Study to Combine Interlaken Substation with Ardmore Substation

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Executive Summary

Ardmore Substation has been in planning and development by PSE for several years. It has been planned as a combination distribution and transmission switching substation, while taking advantage of its location to bring together three existing transmission lines. This will both beef up the distribution system capacity in an area that serves critical load with more growth planned, and also increase transmission reliability and capacity.

After working with many property owners and community representatives in the area, PSE has purchased a site in a commercially zoned area to build the new substation. Due to its relatively close proximity to the existing Interlaken Substation, the Ardmore project team examined whether it would make sense, from an engineering, operating and community standpoint, to combine both substation facilities at the new site.

After studying four project configuration alternatives, the team recommends the following:

> **The project scope will be changed to combine both Interlaken and Ardmore at the new substation site. Three transmission lines and two transformer banks will be installed initially. At full build out Ardmore Substation will include four transmission lines and four transformers banks. The Interlaken Substation equipment may be removed after its circuits are cut over to the new Ardmore Substation. The Interlaken Property is recommended to be held for possible future use, and possibly sold at a later date.**

The benefits of this course of action will be:

- Will not need to build a new transmission line between Interlaken and Ardmore
- The existing 1/8 mile transmission line tap on 152nd Avenue NE may be removed
- Lower substation and transmission line presence in the immediate community
- Improved reliability to all of the customers served by Ardmore
- Standard substation equipment and operating procedures may be used
- Permitting will be simpler than the original plan
- The cities of Redmond and Bellevue will be in support of this plan.

The disadvantages of this plan will be:

- Additional distribution lines will be built to tie existing distribution circuits to the new substation.
- Building 20 rather than 10 distribution get-a-ways will be more challenging.
- The distribution cutover from Interlaken to Ardmore will be complex.
- Slightly larger substation at Ardmore
- Surplusing a viable substation site at Interlaken
- Project cost increase of $875,000 estimated, before selling Interlaken site.

Pursuing this course of action can be done while keeping critical action items on course to meet the project schedule.

I. Background

The Ardmore Substation has been in development for the past four years. With increasing development in the Northeast Bellevue/South Redmond area, surrounding substations have been loaded above nameplate for a few years. Additional commercial and multi-family residential load growth is anticipated with plans for developing the Bel-Red corridor in Bellevue, the Overlake area in Redmond and the Microsoft campus in Redmond. After a three-year site selection process, PSE has purchased a site at NE 24th St and NE Bel-Red Road in Redmond, suitable for substation construction.

The transmission system in the area is limited in its ability to provide high reliability. With one transmission line serving six substations already, it is not possible to provide automatic switching to sectionalize transmission faults. For planned work that requires an outage on the transmission line, all six of the substations are at risk of outage if there is an unplanned fault on the other end of the line. This is a good location on the transmission system to build a switching station and bring a third transmission line to this substation, with provisions for a future fourth line for greater capacity and reliability.

The project is intended to build a double bank distribution substation combined with a 115 kV bus designed for four transmission lines. The switching station portion of the substation will include the 115 kV bus and transmission lines. Initially, the 115 kV lines will include a line to Sammamish Substation via Kenilworth Substation, a line to Lakeside Substation via Midlakes substation, and a radial transmission line that serves Lake Hills Substation. There are concurrent plans to build a section of 115 kV line from Lake Hills Substation to Phantom Lake Substation that will result in a second line from Ardmore Substation to Lakeside Substation. In the future, a fourth line from Ardmore Substation will be built to the future Westminster Substation on NE 24th St at approximately 138th Ave NE.

PSE is now commencing the engineering phase of the project, in order to obtain permits in time to meet the project goal of energization in 2011. Key factors in meeting the in-service date include permitting schedule and long-lead time order items such as the 115-12.5 kV transformer, 12.5 kV metalclad switchgear and the 115 kV sulfur hexafluoride (SF_6) gas insulated switchgear (GIS).

PSE has operated the Interlaken Substation for many years at 152nd Ave NE and NE 21st Street. Interlaken Substation is presently a single bank substation, planned for future double bank, served by a short transmission tap connected to the Lakeside-Kenilworth 115 kV line. Before installing a second transformer bank, PSE would need to loop the transmission line through the substation, in order to provide suitable reliability from a transmission and substation standpoint. The project to loop Interlaken Substation is being built in conjunction with the Ardmore Substation project, so that both substations may be appropriately designed for the planned future development. If the Interlaken loop project were deferred until later, the transmission getaways at Ardmore Substation might need to be re-built to a different direction of incoming transmission line in the future. This project is intended to avoid such future conflicts.

Both Interlaken and Ardmore Substations will serve predominantly commercial customers, together with some residential and multifamily customers.

A. Reasons to consider consolidation of substations

1. Close Proximity

With two substations on the same superblock, PSE has a substantial presence in this area. The customers are relatively close to both substations and could be served without a decrease in voltage from the same substation location.

2. Maintenance Replacement Work Planned for Interlaken Substation

PSE has a planned replacement program for substation equipment that reaches end of life and shows indications of loss of life. Planned replacement work at Interlaken Substation within the next three years includes two 12.5 kV circuit breakers and the substation transformer. In addition, Interlaken's 115 kV fuses will be overdutied with the Ardmore Substation improvements and will require replacement with a circuit switcher. The loop through project will require extending the 115 kV bus and installing a second 115 kV switch and dead-end tower. When the second transformer bank is installed at Interlaken, space constrictions will probably require that the existing open-air 12.5 kV feeder structure be replaced with a metalclad structure. The control cabinet will require replacing with a metalclad protection and controls (MPAC) structure.

With Alternatives A, B and C, the 115 kV dead-end tower and buswork and 12.5 kV metalclad structure at Interlaken Substation will not be required. This will reduce the engineering time required for the project, particularly Controls Engineering.

If the existing equipment is moved to the Ardmore site (Alternatives A and B), the cost to move the substation equipment will be offset by the avoided cost to replace the equipment mentioned above. In addition, the Interlaken Substation property could be sold.

3. Avoid Transmission Loop Through at Interlaken Substation

The proposed new transmission line (Alternative D) to loop Interlaken from the Lakeside line to Ardmore will most likely follow the route from Interlaken Substation along SE 21st St to Bel-Red Rd, then north to Ardmore Substation. This project will face challenges in siting three poles along Bel-Red Road. Easements will be required from private property owners along the edge of the road. The City of Redmond suggested building the new line in a new median on Bel-Red Road, but on further review rescinded that suggestion.

The transmission tap to Interlaken Substation uses an additional pole on the north side of NE 24th St. which provides an end point for the conductors, which connect to the main line by way of a "flying tap", since there is not room for a transmission pole at the tap point. The proposed Sound Transit light rail line is intended to turn from NE 24th to 152nd NE at this intersection, requiring relocation or removal of this northerly pole.

Alternatives A, B and C would result in not building a new transmission line the ¼ mile from Interlaken Substation to Ardmore Substation. Alternatives A and B would allow removal of the existing transmission tap line and the pole on the north side of NE 24th St.

If Alternative C is chosen, Interlaken Substation will remain on a short transmission tap, which will provide less transmission reliability to that substation than a looped transmission line.

4. Better Reliability

Customers served out of Ardmore Substation, with a high side 115 kV ring bus with three transmission lines, will receive more reliable service than customers served from a radially-fed substation such as Interlaken or a loop-fed substation. Moving Interlaken's customers to Ardmore will improve reliability for those customers.

The present system serving Interlaken Substation results in a sustained outage at Interlaken for any transmission line fault between Midlakes and Kenilworth or on the Lake Hills Tap or Interlaken Tap. Customers served from the new Ardmore Substation (Alternatives A and B) with three transmission lines will not see an outage for any single transmission fault. The third transmission line, which requires completion of the Lake Hills-Phantom Lake 115 kV transmission line project, will provide high reliability to the customers at Ardmore, even when one of the three lines is out of service for maintenance. The increased reliability with the third transmission line is also a benefit to customers of the other substations on the transmission lines. Customers served by Interlaken after Ardmore is energized (Alternative C) would have an outage only for faults between Midlakes and Ardmore or on the Interlaken Tap, only half the previous exposure. If automatic switching were employed at the transmission line switch west of the Interlaken Tap, Interlaken would be at risk only for the ¼ mile of transmission line between Ardmore and Interlaken Substations; a fault in that line section would require that the fault be repaired in order to restore power, which could take several hours. The original plan looping Interlaken (Alternative D) would also restore Interlaken automatically for all transmission line outages except for a fault between Ardmore and Interlaken, which would result in power being restored by supervisory control within 20 minutes.

B. Possible Detrimental Effects of Consolidation

1. Large Concentration of 12 kV Feeder Cables

With 75 MVA or 120 MVA of capacity at Ardmore Substation, there will be 15-20 12 kV feeder cables leaving the substation. Concentrating many feeders in one trench leads to reduced capacity due to heating. The system will need to be designed to avoid excessive cables in common trenches.

2. More Load Exposure to Terrorist Damage

While the larger substation will have excellent reliability due to its 115 kV bus and breaker layout, in the remote possibility of a terrorist attack or other major local disaster impacting the substation, quite a lot of load will be at risk. This is a very remote possibility and is true of other substations with more than 50 MVA capacity.

3. Larger Substation

Building the Ardmore Substation to accommodate one or two additional transformers and their associated 12 kV equipment will require a slightly larger substation footprint, approximately 11% larger than the original plan. This may be seen as a negative community impact.

II. Alternatives Considered

A. Install 4-25 MVA transformers at Ardmore with a 115 kV 8-position ring bus. Remove Interlaken Substation.

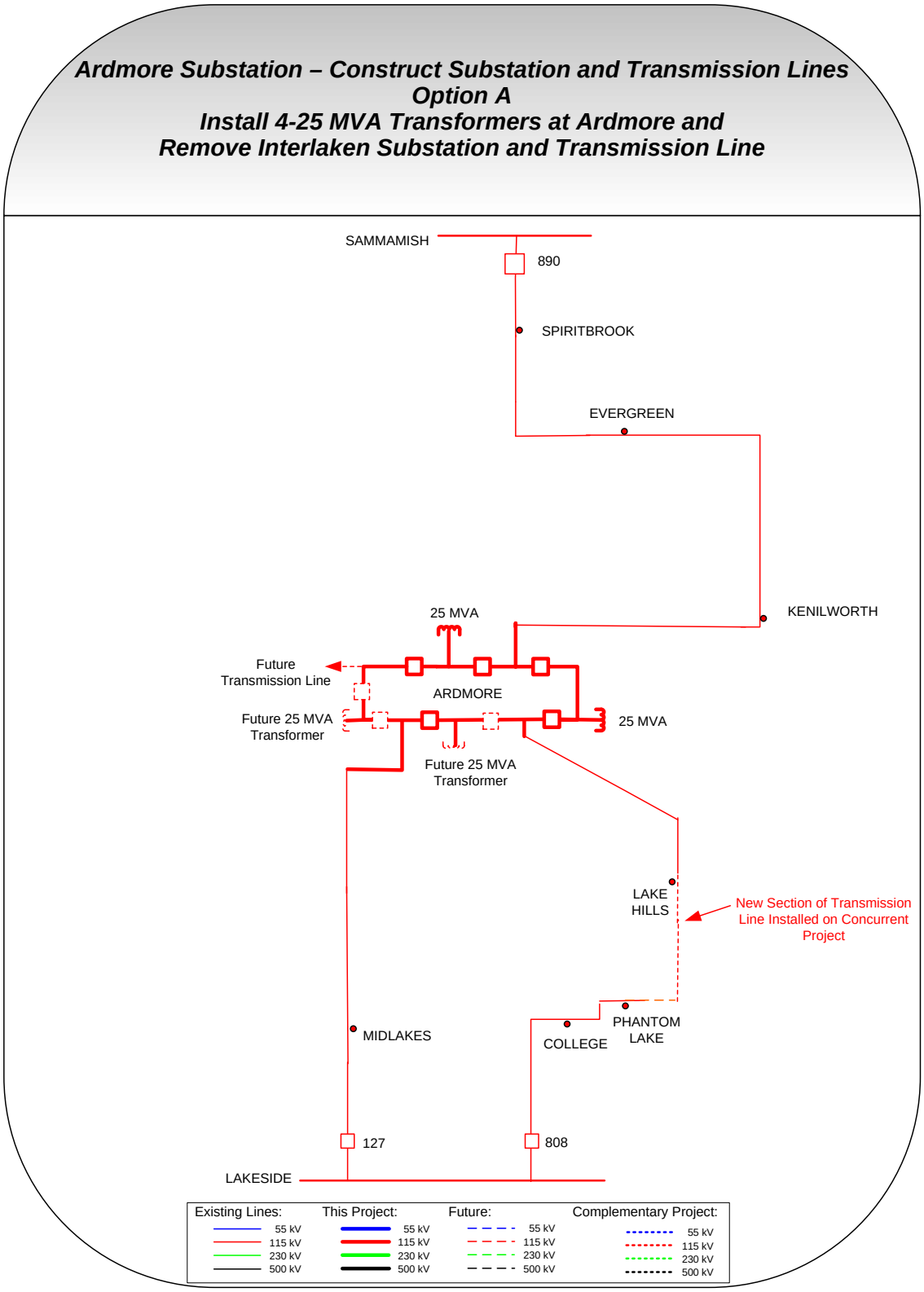

Figure 1: One Line Diagram Alternative A

a. Description

This alternative results in an 8-element 115 kV ring bus connecting ultimately 4 115 kV transmission lines and 4-25 MVA transformers. Initially 3 transmission lines and 2-25 MVA transformers will be installed. Sulfur hexafluoride (SF_6) gas insulated switchgear (GIS) will be used for the 115 kV bus and circuit breakers. The GIS will be configured in a ring bus arrangement, with 5 circuit breakers initially and planned expansion to 8 circuit breakers in the future. Metalclad switchgear will be installed for the 12.5 kV circuits served by each transformer, with bus ties between metalclad structures to enable load transfer. 12.5 kV capacitors will be required, one for each 25 MVA transformer. The equipment will be laid out to enable vehicle access to the major equipment. There will be 3-35 foot dead end towers for the first 3 transmission lines. The fourth line is planned to enter the substation underground, due to a congested line route.

The 115 kV line from Sammamish Substation will approach Ardmore Substation where it already exists along the south side of NE 24th St coming from Kenilworth Substation. It will be terminated from the east side of the substation, having crossed Bel-Red Rd. The 115 kV line to Lake Hills Substation will approach Ardmore Substation along the south side of NE 24th St, where it will be double-circuited with the existing Kenilworth line from 156th Ave NE to Bel-Red Rd, and then into the east side of the substation. The 115 kV line from Lakeside Substation will enter the substation from the north, along PSE's driveway, from its existing location on the south side of NE 24th St.

It should be noted that the benefits of connecting a third line at Ardmore depend on a separate project to build a new section of transmission line to connect Lake Hills and Phantom Lake Substations being completed successfully.

The fourth line is planned to go north on PSE's driveway, then west along NE 24th Street to the future Westminster Substation at NE 24th and approximately 138th Ave NE. This line is probably 10 years or more in the future.

Distribution circuits will be transferred from Interlaken to Ardmore after Ardmore Substation is energized. The Interlaken Substation equipment may then be removed and the substation property sold as surplus. The four poles and 795 kcmil ACSR conductor which form the 1/6 mile Interlaken transmission tap may be removed.

b. Substation Impacts

This alternative can be built using standard PSE equipment at Ardmore Substation. The Maintenance Planning budget intended for replacing aged equipment at Interlaken can be used to install new equipment at Ardmore

instead. The engineering and construction work at Interlaken will be minimal.

The substation design includes adequate space for maintenance and operation of the equipment. The replacement of some transformers will require a line outage in order to safely use a crane to remove the equipment; however, this is typical for many of PSE's existing substations. Provisions were included for 20 feeder getaways on the substation property along with a 15' wide trench with conduit for the future underground transmission line planned for this substation.

c. Distribution Line Impacts

The distribution line getaways maximize the Ardmore substation property frontages along 24th and Bel-Red Rd. This helps separate conduits into multiple trenches to improve heat dissipation and the current carrying capacity of the feeders. Rerouting the Interlaken circuits adds four (4) conduits from Ardmore, south along Bel-Red Rd and then east along 21st to Interlaken substation feeder vaults. The fifth Interlaken circuit adds a conduit from Ardmore substation, north to 24th and intercepts the existing Interlaken circuit. The estimate assumes some use of the sidewalk and includes additional costs for pavement overlay if the trench needs to be in the roadway.

This option will avoid trenching from Interlaken north along the congested 152nd Ave NE for the second bank of feeders that would be added to Interlaken when the new transformer bank is installed.

d. Transmission Line Impacts

Alternative A will result in the first Lakeside line entering the substation from NE 24th rather than from Bel-Red Road. The section of existing transmission line on NE 24th from the north driveway to Bel-Red Rd may be removed.

e. Property Considerations

A benefit of this option is that it avoids the need to obtain frontage and overhang easements for the transmission line loop between Interlaken and Ardmore Substations. This is a very difficult area to site a new line due to future plans to widen NE Bel-Red Road and because zoning provides for multi-story mixed use development with zero lot line setbacks.
One caution with this option is that it is extremely difficult to find a suitable and a well located property near transmission lines for electrical substations in a High Density /Central Business district area. It is also very expensive and very difficult to permit. Therefore, PSE must make every effort to preserve every existing electrical substation, especially one that is located in a High Density /Central Business district, until we know for certain that we no longer have a need.

f. Permitting Considerations

For permitting purposes, the differences between Alternatives A, B, C, and D relate to:

Substation footprint (size, location on the site)
Visibility and screening
Number of new transmission lines required

The different alternatives will not result in different types of permits, except perhaps the need for a Tree Removal Permit (see below). Choosing Alternatives A or B, combining Interlaken and Ardmore, may generate "goodwill" with the City, but the value of goodwill is difficult to measure, and may be partially off-set by additional work needed to permit the larger footprint.

Substation Footprint. Alternatives A, B, and C have similar footprints, and require significant grading and fill in the western portion of the site. Although the slope along the western property line is not considered a critical area, the large new retaining wall will have to be engineered, and the presence of existing vegetation may trigger a Tree Removal Permit if any of the trees are 6 inches or more in diameter (considered "Significant Trees"). Up to 5 Significant Trees per acre may be removed per calendar year; removal of more than 5 such trees requires approval of a Tree Removal Exception Request. One replacement tree is required for each significant tree removed. If replacement trees must be located off-site, longer negotiations with the City of Redmond would be required. If a Landmark tree is removed (30+ inches in diameter), three replacement trees are required.

Visibility and Screening. All four Alternatives would require screening, especially from NE 24th Street and Bel-Red Road. The larger footprint for Alternatives A, B, and C (vs. Alternative D) does not appear to significantly change the area available for screening, except along the west property line.

Transmission Lines. Alternatives A, B, and C do not require the new transmission line between Interlaken and Ardmore; this is a significant advantage. For Alternatives A, B, and C, the only new line is the double circuit on NE 24th; this line would be located within both Redmond and Bellevue. That portion of the line within Redmond (that portion west of Bel-Red Road) would be included in the Redmond CUP for the substation. It is currently unknown what type of permitting will be required for double-circuiting the existing transmission line within the City of Bellevue. If the only new line in Bellevue is the double circuit on NE 24th, it is possible it could be approved administratively (and not require a CUP).

Public Concerns
In comparison with the four alternatives, A and B have the least amount of public concerns.

With there being no need for the installation of a transmission line in between the Interlaken and Ardmore Substations the property owners will benefit from not having a transmission line interfere with their future development.

The City of Bellevue and Redmond have plans for the redevelopment of Bel-Red, which include multi-story/mixed-use development. The construction of a transmission line along this roadway would impede future development, thus making this a benefit for the cities to support this alternative.

The abutting property owners to the north of the Ardmore Substation will benefit from the removal of the existing transmission lines along the north side of their property, on NE 24th Street, but they will have the Ardmore Substation site constructed on the West and South sides of their commercial property, along with two new transmission lines crossing over Bel-Red on the East side of their property. These property owners have already expressed concerns to PSE about Ardmore Substation and the proposed transmission lines.

There is benefit if the Interlaken Substation is sold as surplus, as the City of Redmond is planning for the redevelopment of 152nd Ave NE, which would make the site more attractive to future multi-story/multi-use development. City Department heads have stated that they would write a support letter for our project if we were to combine the two substations, and that they will help us expedite thru the permitting process.

Also, abutting property owners around the Interlaken Substation would support the project since it would eliminate the existing substation site and overhead transmission lines next to their properties.

B. Install 3-40 MVA transformers at Ardmore with a 115 kV 7-position ring bus. Remove Interlaken Substation.

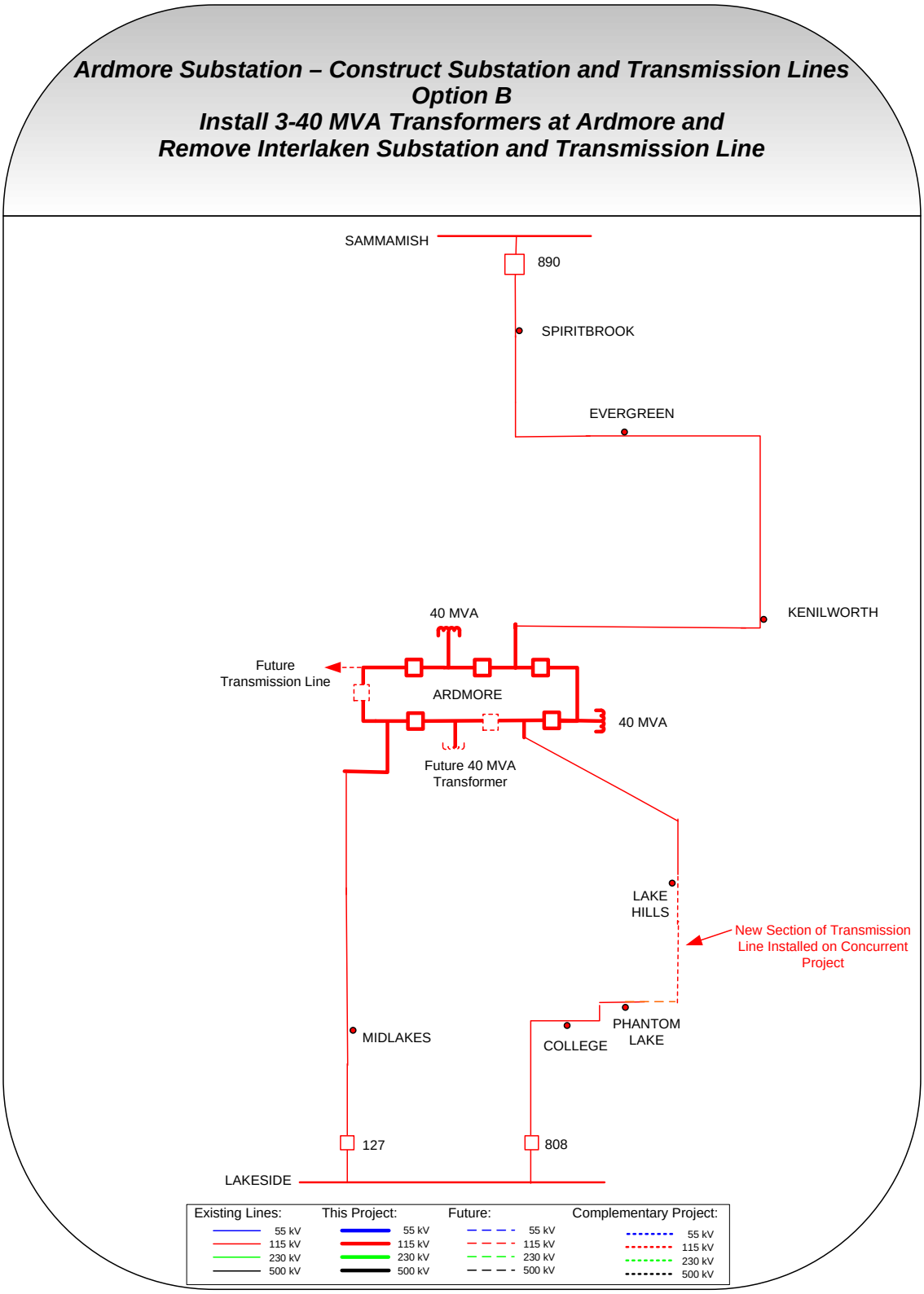

Figure 2: One Line Diagram Alternative B

a. Description

This alternative results in a 7-element 115 kV ring bus connecting ultimately 4-115 kV transmission lines and 3-40 MVA transformers. Initially 3 transmission lines and 2-40 MVA transformers will be installed. Sulfur hexafluoride gas insulated switchgear (GIS) will be used for the 115 kV bus and circuit breakers. The GIS will be configured in a ring bus arrangement, with 5 circuit breakers initially and planned expansion to 7 circuit breakers in the future. Metalclad switchgear will be installed for the 12.5 kV circuits served by each transformer, with bus ties between metalclad structures to enable load transfer. 12.5 kV capacitors will be required, one for each 40 MVA transformer. The equipment will be laid out to enable vehicle access to the major equipment. There will be 3-35 foot dead end towers for the first 3 transmission lines. The fourth line is planned to enter the substation underground, due to a congested line route.

The 115 kV line from Sammamish Substation will approach Ardmore Substation where it already exists along the south side of NE 24th St coming from Kenilworth Substation. It will be terminated from the east side of the substation, having crossed Bel-Red Rd. The 115 kV line to Lake Hills Substation will approach Ardmore Substation along the south side of NE 24th St, where it will be double-circuited with the existing Kenilworth line from 156th Ave NE to Bel-Red Rd, and then into the east side of the substation. The 115 kV line from Lakeside Substation will enter the substation from the north, along PSE's driveway, from its existing location on the south side of NE 24th St.

It should be noted that the benefits of connecting a third line at Ardmore depend on a separate project to build a new section of transmission line to connect Lake Hills and Phantom Lake Substations being completed successfully.

The fourth line is planned to go north on PSE's driveway, then west along NE 24th Street to the future Westminster Substation at NE 24th and approximately 138th Ave NE. This line is probably 10 years or more in the future.

Distribution circuits will be transferred from Interlaken to Ardmore after Ardmore Substation is energized. The Interlaken Substation equipment may then be removed and the substation property sold as surplus. The three poles and 795 kcmil ACSR conductor which form the 1/6 mile Interlaken transmission tap may be removed.

There will be challenges associated with employing 40 MVA transformers in the substation. This is a design that will be new to PSE and should be thought through quite thoroughly. Some of the considerations include:

- Loading: the transformer should not be loaded so high as to experience loss of life. New transformers may be loaded to 132% in the winter or 108% in the summer without loss of life, however older transformers have not been studied as successfully. With high commercial loads, these transformers should be considered summer peaking.
- Load transfer: the distribution system should be designed to be able to transfer load off the transformer at peak. This may take the form of:
    - 12 kV bus section breakers that will limit how many breakers will trip off line for a transformer fault.
    - Bus ties between distribution buses on both sides of the transformer. (2 bus ties instead of 1)
    - Bus ties sized to carry the full 40 MVA load – perhaps overhead like at Juanita
    - Multiple feeder ties (up to 7 for each transformer bank) to neighboring substations with transfer capacity available
    - Feeder ties sized for the high circulating current that will flow (700 A) when a fully loaded 25 MVA transformer is tied to a lightly loaded or unloaded 40 MVA transformer. This may require replacing cables on circuits out of neighboring substations if bus ties are not available in the same substation.
- Number of 12.5 kV feeders
- Fault current: The available fault current will require mitigation to prevent overdutying PSE's 12.5 kV equipment and existing commercial customers' equipment. Perhaps phase reactors will be required or transformers with increased impedance.
- Capacitor bank size: 6 MVAr will be required to offset the transformer reactive requirements at full load. Additional capacitance may be advisable to offset the reactive customer load on circuits that will not have overhead lines for pole-mounted capacitors. It may be necessary to develop a design for switched 6 MVAr or higher capacitors.

b. Substation Impacts

This alternative will require developing new designs and standards for 40 MVA transformer and associated equipment at Ardmore Substation. The Maintenance Planning budget intended for replacing aged equipment at Interlaken can be used to install new equipment at Ardmore instead. The engineering and construction work at Interlaken will be minimal.
The substation design includes adequate space for maintenance and operation of the equipment. Due to the use of 40 MVA transformers and the additional load at risk, new designs and standards will need to be

implemented on the 12.5 kV portion of the substation. Significant impacts include the bus ties between the metalclad switchgear and adding bus section breakers in the 12.5 kV feeder bus.

As in option A, the replacement for some transformers will require a line outage in order to safely use a crane to remove the equipment; however, this is typical for many of PSE's existing substations. Provisions were included for 21 feeder getaways on the substation property along with a 15' wide trench with conduit for the future underground transmission line planned for this substation.

c. Distribution Line Impacts

The distribution line getaways maximize the Ardmore substation property frontages along 24th and Bel-Red Rd. This helps separate conduits into multiple trenches to improve heat dissipation and the current carrying capacity of the feeders. Rerouting the Interlaken circuits adds four (4) conduits from Ardmore, south along Bel-Red Rd and then east along 21st to Interlaken substation feeder vaults. The fifth Interlaken circuit adds a conduit from Ardmore substation, north to 24th and intercepts the existing Interlaken circuit. The estimate assumes some use of the sidewalk and includes additional costs for pavement overlay if the trench needs to be in the roadway. This option will avoid trenching from Interlaken north along the congested 152nd Ave NE for the second bank of feeders that would be added to Interlaken when the new transformer bank is installed.

d. Transmission Line Impacts

Alternative B will result in the first Lakeside line entering the substation from NE 24th rather than from Bel-Red Road. The section of existing transmission line on NE 24th from the north driveway to Bel-Red Rd may be removed.

e. Property Considerations

A benefit of this option is that it avoids the need to obtain frontage and overhang easements for the transmission line loop between Interlaken and Ardmore Substations. This is a very difficult area to site a new line due to future plans to widen NE Bel-Red Road and because zoning provides for multi-story mixed use development with zero lot line setbacks.

One caution with this option is that it is extremely difficult to find a suitable and a well located property near transmission lines for electrical substations in a High Density /Central Business district area. It is also very expensive and very difficult to permit. Therefore, PSE must make every effort to preserve every existing electrical substation, especially one like Interlaken that is located in a High Density /Central Business district, until we know for certain that we no longer have a need.

f. Permitting Considerations

For permitting purposes, the differences between Alternatives A, B, C, and D relate to:

Substation footprint (size, location on the site)
Visibility and screening
Number of new transmission lines required

The different alternatives will not result in different types of permits, except perhaps the need for a Tree Removal Permit (see below). Choosing Alternatives A or B, combining Interlaken and Ardmore, may generate "goodwill" with the City, but the value of goodwill is difficult to measure, and may be partially off-set by additional work needed to permit the larger footprint.

Substation Footprint. Alternatives A, B, and C have similar footprints, and require significant grading and fill in the western portion of the site. Although the slope along the western property line is not considered a critical area, the large new retaining wall will have to be engineered, and the presence of existing vegetation may trigger a Tree Removal Permit if any of the trees are 6 inches or more in diameter (considered "Significant Trees"). Up to 5 Significant Trees per acre may be removed per calendar year; removal of more than 5 such trees requires approval of a Tree Removal Exception Request. One replacement tree is required for each significant tree removed. If replacement trees must be located off-site, longer negotiations with the City of Redmond would be required. If a Landmark tree is removed (30+ inches in diameter), three replacement trees are required.

Visibility and Screening. All four Alternatives would require screening, especially from NE 24th Street and Bel-Red Road. The larger footprint for Alternatives A, B, and C (vs. Alternative D) does not appear to significantly change the area available for screening, except along the west property line.

Transmission Lines. Alternatives A, B, and C do not require the new transmission line between Interlaken and Ardmore; this is a significant advantage. For Alternatives A, B, and C, the only new line is the double circuit on NE 24th; this line would be located within both Redmond and Bellevue. That portion of the line within Redmond (that portion west of Bel-Red Road) would be included in the Redmond CUP for the substation. It is currently unknown what type of permitting will be required for double-circuiting the existing transmission line within the City of Bellevue. If the only new line in Bellevue is the double circuit on NE 24th, it is possible it could be approved administratively (instead of a CUP).

g. Public Concerns

In comparison with the four alternatives, A and B have the least amount of public concerns.

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The City of Bellevue and Redmond have plans for the redevelopment of Bel-Red, which include multi-story/mixed-use development. The construction of a transmission line along this roadway would impede future development, thus making this a benefit for the cities to support this alternative.

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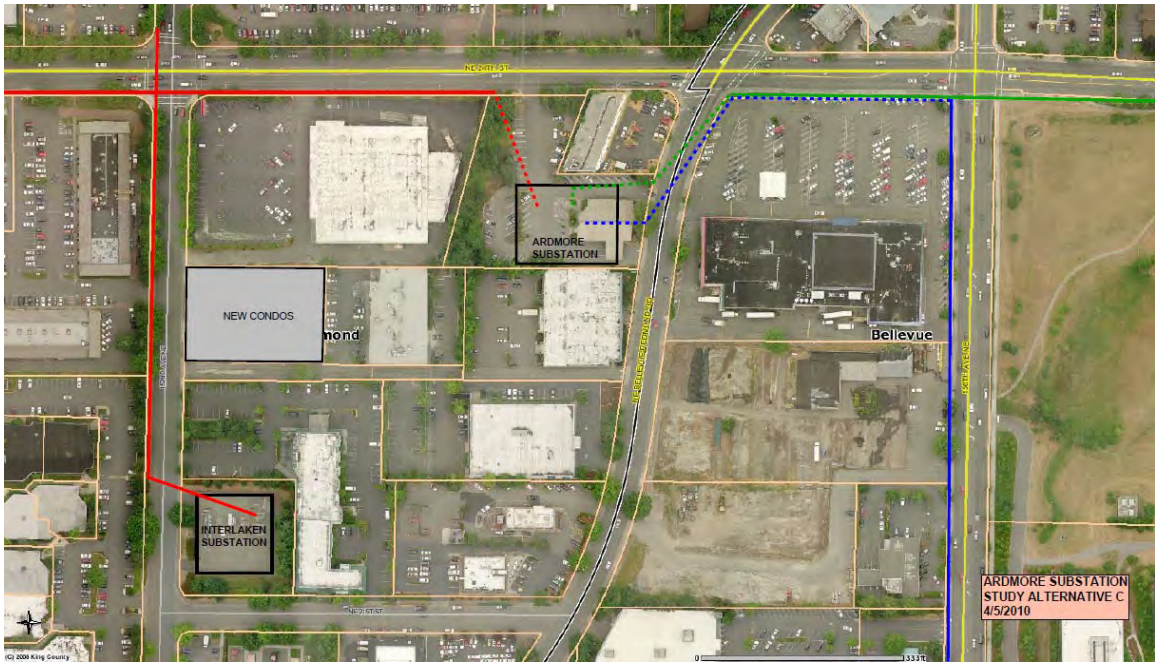
There is benefit if the Interlaken Substation is sold as surplus, as the City of Redmond is planning for the redevelopment of 152nd Ave NE, which would make the site more attractive to future multi-story/multi-use development. City Department heads have stated that they would write a support letter for our project if we were to combine the two substations, and that they will help us expedite thru the permitting process.
Also, abutting property owners around the Interlaken Substation would support the project since it would eliminate the existing substation site and overhead transmission lines next to their properties.

C. Install 3-25 MVA transformers at Ardmore, leaving existing 1-25 MVA transformer at Interlaken on a radial transmission line



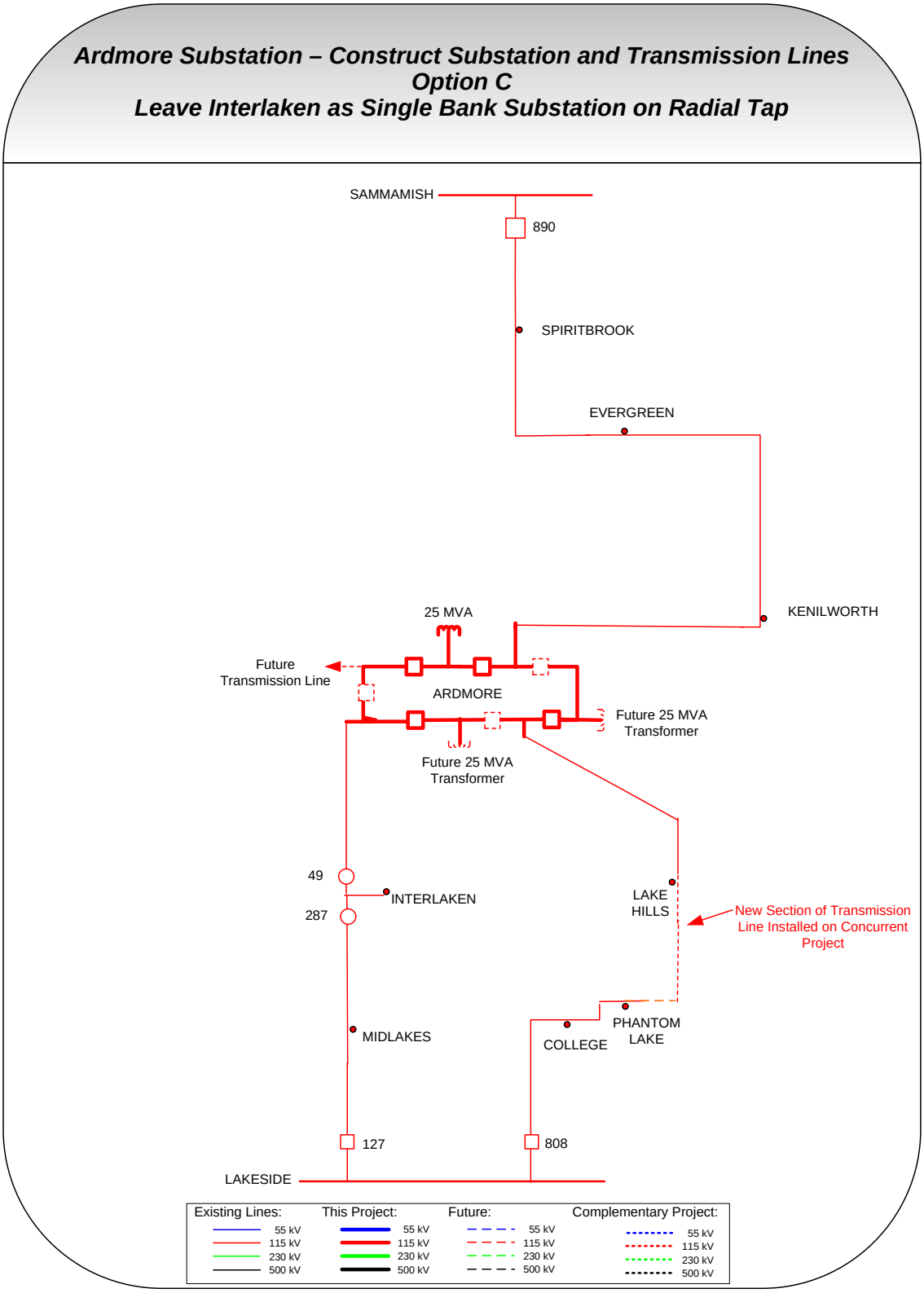


Figure 3: One Line Diagram Alternative C

a. Description

This alternative results in a seven-element 115 kV ring bus connecting ultimately four 115 kV transmission lines and three 25 MVA transformers. Initially three transmission lines and 1-25 MVA transformers will be installed. Gas insulated switchgear (GIS) will be used for the 115 kV bus and circuit breakers. The GIS will be configured in a ring bus arrangement, with four circuit breakers initially and planned expansion to seven circuit breakers in the future. Metalclad switchgear will be installed for the 12.5 kV circuits served by each transformer, with bus ties between metalclad structures to enable load transfer. 12.5 kV capacitors will be required, one for each 25 MVA transformer. The equipment will be laid out to enable vehicle access to the major equipment. There will be three 35 foot dead end towers for the first three transmission lines. The fourth line is planned to enter the substation underground, due to a congested line route.

The 115 kV line from Sammamish Substation will approach Ardmore Substation where it already exists along the south side of NE 24th St coming from Kenilworth Substation. It will be terminated from the east side of the substation, having crossed Bel-Red Rd. The 115 kV line to Lake Hills Substation will approach Ardmore Substation along the south side of NE 24th St, where it will be double-circuited with the existing Kenilworth line from 156th Ave NE to Bel-Red Rd, and then into the east side of the substation. The 115 kV line from Lakeside Substation will enter the substation from the north, along PSE's driveway, from its existing location on the south side of NE 24th St.

It should be noted that the benefits of connecting a third line at Ardmore depend on a separate project to build a new section of transmission line to connect Lake Hills and Phantom Lake Substations being completed successfully.

The fourth line is planned to go north on PSE's driveway, then west along NE 24th Street to the future Westminster Substation at NE 24th and approximately 138th Ave NE. This line is probably ten years or more in the future.

Under this alternative, the Interlaken Substation will be planned to remain a single-bank substation on a short radial transmission line. The transmission line will not be looped through the substation. The transformer, 115 kV fuses and overdutied 12.5 kV breakers will require replacing within the next three years due to maintenance considerations.

To provide better transmission reliability to Interlaken, a transmission line switch will be installed on the Lakeside-Ardmore line on a pole just west of the Interlaken tap. The new switch will be equipped with supervisory

control and automatic switching. The automatic switching will restore Interlaken Substation for any transmission fault on the 4.2 miles between the new switch and Lakeside Substation. There will not be a way to restore power automatically for a fault on the ¼ mile between Interlaken and Ardmore.

b. Substation Impacts

The substation transformer, 115 kV fuses and 12.5 kV circuit breakers will be replaced at Interlaken under planned replacement programs. The control cabinet will be rebuilt or replaced with an MPAC. This will require additional engineering compared to alternatives A & B.

Provisions were included for 15 feeder getaways on the substation property along with a 15' wide trench with conduit for the future underground transmission line planned for this substation.

c. Distribution Line Impacts

The distribution line getaways will need to be designed for only the Ardmore site. Fifteen (15) feeders will be needed at the Ardmore site with this option. Due to the number of feeders, the distribution line getaways maximize the Ardmore substation property frontages along 24th and Bel-Red Rd to minimize cable heating. There will not be a need to relocate distribution circuits from Interlaken Substation.

This option will avoid trenching from Interlaken north along the congested 152nd Ave NE for the second bank of feeders that would be added to Interlaken when the new transformer bank is installed.

d. Transmission Line Impacts

Alternative C will result in the first Lakeside line entering the substation from NE 24th rather than from Bel-Red Road. The section of existing transmission line on NE 24th from the north driveway to Bel-Red Rd may be removed.

e. Property Considerations

A benefit of this option is that it avoids the need to obtain frontage and overhang easements for the transmission line loop between Interlaken and Ardmore Substations. This is a very difficult area to site a new line due to future plans to widen NE Bel-Red Road and because zoning provides for multi-story mixed use development with zero lot line setbacks.

It is extremely difficult to find a suitable and a well located property near transmission lines for electrical substations in a High Density /Central Business district area. It is also very expensive and very difficult to permit. Therefore, PSE must make every effort to preserve every existing electrical substation, especially one that is located in a High Density

/Central Business district, until we know for certain that we no longer have a need. This option preserves a 35,512 square foot operating substation site.

f. Permitting Considerations

For permitting purposes, the differences between Alternatives A, B, C, and D relate to:

Substation footprint (size, location on the site)
Visibility and screening
Number of new transmission lines required

The different alternatives will not result in different types of permits, except perhaps the need for a Tree Removal Permit (see below). Choosing Alternatives A or B, combining Interlaken and Ardmore, may generate "goodwill" with the City, but the value of goodwill is difficult to measure, and may be partially off-set by additional work needed to permit the larger footprint.

Substation Footprint. Alternatives A, B, and C have similar footprints, and require significant grading and fill in the western portion of the site. Although the slope along the western property line is not considered a critical area, the large new retaining wall will have to be engineered, and the presence of existing vegetation may trigger a Tree Removal Permit if any of the trees are 6 inches or more in diameter (considered "Significant Trees"). Up to 5 Significant Trees per acre may be removed per calendar year; removal of more than 5 such trees requires approval of a Tree Removal Exception Request. One replacement tree is required for each significant tree removed. If replacement trees must be located off-site, longer negotiations with the City of Redmond would be required. If a Landmark tree is removed (30+ inches in diameter), three replacement trees are required.

Visibility and Screening. All four Alternatives would require screening, especially from NE 24th Street and Bel-Red Road. The larger footprint for Alternatives A, B, and C (vs. Alternative D) does not appear to significantly change the area available for screening, except along the west property line.

Transmission Lines. Alternatives A, B, and C do not require the new transmission line between Interlaken and Ardmore; this is a significant advantage. For Alternatives A, B, and C, the only new line is the double circuit on NE 24th; this line would be located within both Redmond and Bellevue. That portion of the line within Redmond (that portion west of Bel-Red Road) would be included in the Redmond CUP for the substation. It is currently unknown what type of permitting will be required for double-circuiting the existing transmission line within the

City of Bellevue. If the only new line in Bellevue is the double circuit on NE 24th, it is possible it could be approved administratively (instead of a CUP).

g. Public Concerns

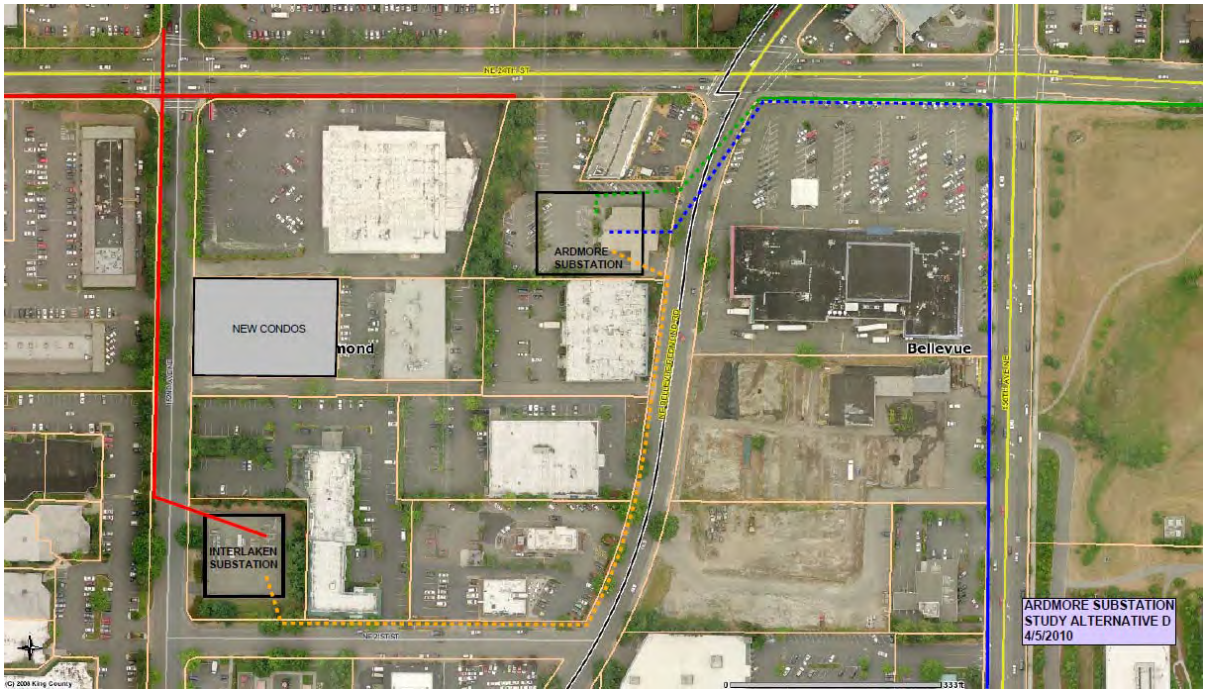
In comparison with the four alternatives, C is rated third in regards to having public concerns.

With there being no need for the installation of a transmission line in between the Interlaken and Ardmore Substations the property owners will benefit from not having a transmission line interfere with their future development.

The City of Bellevue and Redmond have plans for the redevelopment of Bel-Red, which include multi-story/mixed-use development. The construction of a transmission line along this roadway would impede future development, thus making this a benefit for the cities to support this alternative.

The abutting property owners to the north of the Ardmore Substation will benefit from the removal of the existing transmission lines along the north side of their property, on NE 24th Street, but they will have the Ardmore Substation site constructed on the West and South sides of their commercial property, along with two new transmission lines crossing over Bel-Red on the East side of their property. These property owners have already expressed concerns to PSE about Ardmore Substation and the proposed transmission lines.

D. Original Plan: Install 2-25 MVA transformers at Ardmore with a 115 kV 6-position ring bus, with 2-25 MVA transformers at Interlaken on a transmission loop



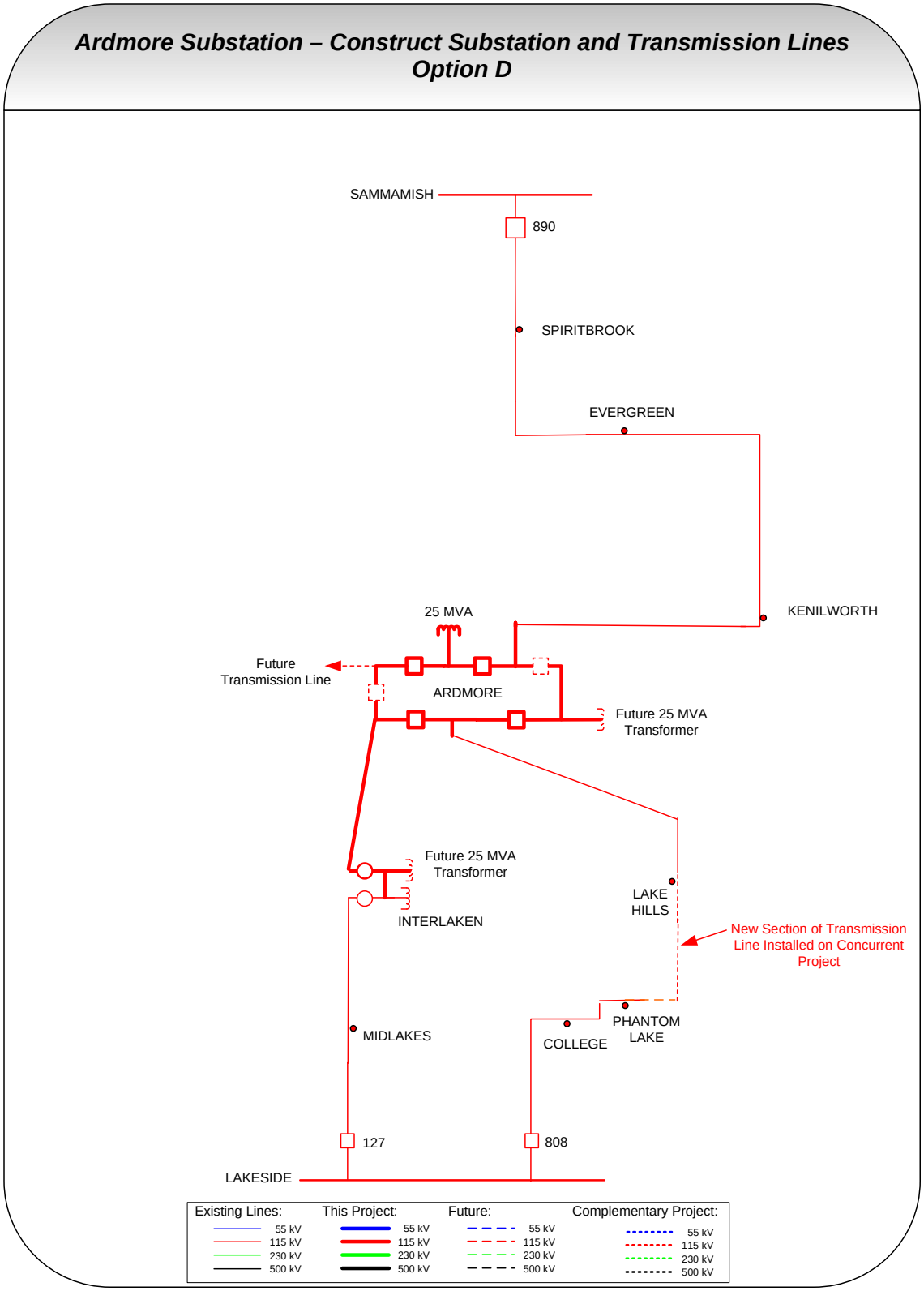


Figure 4: One Line Diagram Alternative D Original Plan

a. Description

This alternative is the original plan for development of Ardmore Substation.

Ardmore Substation will be built as an ultimate six-breaker 115 kV ring bus connecting four transmission lines and two 25 MVA transformers. Initially three transmission lines and one 25 MVA transformer will be installed. Sulfur hexafluoride gas insulated switchgear (GIS) will be used for the 115 kV bus and circuit breakers. The GIS will be configured in a ring bus arrangement, with four circuit breakers initially and planned expansion to six circuit breakers in the future. Metalclad switchgear will be installed for the 12.5 kV circuits served by each transformer, with bus ties between metalclad structures to enable load transfer. 12.5 kV capacitors will be required, one for each 25 MVA transformer. The equipment will be laid out to enable vehicle access to the major equipment. There will be three 35 foot dead end towers for the first three transmission lines. The fourth line is planned to enter the substation underground, due to a congested line route.

A new section of 115 kV transmission line will be looped through Interlaken Substation and extended to Ardmore to form the Lakeside-Ardmore #1 115 kV line via Midlakes and Interlaken. The new section of line will most likely follow the north side of NE 21st St from Interlaken Substation to Bel-Red Road, then north along Bel-Red to enter the east side of Ardmore Substation. The route along Bel-Red Road is being discussed with Bellevue and Redmond. Alternatives include going on the west side of the road in Redmond or on the east side of the road in Bellevue. The line will require transmission easements from private property owners if it goes on the east or west side. The city of Redmond had proposed establishing a median strip in which PSE could install the three poles that would be required along Bel-Red Rd, but upon more in-depth review, rescinded the suggestion. On the west side of Bel-Red Rd, one existing building is quite close to the street, making it likely that the east side will be the preferred route.

The 115 kV line from Sammamish Substation will approach Ardmore Substation where it already exists along the south side of NE 24th St coming from Kenilworth Substation. It will be terminated from the east side of the substation, having crossed Bel-Red Rd. The 115 kV line to Lake Hills Substation will approach Ardmore Substation along the south side of NE 24th St, where it will be double-circuited with the existing Kenilworth line from 156th Ave NE to Bel-Red Rd, and then into the east side of the substation.

It should be noted that the benefits of connecting a third line at Ardmore depend on a separate project to build a new section of transmission line to

connect Lake Hills and Phantom Lake Substations being completed successfully.

The fourth line is planned to go north on PSE's driveway, then west along NE 24th Street to the future Westminster Substation at NE 24th and approximately 138th Ave NE. This line is probably ten years or more in the future.

b. Substation Impacts

The substation transformer, 115 kV fuses and 12.5 kV circuit breakers will be replaced at Interlaken. An additional dead end tower and 115 kV switch will be required to loop the transmission line through the substation. The control cabinet will be either rebuilt or replaced with an MPAC. This will require additional engineering compared to alternatives A & B.

***c.* Distribution Line Impacts**

The distribution line getaways will need to be designed for both the Ardmore and Interlaken sites. Ten (10) feeders will be needed at the Ardmore site with this option. There will not be a need to relocate distribution circuits from Interlaken Substation.

d. Transmission Line Impacts

Alternative D will require construction of a new section of 115 kV transmission line from Interlaken to Ardmore Substation. The most likely route will follow the north side of NE 21st St, then turn and go north on the east side of Bel-Red Road. Easements will be required for transmission poles on private property on the east side of Bel-Red. Due to the angles involved and limited space for guying, steel poles will be used for 5 of the 6 poles required for this ¼ mile section.

Transmission line routes considered and rejected included going north on the east side of 152nd NE, going north on the west side of Bel-Red Rd, or finding an underground route. The underground option was rejected for two reasons: cost and lack of a feasible protected corridor.

e. Property Considerations

It is extremely difficult to find a suitable and a well located property near transmission lines for electrical substations in a High Density /Central Business district area. It is also very expensive and very difficult to permit. Therefore, PSE must make every effort to preserve every existing electrical substation, especially one that is located in a High Density /Central Business district until we know for certain that we no longer have a need. This option preserves an existing 35,512 square foot operating substation site.

f. Permitting Considerations

For permitting purposes, the differences between Alternatives A, B, C, and D relate to:

Substation footprint (size, location on the site)
Visibility and screening
Number of new transmission lines required

Substation Footprint. Alternatives A, B, and C have similar footprints, and require significant grading and fill in the western portion of the site. Although the slope along the western property line is not considered a critical area, the large new retaining wall will have to be engineered, and the presence of existing vegetation may trigger a Tree Removal Permit if any of the trees are 6 inches or more in diameter (considered "Significant Trees"). Up to 5 Significant Trees per acre may be removed per calendar year; removal of more than 5 such trees requires approval of a Tree Removal Exception Request. One replacement tree is required for each significant tree removed. If replacement trees must be located off-site, longer negotiations with the City of Redmond would be required. If a Landmark tree is removed (30+ inches in diameter), three replacement trees are required.

Alternative D would have the smallest new footprint, and could likely be constructed with the least impact to the slope and vegetation along the west property line.

Visibility and Screening. All four Alternatives would require screening, especially from NE 24th Street and Bel-Red Road.

Transmission Lines. With Alternative D, because there will be a transmission line to Interlaken, this new line may be located within Bellevue, on the east side of Bel-Red Road. Construction of a new line could trigger the requirement for a Bellevue CUP.

In addition, there is the new double circuit on NE 24th; this line would be located within both Redmond and Bellevue. That portion of the line within Redmond (that portion west of Bel-Red Road) would be included in the Redmond CUP for the substation. It is currently unknown what type of permitting will be required for double-circuiting the existing transmission line within the City of Bellevue.

g. Public Concerns

In comparison with the four alternatives, D is rated last, in that there will be more public concerns than the other alternatives.

The installation of transmission line in between the Interlaken and Ardmore Substations will interfere with the City of Bellevue and Redmond's plans for the redevelopment of Bel-Red, which include multi-story/mixed-use development. Work will need to be done with the Cities

to find ways of being able to get around their future development plans with the least amount of impact.

It will also impede the property owner's ability to develop their properties according to the Cities development standards which will cause property owners in this area to have issues with the transmission lines.

The abutting property owners to the north of the Ardmore Substation will benefit from the removal of the existing transmission lines along the north side of their property, on NE 24th Street, but they will have the Ardmore Substation site constructed on the West and South sides of their commercial property, along with three new transmission lines crossing over Bel-Red on the East side of their property. These property owners have already expressed concerns to PSE about Ardmore Substation and the proposed transmission lines.

III. Recommendation

After studying the considerations discussed above, the team recommends that the project scope be changed to combine both Interlaken and Ardmore at the same site. Three transmission lines and two transformer banks will be installed initially. At full build out Ardmore Substation will include four transmission lines and four transformers banks. The Interlaken Substation equipment may be removed after its circuits are cut over to the new Ardmore Substation. The Interlaken Property is recommended to be held for possible future use, and possibly sold at a later date.

The benefits of this course of action will be:

- Will not need to build a new transmission line between Interlaken and Ardmore
- The existing 1/8 mile transmission line tap on 152nd Avenue NE may be removed
- Lower substation and transmission line presence in the immediate community
- Improved reliability to all of the customers served by Ardmore
- Standard substation equipment and operating procedures may be used
- Permitting will be simpler than the original plan
- The cities of Redmond and Bellevue will be in support of this plan.

The disadvantages of this plan will be:

- Additional distribution lines will be built to tie existing distribution circuits to the new substation.
- Design and construction of 20 rather than 10 distribution get-a-ways will be more challenging.
- The distribution cutover from Interlaken to Ardmore will be complex.
- Slightly larger substation at Ardmore
- Surplusing a viable substation site at Interlaken

Pursuing this course of action can be done while keeping critical items on course to meet the project schedule.

IV. Cost Estimates

These cost estimates include substation, transmission and distribution costs in excess of the original planned project, described here as Alternative D. A 30% contingency was used. No OMRC costs are anticipated in conjunction with any of the alternatives.

Alternative A:

Incremental Capital Cost:	$ 825,000
Less Sale of Interlaken Property:	$ 1,500,000
Net Incremental Capital Cost:	$ - 675,000

Alternative B:

Incremental Capital Cost:	$ 2,250,000
Less Sale of Interlaken Property:	$ 1,500,000
Net Incremental Capital Cost:	$ 750,000

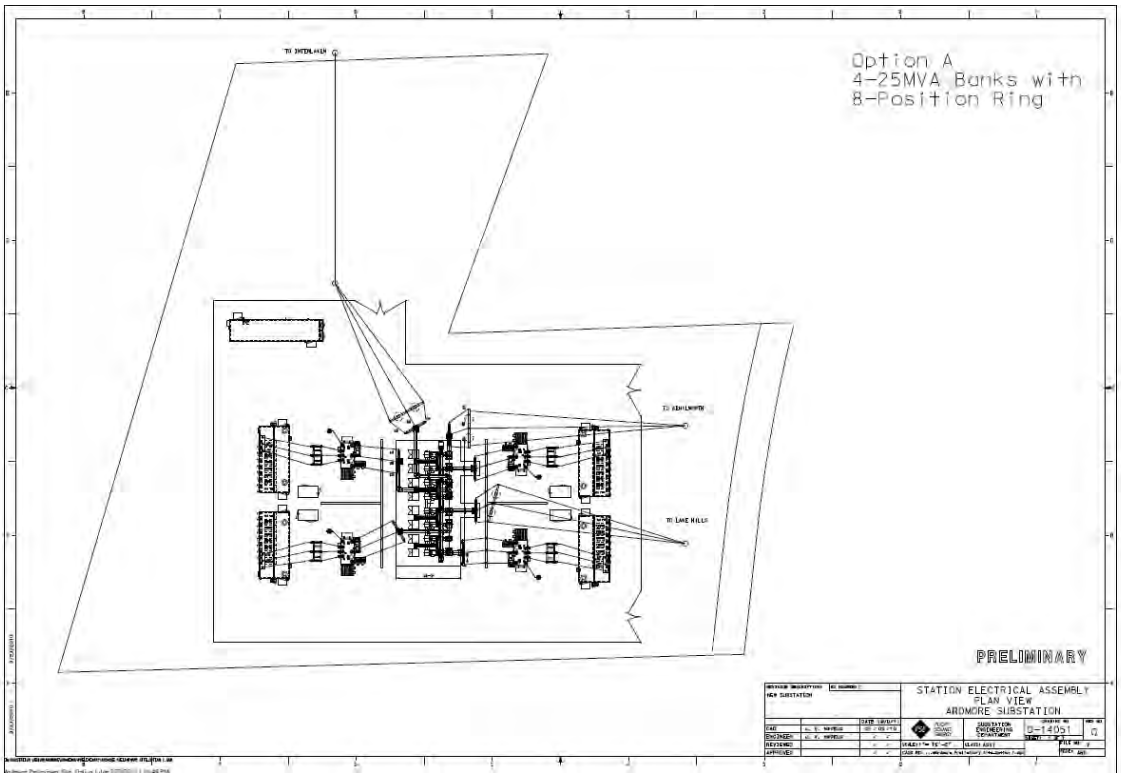
Alternative C:

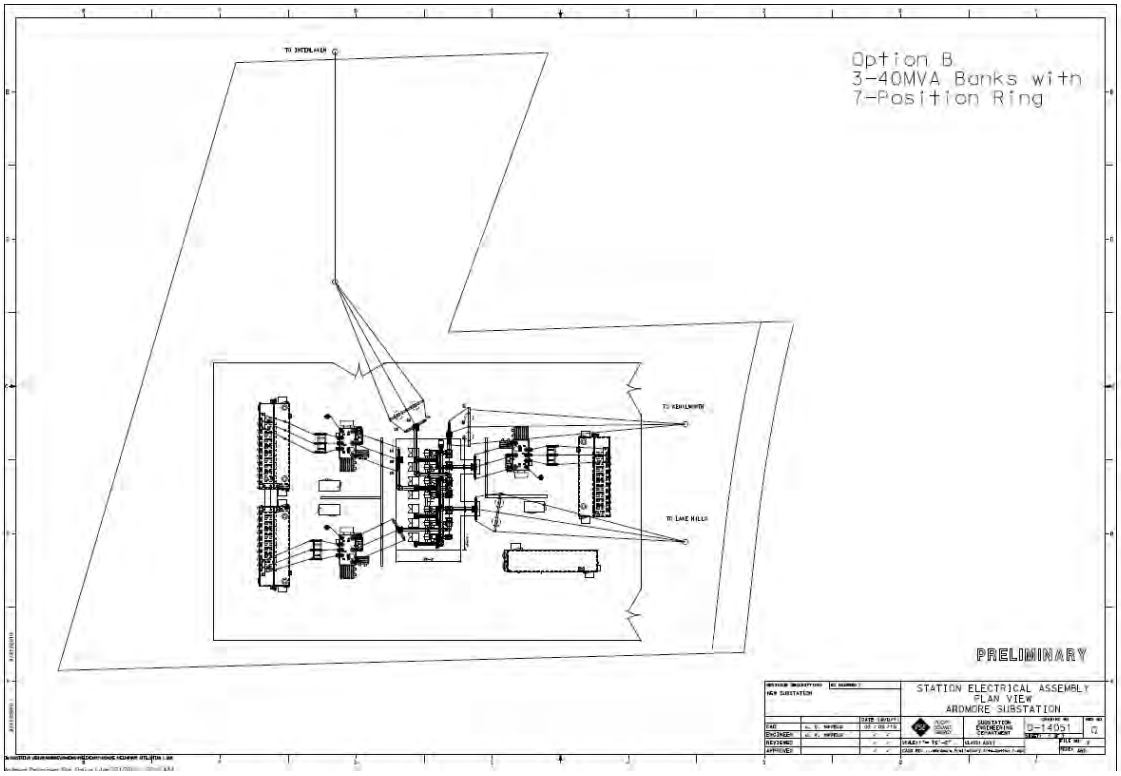
Incremental Capital Cost:	$ - 425,000

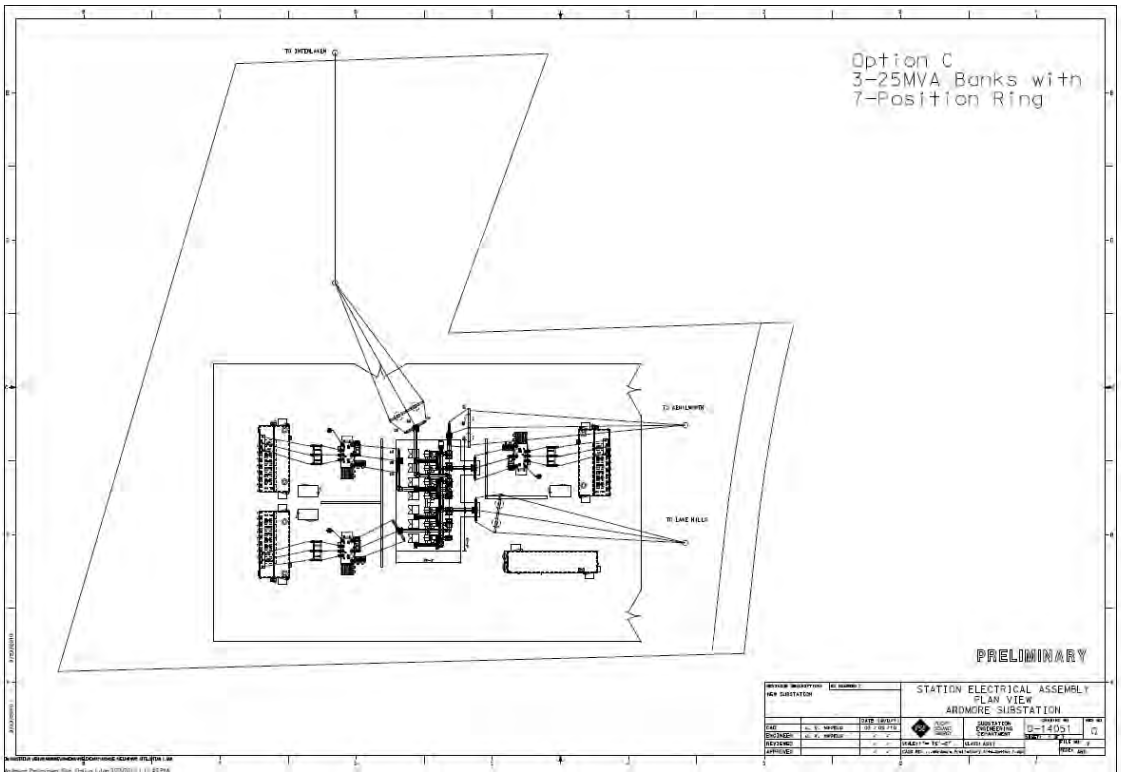
Alternative D:

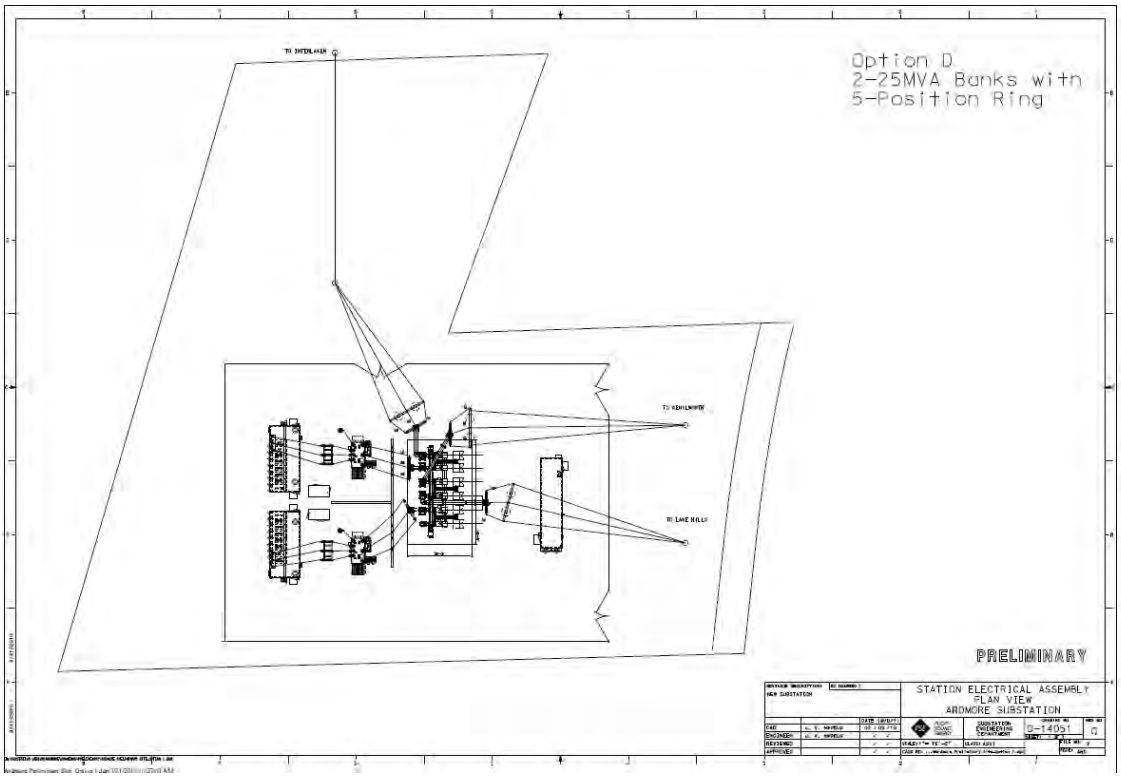
This is the baseline for analysis. No incremental cost.

Appendix I: Substation Layouts

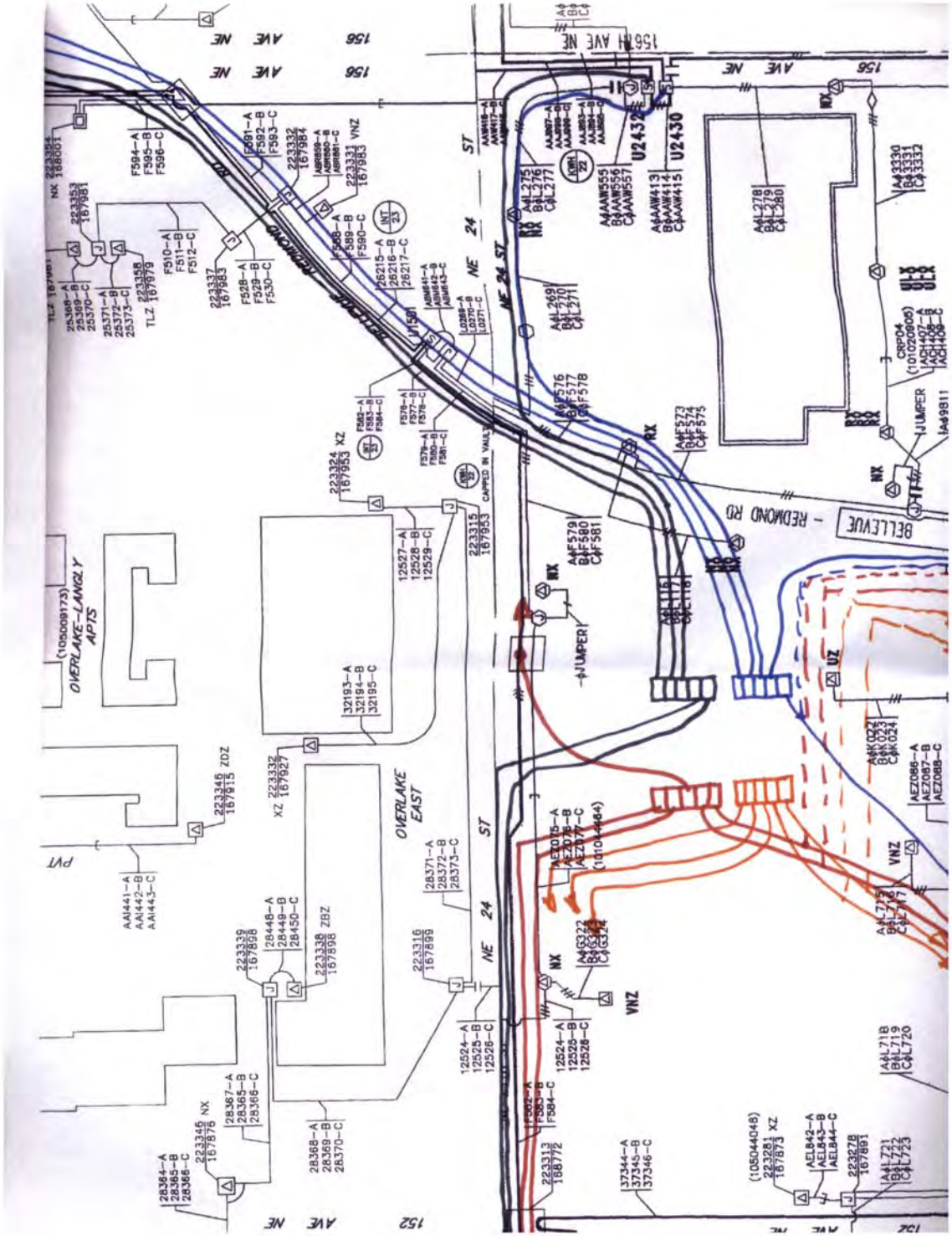




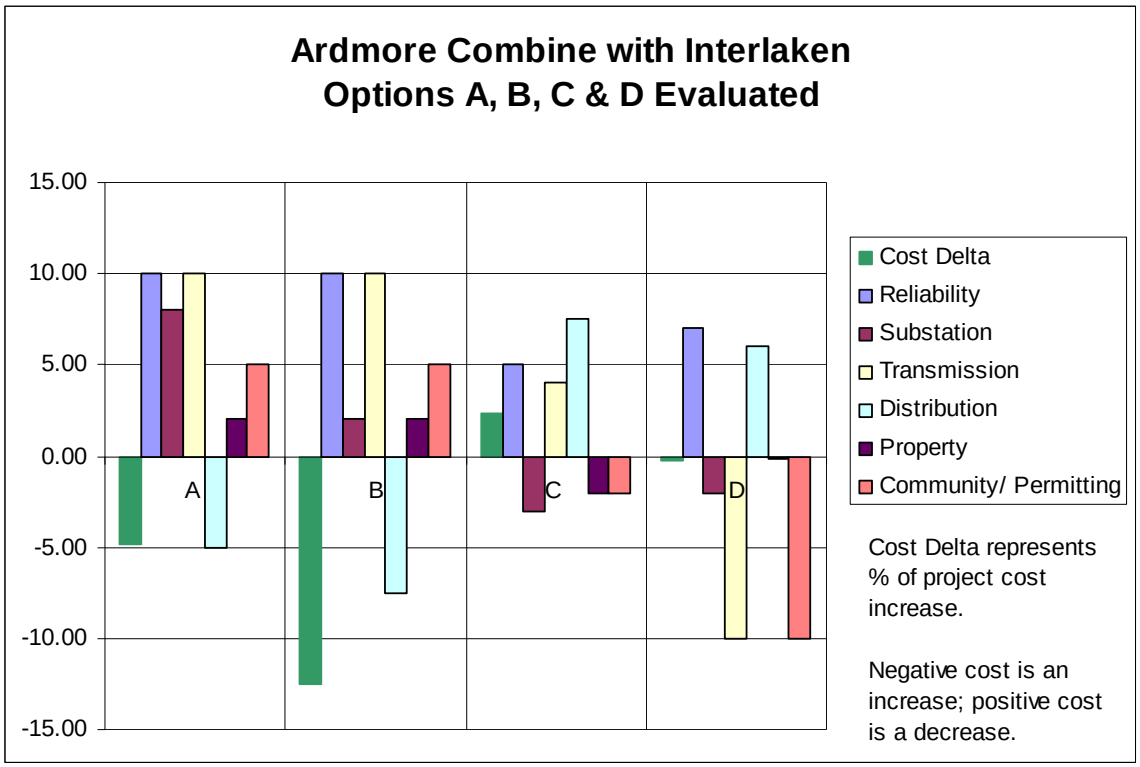

Option C
3-25MVA Banks with
7-Position Ring
PRELIMINARY
STATION ELECTRICAL ASSEMBLY
PLAN VIEW
ARDMORE SUBSTATION


Option D
2-25MVA Banks with
5-Position Ring
PRELIMINARY
STATION ELECTRICAL ASSEMBLY
PLAN VIEW
ARDMORE SUBSTATION

Appendix II: Distribution Feeder Layout



Appendix III: Benefits Weighted for Alternative Comparison



Appendix IV: Decision Process Chart

Alternative	Reliability	Substation Pros	Substation Cons	Transmission Pros	Transmission Cons	Distribution Pros	Distribution Cons	Property Pros	Property Cons	Community Pros	Community Cons	Permitting Pros	Permitting Cons
A Install 4-25 MVA transformers at Ardmore with 8-position ring. Remove Interlaken Substation. **Incr Cap: $0.875 M - Sell INT: $ -1.5 M Net Incr: $ -0.675 M Incr OMRC: $0**	Very High- all customers served by ring bus with more than 2 sources. Can transfer all load off transformer on distribution lines.	This can be built using standard PSE equipment. Will be similar to Bow Lake Sub. Stay in our comfort zone. Use Maintenance Capital Budget to move Interlaken equipment.		Avoid building new line between Interlaken and Ardmore. Avoid impact of Sound Transit rail line at 152nd & north side of NE 24th St.	Requires transmission line on west side of Ramon property.	Avoid trenching from Interlaken north along the congested 152nd AV NE for the second bank feeders.	20+ feeders to get out of one substation	Can surplus Interlaken. Eliminating the 2nd substation is a plus with Redmond. Silver Cloud & condos would be positively affected. No overhang easements required for new line	Loss of the use of a viable substation site.	Cities would support this alternative. Siting a new line will be eliminated.	Neighbor at corner of NE 24th & Bel-Red Rd not happy with this option - puts transmission line in view corridor	City permits may be easier to obtain. No CUP required in Bellevue.	
B Install 3 - 40 MVA transformers at Ardmore with 7-position ring. Remove Interlaken Substation. **Incr Cap: $ 2.25 M - Sell INT: $ -1.5 M Net Incr: $ 0.75 M Incr OMRC: $0**	Very High- all customers served by ring bus with more than 2 sources. Can transfer all load off transformer on distribution lines or bus ties.	3-40 MVA's cost about the same as 4-25 MVA's. Saves future transformer cost. 1 less transformer to maintain. Use Maintenance Capital Budget to move Interlaken equipment.	40 MVA transformer issues will require work by PSE Engineering & Standards to assure that the substation works flawlessly.	Avoid building new line between Interlaken and Ardmore. Avoid impact of Sound Transit rail line at 152nd & north side of NE 24th St.	Requires transmission line on west side of Ramon property.	3-40 MVA's would provide an additional 20 MVA of capacity over 4-25 MVA transformer banks. Use of 40 MVA banks could move PSE toward standard use of 40's. Avoid trenching from Interlaken north along the congested 152nd AV NE for the second bank feeders.	20+ feeders to get out of one substation. Taking 40 MVA transformer off line may challenge feeder ties and may require replacing several existing feeders with larger conductor. Increased fault duty on the 40 MVA's may over duty the distribution equipment	Can surplus Interlaken. Eliminating the 2nd substation is a plus with Redmond. Silver Cloud & condos would be positively affected. No overhang easements required for new line	Loss of the use of a viable substation site	Cities would support this alternative. Siting a new line will be eliminated.	Neighbor at corner of NE 24th & Bel-Red Rd not happy with this option - puts transmission line in view corridor	City permits may be easier to obtain. No CUP required in Bellevue.	
C Install 3-25 MVA transformers with 7-position ring at Ardmore, with existing station at Interlaken remaining 1 bank on a tap. **Incr Cap: $ -425 K Incr OMRC: $0**	Lower than other options. Existing Interlaken customers exposed to extended outages for transmission line outage. Must transfer on distribution for planned maintenance on transmission as well as substation transformer.	Stay in our comfort zone regarding equipment. More engineering required to work at both Interlaken and Ardmore. Ardmore fenced area is 11% smaller.	Interlaken reliability will not improve much with this plan. No loop at Interlaken. Maintenance Capital Budget will be spent rebuilding much of older station at Interlaken.	Avoid building new line between Interlaken and Ardmore.	Requires transmission line on west side of Ramon property.	Less distribution re-work. Avoid trenching from Interlaken north along the congested 152nd AV NE for the second bank feeders.	15+ feeders to get out of one substation.	No overhang easements required for new line	No option to sell Interlaken.	Siting a new line will be eliminated.	PSE has made a point with the community that looped substations are more reliable. Keeping a commercial substation on a radial tap minimizes that message. Neighbor at corner of NE 24th & Bel-Red Rd not happy - transmission line in view corridor	City permits may be easier to obtain. No CUP required in Bellevue.	
D Planned project: Install 2-25 MVA transformers with 6-position ring at Ardmore and loop through Interlaken with 2-25 MVA transformers. **Incr Cap: $0 Incr OMRC: $0**	Not as good as A & B, better than C. Customers at Interlaken not as high reliability as those served by the ring bus at Ardmore. Can transfer all load off transformers on distribution lines.	Stay in our comfort zone regarding equipment. More engineering required to work at both Interlaken and Ardmore Keep 2 substations for future growth.	Maintenance Capital Budget will be spent rebuilding much of older station at Interlaken.	No transmission line on west side of property at NE 24th & Bel-Red Rd.	High level of political difficulty in building new transmission line between Interlaken and Ardmore.	No distribution re-work.	Trenching in the second bank feeders for Interlaken would be still be difficult going north along the congested 152nd AV NE to NE 24th ST.		Easements will be required from private property owners for new line.	No community related pros compared to other options.	Highest community impact due to construction of new transmission line along Bel-Red Rd.		May require Bellevue Conditional Use Permit (CUP) for construction of the new line from Ardmore to Interlaken, extending schedule 1 year.