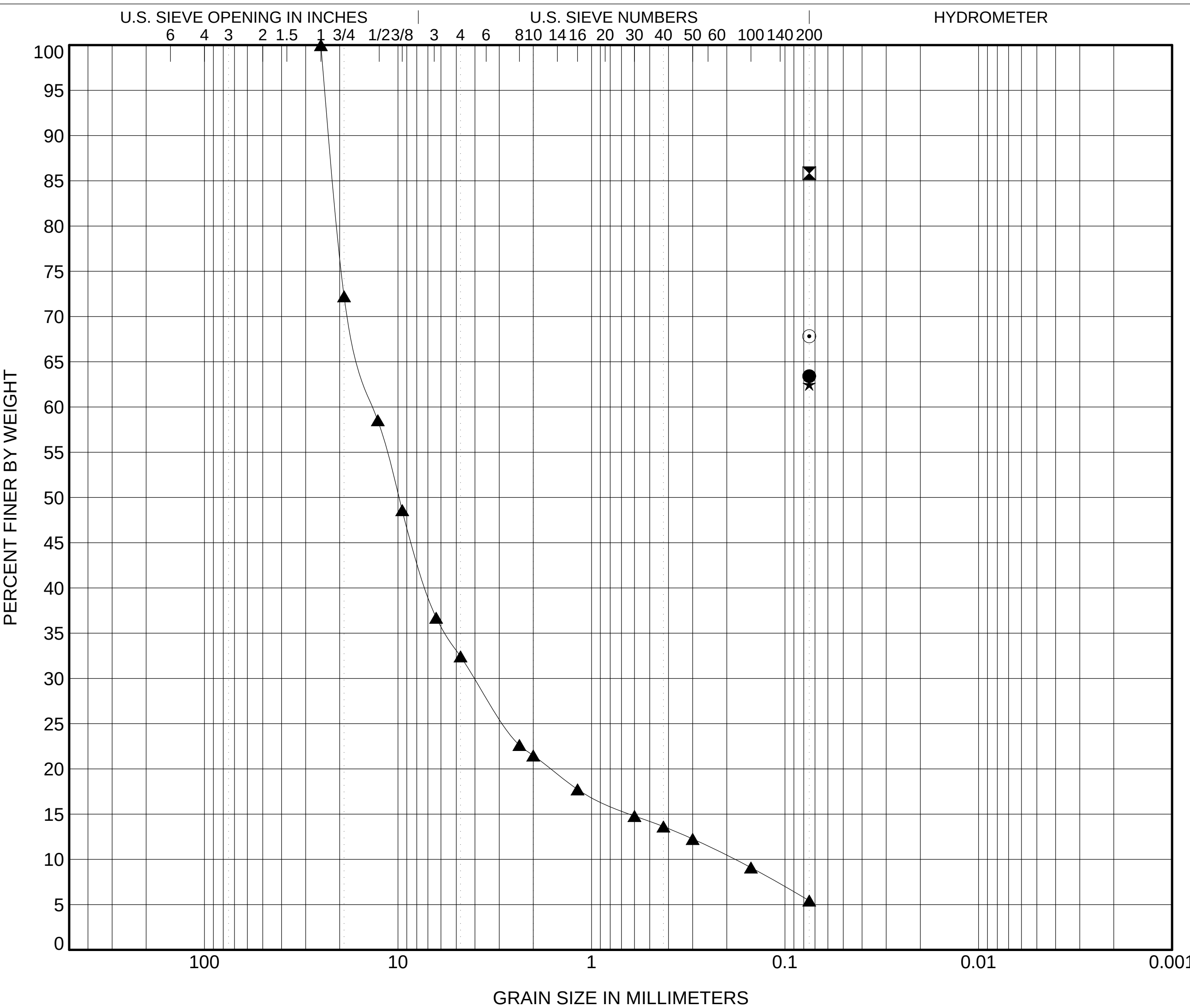
CLIENT Power Engineers | **PROJECT NAME** SW Wyoming to Silver Creek Transmission Line

PROJECT NUMBER 11173 | **PROJECT LOCATION** Evanston, Wyoming to Park City, Utah



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-203	10.0	SANDY LEAN CLAY(CL)	32	14	18		
⧗	B-203	15.0	LEAN CLAY(CL)	31	15	16		
▲	B-204	5.0					6.58	72.54
★	B-204	10.0	SANDY LEAN CLAY(CL)	27	16	11		
⊙	B-204	15.0	SANDY LEAN CLAY(CL)	29	14	15		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-203	10.0	0.075						63.4	
⧗	B-203	15.0	0.075						85.8	
▲	B-204	5.0	25	13.259	3.994	0.183	68	27	5.4	
★	B-204	10.0	0.075						62.5	
⊙	B-204	15.0	0.075						67.8	

GRAIN SIZE DISTRIBUTION

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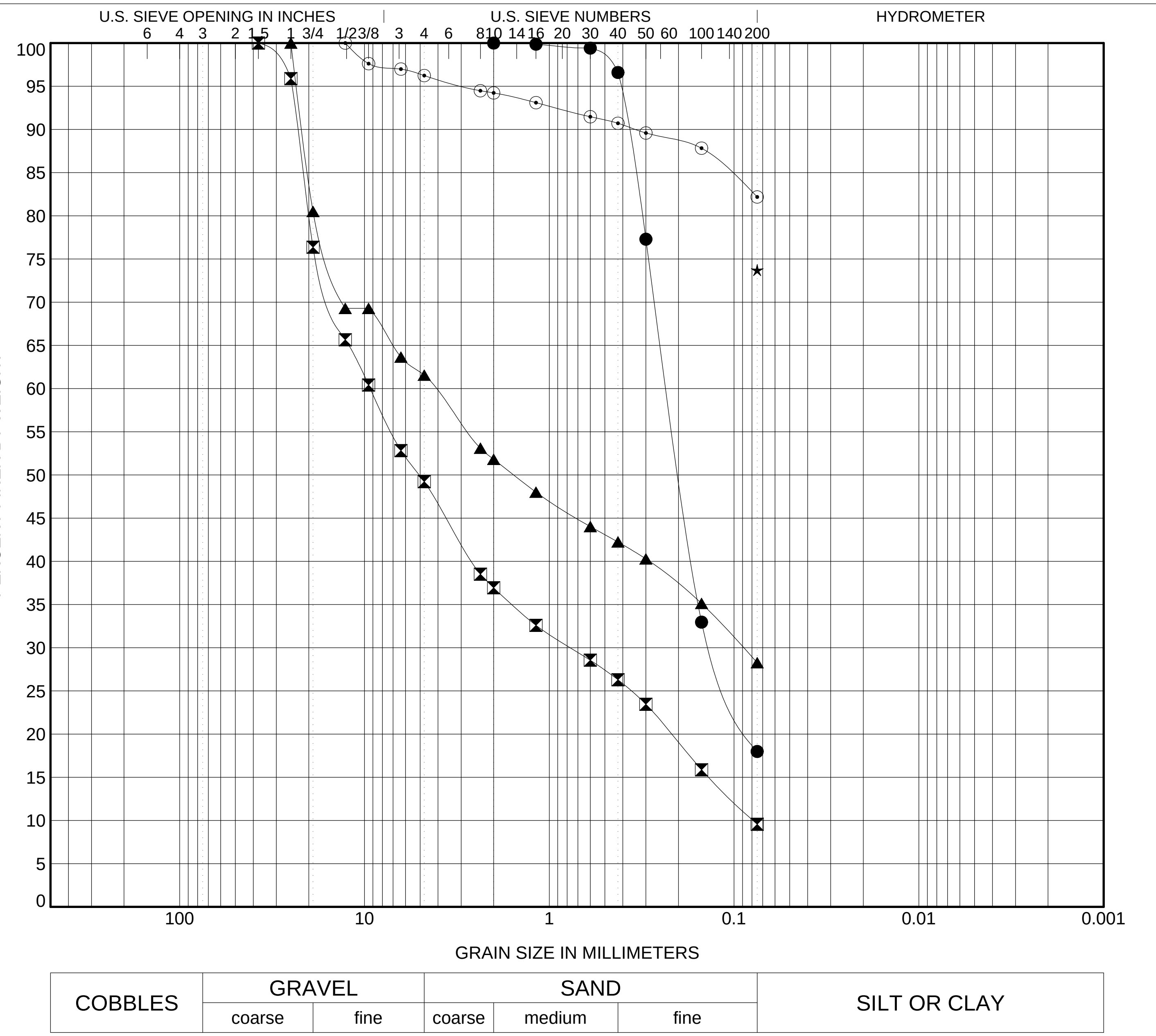

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-206**	**5.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
⧗	**B-206**	**12.5**					**0.80**	**117.99**
▲	**B-207**	**5.0**						
★	**B-207**	**20.0**	**LEAN CLAY with SAND(CL)**	**25**	**14**	**11**		
☉	**B-208**	**10.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-206**	**5.0**	**2**	**0.229**	**0.131**		**0**	**82**	**18.0**	
⧗	**B-206**	**12.5**	**37.5**	**9.293**	**0.764**	**0.079**	**51**	**40**	**9.6**	
▲	**B-207**	**5.0**	**25**	**4.176**	**0.089**		**38**	**33**	**28.3**	
★	**B-207**	**20.0**	**0.075**						**73.7**	
☉	**B-208**	**10.0**	**12.7**				**4**	**14**	**82.2**	

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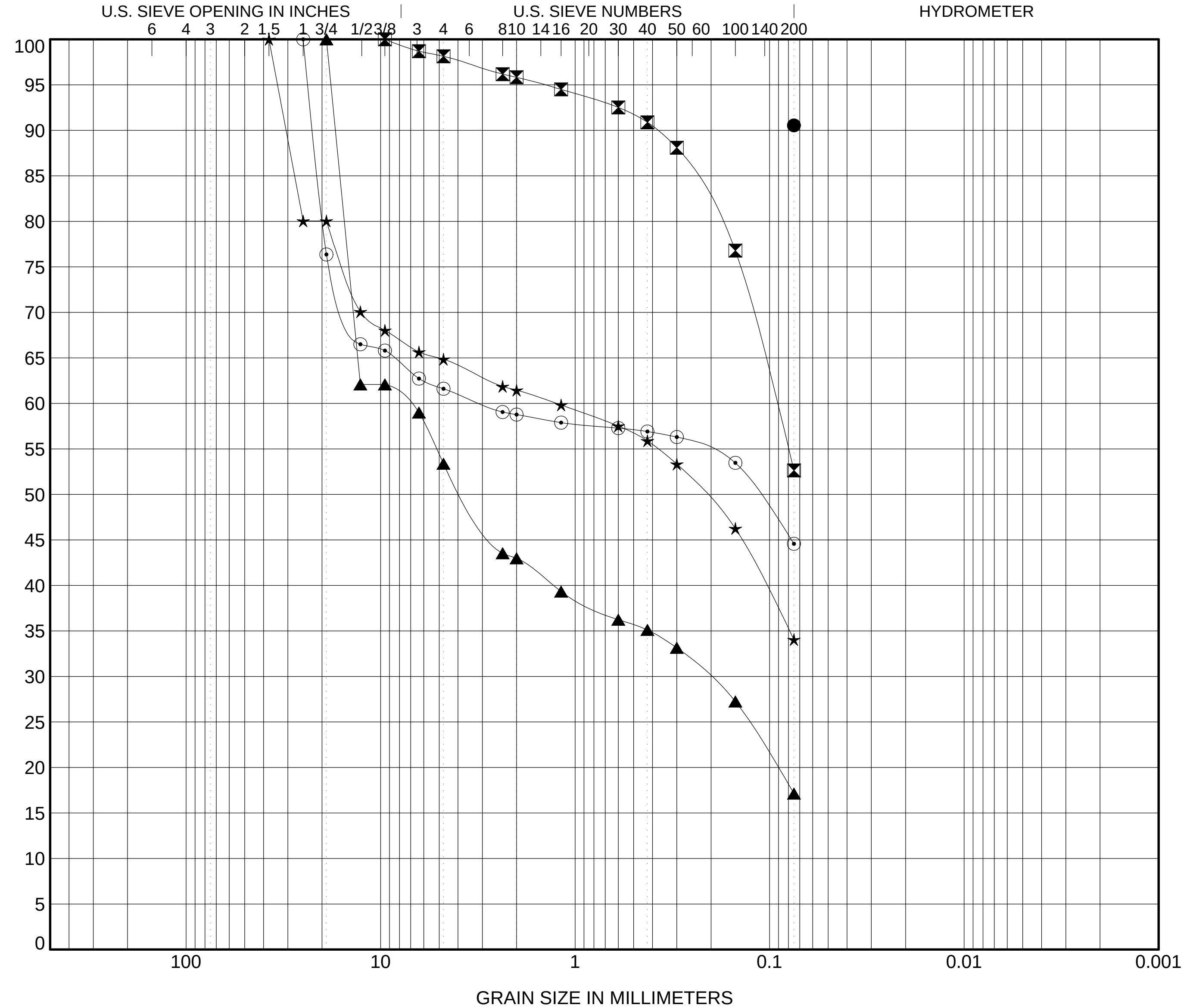
GRAIN SIZE DISTRIBUTION

CLIENT Power Engineers **PROJECT NAME** SW Wyoming to Silver Creek Transmission Line

PROJECT NUMBER 11173 **PROJECT LOCATION** Evanston, Wyoming to Park City, Utah



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-208**	**20.0**	**FAT CLAY(CH)**	**60**	**23**	**37**		
⧗	**B-210**	**10.0**	**SANDY SILTY CLAY(CL-ML)**	**23**	**16**	**7**		
▲	**B-210**	**15.0**						
★	**B-211**	**5.0**						
⊙	**B-211**	**15.0**	**CLAYEY GRAVEL with SAND(GC)**	**30**	**14**	**16**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-208**	**20.0**	**0.075**						**90.5**	
⧗	**B-210**	**10.0**	**9.5**	**0.093**			**2**	**45**	**52.6**	
▲	**B-210**	**15.0**	**19**	**7.245**	**0.207**		**47**	**36**	**17.1**	
★	**B-211**	**5.0**	**37.5**	**1.249**			**35**	**31**	**34.1**	
⊙	**B-211**	**15.0**	**25**	**3.059**			**38**	**17**	**44.6**	

GRAIN SIZE DISTRIBUTION

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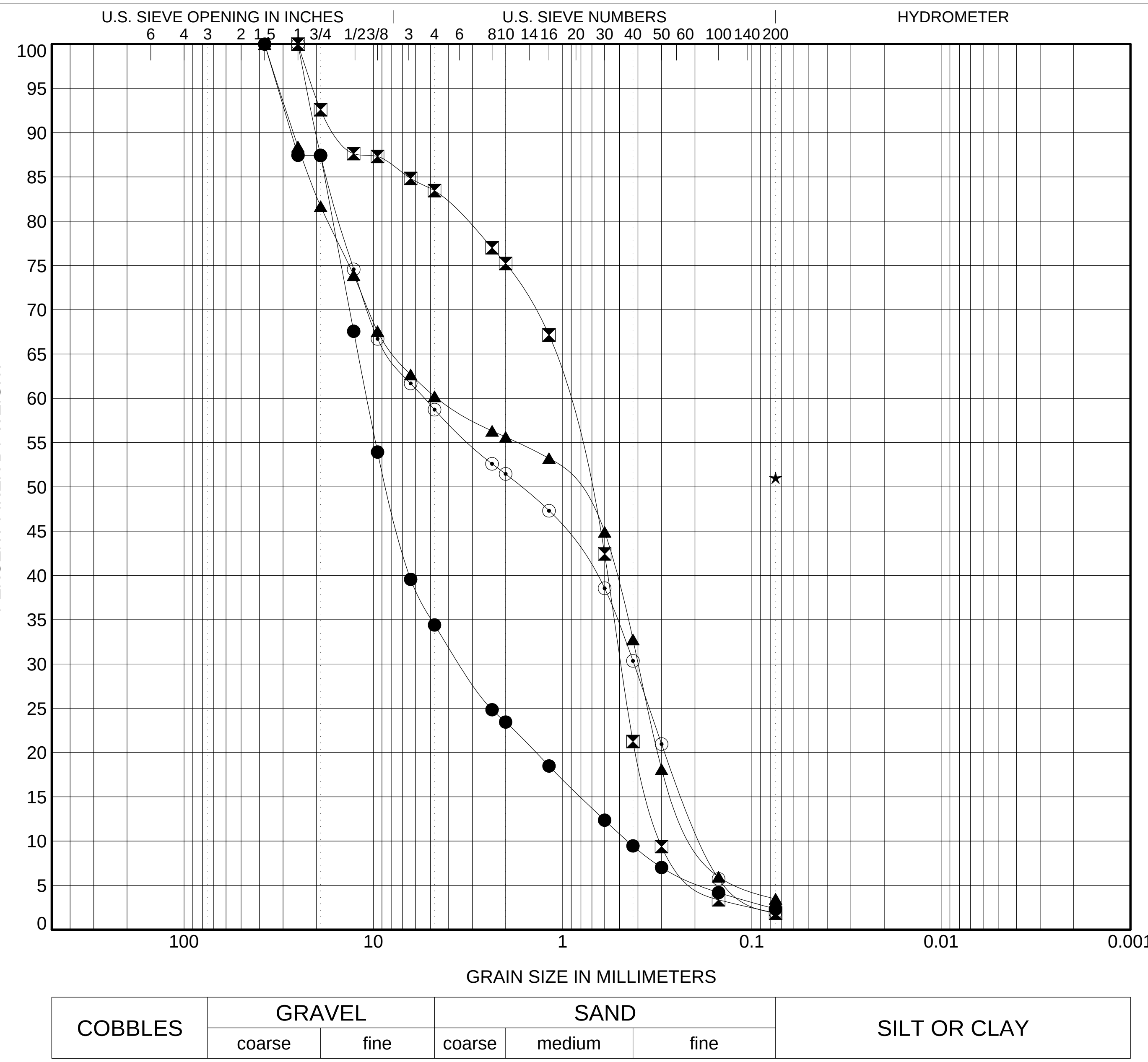
PROJECT NUMBER 11173 **PROJECT LOCATION** Evanston, Wyoming to Park City, Utah



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-201**	**10.0**	**POORLY-GRADED GRAVEL with SAND(GP)**				**2.42**	**23.84**
⧗	**B-DP-201**	**20.0**	**POORLY GRADED SAND with GRAVEL(SP)**				**0.81**	**3.18**
▲	**B-DP-201**	**30.0**	**POORLY GRADED SAND with GRAVEL(SP)**				**0.18**	**24.19**
★	**B-DP-202**	**5.0**	**SANDY LEAN CLAY(CL)**	**34**	**19**	**15**		
⊙	**B-DP-202**	**12.5**	**POORLY GRADED SAND with GRAVEL(SP)**				**0.18**	**29.56**

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-201**	**10.0**	**37.5**	**10.81**	**3.442**	**0.453**	**66**	**32**	**2.3**	
⧗	**B-DP-201**	**20.0**	**25**	**0.97**	**0.49**	**0.306**	**17**	**82**	**1.9**	
▲	**B-DP-201**	**30.0**	**37.5**	**4.569**	**0.398**	**0.189**	**40**	**57**	**3.5**	
★	**B-DP-202**	**5.0**	**0.075**						**51.0**	
⊙	**B-DP-202**	**12.5**	**25**	**5.386**	**0.42**	**0.182**	**41**	**57**	**1.9**	

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GRAIN SIZE DISTRIBUTION

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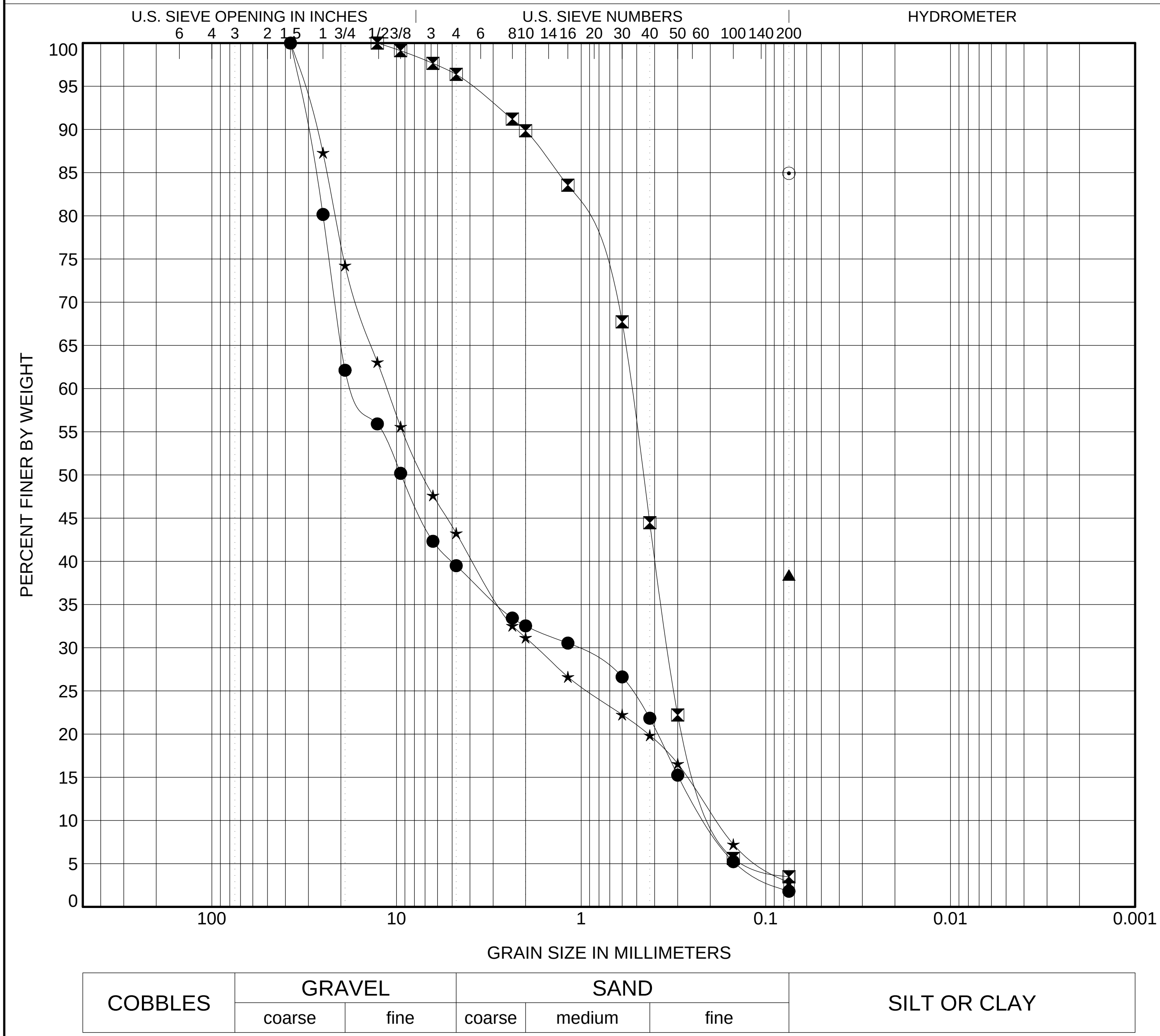
PROJECT NUMBER 11173 **PROJECT LOCATION** Evanston, Wyoming to Park City, Utah



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-202**	**20.0**	**POORLY GRADED GRAVEL with SAND(GP)**				**0.34**	**79.36**
⧗	**B-DP-202**	**30.0**	**POORLY GRADED SAND(SP)**				**1.19**	**2.97**
▲	**B-DP-205**	**7.5**	**CLAYEY SAND(SC)**	**27**	**17**	**10**		
★	**B-DP-205**	**20.0**	**POORLY-GRADED GRAVEL with SAND(GP)**				**1.47**	**61.22**
⊙	**B-DP-209**	**7.5**	**LEAN CLAY with SAND(CL)**	**37**	**17**	**20**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-202**	**20.0**	**37.5**	**16.556**	**1.076**	**0.209**	**61**	**38**	**1.8**	
⧗	**B-DP-202**	**30.0**	**12.7**	**0.535**	**0.339**	**0.18**	**4**	**93**	**3.5**	
▲	**B-DP-205**	**7.5**	**0.075**						**38.4**	
★	**B-DP-205**	**20.0**	**37.5**	**11.271**	**1.744**	**0.184**	**57**	**40**	**2.8**	
⊙	**B-DP-209**	**7.5**	**0.075**						**84.9**	

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PROJECT NAME SW Wyoming to Silver Creek Transmission Line

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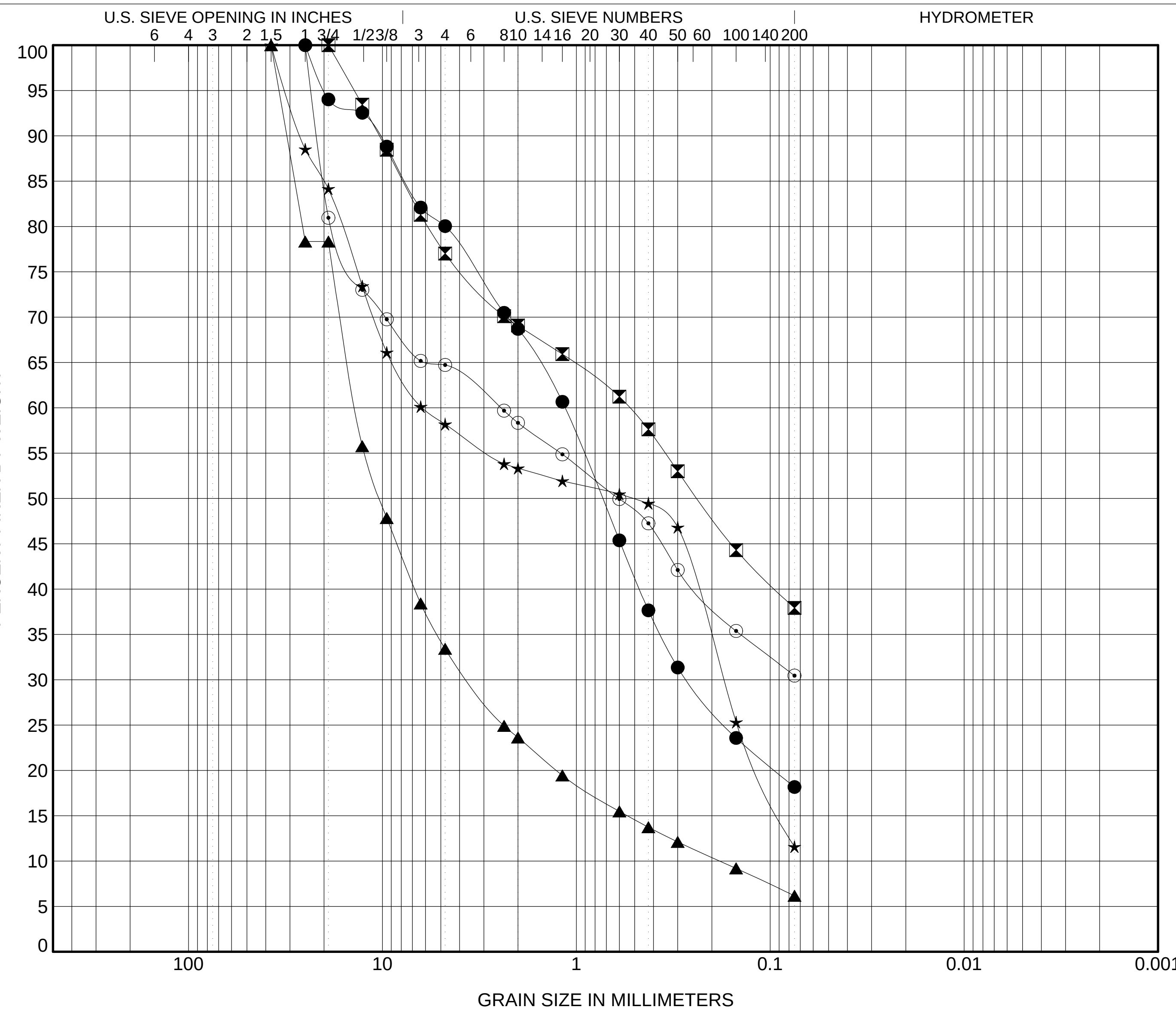
PROJECT LOCATION Evanston, Wyoming to Park City, Utah



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-209**	**20.0**						
⧗	**B-DP-212**	**5.0**	**CLAYEY SAND with GRAVEL(SC)**	**38**	**18**	**20**		
▲	**B-DP-212**	**12.5**					**5.17**	**75.41**
★	**B-DP-212**	**20.0**					**0.07**	**89.95**
⊙	**B-DP-213**	**10.0**	**CLAYEY GRAVEL with SAND(GC)**	**36**	**19**	**17**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-209**	**20.0**	**25**	**1.146**	**0.266**		**20**	**62**	**18.2**	
⧗	**B-DP-212**	**5.0**	**19**	**0.534**			**23**	**39**	**37.9**	
▲	**B-DP-212**	**12.5**	**37.5**	**13.697**	**3.587**	**0.182**	**67**	**27**	**6.2**	
★	**B-DP-212**	**20.0**	**37.5**	**6.228**	**0.174**		**42**	**47**	**11.6**	
⊙	**B-DP-213**	**10.0**	**25**	**2.465**			**35**	**34**	**30.5**	

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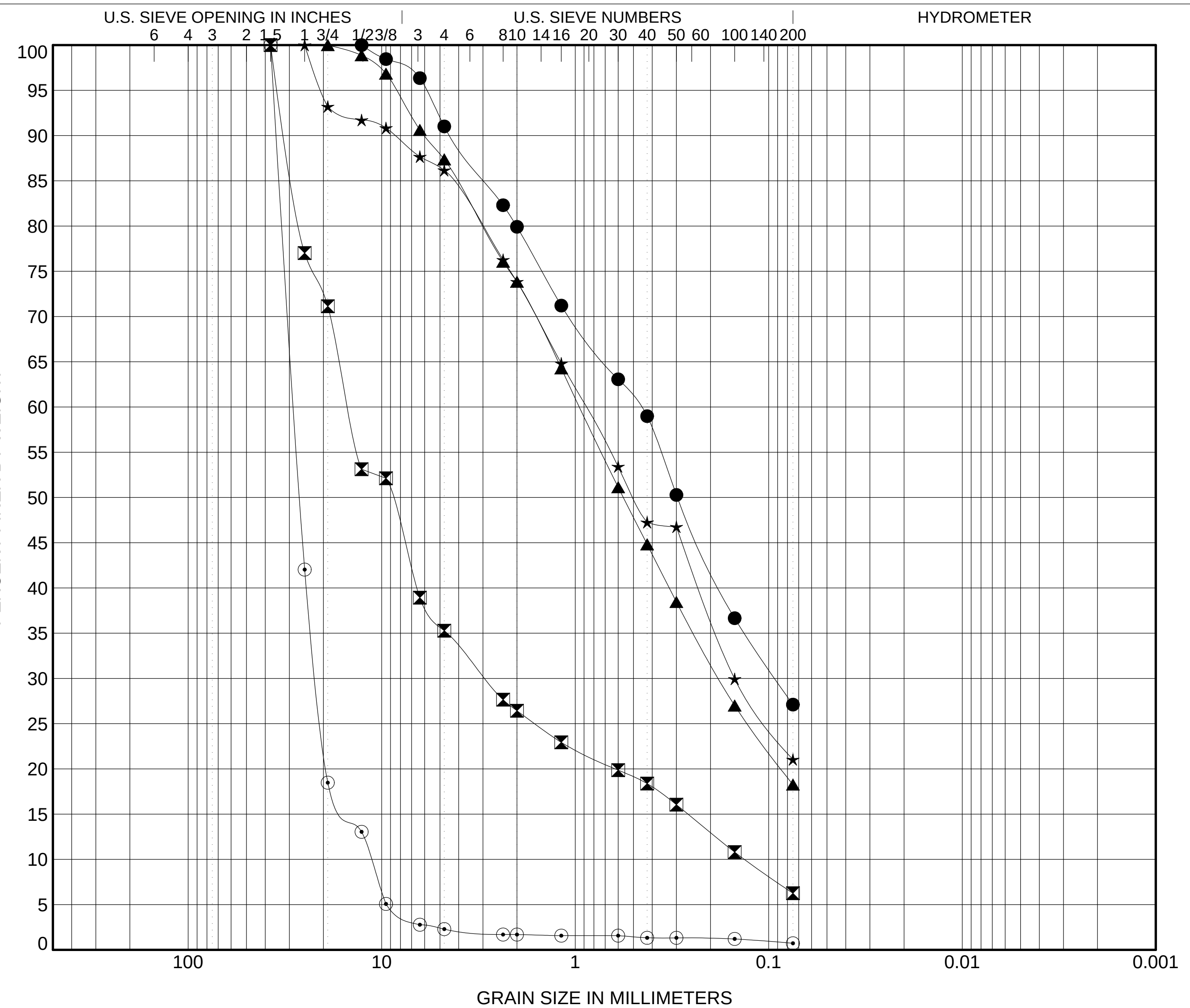
GRAIN SIZE DISTRIBUTION

CLIENT Power Engineers **PROJECT NAME** SW Wyoming to Silver Creek Transmission Line

PROJECT NUMBER 11173 **PROJECT LOCATION** Evanston, Wyoming to Park City, Utah



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-213**	**20.0**	**CLAYEY SAND(SC)**	**37**	**19**	**18**		
⧗	**B-DP-214**	**10.0**					**4.36**	**111.61**
▲	**B-DP-214**	**20.0**						
★	**B-DP-214**	**30.0**						
⊙	**B-DP-215**	**7.5**	**POORLY GRADED GRAVEL(GP)**				**1.47**	**2.49**

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-213**	**20.0**	**12.7**	**0.463**	**0.093**		**9**	**64**	**27.1**	
⧗	**B-DP-214**	**10.0**	**37.5**	**14.811**	**2.928**	**0.133**	**65**	**29**	**6.3**	
▲	**B-DP-214**	**20.0**	**19**	**0.947**	**0.18**		**13**	**69**	**18.3**	
★	**B-DP-214**	**30.0**	**25**	**0.886**	**0.15**		**14**	**65**	**21.0**	
⊙	**B-DP-215**	**7.5**	**37.5**	**28.348**	**21.73**	**11.367**	**98**	**2**	**0.7**	

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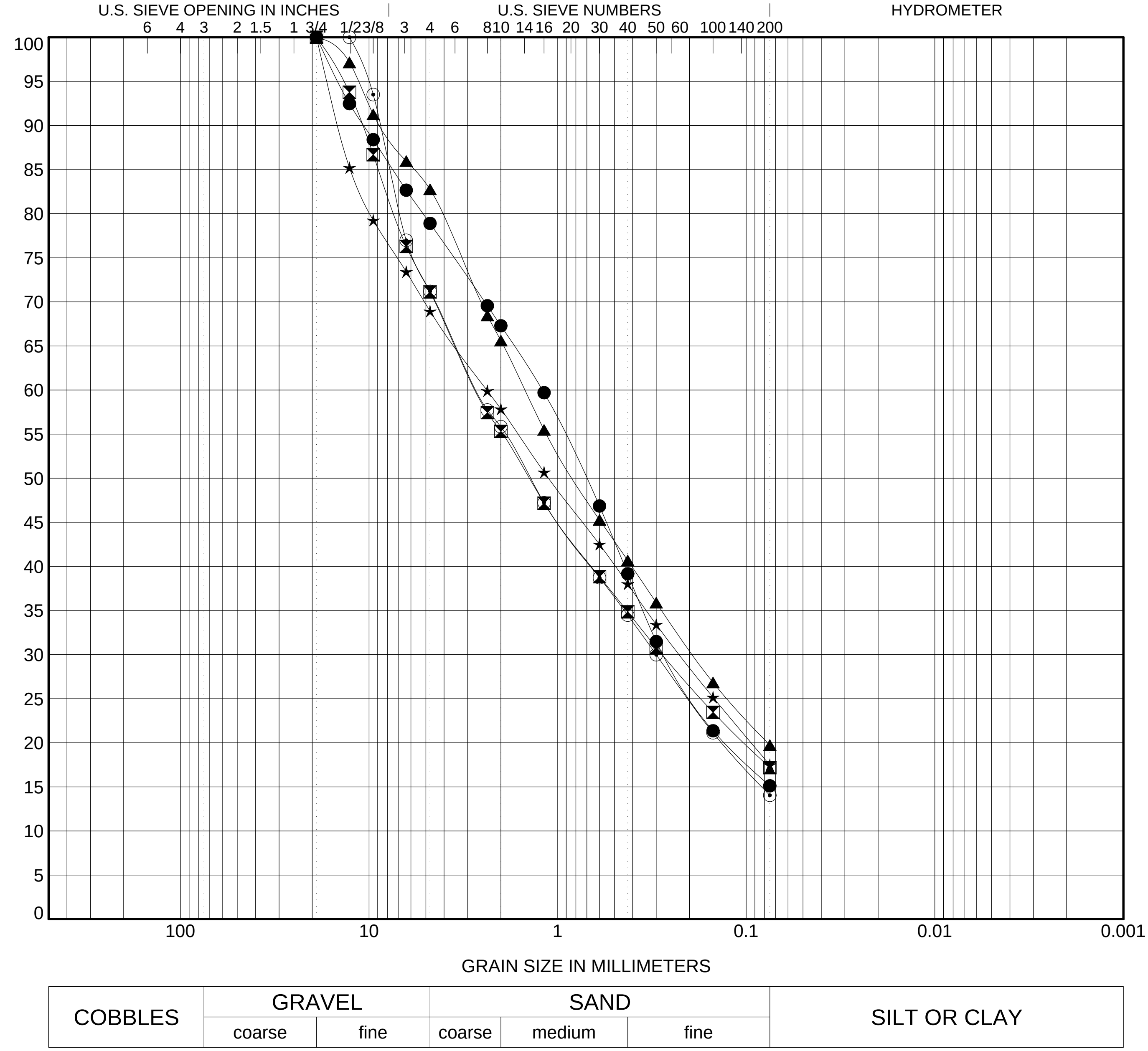

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-215**	**15.0**						
⧗	**B-DP-215**	**30.0**						
▲	**B-DP-218**	**7.5**						
★	**B-DP-218**	**20.0**						
⊙	**B-DP-218**	**30.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-215**	**15.0**	**19**	**1.205**	**0.271**		**21**	**64**	**15.1**	
⧗	**B-DP-215**	**30.0**	**19**	**2.69**	**0.278**		**29**	**54**	**17.2**	
▲	**B-DP-218**	**7.5**	**19**	**1.493**	**0.191**		**17**	**63**	**19.7**	
★	**B-DP-218**	**20.0**	**19**	**2.376**	**0.225**		**31**	**51**	**17.5**	
⊙	**B-DP-218**	**30.0**	**12.7**	**2.655**	**0.3**		**29**	**57**	**14.0**	

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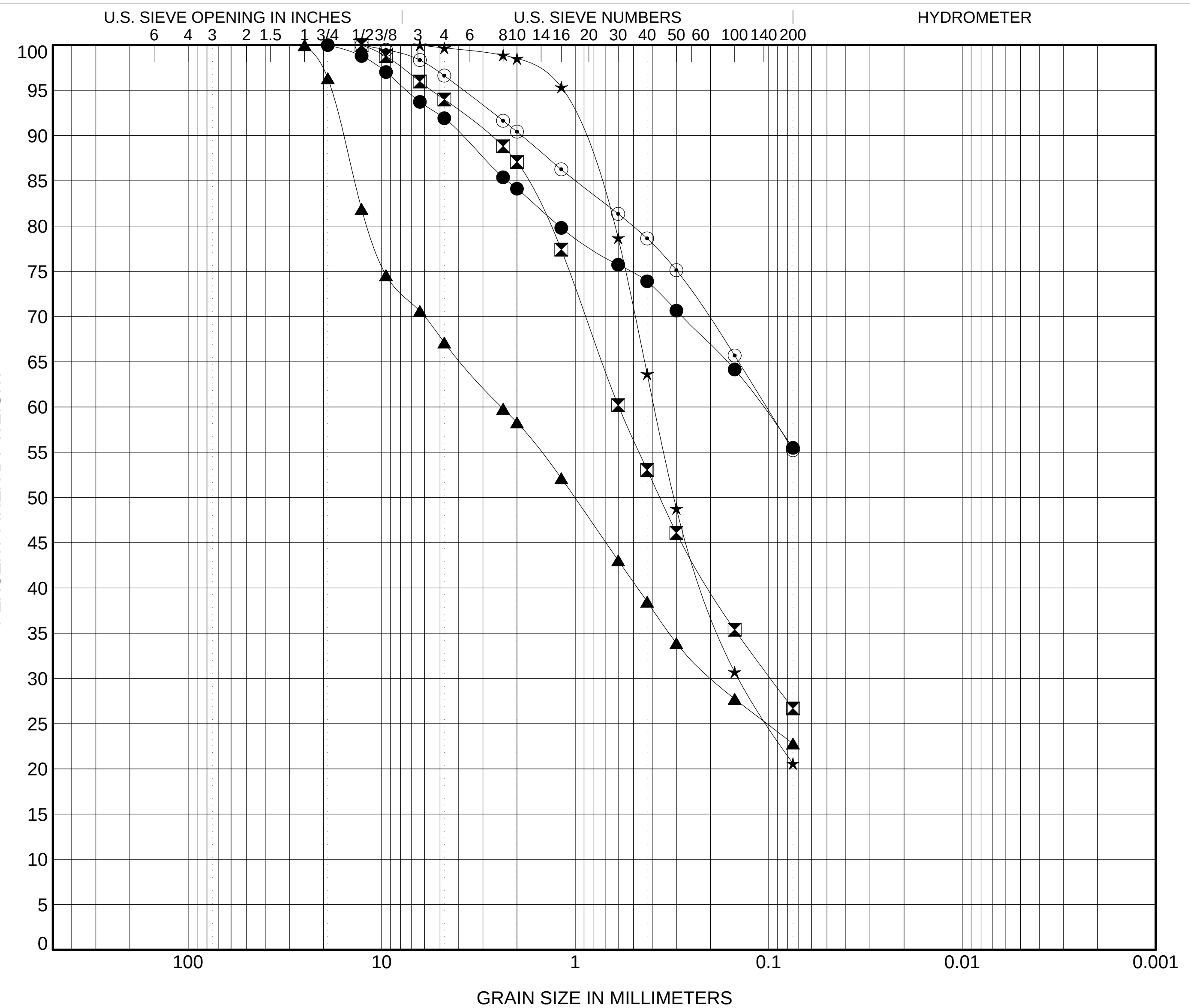

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-219**	**5.0**	**SANDY FAT CLAY(CH)**	**51**	**25**	**26**		
⧗	**B-DP-219**	**15.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
▲	**B-DP-219**	**25.0**						
★	**B-DP-219**	**35.0**						
⊙	**B-DP-221**	**10.0**	**SANDY FAT CLAY(CH)**	**52**	**16**	**36**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-219**	**5.0**	**19**	**0.108**			**8**	**36**	**55.5**	
⧗	**B-DP-219**	**15.0**	**12.7**	**0.594**	**0.098**		**6**	**67**	**26.7**	
▲	**B-DP-219**	**25.0**	**25**	**2.402**	**0.193**		**33**	**44**	**22.8**	
★	**B-DP-219**	**35.0**	**6.35**	**0.39**	**0.143**		**0**	**79**	**20.6**	
⊙	**B-DP-221**	**10.0**	**12.7**	**0.103**			**3**	**41**	**55.2**	

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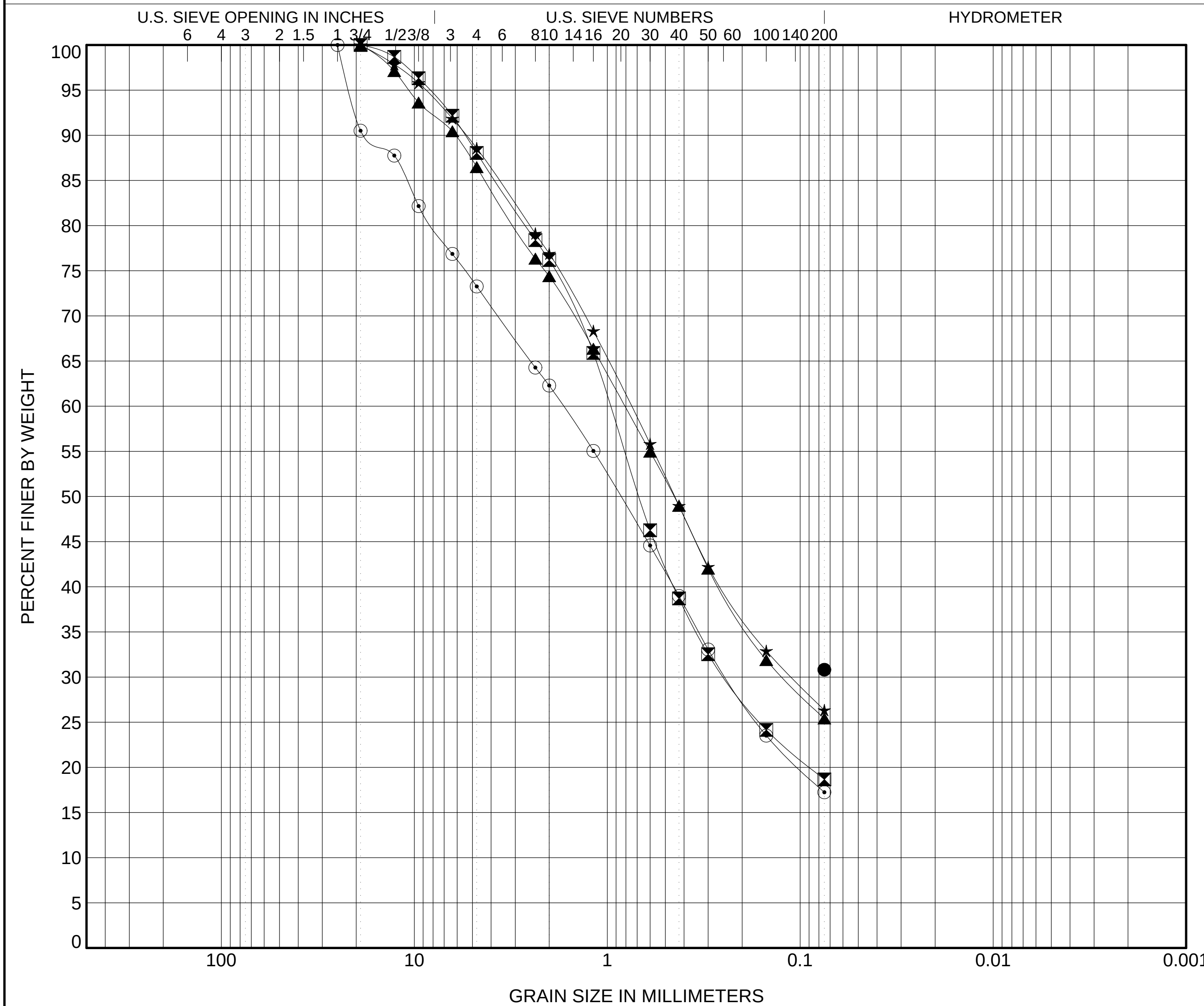

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-221**	**20.0**	**CLAYEY SAND(SC)**	**79**	**29**	**50**		
⧗	**B-DP-221**	**30.0**	**CLAYEY SAND(SC)**	**74**	**30**	**44**		
▲	**B-DP-222**	**7.5**	**CLAYEY SAND(SC)**	**64**	**28**	**36**		
★	**B-DP-222**	**15.0**	**CLAYEY SAND(SC)**	**66**	**26**	**40**		
⊙	**B-DP-222**	**25.0**	**SILTY SAND with GRAVEL(SM)**	**47**	**31**	**16**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-221**	**20.0**	**0.075**						**30.8**	
⧗	**B-DP-221**	**30.0**	**19**	**0.963**	**0.243**		**12**	**69**	**18.7**	
▲	**B-DP-222**	**7.5**	**19**	**0.809**	**0.123**		**14**	**61**	**25.4**	
★	**B-DP-222**	**15.0**	**19**	**0.751**	**0.11**		**11**	**62**	**26.3**	
⊙	**B-DP-222**	**25.0**	**25**	**1.693**	**0.24**		**27**	**56**	**17.2**	

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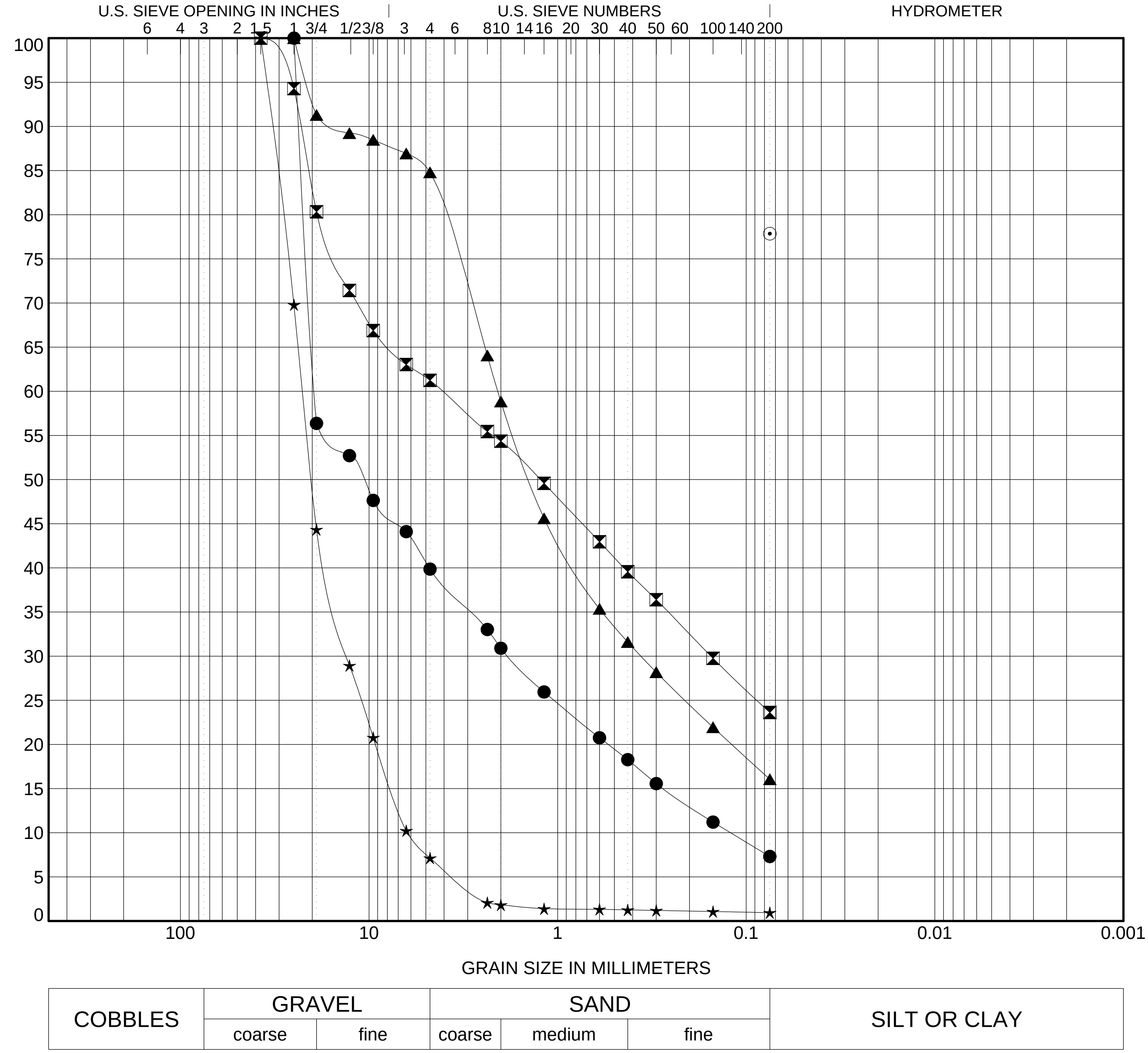
PROJECT NUMBER 11173

PROJECT LOCATION Evanston, Wyoming to Park City, Utah



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-224**	**5.0**					**1.40**	**160.56**
⧗	**B-DP-224**	**12.5**						
▲	**B-DP-224**	**30.0**						
★	**B-DP-228**	**7.5**	**POORLY GRADED GRAVEL(GP)**				**1.22**	**3.62**
⊙	**B-DP-228**	**12.5**	**SILT with SAND(ML)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-224**	**5.0**	**25**	**19.439**	**1.818**	**0.121**	**60**	**33**	**7.3**	
⧗	**B-DP-224**	**12.5**	**37.5**	**4.09**	**0.154**		**39**	**38**	**23.6**	
▲	**B-DP-224**	**30.0**	**25**	**2.075**	**0.361**		**15**	**69**	**16.1**	
★	**B-DP-228**	**7.5**	**37.5**	**22.493**	**13.059**	**6.212**	**93**	**6**	**0.9**	
⊙	**B-DP-228**	**12.5**	**0.075**						**77.9**	

GRAIN SIZE DISTRIBUTION

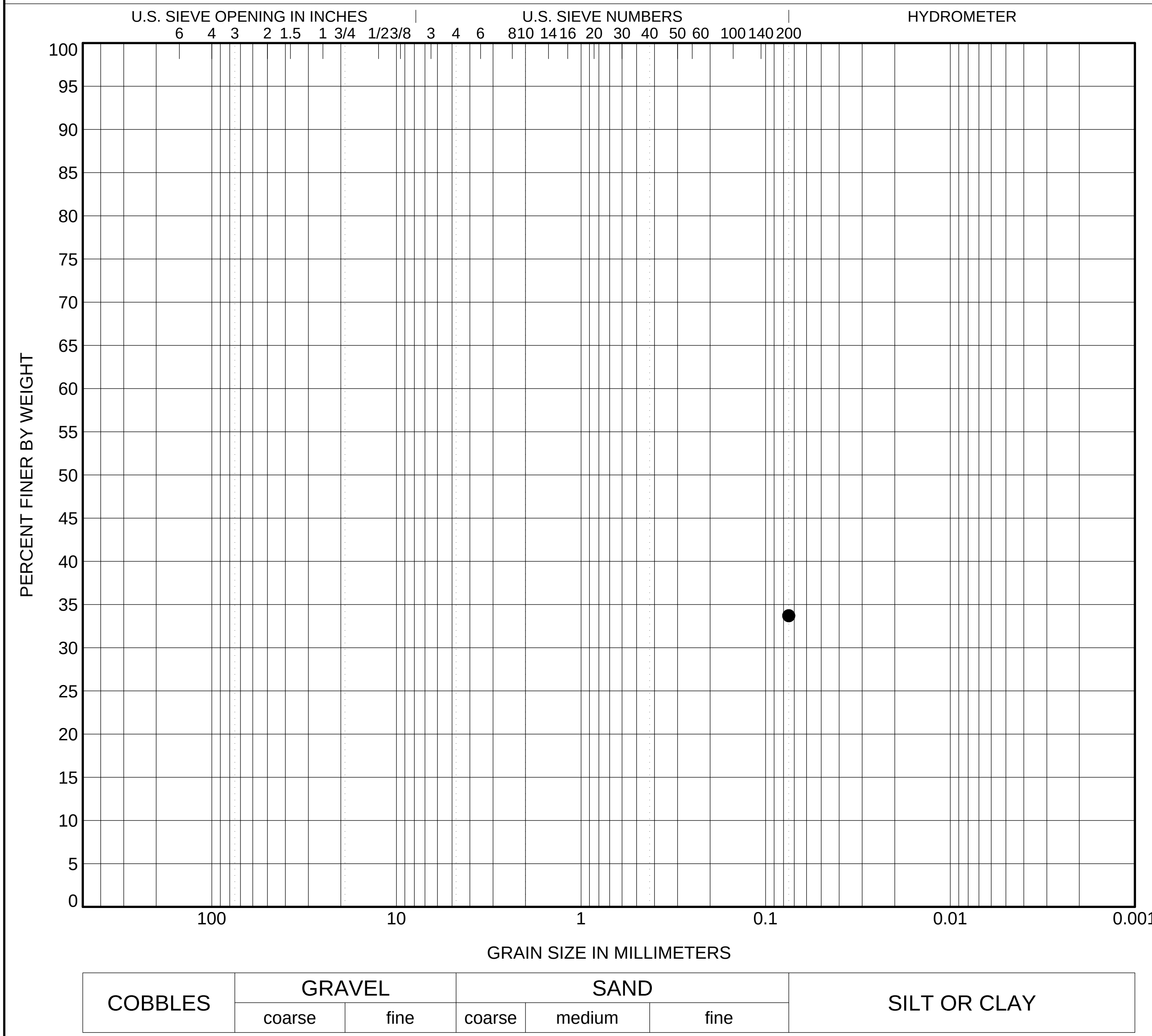
Wilding Engineering Inc

CLIENT Power Engineers

PROJECT NAME SW Wyoming to Silver Creek Transmission Line

PROJECT NUMBER 11173

PROJECT LOCATION Evanston, Wyoming to Park City, Utah



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-DP-228**	**25.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-DP-228**	**25.0**	**0.075**						**33.7**	

INORGANIC ANALYTICAL REPORT

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-001
Client Sample ID: B-DP-228 @ 10'
Collection Date: 10/24/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.78**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**6,640**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	6.02	< 6.02	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Laboratory Director

Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-002
Client Sample ID: B-DP-228 @ 20'
Collection Date: 10/24/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	6.00	**24.8**	&H

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-003
Client Sample ID: B-DP-228 @ 35'
Collection Date: 10/24/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	6.26	**19.5**	&H

& - Analysis is performed on a 1:1 DI water extract for soils.
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INORGANIC ANALYTICAL REPORT

American West ANALYTICAL LABORATORIES

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-004
Client Sample ID: B-DP-201 @ 5'
Collection Date: 10/24/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.43**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**5,890**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	5.86	**40.6**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-005
Client Sample ID: B-DP-201 @ 15'
Collection Date: 10/24/2011
Received Date: 11/16/2011 1547h

Analytical Results

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Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 1000h	SM4500-SO4-E	6.02	**35.9**	&H

& - Analysis is performed on a 1:1 DI water extract for soils.
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INORGANIC ANALYTICAL REPORT

Client:	Wilding Engineering, Inc.	**Contact:**	Chad Bhongir
Project:	SW Wyoming to Silver Creek Transmission Line/11173		
Lab Sample ID:	1111290-006		
Client Sample ID:	B-DP-201 @ 35'		
Collection Date:	10/24/2011		
Received Date:	11/16/2011 1547h		

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/18/2011 1130h	SM4500-SO4-E	75.1	**213**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-007
Client Sample ID: B-DP-202 @ 10'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.40**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**4,950**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	5.66	**26.6**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-008
Client Sample ID: B-DP-202 @ 25'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-wet		11/22/2011 0710h	SM4500-SO4-E	5.00	< 5.00	&H

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-009
Client Sample ID: B-203 @ 5'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**7.72**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**21,300**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	14.7	**41.2**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-010
Client Sample ID: B-203 @ 20'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	5.86	21.9	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-011
Client Sample ID: B-204 @ 7.5'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**7.80**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**21,700**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	13.9	**33.9**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-012
Client Sample ID: B-204 @ 20'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 1000h	SM4500-SO4-E	14.3	**35.2**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-013
Client Sample ID: B-DP-205 @ 5'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.63**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**8,350**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	6.08	< 6.08	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-014
Client Sample ID: B-DP-205 @ 15'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-wet		11/21/2011 1000h	SM4500-SO4-E	5.00	< 5.00	&

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-015
Client Sample ID: B-DP-205 @ 25'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	5.96	**19.8**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

American West
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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-016
Client Sample ID: B-206 @ 7.5'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**7.36**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**5,270**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	79.4	**194**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
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INORGANIC ANALYTICAL REPORT

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-017
Client Sample ID: B-206 @ 15'
Collection Date: 10/25/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/22/2011 0710h	SM4500-SO4-E	13.3	**22.5**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-018
Client Sample ID: B-207 @ 7.5'
Collection Date: 10/31/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**9.50**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**4,980**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	28.5	< 28.5	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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INORGANIC ANALYTICAL REPORT

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-019
Client Sample ID: B-208 @ 7.5'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**9.48**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**5,960**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	5.28	< 5.28	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-020
Client Sample ID: B-208 @ 15'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	14.4	**79.6**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-021
Client Sample ID: B-DP-209 @ 5'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.60**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**8,250**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	5.31	< 5.31	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-022
Client Sample ID: B-DP-209 @ 12.5'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	26.9	**138**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

American West
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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-023
Client Sample ID: B-DP-209 @ 25'
Collection Date: 10/26/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-wet		11/21/2011 0835h	SM4500-SO4-E	5.00	< 5.00	&

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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-024
Client Sample ID: B-210 @ 7.5'
Collection Date: 10/27/2011
Received Date: 11/16/2011 1547h

Analytical Results

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Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.31**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**574**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	28.5	**192**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

Kyle F. Gross
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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-025
Client Sample ID: B-211 @ 7.5'
Collection Date: 10/27/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**9.20**	H
Resistivity	ohm-cm		11/17/2011 1030h	SM2510B	10.0	**8,310**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	5.14	< 5.14	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-026
Client Sample ID: B-211 @ 12.5'
Collection Date: 10/27/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 1000h	SM4500-SO4-E	5.21	< 5.21	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-027
Client Sample ID: B-DP-212 @ 7.5'
Collection Date: 10/27/2011
Received Date: 11/16/2011 1547h

Analytical Results

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Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.60**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**6,220**	&
Sulfate	mg/kg-dry		11/17/2011 1148h	SM4500-SO4-E	6.20	**11.6**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-028
Client Sample ID: B-DP-212 @ 15'
Collection Date: 10/27/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/18/2011 1130h	SM4500-SO4-E	36.9	**97.2**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-029
Client Sample ID: B-DP-212 @ 25'
Collection Date: 10/27/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-wet		11/18/2011 1130h	SM4500-SO4-E	5.00	**18.2**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-030
Client Sample ID: B-DP-213 @ 7.5'
Collection Date: 11/1/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**9.12**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**8,510**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	5.50	**16.1**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-031
Client Sample ID: B-DP-213 @ 15'
Collection Date: 11/1/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	5.73	**21.3**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-032
Client Sample ID: B-DP-213 @ 30'
Collection Date: 11/1/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	6.11	**22.8**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-033
Client Sample ID: B-DP-214 @ 7.5'
Collection Date: 10/28/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.68**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**22,700**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	5.03	< 5.03	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-034
Client Sample ID: B-DP-214 @ 25'
Collection Date: 10/28/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	14.9	**109**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-035
Client Sample ID: B-DP-214 @ 40'
Collection Date: 10/28/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	5.70	**7.43**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-036
Client Sample ID: B-DP-215 @ 5'
Collection Date: 10/28/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1750h	SW9045D	1.00	**8.99**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**12,500**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	5.22	< 5.22	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-037
Client Sample ID: B-DP-215 @ 20'
Collection Date: 10/28/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/18/2011 1130h	SM4500-SO4-E	13.9	**36.7**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-038
Client Sample ID: B-DP-215 @ 35'
Collection Date: 10/28/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/18/2011 1130h	SM4500-SO4-E	34.4	**90.8**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-039
Client Sample ID: B-DP-218 @ 10'
Collection Date: 10/31/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1830h	SW9045D	1.00	**6.97**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**14,300**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	5.62	**7.52**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-040
Client Sample ID: B-DP-218 @ 25'
Collection Date: 10/31/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-wet		11/18/2011 1130h	SM4500-SO4-E	5.00	19.2	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client:	Wilding Engineering, Inc.	**Contact:**	Chad Bhongir
Project:	SW Wyoming to Silver Creek Transmission Line/11173		
Lab Sample ID:	1111290-041		
Client Sample ID:	B-DP-218 @ 35'		
Collection Date:	10/31/2011		
Received Date:	11/16/2011 1547h		

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	5.65	< 5.65	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client:	Wilding Engineering, Inc.	**Contact:**	Chad Bhongir
Project:	SW Wyoming to Silver Creek Transmission Line/11173		
Lab Sample ID:	1111290-042		
Client Sample ID:	B-DP-219 @ 7.5'		
Collection Date:	10/31/2011		
Received Date:	11/16/2011 1547h		

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1830h	SW9045D	1.00	**8.25**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**2,160**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	18.0	**84.4**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-043
Client Sample ID: B-DP-219 @ 12.5'
Collection Date: 10/31/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 1000h	SM4500-SO4-E	32.1	**66.0**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-044
Client Sample ID: B-DP-219 @ 30'
Collection Date: 10/31/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	35.8	**90.0**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-045
Client Sample ID: B-DP-221 @ 7.5'
Collection Date: 11/1/2011
Received Date: 11/16/2011 1547h

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Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1830h	SW9045D	1.00	**7.82**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**6,910**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	6.30	**19.6**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-046
Client Sample ID: B-DP-221 @ 15'
Collection Date: 11/1/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/22/2011 0710h	SM4500-SO4-E	6.20	**15.6**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

INORGANIC ANALYTICAL REPORT

American West
ANALYTICAL LABORATORIES

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-047
Client Sample ID: B-DP-221 @ 25'
Collection Date: 11/1/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	6.74	< 6.74	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Kyle F. Gross
Laboratory Director

Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

American West
ANALYTICAL LABORATORIES

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-048
Client Sample ID: B-DP-222 @ 10'
Collection Date: 11/3/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1830h	SW9045D	1.00	**7.12**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**41,800**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	6.36	**16.1**	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Jose Rocha
QA Officer

INORGANIC ANALYTICAL REPORT

American West
ANALYTICAL LABORATORIES

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-049
Client Sample ID: B-DP-222 @ 20'
Collection Date: 11/3/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/22/2011 0710h	SM4500-SO4-E	79.8	**86.5**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

American West
ANALYTICAL LABORATORIES

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-050
Client Sample ID: B-DP-222 @ 35'
Collection Date: 11/3/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	33.7	**71.7**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

American West
ANALYTICAL LABORATORIES

Client:	Wilding Engineering, Inc.	**Contact:**	Chad Bhongir
Project:	SW Wyoming to Silver Creek Transmission Line/11173		
Lab Sample ID:	1111290-051		
Client Sample ID:	B-DP-224 @ 7.5'		
Collection Date:	11/3/2011		
Received Date:	11/16/2011 1547h		

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
pH @ 25° C	pH Units		11/16/2011 1830h	SW9045D	1.00	**8.75**	H
Resistivity	ohm-cm		11/18/2011 0820h	SM2510B	10.0	**17,400**	&
Sulfate	mg/kg-dry		11/18/2011 1030h	SM4500-SO4-E	5.45	< 5.45	&

& - Analysis is performed on a 1:1 DI water extract for soils.
H - Sample was received outside of the holding time.

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Jose Rocha
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INORGANIC ANALYTICAL REPORT

American West
ANALYTICAL LABORATORIES

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-052
Client Sample ID: B-DP-224 @ 15'
Collection Date: 11/3/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 0835h	SM4500-SO4-E	5.40	**10.7**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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INORGANIC ANALYTICAL REPORT

Client: Wilding Engineering, Inc. **Contact:** Chad Bhongir
Project: SW Wyoming to Silver Creek Transmission Line/11173
Lab Sample ID: 1111290-053
Client Sample ID: B-DP-224 @ 35'
Collection Date: 11/3/2011
Received Date: 11/16/2011 1547h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Sulfate	mg/kg-dry		11/21/2011 1000h	SM4500-SO4-E	5.45	< 5.45	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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Appendix 10
Property Valuation Report

Transmission Lines and Property Values: Review of the Research

Presentation to the Emerging Technology Issues Advisory Committee of the Virginia General Assembly Joint Commission on Technology and Science

July 18, 2005

Prepared by

Thomas Priestley, Ph.D.

CH2MHILL

There is a substantial body of systematic research on the relationship between transmission lines and property values.

The research provides empirically based data points against which claims based on anecdotes and speculation can be evaluated.

What the Research Findings Suggest:

- Proximity to transmission lines is not the major factor that determines property values.
- In some cases, there may not be any impacts.
- Any impacts on the value of single family homes tend to be small.
- In some cases, the impact can be positive.

What the Research Findings Suggest:
(Continued)

- In some specific cases – single family homes located immediately adjacent to towers, vacant rural land suitable for residential development – the degree of impact could be somewhat higher.

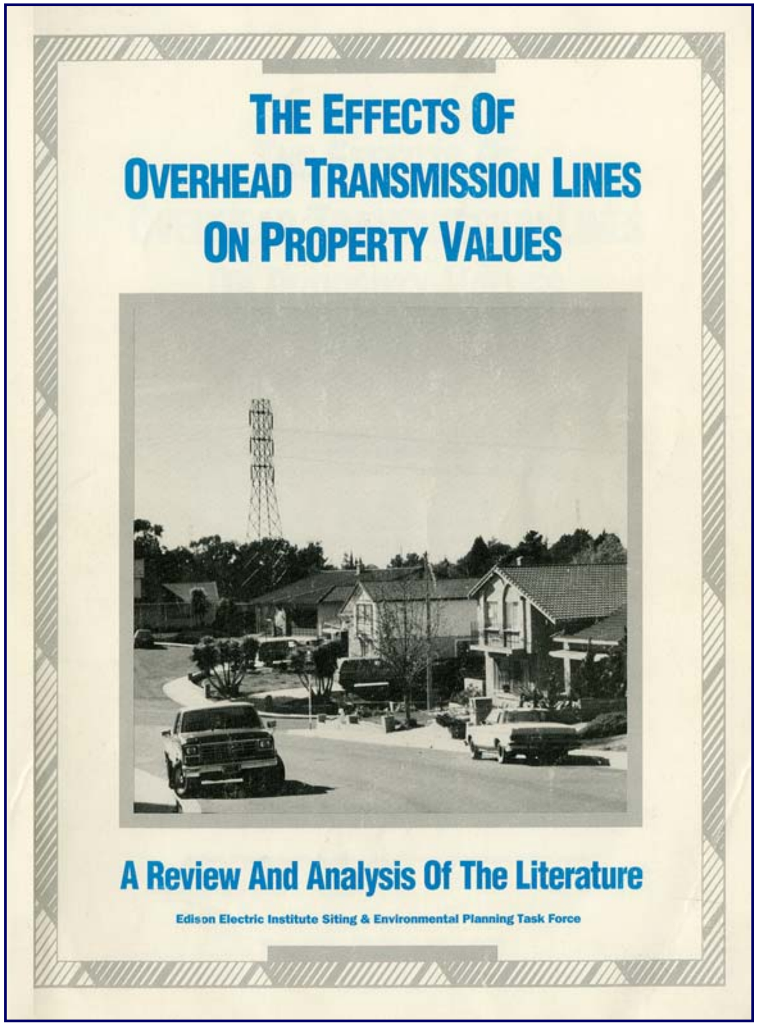
- When there are impacts, they tend to be highest right next to the line, and to taper off very quickly with distance, essentially disappearing at distances ranging from 200 to 650 feet.

What the Research Findings Suggest:
(Continued)

- Some studies indicate that property value impacts are greatest right after a transmission line is constructed or upgraded, and that the impacts decrease over time.

- Northern California study found effects of a transmission line project to be greatest in the first year, then fading out after 4 years.

Drew From 1992 Research Review



Supplemented the 1992 Review

Supplemented the 1992 EEI report with a search for and assessment of the North American research published since the 1992 review was completed.

The Research Landscape

- Appraiser Studies
- Attitudinal Surveys
- Statistical Analyses/Regression Modeling

Findings – Single Family Residences

- Most of the paired sales analyses and two of the multiple regression analyses have concluded that transmission lines do not have an effect on the value of nearby single family residences.

CH2MHILL

Findings – Single Family Residences

- Other paired sales analyses and multiple regression analyses have found some degree of impact (in the range of 2% to 10%) to single family properties located in close proximity to transmission lines.

Findings – Single Family Residences

- Positive impacts found in some cases.

- In a Montreal suburb, positive price impacts (from 7% to 22%) related to increased privacy and more open views.

- In a northern California suburb, positive price impacts of 10% for parcels located next to a transmission line that had been integrated in the subdivision's open space system.

Findings – Vacant Residential Land

- Mixed results

- Studies of properties with residential development potential in Maine and New York found power lines had no effects.

- Study in Maryland found no effect on lots in one subdivision and 4% to 5% effect on lots adjacent to the transmission line in another subdivision.

Findings – Distance Effects

- For studies that find impacts, the impacts are highest next to the right-of-way and/or close to the towers.

- Effects drop off sharply with distance.

- In studies that have found effects, these effects essentially disappear after 200, 500, and 650 feet.

Findings – Temporal Effects

- Illinois study found transmission line property value effects to decrease over time, possibly because of increased growth in screening vegetation.

- Northern California study found effects of a transmission line project to be greatest in the first year, and then to decrease quickly, fading out after 4 years.

Findings - Appreciation

- A topic that has not received much attention in the studies so far

- A study in the Pacific Northwest that looked at this issue with an analysis of a large number of sales concluded that properties next to the transmission right of way appreciated at the same rate as similar properties located away from the line.

Summary

A valuable body of research on the relationships between transmission lines and property values.

This research provides data and insights that are of assistance in putting property value concerns into perspective. However, it is important to emphasize that each of the studies reflect site specific circumstances and caution is required in applying their findings to other situations.

Appendix 11
Electromagnetic Field Articles

June 2002

EMF

Electric and Magnetic Fields Associated with the Use of Electric Power

Questions & Answers

prepared by the
National Institute of Environmental Health Sciences
National Institutes of Health

sponsored by the
NIEHS/DOE EMF RAPID Program

Contents

Introduction

Since the mid-twentieth century, electricity has been an essential part of our lives. Electricity powers our appliances, office equipment, and countless other devices that we use to make life safer, easier, and more interesting. Use of electric power is something we take for granted. However, some have wondered whether the electric and magnetic fields (EMF) produced through the generation, transmission, and use of electric power [power-frequency EMF, 50 or 60 hertz (Hz)] might adversely affect our health. Numerous research studies and scientific reviews have been conducted to address this question.

Unfortunately, initial studies of the health effects of EMF did not provide straightforward answers. The study of the possible health effects of EMF has been particularly complex and results have been reviewed by expert scientific panels in the United States and other countries. This booklet summarizes the results of these reviews. Although questions remain about the possibility of health effects related to EMF, recent reviews have substantially reduced the level of concern.

The largest evaluation to date was led by two U.S. government institutions, the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health and the Department of Energy (DOE), with input from a wide range of public and private agencies. This evaluation, known as the Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) Program, was a six-year project with the goal of providing scientific evidence to determine whether exposure to power-frequency EMF involves a potential risk to human health.

In 1999, at the conclusion of the EMF RAPID Program, the NIEHS reported to the U.S. Congress that the overall scientific evidence for human health risk from EMF exposure is weak. No consistent pattern of biological effects from exposure to EMF had emerged from laboratory studies with animals or with cells. However, epidemiological studies (studies of disease incidence in human populations) had shown a fairly consistent pattern that associated potential EMF exposure with a small increased risk for leukemia in children and chronic lymphocytic leukemia in adults. Since 1999, several other assessments have been completed that support an association between childhood leukemia and exposure to power-frequency EMF. These more recent reviews, however, do not support a link between EMF exposures and adult leukemias. For both childhood and adult leukemias, interpretation of the epidemiological findings has been difficult due to the absence of supporting laboratory evidence or a scientific explanation linking EMF exposures with leukemia.

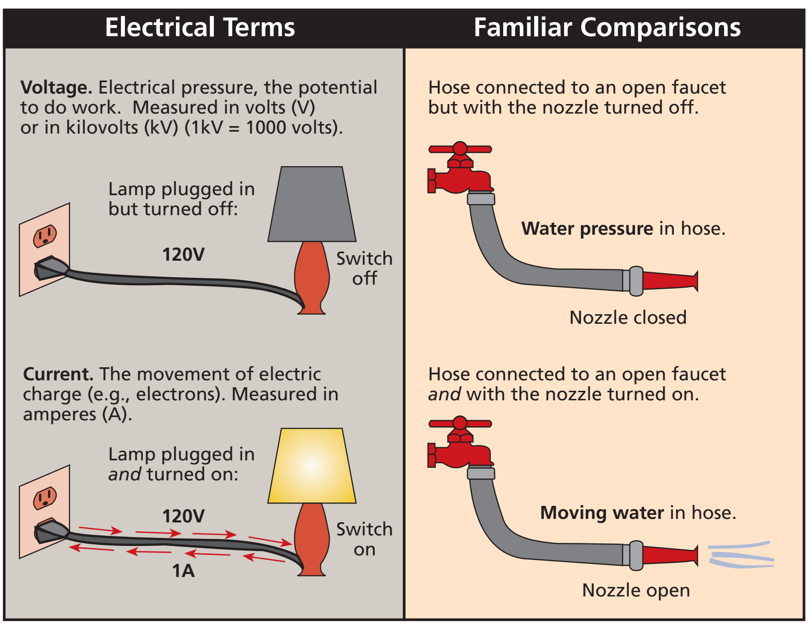
EMF exposures are complex and exist in the home and workplace as a result of all types of electrical equipment and building wiring as well as a result of nearby power lines. This booklet explains the basic principles of electric and magnetic fields, provides an overview of the results of major research studies, and summarizes conclusions of the expert review panels to help you reach your own conclusions about EMF-related health concerns.

1 EMF Basics

This chapter reviews terms you need to know to have a basic understanding of electric and magnetic fields (EMF), compares EMF with other forms of electromagnetic energy, and briefly discusses how such fields may affect us.

Q What are electric and magnetic fields?

A Electric and magnetic fields (EMF) are invisible lines of force that surround any electrical device. Power lines, electrical wiring, and electrical equipment all produce EMF. There are many other sources of EMF as well (see pages 33–35). The focus of this booklet is on power-frequency EMF—that is, EMF associated with the generation, transmission, and use of electric power.



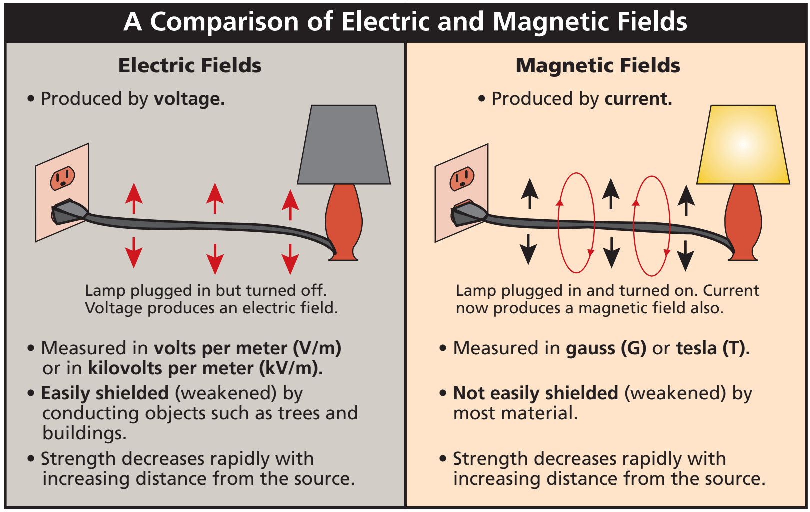
Voltage produces an electric field and current produces a magnetic field.

Electric fields are produced by voltage and increase in strength as the voltage increases. The electric field strength is measured in units of volts per meter (V/m). Magnetic fields result from the flow of current through wires or electrical devices and increase in strength as the current increases. Magnetic fields are measured in units of gauss (G) or tesla (T).

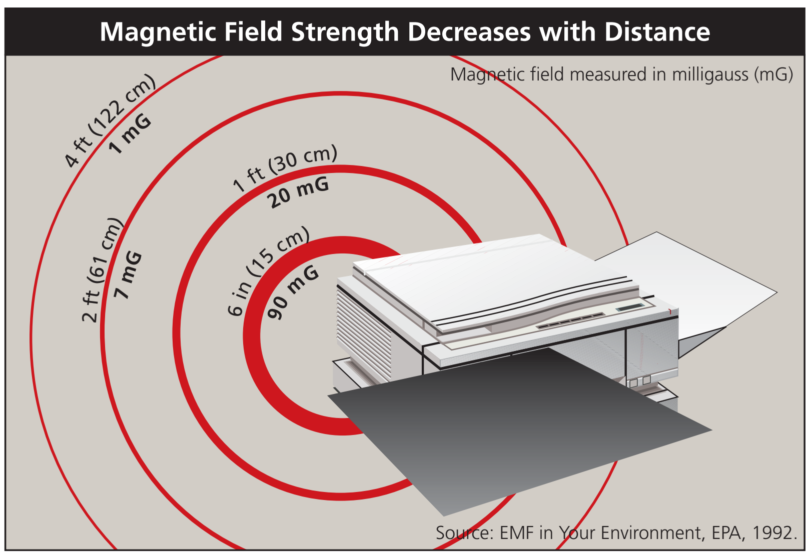
Most electrical equipment has to be turned on, i.e., current must be flowing, for a magnetic field to be produced. Electric fields are often present even when the equipment is switched off, as long as it remains connected to the source of electric power. Brief bursts of EMF (sometimes called "transients") can also occur when electrical devices are turned on or off.

Electric fields are shielded or weakened by materials that conduct electricity—even materials that conduct poorly, including trees, buildings, and human skin. Magnetic fields, however, pass through most materials and are therefore more difficult to shield. Both electric fields and magnetic fields decrease rapidly as the distance from the source increases.

Even though electrical equipment, appliances, and power lines produce both electric and magnetic fields, most recent research has focused on potential health effects of magnetic field exposure. This is because some epidemiological studies have reported an increased cancer risk associated with estimates of magnetic field exposure (see pages 19 and 20 for a summary of these studies). No similar associations have been reported for electric fields; many of the studies examining biological effects of electric fields were essentially negative.



An appliance that is plugged in and therefore connected to a source of electricity has an electric field even when the appliance is turned off. To produce a magnetic field, the appliance must be plugged in and turned on so that the current is flowing.



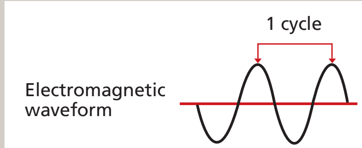
You cannot see a magnetic field, but this illustration represents how the strength of the magnetic field can diminish just 1–2 feet (30–61 centimeters) from the source. This magnetic field is a 60-Hz power-frequency field.

Characteristics of electric and magnetic fields

Electric fields and magnetic fields can be characterized by their wavelength, frequency, and amplitude (strength). The graphic below shows the waveform of an alternating electric or magnetic field. The direction of the field alternates from one polarity to the opposite and back to the first polarity in a period of time called one cycle. Wavelength describes the distance between a peak on the wave and the next peak of the same polarity. The frequency of the field, measured in hertz (Hz), describes the number of cycles that occur in one second. Electricity in North America alternates through 60 cycles per second, or 60 Hz. In many other parts of the world, the frequency of electric power is 50 Hz.

Frequency and Wavelength

Frequency is measured in hertz (Hz).
1 Hz = 1 cycle per second.



Examples:

Source	Frequency	Wavelength
Power line (North America)	60 Hz	3100 miles (5000 km)
Power line (Europe and most other locations)	50 Hz	3750 miles (6000 km)

Q How is the term EMF used in this booklet?

A The term “EMF” usually refers to electric and magnetic fields at extremely low frequencies such as those associated with the use of electric power. The term EMF can be used in a much broader sense as well, encompassing electromagnetic fields with low or high frequencies (see page 8).

Measuring EMF: Common Terms

Electric fields

Electric field strength is measured in volts per meter (V/m) or in kilovolts per meter (kV/m). 1 kV = 1000 V

Magnetic fields

Magnetic fields are measured in units of gauss (G) or tesla (T). Gauss is the unit most commonly used in the United States. Tesla is the internationally accepted scientific term. 1 T = 10,000 G

Since most environmental EMF exposures involve magnetic fields that are only a fraction of a tesla or a gauss, these are commonly measured in units of microtesla (μT) or milligauss (mG). A milligauss is 1/1,000 of a gauss. A microtesla is 1/1,000,000 of a tesla. 1 G = 1,000 mG; 1 T = 1,000,000 μT

To convert a measurement from microtesla (μT) to milligauss (mG), multiply by 10.
1 μT = 10 mG; 0.1 μT = 1 mG

When we use EMF in this booklet, we mean extremely low frequency (ELF) electric and magnetic fields, ranging from 3 to 3,000 Hz (see page 8). This range includes power-frequency (50 or 60 Hz) fields. In the ELF range, electric and magnetic fields are not coupled or interrelated in the same way that they are at higher frequencies. So, it is more useful to refer to them as "electric and magnetic fields" rather than "electromagnetic fields." In the popular press, however, you will see both terms used, abbreviated as EMF.

This booklet focuses on extremely low frequency EMF, primarily power-frequency fields of 50 or 60 Hz, produced by the generation, transmission, and use of electricity.

Q How are power-frequency EMF different from other types of electromagnetic energy?

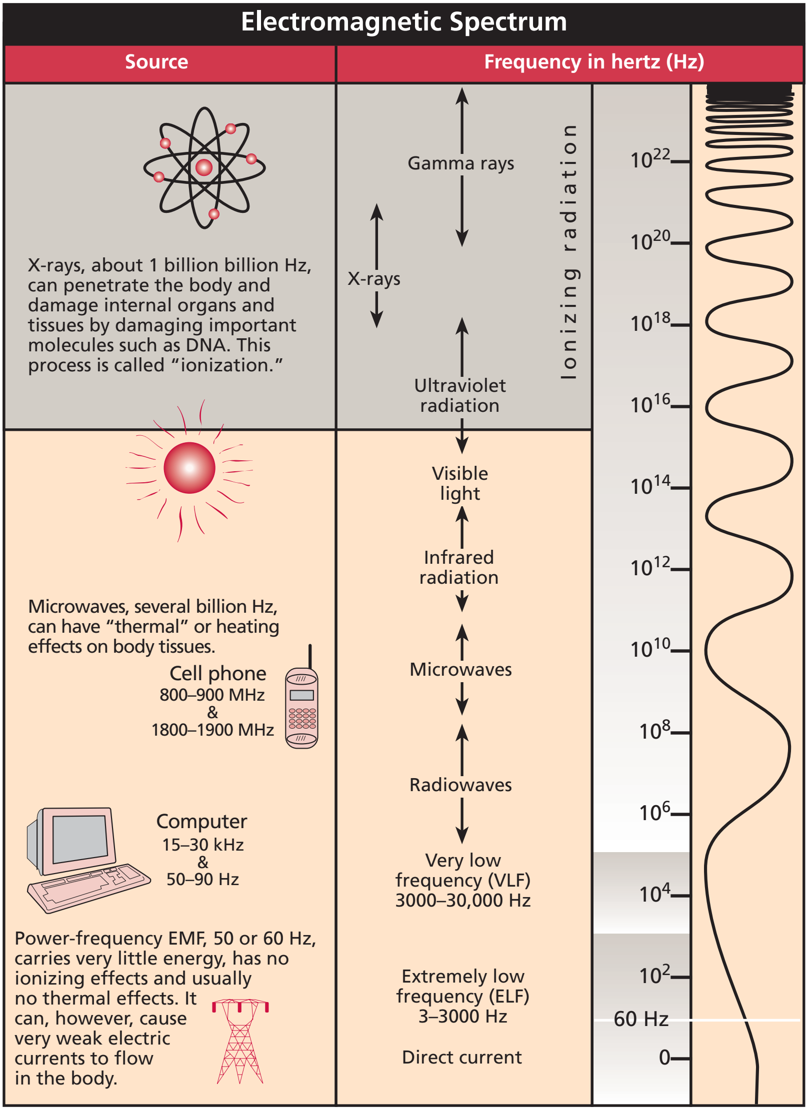
A X-rays, visible light, microwaves, radio waves, and EMF are all forms of electromagnetic energy. One property that distinguishes different forms of electromagnetic energy is the frequency, expressed in hertz (Hz). Power-frequency EMF, 50 or 60 Hz, carries very little energy, has no ionizing effects, and usually has no thermal effects (see page 8). Just as various chemicals affect our bodies in different ways, various forms of electromagnetic energy can have very different biological effects (see "Results of EMF Research" on page 16).

Some types of equipment or operations simultaneously produce electromagnetic energy of different frequencies. Welding operations, for example, can produce electromagnetic energy in the ultraviolet, visible, infrared, and radio-frequency ranges, in addition to power-frequency EMF. Microwave ovens produce 60-Hz fields of several hundred milligauss, but they also create microwave energy inside the oven that is at a much higher frequency (about 2.45 billion Hz). We are shielded from the higher frequency fields inside the oven by its casing, but we are not shielded from the 60-Hz fields.

Cellular telephones communicate by emitting high-frequency electric and magnetic fields similar to those used for radio and television broadcasts. These radio-frequency and microwave fields are quite different from the extremely low frequency EMF produced by power lines and most appliances.

Q How are alternating current sources of EMF different from direct current sources?

A Some equipment can run on either alternating current (AC) or direct current (DC). In most parts of the United States, if the equipment is plugged into a household wall socket, it is using AC electric current that reverses direction in the electrical wiring—or alternates—60 times per second, or at 60 hertz (Hz). If the equipment uses batteries, then electric current flows in one direction only. This



The wavy line at the right illustrates the concept that the higher the frequency, the more rapidly the field varies. The fields do not vary at 0 Hz (direct current) and vary trillions of times per second near the top of the spectrum. Note that 10^4 means 10 x 10 x 10 x 10 or 10,000 Hz. 1 kilohertz (kHz) = 1,000 Hz. 1 megahertz (MHz) = 1,000,000 Hz.

produces a “static” or stationary magnetic field, also called a direct current field. Some battery-operated equipment can produce time-varying magnetic fields as part of its normal operation.

Q What happens when I am exposed to EMF?

A In most practical situations, DC electric power does not induce electric currents in humans. Strong DC magnetic fields are present in some industrial environments, can induce significant currents when a person moves, and may be of concern for other reasons, such as potential effects on implanted medical devices (see page 47 for more information on pacemakers and other medical devices).

AC electric power produces electric and magnetic fields that create weak electric currents in humans. These are called “induced currents.” Much of the research on how EMF may affect human health has focused on AC-induced currents.

Electric fields

A person standing directly under a high-voltage transmission line may feel a mild shock when touching something that conducts electricity. These sensations are caused by the strong electric fields from the high-voltage electricity in the lines. They occur only at close range because the electric fields rapidly become weaker as the distance from the line increases. Electric fields may be shielded and further weakened by buildings, trees, and other objects that conduct electricity.

Magnetic fields

Alternating magnetic fields produced by AC electricity can induce the flow of weak electric currents in the body. However, such currents are estimated to be smaller than the measured electric currents produced naturally by the brain, nerves, and heart.

Q Doesn’t the earth produce EMF?

A Yes. The earth produces EMF, mainly in the form of static fields, similar to the fields generated by DC electricity. Electric fields are produced by air turbulence and other atmospheric activity. The earth’s magnetic field of about 500 mG is thought to be produced by electric currents flowing deep within the earth’s core. Because these fields are static rather than alternating, they do not induce currents in stationary objects as do fields associated with alternating current. Such static fields can induce currents in moving and rotating objects.

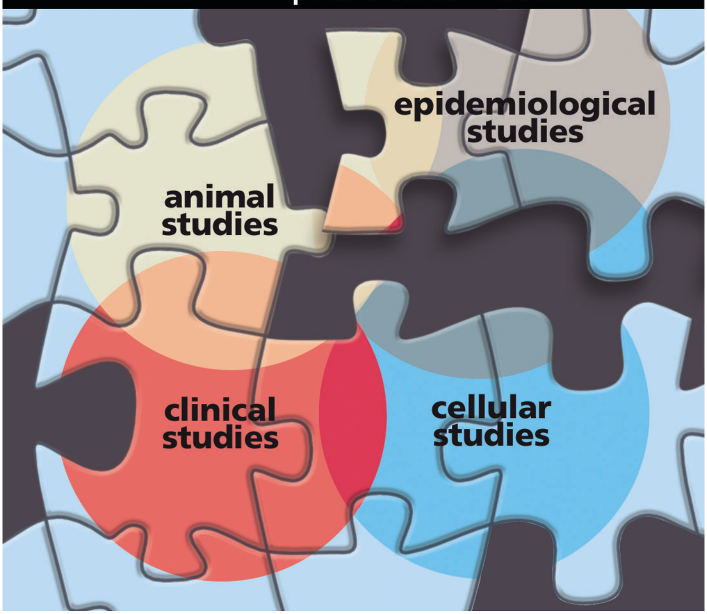
2 Evaluating Potential Health Effects

This chapter explains how scientific studies are conducted and evaluated to assess potential health effects.

Q How do we evaluate whether EMF exposures cause health effects?

A Animal experiments, laboratory studies of cells, clinical studies, computer simulations, and human population (epidemiological) studies all provide valuable information. When evaluating evidence that certain exposures cause disease, scientists consider results from studies in various disciplines. No single study or type of study is definitive.

Does EMF Exposure Cause Disease?



Laboratory studies and human studies provide pieces of the puzzle, but no single study can give us the whole picture.

Laboratory studies

Laboratory studies with cells and animals can provide evidence to help determine if an agent such as EMF causes disease. Cellular studies can increase our understanding of the biological mechanisms by which disease occurs. Experiments with animals provide a means to observe effects of specific agents under carefully controlled conditions. Neither cellular nor animal studies, however, can recreate the complex nature of the whole human organism and its environment. Therefore, we must use caution in applying the results of cellular or animal studies directly to humans or concluding that a lack of an effect in laboratory studies proves that an agent is safe. Even with these limitations, cellular and animal studies have proven very useful over the years for identifying and understanding the toxicity of numerous chemicals and physical agents.

Very specific laboratory conditions are needed for researchers to be able to detect EMF effects, and experimental exposures are not easily comparable to human exposures. In most cases, it is not clear how EMF actually produces the effects observed in some experiments. Without understanding how the effects occur, it is difficult to evaluate how laboratory results relate to human health effects.

Some laboratory studies have reported that EMF exposure can produce biological effects, including changes in functions of cells and tissues and subtle changes in hormone levels in animals. It is important to distinguish between a biological effect and a health effect. Many biological effects are within the normal range of variation and are not necessarily harmful. For example, bright light has a biological effect on our eyes, causing the pupils to constrict, which is a normal response.

Clinical studies

In clinical studies, researchers use sensitive instruments to monitor human physiology during controlled exposure to environmental agents. In EMF studies, volunteers are exposed to electric or magnetic fields at higher levels than those commonly encountered in everyday life. Researchers measure heart rate, brain activity, hormonal levels, and other factors in exposed and unexposed groups to look for differences resulting from EMF exposure.

Epidemiology

A valuable tool to identify human health risks is to study a human population that has experienced the exposure. This type of research is called epidemiology.

The epidemiologist observes and compares groups of people who have had or have not had certain diseases and exposures to see if the risk of disease is different between the exposed and unexposed groups. The epidemiologist does not control the exposure and cannot experimentally control all the factors that might affect the risk of disease.

Most researchers agree that epidemiology—the study of patterns and possible causes of diseases—is one of the most valuable tools to identify human health risks.

Q How do we evaluate the results of epidemiological studies of EMF?

A Many factors need to be considered when determining whether an agent causes disease. An exposure that an epidemiological study associates with increased risk of a certain disease is not always the actual cause of the disease. To judge whether an agent actually causes a health effect, several issues are considered.

Strength of association

The stronger the association between an exposure and disease, the more confident we can be that the disease is due to the exposure being studied. With cigarette smoking and lung cancer, the association is very strong—20 times the normal risk. In the studies that suggest a relationship between EMF and certain rare cancers, the association is much weaker (see page 19).

Dose-response

Epidemiological data are more convincing if disease rates increase as exposure levels increase. Such dose-response relationships have appeared in only a few EMF studies.

Consistency

Consistency requires that an association found in one study appears in other studies involving different study populations and methods. Associations found consistently are more likely to be causal. With regard to EMF, results from different studies sometimes disagree in important ways, such as what type of cancer is associated with EMF exposure. Because of this inconsistency, scientists cannot be sure whether the increased risks are due to EMF or other factors.

Biological plausibility

When associations are weak in an epidemiological study, results of laboratory studies are even more important to support the association. Many scientists remain skeptical about an association between EMF exposure and cancer because laboratory studies thus far have not shown any consistent evidence of adverse health effects, nor have results of experimental studies revealed a plausible biological explanation for such an association.

Reliability of exposure information

Another important consideration with EMF epidemiological studies is how the exposure information was obtained. Did the researchers simply estimate people's EMF exposures based on their job titles or how their houses were wired, or did they actually conduct EMF measurements? What did they measure (electric fields, magnetic fields, or both)? How often were the EMF measurements made and at what time? In how many different places were the fields measured? More recent studies have included measurements of magnetic field exposure. Magnetic fields measured at the time a study is conducted can only estimate exposures that occurred in previous years (at the time a disease process may have begun). Lack of comprehensive exposure information makes it more difficult to interpret the results of a study, particularly considering that everyone in the industrialized world has been exposed to EMF.

Confounding

Epidemiological studies show relationships or correlations between disease and other factors such as diet, environmental conditions, and heredity. When a disease is correlated with some factor, it does not necessarily mean that the correlated factor causes the disease. It could mean that the factor occurs together with some other factor, not measured in the study, that actually causes the disease. This is called confounding.

For example, a study might show that alcohol consumption is correlated with lung cancer. This could occur if the study group consists of people who drink and also smoke tobacco, as often happens. In this example, alcohol use is correlated with lung cancer, but cigarette smoking is a confounding factor and the true cause of the disease.

Statistical significance

Researchers use statistical methods to determine the likelihood that the association between exposure and disease is due simply to chance. For a result to be considered "statistically significant," the association must be stronger than would be expected to occur by chance alone.

Meta-analysis

One way researchers try to get more information from epidemiological studies is to conduct a meta-analysis. A meta-analysis combines the summary statistics of many studies to explore their differences and, if appropriate, calculates an overall summary risk estimate. The main challenge faced by researchers performing meta-analyses is that populations, measurements, evaluation techniques, participation rates, and potential confounding factors vary in the original studies. These differences in the studies make it difficult to combine the results in a meaningful way.

Pooled analysis

Pooled analysis combines the original data from several studies and conducts a new analysis on the primary data. It requires access to the original data from individual studies and can only include diseases or factors included in all the studies, but it has the advantage that the same parameters can be applied to all studies. As with meta-analysis, pooled analysis is still subject to the limitations of the experimental design of the original studies (for example, evaluation techniques, participation rates, etc.). Pooled analysis differs from meta-analysis, which combines the summary statistics from different studies, not their original data.

Q How do we characterize EMF exposure?

A No one knows which aspect of EMF exposure, if any, affects human health. Because of this uncertainty, in addition to the field strength, we must ask how long an exposure lasts, how it varies, and at what time of day or night it occurs. House wiring, for example, is often a significant source of EMF exposure for an individual, but the magnetic fields produced by the wiring depend on the amount of current flowing. As heating, lighting, and appliance use varies during the day, magnetic field exposure will also vary.

For many studies, researchers describe EMF exposures by estimating the average field strength. Some scientists believe that average exposure may not be the best measurement of EMF exposure and that other parameters, such as peak exposure or time of exposure, may be important.

Q What is the average field strength?

A In EMF studies, the information reported most often has been a person's EMF exposure averaged over time (average field strength). With cancer-causing chemicals, a person's average exposure over many years can be a good way to predict his or her chances of getting the disease.

There are different ways to calculate average magnetic field exposures. One method involves having a person wear a small monitor that takes many measurements over a work shift, a day, or longer. Then the average of those measurements is calculated. Another method involves placing a monitor that takes many measurements in a residence over a 24-hour or 48-hour period. Sometimes averages are calculated for people with the same occupation, people working in similar environments, or people using several brands of the same type or similar types of equipment.

Q How is EMF exposure measured in epidemiological studies?

A Epidemiologists study patterns and possible causes of diseases in human populations. These studies are usually observational rather than experimental. This means that the researcher observes and compares groups of people who have had certain diseases and exposures and looks for possible "associations." The epidemiologist must find a way to estimate the exposure that people had at an earlier time.

Association

In epidemiology, a positive association between an exposure (such as EMF) and a disease is not necessarily proof that the exposure *caused* the disease. However, the more often the exposure and disease occur together, the stronger the association, and the stronger is the possibility that the exposure may increase the risk of the disease.

Some exposure estimates for residential studies have been based on designation of households in terms of "wire codes." In other studies, measurements have been made in homes, assuming that EMF levels at the time of the measurement are similar to levels at some time in the past. Some studies involved "spot measurements." Exposure levels change as a person moves around in his or her environment, so spot measurements taken at specific locations only approximate the complex variations in exposure a person experiences. Other studies measured magnetic fields over a 24-hour or 48-hour period. Exposure levels for some occupational studies are measured by having certain employees wear personal monitors. The data taken from these monitors are sometimes used to estimate typical exposure levels for employees with certain job titles. Researchers can then estimate exposures using only an employee's job title and avoid measuring exposures of all employees.

Methods to Estimate EMF Exposure

Wire Codes

A classification of homes based on characteristics of power lines outside the home (thickness of the wires, wire configuration, etc.) and their distance from the home. This information is used to code the homes into groups with higher and lower predicted magnetic field levels.

Spot Measurement

An instantaneous or very short-term (e.g., 30-second) measurement taken at a designated location.

Time-Weighted Average

A weighted average of exposure measurements taken over a period of time that takes into account the time interval between measurements. When the measurements are taken with a monitor at a fixed sampling rate, the time-weighted average equals the arithmetic mean of the measurements.

Personal Monitor

An instrument that can be worn on the body for measuring exposure over time.

Calculated Historical Fields

An estimate based on a theoretical calculation of the magnetic field emitted by power lines using historical electrical loads on those lines.

3 Results of EMF Research

This chapter summarizes the results of EMF research worldwide, including epidemiological studies of children and adults, clinical studies of how humans react to typical EMF exposures, and laboratory research with animals and cells.

Q Is there a link between EMF exposure and childhood leukemia?

A Despite more than two decades of research to determine whether elevated EMF exposure, principally to magnetic fields, is related to an increased risk of childhood leukemia, there is still no definitive answer. Much progress has been made, however, with some lines of research leading to reasonably clear answers and others remaining unresolved. The best available evidence at this time leads to the following answers to specific questions about the link between EMF exposure and childhood leukemia:

Is there an association between power line configurations (wire codes) and childhood leukemia? No.

Is there an association between measured fields and childhood leukemia? Yes, but the association is weak, and it is not clear whether it represents a cause-and-effect relationship.

Q What is the epidemiological evidence for evaluating a link between EMF exposure and childhood leukemia?

A The initial studies, starting with the pioneering research of Dr. Nancy Wertheimer and Ed Leeper in 1979 in Denver, Colorado, focused on power line configurations near homes. Power lines were systematically evaluated and coded for their presumed ability to produce elevated magnetic fields in homes and classified into groups with higher and lower predicted magnetic field levels (see discussion of wire codes on page 15). Although the first study and two that followed in Denver and Los Angeles showed an association between wire codes indicative of elevated magnetic fields and childhood leukemia, larger, more recent studies in the central part of the United States and in several provinces of Canada did not find such an association. In fact, combining the evidence from all the studies, we can conclude with some confidence that wire codes are not associated with a measurable increase in the risk of childhood leukemia.

The other approach to assessing EMF exposure in homes focused on the measurements of magnetic fields. Unlike wire codes, which are only applicable in North America due to the nature of the electric power distribution system, measured fields have been studied in relation to childhood leukemia in research conducted around the world, including Sweden, England, Germany, New Zealand, and Taiwan. Large, detailed studies have recently been completed in the United States, Canada, and the United Kingdom that provide the most evidence for making an evaluation. These studies have produced variable findings, some reporting small associations, others finding no associations.

National Cancer Institute Study

In 1997, after eight years of work, Dr. Martha Linet and colleagues at the National Cancer Institute (NCI) reported the results of their study of childhood acute lymphoblastic leukemia (ALL). The case-control study involved more than 1,000 children living in 9 eastern and midwestern U.S. states and is the largest epidemiological study of childhood leukemia to date in the United States. To help resolve the question of wire code versus measured magnetic fields, the NCI researchers carried out both types of exposure assessment. Overall, Linet reported little evidence that living in homes with higher measured magnetic-field levels was a disease risk and found no evidence that living in a home with a high wire code configuration increased the risk of ALL in children.

United Kingdom Childhood Cancer Study

In December 1999, Sir Richard Doll and colleagues in the United Kingdom announced that the largest study of childhood cancer ever undertaken—involving nearly 4,000 children with cancer in England, Wales, and Scotland—found no evidence of excess risk of childhood leukemia or other cancers from exposure to power-frequency magnetic fields. It should be noted, however, that because most power lines in the United Kingdom are underground, the EMF exposures of these children were mostly lower than 0.2 microtesla or 2 milligauss.

After reviewing all the data, the U.S. National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that the evidence was weak, but that it was still sufficient to warrant limited concern. The NIEHS rationale was that no individual epidemiological study provided convincing evidence linking magnetic field exposure with childhood leukemia, but the overall pattern of results for some methods of measuring exposure suggested a weak association between increasing exposure to EMF and increasing risk of childhood leukemia. The small number of cases in these studies made it impossible to firmly demonstrate this association. However, the fact that similar results had been observed in studies of different populations using a variety of study designs supported this observation.

A major challenge has been to determine whether the most highly elevated, but rarely encountered, levels of magnetic fields are associated with an increased risk of leukemia. Early reports focused on the risk associated with exposures above 2 or 3 milligauss, but the more recent studies have been large enough to also provide some information on levels above 3 or 4 milligauss. It is estimated that 4.5% of homes in the United States have magnetic fields above 3 milligauss, and 2.5% of homes have levels above 4 milligauss.

What is Cancer?

Cancer

"Cancer" is a term used to describe at least 200 different diseases, all involving uncontrolled cell growth. The frequency of cancer is measured by the incidence—the number of new cases diagnosed each year. Incidence is usually described as the number of new cases diagnosed per 100,000 people per year.

The incidence of cancer in adults in the United States is 382 per 100,000 per year, and childhood cancers account for about 1% of all cancers. The factors that influence risk differ among the forms of cancer. Known risk factors such as smoking, diet, and alcohol contribute to specific types of cancer. (For example, smoking is a known risk factor for lung cancer, bladder cancer, and oral cancer.) For many other cancers, the causes are unknown.

Leukemia

Leukemia describes a variety of cancers that arise in the bone marrow where blood cells are formed. The leukemias represent less than 4% of all cancer cases in adults but are the most common form of cancer in children. For children age 4 and under, the incidence of childhood leukemia is approximately 6 per 100,000 per year, and it decreases with age to about 2 per 100,000 per year for children 10 and older. In the United States, the incidence of adult leukemia is about 10 cases per 100,000 people per year. Little is known about what causes leukemia, although genetic factors play a role. The only known causes are ionizing radiation, benzene, and other chemicals and drugs that suppress bone marrow function, and a human T-cell leukemia virus.

Brain Cancer

Cancer of the central nervous system (the brain and spinal cord) is uncommon, with incidence in the United States now at about 6 cases in 100,000 people per year. The causes of the disease are largely unknown, although a number of studies have reported an association with certain occupational chemical exposures. Ionizing radiation to the scalp is a known risk factor for brain cancer. Factors associated with an increased risk for other types of cancer—such as smoking, diet, and excessive alcohol use—have not been found to be associated with brain cancer.

To determine what the integrated information from all the studies says about magnetic fields and childhood leukemia, two groups have conducted pooled analyses in which the original data from relevant studies were integrated and analyzed. One report (Greenland et al., 2000) combined 12 relevant studies with magnetic field measurements, and the other considered 9 such studies (Ahlbom et al., 2000). The details of the two pooled analyses are different, but their findings are similar. There is weak evidence for an association (relative risk of approximately 2) at exposures above 3 mG. However, few individuals had high exposures in these studies; therefore, even combining all studies, there is uncertainty about the strength of the association.

The following table summarizes the results for the epidemiological studies of EMF exposure and childhood leukemia analyzed in the pooled analysis by Greenland et al. (2000). The focus of the summary review was the magnetic fields that occurred three months prior to diagnosis. The results were derived from either calculated historical fields or multiple measurements of magnetic fields. The North American

Residential Exposure to Magnetic Fields and Childhood Leukemia

First author	Magnetic field category (mG) >1 – ≤2 mG Estimate	95% CL	>2 – ≤3 mG Estimate	95% CL	>3 mG Estimate	95% CL
Coghill	0.54	0.17, 1.74	No controls		No controls	
Dockerty	0.65	0.26, 1.63	2.83	0.29, 27.9	No controls	
Feychting	0.63	0.08, 4.77	0.90	0.12, 7.00	4.44	1.67, 11.7
Linet	1.07	0.82, 1.39	1.01	0.64, 1.59	1.51	0.92, 2.49
London	0.96	0.54, 1.73	0.75	0.22, 2.53	1.53	0.67, 3.50
McBride	0.89	0.62, 1.29	1.27	0.74, 2.20	1.42	0.63, 3.21
Michaelis	1.45	0.78, 2.72	1.06	0.27, 4.16	2.48	0.79, 7.81
Olsen	0.67	0.07, 6.42	No cases		2.00	0.40, 9.93
Savitz	1.61	0.64, 4.11	1.29	0.27, 6.26	3.87	0.87, 17.3
Tomenius	0.57	0.33, 0.99	0.88	0.33, 2.36	1.41	0.38, 5.29
Tynes	1.06	0.25, 4.53	No cases		No cases	
Verkasalo	1.11	0.14, 9.07	No cases		2.00	0.23, 17.7
Study summary	0.95	0.80, 1.12	1.06	0.79, 1.42	1.69*	1.25, 2.29
	1 – <2 mG		2 – <4 mG		≥4 mG	
**United Kingdom	0.84	0.57, 1.24	0.98	0.50, 1.93	1.00	0.30, 3.37

95% CL = 95% confidence limits.
Source: Greenland et al., 2000.

* Mantel-Haenszel analysis (*p* = 0.01). Maximum-likelihood summaries differed by less than 1% from these summaries; based on 2,656 cases and 7,084 controls. Adjusting for age, sex, and other variables had little effect on summary results.

** These data are from a recent United Kingdom study not included in the Greenland analysis but included in another pooled analysis (Ahlbom et al. 2000). The United Kingdom study included 1,073 cases and 2,224 controls.

For this table, the column headed "estimate" describes the relative risk. Relative risk is the ratio of the risk of childhood leukemia for those in a magnetic field exposure group compared to persons with exposure levels of 1.0 mG or less. For example, Coghill estimated that children with exposures between 1 and 2 mG have 0.54 times the risk of children whose exposures were less than 1 mG. London's study estimates that children whose exposures were greater than 3 mG have 1.53 times the risk of children whose exposures were less than 1 mG. The column headed "95% CL" (confidence limits) describes how much random variation is in the estimate of relative risk. The estimate may be off by some amount due to random variation, and the width of the confidence limits gives some notion of that variation. For example, in Coghill's estimate of 0.54 for the relative risk, values as low as 0.17 or as high as 1.74 would not be statistically significantly different from the value of 0.54. Note there is a wide range of estimates of relative risk across the studies and wide confidence limits for many studies. In light of these findings, the pooling of results can be extremely helpful to calculate an overall estimate, much better than can be obtained from any study taken alone.

studies (Linet, London, McBride, Savitz) were 60 Hz; all other studies were 50 Hz. Results from the recent study from the United Kingdom (see page 17) are also included in the table. This study was included in the analysis by Ahlbom et al. (2000). The relative risk estimates from the individual studies show little or no association of magnetic fields with childhood leukemia. The study summary for the pooled analysis by Greenland et al. (2000) shows a weak association between childhood leukemia and magnetic field exposures greater 3 mG.

Q Is there a link between EMF exposure and childhood brain cancer or other forms of cancer in children?

A Although the earliest studies suggested an association between EMF exposure and all forms of childhood cancer, those initial findings have not been confirmed by other studies. At present, the available series of studies indicates no association between EMF exposure and childhood cancers other than leukemia. Far fewer of these studies have been conducted than studies of childhood leukemia.

Q Is there a link between residential EMF exposure and cancer in adults?

A The few studies that have been conducted to address EMF and adult cancer do not provide strong evidence for an association. Thus, a link has not been established between residential EMF exposure and adult cancers, including leukemia, brain cancer, and breast cancer (see table below).

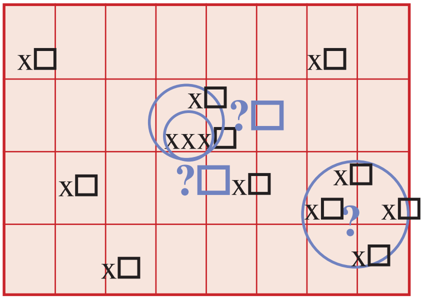
Residential Exposure to Magnetic Fields and Adult Cancer

			Results (odds ratios)		
First author	Location	Type of exposure data	Leukemia	CNS tumors	All cancers
Coleman	United Kingdom	Calculated historical fields	0.92	NA	NA
Feychting and Ahlbom	Sweden	Calculated & spot measurements	1.5*	0.7	NA
Li	Taiwan	Calculated historical fields	1.4*	1.1	NA
Li	Taiwan	Calculated historical fields		1.1 (breast cancer)	
McDowall	United Kingdom	Calculated historical fields	1.43	NA	1.03
Severson	Seattle	Wire codes & spot measurements	0.75	NA	NA
Wrensch	San Francisco	Wire codes & spot measurements	NA	0.9	NA
Youngson	United Kingdom	Calculated historical fields	1.88	NA	NA

CNS = central nervous system.
*The number is statistically significant (greater than expected by chance).
Study results are listed as "odds ratios" (OR). An odds ratio of 1.00 means there was no increase or decrease in risk. In other words, the odds that the people in the study who had the disease (in this case, cancer) and were exposed to a particular agent (in this case, EMF) are the same as for the people in the study who did not have the disease. An odds ratio greater than 1 may occur simply by chance, unless it is statistically significant.

Q Have clusters of cancer or other adverse health effects been linked to EMF exposure?

A An unusually large number of cancers, miscarriages, or other adverse health effects that occur in one area or over one period of time is called a "cluster." Sometimes clusters provide an early warning of a health hazard. But most of the time the reason for the cluster is not known. There have been no proven instances of cancer clusters linked with EMF exposure.



The definition of a "cluster" depends on how large an area is included. Cancer cases (x's in illustration) in a city, neighborhood, or workplace may occur in ways that suggest a cluster due to a common environmental cause. Often these patterns turn out to be due to chance. Delineation of a cluster is subjective—where do you draw the circles?

Q If EMF does cause or promote cancer, shouldn't cancer rates have increased along with the increased use of electricity?

A Not necessarily. Although the use of electricity has increased greatly over the years, EMF exposures may not have increased. Changes in building wiring codes and in the design of electrical appliances have in some cases resulted in lower magnetic field levels. Rates for various types of cancer have shown both increases and decreases through the years, due in part to improved prevention, diagnosis, reporting, and treatment.

Q Is there a link between EMF exposure in electrical occupations and cancer?

A For almost as long as we have been concerned with residential exposure to EMF and childhood cancers, researchers have been studying workplace exposure to EMF and adult cancers, focusing on leukemia and brain cancer. This research began with surveys of job titles and cancer risks, but has progressed to include very large, detailed studies of the health of workers, especially electric utility workers, in the United States, Canada, France, England, and several Northern European countries. Some studies have found evidence that suggests a link between EMF exposure and both leukemia and brain cancer, whereas other studies of similar size and quality have not found such associations.

California
A 1993 study of 36,000 California electric utility workers reported no strong, consistent evidence of an association between magnetic fields and any type of cancer.

Canada/France
A 1994 study of more than 200,000 utility workers in 3 utility companies in Canada and France reported no significant association between all leukemias combined and cumulative exposure to magnetic fields. There was a slight, but not statistically significant, increase in brain cancer. The researchers concluded that the study did not provide clear-cut evidence that magnetic field exposures caused leukemia or brain cancer.

North Carolina
Results of a 1995 study involving more than 138,000 utility workers at 5 electric utilities in the United States did not support an association between occupational magnetic field exposure and leukemia, but suggested a link to brain cancer.

Denmark
In 1997 a study of workers employed in all Danish utility companies reported a small, but statistically significant, excess risk for all cancers combined and for lung cancer. No excess risk was observed for leukemia, brain cancers, or breast cancer.

United Kingdom
A 1997 study among electrical workers in the United Kingdom did not find an excess risk for brain cancer. An extension of this work reported in 2001 also found no increased risk for brain cancer.

Efforts have also been made to pool the findings across several of the above studies to produce more accurate estimates of the association between EMF and cancer (Kheifets et al., 1999). The combined summary statistics across studies provide insufficient evidence for an association between EMF exposure in the workplace and either leukemia or brain cancer.

Q Have studies of workers in other industries suggested a link between EMF exposure and cancer?

A One of the largest studies to report an association between cancer and magnetic field exposure in a broad range of industries was conducted in Sweden (1993). The study included an assessment of EMF exposure in 1,015 different workplaces and involved more than 1,600 people in 169 different occupations. An association was reported between estimated EMF exposure and increased risk for chronic lymphocytic leukemia. An association was also reported between exposure to magnetic fields and brain cancer, but there was no dose-response relationship.

Another Swedish study (1994) found an excess risk of lymphocytic leukemia among railway engine drivers and conductors. However, the total cancer incidence (all tumors included) for this group of workers was lower than in the general Swedish population. A study of Norwegian railway workers found no evidence for an association between EMF exposure and leukemia or brain cancer. Although both positive and negative effects of EMF exposure have been reported, the majority of studies show no effects.

Q Is there a link between EMF exposure and breast cancer?

A Researchers have been interested in the possibility that EMF exposure might cause breast cancer, in part because breast cancer is such a common disease in adult women. Early studies identified a few electrical workers with male breast cancer, a very rare disease. A link between EMF exposure and alterations in the hormone melatonin was considered a possible hypothesis (see page 24). This idea provided motivation to conduct research addressing a possible link between EMF exposure and breast cancer. Overall, the published epidemiological studies have not shown such an association.

Q What have we learned from clinical studies?

A Laboratory studies with human volunteers have attempted to answer questions such as,

Does EMF exposure alter normal brain and heart function?
Does EMF exposure at night affect sleep patterns?
Does EMF exposure affect the immune system?
Does EMF exposure affect hormones?

The following kinds of biological effects have been reported. Keep in mind that a biological effect is simply a measurable change in some biological response. It may or may not have any bearing on health.

Heart rate

An inconsistent effect on heart rate by EMF exposure has been reported. When observed, the biological response is small (on average, a slowing of about three to five beats per minute), and the response does not persist once exposure has ended.

Two laboratories, one in the United States and one in Australia, have reported effects of EMF on heart rate variability. Exposures used in these experiments were relatively high (about 300 mG), and lower exposures failed to produce the effect. Effects have not been observed consistently in repeated experiments.

Sleep electrophysiology

A laboratory report suggested that overnight exposure to 60-Hz magnetic fields may disrupt brain electrical activity (EEG) during night sleep. In this study subjects were exposed to either continuous or intermittent magnetic fields of 283 mG. Individuals exposed to the intermittent magnetic fields showed alterations in traditional EEG sleep parameters indicative of a pattern of poor and disrupted sleep. Several studies have reported no effect with continuous exposure.

Hormones, immune system, and blood chemistry

Several clinical studies with human volunteers have evaluated the effects of power-frequency EMF exposure on hormones, the immune system, and blood chemistry. These studies provide little evidence for any consistent effect.

Melatonin

The hormone melatonin is secreted mainly at night and primarily by the pineal gland, a small gland attached to the brain. Some laboratory experiments with cells and animals have shown that melatonin can slow the growth of cancer cells, including breast cancer cells. Suppressed nocturnal melatonin levels have been observed in some studies of laboratory animals exposed to both electric and magnetic fields. These observations led to the hypothesis that EMF exposure might reduce melatonin and thereby weaken one of the body's defenses against cancer.

Many clinical studies with human volunteers have now examined whether various levels and types of magnetic field exposure affect blood levels of melatonin. Exposure of human volunteers at night to power-frequency EMF under controlled laboratory conditions has no apparent effect on melatonin. Some studies of people exposed to EMF at work or at home do report evidence for a small suppression of melatonin. It is not clear whether the decreases in melatonin reported under environmental conditions are related to the presence of EMF exposure or to other factors.

Q What effects of EMF have been reported in laboratory studies of cells?

A Over the years, scientists have conducted more than 1,000 laboratory studies to investigate potential biological effects of EMF exposure. Most have been *in vitro* studies; that is, studies carried out on cells isolated from animals and plants, or on cell components such as cell membranes. Other studies involved animals, mainly rats and mice. In general, these studies do not demonstrate a consistent effect of EMF exposure.

Most *in vitro* studies have used magnetic fields of 1,000 mG (100 µT) or higher, exposures that far exceed daily human exposures. In most incidences, when one laboratory has reported effects of EMF exposure on cells, other laboratories have not been able to reproduce the findings. For such research results to be widely accepted by scientists as valid, they must be replicated—that is, scientists in other laboratories should be able to repeat the experiment and get similar results. Cellular studies have investigated potential EMF effects on cell proliferation and differentiation, gene expression, enzyme activity, melatonin, and DNA. Scientists reviewing the EMF research literature find overall that the cellular studies provide little convincing evidence of EMF effects at environmental levels.

Q Have effects of EMF been reported in laboratory studies in animals?

A Researchers have published more than 30 detailed reports on both long-term and short-term studies of EMF exposures in laboratory animals (bioassays). Long-term animal bioassays constitute an important group of studies in EMF research. Such studies have a proven record for predicting the carcinogenicity of chemicals, physical agents, and other suspected cancer-causing agents. In the EMF studies, large groups of mice or rats were continuously exposed to EMF for two years or longer and were then evaluated for cancer. The U.S. National Toxicology Program (http://ntp-server.niehs.nih.gov/) has an extensive historical database for hundreds of different chemical and physical agents evaluated using this model. EMF long-term bioassays examined leukemia, brain cancer, and breast cancer—the diseases some epidemiological studies have associated with EMF exposure (see pages 16–23).

Several different approaches have been used to evaluate effects of EMF exposure in animal bioassays. To investigate whether EMF could promote cancer after genetic damage had occurred, some long-term studies used cancer initiators such as ultraviolet light, radiation, or certain chemicals that are known to cause genetic damage. Researchers compared groups of animals treated with cancer initiators to groups treated with cancer initiators and then exposed to EMF, to see if EMF exposure promoted the cancer growth (initiation-promotion model). Other studies tested the cancer promotion potential of EMF using mice that were predisposed to cancer because they had defects in the genes that control cancer.

Animal Leukemia Studies: Long-Term, Continuous Exposure Studies, Two or More Years in Length			
First author	Sex/species	Exposure/animal numbers	Results
Babbitt (U.S.)	Female mice	14,000 mG, 190 or 380 mice per group. Some groups treated with ionizing radiation.	No effect
Boorman (U.S.)	Male and female rats	20 to 10,000 mG, 100 per group	No effect
McCormick (U.S.)	Male and female mice	20 to 10,000 mG, 100 per group	No effect
Mandeville (Canada)	Female rats	20 to 20,000 mG, 50 per group *In utero* exposure	No effect
Yasui (Japan)	Male and female rats	5,000 to 50,000 mG, 50 per group	No effect

10 milligauss (mG) = 1 microtesla (µT) = 0.001 millitesla (mT)

Leukemia

Fifteen animal leukemia studies have been completed and reported. Most tested for effects of exposure to power-frequency (60-Hz) magnetic fields using rodents. Results of these studies were largely negative. The Babbitt study evaluated the subtypes of leukemia. The data provide no support for the reported epidemiology findings of leukemia from EMF exposure. Many scientists feel that the lack of effects seen in these laboratory leukemia studies significantly weakens the case for EMF as a cause of leukemia.

Breast cancer

Researchers in the Ukraine, Germany, Sweden, and the United States have used initiation-promotion models to investigate whether EMF exposure promotes breast cancer in rats.

The results of these studies are mixed; while the German studies showed some effects, the Swedish and U.S. studies showed none. Studies in Germany reported effects on the numbers of tumors and tumor volume. A National Toxicology Program long-term bioassay performed without the use of other cancer-initiating substances showed no effects of EMF exposure on the development of mammary tumors in rats and mice.

The explanation for the observed difference among these studies is not readily apparent. Within the limits of the experimental rodent model of mammary carcinogenesis, no conclusions are possible regarding a promoting effect of EMF on chemically induced mammary cancer.

Other cancers

Tests of EMF effects on skin cancer, liver cancer, and brain cancer have been conducted using both initiation-promotion models and non-initiated long-term bioassays. All are negative.

Three positive studies were reported for a co-promotion model of skin cancer in mice. The mice were exposed to EMF plus cancer-causing chemicals after cancers had already been initiated. The same research team as well as an independent laboratory were unable to reproduce these results in subsequent experiments.

Non-cancer effects

Many animal studies have investigated whether EMF can cause health problems other than cancer. Researchers have examined many endpoints, including birth defects, immune system function, reproduction, behavior, and learning. Overall, animal studies do not support EMF effects on non-cancer endpoints.

Q Can EMF exposure damage DNA?

A Studies have attempted to determine whether EMF has genotoxic potential; that is, whether EMF exposure can alter the genetic material of living organisms. This question is important because genotoxic agents often also cause cancer or birth defects. Studies of genotoxicity have included tests on bacteria, fruit flies, and some tests on rats and mice. Nearly 100 studies on EMF genotoxicity have been reported. Most evidence suggests that EMF exposure is not genotoxic. Based on experiments with cells, some researchers have suggested that EMF exposure may inhibit the cell's ability to repair normal DNA damage, but this idea remains speculative because of the lack of genotoxicity observed in EMF animal studies.

4 Your EMF Environment

This chapter discusses typical magnetic field exposures in home and work environments and identifies common EMF sources and field intensities associated with these sources.

Q How do we define EMF exposure?

A Scientists are still uncertain about the best way to define "exposure" because experiments have yet to show which aspect of the field, if any, may be relevant to reported biological effects. Important aspects of exposure could be the highest intensity, the average intensity, or the amount of time spent above a certain baseline level. The most widely used measure of EMF exposure has been the time-weighted average magnetic field level (see discussion on page 15).

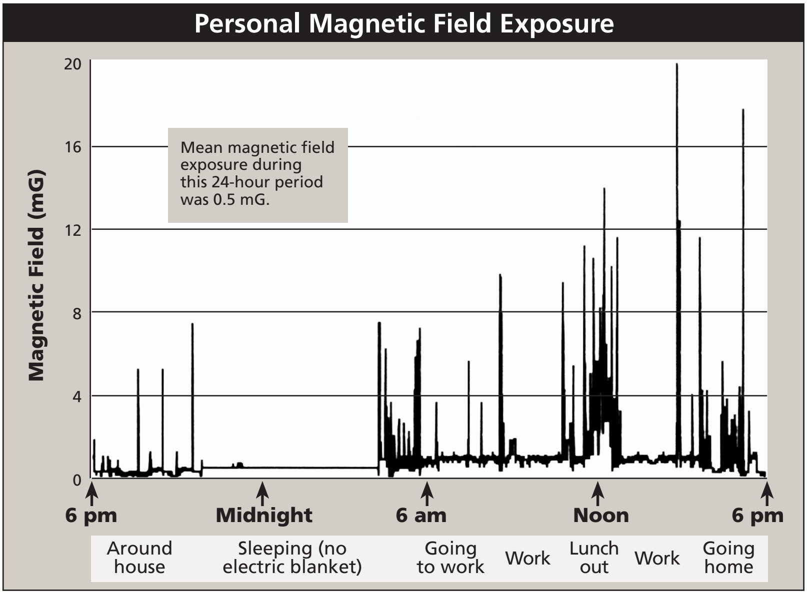
Q How is EMF exposure measured?

A Several kinds of personal exposure meters are now available. These automatically record the magnetic field as it varies over time. To determine a person's EMF exposure, the personal exposure meter is usually worn at the waist or is placed as close as possible to the person during the course of a work shift or day.

EMF can also be measured using survey meters, sometimes called "gaussmeters." These measure the EMF levels in a given location at a given time. Such measurements do not necessarily reflect personal EMF exposure because they are not always taken at the distance from the EMF source that the person would typically be from the source. Measurements are not always made in a location for the same amount of time that a person spends there. Such "spot measurements" also fail to capture variations of the field over time, which can be significant.

Q What are some typical EMF exposures?

A The figure below is an example of data collected with a personal exposure meter.



In the above example, the magnetic field was measured every 1.5 seconds over a period of 24 hours. For this person, exposure at home was very low. The occasional spikes (short exposure to high fields) occurred when the person drove or walked under power lines or over underground power lines or was close to appliances in the home or office.

Several studies have used personal exposure meters to measure field exposure in different environments. These studies tend to show that appliances and building wiring contribute to the magnetic field exposure that most people receive while at home. People living close to high voltage power lines that carry a lot of current tend to have higher overall field exposures. As shown on page 32, there is considerable variation among houses.

Q What are typical EMF exposures for people living in the United States?

A Most people in the United States are exposed to magnetic fields that average less than 2 milligauss (mG), although individual exposures vary.

The following table shows the estimated average magnetic field exposure of the U.S. population, according to a study commissioned by the U.S. government as part of the EMF Research and Public Information Dissemination (EMF RAPID) Program (see page 50). This study measured magnetic field exposure of about 1,000 people of all ages randomly selected among the U.S. population. Participants wore or carried with them a small personal exposure meter and kept a diary of their activities both at home and away from home. Magnetic field values were automatically recorded twice a second for 24 hours. The study reported that exposure to magnetic fields is similar in different regions of the country and similar for both men and women.

Estimated Average Magnetic Field Exposure of the U.S. Population

Average 24-hour field (mG)	Population exposed (%)	95% confidence interval (%)	People exposed* (millions)
> 0.5	76.3	73.8–78.9	197–211
> 1	43.6	40.9–46.5	109–124
> 2	14.3	11.8–17.3	31.5–46.2
> 3	6.3	4.7–8.5	12.5–22.7
> 4	3.6	2.5–5.2	6.7–13.9
> 5	2.42	1.65–3.55	4.4–9.5
> 7.5	0.58	0.29–1.16	0.77–3.1
> 10	0.46	0.20–1.05	0.53–2.8
> 15	0.17	0.035–0.83	0.09–2.2

*Based on a population of 267 million. This table summarizes some of the results of a study that sampled about 1,000 people in the United States. In the first row, for example, we find that 76.3% of the sample population had a 24-hour average exposure of greater than 0.5 mG. Assuming that the sample was random, we can use statistics to say that we are 95% confident that the percentage of the overall U.S. population exposed to greater than 0.5 mG is between 73.8% and 78.9%. Source: Zaffanella, 1993.

The following table shows average magnetic fields experienced during different types of activities. In general, magnetic fields are greater at work than at home.

Estimated Average Magnetic Field Exposure of the U.S. Population for Various Activities

Average field (mG)	Population exposed (%)				
	Home	Bed	Work	School	Travel
> 0.5	69	48	81	63	87
> 1	38	30	49	25	48
> 2	14	14	20	3.5	13
> 3	7.8	7.2	13	1.6	4.1
> 4	4.7	4.7	8.0	< 1	1.5
> 5	3.5	3.7	4.6		1.0
> 7.5	1.2	1.6	2.5		0.5
> 10	0.9	0.8	1.3		< 0.2
> 15	0.1	0.1	0.9		

Source: Zaffanella, 1993.

Q What levels of EMF are found in common environments?

A Magnetic field exposures can vary greatly from site to site for any type of environment. The data shown in the following table are median measurements taken at four different sites for each environment category.

EMF Exposures in Common Environments
Magnetic fields measured in milligauss (mG)

Environment	Median* exposure	Top 5th percentile	Environment	Median* exposure	Top 5th percentile
OFFICE BUILDING			MACHINE SHOP		
Support staff	0.6	3.7	Machinist	0.4	6.0
Professional	0.5	2.6	Welder	1.1	24.6
Maintenance	0.6	3.8	Engineer	1.0	5.1
Visitor	0.6	2.1	Assembler	0.5	6.4
SCHOOL			Office staff	0.7	4.7
Teacher	0.6	3.3	GROCERY STORE		
Student	0.5	2.9	Cashier	2.7	11.9
Custodian	1.0	4.9	Butcher	2.4	12.8
Administrative staff	1.3	6.9	Office staff	2.1	7.1
HOSPITAL			Customer	1.1	7.7
Patient	0.6	3.6			
Medical staff	0.8	5.6			
Visitor	0.6	2.4			
Maintenance	0.6	5.9			

*The median of four measurements. For this table, the median is the average of the two middle measurements. Source: National Institute for Occupational Safety and Health.

Q What EMF field levels are encountered in the home?

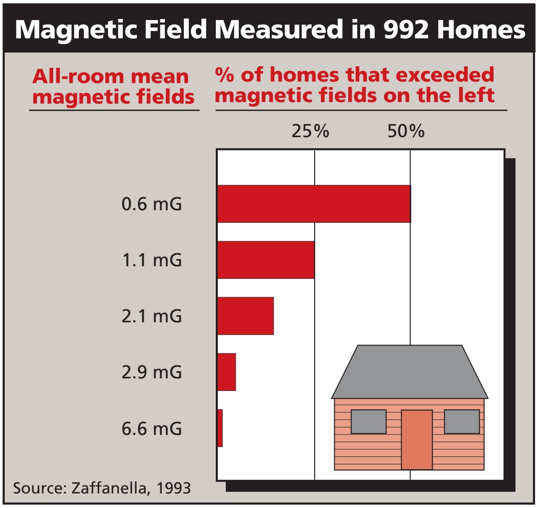
A

Electric fields

Electric fields in the home, on average, range from 0 to 10 volts per meter. They can be hundreds, thousands, or even millions of times weaker than those encountered outdoors near power lines. Electric fields directly beneath power lines may vary from a few volts per meter for some overhead distribution lines to several thousands of volts per meter for extra high voltage power lines. Electric fields from power lines rapidly become weaker with distance and can be greatly reduced by walls and roofs of buildings.

Magnetic fields

Magnetic fields are not blocked by most materials. Magnetic fields encountered in homes vary greatly. Magnetic fields rapidly become weaker with distance from the source.



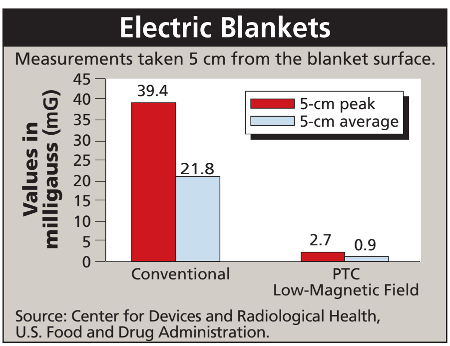
The chart on the left summarizes data from a study by the Electric Power Research Institute (EPRI) in which spot measurements of magnetic fields were made in the center of rooms in 992 homes throughout the United States. Half of the houses studied had magnetic field measurements of 0.6 mG or less, when the average of measurements from all the rooms in the house was calculated (the all-room mean magnetic field). The all-room mean magnetic field for all houses studied was 0.9 mG. The measurements were made away from electrical appliances and reflect primarily the fields from household wiring and outside power lines.

If you are comparing the information in this chart with measurements in your own home, keep in mind that this chart shows averages of measurements taken throughout the homes, not the single highest measurement found in the home.

Q What are EMF levels close to electrical appliances?

A Magnetic fields close to electrical appliances are often much stronger than those from other sources, including magnetic fields directly under power lines. Appliance fields decrease in strength with distance more quickly than do power line fields.

The following table, based on data gathered in 1992, lists the EMF levels generated by common electrical appliances. Magnetic field strength (magnitude) does not depend on how large, complex, powerful, or noisy the appliance is. Magnetic fields near large appliances are often weaker than those near small devices. Appliances in your home may have been redesigned since the data in the table were collected, and the EMF they produce may differ considerably from the levels shown here.



The graph shows magnetic fields produced by electric blankets, including conventional 110-V electric blankets as well as the PTC (positive temperature coefficient) low-magnetic-field blankets. The fields were measured at a distance of about 2 inches from the blanket's surface, roughly the distance from the blanket to the user's internal organs. Because of the wiring, magnetic field strengths vary from point to point on the blanket. The graph reflects this and gives both the peak and the average measurement.

Sources of Magnetic Fields (mG)*

Office Sources

	Distance from source 6″	1′	2′	4′
AIR CLEANERS				
Lowest	110	20	3	–
Median	180	35	5	1
Highest	250	50	8	2
COPY MACHINES				
Lowest	4	2	1	–
Median	90	20	7	1
Highest	200	40	13	4
FAX MACHINES				
Lowest	4	–	–	–
Median	6	–	–	–
Highest	9	2	–	–
FLUORESCENT LIGHTS				
Lowest	20	–	–	–
Median	40	6	2	–
Highest	100	30	8	4
ELECTRIC PENCIL SHARPENERS				
Lowest	20	8	5	–
Median	200	70	20	2
Highest	300	90	30	30
VIDEO DISPLAY TERMINALS (see page 48) (PCs with color monitors)**				
Lowest	7	2	1	–
Median	14	5	2	–
Highest	20	6	3	–

Bathroom Sources

	6″	1′	2′	4′
HAIR DRYERS				
Lowest	1	–	–	–
Median	300	1	–	–
Highest	700	70	10	1
ELECTRIC SHAVERS				
Lowest	4	–	–	–
Median	100	20	–	–
Highest	600	100	10	1

Workshop Sources

	Distance from source 6″	1′	2′	4′
BATTERY CHARGERS				
Lowest	3	2	–	–
Median	30	3	–	–
Highest	50	4	–	–
DRILLS				
Lowest	100	20	3	–
Median	150	30	4	–
Highest	200	40	6	–
POWER SAWS				
Lowest	50	9	1	–
Median	200	40	5	–
Highest	1000	300	40	4
ELECTRIC SCREWDRIVERS (while charging)				
Lowest	–	–	–	–
Median	–	–	–	–
Highest	–	–	–	–

Living/Family Room Sources

	Distance from source 1′	2′	4′
CEILING FANS			
Lowest	–	–	–
Median	3	–	–
Highest	50	6	1
WINDOW AIR CONDITIONERS			
Lowest	–	–	–
Median	3	1	–
Highest	20	6	4
COLOR TELEVISIONS**			
Lowest	–	–	–
Median	7	2	–
Highest	20	8	4

Continued

Sources of Magnetic Fields (mG)*

Kitchen Sources	Distance from source 6″	1′	2′	4′
BLENDERS				
Lowest	30	5	–	–
Median	70	10	2	–
Highest	100	20	3	–
CAN OPENERS				
Lowest	500	40	3	–
Median	600	150	20	2
Highest	1500	300	30	4
COFFEE MAKERS				
Lowest	4	–	–	–
Median	7	–	–	–
Highest	10	1	–	–
DISHWASHERS				
Lowest	10	6	2	–
Median	20	10	4	–
Highest	100	30	7	1
FOOD PROCESSORS				
Lowest	20	5	–	–
Median	30	6	2	–
Highest	130	20	3	–
GARBAGE DISPOSALS				
Lowest	60	8	1	–
Median	80	10	2	–
Highest	100	20	3	–
MICROWAVE OVENS* **				
Lowest	100	1	1	–
Median	200	4	10	2
Highest	300	200	30	20
MIXERS				
Lowest	30	5	–	–
Median	100	10	1	–
Highest	600	100	10	–

Kitchen Sources	Distance from source 6″	1′	2′	4′
ELECTRIC OVENS				
Lowest	4	1	–	–
Median	9	4	–	–
Highest	20	5	1	–
ELECTRIC RANGES				
Lowest	20	–	–	–
Median	30	8	2	–
Highest	200	30	9	6
REFRIGERATORS				
Lowest	–	–	–	–
Median	2	2	1	–
Highest	40	20	10	10
TOASTERS				
Lowest	5	–	–	–
Median	10	3	–	–
Highest	20	7	–	–

Bedroom Sources	6″	1′	2′	4′
DIGITAL CLOCK** **				
Lowest		–	–	–
Median		1	–	–
High		8	2	1
ANALOG CLOCKS (conventional clockface)** **				
Lowest		1	–	–
Median		15	2	–
Highest		30	5	3
BABY MONITOR (unit nearest child)				
Lowest	4	–	–	–
Median	6	1	–	–
Highest	15	2	–	–

Continued

Sources of Magnetic Fields (mG)*

	Distance from source 6″	1′	2′	4′
Laundry/Utility Sources				
ELECTRIC CLOTHES DRYERS				
Lowest	2	–	–	–
Median	3	2	–	–
Highest	10	3	–	–
WASHING MACHINES				
Lowest	4	1	–	–
Median	20	7	1	–
Highest	100	30	6	–
IRONS				
Lowest	6	1	–	–
Median	8	1	–	–
Highest	20	3	–	–

	Distance from source 6″	1′	2′	4′
Laundry/Utility Sources				
PORTABLE HEATERS				
Lowest	5	1	–	–
Median	100	20	4	–
Highest	150	40	8	1
VACUUM CLEANERS				
Lowest	100	20	4	–
Median	300	60	10	1
Highest	700	200	50	10

SEWING MACHINES

Home sewing machines can produce magnetic fields of 12 mG at chest level and 5 mG at head level. Magnetic fields as high as 35 mG at chest level and 215 mG at knee level have been measured from industrial sewing machine models (Sobel, 1994).

Source: EMF In Your Environment, U.S. Environmental Protection Agency, 1992.

* Dash (–) means that the magnetic field at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on.

** Some appliances produce both 60-Hz and higher frequency fields. For example, televisions and computer screens produce fields at 10,000-30,000 Hz (10-30 kHz) as well as 60-Hz fields.

*** Microwave ovens produce 60-Hz fields of several hundred milligauss, but they also create microwave energy inside the appliance that is at a much higher frequency (about 2.45 billion hertz). We are shielded from the higher frequency fields but not from the 60-Hz fields.

**** Most digital clocks have low magnetic fields. In some analog clocks, however, higher magnetic fields are produced by the motor that drives the hands. In the above table, the clocks are electrically powered using alternating current, as are all the appliances described in these tables.

Q What EMF levels are found near power lines?

A Power transmission lines bring power from a generating station to an electrical substation. Power distribution lines bring power from the substation to your home. Transmission and distribution lines can be either overhead or underground. Overhead lines produce both electric fields and magnetic fields. Underground lines do not produce electric fields above ground but may produce magnetic fields above ground.

Power transmission lines

Typical EMF levels for transmission lines are shown in the chart on page 37. At a distance of 300 feet and at times of average electricity demand, the magnetic fields from many lines can be similar to typical background levels found in most homes. The distance at which the magnetic field from the line becomes indistinguishable from typical background levels differs for different types of lines.

Power distribution lines

Typical voltage for power distribution lines in North America ranges from 4 to 24 kilovolts (kV). Electric field levels directly beneath overhead distribution lines may vary from a few volts per meter to 100 or 200 volts per meter. Magnetic fields directly beneath overhead distribution lines typically range from 10 to 20 mG for main feeders and less than 10 mG for laterals. Such levels are also typical directly above underground lines. Peak EMF levels, however, can vary considerably depending on the amount of current carried by the line. Peak magnetic field levels as high as 70 mG have been measured directly below overhead distribution lines and as high as 40 mG above underground lines.

Q How strong is the EMF from electric power substations?

A In general, the strongest EMF around the outside of a substation comes from the power lines entering and leaving the substation. The strength of the EMF from equipment within the substations, such as transformers, reactors, and capacitor banks, decreases rapidly with increasing distance. Beyond the substation fence or wall, the EMF produced by the substation equipment is typically indistinguishable from background levels.

Q Do electrical workers have higher EMF exposure than other workers?

A Most of the information we have about occupational EMF exposure comes from studies of electric utility workers. It is therefore difficult to compare electrical workers' EMF exposures with those of other workers because there is less information about EMF exposures in work environments other than electric utilities. Early studies did not include actual measurements of EMF exposure on the job but used job titles as an estimate of EMF exposure among electrical workers. Recent studies, however, have included extensive EMF exposure assessments.

A report published in 1994 provides some information about estimated EMF exposures of workers in Los Angeles in a number of electrical jobs in electric utilities and other industries. Electrical workers had higher average EMF exposures (9.6 mG) than did workers in other jobs (1.7 mG). For this study, the category "electrical workers" included electrical engineering technicians, electrical engineers, electricians, power line workers, power station operators, telephone line workers, TV repairers, and welders.

Typical EMF Levels for Power Transmission Lines*

115 kV

		Approx. Edge of Right-of-Way 15 m (50 ft)	30 m (100 ft)	61 m (200 ft)	91 m (300 ft)
Electric Field (kV/m)	1.0	0.5	0.07	0.01	0.003
Mean Magnetic Field (mG)	29.7	6.5	1.7	0.4	0.2

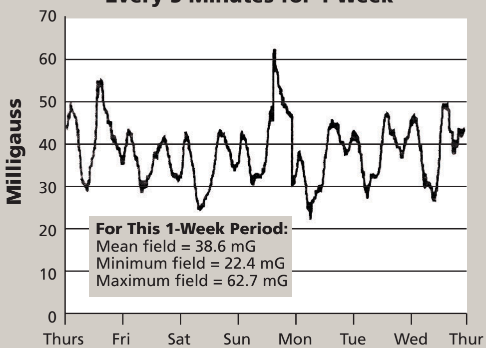
230 kV

		Approx. Edge of Right-of-Way 15 m (50 ft)	30 m (100 ft)	61 m (200 ft)	91 m (300 ft)
Electric Field (kV/m)	2.0	1.5	0.3	0.05	0.01
Mean Magnetic Field (mG)	57.5	19.5	7.1	1.8	0.8

500 kV

		Approx. Edge of Right-of-Way 20 m (65 ft)	30 m (100 ft)	61 m (200 ft)	91 m (300 ft)
Electric Field (kV/m)	7.0	3.0	1.0	0.3	0.1
Mean Magnetic Field (mG)	86.7	29.4	12.6	3.2	1.4

Magnetic Field from a 500-kV Transmission Line Measured on the Right-of-Way Every 5 Minutes for 1 Week



Electric fields from power lines are relatively stable because line voltage doesn't change very much. Magnetic fields on most lines fluctuate greatly as current changes in response to changing loads. Magnetic fields must be described statistically in terms of averages, maximums, etc. The magnetic fields above are means calculated for 321 power lines for 1990 annual mean loads. During peak loads (about 1% of the time), magnetic fields are about twice as strong as the mean levels above. The graph on the left is an example of how the magnetic field varied during one week for one 500-kV transmission line.

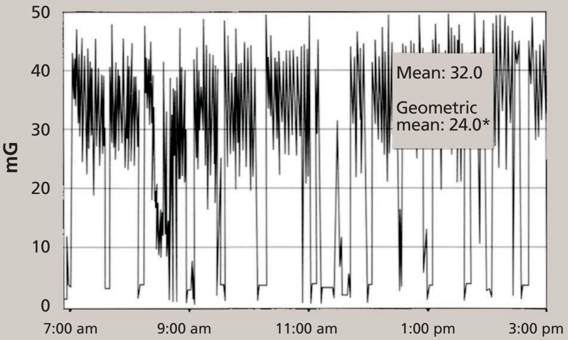
*These are typical EMFs at 1 m (3.3 ft) above ground for various distances from power lines in the Pacific Northwest. They are for general information. For information about a specific line, contact the utility that operates the line.
Source: Bonneville Power Administration, 1994.

Q What are possible EMF exposures in the workplace?

A The figures below are examples of magnetic field exposures determined with exposure meters worn by four workers in different occupations. These measurements demonstrate how EMF exposures vary among individual workers. They do not necessarily represent typical EMF exposures for workers in these occupations.

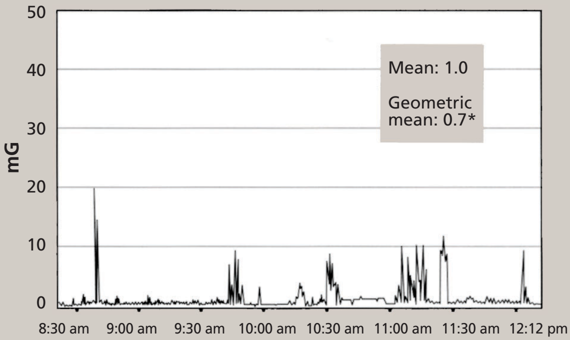
Magnetic Field Exposures of Workers (mG)

Sewing machine operator in garment factory



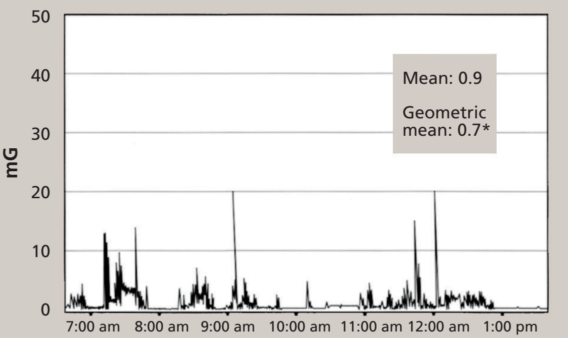
The sewing machine operator worked all day, took a 1-hour lunch break at 11:15 am, and took 10-minute breaks at 8:55 am and 2:55 pm.

Maintenance mechanic



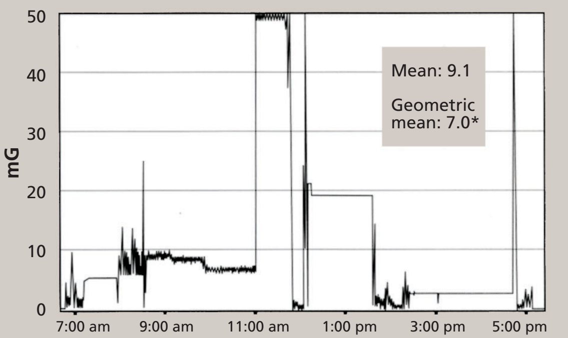
The mechanic repaired a compressor at 9:45 am and 11:10 am.

Electrician



The electrician repaired a large air-conditioning motor at 9:10 am and at 11:45 am.

Government office worker



The government worker was at the copy machine at 8:00 am, at the computer from 11:00 am to 1:00 pm and also from 2:30 pm to 4:30 pm.

*The geometric mean is calculated by squaring the values, adding the squares, and then taking the square root of the sum.
Source: National Institute for Occupational Safety and Health and U.S. Department of Energy.

The tables below and on page 41 can give you a general idea about magnetic field levels for different jobs and around various kinds of electrical equipment. It is important to remember that EMF levels depend on the actual equipment used in

EMF Measurements During a Workday

Industry and occupation	ELF magnetic fields measured in mG: Median for occupation*	Range for 90% of workers**
ELECTRICAL WORKERS IN VARIOUS INDUSTRIES		
Electrical engineers	1.7	0.5–12.0
Construction electricians	3.1	1.6–12.1
TV repairers	4.3	0.6–8.6
Welders	9.5	1.4–66.1
ELECTRIC UTILITIES		
Clerical workers without computers	0.5	0.2–2.0
Clerical workers with computers	1.2	0.5–4.5
Line workers	2.5	0.5–34.8
Electricians	5.4	0.8–34.0
Distribution substation operators	7.2	1.1–36.2
Workers off the job (home, travel, etc.)	0.9	0.3–3.7
TELECOMMUNICATIONS		
Install, maintenance, & repair technicians	1.5	0.7–3.2
Central office technicians	2.1	0.5–8.2
Cable splicers	3.2	0.7–15.0
AUTO TRANSMISSION MANUFACTURE		
Assemblers	0.7	0.2–4.9
Machinists	1.9	0.6–27.6
HOSPITALS		
Nurses	1.1	0.5–2.1
X-ray technicians	1.5	1.0–2.2
SELECTED OCCUPATIONS FROM ALL ECONOMIC SECTORS		
Construction machine operators	0.5	0.1–1.2
Motor vehicle drivers	1.1	0.4–2.7
School teachers	1.3	0.6–3.2
Auto mechanics	2.3	0.6–8.7
Retail sales	2.3	1.0–5.5
Sheet metal workers	3.9	0.3–48.4
Sewing machine operators	6.8	0.9–32.0
Forestry and logging jobs	7.6	0.6–95.5***

Source: National Institute for Occupational Safety and Health.
ELF (extremely low frequency)—frequencies 3–3,000 Hz.
* The median is the middle measurement in a sample arranged by size. These personal exposure measurements reflect the median magnitude of the magnetic field produced by the various EMF sources and the amount of time the worker spent in the fields.
** This range is between the 5th and 95th percentiles of the workday averages for an occupation.
*** Chain saw engines produce strong magnetic fields that are not pure 60-Hz fields.

the workplace. Different brands or models of the same type of equipment can have different magnetic field strengths. It is also important to keep in mind that the strength of a magnetic field decreases quickly with distance.

If you have questions or want more information about your EMF exposure at work, your plant safety officer, industrial hygienist, or other local safety official can be a good source of information. The National Institute for Occupational Safety and Health (NIOSH) is asked occasionally to conduct health hazard evaluations in workplaces where EMF is a suspected cause for concern. For further technical assistance contact NIOSH at 800-356-4674.

Q What are some typical sources of EMF in the workplace?

A Exposure assessment studies so far have shown that most people's EMF exposure at work comes from electrical appliances and tools and from the building's power supply. People who work near transformers, electrical closets, circuit boxes, or other high-current electrical equipment may have 60-Hz magnetic field exposures of hundreds of milligauss or more. In offices, magnetic field levels are often similar to those found at home, typically 0.5 to 4.0 mG. However, these levels can increase dramatically near certain types of equipment.

EMF Spot Measurements

Industry and sources	ELF magnetic fields (mG)	Other frequencies	Comments
ELECTRICAL EQUIPMENT USED IN MACHINE MANUFACTURING			
Electric resistance heater	6,000–14,000	VLF	
Induction heater	10–460	High VLF	
Hand-held grinder	3,000	–	Tool exposures measured at operator's chest.
Grinder	110	–	Tool exposures measured at operator's chest.
Lathe, drill press, etc.	1–4	–	Tool exposures measured at operator's chest.
ALUMINUM REFINING			
Aluminum pot rooms	3.4–30	Very high static field	Highly-rectified DC current (with an ELF ripple) refines aluminum.
Rectification room	300–3,300	High static field	
STEEL FOUNDRY			
Ladle refinery			
Furnace active	170–1,300	High ULF from the ladle's big magnetic stirrer	Highest ELF field was at the chair of control room operator.
Furnace inactive	0.6–3.7	High ULF from the ladle's big magnetic stirrer	Highest ELF field was at the chair of control room operator.
Electrogalvanizing unit	2–1,100	High VLF	
TELEVISION BROADCASTING			
Video cameras (studio and minicams)	7.2–24.0	VLF	
Video tape degaussers	160–3,300	–	Measured 1 ft away.
Light control centers	10–300	–	Walk-through survey.
Studio and newsrooms	2–5	–	Walk-through survey.
HOSPITALS			
Intensive care unit	0.1–220	VLF	Measured at nurse's chest.
Post-anesthesia care unit	0.1–24	VLF	
Magnetic resonance imaging (MRI)	0.5–280	Very high static field, VLF and RF	Measured at technician's work locations.
TRANSPORTATION			
Cars, minivans, and trucks	0.1–125	Most frequencies less than 60 Hz	Steel-belted tires are the principal ELF source for gas/diesel vehicles.
Bus (diesel powered)	0.5–146	Most frequencies less than 60 Hz	
Electric cars	0.1–81	Some elevated static fields	
Chargers for electric cars	4–63	–	Measured 2 ft from charger.
Electric buses	0.1–88	–	Measured at waist. Fields at ankles 2-5 times higher.
Electric train passenger cars	0.1–330	25 & 60 Hz power on U.S. trains	Measured at waist. Fields at ankles 2-5 times higher.
Airliner	0.8–24.2	400 Hz power on airliners	Measured at waist.
GOVERNMENT OFFICES			
Desk work locations	0.1–7	–	Peaks due to laser printers.
Desks near power center	18–50	–	
Power cables in floor	15–170	–	
Building power supplies	25–1,800	–	
Can opener	3,000	–	Appliance fields measured 6 in. away.
Desktop cooling fan	1,000	–	Appliance fields measured 6 in. away.
Other office appliances	10–200	–	

Source: National Institute for Occupational Safety and Health, 2001.
ULF (ultra low frequency)—frequencies above 0, below 3 Hz.
ELF (extremely low frequency)—frequencies 3–3,000 Hz.
VLF (very low frequency)—frequencies 3,000–30,000 Hz (3–30 kilohertz).

Q What EMF exposure occurs during travel?

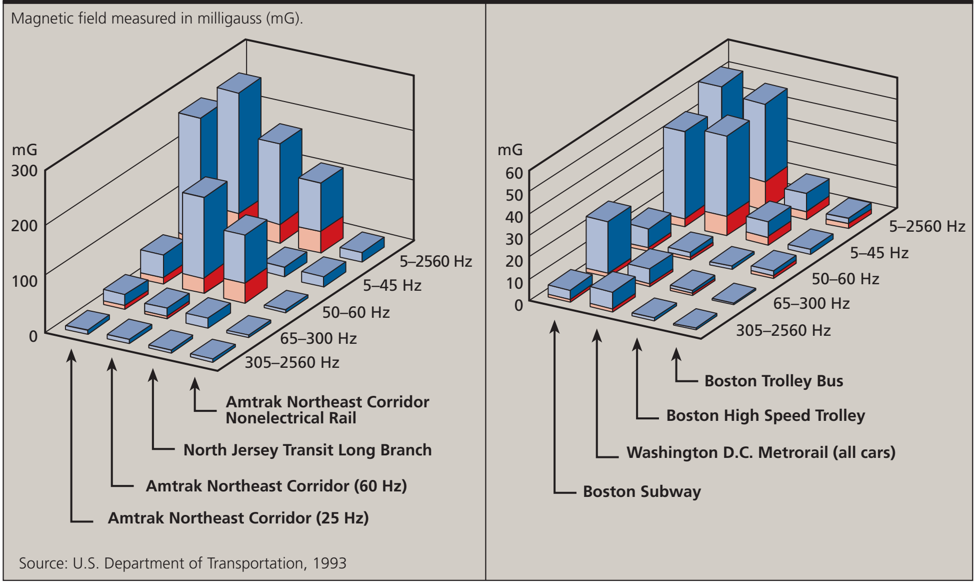
A Inside a car or bus, the main sources of magnetic field exposure are those you pass by (or under) as you drive, such as power lines. Car batteries involve direct current (DC) rather than alternating current (AC). Alternators can create EMF, but at frequencies other than 60 Hz. The rotation of steel-belted tires is also a source of EMF.

Most trains in the United States are diesel powered. Some electrically powered trains operate on AC, such as the passenger trains between Washington, D.C. and New Haven, Connecticut. Measurements taken on these trains using personal exposure monitors have suggested that average 60-Hz magnetic field exposures for passengers and conductors may exceed 50 mG. A U.S. government-sponsored exposure assessment study of electric rail systems found average 60-Hz magnetic field levels in train operator compartments that ranged from 0.4 mG (Boston high speed trolley) to 31.1 mG (North Jersey transit). The graph on the next page shows average and maximum magnetic field measurements in operator compartments of several electric rail systems. It illustrates that 60 Hz is one of several electromagnetic frequencies to which train operators are exposed.

Workers who maintain the tracks on electric rail lines, primarily in the northeastern United States, also have elevated magnetic field exposures at both 25 Hz and 60 Hz. Measurements taken by the National Institute for Occupational Safety and Health show that typical average daily exposures range from 3 to 18 mG, depending on how often trains pass the work site.

Rapid transit and light rail systems in the United States, such as the Washington D.C. Metro and the San Francisco Bay Area Rapid Transit, run on DC electricity. These DC-powered trains contain equipment that produces AC fields. For example, areas of strong AC magnetic fields have been measured on the Washington Metro close to the floor, during braking and acceleration, presumably near equipment located underneath the subway cars.

Magnetic Field Measurements in Train Operators' Compartments



These graphs illustrate that 60 Hz is one of several electromagnetic frequencies to which train operators are exposed. The maximum exposure is the top of the blue (upper) portion of the bar; the average exposure is the top of the red (lower) portion.

Q How can I find out how strong the EMF is where I live and work?

A The tables throughout this chapter can give you a general idea about magnetic field levels at home, for different jobs, and around various kinds of electrical equipment. For specific information about EMF from a particular power line, contact the utility that operates the line. Some will perform home EMF measurements.

You can take your own EMF measurements with a magnetic field meter. For a spot measurement to provide a useful estimate of your EMF exposure, it should be taken at a time of day and location when and where you are typically near the equipment. Keep in mind that the strength of a magnetic field drops off quickly with distance.

Independent technicians will conduct EMF measurements for a fee. Search the Internet under "EMF meters" or "EMF measurement." You should investigate the experience and qualifications of commercial firms, since governments do not standardize EMF measurements or certify measurement contractors.

At work, your plant safety officer, industrial hygienist, or other local safety official can be a good source of information. The National Institute for Occupational Safety and Health (NIOSH) sometimes conducts health hazard evaluations in workplaces where EMF is a suspected cause for concern. For further technical assistance, contact NIOSH at 800-356-4674.

Q How much do computers contribute to my EMF exposure?

A Personal computers themselves produce very little EMF. However, the video display terminal (VDT) or monitor provides some magnetic field exposure unless it is of the new flat-panel design. Conventional VDTs containing cathode ray tubes use magnetic fields to produce the image on the screen, and some emission of those magnetic fields is unavoidable. Unlike most other appliances which produce predominantly 60-Hz magnetic fields, VDTs emit magnetic fields in both the extremely low frequency (ELF) and very low frequency (VLF) frequency ranges (see page 8). Many newer VDTs have been designed to minimize magnetic field emissions, and those identified as "TCO'99 compliant" meet a standard for low emissions (see page 48).

Q What can be done to limit EMF exposure?

A Personal exposure to EMF depends on three things: the strength of the magnetic field sources in your environment, your distance from those sources, and the time you spend in the field.

If you are concerned about EMF exposure, your first step should be to find out where the major EMF sources are and move away from them or limit the time you spend near them. Magnetic fields from appliances decrease dramatically about an arm's length away from the source. In many cases, rearranging a bed, a chair, or a work area to increase your distance from an electrical panel or some other EMF source can reduce your EMF exposure.

Another way to reduce EMF exposure is to use equipment designed to have relatively low EMF emissions. Sometimes electrical wiring in a house or a building can be the source of strong magnetic field exposure. Incorrect wiring is a common source of higher-than-usual magnetic fields. Wiring problems are also worth correcting for safety reasons.

In its 1999 report to Congress, the National Institute of Environmental Health Sciences suggested that the power industry continue its current practice of siting power lines to reduce EMF exposures.

There are more costly actions, such as burying power lines, moving out of a home, or restricting the use of office space that may reduce exposures. Because scientists are still debating whether EMF is a hazard to health, it is not clear that the costs of such measures are warranted. Some EMF reduction measures may create other problems. For instance, compacting power lines reduces EMF but increases the danger of accidental electrocution for line workers.

We are not sure which aspects of the magnetic field exposure, if any, to reduce. Future research may reveal that EMF reduction measures based on today's limited understanding are inadequate or irrelevant. No action should be taken to reduce EMF exposure if it increases the risk of a known safety hazard.

5 EMF Exposure Standards

This chapter describes standards and guidelines established by state, national, and international safety organizations for some EMF sources and exposures.

Q Are there exposure standards for 60-Hz EMF?

A In the United States, there are no federal standards limiting occupational or residential exposure to 60-Hz EMF.

At least six states have set standards for transmission line electric fields; two of these also have standards for magnetic fields (see table below). In most cases, the maximum fields permitted by each state are the maximum fields that existing lines produce at maximum load-carrying conditions. Some states further limit electric field strength at road crossings to ensure that electric current induced into large metal objects such as trucks and buses does not represent an electric shock hazard.

State Transmission Line Standards and Guidelines

	Electric Field		Magnetic Field	
State	On R.O.W.*	Edge R.O.W.	On R.O.W.	Edge R.O.W.
Florida	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	7 kV/m[d]	1 kV/m[e]		
New Jersey	—	3 kV/m		
New York	11.8 kV/m 11.0 kV/m[f] 7.0 kV/m[d]	1.6 kV/m	—	200 mG (max. load)
Oregon	9 kV/m	—	—	—

*R.O.W. = right-of-way (or in the Florida standard, certain additional areas adjoining the right-of-way). 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.

Two organizations have developed voluntary occupational exposure guidelines for EMF exposure. These guidelines are intended to prevent effects, such as induced currents in cells or nerve stimulation, which are known to occur at high magnitudes, much higher (more than 1,000 times higher) than EMF levels found typically in occupational and residential environments. These guidelines are summarized in the tables on the right.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) concluded that available data regarding potential long-term effects, such as increased risk of cancer, are insufficient to provide a basis for setting exposure restrictions.

The American Conference of Governmental Industrial Hygienists (ACGIH) publishes "Threshold Limit Values" (TLVs) for various physical agents. The TLVs for 60-Hz EMF shown in the table are identified as guides to control exposure; they are not intended to demarcate safe and dangerous levels.

ICNIRP Guidelines for EMF Exposure

Exposure (60 Hz)	Electric field	Magnetic field
Occupational	8.3 kV/m	4.2 G (4,200 mG)
General Public	4.2 kV/m	0.833 G (833 mG)

International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an organization of 15,000 scientists from 40 nations who specialize in radiation protection.
Source: ICNIRP, 1998.

ACGIH Occupational Threshold Limit Values for 60-Hz EMF

	Electric field	Magnetic field
Occupational exposure should not exceed	25 kV/m	10 G (10,000 mG)
Prudence dictates the use of protective clothing above	15 kV/m	–
Exposure of workers with cardiac pacemakers should not exceed	1 kV/m	1 G (1,000 mG)

American Conference of Governmental Industrial Hygienists (ACGIH) is a professional organization that facilitates the exchange of technical information about worker health protection. It is not a government regulatory agency.
Source: ACGIH, 2001.

Q Does EMF affect people with pacemakers or other medical devices?

A According to the U.S. Food and Drug Administration (FDA), interference from EMF can affect various medical devices including cardiac pacemakers and implantable defibrillators. Most current research in this area focuses on higher frequency sources such as cellular phones, citizens band radios, wireless computer links, microwave signals, radio and television transmitters, and paging transmitters.

Sources such as welding equipment, power lines at electric generating plants, and rail transportation equipment can produce lower frequency EMF strong enough to interfere with some models of pacemakers and defibrillators. The occupational exposure guidelines developed by ACGIH state that workers with cardiac pacemakers should not be exposed to a 60-Hz magnetic field greater than 1 gauss (1,000 mG) or a 60-Hz electric field greater than 1 kilovolt per meter (1,000 V/m) (see ACGIH guidelines above). Workers who are concerned about EMF exposure effects on pacemakers, implantable defibrillators, or other implanted electronic medical devices should consult their doctors or industrial hygienists.

Nonelectronic metallic medical implants (such as artificial joints, pins, nails, screws, and plates) can be affected by high magnetic fields such as those from magnetic resonance imaging (MRI) devices and aluminum refining equipment, but are generally unaffected by the lower fields from most other sources.

The FDA MedWatch program is collecting information about medical device problems thought to be associated with exposure to or interference from EMF. Anyone experiencing a problem that might be due to such interference is encouraged to call and report it (800-332-1088).

Q What about products advertised as producing low or reduced magnetic fields?

A Virtually all electrical appliances and devices emit electric and magnetic fields. The strengths of the fields vary appreciably both between types of devices and among manufacturers and models of the same type of device. Some appliance manufacturers are designing new models that, in general, have lower EMF than older models. As a result, the words “low field” or “reduced field” may be relative to older models and not necessarily relative to other manufacturers or devices. At this time, there are no domestic or international standards or guidelines limiting the EMF emissions of appliances.

The U.S. government has set no standards for magnetic fields from computer monitors or video display terminals (VDTs). The Swedish Confederation of Professional Employees (TCO) established in 1992 a standard recommending strict limits on the EMF emissions of computer monitors. The VDTs should produce magnetic fields of no more than 2 mG at a distance of 30 cm (about 1 ft) from the front surface of the monitor and 50 cm (about 1 ft 8 in) from the sides and back of the monitor. The TCO’92 standard has become a *de facto* standard in the VDT industry worldwide. A 1999 standard, promulgated by the Swedish TCO (known as the TCO’99 standard), provides for international and environmental labeling of personal computers. Many computer monitors marketed in the U.S. are certified as compliant with TCO’99 and are thereby assured to produce low magnetic fields.

Beware of advertisements claiming that the federal government has certified that the advertised equipment produces little or no EMF. The federal government has no such general certification program for the emissions of low-frequency EMF. The U.S. Food and Drug Administration’s Center for Devices and Radiological Health (CDRH) does certify medical equipment and equipment producing high levels of ionizing radiation or microwave radiation. Information about certain devices as well as general information about EMF is available from the CDRH at 888-463-6332.

Q Are cellular telephones and towers sources of EMF exposure?

A Cellular telephones and towers involve radio-frequency and microwave-frequency electromagnetic fields (see page 8). These are in a much higher frequency range than are the power-frequency electric and magnetic fields associated with the transmission and use of electricity.

The U.S. Federal Communications Commission (FCC) licenses communications systems that use radio-frequency and microwave electromagnetic fields and ensures that licensed facilities comply with exposure standards. Public information on this topic is published on two FCC Internet sites: http://www.fcc.gov/oet/info/documents/bulletins/#56 and http://www.fcc.gov/oet/rfsafety/

The U.S. Food and Drug Administration also provides information about cellular telephones on its web site (http://www.fda.gov/cdrh/ocd/mobilphone.html).

6 National and International EMF Reviews

This chapter presents the findings and recommendations of major EMF research reviews, including the U.S. government's EMF RAPID Program.

Q What have national and international agencies concluded about the impact of EMF exposure on human health?

A Since 1995, two major U.S. reports have concluded that limited evidence exists for an association between EMF exposure and increased leukemia risk, but that when all the scientific evidence is considered, the link between EMF exposure and cancer is weak. The World Health Organization in 1997 reached a similar conclusion.

The two reports were the U.S. National Academy of Sciences report in 1996 and, in 1999, the National Institute of Environmental Health Sciences report to the U.S. Congress at the end of the U.S. EMF Research and Public Information Dissemination (RAPID) Program.

The U.S. EMF RAPID Program

Initiated by the U.S. Congress and established by law in 1992, the U.S. EMF Research and Public Information Dissemination (EMF RAPID) Program set out to study whether exposure to electric and magnetic fields produced by the generation, transmission, or use of electric power posed a risk to human health. For more information about the EMF RAPID Program, visit the web site (http://www.niehs.nih.gov/emfrapid).

The U.S. Department of Energy (DOE) administered the overall EMF RAPID Program, but health effects research and risk assessment were supervised by the National Institute of Environmental Health Sciences (NIEHS), a branch of the U.S. National Institutes of Health (NIH). Together, DOE and NIEHS oversaw more than 100 cellular and animal studies, as well as engineering and exposure assessment studies. Although the EMF RAPID Program did not fund any additional epidemiological studies, an analysis of the many studies already conducted was an important part of its final report.

The electric power industry contributed about half, or $22.5 million, of the $45 million eventually spent on EMF research over the course of the EMF RAPID Program. The NIEHS received $30.1 million from this program for research, public outreach, administration, and the health assessment evaluation of extremely low frequency (ELF) EMF. The DOE received approximately $15 million from this program for engineering and EMF mitigation research. The NIEHS contributed an additional $14.5 million for support of extramural and intramural research including long-term toxicity and carcinogenicity studies conducted by the National Toxicology Program.

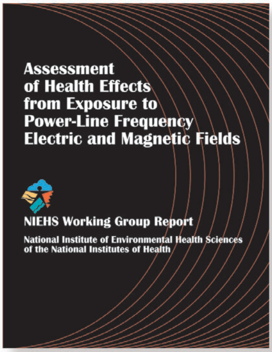
EMF RAPID Program Interagency Committee

- National Institute of Environmental Health Sciences
- Department of Energy
- Department of Defense
- Department of Transportation
- Environmental Protection Agency
- Federal Energy Regulatory Commission
- National Institute of Standards and Technology
- Occupational Safety and Health Administration
- Rural Electrification Administration

An interagency committee was established by the President of the United States to provide oversight and program management support for the EMF RAPID Program. The interagency committee included representatives from NIEHS, DOE, and seven other federal agencies with EMF-related responsibilities.

The EMF RAPID Program also received advice from a National EMF Advisory Committee (NEMFAC), which included representatives from citizen groups, labor, utilities, the National Academy of Sciences, and other groups. They met regularly with DOE and NIEHS staff to express their views. NEMFAC meetings were open to the public. The EMF RAPID Program sponsored citizen participation in some scientific meetings as well. A broad group of citizens reviewed all major public information materials produced for the program.

NIEHS Working Group Report 1998

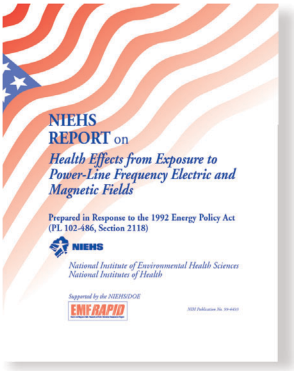


In preparation for the EMF RAPID Program's goal of reporting to the U.S. Congress on possible health effects from exposure to EMF from power lines, the NIEHS convened an expert working group in June 1998. Over 9 days, about 30 scientists conducted a complete review of EMF studies, including those sponsored by the EMF RAPID Program and others. Their conclusions offered guidance to the NIEHS as it prepared its report to Congress.

Using criteria developed by the International Agency for Research on Cancer, a majority of the members of the working group concluded that exposure to power-frequency EMF is a possible human carcinogen.

The majority called their opinion "a conservative public health decision based on limited evidence for an increased occurrence of childhood leukemias and an increased occurrence of chronic lymphocytic leukemia (CLL) in occupational settings." For these diseases, the working group reported that animal and cellular studies neither confirm nor deny the epidemiological studies' suggestion of a disease risk. This report is available on the NIEHS EMF RAPID web site (http://www.niehs.nih.gov/emfrapid).

NIEHS Report to Congress at Conclusion of EMF RAPID Program



In June 1999, the NIEHS reported to the U.S. Congress that scientific evidence for an EMF-cancer link is weak.

The following are excerpts from the 1999 NIEHS report:

> The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal, scientific support that exposure to this agent is causing any degree of harm.
>
> The scientific evidence suggesting that extremely low frequency EMF exposures pose any health risk is weak. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults. While the support from individual studies is weak, the epidemiological studies demonstrate, for some methods of measuring exposure, a fairly consistent pattern of a small, increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia. In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies, although sporadic findings of biological effects (including increased cancers in animals) have been reported. No indication of increased leukemias in experimental animals has been observed.

The full report is available on the NIEHS EMF RAPID web site (http://www.niehs.nih.gov/emfrapid).

No regulatory action was recommended or taken based on the NIEHS report. The NIEHS director, Dr. Kenneth Olden, told the Congress that, in his opinion, the conclusion of the NIEHS report was not sufficient to warrant aggressive regulatory action.

The NIEHS did not recommend adopting EMF standards for electric appliances or burying electric power lines. Instead, it recommended providing public information about practical ways to reduce EMF exposure. The NIEHS also suggested that power companies and utilities "continue siting power lines to reduce exposures and . . . explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards." The NIEHS encouraged manufacturers to reduce magnetic fields at a minimal cost, but noted that the risks do not warrant expensive redesign of electrical appliances.

The NIEHS also encouraged individuals who are concerned about EMF in their homes to check to see if their homes are properly wired and grounded, since incorrect wiring or other code violations are a common source of higher-than-usual magnetic fields.

National Academy of Sciences Report

In October 1996, a National Research Council committee of the National Academy of Sciences (NAS) released its evaluation of research on potential associations between EMF exposure and cancer, reproduction, development, learning, and behavior. The report concluded:

> Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects.

The NAS report focused primarily on the association of childhood leukemia with the proximity of the child's home to power lines. The NAS panel found that although a link between EMF exposure and increased risk for childhood leukemia was observed in studies that had estimated EMF exposure using the wire code method (distance of home from power line), such a link was not found in studies that had included actual measurements of magnetic fields at the time of the study. The panel called for more research to pinpoint the unexplained factors causing small increases in childhood leukemia in houses close to power lines.

World Health Organization International EMF Project

The World Health Organization (WHO) International EMF Project, with headquarters in Geneva, Switzerland, was launched at a 1996 meeting with representatives of 23 countries attending. It was intended to respond to growing concerns in many member states over possible EMF health effects and to address the conflict between such concerns and technological and economic progress. In its advisory role, the WHO International EMF Project is now reviewing laboratory and epidemiological evidence, identifying gaps in scientific knowledge, developing an agenda for future research, and developing risk communication booklets and other public information. The WHO International EMF Project is funded with contributions from governments and institutions and is expected to provide an overall EMF health risk assessment. Additional information about this program can be found on the WHO EMF web site (http://www.who.int/peh-emf).

As part of this project, in 1997 a working group of 45 scientists from around the world surveyed the evidence for adverse

EMF health effects. They reported that, "taken together, the findings of all published studies are suggestive of an association between childhood leukemia and estimates of ELF (extremely low frequency or power-frequency) magnetic fields."

Much like the 1996 U.S. NAS report, the WHO report noted that living in homes near power lines was associated with an approximate 1.5-fold excess risk of childhood leukemia. But unlike the NAS panel, WHO scientists had seen the results of the 1997 U.S. National Cancer Institute study of EMF and childhood leukemia (see page 17). This work showed even more strongly the inconsistency between results of studies that used a wire code to estimate EMF exposure and studies that actually measured magnetic fields.

Regarding health effects other than cancer, the WHO scientists reported that the epidemiological studies "do not provide sufficient evidence to support an association between extremely-low-frequency magnetic-field exposure and adult cancers, pregnancy outcome, or neurobehavioural disorders."

World Health Organization International Agency for Research on Cancer

The WHO International Agency for Research on Cancer (IARC) produces a monograph series that reviews the scientific evidence regarding potential carcinogenicity associated with exposure to environmental agents. An international scientific panel of 21 experts from 10 countries met in June 2001 to review the scientific evidence regarding the potential carcinogenicity of static and ELF (extremely low frequency or power-frequency) EMF. The panel categorized its conclusions for carcinogenicity based on the IARC classification system—a system that evaluates the strength of evidence from epidemiological, laboratory (human and cellular), and mechanistic studies. The panel classified power-frequency EMF as "possibly carcinogenic to humans" based on a fairly consistent statistical association between a doubling of risk of childhood leukemia and magnetic field exposure above 0.4 microtesla (0.4 µT, 4 milligauss or 4 mG).

In contrast, they found no consistent evidence that childhood EMF exposures are associated with other types of cancer or that adult EMF exposures are associated with increased risk for any kind of cancer. The IARC panel reported that no consistent carcinogenic effects of EMF exposure have been observed in experimental animals and that there is currently no scientific explanation for the observed association between childhood leukemia and EMF exposure. Further information can be obtained at the IARC web sites (http://www.iarc.fr and http://monographs.iarc.fr).

International Commission on Non-Ionizing Radiation Protection

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued exposure guidelines to guard against known adverse effects such as stimulation of nerves and muscles at very high EMF levels, as well as shocks and burns caused by touching objects that conduct electricity (see page 47). In April 1998, ICNIRP revised its exposure guidelines and characterized as "unconvincing" the evidence for an association between everyday power-frequency EMF and cancer.

European Union

In 1996, a European Union (EU) advisory panel provided an overview of the state of science and standards among EU countries. With respect to power-frequency EMF, the panel members said that there is no clear evidence that exposure to EMF results in an increased risk of cancer.

Australia—Radiation Advisory Committee Report to Parliament

In 1997, Australia's Radiation Advisory Committee briefly reviewed the EMF scientific literature and advised the Australian Parliament that, overall, there is insufficient evidence to come to a firm conclusion regarding possible health effects from exposure to power-frequency magnetic fields.

The committee also reported that "the weight of opinion as expressed in the U.S. National Academy of Sciences report, and the negative results from the National Cancer Institute study (Linet et al., 1997) would seem to shift the balance of probability more towards there being no identifiable health effects" (see pages 17 and 53).

Canada—Health Canada Report

In December 1998, a working group of public health officers at Health Canada, the federal agency that manages Canada's health care system, issued a review of the scientific literature regarding power-frequency EMF health effects. They found the evidence to be insufficient to conclude that EMF causes a risk of cancer.

The report concluded that while EMF effects may be observed in biological systems in a laboratory, no adverse health effects have been demonstrated at the levels to which humans and animals are typically exposed.

As for epidemiology, 25 years of study results are inconsistent and inconclusive, the panel said, and a plausible EMF-cancer mechanism is missing. Health Canada pledged to continue monitoring EMF research and to reassess this position as new information becomes available.

Germany—Ordinance 26

On January 1, 1997, Germany became the first nation to adopt a national rule on EMF exposure for the general public. Ordinance 26 applies only to facilities such as overhead and underground transmission and distribution lines, transformers, switchgear and overhead lines for electric-powered trains. Both electric (5 kV/m) and magnetic field exposure limits (1 Gauss) are high enough that they are unlikely to be encountered in ordinary daily life. The ordinance also requires that precautionary measures be taken on a case-by-case basis when electric facilities are sited or upgraded near homes, hospital, schools, day care centers, and playgrounds.

Great Britain—National Radiological Protection Board Report

The National Radiological Protection Board (NRPB) in Great Britain advises the government of the United Kingdom regarding standards of protection for exposure to non-ionizing radiation. The NRPB's advisory group on non-ionizing radiation periodically reviews new developments in EMF research and reports its findings. Results of the advisory group's latest review were published in 2001. The report reviewed residential and occupational epidemiological studies, as well as cellular, animal, and human volunteer studies that had been published.

The advisory group noted that there is "some epidemiological evidence that prolonged exposure to higher levels of power frequency magnetic fields is associated with a small risk of leukaemia in children." Specifically, the NRPB advisory group's analysis suggests "that relatively heavy average exposures of 0.4 µT [4 mG] or more are associated with a doubling of the risk of leukaemia in children under 15 years of age." The group pointed out, however, that laboratory experiments have provided "no good evidence that extremely low frequency electromagnetic fields are capable of producing cancer."

Scandinavia—EMF Developments

In October 1995, a group of Swedish researchers and government officials published a report about EMF exposure in the workplace. This "Criteria Group" reviewed EMF scientific literature and, using the IARC classification system, ranked occupational EMF exposure as "possibly carcinogenic to humans." They also endorsed the Swedish government's 1994 policy statement that public exposure limits to EMFs were not needed, but that people might simply want to use caution with EMFs.

In 1996, five Swedish government agencies further explained their precautionary advice about EMF. EMF exposure should be reduced, they said, but only when practical, without great inconvenience or cost.

Health experts in Norway, Denmark, and Finland generally agreed in reviews published in the 1990s that if an EMF health risk exists, it is small. They acknowledged that a link between residential magnetic fields and childhood leukemia cannot be confirmed or denied. In 1994, several Norwegian government ministries also recommended increasing the distance between residences and electrical facilities, if it could be done at low cost and with little inconvenience.

Q What other U.S. organizations have reported on EMF?

A American Medical Association

In 1995, the American Medical Association advised physicians that no scientifically documented health risk had been associated with "usually occurring" EMF, based on a review of EMF epidemiological, laboratory studies, and major literature reviews.

American Cancer Society

In 1996, the American Cancer Society released a review of 20 years of EMF epidemiological research including occupational studies and residential studies of adult and childhood cancer. The society noted that some data support a possible relationship of magnetic field exposure with leukemia and brain cancer, but further research may not be justified if studies continue to find uncertain results. Of particular interest is the summary of results from eight studies of risk from use of household appliances with relatively high magnetic fields, such as electric blankets and electric razors. The summary suggested that there is no persuasive evidence for increased risk with more frequent or longer use of these appliances.

American Physical Society

The American Physical Society (APS) represents thousands of U.S. physicists. Responding to the NIEHS Working Group's conclusion that EMF is a possible human carcinogen, the APS executive board voted in 1998 to reaffirm its 1995 opinion that there is "no consistent, significant link between cancer and power line fields."

California's Department of Health Services

In 1996, California's Department of Health Services (DHS) began an ambitious five-year effort to assess possible EMF public health risk and offer guidance to school administrators and other decision-makers. The California Electric and Magnetic Fields (EMF) Program is a research, education, and technical assistance program concerned with the possible health effects of EMF from power lines, appliances, and other uses of electricity. The program's goal is to find a rational and fair approach to dealing with the potential risks, if any, of exposure to EMF. This is done through research, policy analysis, and education. The web site has educational materials on EMF and related health issues for individuals, schools, government agencies, and professional organizations (http://www.dhs.ca.gov/ps/deodc/ehib/emf).

Q What can we conclude about EMF at this time?

A Electricity is a beneficial part of our daily lives, but whenever electricity is generated, transmitted, or used, electric and magnetic fields are created. Over the past 25 years, research has addressed the question of whether exposure to power-frequency EMF might adversely affect human health. For most health outcomes, there is no evidence that EMF exposures have adverse effects. There is some evidence from epidemiology studies that exposure to power-frequency EMF is associated with an increased risk for childhood leukemia. This association is difficult to interpret in the absence of reproducible laboratory evidence or a scientific explanation that links magnetic fields with childhood leukemia.

EMF exposures are complex and come from multiple sources in the home and workplace in addition to power lines. Although scientists are still debating whether EMF is a hazard to health, the NIEHS recommends continued education on ways of reducing exposures. This booklet has identified some EMF sources and some simple steps you can take to limit your exposure. For your own safety, it is important that any steps you take to reduce your exposures do not increase other obvious hazards such as those from electrocution or fire. At the current time in the United States, there are no federal standards for occupational or residential exposure to 60-Hz EMF.

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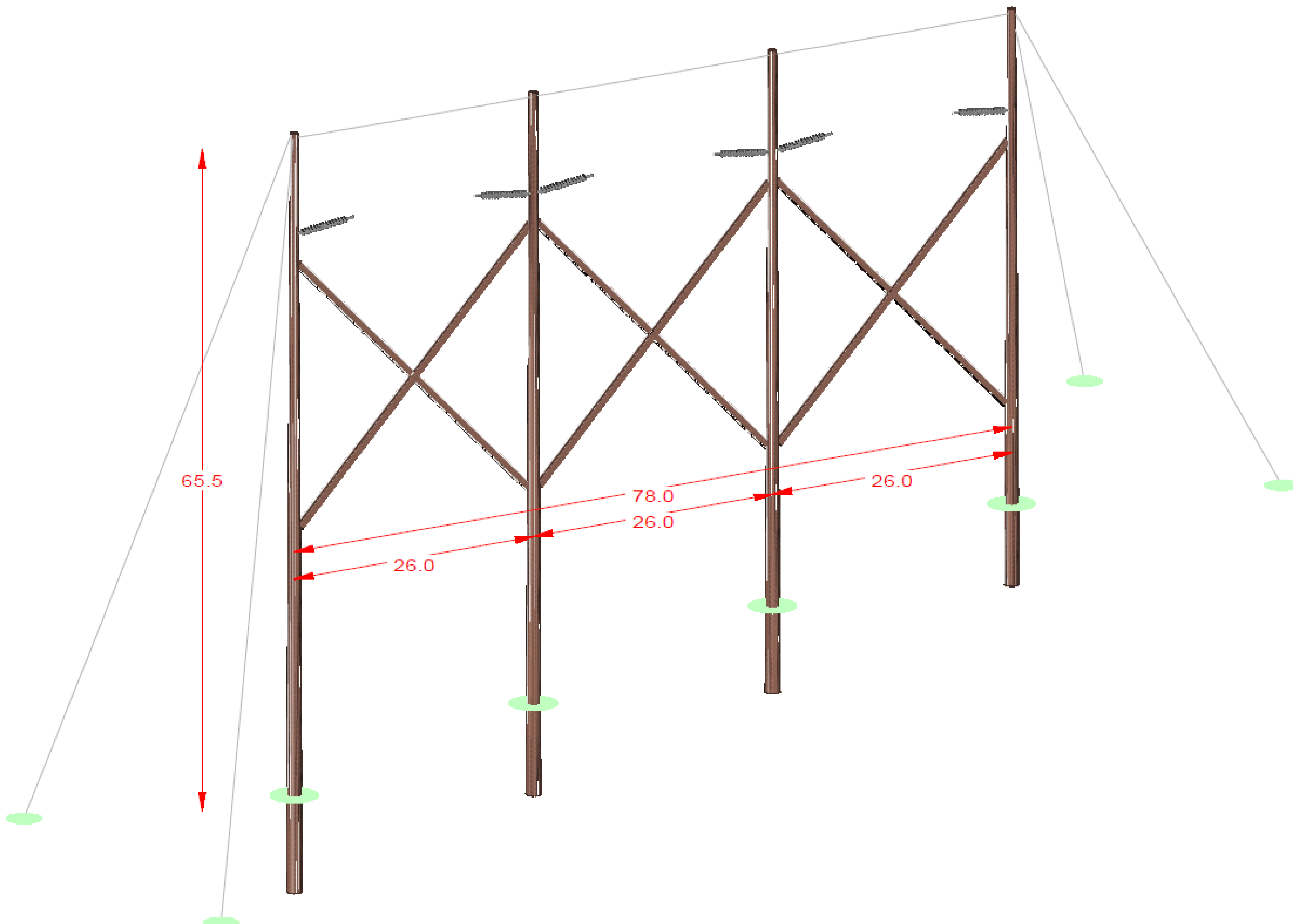
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Magnetic field distribution for double circuit line (138 KV and 46 KV) – At current loading

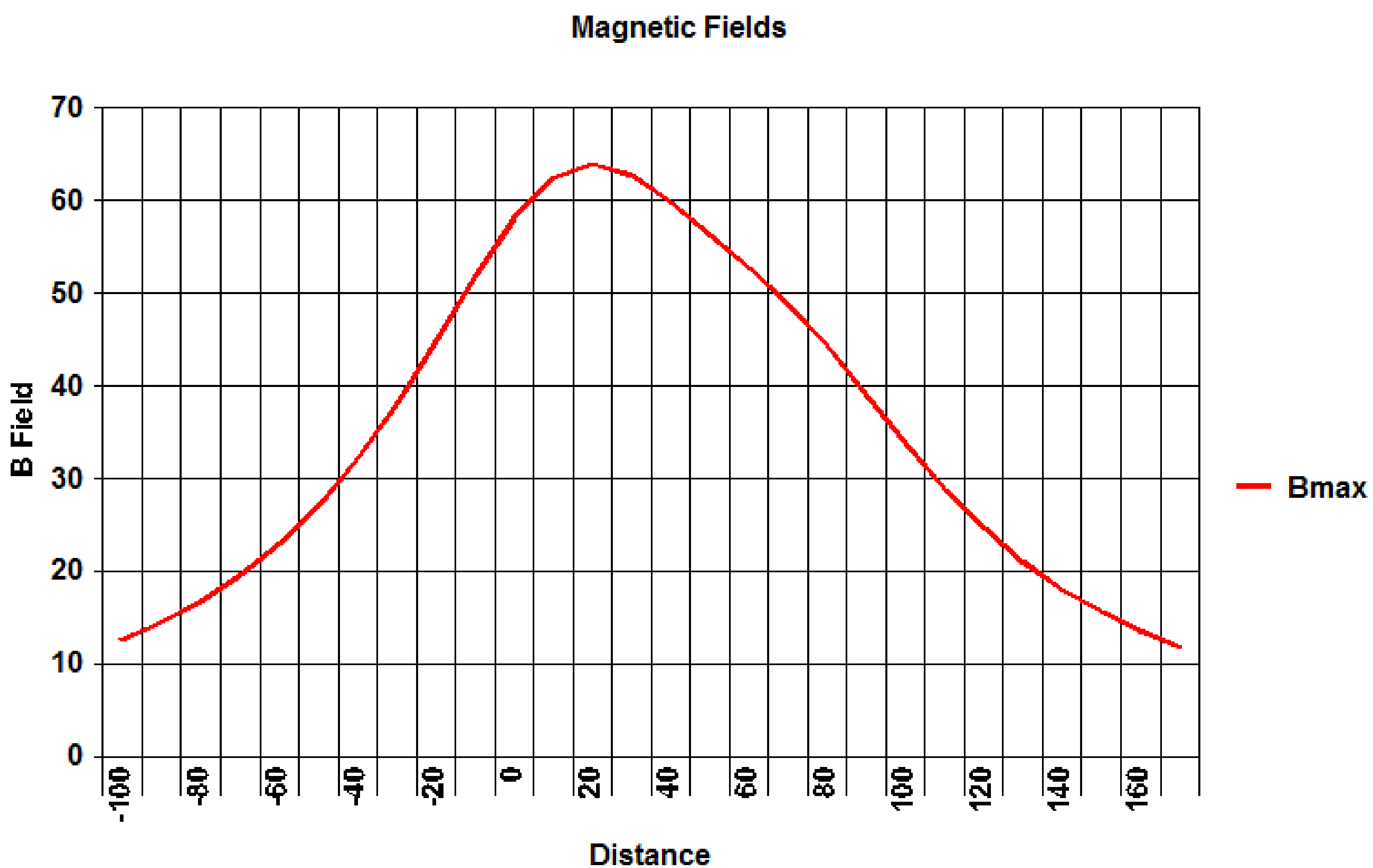


Figure 1 Magnetic Field measured in milligauss mG

Magnetic field distribution for double circuit line (2 Nos. of 138 KV) – At conductor rated capacity

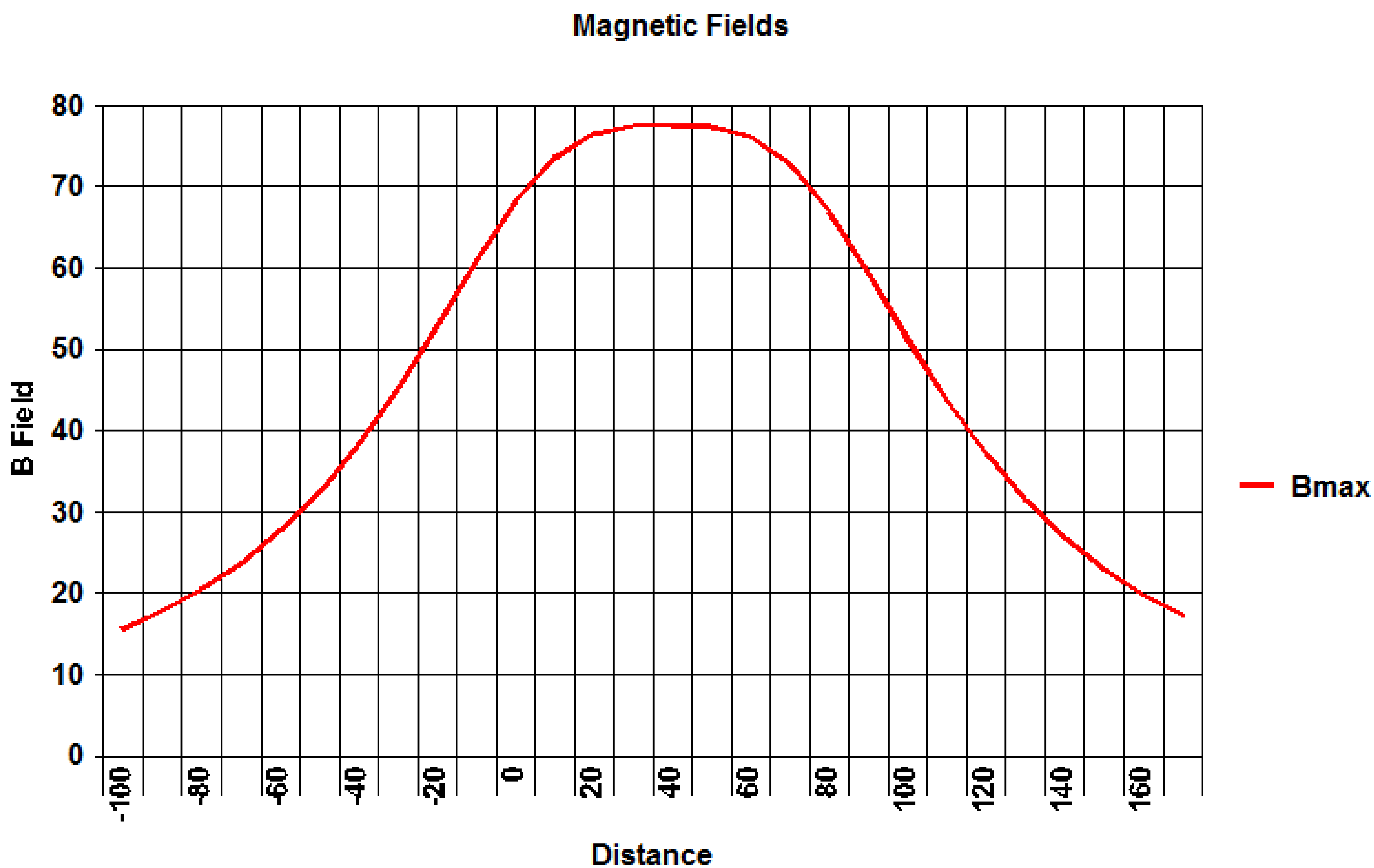
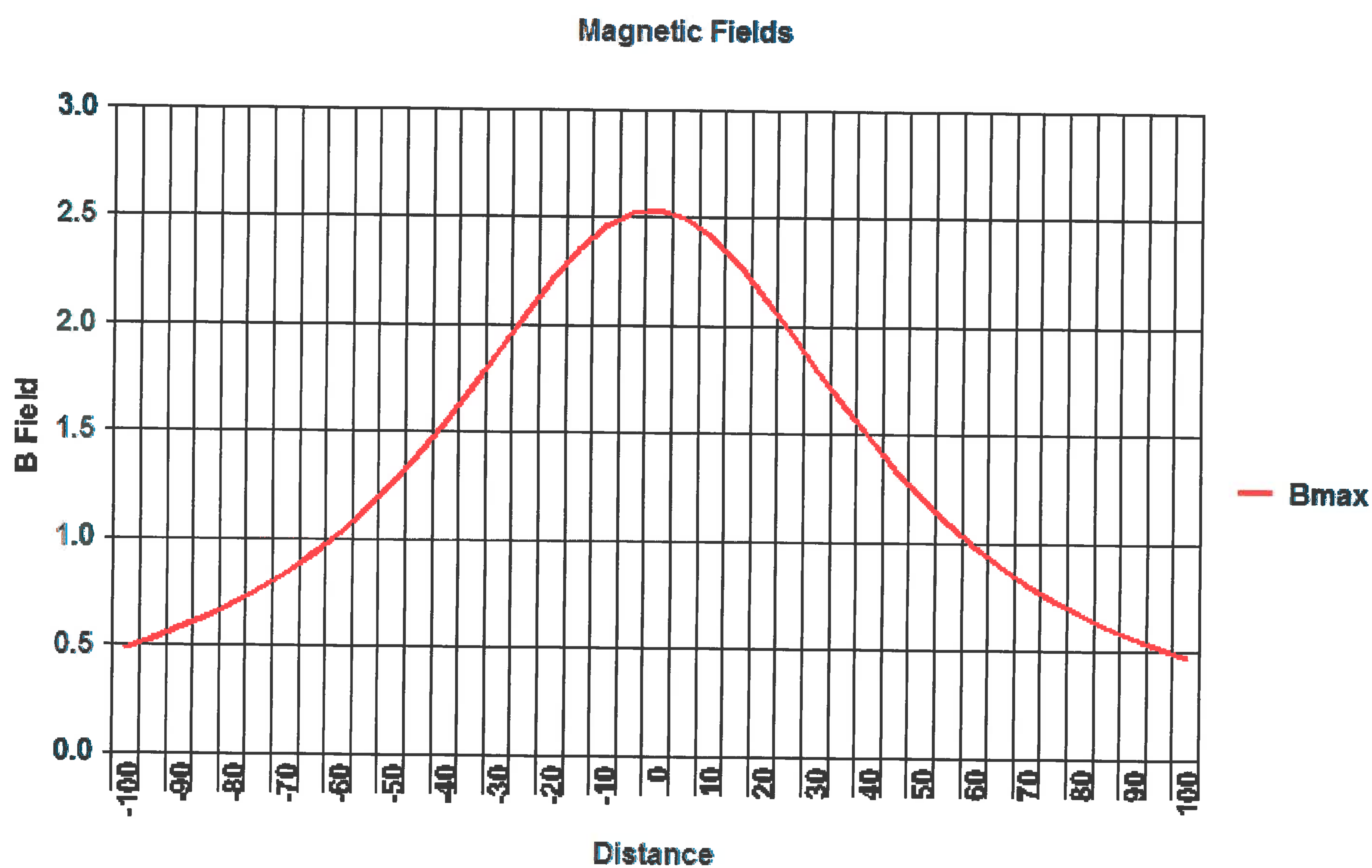
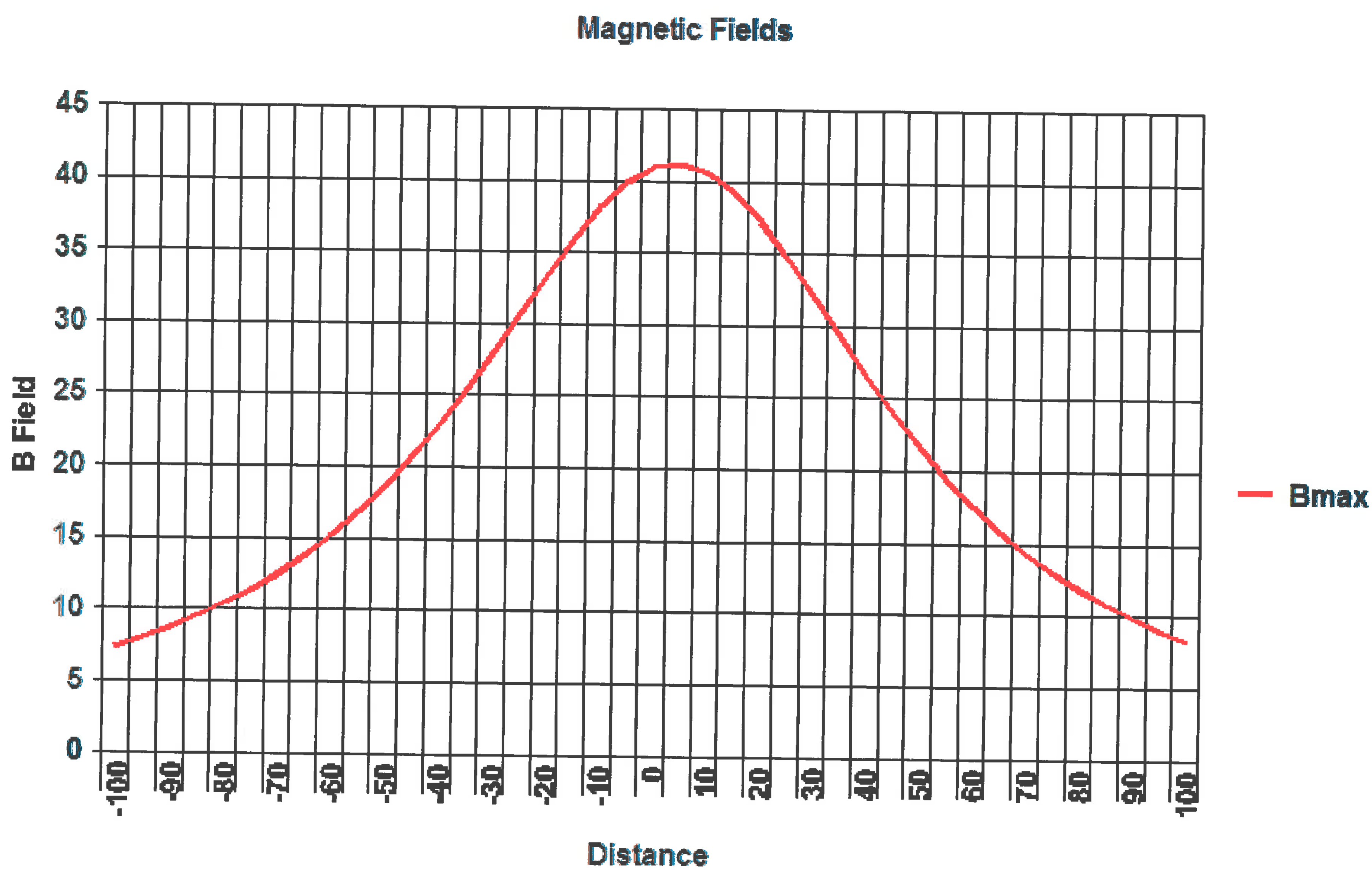


Figure 2 Magnetic Field measured in milliGauss

Magnetic field distribution for double circuit line (138 KV and 46 KV) – At 2014 loading conditions



Magnetic field distribution for double circuit line (138 KV and 46 KV) – At conductor rated capacity



Appendix 12
The Company's Meeting Minutes

Wasatch County meeting timeline and summary of meeting minutes

1. 9/3/2014 – Wasatch County offices reviewed plans and discuss concerns.
    a. Attendees – Mike Davis, Doug Smith, Jay Price, Don Watts, Debbie Mounteer, Rich Wolper, Justin.
    b. Discussed proposed transmission line.
2. 9/17/14 – Meeting with Land owner Promontory Development
    a. Attendees – Debbie Mounteer, Rich Sonntag, Steve Rush
3. 9/26/14 – Site visit to browns canyon road.
    a. Attendees – Mike Davis, Doug Smith, Jay Price, Mackenzie Pino, Don Watts, Rich Wolper
4. 10/3/14 – Site visit to attempt to fly balloons at the pole locations
    a. Attendees – Doug Smith, Mike Davis, Steve Rush, Mackenzie Pino, Don Watts,
5. 11/18/14 – Wasatch County offices meeting
    a. Attendees – Steve Rush, Mackenzie Pino, Don Watts, Doug Smith, Mike Davis, Jay Price
    b. Discussed options in line routes, ridgeline concerns, Wolper's concerns, Promontory concerns.
6. 1/23/15 – CUP filing
7. 3/12/15 – Wasatch County Planning meeting for CUP
    a. Requested item be tabled.
8. 5/14/15 – RMP Simulation presentation and review for 2 options.
    a. Attendees – Mike Davis, Doug Smith, Kendall Crittenden, Don Watts, Heidi Gordon
9. 6/10/15 – Meeting to review simulations with Promontory and gather their input.
    a. Attendees – Rich Sonntag, Attorney for Promontory, Board member, Heidi Gordon, Steve Rush, Don Watts, Brian Bridge
10. 6/16/15 – Wasatch County meeting to discuss options and provide feedback from other stakeholder meetings held to date.
    a. Attendees – Mackenzie Pino, Brian Bridge, Heidi Gordon, Don Watts, Kendall Crittenden, Mike Davis, Doug Smith.
11. 6/18/15 – Meeting with Mark 25LLC to review simulations and discuss concerns
    a. Attendees – Don Watts, Heidi Gordon, Brian Bridge
        i. Discussed plans and options none were acceptable to Mark 25LLC
        ii. Offered screening with strategic vegetation. Offer rejected.
12. 7/13/15 – Meeting with Wasatch County Attorney and planning
    a. Attendees – Tyler Berg, Doug Smith, Heidi Gordon, Don Watts
        i. Noise was brought up as a potential concern.

Appendix 13
Revised Mailing List

Wasatch County Requested Property Owners of Current Record 1/21/15.

Promontory Investments LLC
8758 N. Promontory Ranch Rd.
Park City, UT 84098

Talisker Black Rock LLC
PO Box 4349
Park City, UT 84060

Mark 25 LLC
1739 Lakewood Dr.
Salt Lake City, UT 84117

Theresa H. Farrell
PO Box 982615
Park City, UT 84098

Jessie E. & Mark Bekken
PO Box 683850
Park City, UT 84068-3850

Sandra Tassell
1225 W. Black Rock Rtail #O
Kamas, UT 84036

Garff Rogers Ranch LLC
405 S. Main, Suite 1200
Salt Lake City, UT 84111

Rocky Mountain Power
Don Watts
70 North 200 East
American Fork, UT 84003

Soo Jin Francis and Timothy John Francis
1225 W. Black Rock Trail #A
Heber City, UT 84036

Ranae Rezac
1225 W. Black Rock Trail, #Q
Heber City, UT 84036

Ashley Robinson
6300 N. Sagewood Drive, H335
Park City, UT 84098

Thomas Jay Richard Lanning
1225 W. Black Rock Trail #G
Heber City, UT 84036

Heather J. Kennedy
PO Box 982976
Park City, UT 84098

Marty Ogburn
PO Box 118
Kamas, UT 84036

Joseph and Jennifer Stevens
1225 W. Black Rock Trail, #I-202
Kamas, UT 84032

Christopher Ames
1225 W. Black Rock Trail, #H
Kamas, UT 84032

Mary Eileen Keller and Rod Keller
2100 Park Ave., Unit 682122
Park City, UT 84068

Ligita Henry
1225 W. Black Rock Trail, #K
Kamas, UT 84036

Virginia Skeffington
1225 W. Black Rock Trail, #P
Kamas, UT 84036

Shaun Conway – ETAL
1225 W. Black Rock Trail #E
Kamas, UT 84036

Racquel Cornali and Gregrory Bellmyer
1225 W. Black Rock Trail, #B
Kamas, UT 84036

Heidi Fuellenbach
PO Box 680144
Park City, UT 84068

Wasatch County Additional Landowners of Current Record 6-18-15

Jeffery & Audrey Talley
14186 N. Council Fire Trail
Heber City, UT 84032

Joseph Graham Flinn, et al
PO Box 982093
Park City, UT 84098

Lori and Alexander Ramirez
105 N. 360 W.
Centerville, UT 84014

Kenneth & Carly Stenmark
PO Box 684302
Park City, UT 84068

Kristina Keikmann & Bartlett Cocke
723 8th Ave
Salt Lake City, UT 84103

Kaara Peterson
PO Box 683714
Park City, UT 84068

Howard Schnieders
1775 Park Ave #4 PMB 125
Park City, UT 84068

Dayna Deuter
14121 N. Council Fire Trail
Kamas, UT 84036

Vincent G. Heyd, etal
14088 Council Fire Trail
Kamas, UT 84036

Andrea & Lisa Fiore
551 Hill Terrace #206
Winnettca, IL 60093

George & Margo Foster
2640 NE 53 Ct.
Lighthouse Point, FL 33064

Keith & Chriss Donaldson
89 Chesternut Ter
Buffalo Grove, IL 60089

Michael & Sherrie Zaifert
467 Santee Drive
Santee, SC 29142

Jack & Rhonda Mccartt
8737 Water Oak Place
Jupiter, FL 33469

Robert N. Halicky
989 W. White Cloud Trail
Kamas, UT 84036

Susan Hatch
972 W. White Cloud Trail
Kamas, UT 84036

Bernadette Cordova
980 W. White Cloud Trail
Kamas, UT 84036

Raymond Navdain and Diane Jamail
1025 W. White Cloud Trail
Kamas, UT 84036

James C. Wilson
6905 S. 1300 E. #113
Midvale, UT 84047

Exchange Solutions, Inc.
3031 Tisch Way,Suite 901
San Jose, CA 95128

Marco Cortez
1739 Lakewood Drive
Salt Lake City, UT 84117

Todd J. & Gail Stark
14321 N. Council Fire Trail
Kamas, UT 84036

Brett Labab and Caley Johnson
PO Box 980981
Park City, UT 84098

Charles & Beth Holmberg
6700 Springhill Drive
Frederick, MD 21702

Terry & Linda Johncock
1579 S. Crooked Lake Drive
Kalamazoo, MI 49009

Mark Luebke
976 W. White Cloud Trail
Kamas, UT 84036

Rakj Holdings, Inc.
19515 Presidential Way
Miami, FL 33179

360 Productions, LLC
14374 N. Council Fire Trail
Kamas, UT 84036

Lisa A. Werner and Matt Jamison
8420 Point Drive
Park City, UT 84098-4649

Joyce Rocklin & Jessica Jarick
14047 N. Council Fire Trail
Kamas, UT 84036

Taylor Syphus
641 S. 680 E.
Heber City, UT 84032

Patrick Scanlon
5 Dale Road
Orchard Park, NY 00023-0933

William Schneiders
14295 N. Council Fire Trail
Kamas, UT 84036

Rickie Benson
14261 Council Fire Trail
Kamas, UT 84036

Richard Dinsdale
1603 N. 129th Street
Omaha, NE 68154

Johnathon & Louisa Gray
110 Comdale Court
Roswell, GA 30075

Appendix 14
Letter of Support from Heber Light & Power

A Municipal Electric Utility

Heber Light & Power

Founded 1909

July 28, 2015

Don Watts
Customer and Community Manager
70 North 200 East
American Fork, Utah 84003

Re: Rocky Mountain Power Transmission Line Extension

Dear Mr. Watts:

Heber Light & Power Company supports Rocky Mountain Power's plan to complete the connection of its 138kV line from Evanston, Wyoming to its Silver Creek Substation. As a transmission customer of Rocky Mountain Power, Heber Light & Power is very concerned that Rocky Mountain Power's system lacks sufficient capacity to serve the ever increasing load of Heber Light & Power Company. We have therefore been working with Rocky Mountain Power for several years to assist it in increasing the capacity through this transmission corridor.

Heber Light & Power Company is, however, concerned that the public and community leaders do not fully appreciate that the connection to the Silver Creek Substation is critical to Heber Light & Power Company's operations and will directly benefit the Company's customers. First, this connection coupled with the proposed 138kV line serving the Heber Valley will eliminate voltage fluctuations that have plagued the system during peak loads by increasing the capacity of the Rocky Mountain Power lines feeding the Heber Valley. Second, this connection and related line serving the Heber Valley from the north will solve the Company's precarious reliance on the single 138kV line in Provo Canyon. Finally, it will allow the Company to construct a second point of interconnect to the Rocky Mountain Power transmission system providing needed redundancy for the Company's Midway Substation and facilitating vital system maintenance.

These improvements to reliability could be lost by constructing the transmission line underground. Underground transmission lines are more vulnerable to failure than above ground lines and are more difficult and time consuming to repair. Undergrounds lines would thus expose the Company's customers to unnecessary and lengthy service interruptions.

Heber Light & Power Company and its more than 11,000 customers within the Heber Valley depend on the reliability of PacifiCorp's transmission system and, ultimately, on the completion of the proposed connection of 138kV transmission line to the Silver Creek Substation. We are deeply worried that the failure of this project will severely impair our ability to provide safe, reliable, and

31 South 100 West Heber City, Utah 84032 (435) 654-1581 fax (435) 654-1682

uninterrupted electric service to our customers. For our system to continue to function effectively, this overhead transmission line needs to be completed within the next two years.

Sincerely

Jason Norlen
General Manager
Heber Light & Power Company