KITTELSON & ASSOCIATES

City of Sherwood Oregon

ICE AGE DRIVE

30% FEASIBILITY AND ALIGNMENT STUDY

SHERWOOD, OR

November 2022

Ice Age Drive

30% Feasibility and Alignment Study

Sherwood, OR

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City Project Number 723ST
KAI Project Number 27311

November 2022

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INTRODUCTION

PROJECT BACKGROUND

The City of Sherwood is planning to create a new east-west connection between SW Oregon Street and SW 124th Avenue in Sherwood, OR to facilitate development within the Tonquin Employment Area (TEA). Historically referred to as Blake Street, and now called Ice Age Drive, the proposed collector roadway and utilities built with the roadway will provide access for industrial development within the TEA. The proposed roadway alignment will tie in with the roadway segment currently being constructed in conjunction with the Willamette Water Supply development at the intersection of SW 124th Avenue / Ice Age Drive-Blake Street, on the east end of the project limits. The west terminus along SW Oregon Street will align with an existing private driveway to 21389 SW Oregon Street that is just north of Allied Systems, as determined by an Access Management Plan led by the City in 2021. Kittelson & Associates (Kittelson) was selected by the City to develop 30% conceptual design alignment alternatives and coordinate with City staff and area utility stakeholders to determine the preferred alignment alternative and to evaluate overall project feasibility considering project cost, right-of-way impacts and remnant parcels, and ability to provide access, a regional water quality facility and water/sewer service to developable areas within TEA.

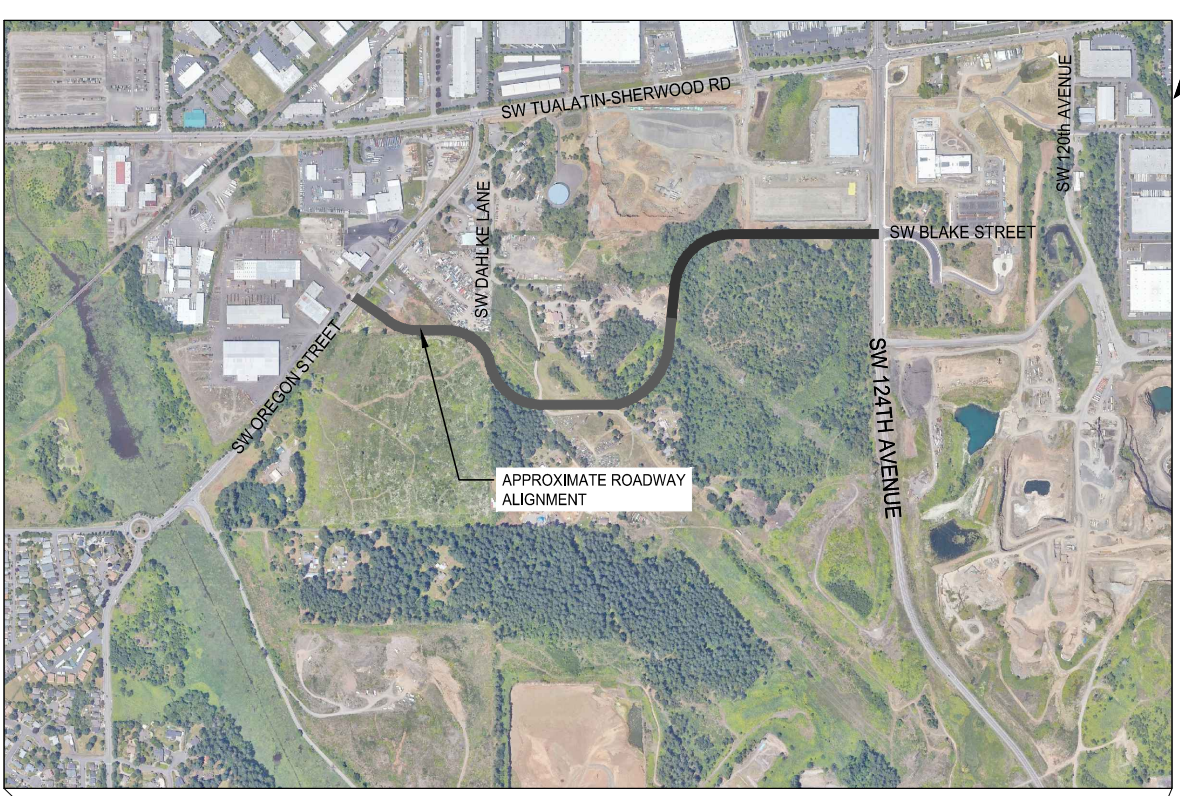
STUDY AREA

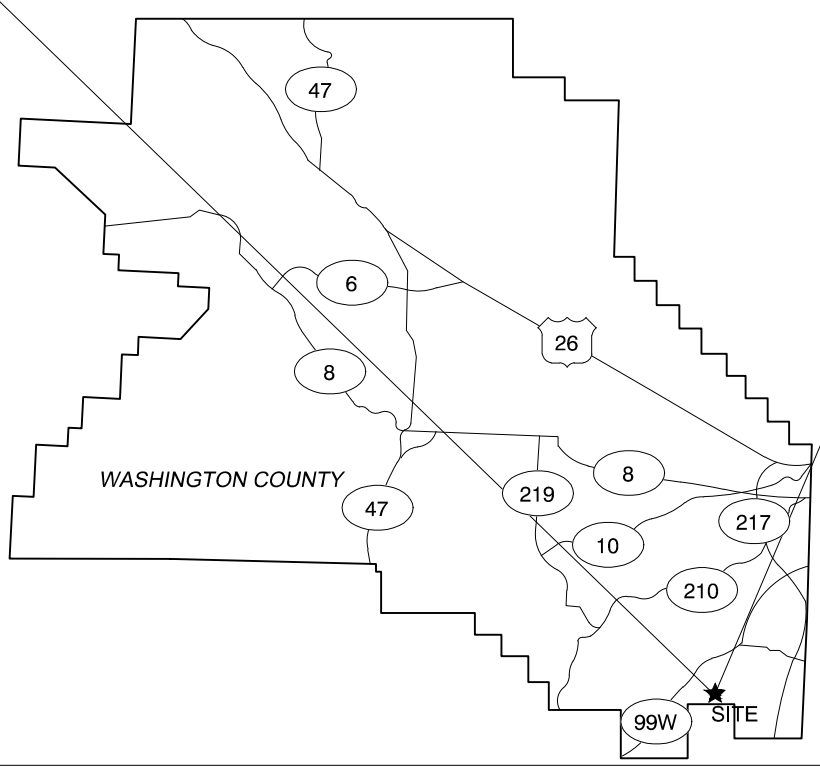
TEA is located south of SW Tualatin-Sherwood Road, east of SW Oregon Street, and west of SW 124th Avenue, as shown in Figure 1. Figure 2 displays an area property taxlot map and identifies known in-process developments, which includes the currently under construction Willamette Water Supply facility and the planned Sherwood Commerce Center development.

There are several significant existing utility constraints within the study area including:

- A 287.5 foot wide Bonneville Power Association (BPA) easement that includes two parallel BPA high-voltage (500 KV and 230 KV) overhead transmission lines and associated towers. This easement extends from Oregon Street to the south-east, covering much of the TEA
- An addition 100 foot wide BPA fee area that includes 115 KV Portland General Electric (PGE) overhead line and associated wood towers and a BPA 115 KV overhead line and associated tower wood. This easement extends from Oregon Street to the south-east, through the TEA and specifically bisects Taxlots 2S128D602, 2S128D700 and 2S128D800.
- An existing 8" Kinder Morgan gasline and 10 to 20 foot wide easement that extends from Oregon Street to the south/southeast through TEA
- SW Dahlke Lane is an unimproved local access, public roadway that runs north-south through TEA. Under the BPA easement and to the south, SW Dahlke Lane is indistinguishable from a BPA access road, which is instead utilized by property owners for access.

Additional constraints in the area include isolated wetlands, shallow basalt bedrock, headwaters of Hedges Creek, virgin topography and dense trees, as highlighted on Figure 3.





Site Vicinity Map
Sherwood, Oregon

Figure
1

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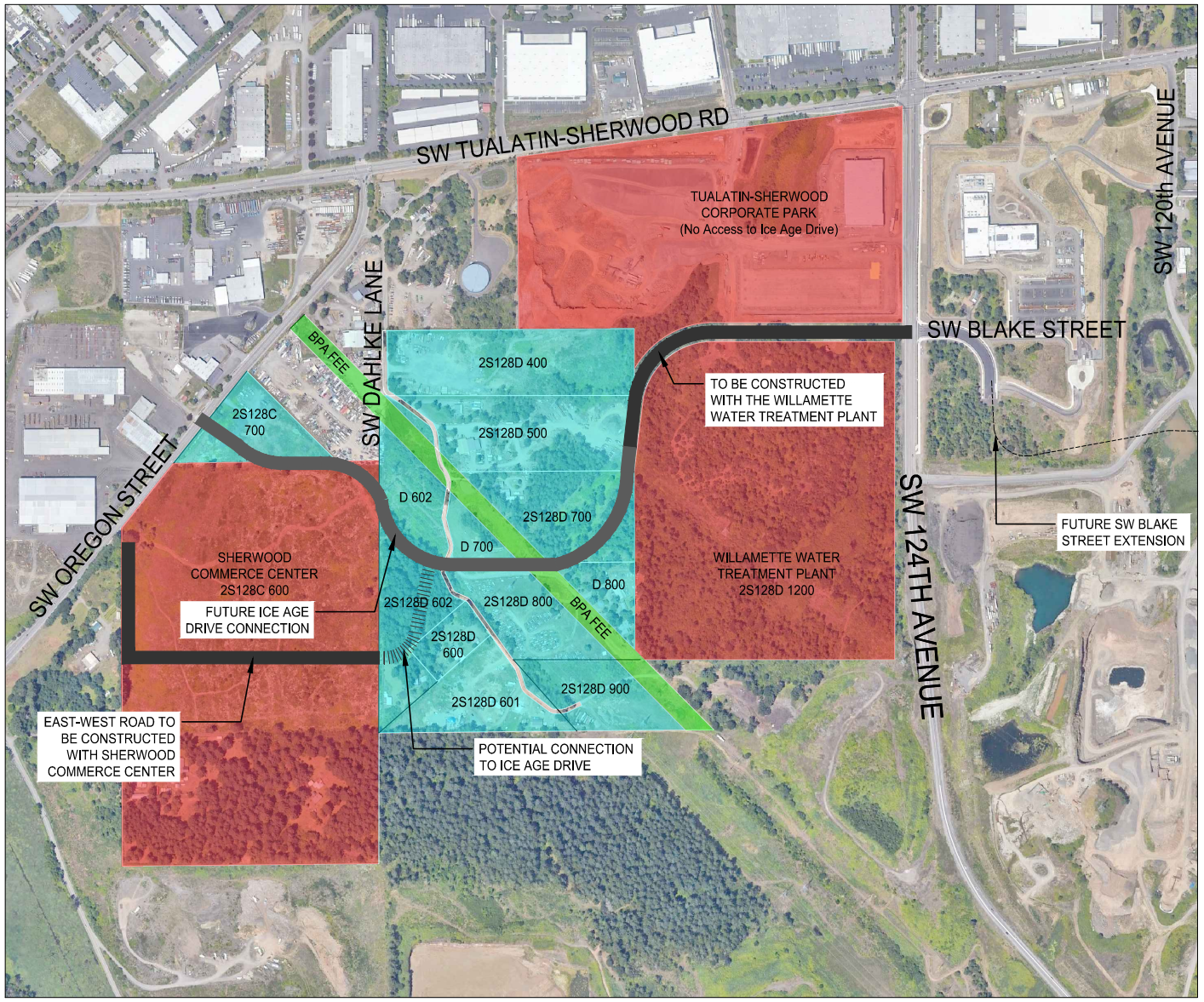

IN-PROCESS / PLANNED DEVELOPMENTS

TAXLOTS FOR FUTURE REDEVELOPMENT WITHIN TONQUIN EMPLOYMENT AREA

Taxlot and Property Ownership Map
Sherwood, Oregon

Figure
2

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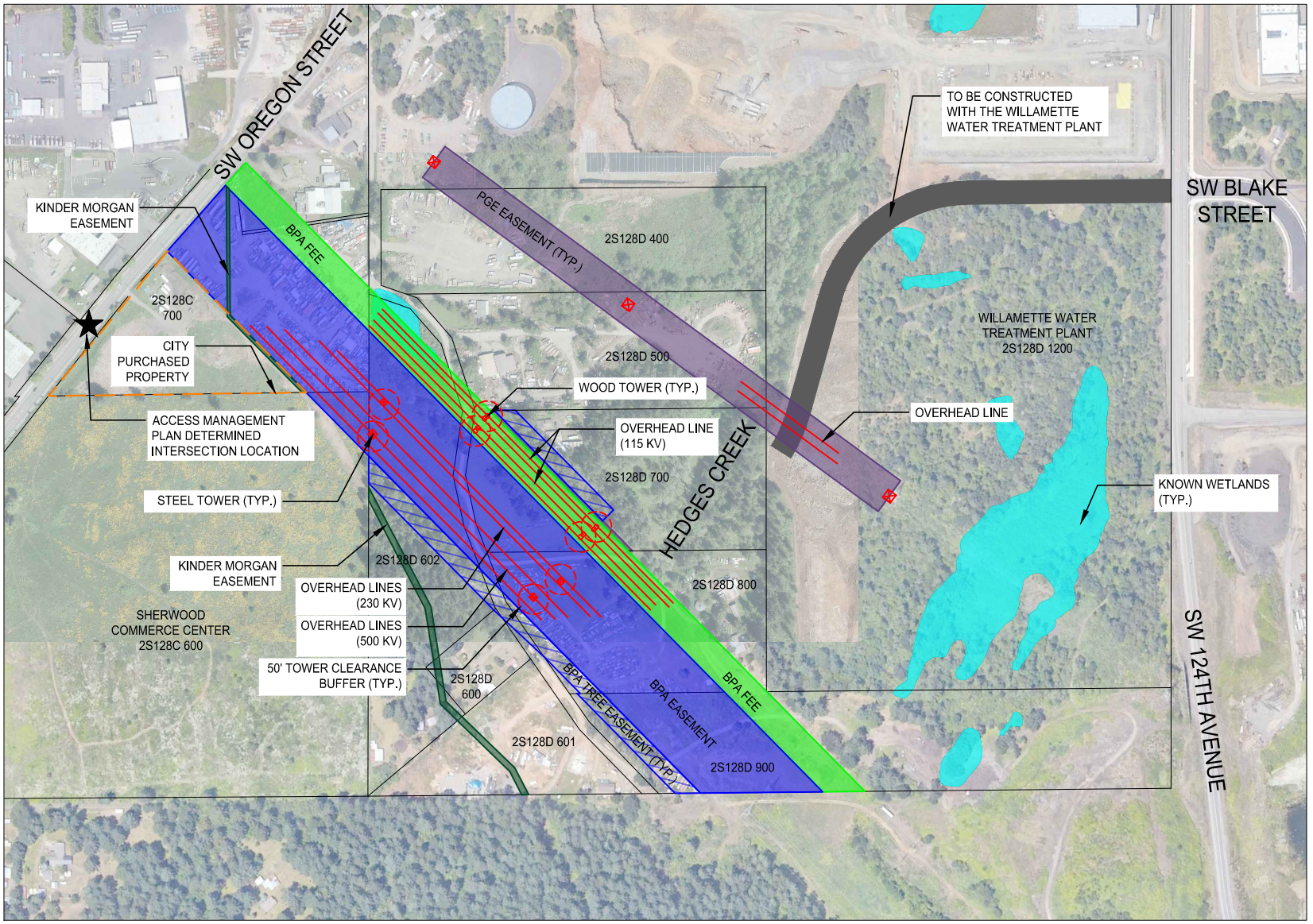

Constraints Map
Sherwood, Oregon

Figure
3

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EXISTING CONDITIONS

TONQUIN EMPLOYMENT AREA

The Tonquin Employment Area Plan (2010) identified the Tonquin Employment Area (TEA) is an approximately 300 acre area added to the Urban Growth Boundary (UGB) by Metro Council 2004. The designated Industrial Area is expected to help fulfill the City's, and regions, employment needs. As of 2022, there are 3 major developments in various stages of design and construction within TEA. All three of these parcels have frontage and access along SW Oregon Street, SW Tualatin-Sherwood Road or SW 124th Avenue. Ice Age Drive is necessary to improve access and facilitate development of the central parcels within TEA.

Historically, much of the undeveloped land with TEA has been used for agricultural purposes, with several machinery or trucking businesses located along SW Oregon Street. SW Dalhke Lane serves as the only existing access to the central undeveloped areas with TEA and is an unimproved local gravel roadway that is in places indistinguishable from crossing BPA access roads.

Lands within TEA are not particularly flat, with varying slopes generally less than 10 percent. Area grades vary in elevation 210 to 255 feet. From SW Oregon Street (elevation 210 feet), the existing grade climbs to the east for approximately 1000 feet (to 230 feet) before slowly descending towards Hedges Creek (elevation 215). Existing grade then climbs from Hedges Creek towards SW 124th Avenue (elevation 255 feet)

IN-PROCESS DEVLOPMENTS

There are several on-going re-development efforts within TEA paralleling this roadway study.

WILLAMETTE WATER SUPPLY PLANT

As of Fall 2022, site grading and utility work is underway for the new Willamette Water Supply Plant, with facility construction anticipated to continue for 2-3 years. Though the eastern most stretch of Ice Age Drive will be constructed by the WWSP in conjuction to site development, final paving and opening of the roadway will likely wait site development is nearly complete to avoid any potential damage to the new roadway from heavy equipment deliveries.

TUALATIN SHERWOOD INDUSTRIAL PARK

As of Fall 2022, site development and construction is on-going but visibly nearing completion. Though this property is located just north of the Ice Age Drive segment to be constructed with the Willamette Water Supply Plant to the south, this property will not have direct access to Ice Age Drive due to site grading constraints.

SHERWOOD COMMERCE CENTER

Site survey and mass grading activities are underway for Phase I of the Sherwood Commerce Center, though site design is still going through permitting review with the City. While Sherwood Commerce Center will initially be granted an interim direct access to SW Oregon Street, once Ice Age Drive is constructed, the northern most Sherwood Commerce Center access will be via Ice Age Drive and the SW Oregon Street access will be gated and used for emergency access only. The right turn lane into the interim driveway will be extended to Ice Age Drive as part of the City's roadway project.

As part of the Sherwood Commerce Center development, a new east-west roadway connection and public utilities will be built from Oregon Street to the west property boundary. **While the ultimate intention would be for this east-west connection to continue east, intersecting with Ice Age Drive near Dalkhe Lane as shown conceptually in Figure 2, design of any such connection is awaiting final determination by the City. Alignments for the east-west connection shown further in this report are conceptual, no decisions on the alignment have been made.**

AREA EXPLORATION INFORMATION

GEOTECHNICAL

Surface soil conditions are highly variable through the study area, with forest duff, organic silts and topsoil located across portions of the site. Native soils contain fine-grained soils that can be easily disturbed when wet.

While extensive geotechnical exploration has been conducted for the in-process developments, due to limited access, only one additional subsurface exploration was conducted as part of this feasibility study.

Shallow and surface basalt bedrock was encountered at varying depths throughout TEA. Where subsurface exploration was conducted for this study, near SW Dalhke Lane where is crosses under the BPA easement, showed bedrock at a depth of 13 feet. All area geotechnical data indicate that bedrock will likely encountered during construction of Ice Age Drive and associated utilities.

Infiltration testing throughout the TEA show a range of rates, though the most recently conducted testing near SW Dalhke Lane where is crosses under the BPA easement showed a high infiltration rate (100 inches per hour).

Further subsurface exploration along the preferred roadway alignment will be necessary as part of the final design effort.

CULTURAL

A preliminary cultural resources review was conducted to assess the effects of the proposed project on cultural resources (archeological or historic) within the study area. Background research indicates that though the area of potential impact (API) is located in an area with moderate to high archaeological probability, the majority of the lands are previously disturbed. Additionally, the majority of the API is mapped as rocky outcrop soils, further reducing the potential for buried deposits. Field assessments were conducted in the summer of 2022 and no new cultural materials were observed. As an outcome, no further cultural study through final design is anticipated to be necessary, unless pre-contact or historic-period resources are encountered during construction.

WETLANDS

To inform project feasibility, a field review was conducted looking for possible area wetlands, and historical wetland delineations in the area were reviewed.

Within the study area, there have been nine wetlands located within proximity to the proposed alignment, though none of the known wetlands will be impacted by any of the proposed roadway alignment alternatives. Most of the wetlands are on the Willamette Water Treatment plant site.

Additionally, it is noted that the roadway alignment alternatives will have to cross the headwaters of Hedges Creek, therefore a culvert will be provided with roadway construction. Once a preferred alternative is progressed towards final design, **a formal wetland delineation along the alignment will be necessary for compliance with Clean Water Services and Oregon Department of State Land regulations. It is anticipated that the proximity of the headwaters of Hedges Creek and minimum buffer requirements may require permitting and mitigation.**

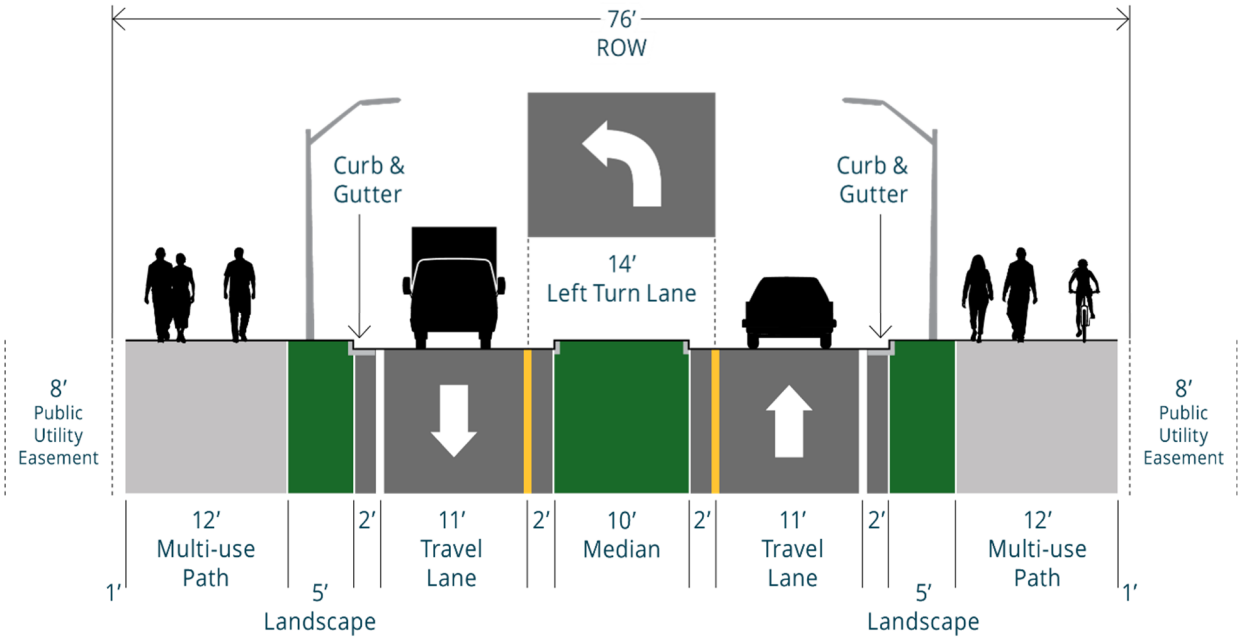
ROADWAY DESIGN FEATURES

CROSS-SECTION

The planned collector roadway cross section will continue the roadway cross section approved for construction with Willamette Water Treatment Plan, as displayed in Figure 4.

The 76’ right-of-way width will include two vehicle travel lanes, a center median (or left turn lane at access), landscaping buffers with mast arm style street lighting and a 12 foot wide multiuse pathway on each side of the roadway. Additionally, an 8 foot wide public utility easement (PUE) will be reserved outside of the roadway right-of-way.

Figure 4. Planned Collector Cross-Section



DESIGN SPEED

As coordinated with City staff, the roadway horizontal alignments and vertical design profiles consider a design speed of 30 miles per hour (MPH), though the City may ultimately to utilize a lower posted speed of 25 MPH. The horizontal curvature of the roadway centerline has selected based on a 30 MPH design speed and to a avoid the need to superelevate any curves, though it is noted that the curve to be constructed by the Willamette Water Treatment Plant will be superelevated.

An additional benefit of utilizing 30 MPH design speed, normal crown radius curves ensures that the new collector roadway can accommodate future truck traffic (including WB-53 and WB-67 heavy vehicles) with reduced truck path overlap risk.

PAVEMENT SECTION

The planned Ice Age Drive pavement section to be constructed by Willamette Water Treatment plant includes 6 inches of asphalt concrete pavement (ACP) over 12 inches of aggregate base course.

After consideration of the forecast traffic volumes on Ice Age Drive and review of available heavy vehicle information on nearby roadways, it was determined by the project geotechnical engineer that a reduced depth pavement section could be considered for the remainder of Ice Age Drive. The reduced pavement section would consist of 5 inches of asphalt concrete pavement (ACP) over 9 inches of aggregate base course. Table 1 summarizes the two pavement section alternatives.

For the purposes of this 30% design and feasibility analysis, the thicker, more conservative pavement section was utilized to develop the project cost estimates, however when the project moves into final design, the project costs could be reduced by utilizing the alternative reduced pavement section.

Table 1. Ice Age Drive Pavement Alternatives

Ice Age Drive—Pavement Section to be Constructed by Willamette Water Treatment Plant	Ice Age Drive—Alternative Reduced Pavement Section for remainder of Ice Age Drive (to be constructed by City)
6 inches of Asphalt Concrete	5 inches of Asphalt Concrete
12 inches of aggregate base	9 inches of aggregate base

ACCESS

Initially upon construction of Ice Age Drive, only two new direct accesses are anticipated:

- A new driveway to Sherwood Commerce Center along the northern property limit
    - After construction of this access, the Sherwood Commerce Center direct access to Oregon Street would be gated and limited to emergency vehicle traffic only
- Two interim driveways to connect SW Dahlke Lane to the north and SW Dahlke Lane and the BPA access road to Ice Age Drive
    - If the planned east-west connection from the Sherwood Commerce Center property is extended to Ice Age Drive near Dahlke Lane in the future, a new intersection would be constructed.

TERMINUS INTERSECTION TRAFFIC CONTROL

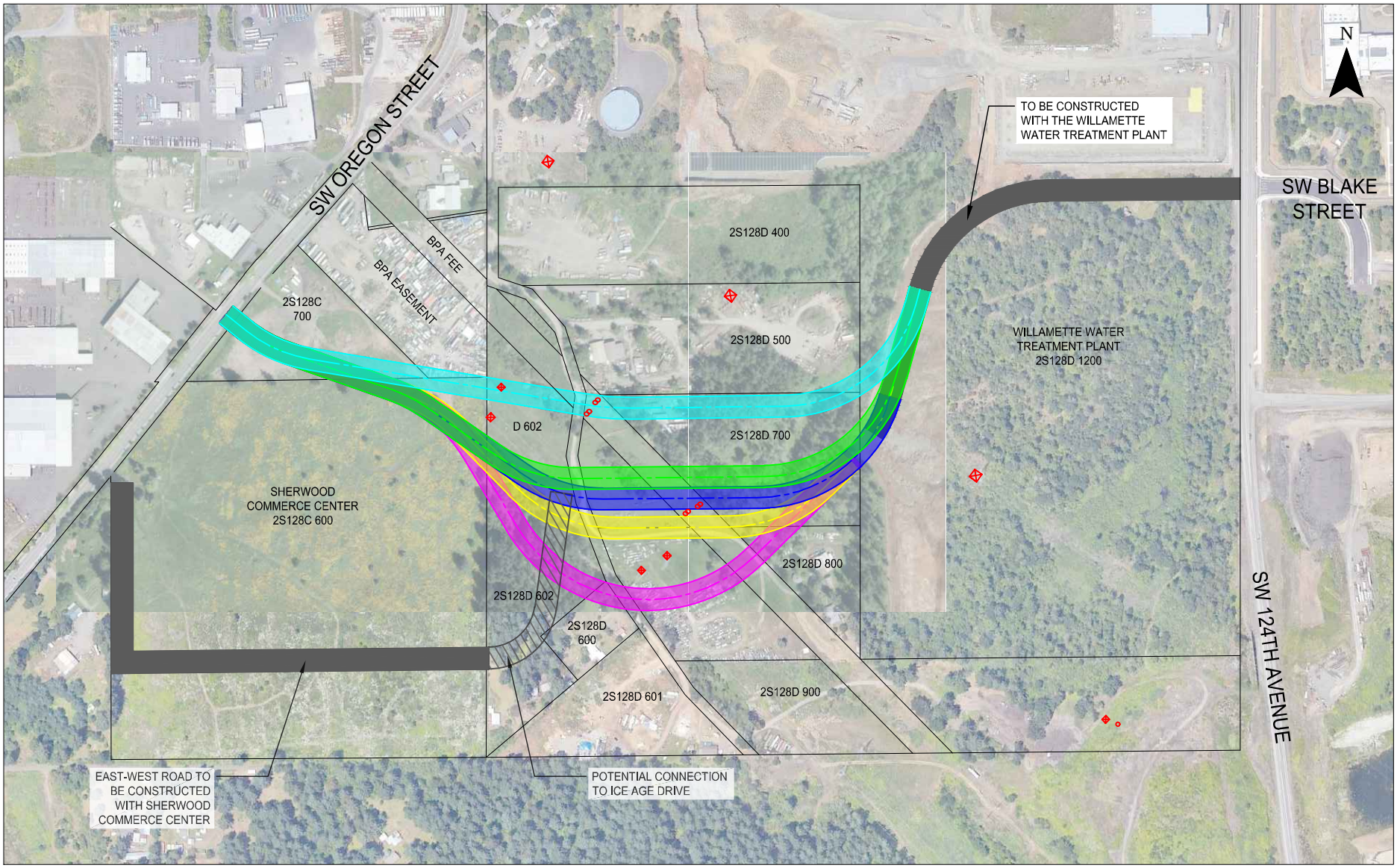
To inform traffic control needs at the terminus intersections with SW Oregon Street and SW 124th Avenue, a future traffic forecast for Ice Age Drive was developed utilizing the Washington County Travel Demand Model future volumes for Ice Age Drive and a trip generation estimate for the remaining developable parcels within the TEA. Key findings include:

- Signal warrants are forecast to be met at both terminus intersections by 2045, assuming build out of the TEA middle parcels with improved access via Ice Age Drive
- In the near-term, a traffic signal should be constructed with the Ice Age Drive roadway project at the SW Oregon Street terminus. Benefits include:
    - Construction cost efficiencies inherent to building Ice Age Drive, utilities and the traffic signal at the same time
    - The traffic signal would provide a signalized crossing for pedestrian and bicycle traffic on SW Oregon Street
    - Construction of the terminus traffic signal in the near-term would reduce the development cost burden for industrial development of the remaining parcels within the TEA
- In the longer term, the SW 124th Avenue / Ice Age Drive-Blake Street intersection volumes should be monitored, and a traffic signal be considered by Washington County and the City as further development in the area occurs.

ALIGNMENT ALTERNATIVES

With the west and east terminus of Ice Age Drive set, initially 5 alignment alternatives were considered. Figure 5 displays initial alignment alternatives A through E. After coordinating with City staff, alignment alternatives B and E were discarded for directly impacting the existing transmission line steel or wood towers while alternatives A, C, and D were selected for further refinement and were retitled as the North, Middle and South Alignment alternatives, as shown in Figure 6.

The alignment and profile for each of the three main alternatives was then further refined assuming a 30 MPH design and ability accommodate a WB-67 design vehicle through the reverse curves along the Sherwood Commerce Center site.



CONCEPT A
CONCEPT B
CONCEPT C
CONCEPT D
CONCEPT E
STEEL TOWER
WOOD TOWER

Initial Alignment Altneratives
Sherwood, Oregon

Figure
5

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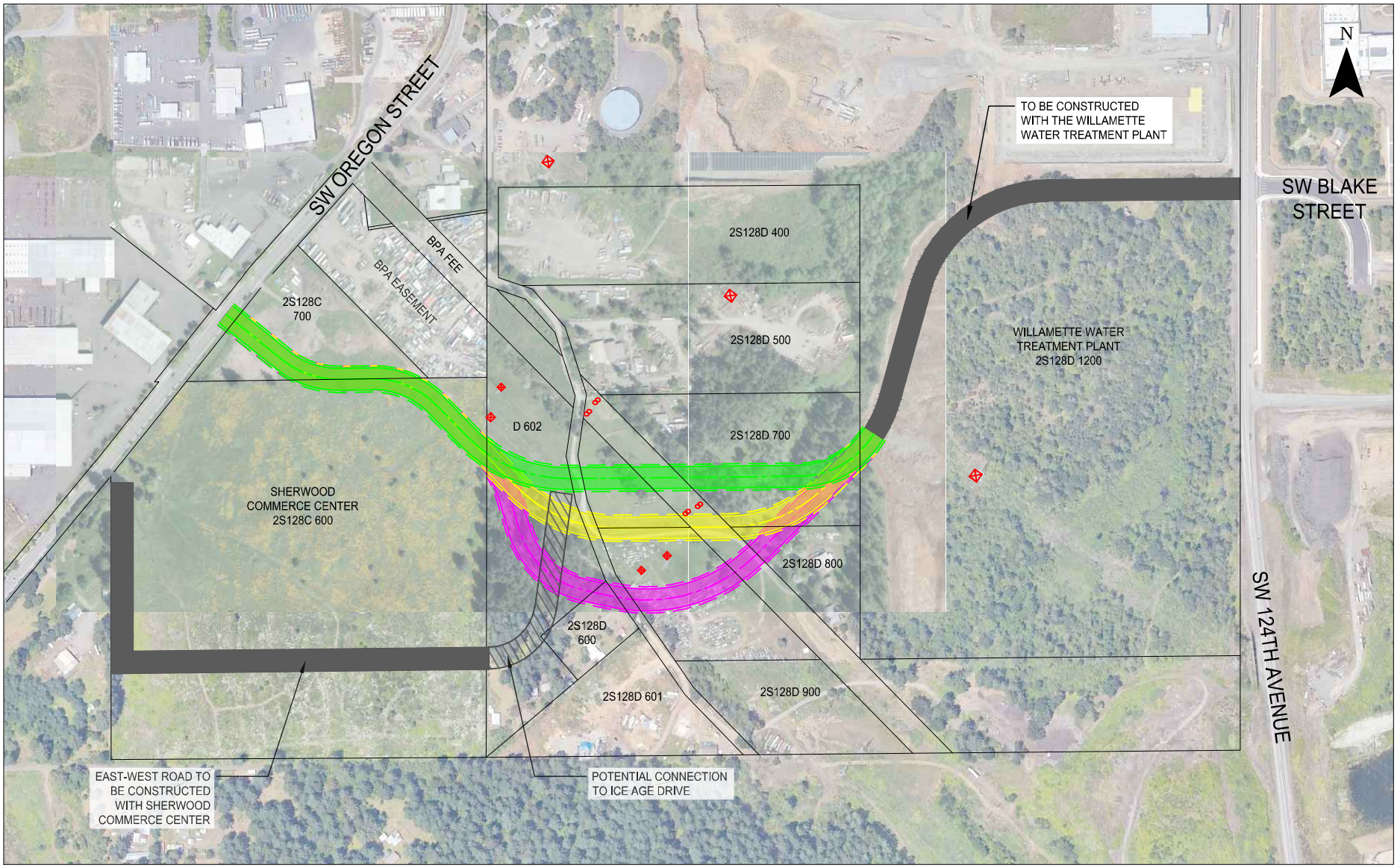

NORTH ALIGNMENT
MIDDLE ALIGNMENT
SOUTH ALIGNMENT
STEEL TOWER
WOOD TOWER

Investigated Alignment Alternatives
Sherwood, Oregon

Figure
6

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FEASIBILITY CONSIDERATIONS

Additional feasibility considerations further explored include:

- Ability to provide Sewer and Water for development within TEA
- Minimize impacts to existing private utilities already present in TEA (BPA, PGE, and Kinder Morgan)
- ROW impacts, especially remnant developable parcels after roadway construction
- Overall project cost

PUBLIC UTILITY SERVICE

Beyond providing improved access to properties within TEA, significant benefits of constructing Ice Age Drive include:

- Reducing the individual property development burden of meeting Clean Water Standards for stormwater, and
- Facilitating development with simple trunk connections to public stormwater, water and sewer mainlines that would be constructed with Ice Age Drive.

STORMWATER

To reduce the individual property development burden of meeting Clean Water Standards for stormwater, the initial stormwater analysis focused on providing a regional water quality. The amount of area able to be served by a regional facility varies for each of the alignment alternatives. As shown in Table 2, the further south the horizontal alignment extends, the more area within TEA that can be served by a regional facility.

Table 2. Regional Stormwater Facility Basin Service Area

Facility Basin	Total Basin Area (acres)
North Alignment	9.65
Middle Alignment	14.46
South Alignment	24.82

Regardless of the alternative alignment selected, two stormwater treatment facilities would be required due to the roadway profile grading, though exact placement and initial facility layout would maintain maximize developable ROW within TEA by providing stormwater management facilities:

- Near SW Oregon Street, to be located on the City owned property just north of Sherwood Commerce Center, and
- Near Dahlke Lane, within the BPA easement that would otherwise encumber development.

WATER AND SEWER SERVICE

With roadway construction, the intent would be to also install City water and sanitary sewer infrastructure along the roadway alignment. Both utilities would need to installed after, and underneath the relocated Kinder Morgan gas line.

Water

A 16-inch DI water main will be provided along Ice Age Drive, consistent with the water system to be provided by the adjacent development. The new water main will provide adequate capacity to serve all of TEA. Under each alignment alternative, the water main will connect at the west end of the project to the main to be constructed by the Sherwood Commerce Center project, and at the east end, the water main will connect to the water main that will be constructed with the Willamette Water Treatment facility. Should an east-west roadway connection from the Sherwood Commerce Development be extended to Ice Age Drive, a 12-inch water could be installed connecting to the Ice Age Drive water line. The new 16-inch water main can serve all properties adjacent to Ice Age Drive. Developments without frontage will need to install new water main connections, or service in an easement.

An initial corrosion analysis found that no cathodic protection would be required for the new water main. However, where the new water main will cross underneath the relocated Kinder Morgan 8-inch gas line, a non-metallic casing extending 20 feet beyond the crossing is recommended.

Sanitary Sewer

A 10-inch new sanitary sewer main will be provided along Ice Age Drive as recommended in the City's Sanitary Sewer Master Plan. A sanitary sewer service area analysis and preliminary system design was completed that considered the depths necessary to provide service within the TEA. The analysis considered implications of the sanitary sewer main connecting at SW Oregon Street (following the entirety Ice Age Drive) or connecting to the potential east-west roadway. Key takeaways of the sanitary sewer serviceability analysis included:

- All three Ice Age Drive roadway alignment alternatives (Labled 1, 2, & 3) are able to provide sanitary sewer service to most developable areas within TEA.
    - The north and middle alignments (1 & 2) have similar costs and service areas.
    - The south alignment (3) has a higher cost and a slightly reduced service area.
        - While the service areas are estimated based on existing topography, site development and re-grading activities of properties within TEA could increase the sanitary service areas.
- The deeper sewer options (labeled 1B, 2B, 3B) would result in significantly higher costs with a relatively limited increase in service area.
- Connection to the east-west road, instead of at Oregon Street, results more service area in the southern TEA taxlots, at a similar cost.

Considering the bedrock depths, and limited increase in service area for the deeper sewer options, the shallower sewer option is carried forward in the project cost estimate.

Sewer Alignment Alternative	Area Served (Acres)	Cost
1A (North)	58	$ 1,250,000.00
1B (North Deep)	62	$ 2,200,000.00
2A (Middle)	57	$ 1,250,000.00
2B (Middle Deep)	61	$ 2,350,000.00
3A (South)	52	$ 1,450,000.00
3B (South Deep)	61	$ 2,500,000.00
4(E/W-North)	56	$ 1,300,000.00
5 (E/W-Middle	55	$ 1,150,000.00
6 (E/W-South)	55	$ 1,150,000.00

SHERWOOD BROADBAND

As the local internet provider, conduit for Sherwood Broadband would be included within a joint utility trench for future internet service for adjacent developments.

UTILITY IMPACTS

Each of the existing private utilities with facilities and easements within TEA were presented the draft Ice Age Drive alignment alternatives and were asked for feedback on, construction feasibility and time and cost impacts to the roadway project based on the level of impact.

BPA

Key takeways from initial coordination with BPA include:

- BPA standard is a 50’ buffer around existing metal towers and a minimum 30’ buffer around wood towers
- Though BPA generally prefers perpendicular crossings to roadways when feasible, BPAs main concern regarding their existing facilities in the area is maintaining access.
- Avoiding a tower move would help facilitate quick construction of the roadway project – a tower move could take 5 years to coordinate, design and complete.

BPA expressed a strong preference for the south alignment as if would not impact any existing towers and would ensure a relatively low Electric field (EF). From BPA’s perspective, the second best option would be the north alignment. The middle alignment would fall within the minimum buffer distances, and may create EF issues necessitating tower moves, which would have significant construction costs and time delays.

In order for Ice Age Drive to pass through the BPA Fee areas, BPA and the City would have to establish a land use agreement. While there may be some limitations on light pole and fire hydrant placements, ultimately BPA would not charge the City for use of these areas.

Within existing BPA overhead easement areas, no buildings or structures would be allowable with future development of the area. This severely limits the amount of fully developable lands within TEA. However, these encumbered BPA easement areas can typically be used for parking, stormwater ponds, trails and low plantings so long as there are no safety or overhead clearance concerns.

PGE

PGE facilities, beyond the leased line within the BPA fee area do not stand to be otherwise directly impacted by the Ice Age Drive alternatives. **Similar to BPA, PGE expressed preference for the north or south alignment alternatives, as the middle alternative would potentially necessitate relocation of a wood tower.** Relocation of a wood tower would have cost and potentially time delays. The wood tower that impacted within the BPA fee area is functionally PGE owned/maintained – any impact to the existing wood towers will need to be coordinated with both BPA and PGE.

Regardless of the roadway alignment alternative selected, PGE is interested in continuing a mainline connection including vaults, conduits and wiring within the PUE planned to be parallel to the roadway. Providing this infrastructure would help facilitate electrical service for developments along Ice Age Drive. As the PGE mainline being built along the Willamette Water Treatment Plant will be built in the PUE along the south side of the roadway, PGE would likely continue this mainline along the south side of Ice Age Drive, with occasional vaults also located within the northside PUE.

When the Oregon Street right-turn lane is extended to Ice Age Drive, the existing overhead power lines will be placed underground.

KINDER MORGAN

Kinder Morgan would prefer for their gasline facility to cross new roadway facilities perpendicularly. The roadway alignment alternatives resulting in varying levels of gasline relocation – limited relocation for the north and middle alignment, more significant relocation needed for the south alignment alternative.

Additionally, Kinder Morgan will require that underground utilities to be built with the roadway (water and sanitary sewer) be located at least 2 feet beneath the Kinder Morgan gasline. A casing may be provided with water and sanitary sewer construction for ease is working around the gasline in the future.

On-going coordination with Kinder Morgan and the Sherwood Commerce Center is being conducted to determine the relocation alignment and costs. Given that the costs of gas relocation are similar, the relocation will have no weight in selecting a roadway alignment.

If an east-west roadway is extended from the Sherwood Commerce Center site to Ice Age Drive, further Kinder Morgan relocation may be necessary.

ROW IMPACTS

PRIVATE PROPERTIES IMPACTS

There are five taxlots directly impacted by the completion of Ice Age Drive:

- Taxlot 2S128C700
    - As of Fall 2022, the City has acquired this entire taxlot.
- Taxlot 2S128D602
    - As of November 2022, the City is in the process of purchasing this property.
- Taxlot 2S128D600
- Taxlot 2S128D700
- Taxlot 2S128D800

Table 3 summarizes the existing area and estimated ROW and public utility easement need for each alignment alternative for **Ice Age Drive only**. The following section further expands on the remaining developable land considerations for each of the four key impacted properties.

Additionally, a BPA fee area exists through Taxlots D602, D700 and D800, which is property that BPA owns. For Ice Age Drive to go through these Fee areas, BPA and the City would have to establish a land use agreement. While there may be some limitations on light pole and fire hydrant placements, ultimately BPA would not charge the City for use of these areas.

The specific impacts to each of the four impacted private properties and remanent north and south of each roadway alignment alternative are then further explored.

Table 3. ROW Summary Table

Taxlot	Existing Area	Existing Area Encumbered by Easement	Existing Developable Area	North Alignment Alternative			Middle Alignment Alternative			South Alignment Alternative		
				Roadway ROW	PUE, Stormwater or New Kinder Morgan Easement	Remaining Area	Roadway ROW	PUE, Stormwater or New Kinder Morgan Easement	Remaining Area	Roadway ROW	PUE, Stormwater or New Kinder Morgan Easement	Remaining Area
C700[1]	199,933	3,593	196,340	37,007	22,195	140,731	37,007	22,195	140,731	37,007	22,195	140,731
C600[2]	1,689,043	26,365	1,662,678	41,684	9,883	1,637,476	42,275	9,883	1,636,885	42,343	9,883	1,636,817
D602[3]	392,326	139,270	253,056	23,684	5,029	636,613	32,070	6,850	353,406	48,824	18,561	325,241
BPA Fee (D602)	41,176	-	-	-	-	41,176	-	-	41,176	-	-	41,176
D600	57,908	1,698	56,210	-	-	57,908	-	-	57,908	6,595	1,379	49,934
D601[4]	193,112	6,651	186,461	-	-	193,112	-	-	193,112	-	-	193,112
D700	386,255	80,436	305,819	64,853	16,771	304,631	48,867	21,276	316,112	27,963	5,889	352,403
BPA Fee (D700)	61,014	-	-	10,561	6,404	44,049	1,112	5,281	54,621	-	-	61,014
D800	306,312	181,420	124,892	-	-	306,312	16,832	4,143	285,337	39,020	20,764	246,528
BPA Fee (D800)	64,776	-	-	-	-	64,776	5,288	1,111	58,407	7,633	4,710	52,433

Note - All Units are in square feet (S.F.)

[1] The City of Sherwood purchased Taxlot 2S128C700 in Fall 2022.

[2] Sherwood Commerce Center will have to dedicate ROW.

[3] As of November 2022, the City of Sherwood has begun the process to purchase Taxlot 2S128C602

[4] While Taxlot 2S128D601 will not be directly impacted by Ice Age Drive, it would be impacted if the east-west roadway to be constructed by Sherwood Commerce Center were extended to intersect with Ice Age Drive, therefore the existing Taxlot details are included for informational purposes.

Taxlot 2S128D602

Table 4 and Exhibits 1 - 3 summarize the property impacts to taxlot D602 for each of the alignment alternatives. The north alignment alternative results in the largest remnant property south of Ice Age Drive, though that area would still be bisected by the existing Kinder Morgan gasline easement, unless a more significant re-route of the Kinder Morgan along the D602 west property line was pursued. An east-west connection would further impact D602.

Table 4. Taxlot 2S128D602 ROW Summary

Taxlot		Existing Area	Existing Encumbered Area		Existing Developable Area		
2S128D602		392,326	139,270		253,056		
Ice Age Drive Alignment Alternative	Required ROW for Roadway	Required Easement (PUE, Stormwater, relocated Kinder Morgan)	Remaining Area North of Roadway (Encumbered by Existing Easement)	Remaining Area North of Roadway (Fully Developable)	Remaining Area South of Roadway (Encumbered by Existing Easement)	Remaining Area South of Roadway (Fully Developable)	Total Remaining Developable Area (North and South)
North	23,684	5,029	94,824	10,558	25,365	233,232	243,790
Middle	32,070	6,850	117,036	10,558	14,634	210,607	221,165
South	48,524	18,561	123,299	55,604	5,730	140,914	196,518

Exhibit 1. North Alignment

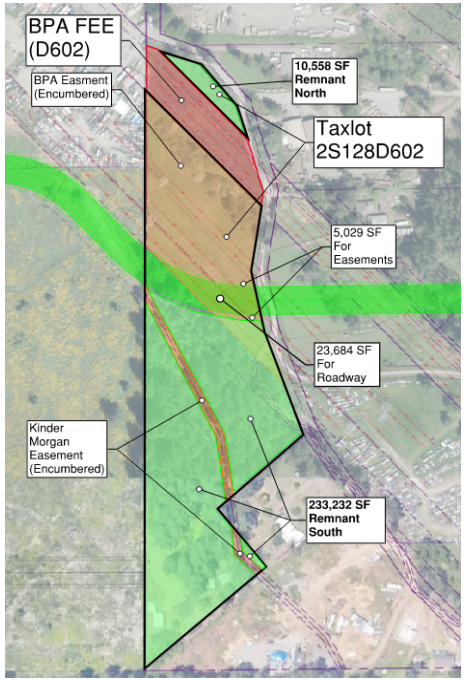


Exhibit 2. Middle Alternative

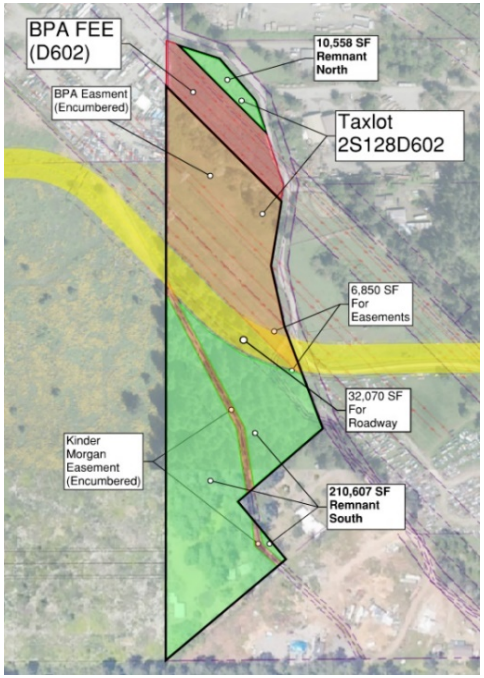
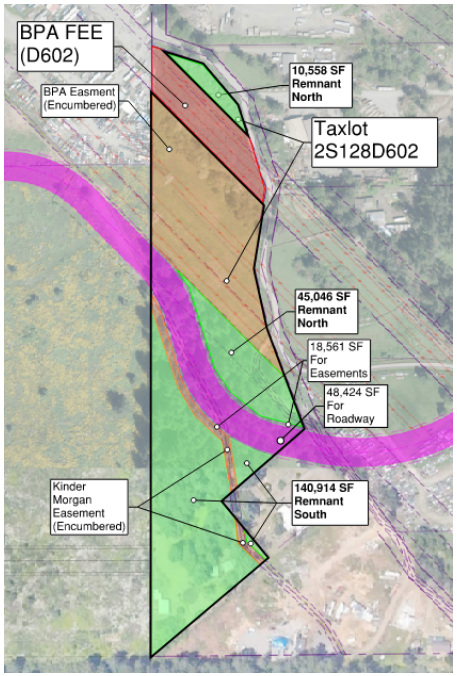


Exhibit 3. South Alternative



Taxlot 2S128D600

Table 5 and Exhibits 4 – 6 summarize the property impacts to taxlot D600 for each of the alignment alternatives. As shown, only the south alignment alternative impacts property D600; however, if the east-west roadway planned to be constructed through the Sherwood Commerce Center site were to be extended to Ice Age Drive, additional ROW take from D600 would likely be necessary.

Table 5. Taxlot 2S128D600 ROW Summary

Taxlot		Existing Area	Existing Encumbered Area		Existing Developable Area	
2S128D600		57,908	1,698		56,210	
Ice Age Drive Alignment Alternative	**Required ROW for Roadway**	**Required Easement (PUE, Stormwater, relocated Kinder Morgan)**	**Remaining Area North of Roadway (Encumbered by Existing Easement)**	**Remaining Area North of Roadway (Fully Developable)**	**Remaining Area South of Roadway (Encumbered by Existing Easement)**	**Remaining Area South of Roadway (Fully Developable)**
North	-	-	-	-	-	-
Middle	-	-	-	-	-	-
South	6,595	1,379	-	-	1,698	48,236

Exhibit 4. North Alternative

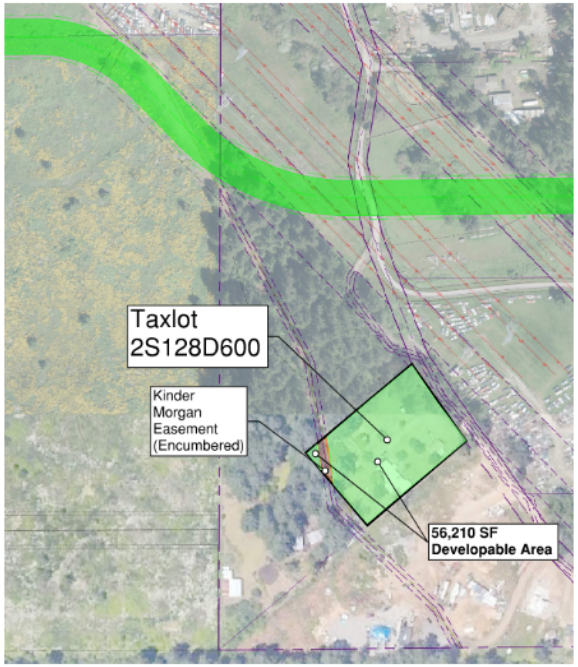


Exhibit 5. Middle Alternative

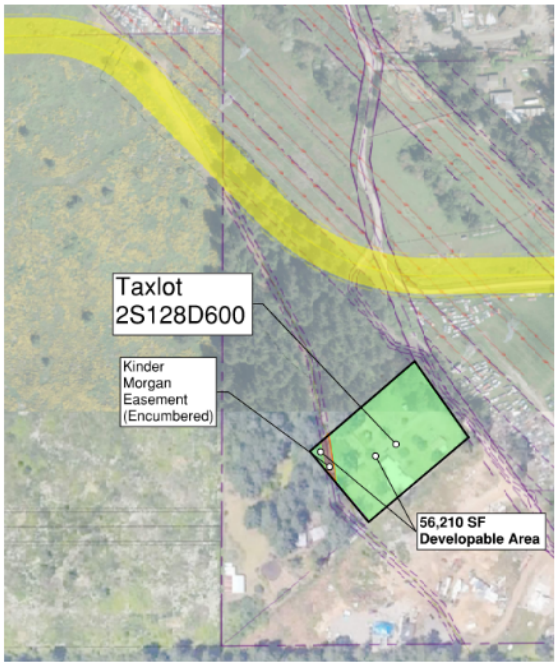
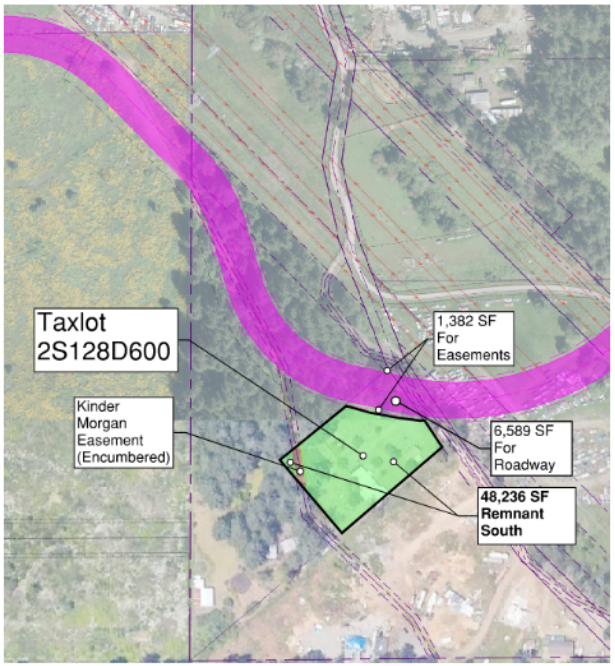


Exhibit 6. South Alternative



Taxlot 2S128D700

Table 6 and Exhibits 7 – 9 summarize the property impacts to taxlot D700 for each of the alignment alternatives. If the additional east-west connection were extended from Sherwood Commerce Center to Ice Age Drive, there would be additional ROW impacts to D700 for only the North alternative.

Table 6. Taxlot 2S128D700 ROW Summary

Taxlot		Existing Area	Existing Encumbered Area		Existing Developable Area		
2S128D700		368,255	80,436		305,819		
Ice Age Drive Alignment Alternative	**Required ROW for Roadway**	**Required Easement (PUE, Stormwater, relocated Kinder Morgan)**	**Remaining Area North of Roadway (Encumbered by Existing Easement)**	**Remaining Area North of Roadway (Fully Developable)**	**Remaining Area South of Roadway (Encumbered by Existing Easement)**	**Remaining Area South of Roadway (Fully Developable)**	**Total Remaining Developable Area (North and South)**
North	64,853	16,771	21,334	178,659	35790	68,971	247,630
Middle	48,867	21,276	53,748	242,384	0	20,122	262,506
South	27,963	5,889	80,331	253,051	0	18,748	271,799

Exhibit 7. North Alternative

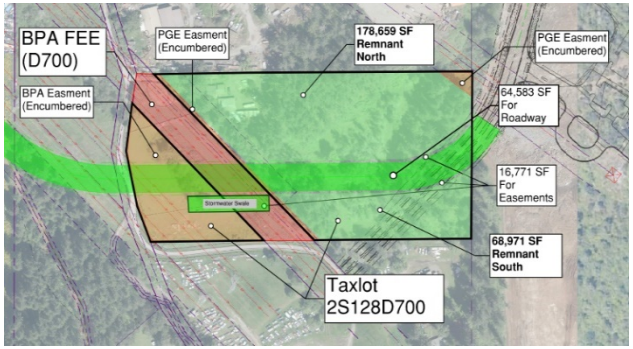


Exhibit 8. Middle Alternative

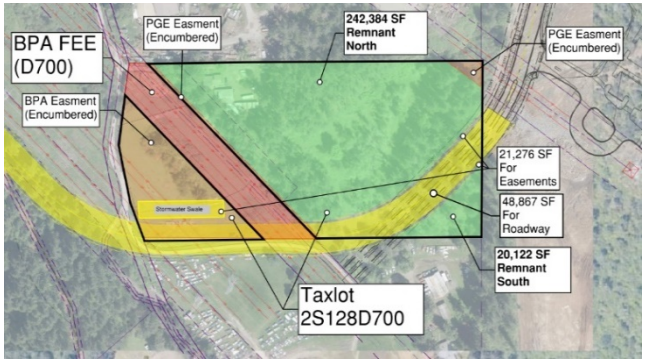
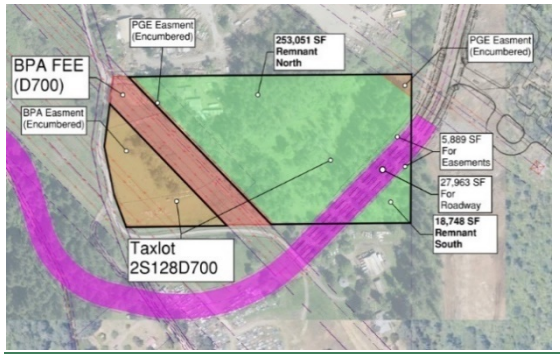


Exhibit 9. South Alternative



Taxlot 2S128D800

Table 7 and Exhibits 10-12 summarize the property impacts to taxlot D800 for each of the alignment alternatives. If the additional east-west connection were extended from Sherwood Commerce Center to Ice Age Drive, there would likely not be additional ROW impacts to D800.

Table 7. Taxlot 2S128D800 ROW Summary

Taxlot			Existing Area	Existing Encumbered Area		Existing Developable Area	
2S128D800			308,312	181,420		124,892	
Ice Age Drive Alignment Alternative	Required ROW for Roadway	Required Easement (PUE, Stormwater, relocated Kinder Morgan)	Remaining Area North of Roadway (Encumbered by Existing Easement)	Remaining Area North of Roadway (Fully Developable)	Remaining Area South of Roadway (Encumbered by Existing Easement)	Remaining Area South of Roadway (Fully Developable)	Total Remaining Developable Area (North and South)
North	-	-	-	-	-	-	-
Middle	16,832	4,143	-	-	165,873	119,481	119,481
South	39,020	20,764	54,821	5,189	83,827	102,996	108,185

Exhibit 10. North Alternative

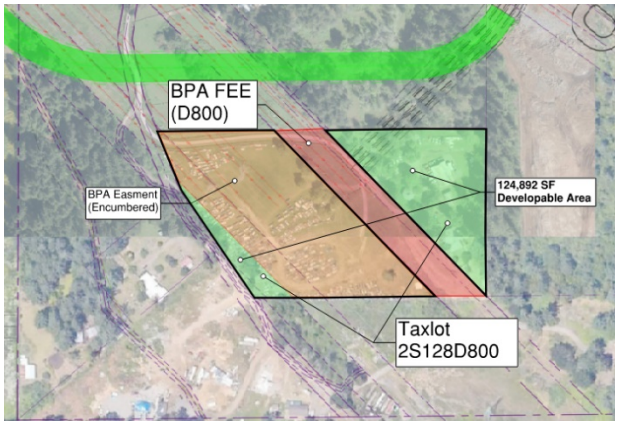


Exhibit 11. Middle Alternative

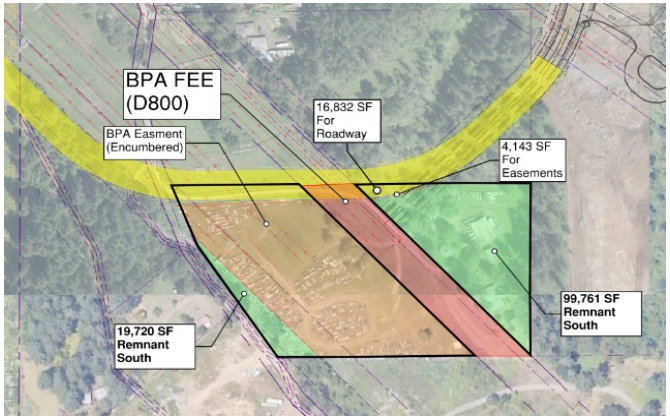
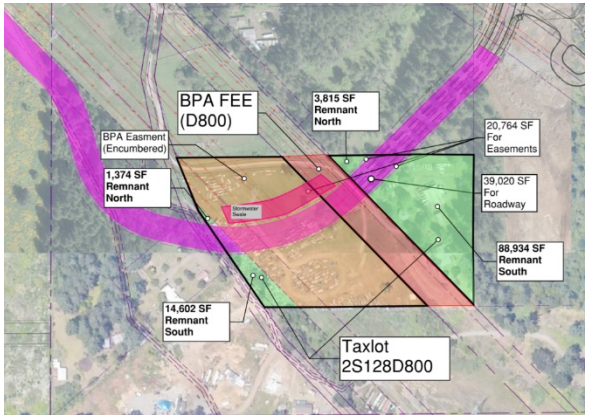


Exhibit 12. South Alternative



REMAINING DEVLOPABLE PROPERTY

The remaining fully developable property for each of the impacted taxlots is summarized in Table 8. As shown, the North alignment alternatives results in the most remaining fully developable land, while the South alignment alternative results in the least. However, the remaining total developable land varies by alignment alternative by only 10 percent or so.

Table 8. Remaining Developable Land Summary

Roadway Alignment	Developable Land Remaining (SF)					
	C700	D602	D600	D700	D800	Total (SF)
North Alignment	120,670	243,790	56,210	247,630	124,892	793,192 (18.2 acres)
Middle Alignment	120,670	221,165	56,210	262,506	119,481	780,032 (17.9 acres)
South Alignment	120,670	196,518	48,236	271,799	108,185	745,408 (17.1 acres)

ICE AGE DRIVE PROJECT COSTS

The construction cost estimates for the three Ice Age Drive alignment alternatives were prepared based on 30% concept plans and the following assumptions:

- 30% contingency applied to construction costs
    - The relatively high contingency is partially to account for any natural resource mitigation and permitting around Hedges Creek.
- Engineering & Construction management was assumed to be 15% of all construction costs
- Stormwater, Water and Sanitary Sewer, Illumination costs are included
- Costs for providing underground PGE power service within the PUE paralleling the roadway are included, and Sherwood Broadband within a joint utility trench
- Costs for a potential east-west roadway and utility connection from Sherwood Commerce Center to Ice Age Drive **were not** included in Table 9, however the potential costs are discussed below.

Additionally, Kinder Morgan and BPA/PGE relocation costs for each alternative were coordinated with each respective agency.

ROW acquisition costs were estimated at $15 per square foot, with areas of new public utility or stormwater easements at half that ($7.50 per square foot), and temporary construction easements at $2.00 per square foot. This analysis assumes only the areas need to accommodate Ice Age Drive and public utility easements are acquired – if impacted properties are purchased in full, ROW costs may be higher. Additionally, construction of a potential east-west connection from Sherwood Commerce Center to Ice Age Drive may result in additional ROW costs.

Table 9. Ice Age Drive Project Cost Summary

Alignment Alternative	Roadway and Public Utility Construction Costs	Kinder Morgan Relocation Costs[2]	BPA/PGE Tower Relocation Costs[2]	ROW Acquisition Costs	Public Easement Acquisition Costs	Temporary Construction Easements	Engineering Support and Permits	Overall Costs[2]
North	$8.51M	$0.04M	-	$1.33M	$0.17M	$0.036M	$1.13M	**$11.2M**
Middle	$8.78M	$0.04M	$0.5M[1]	$1.47M	$0.24M	$0.040M	$1.12M	**$12.2M**
South	$9.86M	$0.04M	-	$1.83M	$0.35M	$0.048M	$1.2M	**$13.3M**

[1]Without completing additional electric field analysis, neither BPA or PGE were able to state if a wood tower relocation would be necessary or what the cost might be – This value is included as a conservative ballpark estimate should a wood tower relocation be necessary.

[2]Kinder Morgan and BPA/PGE Tower costs are not included in the cost estimates included in the appendix.

More detailed quantity summaries and cost estimates can be found in **Appendix** B.

EAST-WEST ROADWAY CONNECTION ADDITIONAL COSTS

If the east-west roadway connection extending from the Sherwood Commerce Center were designed and constructed as part of the Ice Age Drive project moving forward, there would be additional roadway and public utility construction costs, Kinder Morgan relocation costs and ROW and easement acquisition costs not represented in Table 9. The length of this connection would vary by Ice Age Drive alignment alternative, from approximately 850 feet for the North alignment alternative, 675 feet for the Middle alignment alternative to 450 feet for the South alignment alternative. These additional order-of-magnitude, illustrative costs including 30% contingency, are summarized below for City consideration.

- Additional roadway and public utility construction costs
  - North - $2.2M
  - Middle -$1.9M
  - South - $1.4M
- Additional Kinder Morgan Relocation costs (~400 LF of additional gasline relocation)
  - North, Middle, South - $0.5M
- Additional ROW Acquisition Costs
  - North - $800K
  - Middle - $650K
  - South - $450K

COST SUMMARY

Alignment Alternative	Ice Age Drive Cost	E-W Connector Cost	Total
North	$11.2M	$3.5M	$14.7M
Middle	$12.2M	$3.0M	$15.2M
South	$13.3M	$2.4M	$15.7M

ALIGNMENT ALTERNATIVE EVALUATION

Each of three alignment alternatives was ranked compared to each other considering construction costs, ROW costs and creation of remnant parcels, regional stormwater facility capture area and sanitary sewer service areas.

Table 10. Alignment Opportunities and Challenges Summary

Alignment Alternative	Opportunities (Pros)	Challenges (Cons)
North	• **Lowest cost alternative, though cost would be increased for east-west connection** • Least impact to Kinder Morgan and likely limited BPA impact. • Results in the most remaining fully developable land	• A regional storm water facility would serve a small basin • Taxlot D700 would be bisected. • No access improvements for Taxlots D600 or D800, unless the east-west connection is made too. • Most impact to headwaters of Hedges Creek
Middle	• Facilitates direct access to Taxlot D700 and D800	• Threads the needle between existing steel and wood towers - Existing wood tower impacts may delay construction and have significant cost. • BPA would need to run additional analysis to verify no Electric Field concerns.
South	• **BPA preferred concept** • A regional storm water facility would serve a larger basin • Facilitates improved access to all impacted taxlots (D602,D600,D700 and D800), • Highest amount of developable remnant ROW in combined TL D700 and TL D800	• **Highest cost alternative though may result in reduced cost for east-west roadway if that connection is made.** • Has the highest impact to Kinder Morgan gasline • The sanitary sewer cost is the highest, for a reduced service area unless the east-west connection is made. • Roadway covers more developable land, resulting in the least remaining fully developable land.

Additionally, Table 11 ranks the alignment alternative considering construction costs and time, ROW costs and remnanent parcels, and regional stormwater facility basin and sanitary sewer service . As shown, the north and south alignment alternatives are generally equivalent overall.

Table 11. Alignment Evaluation Criteria and Ranking

Alignment Alternative	Construction Costs	Construction Time	BPA/ PGE Preference	ROW Costs	Develop-able Area	Potential Environ-mental Impacts	Stormwater Basin Areas	Sanitary Sewer Service Cost	Sanitary Sewer Service Area Served	Overall Total
North	1	2	2	1	1	3	3	2	1	**16**
Middle	2	3	3	2	2	2	2	1	2	**19**
South	3	1	1	3	3	1	1	1	2	**16**

Note: 1 represents the most preferred, 3 represents the least preferred

NEXT STEPS TO MOVE INTO FINAL DESIGN

When the preferred alternative is selected and advanced through final design and construction, key elements that will need to be further explored include:

- Additional geotechnical borings and infiltration testing along the alignment and at the actual locations for regional stormwater facilities.
- Additional survey (especially for South alignment) and to design east-west roadway connection
- CWS provider letter, necessitating refined wetland delineation along the alignment
- Hazardous material survey
- Continued coordination with Kinder Morgan regarding relocated facilities and easement needs.
- Continued coordination with BPA and PGE regarding impacts to existing easements and easement access changes

Appendix A. Roadway Alignment Alternatives Plan and Profile Exhibit

Appendix B. Cost Estimates

Appendix C. Geotechnical Memo

Appendix D. Cultural Resources Memo

Appendix E. Wetland Memo

Appendix F. Stormwater Memo

Appendix G. Sanitary and Water, and Corrosion Memo

Appendix H. Traffic Memo