West Central Mountains Electrical Plan

Final Report

Final report prepared by
Delivery Planning Department

In cooperation with the
West Central Mountains Electrical Plan Community Advisory Committee

December 2014

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

GLOSSARY

138-kV Source Substation—Acts as the supply point for the 138,000-volt (V) sub-transmission. Power arrives at a 138-kilovolt (kV) source substation at 230,000 V and is stepped down by transformers to 138,000 V.

BLM—United States **(**US) Bureau of Land Management.

Buildout—The point when all available land is developed in accordance with zoning ordinances.

CAC—Community Advisory Committee (referred to herein as the Committee).

Distribution Substation—A relatively small substation located near its electrical load that transforms (reduces) sub-transmission voltages to distribution voltages. In the West Central Mountains, the sub-transmission voltage is either 138,000 or 69,000 volts (V) and the distribution voltage is either 34,500 V or 12,470 V.

ETVEP—*Eastern Treasure Valley Electrical Plan*.

kV—Kilovolts (thousands of volts). 1,000 volts = 1 kV.

kW—Kilowatts (thousands of watts). 1,000 watts = 1 kW.

MW—Megawatt (millions of watts). 1,000,000 watts = 1 MW.

The Plan—*West Central Mountains Electrical Plan*.

Relationship between Power and Voltage—Two quantities are referred to in this report when describing the electrical system: power and voltage.

> **Power—**The amount of work performed in one second. The term is used to express the electrical workload of the West Central Mountains and the capability of a transmission line to move electricity. Power is measured in watts (kilowatts [kW] and megawatts [MW]).
>
> **Voltage—**A component of power that enables the power to flow on a transmission line. It is the "push" behind the power. In general, a higher voltage line can carry more power than a lower voltage line. Voltage is measured in volts (V) at your household (110 and 220 V) and kilovolts (kV) on the transmission network (138 kV).

Substation—A facility that provides transmission line switching with electrical transformation (voltage reduction).

TVEP—*Treasure Valley Electrical Plan.*

WTVEP—*Western Treasure Valley Electrical Plan*.

EXECUTIVE SUMMARY

Electricity—it lights our homes, runs our computers, cooks our food, and entertains our kids. It can be used to save a life, and it can ease our work. We don't often think about how much effort is put in every day to keep the electricity flowing and how much planning must take place to ensure electrical facilities are built when they are needed. The cost for electrical facilities is tremendous. The electric utility industry is one of the most—perhaps the most—capital-intensive industries in the United States (US).

The West Central Mountains' population and commercial base have grown over the past 20 years, and Idaho Power continually adds new infrastructure to meet the resulting electricity needs. Even with the economic recession that began in 2007, Idaho Power's existing customers continue to purchase devices that consume more and more energy on a per-capita basis. Although these devices are becoming more energy efficient, customers seem to have more of them. Industry, businesses, farms, and residences are becoming more dependent on a reliable supply of electricity with every passing year. Now in 2014, growth is picking up in this region, and new facilities will be needed to supply the energy new businesses and homes will need. It is important that Idaho Power takes a long-term view of the future and plans new generation, transmission, and substation facilities to serve their electrical need and fit the desires of the communities within which they reside.

Even though electricity has become a necessity to modern life, many people find electrical facilities visually and environmentally intrusive. Each new facility location needs to address safety, property owner concerns, jurisdictional siting requirements, environmental laws and regulations, and federal reliability standards. A long-term plan is necessary to ensure the transmission lines and substations are there when needed, and it is important to locate the facilities so they fit into a larger strategy to serve the area. This larger strategy or plan should accommodate the vision and perspective of local communities.

In August 2013, Idaho Power invited members of the West Central Mountains community to participate in a community advisory committee (the Committee) to help plan for the new electrical facilities that will provide for growth. The Committee, made up of local elected officials, city and county planning representatives, industrial representatives, community members, representatives from the Bureau of Land Management (BLM) and the forest service, the Idaho Department of Fish and Game (IDFG), and a representative from the Nez Perce Tribe, met monthly for a year. (The inside cover of this report shows a complete list of the Committee members.) Developed in concert with the Committee, the *West Central Mountains Electrical Plan* (the Plan) describes infrastructure improvements and additions needed to provide an adequate and dependable power supply far into the future. It provides a long-range (buildout) strategy to serve the electrical power needs of Idaho Power's customers in a region consisting of Valley, Boise, and Adams counties. The Committee did not address any high-voltage transmission external to the West Central Mountains that might be used to deliver energy to the area.

From 2010 through 2012, Idaho Power convened two additional community advisory committees to site buildout facilities for the Treasure Valley and named the plans the *Western*

Treasure Valley Electrical Plan (WTVEP) and the *Eastern Treasure Valley Electrical Plan* (ETVEP). These plans laid out substation locations and transmission line routes in Ada, Elmore, Canyon, Payette, Washington, and Owyhee counties in Idaho and Malheur County in Oregon. The substation locations and transmission line routes identified by the WTVEP and the ETVEP were available to the Committee.

The Committee started its work in August 2013 with a general education session, followed in September with a bus tour of generation and transmission facilities, as well as the Rapid River Fish Hatchery. The following two months were devoted to providing the Committee background information relating to electrical power systems. Through these educational sessions, the Committee was introduced to the concepts of electrical power generation, transmission, substations, energy efficiency, and regulatory affairs. Additionally, the Committee was introduced to Idaho Power's electrical system from production to delivery.

Guiding Principles and Community Criteria

As a first step in determining the feasibility of individual transmission line routes and substation locations, the Committee members created a *Guiding Principles and Community Criteria* document. The guiding principles are key themes that serve as a foundation for making decisions concerning the West Central Mountains electrical system, while the community criteria are used more specifically for locating future transmission lines and substations.

The final guiding principles are divided into seven categories:

1. **Promote economic development.**

    - Support and sustain economic development.
    - Incorporate the *Valley County Economic Development Plan* in planning efforts.

2. **Support existing businesses, property rights, and land uses (e.g., historic sites, industries).**

    - Consider how future infrastructure could adversely affect high-value resources, recreational sites, or other facilities.
    - Respect private property (i.e., some property owners may want transmission lines on their land, but others may not).
    - Avoid the use of eminent domain on private land.

3. **Work with local jurisdictions.**

    - Comply with federal and local land-use plans and ordinances.
    - Coordinate with federal, state, and local planning activities.

4. **Be aware of environmentally sensitive areas.**

- Protect the environment and preserve open space, viewsheds, and wildlife.

5. **Consider community character.**

   - As infrastructure is built, ensure substations and transmission lines fit into the local environment.

6. **Continue to meet power needs and prepare for future unknowns.**

   - Ensure electrical infrastructure has the ability to meet current and future needs of the area.

   - Support localized generation, and promote the possibility of self-sustaining electrical generation in Valley County.

   - Improve reliability and redundancy of the West Central Mountains electrical system.

   - Integrate the Plan with the whole Northwest grid system.

   - Make transmission lines and substations accessible for repair and maintenance (especially in winter).

7. **Be as efficient as possible.**

   - Upgrade existing electrical infrastructure when possible.

   - Collocate with other utilities when feasible.

The community criteria are divided into two lists that provide guidance for the specific placement of substations and transmission lines. The first list includes areas deemed favorable to electrical infrastructure placement, while the second list includes areas that should be avoided. The combined lists are shown in Table 1.

Table 1
Community criteria

Areas to Site Electrical Infrastructure	Areas to Avoid Siting Electrical Infrastructure
Existing energy/power corridors (with the exception of existing subdivisions)	Waterways (rivers/lakes/springs)
Industrial areas	Viewsheds from the valley floor
Near like land use	Residential areas
In appropriate railroad right-of-way (ROW) (i.e., not in Rails-to-Trails)	Parks
Industrial corridors	Recreation areas (winter and summer)
Consolidated along one side of travel corridors, US Forest Service (USFS)/fire roads, county roads, and state highway ROWs not within a designated Scenic Byway	Sensitive wildlife areas and corridors
Near areas where future development is planned	Schools
Lots at intersections, except in very visible areas (for substations)	Minimize river crossings
Set far enough away from roadways to not pose a safety hazard and to leave room for future widening and growth	Riparian conservation areas
Previously developed areas (e.g., old ROWs and easements)	Airport zones
	Ridgelines
	Aesthetic areas near private land
	Designated Scenic Byways and corridors in Boise, Valley, and Adams counties
	Natural scenery
	Close to lakefronts
	Boat fronts
	Land under cultivation (includes both pasture and farmland)
	Irrigation canals
	Wetlands

Mapping Exercise

Using the information gained from the first four meetings and from the guiding principles and community criteria it developed, the Committee laid out proposed substation locations and transmission line routes to serve the West Central Mountains through buildout. The Committee identified many different alternatives for evaluation. Idaho Power staff provided technical analysis for each alternative to help the Committee further refine its choices. The Committee reached a consensus on preferred and acceptable secondary alternatives. A preferred alternative represents the committee's first choice for a substation location or transmission line route,

while a secondary alternative represents the committee's recommendations for substation sites or transmission line routes if a preferred alternative cannot be obtained.

For the purposes of this report, the West Central Mountains is broken down into three sub-areas:

- Adams County Area—Includes the cities of Council and New Meadows.
- Valley County Area—Includes the cities of McCall, Cascade, and Donnelly.
- Boise County Area—Includes the cities of Horseshoe Bend, Placerville, Idaho City, and Smith's Ferry. (Though Smith's Ferry is part of Valley County, it makes sense electrically to include it with this area.)

In addition to the city areas described above, each sub-area includes public lands evaluated by the Committee.

Preferred Alternatives

The Committee's preferred alternatives to serve the West Central Mountains service area at buildout are shown in the following figures. The Committee produced a preferred alternative, eliminated "no go" alternatives, and identified remaining alternatives deemed acceptable if the preferred alternative becomes infeasible. The Committee generally recommended Idaho Power refer to their *Guiding Principles and Community Criteria* when siting any new facilities in the West Central Mountains.

For clarity, the West Central Mountains in the following drawings is split between Adams, Valley, and Boise counties. Further subdivisions are shown in the Committee's Preferred Alternatives section of this report and in Appendix D.

Adams County Area (Figure 1). The Committee's preferred alternatives for the Adams County area include a new distribution substation (D2) in the Indian Valley area and a 138-kV transmission line to interconnect the substation to existing transmission lines. A secondary location was indicated by the Committee if the first location is deemed infeasible. If a 138-kV line ROW cannot be obtained, a 69-kV source substation can be added to the existing Horse Flat Substation, and a 69-kV line can be added to connect the Horse Flat Substation to the Cambridge Substation.

No new high-voltage transmission lines (230 kV and above) were recommended by the Committee in this area.

Valley County Area (Figure 2). The Committee's preferred alternatives for the Valley County area include one preferred new distribution substation south of Cascade and four secondary substation locations, one south of Cascade and three between Cascade and Donnelly. The Committee also recommended upgrading the 69-kV transmission lines from the Lake Fork Substation south to Boise County.

No new source substations or high-voltage transmission lines (230 kV and above) were recommended by the Committee in this area.

Boise County Area (figures 3 and 4). The Committee's preferred alternatives for the Boise County area include two new distribution substations (Placerville [D1] and Smith's Ferry [D3]) and the associated 138-kilovolt (kV) transmission to interconnect and support them. A 138-kV line was chosen by the Committee to connect the proposed Placerville Substation with the existing Boise Bench Substation. One new 138-kV source substation is also recommended with a new 138-kV line to connect it to the existing system. A 230-kV line route through Gem County to the proposed location of the Smith's Ferry Substation (D3) is also an alternative.

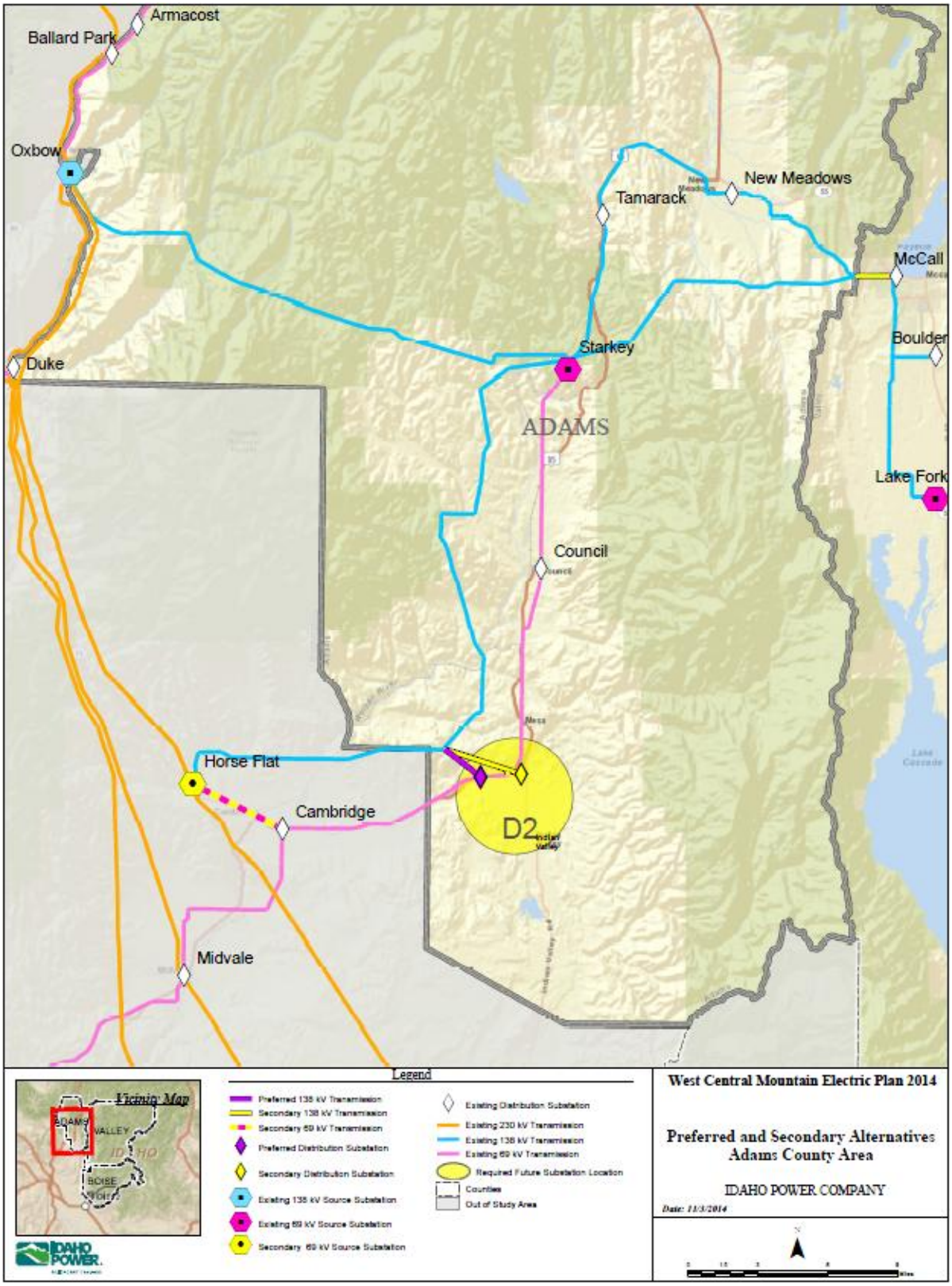

Figure 1
Preferred and secondary alternatives, Adams County area

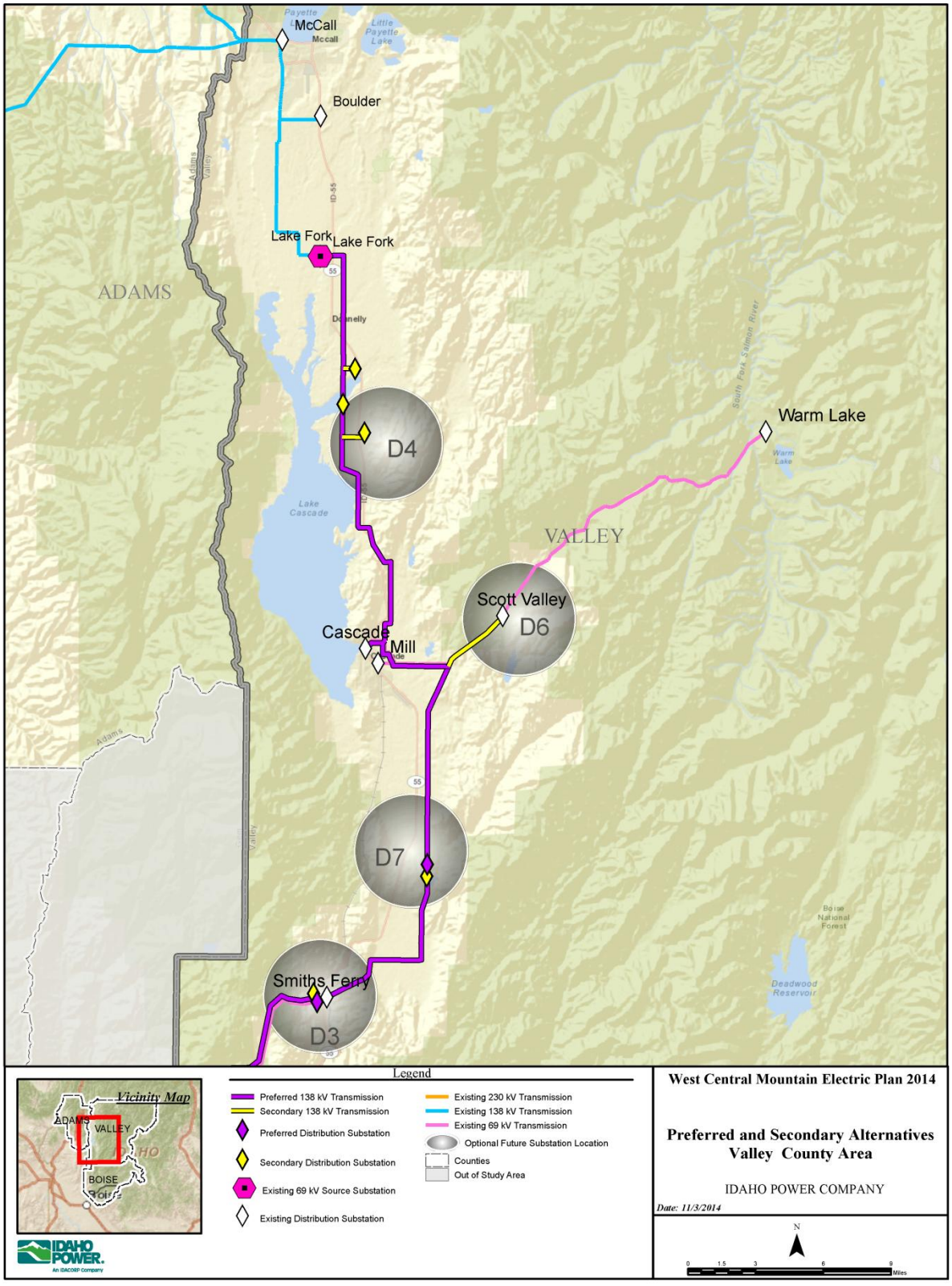

Figure 2
Preferred and secondary alternatives, Valley County area

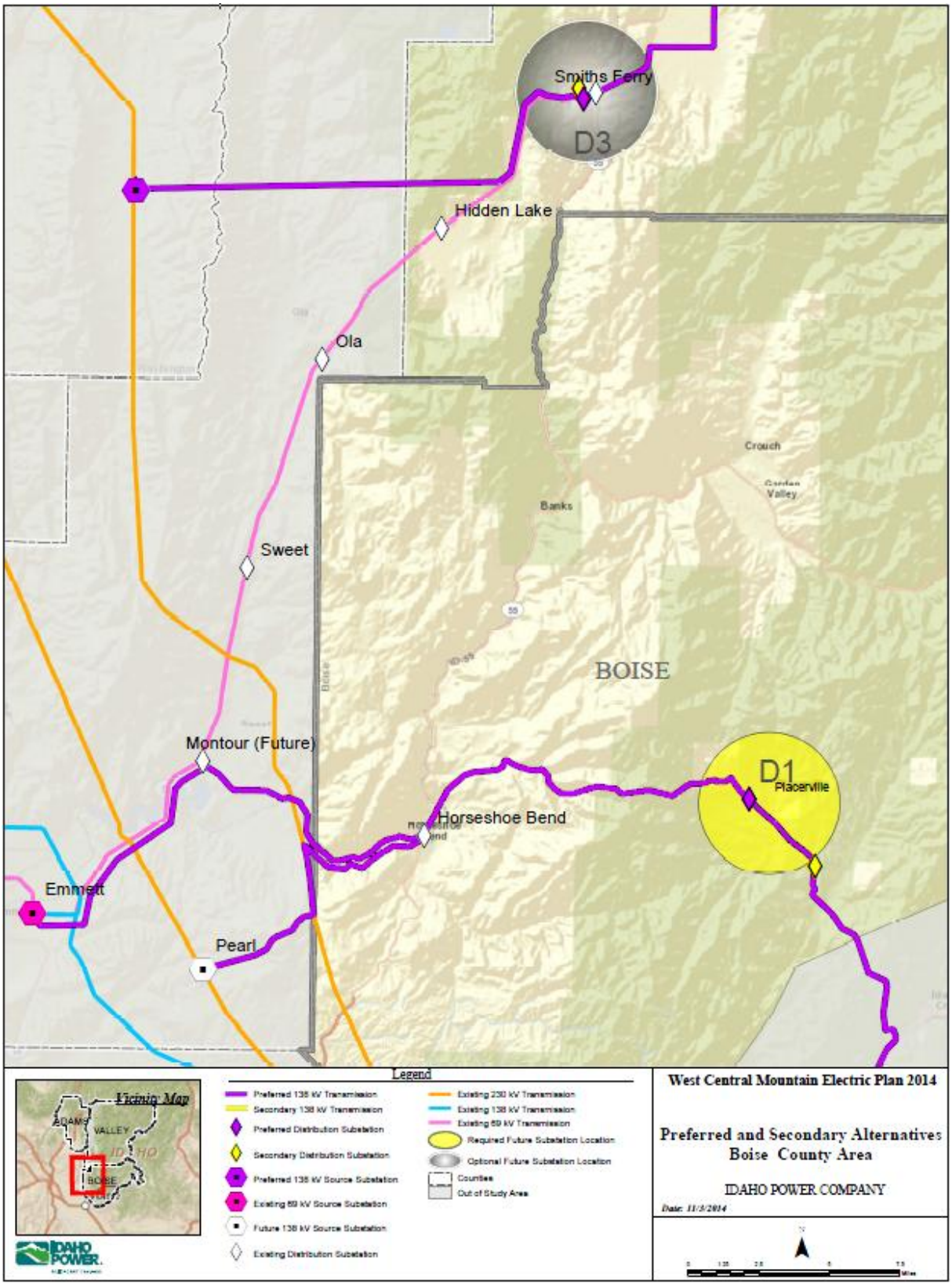

Figure 3
Preferred and secondary alternatives, Boise County area

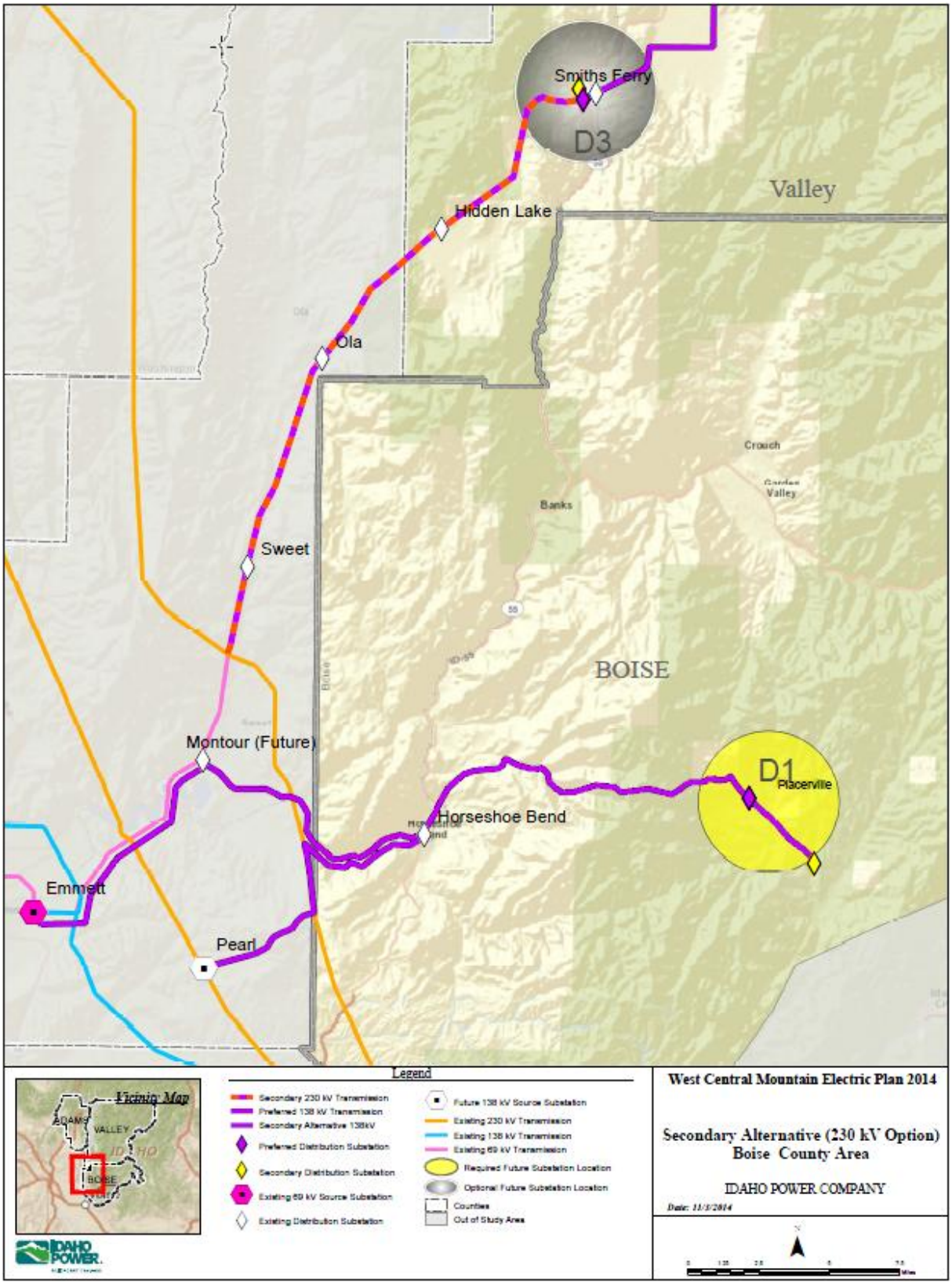

Figure 4
Secondary alternative (230-kV option), Boise County area

Not all facilities proposed by the Committee will be needed in the near term; facilities will be phased in based on load growth, reliability, system capacity, available budget, and Committee recommendations. If all or some parts of the preferred alternatives become unbuildable or unfeasible because of future constraints, the Committee identified secondary alternatives. Idaho Power will pursue the secondary alternatives as necessary to meet future electrical service requirements. Additionally, Idaho Power will make every effort to honor the Committee's *Guiding Principles and Community Criteria* when siting new infrastructure. Details for the preferred and secondary options are found in the body of this report in the Committee's Preferred Alternative section.

The Plan is conceptual and is the first step in planning for new and upgraded transmission lines and substations. Individual projects resulting from this plan will still require jurisdictional approval and will be subject to the public siting process. Before Idaho Power does any siting or places infrastructure, open houses and community meetings (for projects with significant local impact) may be held to provide information and gather input on specific proposed projects. Substations and transmission lines associated with this plan are subject to change due to land availability, jurisdictional objections, or other needs discovered during the project development phase. However, this first step will give the jurisdictions and citizens advance notice as to where high-voltage transmission facilities may be located and will allow the jurisdictions and citizens to plan accordingly. It is also Idaho Power's request that this plan be incorporated into jurisdictional comprehensive plans.

In preparing the Plan, Idaho Power has accounted for the anticipated effect energy efficiency will have on future electrical load in the West Central Mountains. Idaho Power is committed to reducing electrical load through the use of energy efficiency at all customer levels. Continued evaluation of energy efficiency, building standards, and distributed generation will influence when and which infrastructure changes will be required to meet customer loads in a safe and reliable manner. Appendix B of this report discusses the various energy efficiency programs offered by Idaho Power.

Future changes in technology may make some of these improvements unnecessary or delay their need. These types of shifts, however, are difficult to predict. Idaho Power will monitor these potential shifts, recognizing that external forces can force change. The Plan is flexible and will be maintained and kept viable through continued public involvement.

Idaho Power sincerely thanks every member of the Committee. The time and effort the Committee gave to this project will enable Idaho Power to go forward with plans to serve the West Central Mountains and gain public acceptance of the specific pieces that must, through further public collaboration, be put in place to make this plan a reality. This Plan is a result of the Committee's efforts and will serve as the basis for further studies to refine, stage, and request permitting for future infrastructure improvements in the West Central Mountains.

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INTRODUCTION

The West Central Mountains, as defined in this Plan, is the Idaho Power service area contained within Adams, Valley, and Boise counties. The Idaho Power electrical facilities serving these counties are part of an interconnected system that relies on a diversity of sources to provide a reliable source of electricity. This diversity comes from multiple generation resources, multiple substations, and redundant transmission lines that deliver power from the generators and between the substations.

Growth is increasing, with commercial building leading the way. Along with a renewed growth, the West Central Mountains is becoming more dependent on a reliable electric supply. It is important that the electrical system keeps pace with growth and increasing reliability demands and supports the growth this region depends on.

The electrical needs of the West Central Mountains can be described using two interrelated concepts: reliability and capacity.

- **Reliability**. If the power goes out, the inconvenience the outage causes increases every year. To maximize its reliability, an electrical system must be redundant—more than one transmission line must serve an area so if one line is damaged, the other can still provide electricity.

- **Capacity**. Capacity describes the maximum amount of power an electrical system can carry. An electrical system must have adequate capacity to serve the maximum electrical load, which, in the West Central Mountains, occurs in the winter. The maximum, or peak, electrical demand occurs when heating load is greatest and when the weather is cold. Today, Idaho Power's energy supply feeding into the West Central Mountains is adequate to serve the peak load. As load continues to grow, reinforcements and additions will be required to serve the increasing load.

To plan the future transmission and substation infrastructure for the West Central Mountains and ensure a reliable and adequate electrical supply, Idaho Power invited members of the West Central Mountains community to be involved in a community advisory committee (the Committee) to develop the Plan. The WCMEP outlines the electrical infrastructure needs of the area from today through the area's population and load buildout. The Committee included local elected officials, city and county planning representatives, commercial interests, Idaho Department of Fish and Game (IDFG) and Bureau of Land Management (BLM) representatives, economic development representatives, United States Forest Service (USFS) representatives, industrial representatives, and community members. (The inside cover of this report lists the complete roster of Committee members.) This report documents the study process and the Committee's consensus recommendations pertaining to the power system serving the West Central Mountains.

From 2005 through 2006, Idaho Power convened the Committee to site buildout facilities for the Treasure Valley and named the plan the *Treasure Valley Electrical Plan* (TVEP). The TVEP laid out 230-kilovolt (kV) and 500-kV substation locations and transmission line routes in Ada,

Canyon, and Owyhee counties in Idaho and Malheur County in Oregon. The TVEP did not consider 138-kV facilities.

From 2010 through 2011, Idaho Power convened another community advisory committee to site 138-kV and 230-kV facilities in the western part of the Treasure Valley (including Canyon, Gem, Owyhee, Payette, and Washington counties in Idaho and Malheur County in Oregon). The *Western Treasure Valley Electrical Plan* (WTVEP) used the TVEP 230-kV substation locations and transmission line routes as a starting point in planning their 230-kV source substation locations and transmission line routes. The WTVEP committee confirmed nearly all the locations sited in the TVEP.

In 2011 through 2012, Idaho Power convened a community advisory committee to site facilities in the eastern part of the Treasure Valley (including Ada, Elmore, and part of Owyhee counties). The *Eastern Treasure Valley Electrical Plan* (ETVEP) used the TVEP 230-kV substation locations and transmission line routes and the results of the WTVEP as a starting point in planning their 230-kV source substation locations and transmission line routes. Together, the ETVEP and the WTVEP form the basis of a Treasure Valley-encompassing plan that ties the power systems between the two plans together.

The West Central Mountains Electrical Plan used the Pearl Substation location that was a result of these plans (TVEP, WTVEP, and ETVEP) and proposed a 138-kV line that connects the proposed Placerville Substation with the existing Boise Bench Substation that will need to be reviewed by the ETVEP committee.

BACKGROUND

Existing Population and Electrical Load

Idaho Power currently serves a population of 20,269 in the three-county West Central Mountains area (2014 numbers).

The highest power demands in the West Central Mountains area occur in the winter, and the peak historic electrical load consumed by this population is 105 megawatts (MW). Therefore, all studies, projections, and requirements described in this plan are designed to meet the projected winter peak buildout demands. The population and electrical load (MW) breakdown by county is shown in Table 2.

Table 2
West Central Mountains population and electrical demand served by Idaho Power

County	2013 Population	Peak Winter Electrical Demand (MW)
Adams	3,938	22
Boise*	6,786	20
Valley	9,545	63
Total	**20,269**	**105**

* Not all portions of Boise County were included in this study. It is expected that the southernmost portions of Boise County will be served from Ada County at buildout. This study only considers areas that will likely not be served from facilities in Ada County.

West Central Mountains Growth

Electrical load growth calculations for the Plan were performed using a spatial load-forecasting approach. The spatial growth approach was based on the comprehensive plans and current zoning and land-use maps for the three counties (Adams, Boise, and Valley counties). Current zoning for the cities of Cascade, Council, Donnelly, Horseshoe Bend, McCall, and New Meadows were also used in the study. The projected timeframe for buildout used a population growth approach based on county economic development-growth projections developed by Moody's Economic and Consumer Credit Analytics (ECCA) forecast. Uniform growth rates were then applied.

Spatial Growth Approach

The spatial growth method involved accessing the jurisdictional comprehensive plans, reviewing the existing zoning laws, and assigning a load density in megawatts per square mile (MW/mi^2) to each zoning area. *Buildout* is defined as the point in time when all available land is developed according to the land-use ordinances. Modifications were made to existing land-use maps to better approximate the buildout of the three counties. These modifications were based on the following assumptions:

- Agriculture zones within any city area of impact will be developed into a mix of residential and commercial loads.
- Commercial development will concentrate along transportation corridors.
- Development occurs to the maximum allowed load density per zone. Complete fill-in is assumed.

Zoning load densities were estimated based on existing built-out areas in the Idaho Power service area. For residential zones, 2 to 10 kilowatts (kW) per lot were used to calculate residential load density, depending on the zoning. Table 3 shows the specific kW per dwelling (zones values) assigned to each.

Note: Zoning designations for single family residential differ between jurisdictions, and Idaho Power planners took these differences into account during the study process.

Table 3
Load density assignments for residential zoning

Zone	kW/lot
Large estate residential	10.0
Single family residential	4.5
Multi-family residential	2.0

Much of the land in the West Central Mountains area is publicly owned (mostly USFS), and it was assumed there would be no development on these publicly owned lands.

Multiplying the load density (MW/mi^2) for each zoning class by the total area associated with each zoning class (private land only) results in an estimate of the total load in MW for each zoning class. Designated wetlands and private land on steep slopes were determined undevelopable and were filtered out of the results. Finally, the total Idaho Power West Central Mountains buildout load was calculated by summing the total load for all the zoning classes. This approach resulted in a total buildout load of 550 MW. Table 4 details the projected buildout electric load by county. Appendix F contains the detailed load density numbers used in the calculations.

Table 4
Projected West Central Mountains electrical demand

County	Projected Buildout Electrical Demand (MW)
Adams	141
Boise*	109
Valley	300
Total MW	**550**

* Not all portions of Boise County were included in this study. It is expected that the southernmost portions of Boise County will be served from Ada County at buildout. This study considers all areas that will likely not be served from Ada County facilities.

Projected Buildout Timeframe

The projected buildout timeframe uses county population growth projection numbers from Moody's Analytics ECCA forecast. Historic and projected population growth rates are shown in Table 5. Population and electric load growth will continue throughout the West Central Mountains service area. It is expected that buildout growth will eventually be limited by the amount of private, buildable land. Therefore, it is assumed that for the near future, growth rates will be similar to the growth rate of the past 25 years. Over the long term, growth rates will gradually slow down as the amount of developable land and available water diminish. A conservative constant average annual growth rate of 0.45% was used to estimate the buildout population values.

Table 5
West Central Mountains population growth

County	Previous 10-Year Annual Population Growth Rate	Previous 25-Year Annual Population Growth Rate	Next 25-Year Annual Population Growth Rate	Growth Rate to Buildout Population
Adams	0.97%	0.527%	0.58%	0.085%
Boise*	0.15%	2.62%	-0.72%	0.147%
Valley	1.77%	1.35%	1.03%	0.207%
Total	**1.05%**	**1.56%**	**0.44%**	**0.44%**

* Not all portions of Boise County were included in this study. It is expected that the southernmost portions of Boise County will be served from Ada County at buildout. This study considers all areas that will likely not be served from Ada County facilities.

For the West Central Mountains area, the current average power demand is about 5.2 kW per person. As more irrigated farmland is developed into residential and commercial subdivisions, the total electric demand will increase, but the average electric demand per person will tend to decline. On the other hand, as large industrial users of electricity expand or move into the region, the average power use per person tends to increase. Therefore, assuming a relatively constant average power use per person in each of the three counties in the study area is reasonable. Using an average demand of 5.2 kW per person, the 550 MW projected buildout load would support a population of approximately 106,300 people. It is projected, using present and future growth rates, that the West Central Mountains will reach this population value in approximately 369 years (from 2013) in the year 2382. Table 6 shows projected buildout population and power use per person by county.

Table 6
West Central Mountains population by county, current and at buildout

County	2013 Population	2013 kW/person	Buildout Population
Adams	3,938	5.6	20,644
Boise	6,786	2.9	35,575
Valley	9,545	6.6	50,039
Total	**20,269**	**5.2**	**106,258**

Potential variations in the spatial growth approach could result from future zoning changes and developments at a lower density rather than at the maximum density allowed by the zoning laws. The population growth results will vary because of economic and political changes in the area and other potential limits, such as limited water, developable land, or transportation.
The Committee's work and this report assume a buildout power demand value of 550 MW in the West Central Mountains area.

Existing West Central Mountains Electrical Supply System

The power supplied to the West Central Mountains electrical system is provided primarily by high-voltage transmission lines connected to generation located outside the area. The generation facilities within the study area are located at the Cascade Reservoir, the Horseshoe Bend

Irrigation Canal, and the Tamarack Mill. The generation within the area also requires transmission to transport the electrical energy to the load.

Figure 5 shows existing transmission and substation facilities in the West Central Mountains. Idaho Power serves this area via transmission lines from three source stations: Emmett, Horse Flat, and Oxbow substations.

- Emmett Substation—Located in Emmett on the east side of the city, Emmett is served by two 138-kV transmission lines. One line connects Emmett to the Hells Canyon generation complex and the high-voltage transmission system. The other line connects to the Boise Bench Substation.

- Horse Flat Substation—Located about 5 miles northwest of Cambridge, the Horse Flat Substation is connected to the Hells Canyon generation complex and Boise Bench Substation on a 230-kV line.

- Oxbow Substation—This substation is part of the Hells Canyon generation complex.

Power flows through these three substations into the West Central Mountains area.

There are 18 existing distribution substations in the West Central Mountains area serving the 12.5-kV and 34.5-kV distribution lines feeding power to customers. Of these 18 substations, 5 are served from the 138-kV system and 13 are on the 69-kV system.

Existing System Reliability

Idaho Power strives to provide reliable, responsible, fair-priced energy services to its customers. Beyond Idaho Power's desire to provide reliable energy, it must also comply with regulations set forth by the North American Electric Reliability Corporation (NERC), which is tasked by the federal government with developing and enforcing reliability requirements.

The high-voltage transmission lines serving the West Central Mountains area must provide a high level of reliability and must adhere to N-1 reliability criteria for main grid transmission. This means that for multiple transmission lines delivering power to the same point, if one of the lines goes out of service, the remaining line or lines must be able to carry both the load they were carrying before the event as well as the load carried by the line that is out of service. See Appendix G for a more detailed explanation and example of the N-1 criteria.

The 69-kV system located within the West Central Mountains is not generally required to perform to the same federal standards as the main grid transmission. Idaho Power does, however, endeavor to maintain the system in a state that maximizes its reliability while keeping power rates reasonable for all customers. The non-radial 138-kV sub-transmission system in the West Central Mountains area provides redundant service to most of the substations connected to the 138-kV system; 69-kV systems tend to serve more remote, outlying areas and are not as redundant as the 138-kV system. The 69-kV system has capacity to serve all existing customers when all lines and stations are operating normally, even under peak load conditions. However,

if there is a failure of a 69-kV line that has no redundancy; customers will be without power until repairs can be made.

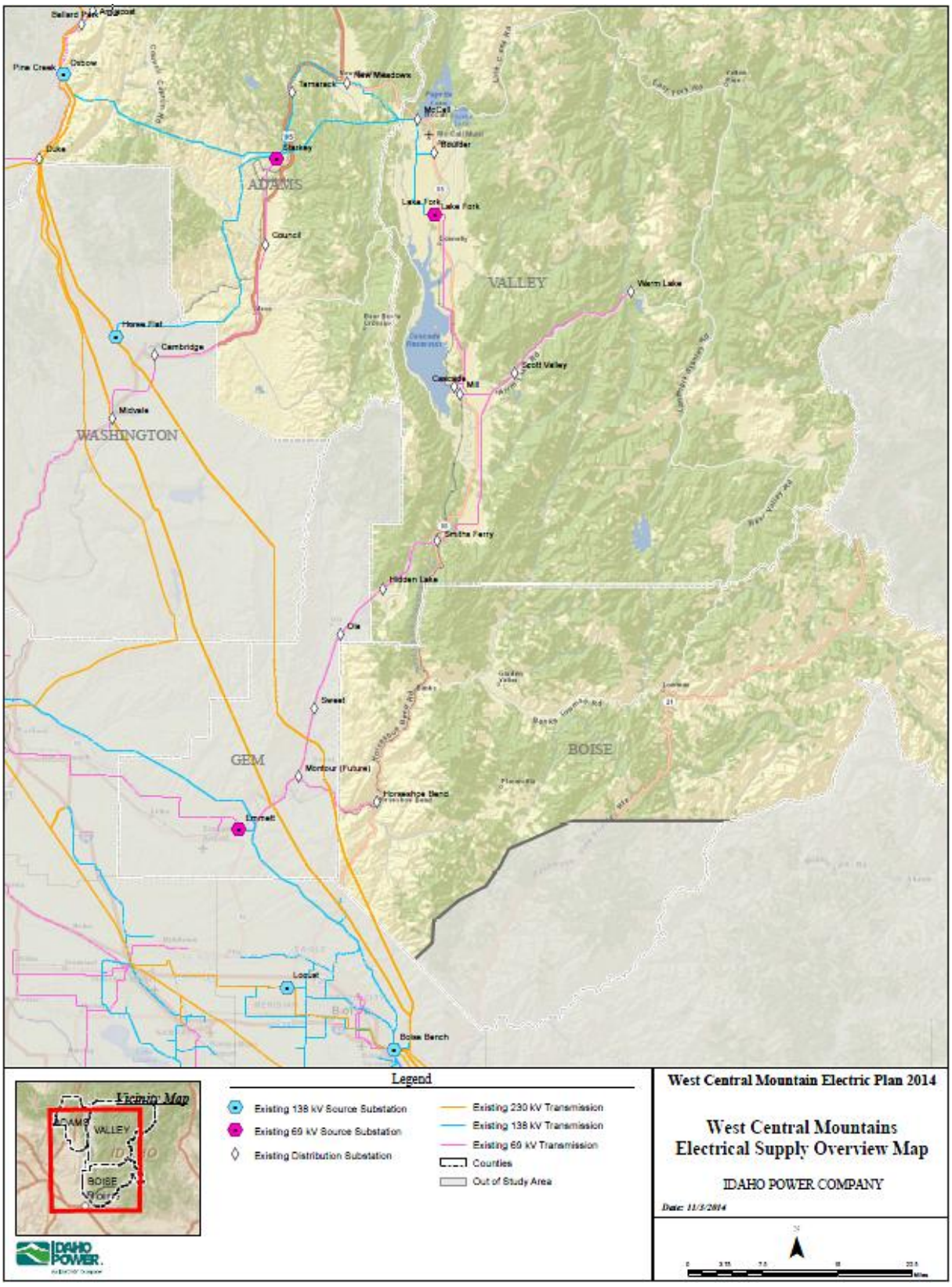

Figure 5
West Central Mountains electrical supply overview map

COMMITTEE PROCESS AND INPUT

Idaho Power engaged RBCI of Boise, a public process consulting firm, to facilitate the Community Advisory Committee meetings. The meetings began in August 2013 with a general education session, followed in September with a bus tour of generation and transmission facilities. The following two months were devoted to providing the Committee a good background on electrical power systems. Through these educational sessions, the Committee was introduced to the concepts of electrical power generation, transmission, substations, energy efficiency, and regulatory affairs. Additionally, the Committee was introduced to Idaho Power's electrical system from production to delivery. Using the information gained from the first four meetings, the Committee set out in March 2014 to determine siting criteria and lay out proposed 230-kV, 138-kV, and 69-kV substation locations and transmission line routes to serve the West Central Mountains through buildout.

- Meeting 1 (August 2013): The first meeting provided an orientation to the project; an education session concerning basic electrical concepts; and an overview of Idaho Power's electrical system, electrical power generation, transmission lines, and substations.

- Meeting 2 (September 2013): This full-day meeting consisted of tours of the Rapid River Fish Hatchery facility, located near Riggins, and the Cascade Power Plant hydrogenation facility, located just north of Cascade. Additionally, the Committee was shown the Lake Fork Substation north of Donnelly. While in transit between the electrical facilities, the Committee discussed the various electrical transmission lines and substations passed along the way.

- Meeting 3 (October 2013): Continuing the education series begun in Meeting 1, the Committee learned about Idaho Power's pricing and regulatory process as well as Idaho Power's energy efficiency programs. The Committee was also presented information concerning the existing population and electrical conditions in the West Central Mountains. A group discussion was held to begin creating a set of guiding principles and community criteria to be used in the future mapping sessions, after which the Committee separated into smaller groups to discuss specific Committee issues and concerns to further refine the guiding principles and community criteria.

- Meeting 4 (November 2013): During this session, the Committee reviewed and modified the draft list of the guiding principles and community criteria it began in Meeting 3. Idaho Power gave presentations concerning planning for the West Central Mountains electrical needs, the projected buildout of the area, and the transmission and substation components needed to meet the buildout needs.

- Meeting 5 (February 2014): After an orientation, the Committee separated into small groups to begin mapping alternatives for substation and transmission line placement in the West Central Mountains. The small groups ended the session by reporting to the entire Committee the alternatives they had begun to develop.

- Meeting 6 (March 2014): The Committee completed its small-group mapping exercises begun in Meeting 5. Once the mapping was complete, the individual groups reported their results to the full Committee.

- Meeting 7 (April 2014): Idaho Power provided technical feedback to the initial set of alternatives developed by the small-group mapping sessions in meetings 5 and 6. The Committee then began the process of identifying preferred and secondary alternatives for each substation and transmission line to be used in the buildout plan.

- Meeting 8 (May 2014): Continuing the process begun in Meeting 7, the Committee further refined the list of preferred and secondary alternatives. A list of preferred alternatives for all areas was developed and finalized.

- Meeting 9 (August 2014): The Committee convened for a final meeting to present the draft plan developed by Idaho Power and to give the Committee an opportunity to make changes to the report. The Committee and Idaho Power discussed how to implement the Plan, as well as how to integrate the Plan into jurisdictional comprehensive plans.

Alternative Energy Generating Technologies

During the generation education session in August 2013, the Committee received information regarding alternative generation technologies. This presentation, and the discussion that followed, outlined various alternative energy generating technologies that could be used to meet the energy needs of the West Central Mountains or to reduce the need for future transmission lines. The technologies discussed included wind turbines, solar (photovoltaic and thermal), geothermal generators, combustion turbines, and fuel cells. A more detailed description and discussion concerning alternative energy generating technologies can be found in Appendix A.

Idaho Power currently purchases the output of many alternative energy generators in its service area. The amount of energy produced by renewable resources and delivered to the Idaho Power system is rapidly increasing. Idaho Power currently contracts for the entire output of wind generation projects in Idaho near Hagerman and Mountain Home, as well as wind generation projects in northeastern Oregon near North Powder. The output of the Raft River geothermal project in eastern Idaho is purchased by Idaho Power, as is the output from the Neil Hot Springs geothermal project near Vale, Oregon. Additionally, new wind turbine facilities are being brought on-line near Hagerman and Burley, with more planned in other areas in the next few years.

Some large-scale solar generation projects are also planned in the Idaho Power service area in the next few years. Two methane digester generation projects at large dairies in the Magic Valley are currently operating, and several more digesters are planned at other large dairies and feedlots in the region.

Idaho Power, in a joint venture with PacifiCorp, is planning to build 500-kV transmission lines into Idaho from Wyoming that will enable the wind resources in Wyoming to be developed and transported to the region. Additionally, the Boardman to Hemingway 500-kV transmission line will transport energy into Idaho Power’s service area, much of which will be produced by wind

turbines along the Columbia River. All of the above technologies will still require more transmission lines and substations to be built in the West Central Mountains to deliver the energy within the area.

Distributed Generation

Small-scale solar (roof-mounted photovoltaic), small wind turbines, and residential-sized fuel cells could reduce the need for, or serve as an alternative to, new transmission and substation facilities in the West Central Mountains. In this respect, these technologies could be referred to as distributed generation because they distribute the generation so it is nearer to the load and reduce the need for more transmission. Idaho Power has a net metering tariff (Schedule 84) in place that allows residential customers to connect a small generator, up to 25 kW (commercial customers up to 100 kW), to the customer side of the meter that can serve to reduce the customer's metered energy use and can even result in credits back to the customer if the generated energy exceeds the energy used. Dozens of small-scale wind and photovoltaic projects at homes and businesses are currently operating under this tariff. Continued growth in the numbers of these systems could reduce or delay the need for additional transmission lines and substations.

Energy Efficiency

The implementation of energy efficiency technologies in the West Central Mountains could reduce or delay the need for additional transmission. Idaho Power is currently providing many programs to promote energy efficiency and reduce electricity usage. These programs are funded by a Customer Conservation Charge added to customer bills. The number and scope of these programs continues to grow. For example, in 2012, the Idaho Power system-wide energy savings from energy efficiency was over 170,000 megawatt-hours (MWh) compared to under 20,000 MWh in 2002—almost a nine-fold increase. Energy efficiency programs from both the existing portfolio and new program opportunities included in the *2013 Integrated Resource Plan* (IRP) are forecasted to reduce average load by 234 MW by 2032.

Demand response is a subcategory of energy efficiency designed to reduce the peak demand on the power system during summer peak hours. Examples of demand response programs include the residential A/C Cool Credit program and the agricultural Irrigation Peak Rewards program. In 2012, Idaho Power's demand response programs reduced peak-hour load by 437.6 MW. Table 7 shows the current Idaho Power programs. A complete description of the various energy efficiency programs offered by Idaho Power can be found in Appendix B.

Table 7
Idaho Power energy efficiency programs

Residential	Commercial/Industrial/Irrigation
A/C Cool Credit	Irrigation Efficiency Rewards
Ductless Heat Pump Pilot	Irrigation Peak Rewards
Energy Efficiency Lighting	Building Efficiency
Energy House Calls	Custom Efficiency (complex projects)
ENERGY STAR® Homes Northwest	Easy Upgrades (simple retrofits)
Heating and Cooling Efficiency Program	FlexPeak Management
Home Energy Audit	Commercial Education Initiative
Home Improvement Program	Green Power
Home Products Program	Net Metering
Rebate Advantage	
See ya later, refrigerator®	
Weatherization Solutions for Eligible Customers	
Green Power	
Net Metering	
Residential Education Initiative	
Kill A Watt™ Meters	

Additionally, Idaho Power has rates that vary by season in Idaho, with summer electricity rates being higher than winter rates to encourage lower energy use in the summer when the overall electricity usage on the Idaho Power system is greatest. In both Idaho and Oregon, Idaho Power has tiered rates that increase as energy use increases.

Idaho Power is now offering a Time of Day rate plan (on a limited basis) that encourages, through price incentives, customers to use less energy during peak times, such as afternoon and early evening.

Transmission Characteristics

The Committee was provided construction cost estimates for the various types of transmission lines, by voltage, that are typical to the Idaho Power system. Table 8 shows these costs. Note that the right-of-way (ROW) widths shown in Table 8 are for total ROW requirements, not width from center line. The transmission line cost on a per-mile basis does not include costs for ROWs.

Table 8
Estimated overhead transmission costs for various voltage levels

Voltage	Type	$/mi	ROW (ft)
230 kV	Overhead	1,000k	120
138 kV	Overhead, Single Circuit	500k	100
138 kV	Overhead, Double Circuit	700k	120

Underground transmission characteristics were also discussed. Costs for underground 138-kV transmission lines are generally 10 times the costs of overhead 138-kV transmission lines. While Idaho Power does have an extensive underground distribution system, it has no underground transmission within its service area. Idaho Power uses the most cost-effective method for transmission construction, and should any entity desire a transmission line be underground, they will be required to pay the difference between the overhead line costs and underground line costs. This practice is supported by the Idaho Public Utilities Commission (IPUC).

Figure 6 shows a comparison of various typical transmission tower and distribution pole heights used by Idaho Power. These heights are representative of various tower and pole designs but do not include all possible designs. Using different designs, the towers and poles can be shorter or taller than shown. Additionally, if a tower or a pole is placed in hilly terrain, it will sometimes be taller than shown to ensure adequate ground clearance for the lines. For example, a 500-kV transmission tower might go as high as 190 feet if it is located in hilly or mountainous terrain.

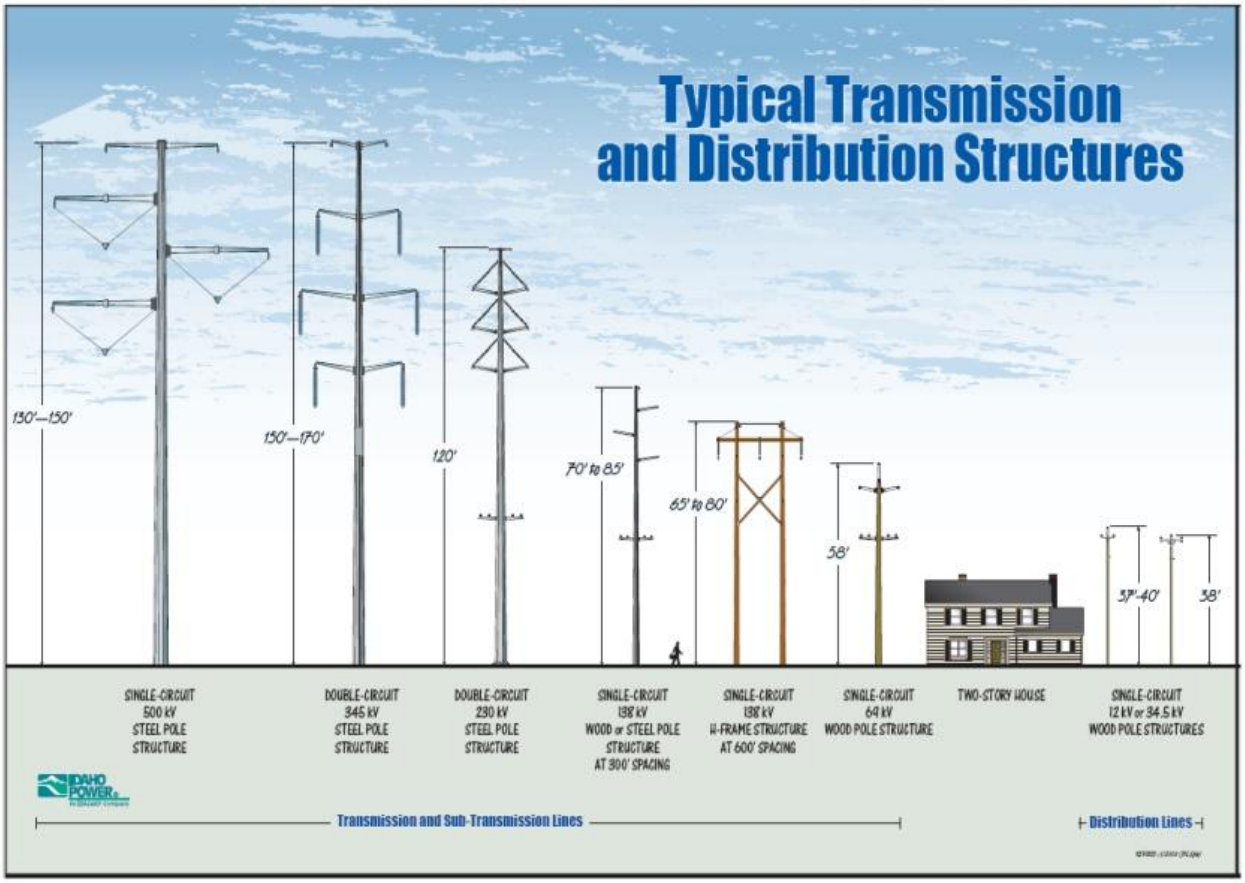

Figure 6
Typical transmission and distribution structures

Substation Characteristics

In addition to transmission characteristics, the Committee was presented information concerning distribution substations and source substations. A distribution substation is a relatively small substation located near the electrical load it serves that transforms (reduces) sub-transmission voltages to distribution voltages. In the West Central Mountains, the sub-transmission voltage is either 138 kV or 69 kV, and the distribution voltage is either 34.5 kV or 12.47 kV. A 138-kV source substation acts as the supply point for the 138-kV sub-transmission system. Power arrives at a 138-kV source substation at 230 kV and is stepped down by transformers to 69 kV or 138 kV. Table 9 shows a comparison of distribution and 138-kV source substation characteristics.

Table 9
Substation characteristics

Characteristic	138-kV Source Substation	Distribution Substation
Supply voltage	230 kV	69 kV or 138 kV
Land required	5 to 10 acres	2 to 3 acres
Load served	400 to 600 MW	40 to 80 MW
Cost	$7M to $10M	$2.5M to $4M

Guiding Principles and Community Criteria

As a first step in determining the feasibility of individual transmission line routes and substation locations, the Committee members created a *Guiding Principles and Community Criteria* document that set forth various measureable and non-measureable principles to guide their choices for the alternatives they would develop.

- Guiding principles are key themes that serve as a foundation for making decisions concerning the West Central Mountains electrical system.

- Community criteria were used more specifically for locating transmission lines and substations by providing land-use characteristics that are either more favorable or less favorable to electrical infrastructure siting.

The effort to define guiding principles and community criteria began in October 2013, when the Committee separated into small groups facilitated by RBCI to discuss issues important to Committee members when planning to meet the West Central Mountains' future energy needs. The small groups were asked to discuss the following questions:

- What are the principles important to you when siting future transmission lines and substations?

- Where should future transmission lines and substations be sited in your community?

- Are there areas in your community to avoid when siting future transmission lines and substations?

The issues recorded during the small groups' discussions were refined and synthesized by RBCI staff and formatted to fit into the *Guiding Principles and Community Criteria* format. The Committee used *Guiding Principles and Community Criteria* when they developed the proposed siting alternatives. The *Guiding Principles and Community Criteria* represent the Committee's instructions and desires for Idaho Power in implementing the Plan and serving the communities in the West Central Mountains.

If the Committee's preferred substation and transmission line locations as shown in the Committee's Preferred Alternatives section of this report cannot be obtained, Idaho Power will

use the Committee's *Guiding Principles and Community Criteria* for siting transmission lines and substations in the West Central Mountains.

The final guiding principles are divided into seven categories (listed in no particular order):

- Promote economic development.
    - Support and sustain economic development.
    - Incorporate the *Valley County Economic Development Plan* in planning efforts.
    - Support existing businesses, property rights, and land uses (e.g., historic sites, industries).
    - Consider how future infrastructure could adversely affect high-value resources, recreational sites, or other facilities.
    - Respect private property (i.e., some property owners may want transmission lines on their land, but others may not).
    - Avoid the use of eminent domain on private land.
- Work with local jurisdictions.
    - Comply with federal and local land-use plans and ordinances.
    - Coordinate with federal, state, and local planning activities.
- Be aware of environmentally sensitive areas.
    - Protect the environment and preserve open space, viewsheds, and wildlife.
- Consider community character.
    - As infrastructure is built, ensure substations and transmission lines fit into the local environment.
- Continue to meet power needs and prepare for future unknowns.
    - Ensure electrical infrastructure has the ability to meet current and future needs of the area.
    - Support localized generation and promote the possibility of self-sustaining electrical generation in Valley County.
    - Improve reliability and redundancy of the West Central Mountains electrical system.
    - Integrate the Plan with the whole Northwest grid system.

    - Make transmission lines and substations accessible for repair and maintenance (especially in winter).

- Be as efficient as possible.

    - Upgrade existing electrical infrastructure when possible.

    - Collocate with other utilities when feasible.

The community criteria were divided into two lists that provide guidance for the specific placement of substations and transmission lines. The first list shows areas that can be deemed favorable to electrical infrastructure placement (Table 10); the second list includes areas that should be avoided (Table 11).

Table 10
Areas where future infrastructure should be sited

Existing energy/power corridors (with the exception of existing subdivisions)	Consolidated along one side of travel corridors, Forest Service/fire roads, county roads, and state highway ROWs not within a designated Scenic Byway
Industrial areas	Near areas where future development is planned
Near like land use	Lots at intersections, except in very visible areas (for substations)
In appropriate railroad ROW (i.e., not in Rails-to-Trails)	Set back far enough away from roadways to not pose a safety hazard and to leave room for future widening and growth
Industrial corridors	Previously developed areas (e.g., old ROWs and easements)

Table 11
Areas to avoid when siting future infrastructure

Waterways (rivers/lakes/springs)	Ridgelines
Viewsheds from the valley floor	Aesthetic areas near private land
Residential areas	Designated Scenic Byways and corridors in Boise, Valley, and Adams counties
Parks	Natural scenery
Recreation areas (winter and summer)	Close to lakefronts
Sensitive wildlife areas and corridors	Boat fronts
Schools	Land under cultivation (includes both pasture and farmland)
Minimize river crossings	Irrigation canals
Riparian conservation areas	Wetlands
Airport zones	

Mapping Exercise

Building on the information provided in the first four Committee meetings, and using the *Guiding Principles and Community Criteria* document as a guide, the Committee was divided into three smaller teams at the November meeting to map out recommended substation sites and transmission line routes. The teams were given large aerial maps on which to place stickers (representing substations) and colored tape (representing transmission lines). Each team had access to computer-generated Geographic Information System (GIS) maps projected on screens to provide geographical details.

The GIS data included the following:

- Facilities—Idaho Power facilities located in the West Central Mountains.
- Environmental—Habitat information on plants and animals plus land-use information, such as agricultural land.
- Base Layers—Data included cities, roads, railroads, and general land ownership.
- Zoning—Data included zoning designations from each major jurisdiction.
- Aerial—Data included aerial imagery of the entire region.

A complete list of the GIS data provided for the Committee use can be found in Appendix C.

Idaho Power identified potential deficiencies in the electrical infrastructure required to meet the West Central Mountains' buildout needs. The region was divided into three areas; Boise County area, Valley County area, and Adams County area. To be able to deliver power to customers, the Committee was asked to locate at least three new distribution substations as well as the accompanying interconnecting transmission lines. The following details concerning substations were provided:

- 138-kV source substation
  - Requires 5 to 10 acres of land
  - Serves 400 to 600 MW of load from each source substation
  - Costs between $7M and $10M to construct
  - Requires a minimum of two high-voltage lines (230 kV)

  Note: Sub-transmission line(s) (138 kV) will feed out of each 138-kV source substation to deliver power to distribution substations.

- Distribution substation
  - Requires 2 to 3 acres of land.

- Serves 40 to 80 MW of load from each distribution substation.
- Costs between $2.5M and $4M to construct.

Note: Generally, distribution substations are placed near the center of their assigned service area to improve the efficiency of the distribution system coming out of the substation.

To help show where the load growth is expected to occur, maps were provided showing the electric load densities in the West Central Mountains. Figure 7 shows the current electric load densities for the West Central Mountains (winter 2012–2013). The higher load densities are found in and around the cities, as shown by the darker coloring. The total existing West Central Mountains load was 105 MW for the winter of 2012 through 2013, with most of the load located in the darker areas around the cities. Figure 8 shows the corresponding load density map for buildout and shows how the total expected 550 MW buildout load would be distributed throughout the area. While load growth is expected throughout the West Central Mountains, a quick comparison of these maps shows that the bulk of the load growth will still be near the cities. These maps begin to indicate to the Committee where they need to site new substations and corresponding transmission lines.

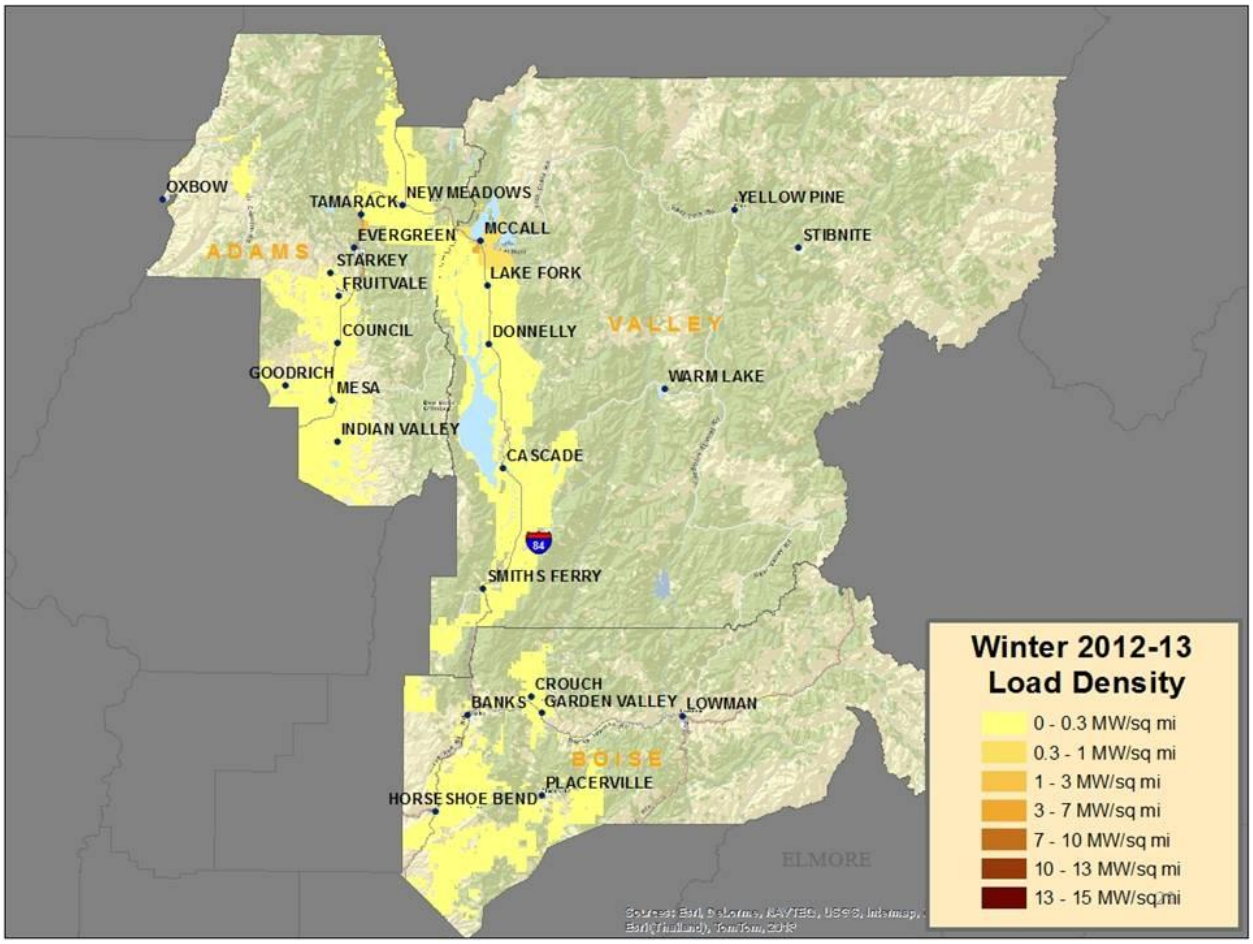

Figure 7
West Central Mountains current load densities—105 MW total winter peak

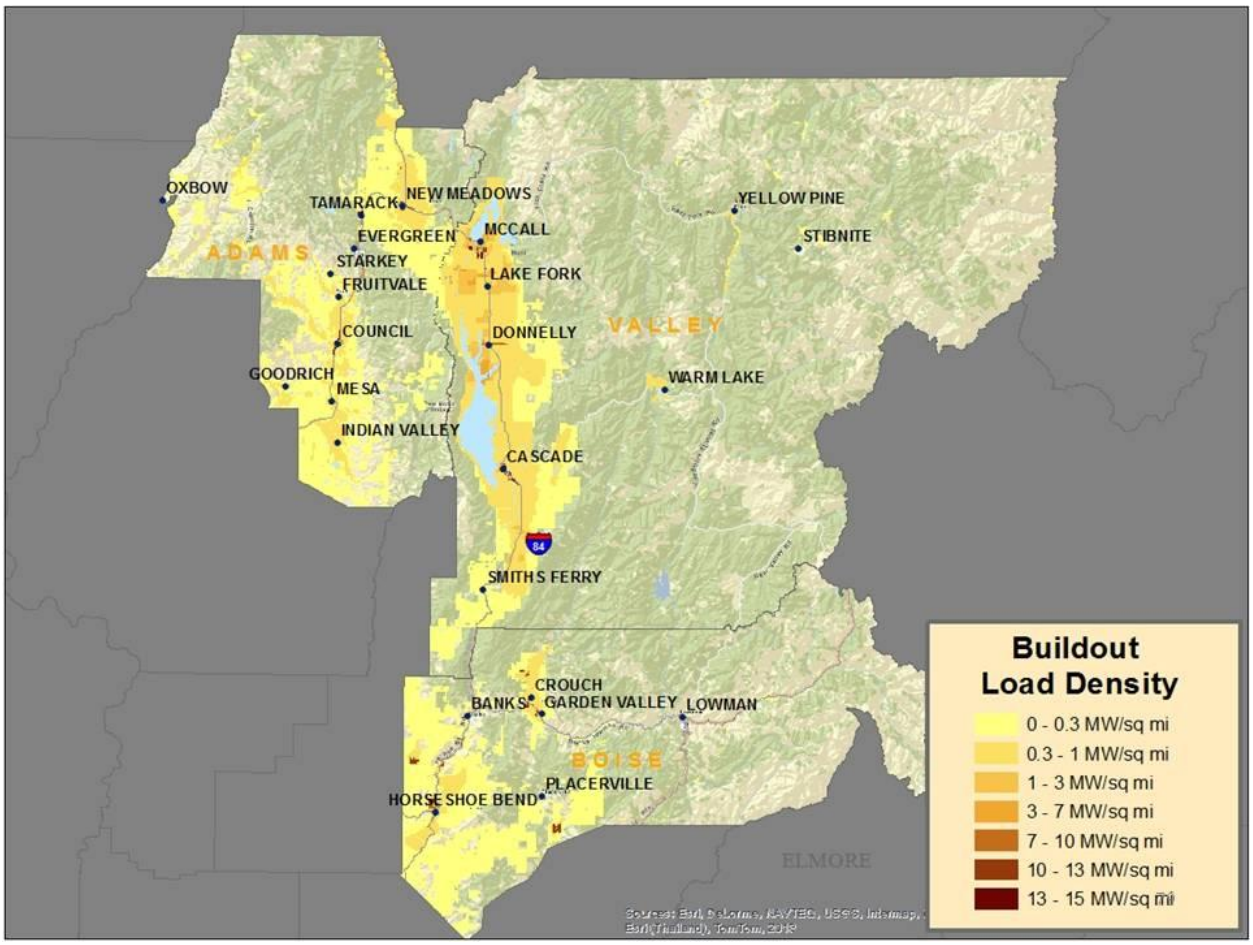

Figure 8
West Central Mountains buildout load densities—550 MW total winter peak

To prepare for the mapping sessions, the Committee needed to understand the size and location of the electrical load anticipated at buildout. They also needed to know where and how the existing electrical system would be deficient in serving the buildout load. This information helped the Committee determine the amount and general locations of new and/or upgraded electrical infrastructure. It was then the Committee's responsibility to specifically determine new substation locations and transmission line routes. They were asked to specify which of the existing electrical facilities would be upgraded to accommodate the buildout demand.

In general, each of the small mapping teams followed a four-step process in designing their buildout system options.

1. Site two distribution substations in the required future substation areas.
    a. Indian Valley
    b. Placerville

2. Site between one and four substations in the optional future substation areas.
    a. Alpha
    b. Smith's Ferry
    c. Day Star
    d. Scott Valley
3. Determine sub-transmission line routes (69 kV or 138 kV) to existing and new distribution substations.
4. Determine additional line routes to resolve capacity and reliability issues.

The first and second steps in the mapping process involved placing new distribution substations within the areas. Maps were provided to help the Committee understand where the existing distribution stations would be deficient in meeting buildout electrical demand. The West Central Mountains study area was divided into three areas for this discussion as shown in Figure 9. Maps for each area were provided, showing the existing capacity and buildout load requirements for each distribution substation. In areas where a new substation will be required at buildout, the expected buildout load requirement for the substation was also provided (see Figure 10). In this figure, yellow circles indicate Idaho Power-recommended general locations for distribution substations, and gray circles indicate optional future substation areas.

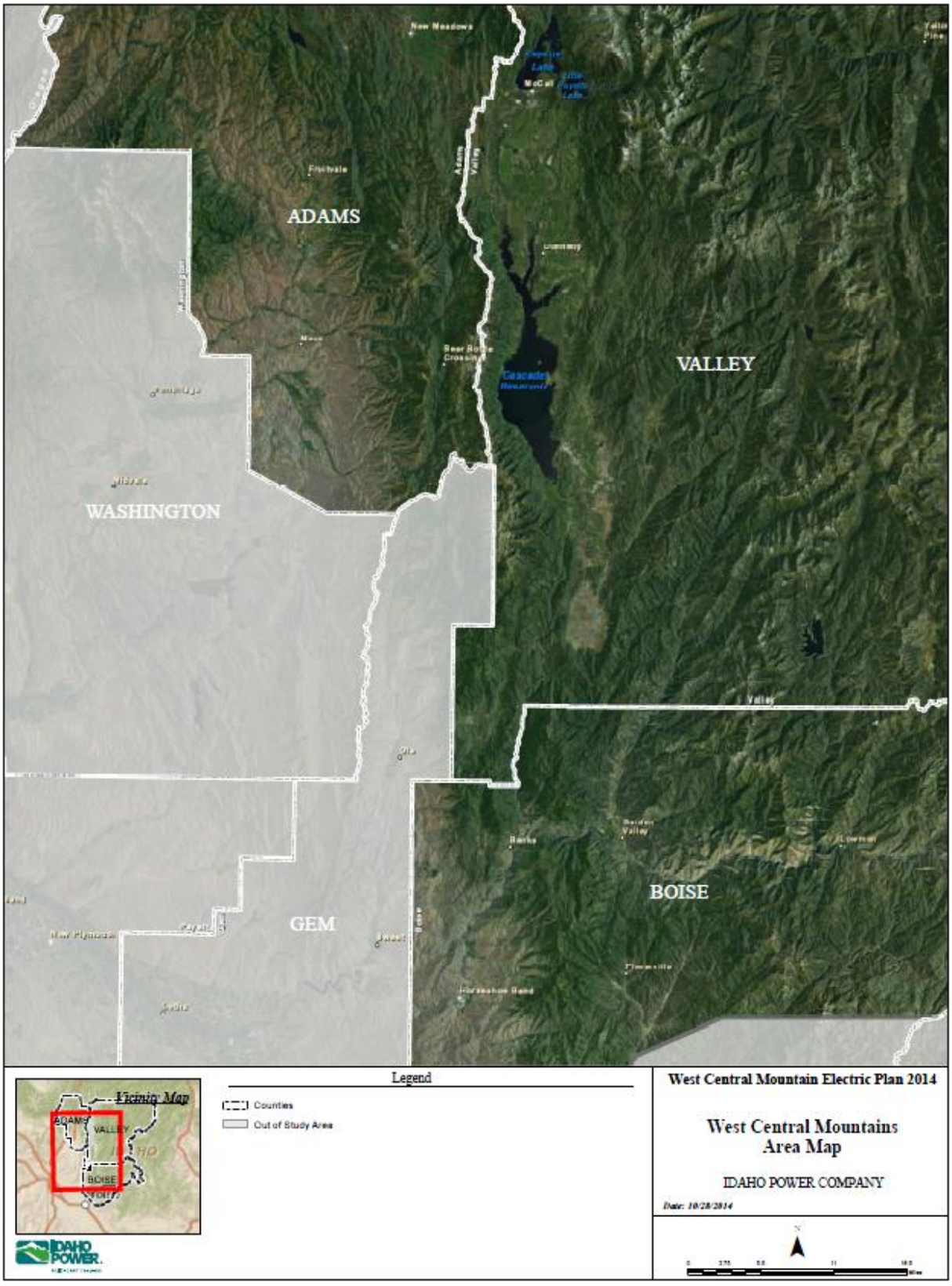

Figure 9
West Central Mountains area map

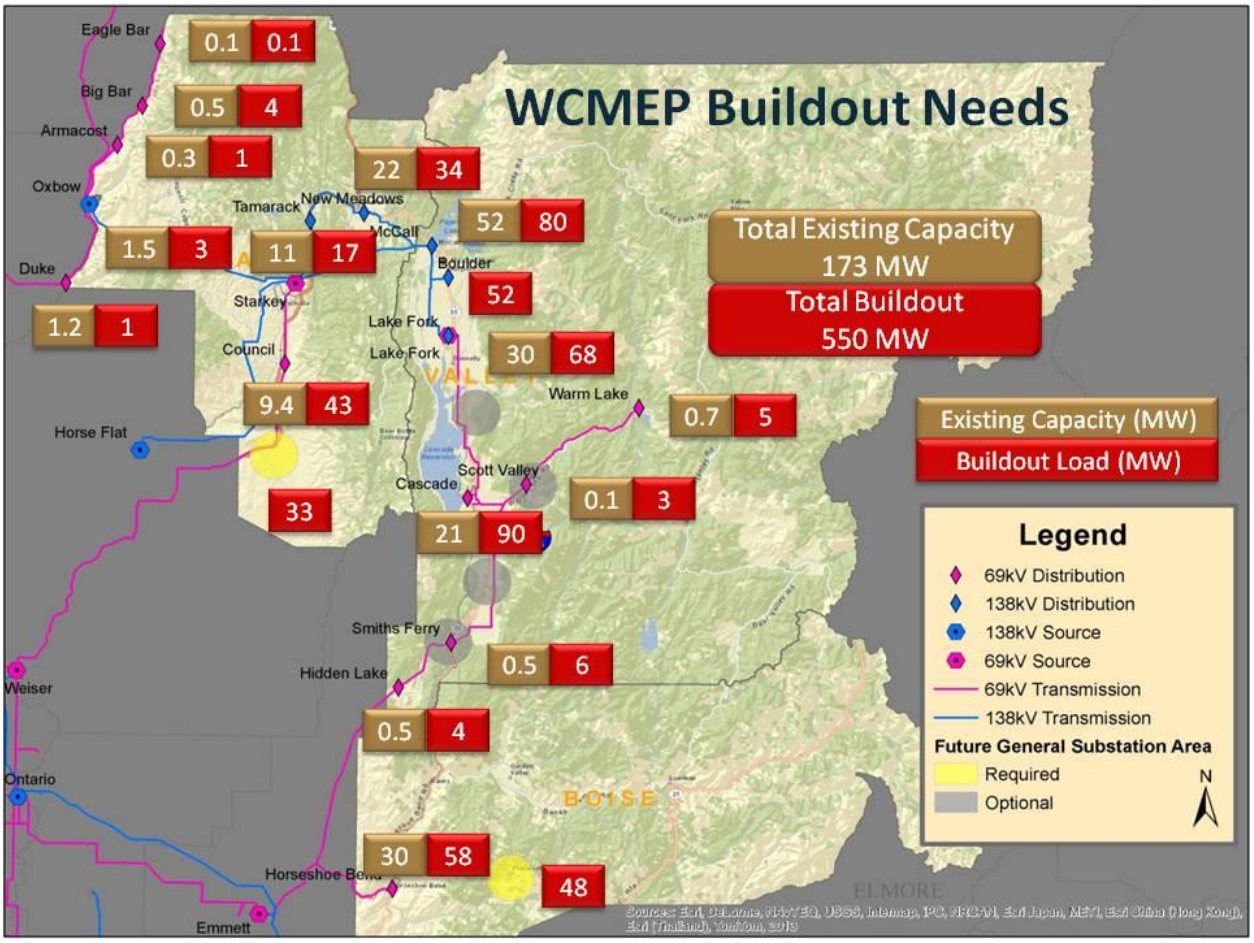

Figure 10
WCEMP buildout distribution substation requirements

The total existing distribution substation capacity in the West Central Mountains area is 173 MW. The total buildout distribution substation capacity needed at buildout is projected to be 550 MW.

The third mapping step was to site new or upgraded sub-transmission lines to connect the distribution substations to other distribution substations.

The fourth and final step for each team was to add lines to resolve capacity or reliability issues. The current 69-kV system cannot support the buildout loads. Additional infrastructure will need to be added to the system. Each team was tasked with determining a solution to this need.

Using the information provided in the August through November 2013 meetings as well as the goals developed in October and November 2013, the Committee began to lay out the proposed West Central Mountains transmission line routes and substation locations in November 2013. The Committee separated into three teams. Each team was given a large aerial photograph showing terrain, cities, and roads. Also included on the aerial map were yellow circles showing recommended distribution substation locations and gray circles showing optional distribution substation locations based on Idaho Power's estimated future electrical load locations.

The suggested substation location circles represented the buildout load centers that would need new distribution substations. The mapping teams were free to site new substations inside or outside the circles. They were encouraged to site the substations in areas that would best meet the local needs and conform to the *Guiding Principles and Community Criteria* developed in previous meetings.

In addition to the printed maps, each team was provided with GIS data projected on screens, along with Idaho Power GIS staff to operate the software and record the substation locations and transmission line routes developed by the team.

COMMITTEE SMALL GROUP MAPPING RESULTS

Using the *Guiding Principles and Community Criteria* document as a guide, each group developed feasible alternatives to meet the area's buildout requirements. The following guidelines were used to form the small groups:

- Groups (teams) were designated by color—Red, Yellow and Green—for alternative discussion and identification purposes.
- Each team included Committee members from throughout the planning area.
- Each team included an Idaho Power planning engineer to provide technical support and a facilitator to capture the details for each of the alternatives.
- Each team included an Idaho Power GIS operator, computer, and computer projector to project the GIS mapping representations on screens.

After the mapping teams completed their work, Idaho Power engineers evaluated each alternative to ensure it worked electrically and met reliability standards. Power flow analysis was performed using PowerWorld Simulator software, which is one of the standard software packages Idaho Power uses to perform planning and design of its transmission network.

The power flow analysis found each team's alternative contained some minor deficiencies or incorrect assumptions, so Idaho Power's engineers made some adjustments to each alternative so it would perform to Idaho Power standards. This is to be expected with a system as large as the West Central Mountains. Idaho Power engineers normally perform many iterations of analysis before an optimum design or configuration is found. The adjustments and assumptions made to each alternative were presented to the Committee at the April 2014 meeting for its information and concurrence. In all cases, the Committee agreed to these changes.

The following descriptions and maps show each team's alternative as it was developed in the small-group mapping sessions and also include the changes made by Idaho Power engineers as a result of the power flow analysis. For clarity, the mapping results are separated into three areas: Adams County area, Valley County area, and Boise County area. The individual alternatives are broken down further when necessary.

Red Team Mapping Results

The Red Team created a map showing the locations for one new 138-kV source substation. They also provided the locations for six new distribution substations, two with alternatives. The Red Team's Adams County area alternatives are shown in Figure 11, Valley County area alternatives in Figure 12, and Boise County area alternatives in Figure 13. The details are as follows.

Adams County Area

- 138-kV source substations
    - No new 138-kV source substations were identified in this area.
- 230-kV transmission lines
    - No new 230-kV transmission lines were included in the Red Team alternative.
- Distribution substations
    - D2 (Indian Valley)—Locate south of Mesa at the entrance to Indian Valley, off US Highway 95 (US 95). The following comments were made:
        - Locate the substation near an existing transmission line.
        - Locate the substation south of US 95 in unfarmed land.
        - Use the distribution line that connects to the substation.
- 138-kV transmission lines

Add a new 138-kV transmission line connecting Substation D2 (Indian Valley) to the existing 138-kV line that connects Horse Flat Substation with Starkey Substation. The route shown is a straight line, but the Red Team indicated to use the guiding principles and siting criteria when siting the line.

Valley County Area

- 138-kV source substations
    - No new 138-kV source substations were identified in this area, with the exception of the one detailed in the Boise County area.
- 230-kV transmission lines
    - No new 230-kV transmission lines were included in the Red Team alternative.

- Distribution substations
    - D4 (between Cascade and Lake Fork)—The group's preference is not to site this substation. However, the team did identify two locations as alternatives if the substation is needed. For both locations, the team indicated that deer and elk winter ranges should be considered. Do not locate the substation on the gravel pit because this is Valley County's only source of hard rock for building roads.
        - Alternative 1 is along the east side of Lake Cascade, along the existing 138-kV line and adjacent to Old Highway 55.
        - Alternative 2 is at the intersection of Loomis Lane and Idaho Highway 55 (Idaho 55).
    - D6 (Scott Valley)—Located west of Warm Lake Highway and east of the existing Scott Valley Substation.
        - Building a substation in this area will serve future load near Horsethief Reservoir. If a substation is not built, a distribution line from Cascade should be added to serve load.
    - D7 (between Smith's Ferry and Cascade)—Located near Herrick Reservoir in an existing transmission corridor. The Red Team gave the following comments concerning the site:
        - Locate the substation along a road that can be maintained in the winter. The substation should be easily accessible, but out of view.
        - Avoid ground squirrel habitat.
        - Locate the substation near future development (i.e., new subdivisions, houses, etc.). This substation will serve potential residential development in the area.
        - Building this substation could eliminate the need to build substation D3 (Smith's Ferry).
- 138-kV transmission lines
    - Upgrade the existing 69-kV line between Emmett Substation and Lake Fork Substation to 138 kV to accommodate future growth. Consider habitat, nearby airports, private land, and viewsheds (reviewed in Boise County area as well).
    - Add a new 138-kV transmission line connecting Cascade Substation to Substation D6 (Scott Valley). The purpose of this transmission line is to increase reliability.

Boise County Area

- 138-kV source substations

  - New 138-kV source substation in Washington County located along the 230-kV Boise Bench to Brownlee line, approximately 16 miles west of Smith's Ferry, where the 230-kV line angles off to the northwest

- 230-kV transmission lines
  - No new 230-kV transmission lines were included in the Red Team alternative.

- Distribution substations
  - D1 (Placerville)—To the east of Centerville Road, about 2 miles north of Grimes Pass Road, southeast of Placerville. The goal was to be between the growing Placerville and Centerville communities. Building this substation will improve redundancy for the Garden Valley/Centerville area. Additional comments are as follows:
    - Locate substation next to an existing distribution line or ROW.
    - Locate substation close to an existing transmission line.
    - Locate substation away from the river corridor.
    - Location could be modified based on the final location of the connecting transmission line.
    - Do not change the transmission lines going in and out of the substation. The group is happy with how these transmission lines are sited on the map.
  - D3 (Smith's Ferry)—The group identified two alternative locations for this substation. The Red Team indicated that both alternatives should stay in consideration in case one is not supported by the community. They also stated that visual impact should be considered in this area. This substation will help provide power to the future Murray Creek subdivision.
    - Alternative 1 (preferred) is on the west side of river near old buildings by Cougar Mountain Lodge. This alternative is preferred because it is more accessible for maintenance.
    - Alternative 2 is on the east side of river, on or near the old dump site and near an existing transmission line. There is no direct road access to this site.

- 138-kV transmission lines
  - Upgrade the existing 69-kV line between Emmett Substation and Lake Fork Substation to 138 kV to accommodate future growth. Consider habitat, nearby airports, private land, and viewsheds.

- Upgrade the existing 69-kV line from Horseshoe Bend Substation to the line between Emmett Substation and Cascade Substation.

- Add a new 138-kV transmission line connecting substation D1 (Placerville) to Horseshoe Bend Substation. The route follows an existing distribution line east from Horseshoe Bend, then follows Centerville Road to the new substation location.

- Add a new 138-kV transmission line connecting the new 138-kV source substation with Substation D3 (Smith's Ferry). The purpose of this transmission line is to increase reliability. The location of the transmission line may be difficult to maintain in the winter, but since this line will improve redundancy, the rewards outweigh the risks. The Red Team specified that a new 138-kV line coming south from McCall to Cascade should not be considered. There would be too many negative impacts.

- Add a new 138-kV transmission line connecting Substation D3 (Smith's Ferry) with the line connecting Emmett and Cascade. This transmission line route was the shortest distance between the two points.

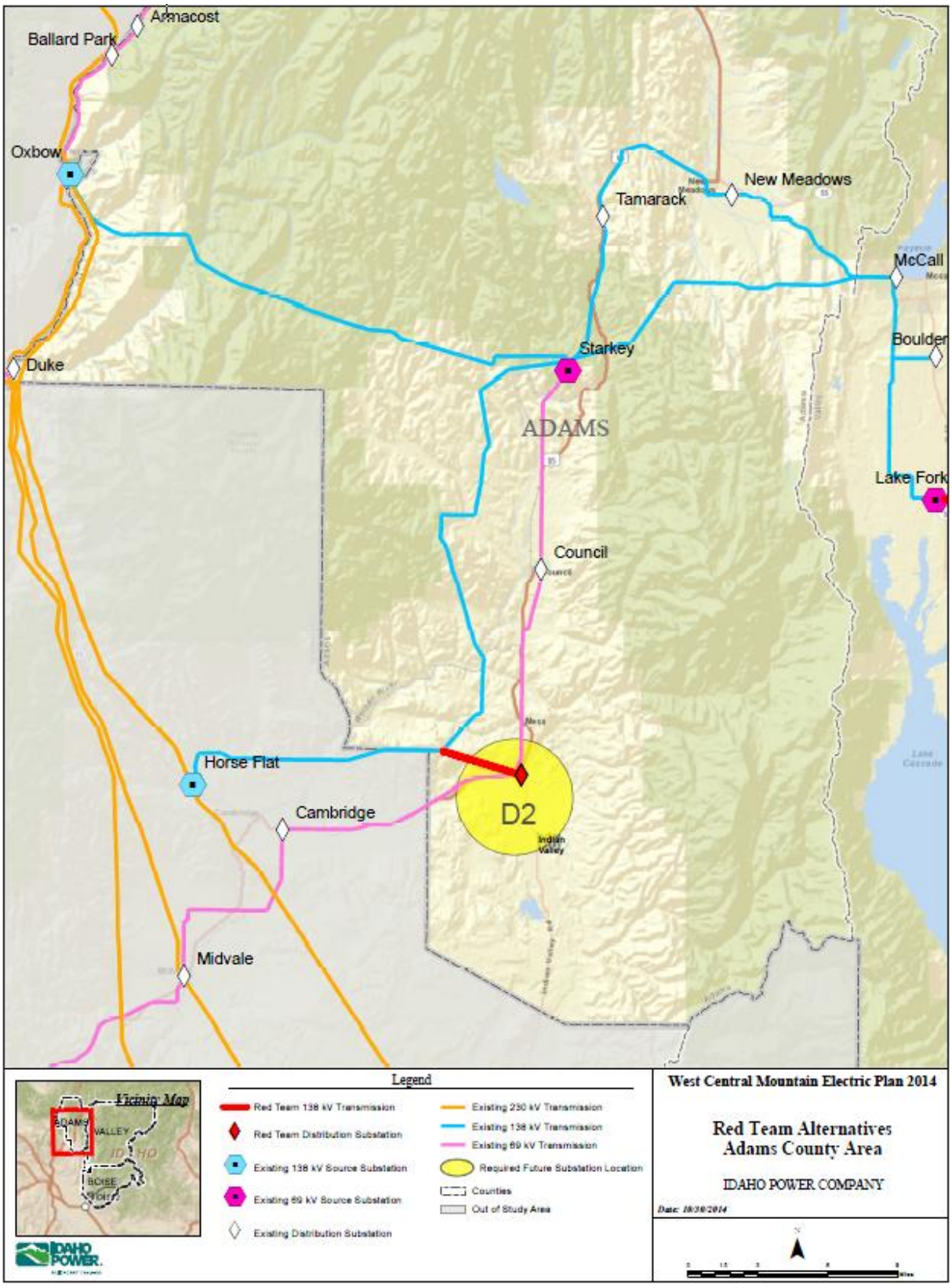

Figure 11
Red Team alternatives, Adams County area

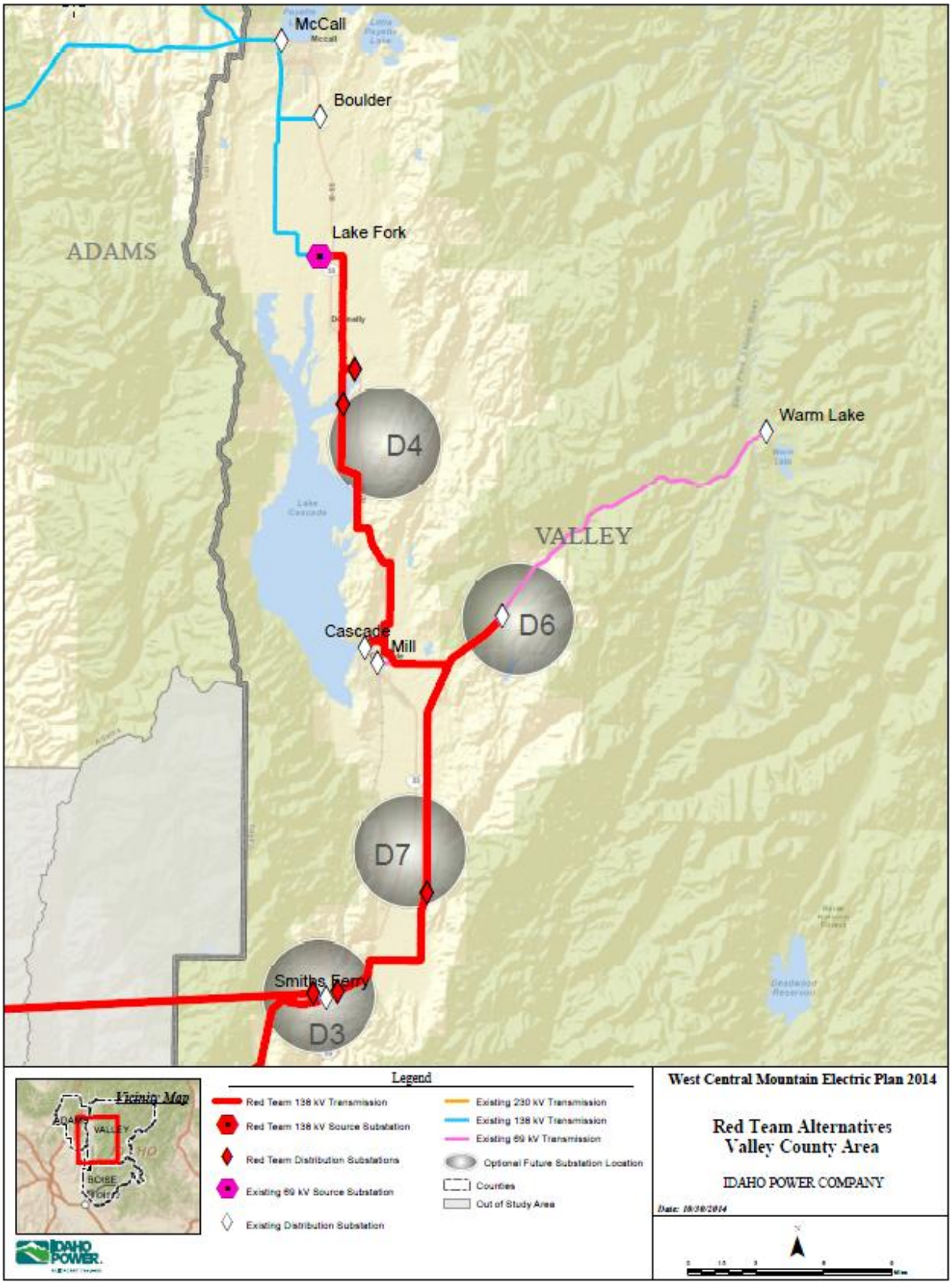

Figure 12
Red Team alternatives, Valley County area

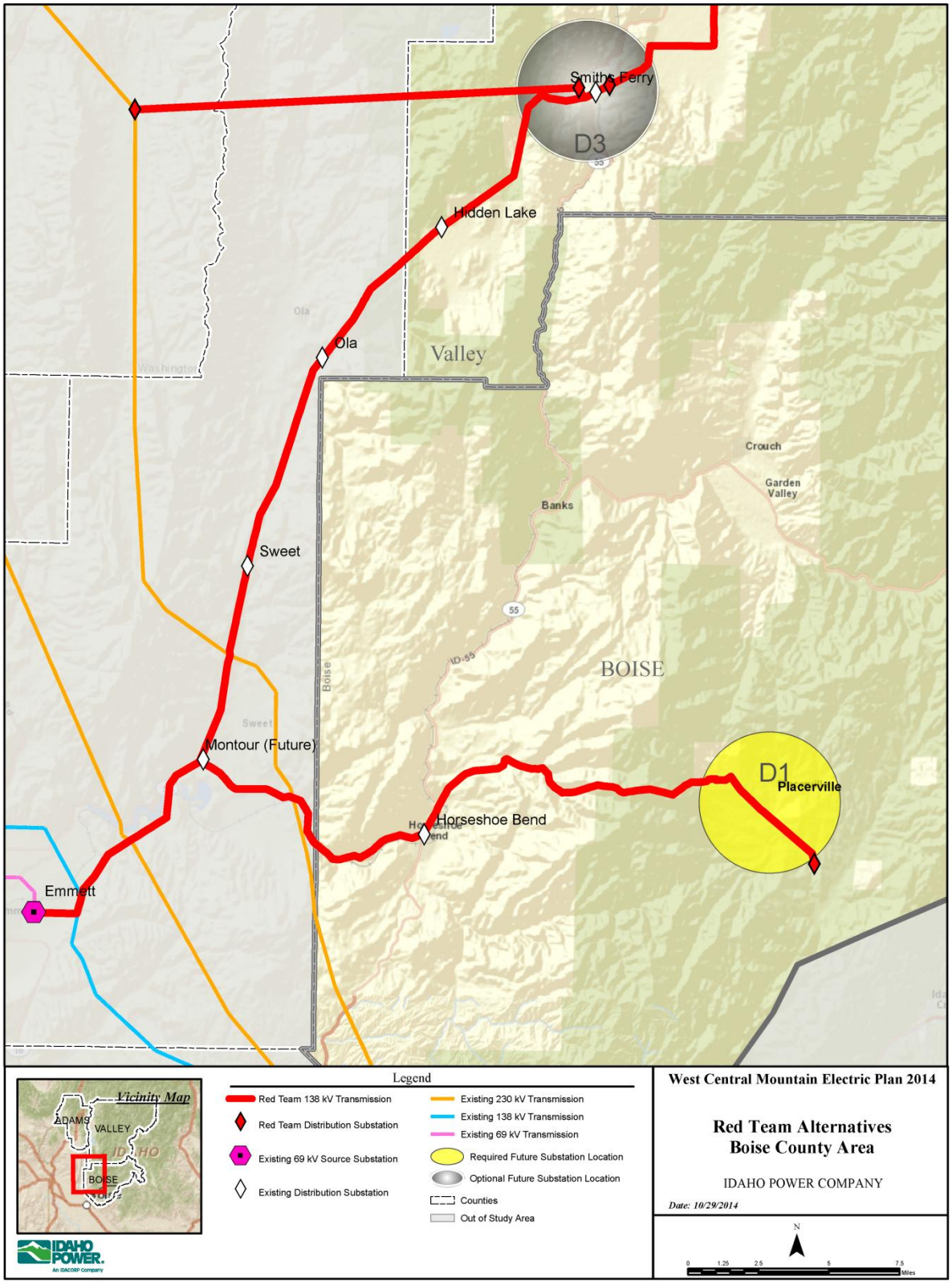

Figure 13
Red Team alternatives, Boise County area

Yellow Team Mapping Results

The Yellow Team created an alternative using one new 69-kV source substation. They also provided the locations for three new distribution substations. The Yellow Team's Adams County area alternatives are shown in Figure 14, Valley County area alternatives in Figure 15, and Boise County area alternatives in Figure 16. One of the goals of the Yellow Team was to prioritize upgrading existing substations. The details are as follows.

Adams County Area

- 69-kV source substations
    - The Yellow Team alternative included expanding the existing Horse Flat Substation to include a 69-kV source substation.
- 230-kV transmission lines
    - No new 230-kV transmission lines were included in the Yellow Team alternative.
- Distribution substations
    - D2 (Indian Valley)—Located north of the highway on private property, out of the viewshed.
- 138-kV transmission lines
    - No new 138-kV transmission lines were included for the Yellow Team alternative in the Adams County area.
- 69-kV transmission lines
    - Add a new 69-kV transmission line connecting the existing Cambridge Substation to the existing Horse Flat Substation. The route is shown as a straight connection between the two substations, but the following comments were made:
        - The route between the Horse Flat Substation and the Cambridge Substation should be as direct and short as possible.
        - Locate transmission along existing roads where possible.

Valley County Area

- 138-kV source substations
    - No new 138-kV source substations were identified in this area.
- 230-kV transmission lines

  - No new 230-kV transmission lines were included in the Yellow Team alternative.

- Distribution substations

  - D7 (between Smith's Ferry and Cascade)—Located approximately 5 miles southeast of Cascade, east of the existing 69-kV transmission line. The site located by the Yellow Team is east of Goslin Loop and north of Corral Creek Road and is outside the area originally recommended by Idaho Power. The Yellow Team gave the following comments concerning the site:

    - The site should be south of the Cascade Airport.

    - A critical environmental analysis will need to be done for wetlands, etc.

    - Depending on where the growth develops, prioritize the upgrading of existing substations or building Substation D7.

    - The purpose for substations D3, D4, and D6 can be met by siting Substation D7.

- 138-kV transmission lines

  - (Reviewed in Boise County Area as well.) Upgrade the existing 69-kV line between Emmett Substation and Lake Fork Substation to 138 kV to accommodate future growth.

  - New 138-kV transmission line connecting Substation D7 directly west to the Emmett Substation to Cascade Substation transmission line.

  - The Yellow Team indicated the double-circuit 138-kV transmission line into McCall should be separated into two routes to reduce the possibility that both lines would go out of service at the same time, though no new line route was identified. The following comments were made:

    - The transmission section is considered a pinch point.

    - The team was concerned that a new route could be politically difficult.

    - There are many people and high-value houses in this area.

Boise County Area

- 138-kV source substations

  - The Yellow Team elected to use the Pearl Substation location identified in the TVEP and identified as a 138-kV source substation in the WTVEP.

- 230-kV transmission lines

  - No new 230-kV transmission lines were included in the Yellow Team alternative.

- Distribution substations
    - D1 (Placerville)—Locate on Baumhoff & Company land about a mile west of Placerville just south of Granite Creek Road. Additional comments are as follows:
        - It is not likely that this substation will be needed for residential or commercial use in the next 40 years.
        - Do not make the decision to build this substation contingent on industrial opportunities (i.e., large mines).
        - Future load should be served out of Horseshoe Bend Substation until Substation D1 (Placerville) is required.
- 138-kV transmission lines
    - Upgrade the existing 69-kV line between Emmett Substation and Lake Fork Substation to 138 kV to accommodate future growth.
    - Upgrade the existing 69-kV Montour to Horseshoe Bend line to 138 kV.
    - Bring a new 138-kV line up from the future Pearl Substation. Locate the transmission line along the valley until it can follow the existing 230-kV transmission corridor. Then follow the existing 69-kV corridor to Horseshoe Bend Substation.
        - This will provide redundant service to Horseshoe Bend.
    - Add a 138-kV circuit from Emmett Substation to Montour Substation. The result will be two independent 138-kV circuits connecting Emmett Substation and Montour Substation, though they may share the same poles.
    - Add a new 138-kV transmission line connecting substation D1 (Placerville) to Horseshoe Bend Substation. The route follows an existing distribution line east from Horseshoe Bend to the new substation location.
        - Viewshed impacts are not anticipated to be an issue due to low population density.

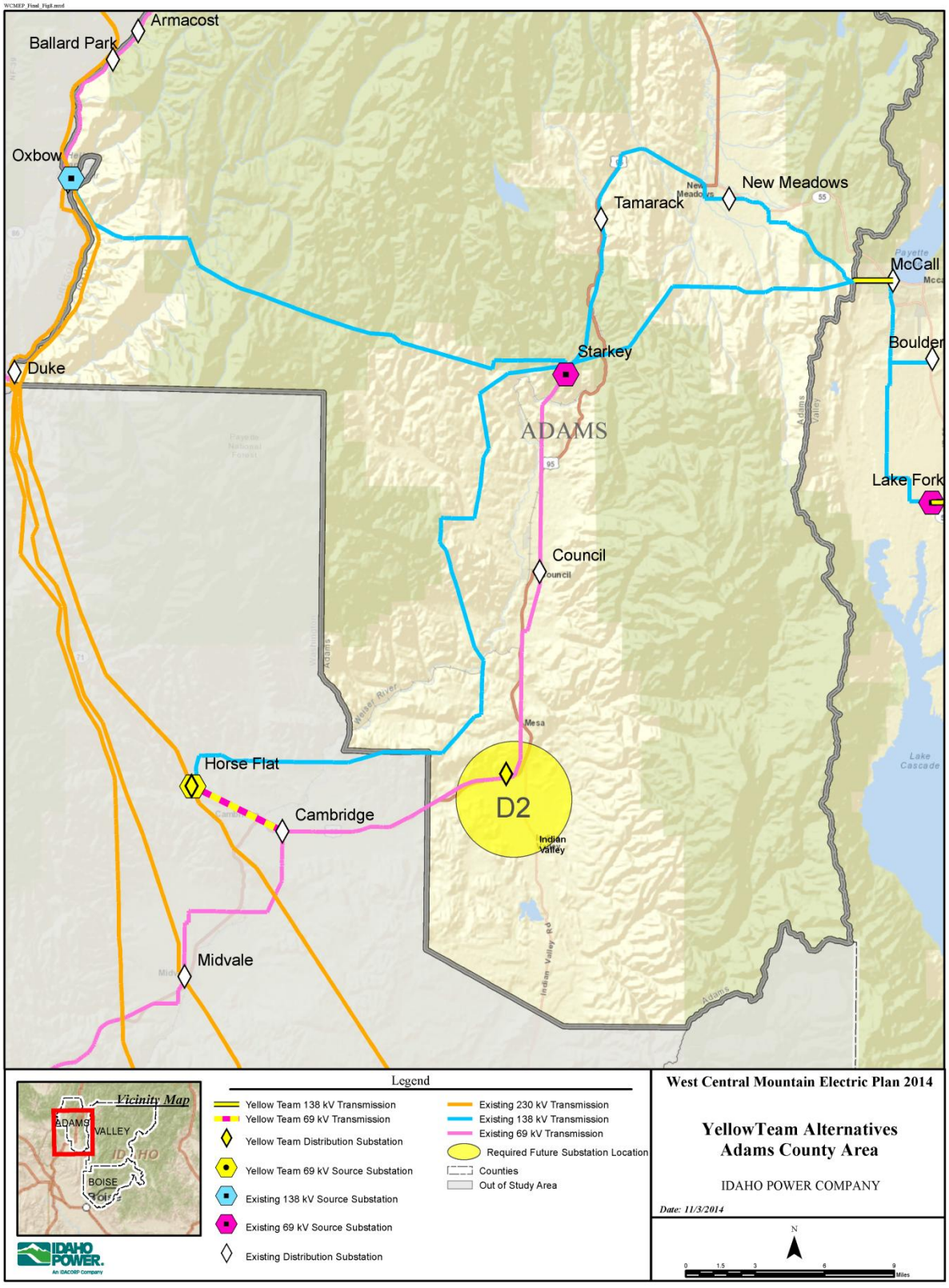

Figure 14
Yellow Team alternatives, Adams County area

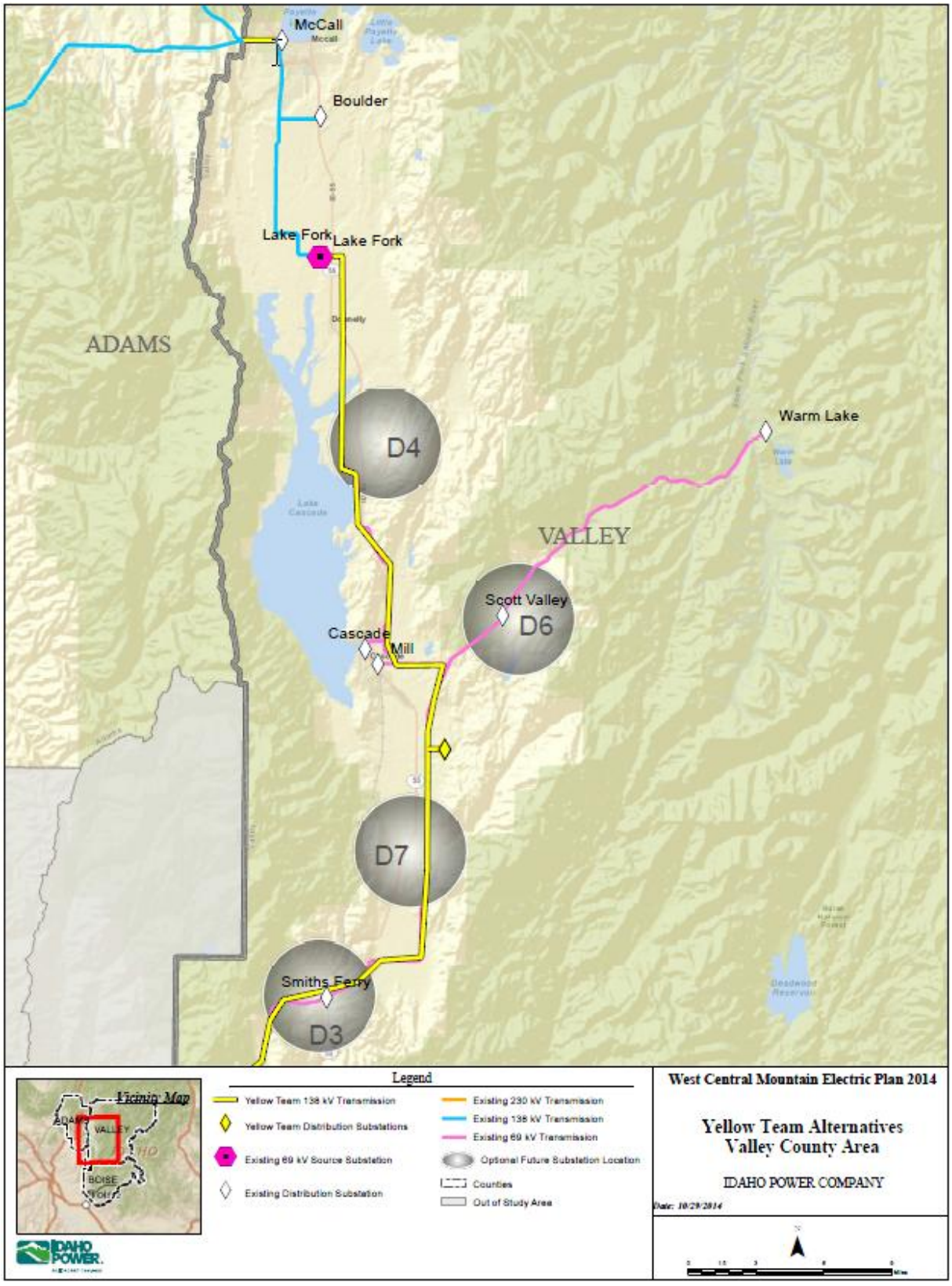

Figure 15
Yellow Team alternatives, Valley County area

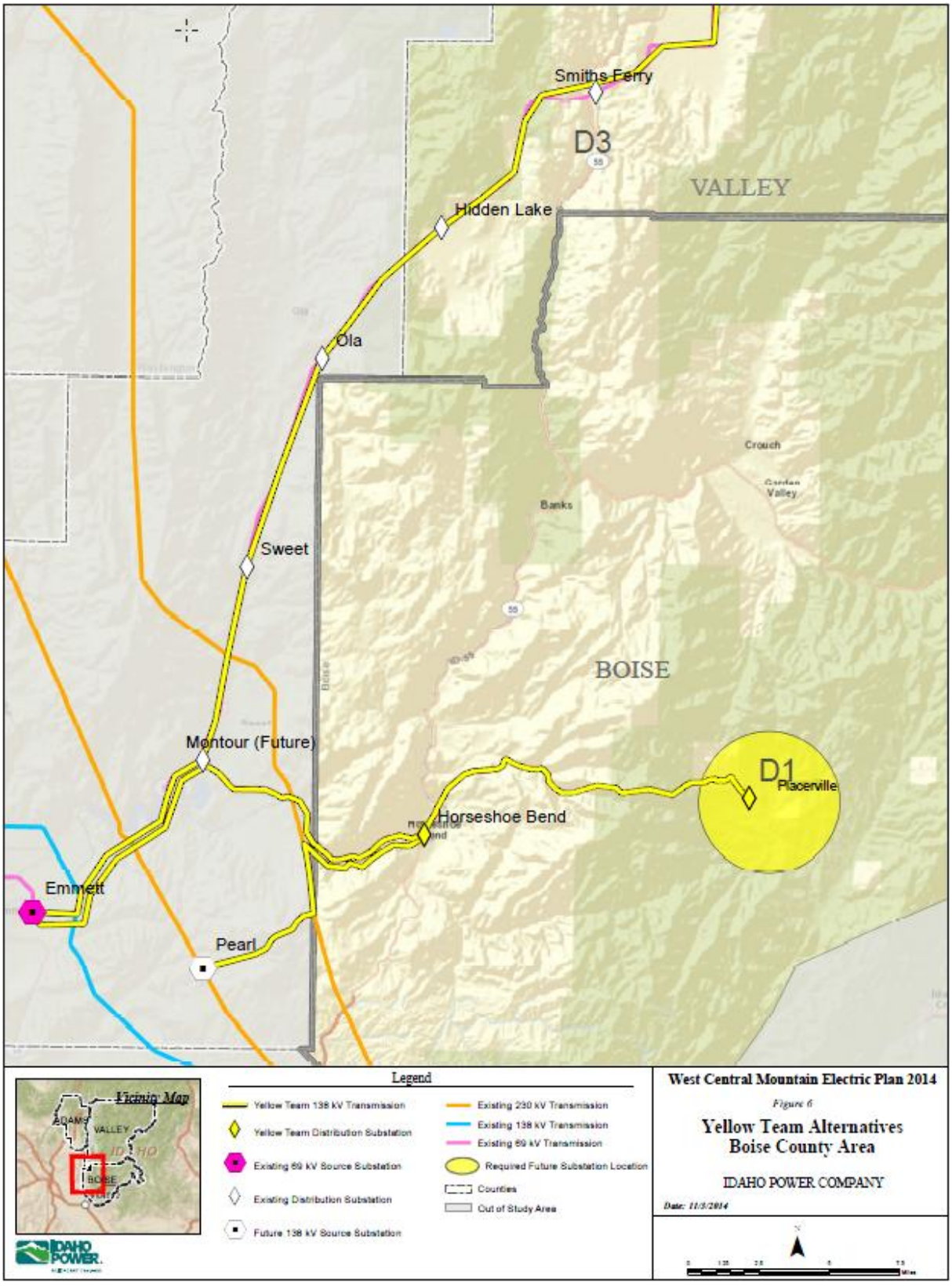

Figure 16
Yellow Team alternatives, Boise County area

Green Team Mapping Results

The Green Team defined an alternative including a 230-kV line and one new 138-kV source substation. They also provided the locations for four new distribution substations, two with alternatives. The Green Team's Adams County area alternatives are shown in Figure 17, Valley County area alternatives in Figure 18, and Boise County area alternatives in Figure 19. The Green Team had divergent opinions about whether to site the minimal amount of infrastructure possible to serve buildout, or to use this opportunity to site the entire foundational infrastructure that Idaho Power presented. The details are as follows.

Adams County Area

- 138-kV source substations
    - No new 138-kV source substations were identified in this area.
- 230-kV transmission lines
    - No new 230-kV transmission lines were included in this area.
- Distribution substations
    - D2 (Indian Valley)—Locate behind Alpine Market off of US 95 along the dirt road.
- 138-kV transmission lines

Add a new 138-kV transmission line connecting Substation D2 (Indian Valley) to the existing 138-kV line that connects Horse Flat Substation with Starkey Substation. The route shown is a straight line, but the Green Team indicated to use the guiding principles and siting criteria when siting the line.

Valley County Area

- 138-kV source substations
    - No new 138-kV source substations were identified in this area, with the exception of the one detailed in the Boise County area.
- 230-kV transmission lines
    - No new 230-kV transmission lines were included, with the exception of the line connecting to D3 (Smith's Ferry) detailed in the Boise County area.
- Distribution substations

- D4 (between Cascade and Lake Fork)—The group's preference is not to site this substation. However, the team did identify two locations as alternatives if the substation is needed.
    - Alternative 1 is at Golden Cove near the existing 69-kV transmission line that connects Cascade Substation to Lake Fork Substation.
    - Alternative 2 is on Idaho Transportation Department (ITD) property currently used as a materials pit, near the intersection of Kantola Road and Koskella Road.
    - The ITD representative suggested the substation be located on ITD property. However, it needs to be as close to the road as possible while the materials pit is still in operation.
- D7 (between Smith's Ferry and Cascade)—Located in the Herrick Subdivision near Clear Creek. The Green Team gave the following comments concerning the site:
    - People are already aware of the existing infrastructure in this area.
    - This location is on private land.
    - This location would generate no surprises for the community.
    - There is a lot of private property south of the reservoir over to Clear Creek along Cabarton.
    - The team did not want the substation to be visible. They suggested hiding the substation within natural landscaping or locating the substation in the trees.
    - Build a good buffer around the substation.
    - Locate the substation along an existing transmission line.
- 138- kV transmission lines
    - (Reviewed in Boise County Area as well.) Upgrade the existing 69-kV line between D3 (Smith's Ferry) Substation and Lake Fork Substation to 138 kV.
    - If the D4 Substation is built between Cascade and Lake Fork, connect it with a new 138-kV transmission line along Kantola Road to the existing line between Cascade and Lake Fork Substations (which will need to be upgraded from 69 kV to 138 kV).

Boise County Area

- 138-kV source substations

    - New 138-kV source substation collocated with Substation D3 (Smith's Ferry) described in the Distribution substations section.

- 230-kV transmission lines

    - A new 230-kV transmission line was specified to connect Substation D3 (Smith's Ferry) to the existing 230-kV transmission line, which connects Boise Bench Substation to Brownlee Substation. The line route was designated as the existing 69-kV line that crosses under the 230-kV line and continues to Smith's Ferry. Originally, the team specified that the 230-kV line should come out of the future Pearl Substation and continue to Cascade, but an analysis determined the goal could be accomplished with a shorter 230-kV line. The following comments were made:

        - Make sure transmission lines are not visible from the Idaho 55 (Payette River Scenic Byway) corridor (Farm Road to Market Road) or major waterways (i.e., Payette River, Lake Cascade, Payette Lake).

        - Use existing routes and upgrade the transmission lines along these routes.

- Distribution substations

    - D3 (Smith's Ferry)—The Green Team preferred to serve load in this area from a substation in another area. However, they identified two alternative locations for this substation:

        - Alternative 1 is on the west side of the river near old buildings by Cougar Mountain Lodge.

        - Alternative 2 is south of Alternative 1, near Wellington Park.

- 138-kV transmission lines

    - Upgrade the existing 69-kV line between Emmett Substation and Montour Substation and from Montour Substation to Horseshoe Bend Substation to 138 kV.

    - Upgrade the existing distribution line from Horseshoe Bend Substation to the future D1 (Placerville) Substation (not sited by the Green Team).

    - New 138-kV transmission line connecting substation D1 (Placerville) to D3 (Smith's Ferry). This line was considered to provide a second source to the Horseshoe Bend and D1 (Placerville) substations. The route goes almost directly north from Placerville, to the west of Garden Valley, and to the east of Crouch. From there, the line route goes northwest to connect to D3 (Smith's Ferry).

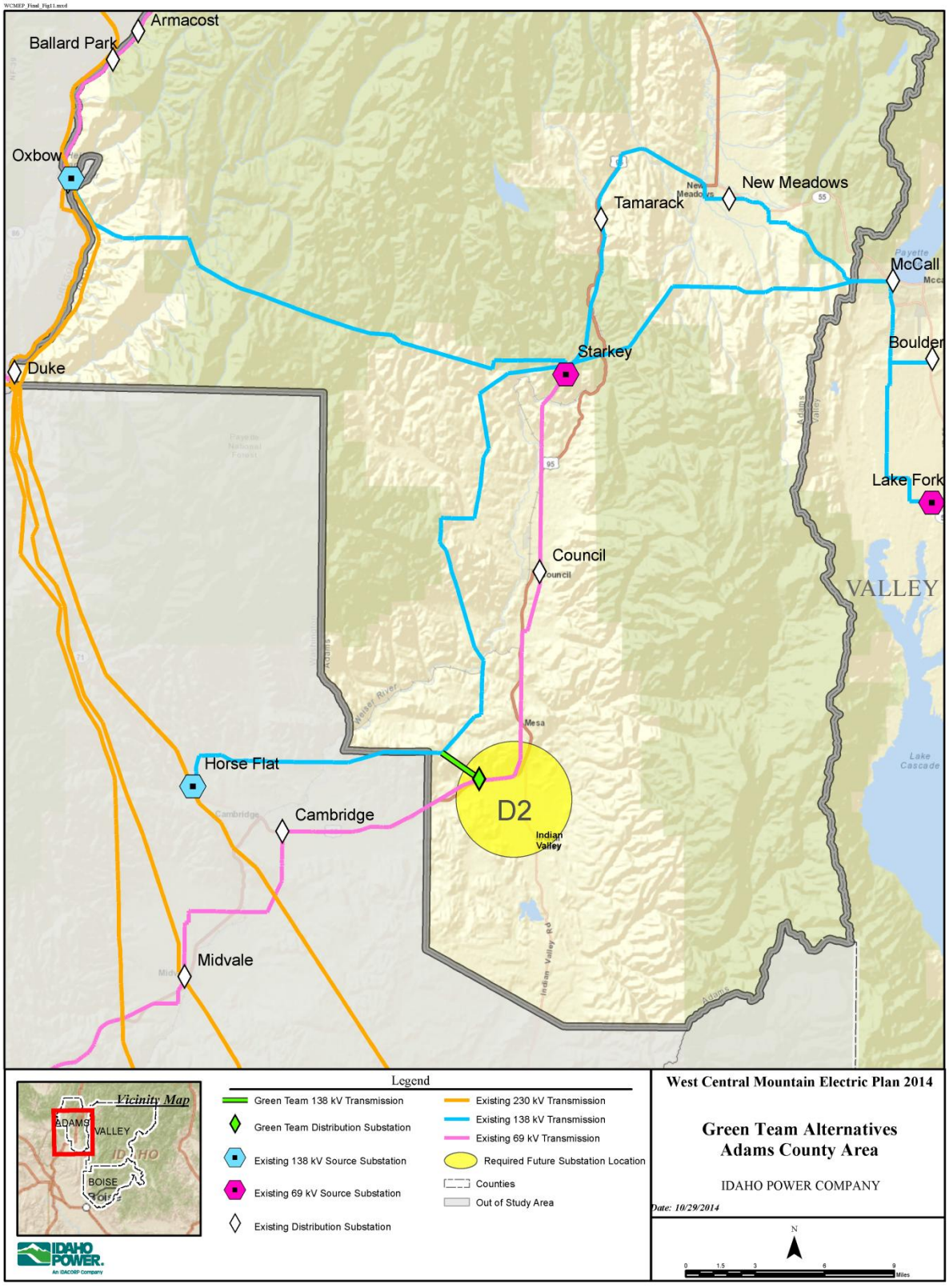

Figure 17
Green Team alternatives, Adams County area

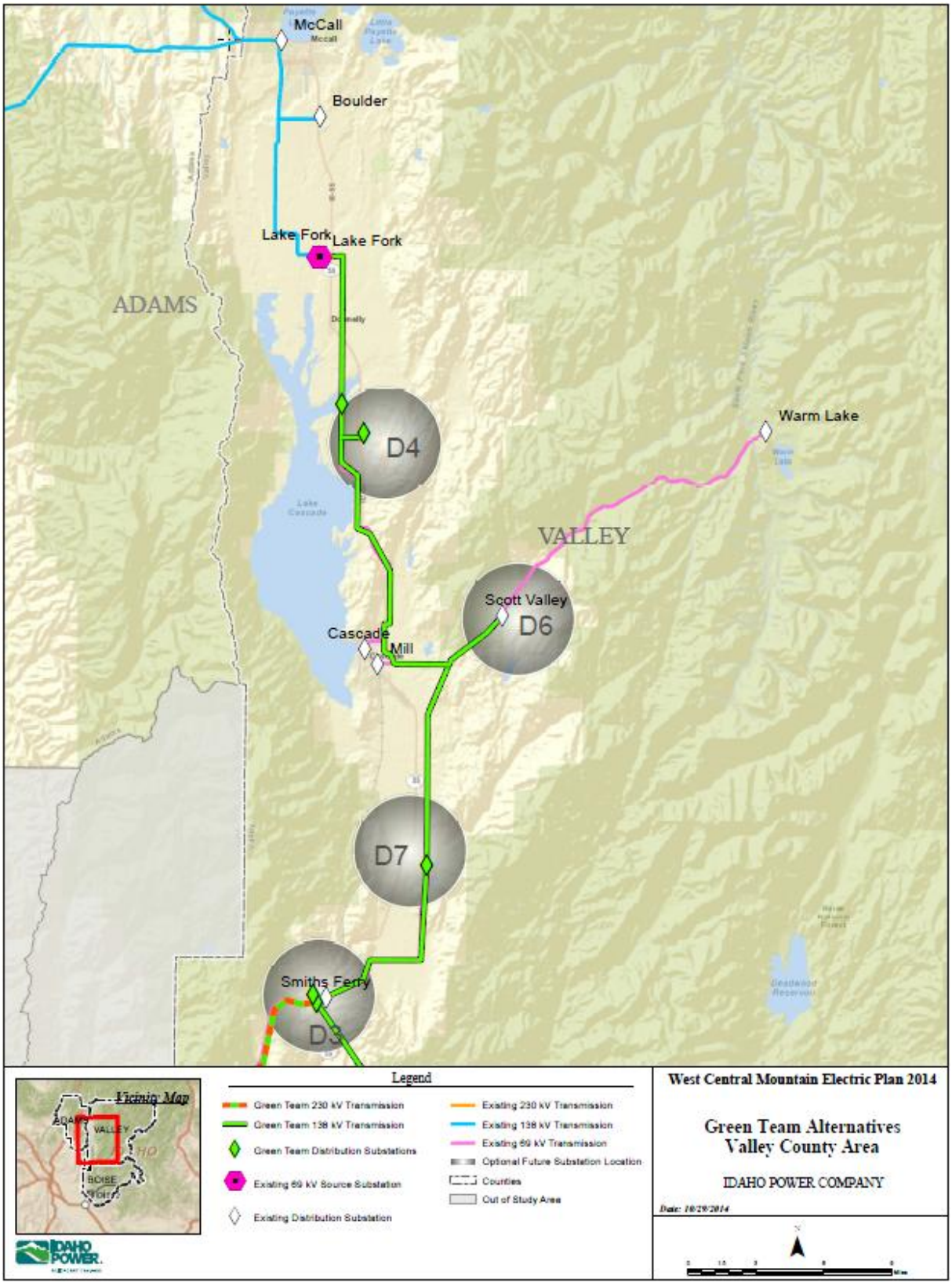

Figure 18
Green Team alternatives, Valley County area

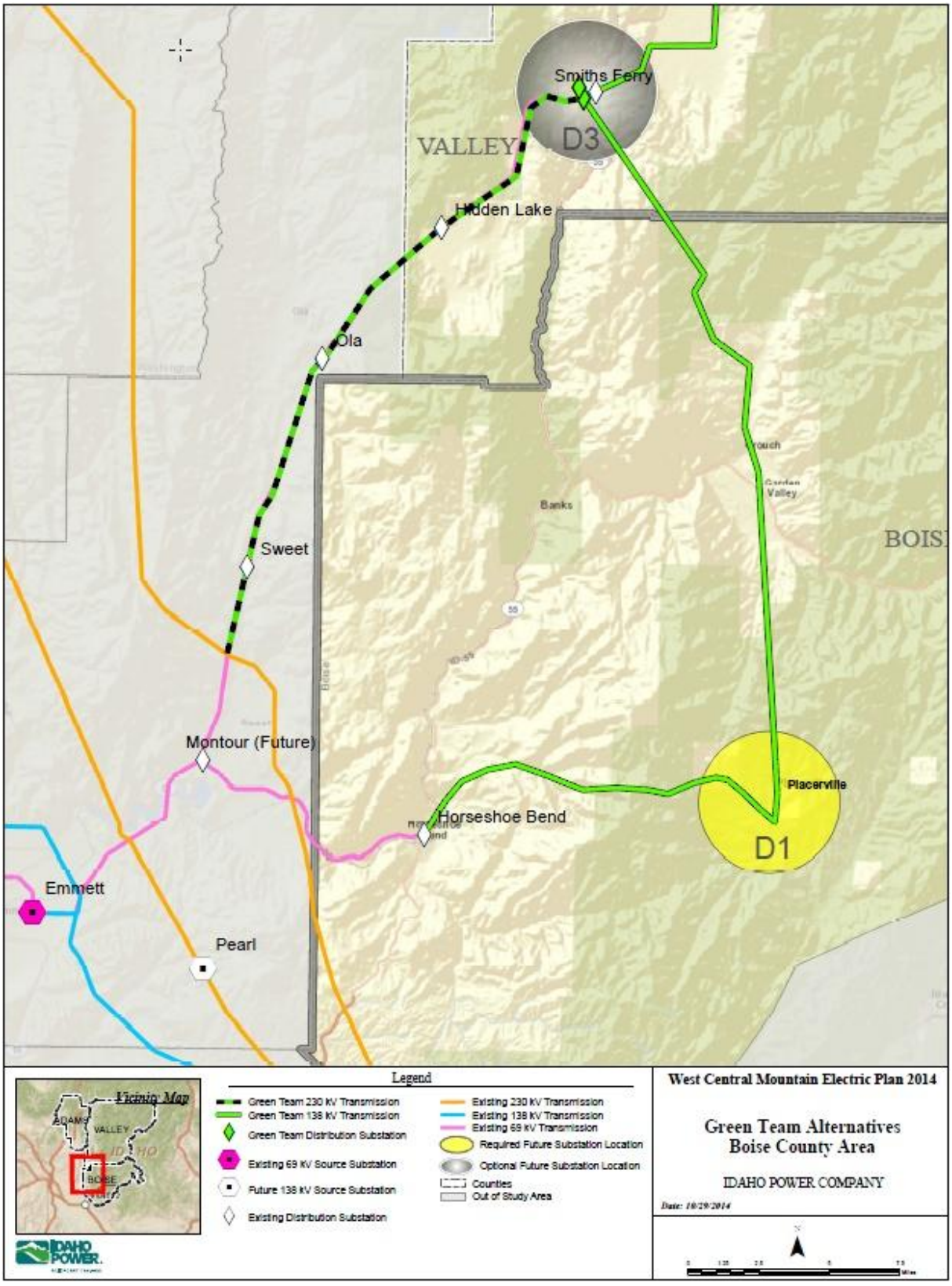

Figure 19
Green Team alternatives, Boise County area

Combined and Common Mapping Results

From the results of the small group mapping exercise, Idaho Power created a set of drawings that combined the alternatives so the Committee could see where commonalities and differences existed between the three teams. The first map developed (Figure 20) shows where all the new distribution substations and transmission lines designated by the teams in the Adams County area are located. Figure 21 shows where the teams sited substations and transmission lines in the Valley County area. Figure 22 shows all teams' siting results in the Boise County area. The Committee discussed the feasibility of each site and evaluated each based on the Committee's *Guiding Principles and Community Criteria*. The Committee eventually came to consensus in choosing a preferred set of substation locations and transmission routes for the area. This preferred alternative is discussed in detail in the Committee's Preferred Alternative section of this report.

Idaho Power staff also developed maps that show the commonalities between the various mapping team alternatives. Figures 23, 24, and 25 show commonalities between all four mapping teams for the Adams County area, Valley County area, and Boise County area, respectively. There were only two locations where the substation sites were close enough to be considered common; those are marked with a circle with an 'x' inside. The colored diamonds represent the team that chose the particular location.

On the same maps, the 138-kV facilities are shown in white for unique line routes, gray for areas where two teams sited the same route, and black where all three teams identified the same line route. There was a high amount of consensus among the teams with most new transmission line routes (i.e., if teams chose to develop new transmission line routes, there was a lot of similarity between the various teams' maps.) The map also includes many colored diamonds that indicate little agreement on distribution substation siting. However, in many cases, the differences were small.

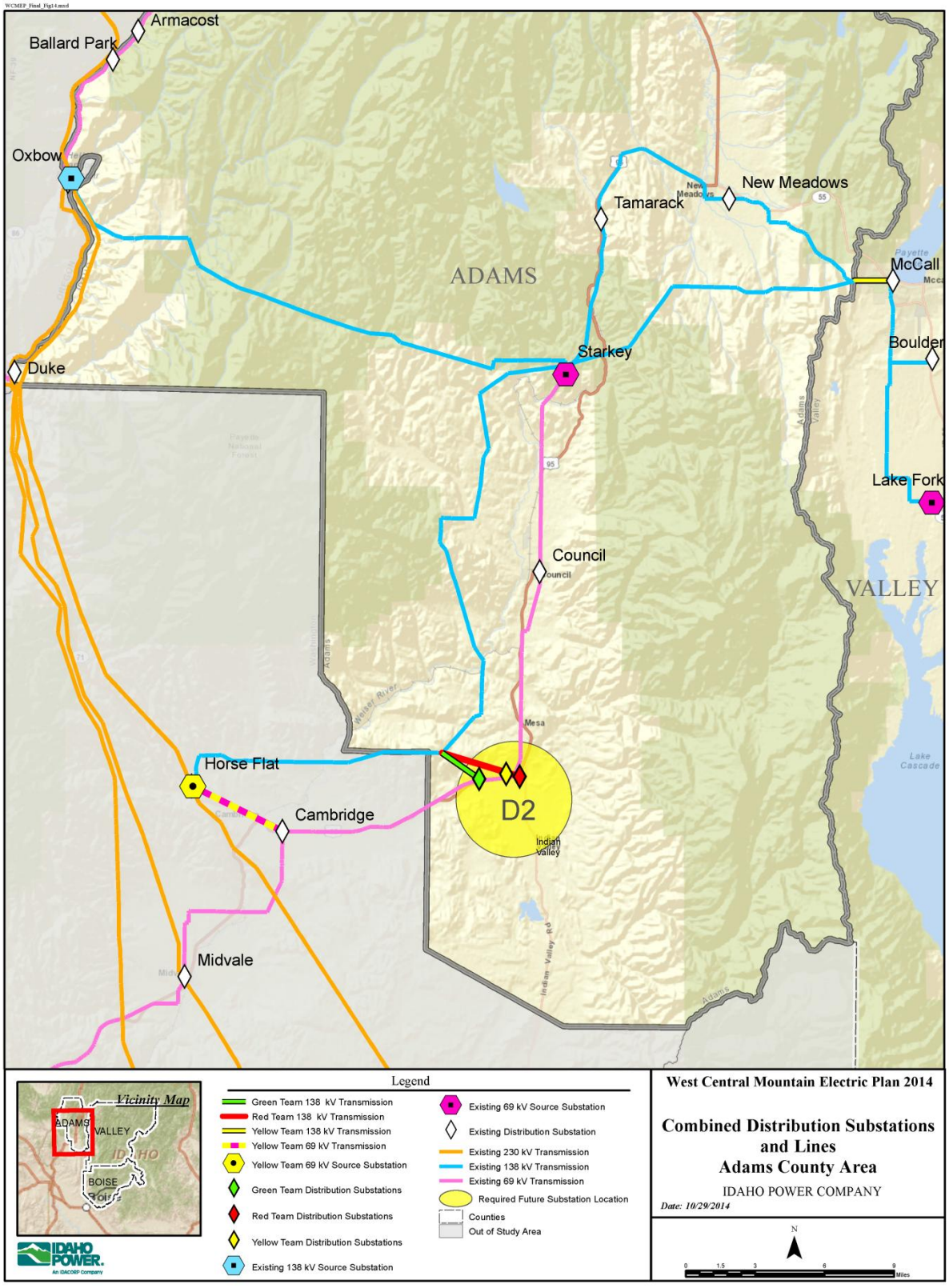

Figure 20
Combined distribution substations and transmission lines, Adams County area

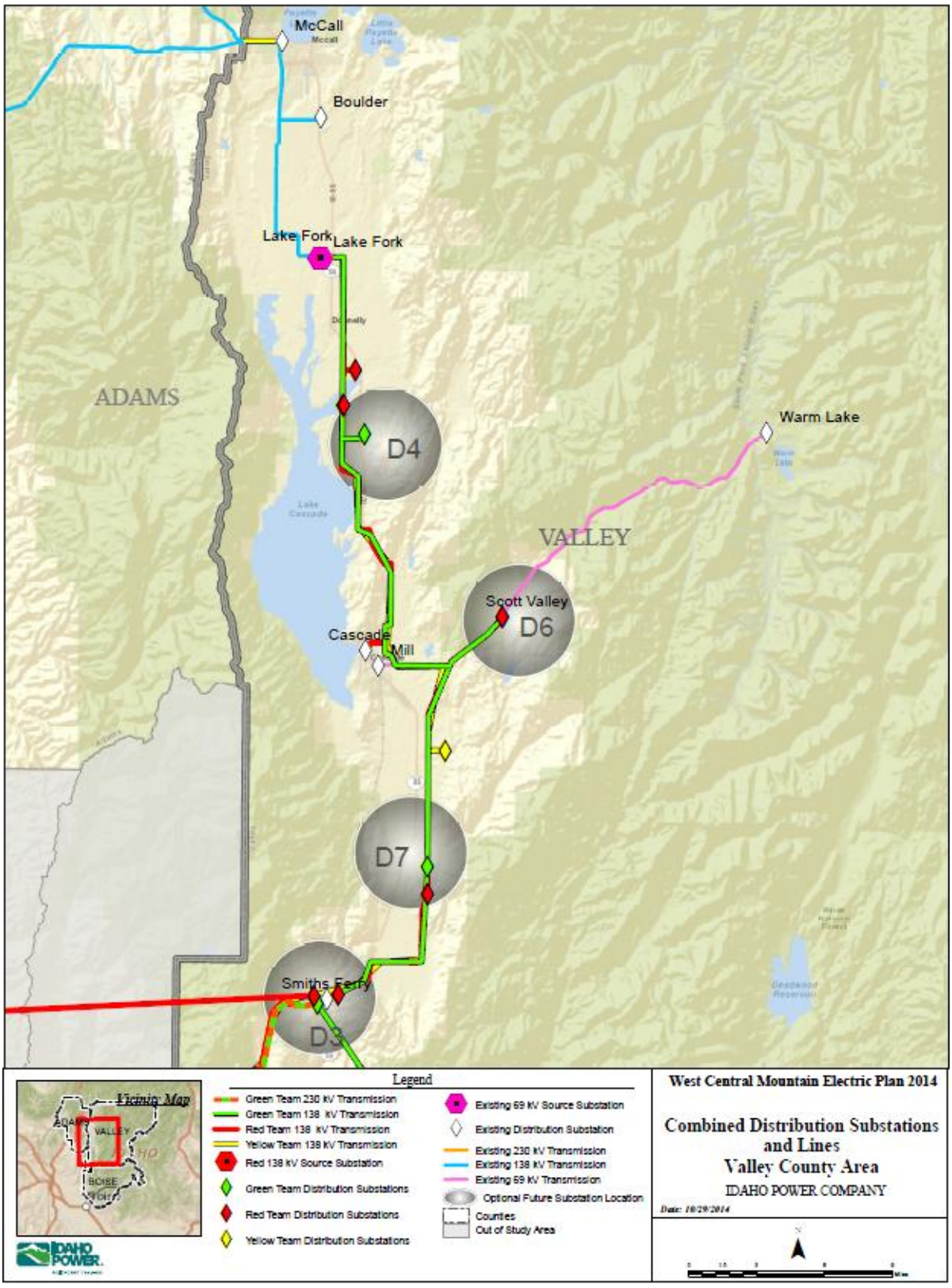

Figure 21
Combined distribution substations and transmission lines, Valley County area

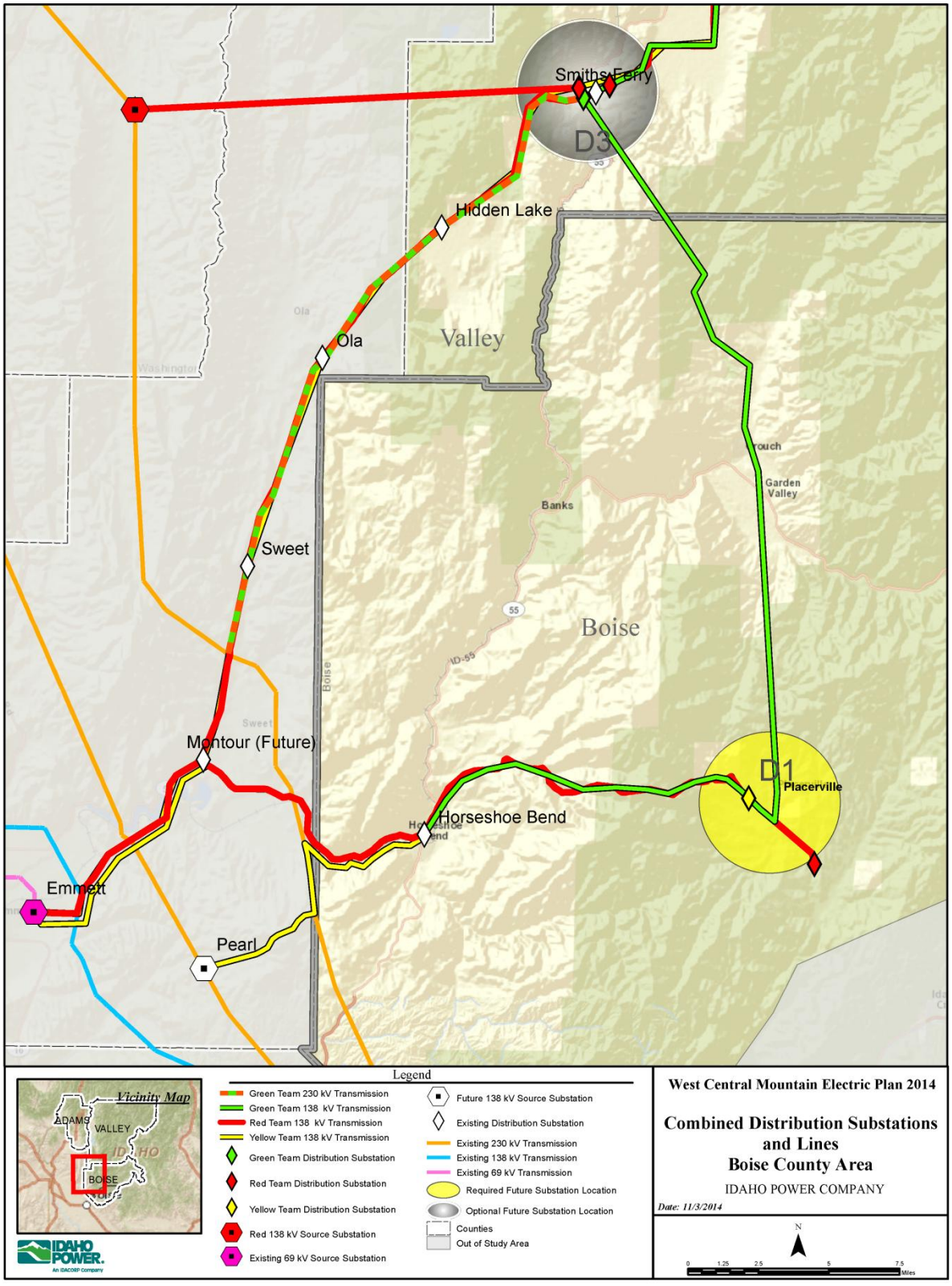

Figure 22
Combined distribution substations and transmission lines, Boise County area

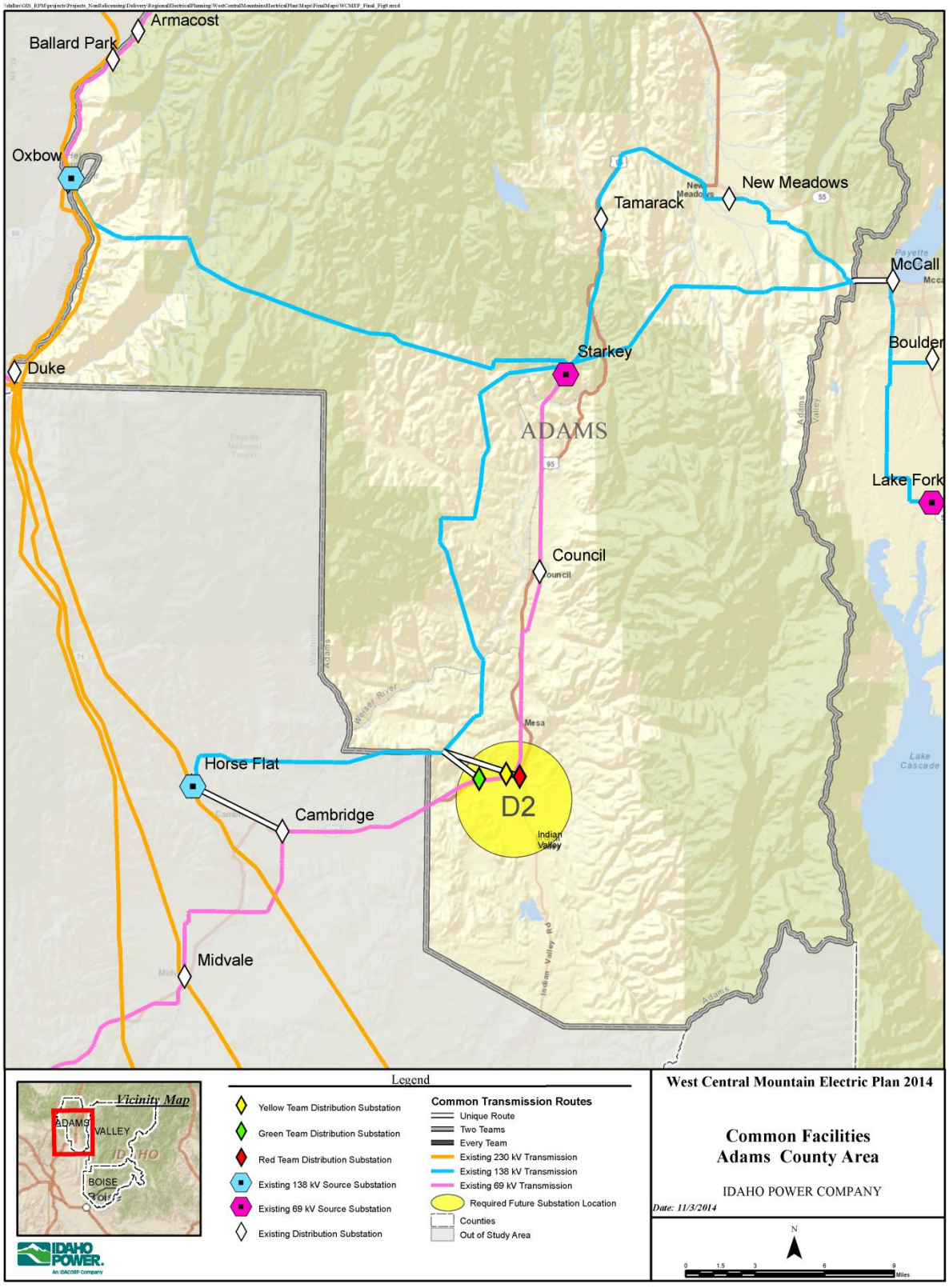

Figure 23
Common facilities, Adams County area

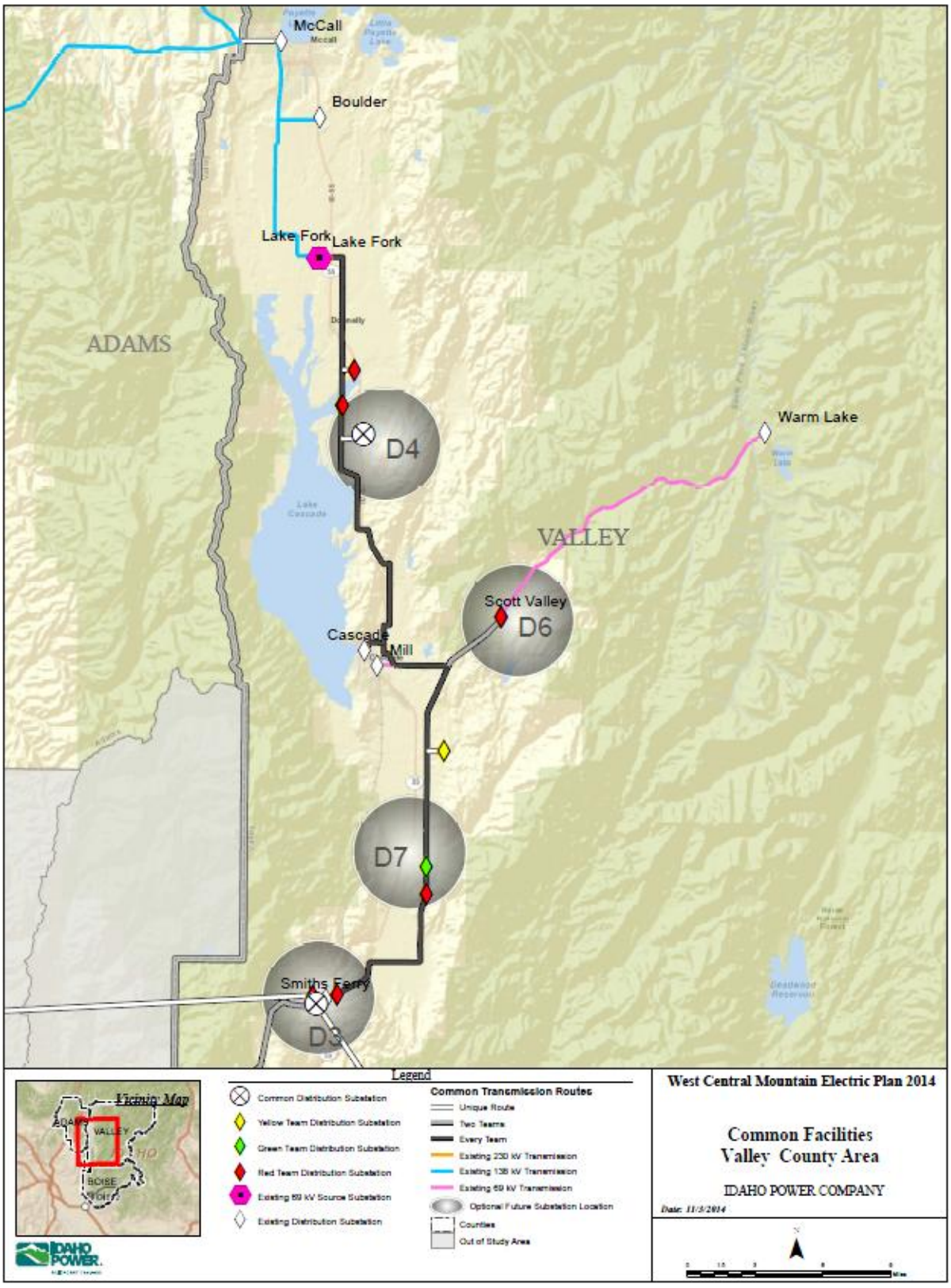

Figure 24
Common facilities, Valley County area

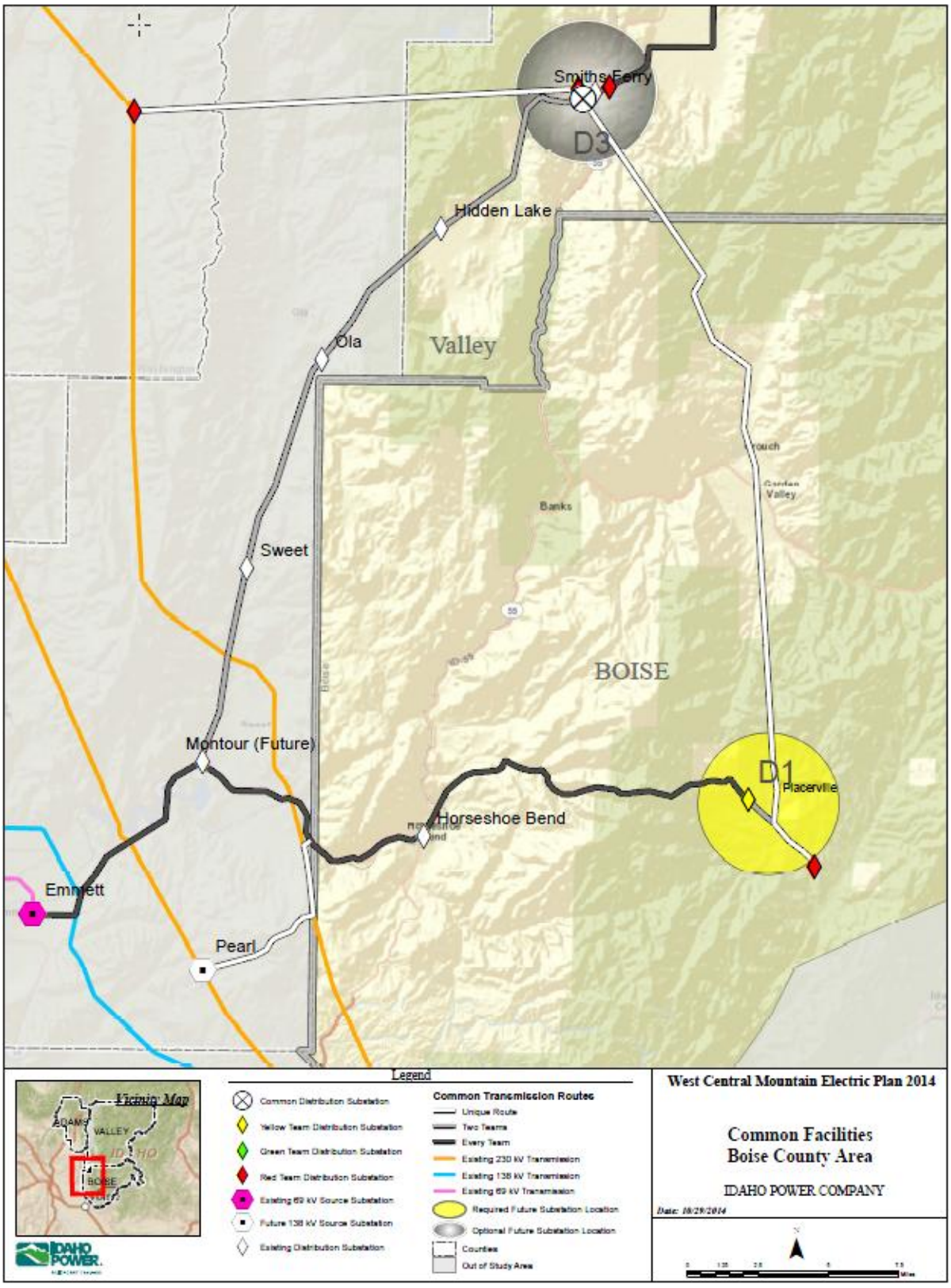

Figure 25
Common facilities, Boise County area

COMMITTEE'S PREFERRED ALTERNATIVES

At the April 2014 meeting, the Committee evaluated each team's alternative and began to determine their preferred locations for individual substations and transmission line routes. The Committee looked at each substation site and transmission line route individually to determine which team's alternative was preferred and if alterations to alternatives were needed. The Committee produced a preferred alternative, eliminated "no go" alternatives, and identified remaining alternatives deemed acceptable if the preferred alternative becomes infeasible.

The Committee generally recommended that Idaho Power refer to their *Guiding Principles and Community Criteria* when siting any new facilities in the West Central Mountains.

The Committee reached consensus on preferred substation locations and transmission line routes in each of the geographical sub-areas of the Plan. The preferred alternatives for the Adams County area and the Valley County area are shown in Figures 26 and 27, respectively. Figures 28 and 29 show the preferred and secondary alternatives for the Boise County area. The preferred alternative shown in Figure 28 provides reliability to the West Central Mountains with a 138-kV source substation to the east of D3 (Smith's Ferry). Figure 29 illustrates the 230-kV secondary alternative to provide the necessary reliability improvement. Also shown on these drawings are alternatives the Committee considered secondary (if the preferred alternative for some transmission line routes and substation locations could not be obtained, Idaho Power could pursue the secondary alternatives.)

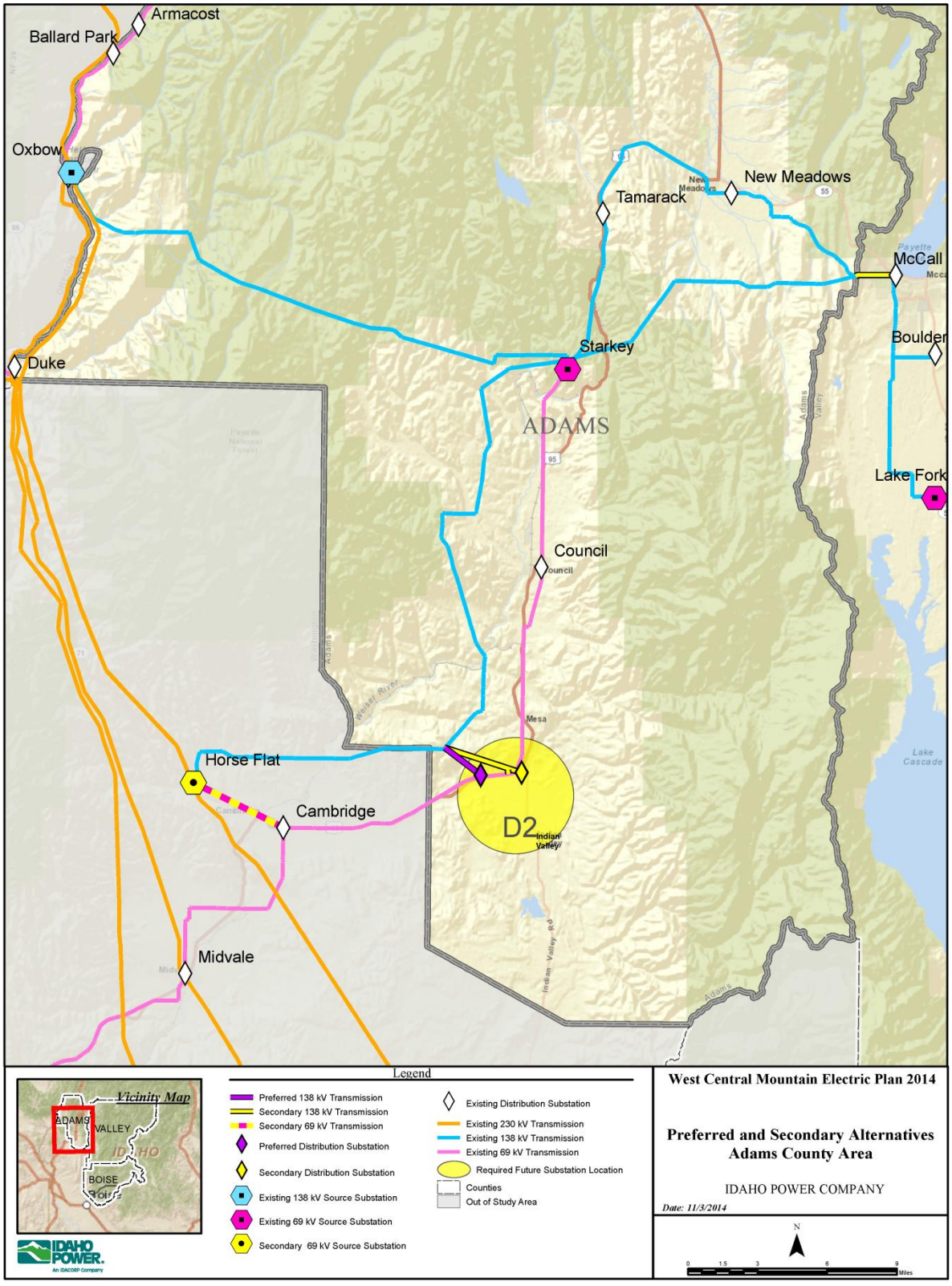

Figure 26
Preferred and secondary alternatives, Adams County area

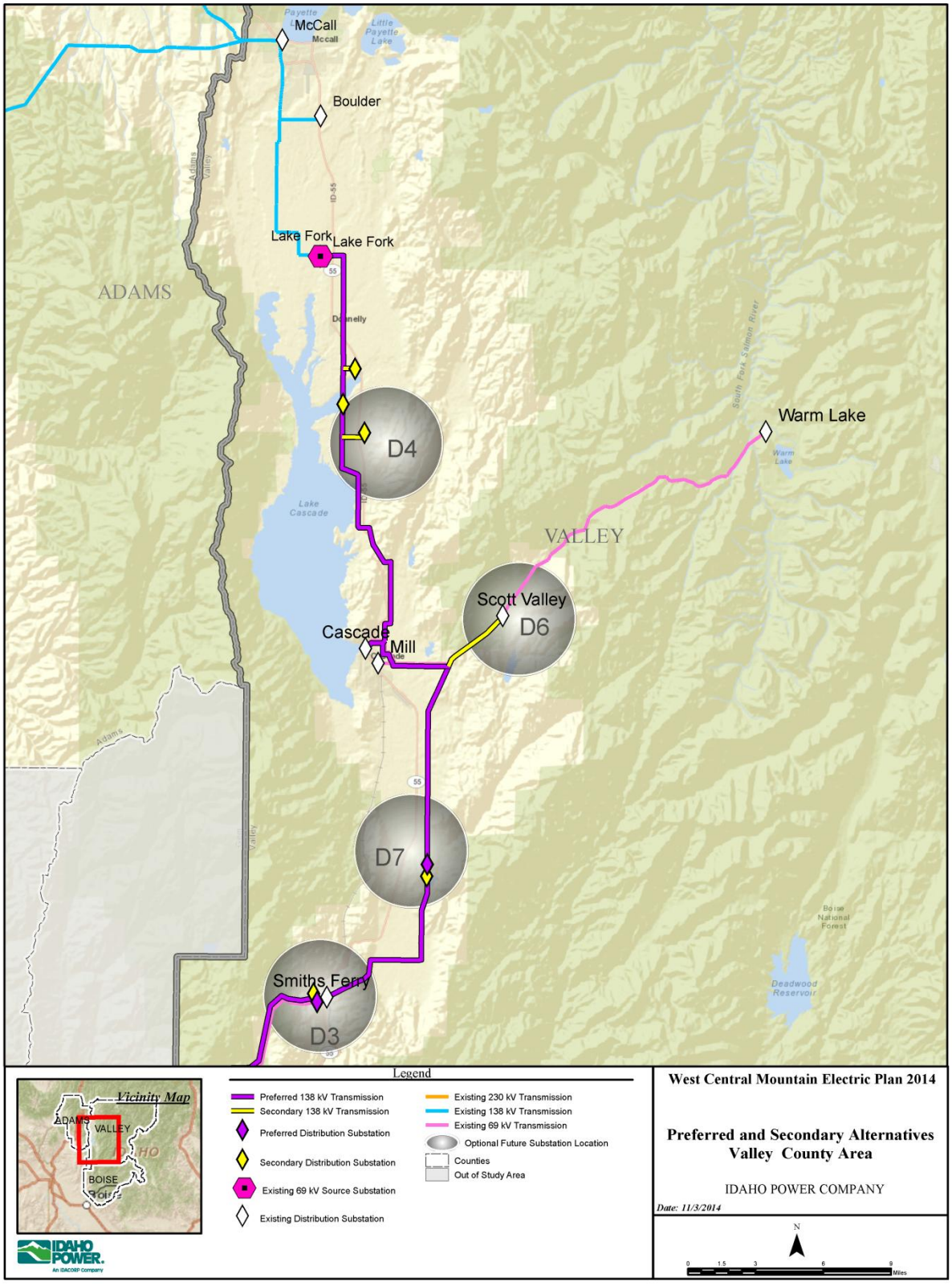

Figure 27
Preferred and secondary alternatives, Valley County area

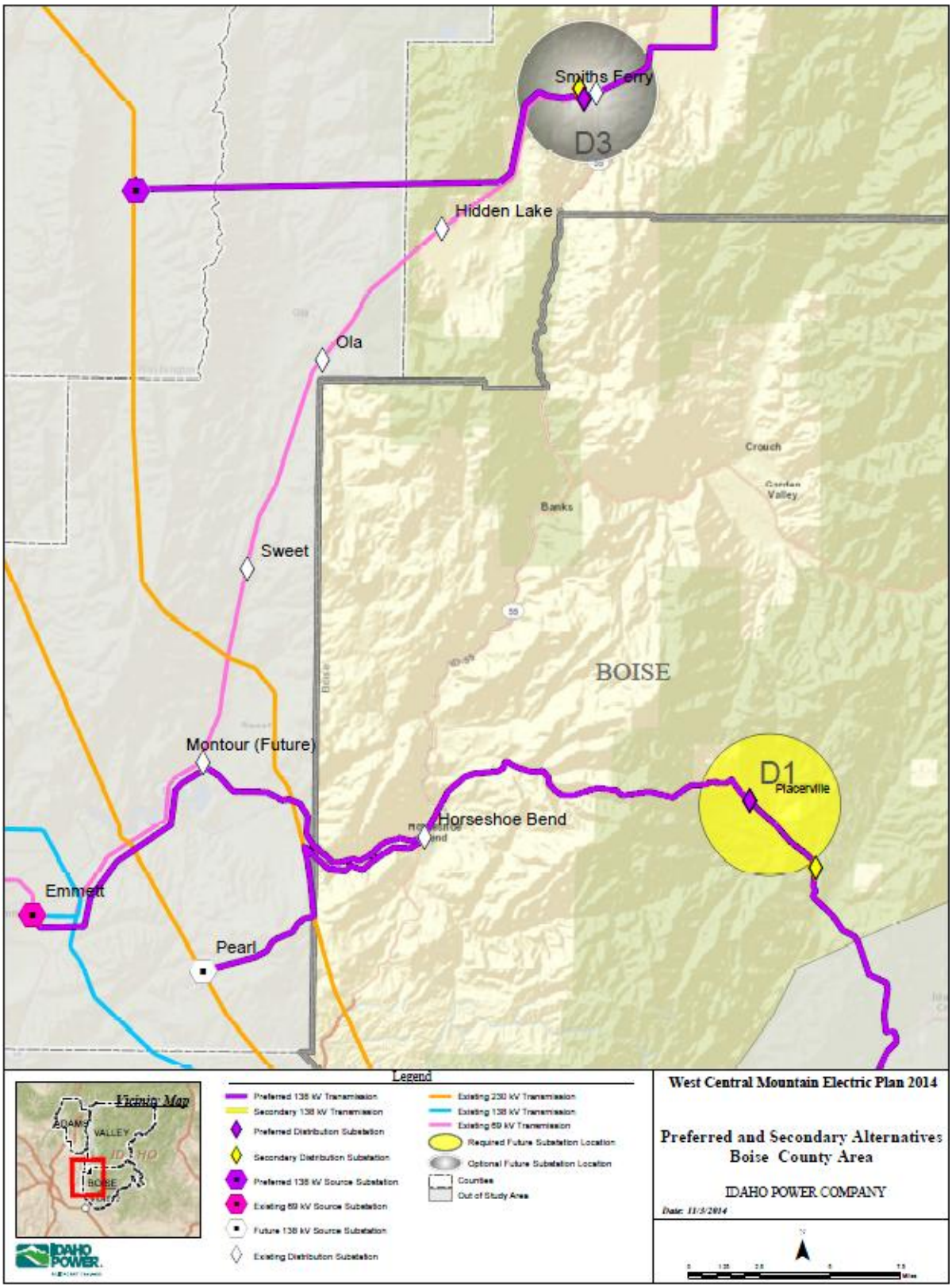

Figure 28
Preferred and secondary alternatives, Boise County area

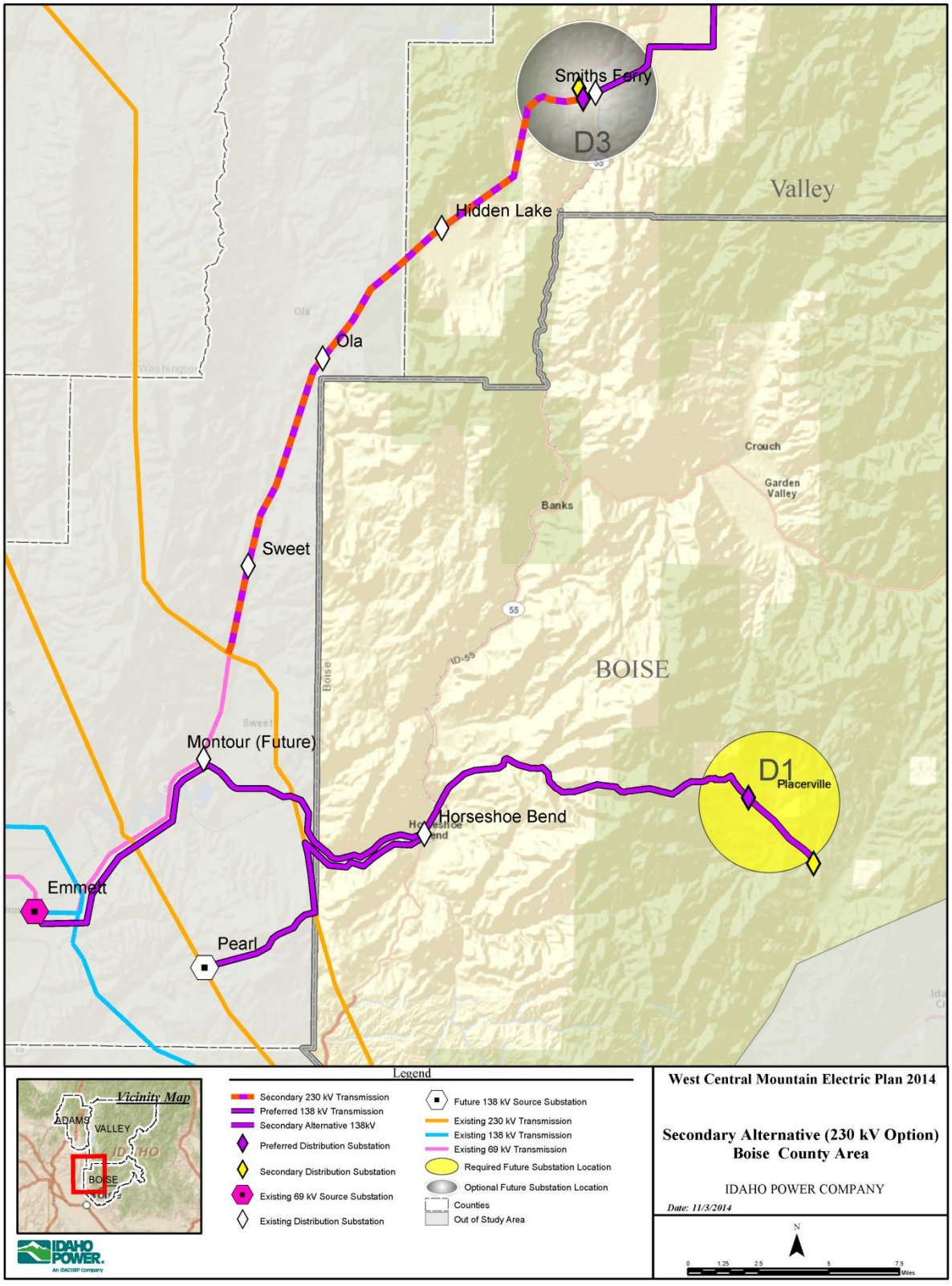

Figure 29
Secondary alternatives (230-kV option), Boise County area

Adams County Area

- Source substations (Figure 26)
    - No new source substations were identified for the preferred alternative in this area. However, an acceptable secondary alternative included expanding the existing Horse Flat Substation to include a 69-kV source substation.
- 230-kV transmission lines (Figure 26)
    - No new 230-kV transmission lines were included in this area.
- Distribution substations (Figure 26)
    - D2 (Indian Valley)—Locate behind Alpine Market, just off of US 95.
- 138-kV transmission lines (Figure 26)
    - Add a new 138-kV transmission line connecting Substation D2 (Indian Valley) to the existing 138-kV line that connects Horse Flat Substation with Starkey Substation. The route shown is a straight line, but the Committee indicated Idaho Power should use the guiding principles and siting criteria when siting the line.
- 69-kV transmission lines (Figure 26)
    - No new 69-kV transmission lines were identified in the preferred alternative. As a secondary alternative (if the preferred alternative is not possible), a new 69-kV transmission line was specified connecting the existing Cambridge Substation to the existing Horse Flat Substation. The route is shown as a straight connection between the two substations, but the following comments were made:
        - The route between the Horse Flat Substation and the Cambridge Substation should be as direct and short as possible.
        - Locate transmission along existing roads where possible.

Valley County Area

- 138-kV source substations (Figure 27)
    - No new 138-kV source substations were identified in this area, with the exception of the one detailed in the Boise County area.
- 230-kV transmission lines (Figure 27)

    - There are no 230-kV lines in the preferred alternative. However, there is a secondary alternative identified in the Boise County area that crosses into Valley County. See the Boise County Area section of the Committee's Preferred Alternatives.

- Distribution substations (Figure 27)

    - D4 (between Cascade and Lake Fork)—The committee's preference is not to site this substation. However, the team identified three locations as secondary alternatives if the substation is needed. For all three locations, the team indicated deer and elk winter ranges should be considered.

        - Secondary Alternative 1 is along the east side of Lake Cascade, along the existing 138-kV line and adjacent to Old Highway 55.

        - Secondary Alternative 2 is at the intersection of Loomis Lane and Idaho 55.

        - Secondary Alternative 3 is on ITD property currently used as a materials pit, near the intersection of Kantola Road and Koskella Road.

        - The ITD representative suggested the substation be located on ITD property. However, it needs to be as close to the road as possible while the materials pit is still in operation.

    - D6 (Scott Valley)—The Committee's preference is not to site this substation. However, the team did identify that the existing Scott Valley Substation can be expanded as a secondary alternative if the substation is needed.

    - D7 (between Smith's Ferry and Cascade)—The preferred alternative is located almost 1 mile north of Herrick Reservoir along the existing 69-kV transmission corridor.

        - A secondary alternative was also identified. The location is approximately 0.5 miles north of Herrick Reservoir along the same transmission corridor described in the preferred alternative. The location is described by the Committee as between Herrick Reservoir and Clear Creek.

- 138-kV transmission lines (Figure 27)

- Upgrade the existing 69-kV line between D3 (Smith's Ferry) Substation and Lake Fork Substation to 138 kV to accommodate future growth. Consider habitat, nearby airports, private land, and viewsheds.

- Upgrade the existing 69-kV line connecting Cascade Substation to the existing line between D3 (Smith's Ferry) Substation and Lake Fork Substation to 138 kV.

Note: Cascade Substation will be a source to the 69-kV system out to the Warm Lake Substation, and a 69-kV line will need to remain from Cascade Substation to the existing Scott Valley

Substation. This line will share the same structures (double circuit) with the 138-kV line into the Cascade Substation.

Boise County Area

- 138-kV source substations (figures 28 and 29)
    - The Committee preferred the Red Team's approach to add a 138-kV source but amended the location. The preferred 138-kV source substation location is in Washington County along the 230-kV Boise Bench to Brownlee line, approximately 11 miles due west and 1.5 miles north of the existing Hidden Lake Substation.
    - The Committee also provided a secondary 138-kV source substation location to be used if the preferred site cannot be realized. This substation would be collocated with the D3 (Smith's Ferry) substation.
- 230-kV transmission lines (Figure 29)
    - There are no 230-kV lines in the preferred alternative. However, if the preferred 138-kV source and associated line route cannot be obtained, a 230-kV line has been identified as a secondary alternative. This line connects to the 230-kV Boise Bench to Brownlee line where it crosses the existing 69-kV Montour to Cascade line. It follows the Montour to Cascade line north to the future D3 (Smith's Ferry) substation.
- Distribution substations (figures 28 and 29)
    - D1 (Placerville)—The Committee chose the site identified by the Yellow Team on private land about a mile west of Placerville, south of Granite Creek Road.
        - The Red Team's alternative was also acceptable to the Committee as a secondary alternative: to the east of Centerville Road, about 2 miles north of Grimes Pass Road, southeast of Placerville. It was described as east of Placerville and west of Centerville.
    - D3 (Smith's Ferry)—The Green Team's alternatives were selected as the preferred and secondary alternatives for this location:
        - The preferred location is near Wellington Park.
        - The secondary alternative is on the west side of the river near old buildings by Cougar Mountain Lodge, north of the preferred alternative.
- 138-kV transmission lines (figures 28 and 29)
    - Upgrade the existing 69-kV line between Emmett Substation and Horseshoe Bend Substation to 138 kV to accommodate future growth. Consider habitat, nearby airports, private land, and viewsheds.

- Bring a new 138-kV line up from the future Pearl Substation. Locate the transmission line along the valley until it can follow the existing 230-kV transmission corridor. Then follow the existing 69-kV corridor to Horseshoe Bend Substation.

    - This will provide redundant service to Horseshoe Bend.

- Add a new 138-kV transmission line connecting substation D1 (Placerville) to Horseshoe Bend Substation. The route follows an existing distribution line east from Horseshoe Bend to the new substation location.

    - Viewshed impacts are not anticipated to be an issue due to low population density.

- Add a new 138-kV transmission line connecting the new 138-kV source substation with Substation D3 (Smith's Ferry). The purpose of this transmission line is to increase reliability. From the new 138-kV source substation, the line route shown on the map is a straight line over the mountains almost directly east so the line passes the Hidden Lakes Substation about 1.5 miles to the north, then the new transmission line should follow the existing transmission corridor north and east to Substation D3 (Smith's Ferry).

    - It was not the desire of the Committee to build into the Wilderness Lakes subdivision.

Note: If the secondary alternative for Substation D3 (Smith's Ferry) is chosen, a new 138-kV line will be needed to connect Substation D3 (Smith's Ferry) with the line connecting Emmett and Cascade. This transmission line route is the shortest distance between the two points.

Preferred Alternative Analysis

Idaho Power planning engineers performed power flow analyses of the Committee's preferred alternative to ensure it 1) provides adequate capacity and 2) meets Idaho Power's reliability standards. The Committee provided a single option within their preferred alternative, and the engineers developed an analysis scenario based on that option. Figure 30 shows the analysis scenario for all facilities in the West Central Mountains Electrical Plan area. Figures 31, 32, and 33 show the analysis scenario facilities in the Adams County area, Valley County area, and Boise County area, respectively. An analysis was completed on the secondary alternative in the Boise County area involving a 230-kV transmission line option with the same result as the preferred option (see Figure 29).

The power flow analysis indicated the preferred alternative provides both adequate capacity and reliability. No additional lines or substations were required.

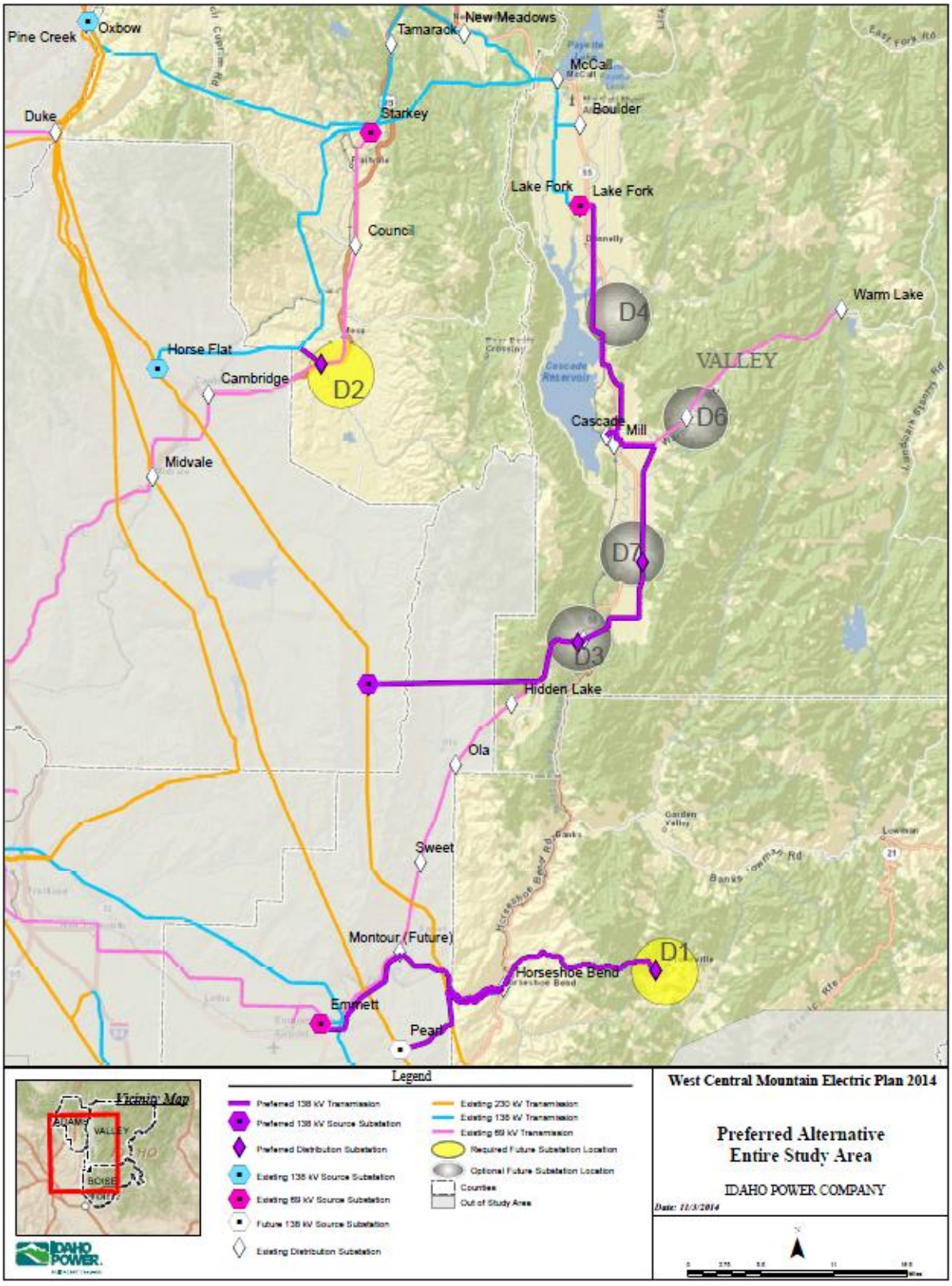

Figure 30
Analysis scenario (preferred alternative), entire study area

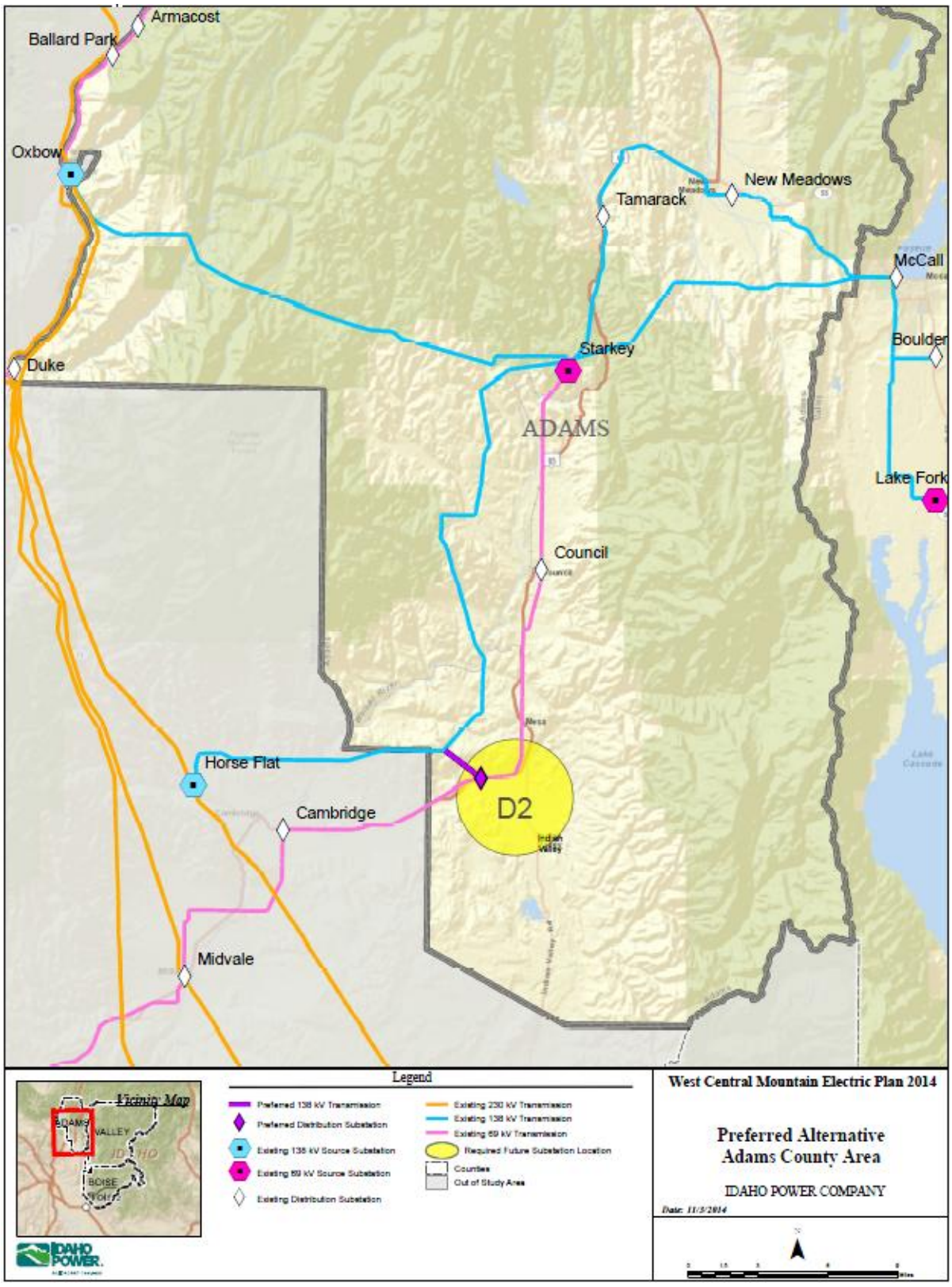

Figure 31
Analysis scenario (preferred alternative), Adams County area

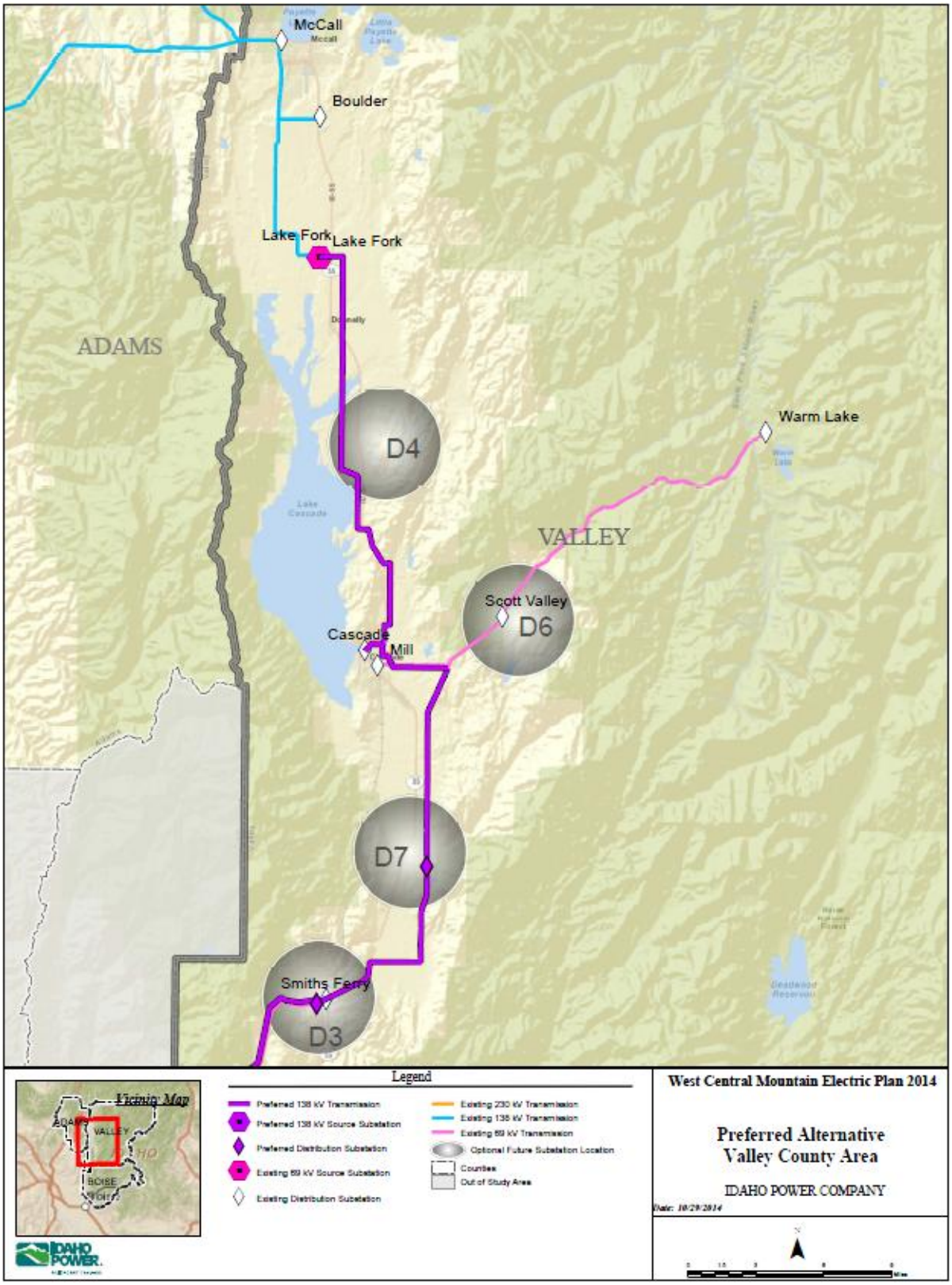

Figure 32
Analysis scenario, (preferred alternative), Valley County area

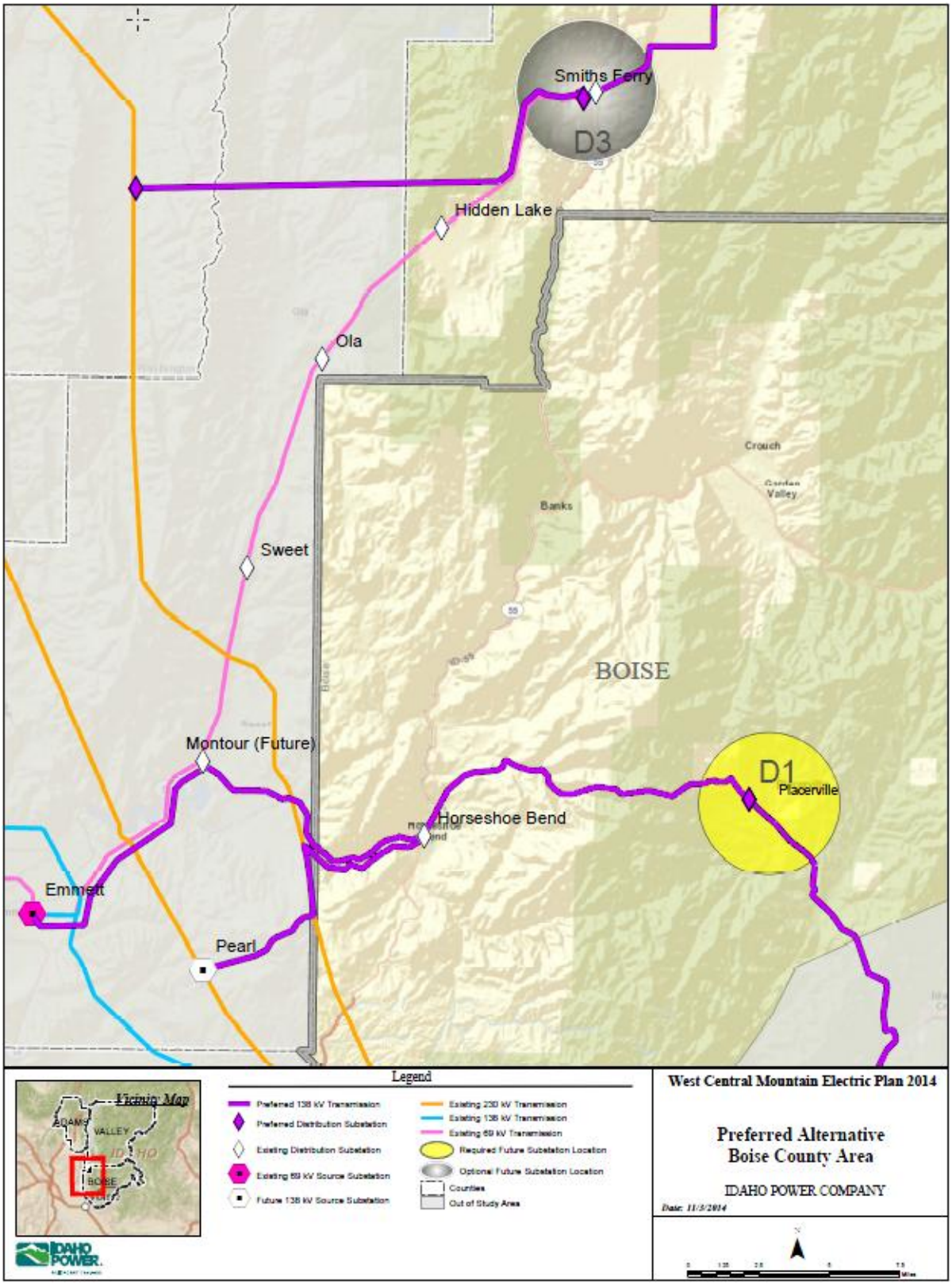

Figure 33
Analysis scenario (preferred alternative), Boise County area

PLAN IMPLEMENTATION

The Plan is a long-term plan that 1) outlines the expected growth in electrical demand in the West Central Mountains region of Idaho Power's service area and 2) delineates the upgrades and additions to the power system needed to serve this growth. This Plan is the result of the Community Advisory Committee process where Idaho Power collected and incorporated the local community's vision and perspective in the earliest stages of the planning process. Creating this Plan is only the first step in building and maintaining a power system that meets the needs of Idaho Power customers in the area. Continued coordination between Idaho Power and the local community is critical when implementing this Plan. Three principle elements will be used to successfully implement the Plan:

1. Introduce the Plan to the public.
2. Integrate the Plan into local comprehensive plans.
3. Phase in the construction of the power system outlined in the Plan.

Introduce the Plan

The collaborative effort between Idaho Power and the Committee has culminated in a written plan to serve the West Central Mountains residents from now to buildout.

Idaho Power will present the WCMEP to the public throughout the West Central Mountains region. Activities will include:

1. Posting the draft and final WCMEP document on Idaho Power's website.
2. Including a feature article in Idaho Power's "Connections" newsletter about the company's efforts to involve the community in long-range planning processes.

Idaho Power will be available upon request to make presentations about the WCMEP process and why Idaho Power believes it is so important to work with local communities to plan for their future electrical needs.

Media Coverage

The media plays an important role in publicizing the West Central Mountains Electrical Plan. Idaho Power will coordinate with written, television, and radio news outlets as necessary to inform and appropriately involve the public throughout the plan implementation process. Idaho Power intends to provide information and resources to the media to distribute accurate information about the Plan. These resources will include the West Central Mountains Electrical Plan webpage, located at idahopower.com/AboutUs/PlanningForFuture/RegionalElectricalPlans/westCentralMountains/, that contains a description of the community advisory process and details of the Plan, including a link to the final report and a contact person for more information. As requested, Idaho Power staff will also be available for interviews by the media throughout the implementation process.

Local Integration of the Plan

The Plan is designed to be a road map for Idaho Power when planning and building the future power system in the West Central Mountains and to assist local governments in their planning processes. Local planning and zoning commissioners, county commissioners, and city planners are encouraged to be familiar with the Plan and to integrate it into their comprehensive plans. This will help ensure the Plan is a relevant, useful part of local area planning. The potential conflict between new residential or commercial developments and the required power system infrastructure can be minimized by planning for future transmission lines and substations and showing their proposed locations in local comprehensive plans as appropriate.

System Implementation

The recommendations of the Plan cover sufficient infrastructure improvements to the Idaho Power system to deliver power for the area's projected load at buildout. Individual projects will be designed and constructed when needed based on future load growth and reliability requirements. As the need for each project nears, Idaho Power will proceed through a detailed design, siting, and permitting process. The recommendations included in this Plan define the optimal location to start the siting process for each project in the West Central Mountains. The current zoning ordinances, land-use restrictions, and availability of the property or ROW will be included in the siting analysis for each project.

The Plan is only the first step in the power system planning process. Idaho Power endeavors to keep the public informed and involved throughout each project's development. The public siting process is adjusted as needed to fit the local community needs and the unique technical and regulatory requirements of each project. Comments from local residents and business owners in the general vicinity of specific projects are gathered through public open houses as necessary. All concerns and recommendations from citizens and jurisdictional representatives will be addressed and considered in choosing the final site or ROW. Final transmission line routes and substation locations are subject to obtaining required permits, easements, and ROWs.

Although a schedule for implementation is listed below, the final implementation of the Plan is dependent on several factors, including the following:

- Load growth rates (resulting from population changes, energy use characteristics, and technology changes)
- Reliability requirements
- Transmission line and transformer capacities (adequacy)
- Budget
- Committee recommendations

The following is a timeline of Idaho Power's recommended near-term implementation plan:

0–10 Years (see yellow legend items in Figure 34)

- Upgrade Boulder Substation facilities. This upgrade will increase the distribution capacity of the Boulder Substation and provide relief to the McCall Substation.

- Upgrade the Montour Substation facilities. This upgrade will add new distribution facilities at the Montour Substation and serve the Montour and Sweet areas currently served from the Horseshoe Bend Substation.

- Rebuild portions of the 69-kV line from the Emmett station to the Montour Substation. The transmission line will be rebuilt to 138-kV construction standards but will continue to operate at the current 69-kV voltage. While this upgrade is located in Gem County, it directly relates to the Plan.

- Rebuild portions of the 69-kV line from the Cambridge Substation to the Starkey Substation. This line serves the cities of Cambridge and Council. While some of this upgrade is located in Washington County, it directly relates to the Plan.

10–20 Years (see green legend item in Figure 34)

- Upgrade Montour Substation facilities. This upgrade will add 138 kV to 69-kV transformation capacity at the Montour Substation and allow the line from the Emmett Substation to the Montour station to operate at 138 kV.

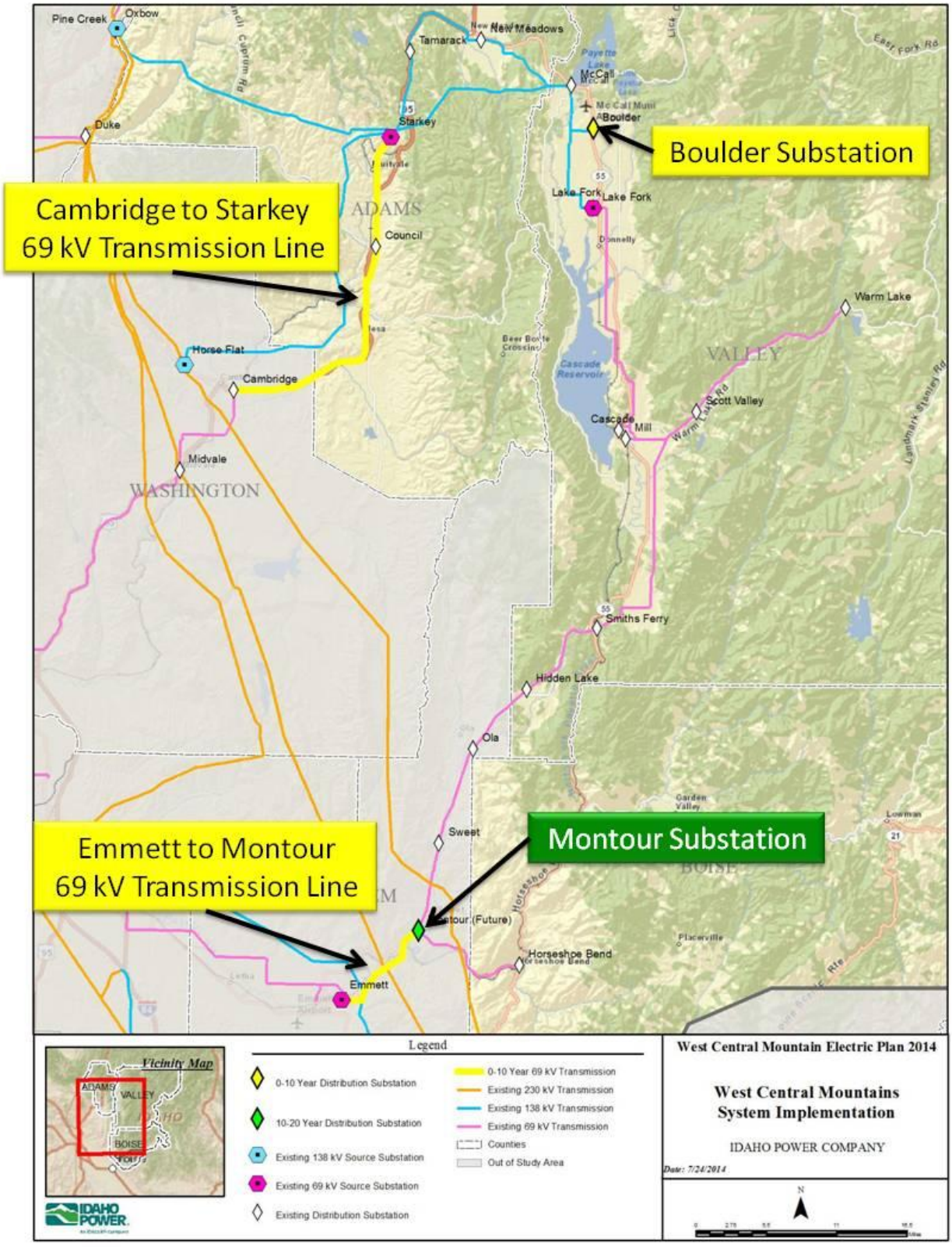

Figure 34
West Central Mountains system implementation

CONCLUSION

The West Central Mountains area population, and its electrical load, has grown significantly over the past 20 years. Growth is picking up, with commercial building leading the way. Along with a renewed growth, the West Central Mountains is becoming more dependent on a reliable electric supply, as is happening across the US. It is important that the electrical system keeps pace with growth and increasing reliability demands and does not deter the growth upon which this region depends.

For these reasons, Idaho Power must be proactive in planning for new infrastructure to serve the needs of the West Central Mountains area and help support continued economic prosperity by providing a reliable electric supply. A long-term plan is necessary to ensure the transmission lines and substations are there when they are needed, and it is important to locate the facilities so they fit into a larger strategy to serve the area. This larger strategy or plan should accommodate the vision and perspective of local communities.

The Plan lays out 230-kV, 138-kV, and 69-kV transmission and substation infrastructure from now through the area's population and electrical load buildout. Developed in a cooperative effort between Idaho Power and the Committee, the Plan identifies locations for transmission lines serving the area for many years to come and provides locations for new substations to serve the region's electrical load. Individual projects proposed by this Plan will require jurisdictional approval and will be put through a public siting process. The Plan is the first step in the planning process. The Plan will provide local governments and citizens advanced notice of where future transmission and substation facilities may be located and allow them to plan accordingly.

Future changes in technology may make some of the proposed improvements unnecessary or delay their need. While these types of shifts are difficult to predict, Idaho Power will monitor them and update the Plan to reflect the changes.

Appendix A
Alternative energy generating technologies

ALTERNATIVE ENERGY GENERATING TECHNOLOGIES

Alternative energy generation technologies were of great interest to some of the Community Advisory Committee (Committee) members. They are included in the *2013 Valley County Economic Development Strategic Plan* as Objective 4.1:

> Energy is a vital input to every economic and household activity of the community, and is a key factor in added-value activities; this is specifically relevant to the Valley County economy with its harsh winters and related energy needs. Self-reliance will therefore not only make our local economy more resilient, it provides more options for economic diversity. The Valley County Region has an abundance of hydro, biomass, geothermal and other renewable resources to produce energy in a distributed and multi-modal manner. The use of these region-specific resources provides a competitive edge to the local economy.

The Committee received a presentation on alternative energy generating technologies during an education session. This presentation and the discussion that followed outlined various alternative energy generating technologies that could be used to meet the energy needs of the West Central Mountains or reduce the need for future transmission lines. The technologies discussed included wind turbines, solar (photovoltaic and thermal), geothermal generators, and fuel cells. A detailed description and discussion concerning these alternative energy generating technologies follows.

Wind Turbines

Wind turbines are an important resource throughout the United States (US) and are becoming more prevalent in Idaho and Oregon for the following reasons:

- The wind speed in the area is generally favorable for wind generation.
- A large amount of land could serve to host wind turbines. A wind turbine can be built on farm land with very little crop land being lost. Additionally, farmers earn rental income by allowing wind turbines to be sited on their land.

Many wind turbine generating facilities have connected to the Idaho Power system in the past 10 years, and more are planned. Transmission lines are required to receive the energy produced by these facilities, so wind turbines do little to reduce the need for transmission infrastructure.

On a smaller scale, residential-size wind turbines mounted on roofs of houses and businesses could provide energy that could displace utility infrastructure. The local residents and governments are the ones who will promote growth in this industry and increase the number of small-scale wind turbines in the area.

Solar-Photovoltaic

The number of sunny days western Idaho has each year indicate it would be a good location for photovoltaic use. On a large scale, solar energy sites benefit from land availability much like wind turbines do in the region. The main negative aspect to photovoltaic energy production is the cost of the photovoltaic panels. The costs are continually decreasing, but it will be a number of years before this type of power production becomes economically viable in Idaho because of the low energy rates already charged to consumers. Like wind turbines, a large photovoltaic facility requires transmission lines to deliver the energy to end users.

But, also like wind, residential- and commercial-size photovoltaic panels could be installed and displace the need for more utility infrastructure. Again, this would be up to the residents, businesses, and local governments to bring greater use of small-scale photovoltaic to fruition.

Solar-Thermal

This type of generation harnesses the energy from the sun to heat a liquid or gaseous medium (e.g. water, sodium, or hydrogen) to turn a turbine that generates electricity. This type of generation requires a tremendous amount of land to produce significant amounts of power. Western Idaho has the advantage of having significant amounts of land that could serve this purpose; however, most of the land that would be available is controlled by the Bureau of Land Management (BLM), and environmental restrictions could limit the land's use. Unlike wind turbine generation, it is unlikely that farm land could be used for solar-thermal generation because it would be quite difficult to farm around these facilities. However, as costs for this generation decrease, some of these solar-thermal facilities might be built in the region. This type of generation would also require transmission lines to deliver its energy.

Geothermal

There are credible geothermal resources within eastern Oregon and eastern Idaho. While much of the geothermal resources are at a lower temperature and not usable for power generation, some are usable. The nearest developed geothermal power generating resources are the Raft River Project located near Raft River, Idaho, and the Neil Hot Springs Project near Vale, Oregon. Idaho Power purchases all the output from these plants.

In addition, geothermal energy is used in Cascade, Idaho, to reduce the energy consumption of the local high school. Future projects are anticipated as well.

If a new geothermal facility is developed in the region on a large scale, it would require electrical transmission lines to deliver the energy to residents.

Fuel Cells

Used in a distributed manner among homes and businesses, fuel cells could displace or delay the need for additional transmission lines in the West Central Mountains. The following drawbacks will take a few years to overcome:

- Residential-size fuel cell systems are currently quite expensive, though there are a number of companies aggressively working to bring down the cost.

- Fuel cells require an outside fuel source, whether it is natural gas, methanol, or pure hydrogen. Unless the fuel cell is fueled by pure hydrogen, some emissions result from making electricity using a fuel cell.

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Appendix B
Energy efficiency

IDAHO POWER ENERGY EFFICIENCY ACTIVITIES AND PROGRAMS

Idaho Power offers a full portfolio of energy efficiency programs in the West Central Mountains as well as throughout most of its service area. A more detailed listing of each program and the various incentives Idaho Power offers can be found at idahopower.com. The following is a brief listing of each program offered.

Residential Customer Programs

A/C Cool Credit

Residential customers with central air conditioning (A/C) can receive a $5 per month credit when the customer allows Idaho Power to cycle their A/C system during periodic June, July, and August afternoons.

Ductless Heat Pump Pilot

Encourages the use of ductless heat pumps to replace electric zonal heating systems. Eligible homeowners receive an incentive for qualified ductless heat pumps installed by a participating contractor.

Energy Efficient Lighting

Teaches customers how ENERGY STAR® qualified compact fluorescent light bulbs (CFL) and light emitting diodes (LED) can save them money every time they flip a light switch. The program offers customer education through retail in-store events, outreach events, and its website.

Energy House Calls

Residential customers can earn a free package of services designed to help save energy for residents of manufactured homes heated by an electric furnace or heat pump.

ENERGY STAR® Homes Northwest

Residential home builders can earn an incentive for each home built to the Northwest ENERGY STAR standard, which is 15% more efficient than a home built to the Idaho energy code.

Heating & Cooling Efficiency Program

This program provides cash incentives to residential customers and heating, ventilation, and air conditioning (HVAC) contractors for choosing and installing qualified energy-efficient heat pumps through approved HVAC contractors.

Home Energy Audit

The program allows all-electric customers to take advantage of a professional in-home energy audit, including recommendations for increasing energy savings and a variety of energy efficiency improvements, such as CFLs, at a discounted price.

Home Improvement Program

Residential customers can earn a 15-cent-per-square-foot cash incentive for upgrading their attic insulation.

Home Products

Customers can earn an incentive payment from Idaho Power for purchasing a qualifying ENERGY STAR product.

Rebate Advantage

This program pays incentives to eligible customers who purchase a new electrically heated ENERGY STAR manufactured home.

See ya later, refrigerator®

Residential customers can receive $30 plus free removal of their old refrigerators or stand-alone freezers.

Weatherization Solutions for Eligible Customers

This program offers weatherization measures for electrically heated homes of qualified customers that help customers maintain a comfortable and energy-efficient home environment.

Irrigation Customer Programs

Irrigation Efficiency Rewards

Agriculture customers can receive incentives of up to 75% for efficiency improvements of an existing pump system or up to 10% when installing a new efficiently designed system.

Irrigation Peak Rewards

This program provides a demand credit for specific irrigation customers who allow Idaho Power to turn off their pumps for a few hours on selected summer days, reducing afternoon peak demand and lowering electric bills. The program works to reduce load on Idaho Power's system as opposed to saving energy.

Commercial/Industrial Customer Programs

Building Efficiency

This program pays incentives of up to $100,000 per project designed to offset part of additional capital expenses for more efficient lighting designs, cooling systems, controls, and building shells in new commercial or industrial construction projects.

Custom Efficiency (complex projects)

Customers can receive financial incentives for large commercial and industrial energy-saving projects to improve the efficiency of their electrical systems or processes. Incentives are $0.12/kilowatt-hour (kWh), up to 70% of the project cost.

Easy Upgrades (simple retrofits)

Commercial customers can receive incentives of up to $100,000 per project for simple energy-saving retrofits to existing commercial and industrial buildings. A menu of eligible retrofits includes improvements, such as new lighting, HVAC equipment, and controls.

FlexPeak Management

Recurring payments for reducing a set amount of electricity consumption in response to Idaho Power peak demand and other system needs.

Renewable Energy Programs

Green Power

Customers contribute funds to purchase energy generated from renewable resources, such as solar and wind. A portion of those funds is used for the Solar 4R Schools program, which installs solar demonstration projects at local schools.

Net Metering

Provides customers the opportunity to operate their own small-scale renewable power generators to offset all or part of their electricity usage. Allows for the sale of excess generation back to Idaho Power.

Energy Efficiency Education Programs

Residential Education Initiative

Homeowners can find valuable information to help reduce energy use and save money via Idaho Power's website, by attending presentations, or by visiting with Idaho Power employees at local events.

Kill A Watt™ Meter Program

Provides easy-to-use meters to local libraries so customers can measure how much electricity appliances and electronics are using.

Commercial Education Initiative

Commercial customers, field personnel, and trade allies may request education to increase understanding and awareness of energy-efficient, conservation-oriented strategies for business and industry.

Appendix C
GIS data layers

Layer	Coverage	Description	Notes
Team Red			
	230-kilovolt (kV) Transmission	230-kV transmission routes (if any) specified by the team	
	138-kV Transmission	138-kV transmission routes specified by the team	
	69-kV Transmission	69-kV transmission routes (if any) specified by the team	
	Distribution Substations	Distribution substation locations specified by the team	
	138-kV Source Substations	138-kV source substations (if any) specified by the team	
	69-kV Source Substations	69-kV source substations (if any) specified by the team	
Team Yellow	Same		
Team Blue	Same		
Facilities ETVEP			
	Preferred_HubSubstations_ETVEP	*Treasure Valley Electrical Plan* (TVEP) Community Advisory Committee (CAC) recommended general areas for siting 138-kV source substations (referred to as hub substations in the *Eastern Treasure Valley Electrical Plan* [ETVEP])	
	Preferred_230kV_ETVEP	ETVEP 230-kV transmission line routes	
	Preferred_138kV_ETVEP	ETVEP 138-kV transmission line routes	
	Preferred_DistSubstation_ETVEP	TVEP CAC recommended general areas for siting distribution substations	
Misc.			
	Parks	Geo Names United States Geological Survey (USGS)	
	Cemetery	Geo Names USGS	
	Airport	Geo Names USGS	
	Schools	Geo Names USGS	
	NatRegHistoricPlace	National Register Historic Place Database	
	Scenic Hwy	Scenic highways	

Layer	Coverage	Description	Notes
	Geo-thermal Resource Area	Geothermal resource area	
	Geo-thermal	Geothermal sites (domestic, hot springs, etc.)	
	SnakeRiver_Scenic Byway	Designated byway	
	West Wide Energy Corridor	Federal utility corridors	
	GeoNames	Geo Names USGS—places, things	
	GeoNamesPlaces	More geothermal information	
Facilities			
	Substations 69 kV	Idaho Power data—existing 69-kV distribution substations	
	Substations 138 kV	Idaho Power data—existing 138-kV distribution substations	
	Source 69 kV	Idaho Power data—existing 69-kV source substations	
	Source 138 kV	Idaho Power data—existing 138-kV source substations	
	Transmission 230 kV	Idaho Power data—existing 230-kV transmission	
	Transmission 138 kV	Idaho Power data—existing 138-kV transmission	
	Transmission 69 kV	Idaho Power data—existing 69-kV transmission	
	Distribution Primary	Idaho Power data—existing distribution (12.5 kV or 34.5 kV)	
	Distribution Secondary	Idaho Power data—existing distribution secondary	
	Future Substation Locations	Circles indicating recommended areas for future substations	
Environmental			
	Natural Areas—IPC GIS Database	Areas of very high environmental values	Added all the Wilderness Study Areas (WSA), Research Natural Areas (RNA), and Areas of Critical Environmental Concern (ACEC) from Enterprise Geographic Information System (GIS) data

Layer	Coverage	Description	Notes
	Visual Resource Management	Bureau of Land Management (BLM) designation for class 1 and 2 visual resource management	Added—only Class 1 shown on maps
	Wetlands	National Wetlands Inventory data	Added from National Wetlands Inventory database
	YellowBillCuckoo	Yellow bill cuckoo habitat areas	
	North_ID_GroundSquirrel	North Idaho ground squirrel habitat areas	
	BaldEagle	Bald eagle	
	FEMA Flood Areas	Federal Emergency Management Agency (FEMA) flood areas	
	Roadless_Areas	Roadless areas	Forest Service
	SageGrouse_Lek_IDFG	Lek locations/both active and unoccupied	
	Sage Grouse Priority Habitat	Key habitats identified by the BLM, 2010	Added Priority-General areas
	Big Game Winter Range—IDFG	Critical elk/deer wintering ground—Identified by the Idaho Department of Fish and Game (IDFG)	Add via Rick Ward /IDFG
	Rare Plants	Idaho Conservation Data Center plant info—National Heritage	Combined with Centers for Disease Control (CDC) Plant & Plan Obs to create RarePlants
	CDC_Animal_ID	Places where certain species of wildlife have been observed. Has no regulatory authority. Only informational Conservation Data Center Wildlife Observations	
	Bull Trout—Streams	Idaho Conservation Data Center	
	Bull Trout—Lakes	Idaho Conservation Data Center	
	Scenic By Way	National scenic byways from the National Scenic Byways Program (NSBP) database	
	Prime Farmland	Derived from Soil Survey Geographic Database (SSURGO)	
	Brownfield Data	Idaho Department of Environmental Quality (IDEQ)	
BaseLayers			
	Cities	Idaho Power Enterprise GIS Data	

Layer	Coverage	Description	Notes
	Roads	Idaho Power Enterprise GIS Data	
	Railroads	Idaho Power Enterprise GIS Data	
	Highway	Idaho Power Enterprise GIS Data	
	City_Boundaries	Idaho Power Enterprise GIS Data	
	IPCoLands	Idaho Power Enterprise GIS Data	
	Parcel	Idaho Power Enterprise GIS Data	
	Ownership	Idaho Power Enterprise GIS Data	
	Waterbody	Idaho Power Enterprise GIS Data	
	Streams_Rivers	Idaho Power Enterprise GIS Data	
	StudyAreaNew	*West Central Mountains Electrical Plan* (WCMEP) area study boundaries	
	County	Idaho Power Enterprise GIS Data	
Zoning			
	Zoning	Aggregated from Boise/Valley/Adams counties and McCall, Horseshoe Bend, Donnelly, New Meadows, Council, and Cascade cities	
Basemap			
	World Imagery	From Esri	
	World Street Map	From Esri	

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Appendix D
ROW analysis

As discussed previously, the Community Advisory Committee (the Committee) chose a number of routes Idaho Power could place 138-kilovolt (kV) and 230-kV transmission lines. Most of the routes follow existing road and transmission rights-of-way (ROW). If the lines are placed in existing transmission corridors, either replacing or upgrading the existing infrastructure or expanding the corridor's width will be required. Securing the ROWs necessary for all transmission lines slated for the West Central Mountains will likely prove the most challenging task facing Idaho Power as it constructs electrical infrastructure to meet the region's buildout scenario.

Transmission line ROWs can be obtained using any of the following methods:

- **Easement**. An easement gives Idaho Power the right to use the land for a specific purpose. Idaho Power acquires rights from private property owners through negotiations. The easement specifies rights and restrictions on Idaho Power's use of the land, while the property owner retains ownership of the land. This is the most common arrangement.

- **Fee Title Ownership**. A landowner may sell the land needed for the transmission line to Idaho Power. Idaho Power then owns the property, receiving title through a deed.

- **Permit**. Idaho Power applies to the appropriate agency for a permit to place the necessary facilities on public lands.

- **Eminent Domain or Condemnation**. If the landowner and Idaho Power are unable to negotiate a price for an easement or purchase of property, Idaho Power may exercise its rights under state law to take the easement or property through court action. The court then determines the fair price to be paid based on testimony provided by independent assessors, Idaho Power, and the property owner's witnesses.

If a transmission line route follows a transportation corridor (ROW), Idaho Power can either place the transmission line within the road ROW or purchase a private easement along the road ROW.

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Appendix E
Load density based on zoning

Jurisdiction	Land Use Definitions	kW/Square Mile
Adams County		
Agriculture, Timber, and Grazing	AG	250
Commercial	C	12,000
Industrial	I	15,000
Irrigated Land Overlay	ILO	300
Recreational Residential	RECR	4,500
Rural Residential	RR	900
Boise County		
Multi-Use		
Commercial	C	12,000
Private Low	P1	250
Private	P2	300
Valley County		
Multi-Use		
Industrial	I	15,000
Residential	R1	900
Low-Density Residential	R2	2,500
Medium-Density Residential	R3	7,000
High-Density Residential	R4	10,000
Rural Low-Density Residential	RR1	300
Rural Medium-Density Residential	RR2	900
Rural High-Density Residential	RR3	3,000
Agriculture/Forest	AG	200
Private	P	250
Cascade		
Agricultural	AG	8,000
Commercial	C	12,000
Low-Density Residential	R1	3,000
Medium-Density Residential	R2	7,000
High-Density Residential	R-1B	10,000
Industrial	I	15,000
Recreational	REC	300
Residential–Commercial	RC	11,000
	R-1AS	5,440

Jurisdiction	Land Use Definitions	kW/Square Mile
Council		
Low-Density Residential	R-3	3,000
Medium-Density Residential	R-2	7,000
High-Density Residential	R-1	10,000
Commercial	C	12,000
Industrial	I	15,000
Donnelly		
Airport	A	2,500
Central Business District	CBD	13,000
Commercial	C	12,000
Industrial	I	15,000
Open	O	300
Medium-Density Residential	R-4	7,000
High-Density Residential	R-8	1,000
Horseshoe Bend		
Residential	R1	10,000
Low-Density Commercial	C2	10,000
High-Density Commercial	C1	12,000
Industrial	I	15,000
Mixed Use	MU	8,000
Public	P	300
McCall		
Agriculture-Forest		3,000
Airport		2,500
Business Park		14,000
Central Business District		13,000
Civic		5,000
Community Commercial		12,000
Estate Residential		1,000
Half-Acre Residential		500
High-Density Residential		10,000
Industrial		15,000
Low-Density Residential		3,000
Medium-Density Residential		7,000
One Acre Residential		1,000
Ponderosa State Park		250
Rural Residential		1,000

Jurisdiction	Land Use Definitions	kW/Square Mile
New Meadows		
Commercial	C	12,000
Industrial	I	15,000
Park	P	300
Residential–Commercial	RC	11,000
Residential	R1	10,000

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Appendix F
N-1 reliability criteria example

Idaho Power must adhere to an "N-1" criterion.

For multiple transmission lines delivering power to the same point, if one of the lines goes out of service, the remaining lines must be able to carry both the load they were carrying before the event and the load carried by the line that goes out of service.

- This is true even if the line with the highest capacity is the one that goes out of service.
- This only holds true for major transmission lines.

Three extra-high-voltage, 345,000-volt (V) transmission lines operating electrically in parallel are shown in Figure F1. All three lines originate at the same location and deliver power to the same location. Each line might take a different path to get there, but all three begin and end in the same locations.

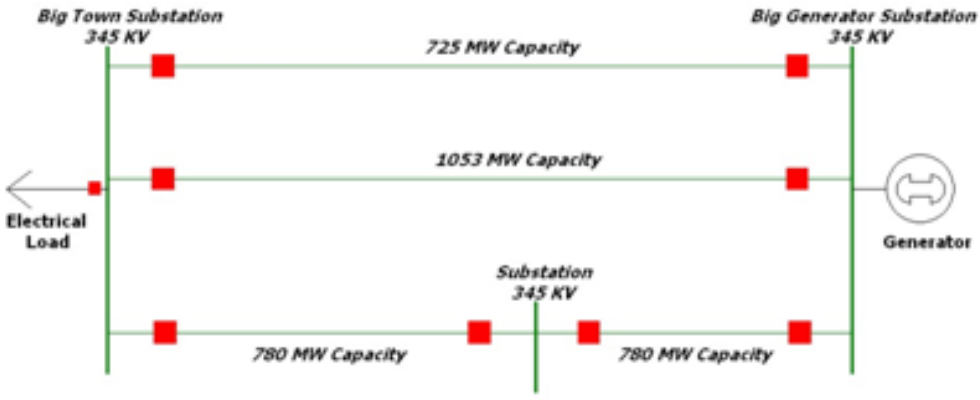

Figure F1
Three parallel transmission lines

In Figure F1, the top line is 100 miles long and has a capacity of 725 megawatts (MW). The middle line is also 100 miles long and has a capacity of 1,053 MW, and the bottom line is 200 miles long and has a capacity of 780 MW. A substation is located at the halfway point on the bottom line, but it has no effect on the power flow.

Normal Operation, No Lines Out

The three lines in Figure F2 are carrying a total of 1,400 MW to a load located at Big Town Substation. The generator is producing 1,406 MW of power, while the load is only consuming 1,400 MW. The difference between the two is due to MW losses on the transmission system, losses that must be supplied by the generator. The green arrows shown on the drawings indicate the direction of power flow.

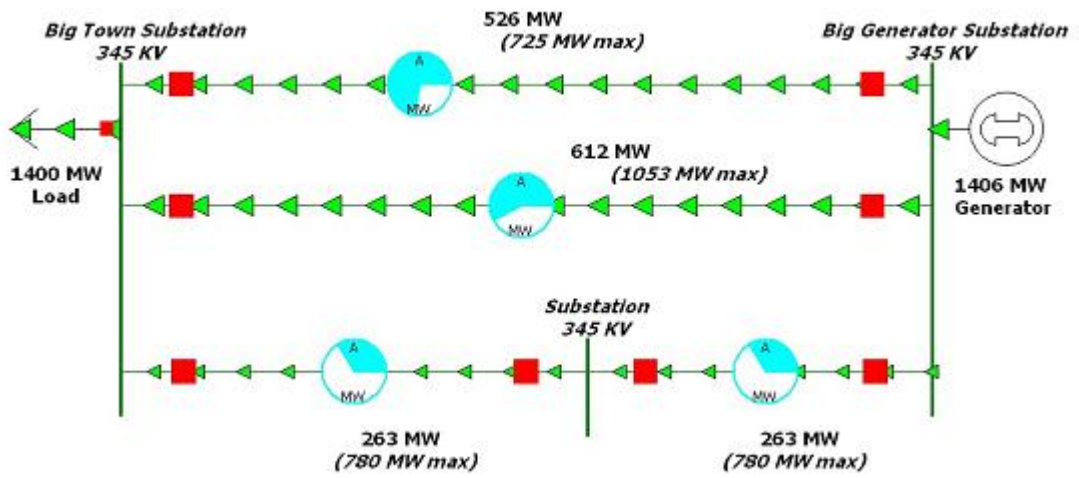

Figure F2
Three parallel transmission lines during normal operation

The blue circle shown on each transmission line is a visual indication of the amount of electrical load on each line. The top circle indicates the line is carrying about three-quarters of the amount it is capable of. If the circle turns orange, it indicates the line is approaching its maximum capacity. A red circle indicates the line has exceeded its capacity.

All three lines are operating within their capacity and could operate like this indefinitely.

- Top line capacity = 725 MW
    - Top line operating at 526 MW
- Middle line capacity = 1,053 MW
    - Middle line operating at 612 MW
- Bottom line capacity = 780 MW
    - Bottom line operating at 263 MW

Bottom Line Out of Service

If the bottom line is removed from service (Figure F3), the circuit breaker located on the right side of the line (red box in upper drawing) turns to a hollow green box when the circuit breaker is open, de-energizing the line.

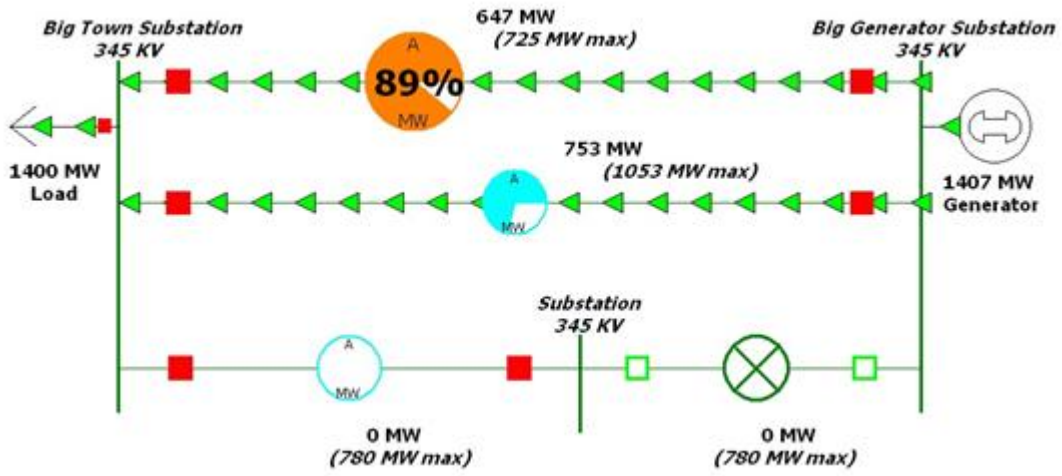

Figure F3
Three parallel transmission lines, bottom line out of service

Notice that no power flows on the bottom line now. The middle line, which has the highest capacity, is now operating at about three-quarters of its capability. The top line indicates it is operating at 89% of its capability, displaying a warning. However, these lines could operate like this indefinitely, so no action is required. In this case, we have met the N-1 criteria.

- Top line capacity = 725 MW
    - Top line operating at 647 MW
- Middle line capacity = 1,053 MW
    - Middle line operating at 753 MW
- Bottom line capacity = 780 MW
    - Bottom line operating at 0 MW

The generator on the right side of the drawing is producing more power compared to the last case. This is because the power losses are higher with one of the lines out of service due to more resistance to power flow.

Top Line Out of Service

When the bottom line is back in-service and the top line is removed from service, the circuit breaker on the right of the top line will change from solid red to hollow green, indicating the line is out of service (Figure F4).

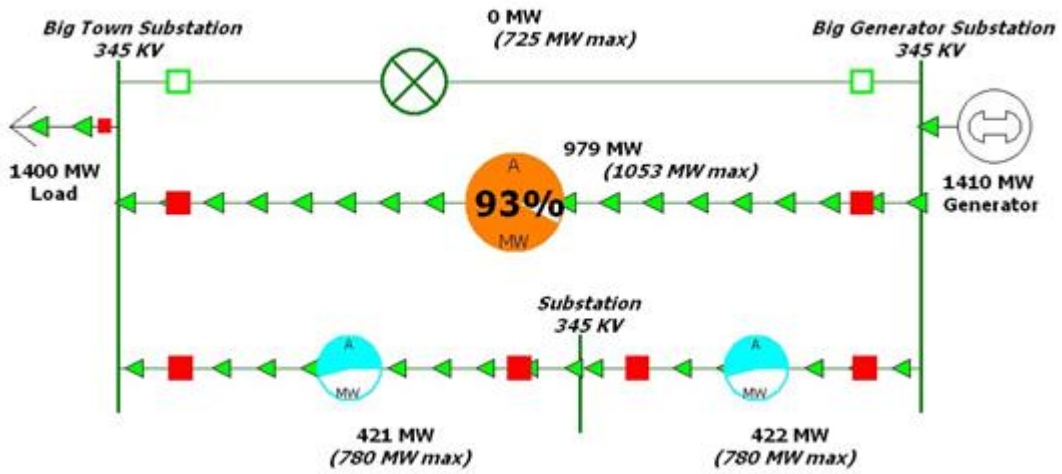

Figure F4
Three parallel transmission lines, top line out of service

No power flows through the top line now. The bottom line indicates it is operating at about two-thirds of its capability, while the middle line is displaying a warning that it is operating at 93% of its capability. These two lines could operate like this indefinitely; no action is required.

- Top line capacity = 725 MW
    - Top line operating at 0 MW
- Middle line capacity = 1,053 MW
    - Middle line operating at 979 MW
- Bottom line capacity = 780 MW
    - Bottom line operating at 421 to 422 MW

The generator is now producing more power because of the greater line losses that occur with one of the lines out of service.

Middle Line Out of Service

In Figure G5, the top line is put back in service and the middle line is removed from service. This is indicated by the circuit breaker located on the right side of the middle line changing from a solid red box to a hollow green box.

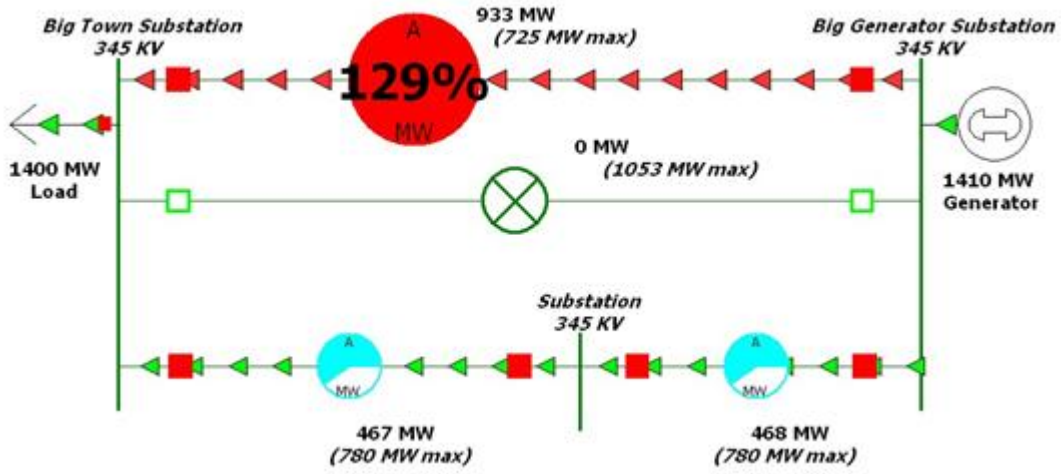

Figure F5
Three parallel transmission lines, middle line out of service

Figure F5 indicates the bottom line is operating at about two-thirds of its capability, and this can be maintained indefinitely. However, the top line's indicator shows it is now operating at 129% of its capability. A transmission line cannot operate like this for very long because the line gets too hot and it can be damaged to the point of breaking. In this case, the three transmission lines have failed the N-1 test. When the largest transmission line was taken out of service, the other two could not safely carry the power it was carrying plus the power they were carrying before the incident.

- Top line capacity = 725 MW
    - Top line operating at **933 MW**
- Middle line capacity = 1,053 MW
    - Middle line operating at 0 MW
- Bottom line capacity = 780 MW
    - Bottom line operating at 467 to 468 MW

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