File No. 13926 Task 3.0PB
Draft Technical Memorandum

Date:	September 28, 2001
To:	Jay Lyman, David Evans and Associates
From:	Connie Kratovil
Subject:	ODOT Contract No. 16902- I-5 Trade Corridor Study Phase II **Conceptual Engineering for Option Package 3: Light Rail Transit (LRT) Without Corridor-Wide Capacity Increase**

GENERAL FUNCTIONAL DESCRIPTION

Option Package 3 includes investment in a regional light rail transit (LRT) system without corridor-wide freeway capacity increases. Two light rail alignments have been developed to assess the benefits of different levels of transit investment, construction of a an arterial parallel to I-5 from Vancouver south to Columbia Blvd., and no investment in I-5 freeway capacity. Key features of each alignment/variation follow:

Option Package 3a: Loop LRT system (SR 500)

Key features of this option package include the following:

- Includes an LRT loop system with the following segments:
  - Expo park-and-ride to Clark College
  - Clark College to 83rd St. park-and-ride lot with service to Vancouver Mall
  - 83rd St. park-and-ride to Parkrose transit center with service to Vancouver Mall
- LRT crossing the Columbia River on an LRT-only bridge
- Assumes no additional capacity on I-5 freeway or parallel arterial roadways
- Represents a "pure" LRT-only option

Option Package 3b: LRT from Expo P&R to Clark College only, with new joint use arterial/HOV bridge

Under this option, LRT would only be extended from Expo/PIR to Clark College via a new joint use arterial/HOV bridge. The roadway and Columbia River crossing improvements under this option package are nearly identical to Option Package 2

The key features of Option Package 3b include:

- Converts the inside (existing/planned) third northbound travel lane from Mill Plain Blvd. to 134th Street for afternoon peak period HOV use

- Results in a northbound HOV system from Going Street to 134th Street and a southbound HOV system from 134th Street to approximately Lombard Street
- Constructs a new four-lane joint use arterial and HOV/express bus bridge across the Columbia River -- serving Hayden Island and matching existing/planned HOV lanes in Oregon and Washington
- Removes the existing I-5/Hayden Island interchange and provides a new connection with Hayden Island via the new bridge
- Includes direct express bus ramps to/from the Expo/PIR transit stations
- Includes HOV specific facility treatments
- Provides truck access between Marine Drive and the new arterial/HOV facility
- Modifications to the existing interchange system between SR 14 and SR 500 to address weaving, merging, and diverging issues

TECHNICAL DESCRIPTION OF OPTION

General Description of Light Rail Facilities

The general description of Option Package 3a is schematically depicted in **Figures 3-1and 3-2** at the end of this memo.

Option Package 3a: Loop LRT system (SR 500)

The total length of the loop system would be approximately 17 miles. There would be 17 or 18 LRT stations depending upon the final alignment, and approximately 6,200 park and ride spaces. The loop LRT option is comprised of three segments:

1. Expo to Clark College (3.0 miles)
2. Clark College to Vancouver Mall Transit Center via SR 500 or Fourth Plain Blvd (4.7 miles)
3. Airport Junction to Padden Expressway Terminus via I-205 (9.3 miles)

Segment 1 Conceptual Alignment: Expo to Clark College

- From Expo Station, LRT would continue north under Columbia Blvd. to a new bridge over North Portland Harbor and Jantzen Drive to an elevated Hayden Island Station.
- The LRT bridge would continue over the Jantzen Beach/Tomahawk Island Drive Interchange, past the Red Lion Hotel, and over the Columbia River.
- On the Washington side of the river, LRT would cross over Columbia Way and under the BNSF Railroad.
- In Downtown Vancouver, LRT would follow Washington St. with possible stations at the 7th St. Transit Center, at 12th St., and at 17th St.
- The alignment then turns east via McLoughlin Blvd. and has a station at E St. to serve the Arnada neighborhood.
- Continuing in the center of McLoughlin Blvd. under I-5, the alignment briefly turns north between I-5 and the Clark College athletic fields with station serving the VA Hospital and a 1,000 space park and ride garage.

Segment 2 Conceptual Alignment: Clark College to Vancouver Mall Transit Center via SR 500 or Fourth Plain Blvd.

Via SR 500 (2 alignment options):

- One alignment option would follow Ft. Vancouver Way north and have a station serving Clark College. The alignment would then continue along Ft. Vancouver to the intersection with St. Johns Blvd. where a station could be located to serve the Rosemere neighborhood.

OR

- An alternative alignment would skirt the neighborhood by following along the east side of I-5 and would have a station at 33rd Ave. The alignment would turn east on the south side of SR 500 and have stations at P and Y Streets.

THEN

- The alignment continues along the south side of SR 500 and has a station at Falk Road, with the possible inclusion of a neighborhood-serving park and ride lot. An additional light rail station could also be at Stapleton Road.
- At Stapleton Road, the alignment crosses to the north side of SR 500 and continues eastward to an elevated crossing of Andresen Road, where an elevated station and adjacent park and ride structure for about 1,000 cars could be sited.
- The alignment continues on the north side of SR 500 and has a station near the Heathman Lodge at 79th St.
- The LRT tracks would pass by Vancouver Mall on the narrow strip of land between the south side of the Mall and SR 500 to a new location for the transit center, east of the Mall, where riders could transfer to C-Trans buses or I-205 LRT trains.

Via Fourth Plain Blvd.:

- In this option, the alignment would turn east from Ft. Vancouver Way along the center of Fourth Plain Blvd.
- Stations could be located at Brand Rd., Caples Ave., 62nd Ave., Burton Rd., and 86th Ave.
- A variation on this alignment option crosses over to the SR 500 alignment just south of the Andresen /Fourth Plain Blvd. intersection.
- Either route ends at the Vancouver Mall Transit Center located at the east side of the Mall.

Segment 3 Conceptual Alignment: Airport Junction to Padden Expressway Terminus via I-205

PDX Airport Junction to SR 14:

- New track would begin at the point where Airport MAX turns west toward the Airport.
- I-205 would be realigned to allow the new tracks to straddle the existing Airport MAX structure.
- Options for crossing the Columbia River include (see Glen Jackson Bridge Technical Memorandum):
    - Option 1: Locate LRT on Glen Jackson Bridge, strengthened as necessary, and either remove one auto lane (Option 1A) or maintain four lanes with narrow (3.5 feet) shoulders (Option 1B).
    - Option 2: Widen Glen Jackson Bridge about 10 feet on the outside and close the gap between the two bridges on the inside to accommodate 4 lanes with 10 foot shoulders and LRT. Relocate the bike path by suspension below the twin bridges.
    - Option 3: Construct a new LRT-only bridge downstream from the Glen Jackson Bridge.

- A fourth option would locate a new LRT bridge further downstream allowing a substantially shorter alignment and bridge structure than Option 3. This alignment would allow the I-205 alignment to go through the Cascade East Station, facilitating transfers to Airport MAX. To proceed with this option, it would first have to be determined that the alignment falls safely outside the landing zone of planes.

- The LRT alignment to the SR 14 interchange would vary depending on the river crossing selected.

SR 14 to Vancouver Mall:

- From SR 14, two alignment options have been identified:
  - Via Chkalov Drive. In this option, LRT would leave the median of I-205 on a new structure to land at the signalized intersection of SE 10th and Chkalov Drive, proceeding north in the center of Chkalov Drive. A station could be located on Chkalov Drive, south of Mill Plain Blvd. The alignment would cross Mill Plain Blvd. at a traffic signal and follow SE 112th a short way and then return to the I-205 median via a new structure. The intent of this option is to locate the station within the community to facilitate pedestrian access, and to generate opportunities for long-term development related to the station.
  - Via I-205. In this option, LRT remains in the median of I-205 with a station located in the median at SE 10th. This option would have fewer impacts compared to the Chkalov option, however, pedestrian accessibility to the station would be less attractive and the station would be physically separated from the community.
- In the median of I-205, LRT passes under SE 9th and SE 18th. At SE 18th a park and ride station would be located to utilize the existing BPA right of way for about 800 surface parking spaces.
- Continuing north, the alignment goes over Burton Road on a new structure, providing a station just north of Burton Road.
- Approaching the SR 500 intersection, the alignment would swing to the west on two successive LRT structures to land at the Vancouver Mall Transit Center and a small surface park and ride parking lot of about 300 spaces (that could be enlarged by constructing structured parking).

Vancouver Mall to Padden Expressway Terminus:

- From the Vancouver Mall Transit Center the alignment would follow NE 94th about ¼ mile to a new structure that carries LRT back into the median of I-205.
- The alignment continues in the median to a terminus station just south of the Padden Expressway. This station is connected to two park and ride lots on the east side of I-205 (1,300 spaces) and on the west side of I-205 (1,200 spaces provide by the Crossroads Church). The station connects to the park and ride lots via a new pedestrian bridge over I-205 that also extends westward the existing bike trail along Padden Expressway.
- The median alignment allows for a future LRT extension to the north.

Park-and-Ride Facilities

Table 3-1 lists the planned park-and-ride facilities supporting the Clark County loop LRT system as well as the Airport and Interstate Max systems.

TABLE 3-1
PLANNED LRT PARK-AND-RIDE LOCATIONS AND CAPACITY

LRT System/P&R Facility	Planned Capacity
Airport MAX	
• Parkrose/Sumner TC	193 spaces[1]
Interstate MAX	
• PIR	300 spaces[1]
• Expo Center	300 spaces[1]
Subtotal	***793 spaces***
Clark Co. LRT Loop System	
• I-5 @ VA Hospital	1,000 spaces[2]
• SR 500 @ Falk Rd.	550 spaces[1]
• SR 500 @ Andresen Rd.	1,000 spaces[2]
• SR 500 @ Vancouver Mall TC	910 spaces[1]
• I-205 @ Crossroads	1,200 spaces[1]
• I-205 @ 83rd Avenue	1,300 spaces[1]
• I-205 @ NE 18th Street	830 spaces[1]
Subtotal	***6,790 spaces***
TOTAL	**7,583 spaces**

1. Surface parking
2. Parking structure

Sources: C-Tran and Tri-Met

General Description of Roadways

The general description of Option Package 3b is schematically depicted in **Figures 3-3, 3-4 and 3-5** at the end of this memo.

The proposed four-lane bridge would provide one HOV and one general purpose (GP) lane in each direction. It would have 12' shoulders on both sides and 20' center median for a total width of 92 feet. It would be located on the west side of the existing I-5 corridor starting at Victory Boulevard and terminating just south of Evergreen Bridge. In addition, the bridge would also carry LRT using a double deck section starting north of Marine Drive. This LRT segment would connect the Expo Center LRT Station in Portland and Sixth Street in Vancouver, and have a total length of 1.7 miles.

The LRT alignment starts at the Expo Center LRT Station and crosses under Marine Drive. It then connects to the proposed double deck bridge across Portland Harbor with LRT occupying the lower deck and vehicular traffic on the upper deck. The proposed LRT alignment would be 32 feet wide and have its center directly below the centerline of the vehicular bridge. It would continue north over Jantzen St. and Tomahawk Drive to an elevated LRT Station at Hayden Island.

Continuing north, the proposed two-level bridge would cross over Hayden Island Drive and the Columbia River. On the Washington side, the LRT crosses over Columbia Way and BNSF railroad. It then continues on a separate bridge adjacent to and on the east side of the proposed southbound entrance ramp along

Washington Street. It would touch down in the vicinity of 4th Street and have an at-grade crossing thru 5th Street. The alignment would stay on the east side of Washington Street and continue north past 6th Street, terminating at the proposed LRT Station between 6th Street and 7th Street.

The bridge mainline carrying the HOV lanes would begin on the north side of Victory Boulevard and have its center matching the existing I-5 centerline. It crosses over I-5, Highway 99 and Expo Road. The existing I-5 northbound on-ramp at Victory Blvd. would be widened to two lanes to accommodate the proposed northbound GP lane that would cross over I-5 and then merge with the mainline bridge at Expo Center. An exit ramp would be provided for the southbound GP lane, which would split into two lanes; one lane would go to Expo road and the other lane would merge into the existing I-5. As shown on the plan, the existing I-5 would be widened to accommodate the additional 2 HOV lanes, 2 GP lanes and the existing 6 lanes.

A bus access ramp is proposed at Expo Center Station to serve Vancouver southbound and northbound buses. In addition, a ramp is also provided southbound to Portland. The existing private road where the bus access is proposed would be improved and converted into a public road to improve traffic circulation.

The existing I-5 connections at Hayden Island would be eliminated to relieve congestion in this area. Instead, a split diamond interchange would be built to access Hayden Island via the new four-lane bridge. Tomahawk Island Drive would be extended thru and under I-5 and have signalized intersections at both ramps. The entrance and exit ramps at the Hayden Island Drive intersections would also be signalized to allow and control all directional traffic movements.

The double deck bridge would cross over the Columbia river and the existing railroad. It would then split into two separate structures. The vehicular bridge would continue north over the SR 14 interchange and touch down south of Evergreen Bridge, while the LRT bridge would touch down in the vicinity of 4th Street. The LRT alignment then continues north along the east side of Washington Street. It passes through 5th and 6th Streets and terminates at a proposed station to the south of 7th Street. The vehicular structure terminates just south of Evergreen and its new lanes are designed to conform to the proposed development of the Mill Plain interchange.

A northbound exit ramp would be provided to connect to SR 14 eastbound and Sixth Avenue westbound. Furthermore, a southbound on-connection from Washington Street is proposed, and a southbound off-connection with an over-crossing is designed to serve Sixth Avenue. All existing SR-14 and I-5 interchange connections would remain.

The affected area of I-5 where the proposed bridge ends would be widened on both sides to accommodate the additional lanes resulting from these improvements. While this widening would not impact the historic hospital in the historic reserve area, its road adjacent to the highway would be affected.

Bicycle/Pedestrian Facilities

This memorandum does not include bicycle/pedestrian facilities on the proposed bridge section. The existing I-5 bridges accommodate pedestrian access. It is recommended that bicycle/pedestrian access be revisited in the future and that access be improved on the proposed or existing structures.

Interchange Modifications

Conceptual interchange modifications along I-5 in Washington are functionally depicted in **Figure 3-4.** It should be noted that the final interchange configurations may change from those shown here as conceptual layouts and designs are refined. However, these functional descriptions can provide guidance to designers as they address interchange spacing and operation issues during the evaluation.

Between Mill Plain Blvd. and SR 500 in Vancouver, the proposed design reconfigures the existing interchanges to reduce the number of weaving sections on the freeway. The freeway would retain six through-lanes and add auxiliary lanes between interchanges where the space between ramps is inadequate to accommodate merges and diverges from the highway. The interchange improvements would be accomplished primarily by braiding the on/off ramps. Construction of the braided ramps would require the replacement of overpasses at 29th St. and 33rd St., and widening of the Mill Plain and McLaughlin overcrossings.

Interchanges were modified based upon the schematic design developed at a workshop held with DOT and consultant team members on June 29, 2001. The design concept included braiding most of the ramps to and from the existing interchanges. Ramps to be braided include:

Northbound

- Fourth Plain on-ramp with SR 500 off-ramp: The new diverge point for the SR 500 off-ramp would begin on the north side of the Fourth Plain overpass. The Fourth Plain on-ramp would pass over the SR 500 off-ramp, merging with the highway near the 29th Street overpass. The Fourth Plain on-ramp would also have a split to allow traffic to access I-5 northbound or SR500 eastbound. Braiding these ramps would require reconstruction of the 29th St. and 33rd St. overpasses.

Southbound

- SR 500 on-ramp with Fourth Plain off-ramp: The diverge point for the Fourth Plain off-ramp would be moved to the area between the 39th St. off-ramp and the SR 500 overpass. The new ramp would align to the west side of the SR 500 on-ramp, cross under the 39th St. on-ramp, and parallel the highway to connect to the existing interchange area. The design currently includes a connection between SR 500 and Fourth Plain Blvd. via a short weaving area. This weave takes place within the same zone that includes the SR 500-to-mainline weave and may negate the advantages of braiding the ramps. As a result, further study of this ramp configuration is recommended during subsequent alternatives analysis to determine the need for this connection and, if warranted, whether the best design solution is to braid the ramps at this location.

- Fourth Plain on-ramp with Mill Plain off-ramp: The diverge point for the Mill Plain off-ramp would be moved to approximately the same location as the existing Fourth Plain off-ramp diverge. The Mill Plain ramp would rise and cross over both the Fourth Plain on-ramp, which is left mostly unchanged from the existing configuration, and Fourth Plain Blvd. Much of this ramp would be on structure because of the need to clear Fourth Plain.

- Mill Plain on-ramp with Downtown Vancouver/SR 14 off-ramp: To mitigate an existing short weave distance between the Mill Plain on-ramp and the Downtown Vancouver/SR14 off-ramp, the off-ramp diverge point would be moved to the north edge of the Mill Plain underpass, braid over the Mill Plain on-ramp and make a connection to SR 14 via the ramp included in the design for each of the river crossing options. The Mill Plain on-ramp would offer the option, via a mid-ramp split, to go to either I-5 southbound or SR 14 eastbound.

The design also includes a connector between SR 500 westbound and the 39th St. northbound on-ramp, providing a direct connection between SR 500 and I-5 northbound.

During the I-5 HOV study completed by Parsons Brinckerhoff, it was noted that in Vancouver, I-5 functions as both a regional and local connector. To improve the performance of I-5, these two traffic types could be separated via a barrier, effectively creating a bypass system through Vancouver for regional traffic. This option would require additional widening of the freeway to accommodate all the lanes, but would eliminate the need to extensively braid the interchanges. Separation of the freeway would occur north of SR 500 and south of SR 14, although the river crossing options that include a bypass bridge could connect into the regional route. Lane configurations would likely include 2 lanes in each direction on the bypass (1 HOV and 1 general purpose) and 2 lanes on the "local" system, plus any necessary auxiliary lanes between interchanges. It is recommended that this option be revisited in future studies along with the braided ramp option shown.

STRUCTURES

Each Option Package 3 variation includes a different Columbia River Bridge concept:

Option Package 3a: Loop LRT system on LRT only bridge
Option Package 3b: LRT from Expo/PIR to Clark College with joint use arterial/HOV bridge

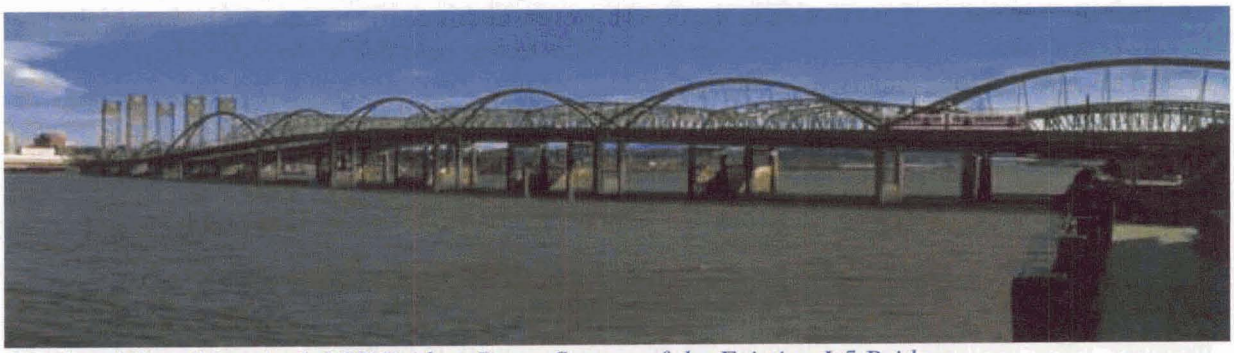
Option Package 3a

This bridge option would be a low-level lift span bridge constructed at a height similar to the existing I-5 Bridge spans. The lift segment could be either a vertical lift, similar to the I-5 bridges, or a bascule type, which is similar to the Morrison and Burnside Bridges in downtown Portland. The main river crossing would consist of multiple spans with pier spacing similar to the existing I-5 Bridges. The vertical alignment must maintain the current dual I-5 Bridges horizontal and vertical clearances. Currently, the dual bridges provide a horizontal clearance of 263 feet between the lift spans piers over the main navigation channel. The lift span provides a 39-foot vertical clearance above the Columbia River Datum (also referred to as zero gage or low water) when closed, and a maximum of 178 feet when fully raised. An increased vertical clearance of 58 feet is provided at the alternate barge channel beneath the bridge's fixed 531-foot truss span. South of the 531-foot span, a vertical clearance of 72 feet is provided between piers 6 and 7 and piers 7 and 8; these spans are outside of the maintained channel limits. Touchdown at the south end would be at Hayden Island, and continuing north, the alignment would go over Columbia Way (with reconstruction and or re-routing of Columbia Way), under the BNSF RR, and become at-grade in downtown Vancouver (not impacting Pearson Airpark flight paths). Regardless of whether the LRT-only bridge parallels the existing bridge to the west or east, column/pier locations would have to be coordinated with river users and the US Coast Guard, given the existing bridge is known to impact river navigation (any additional obstruction would compound these navigational issues).

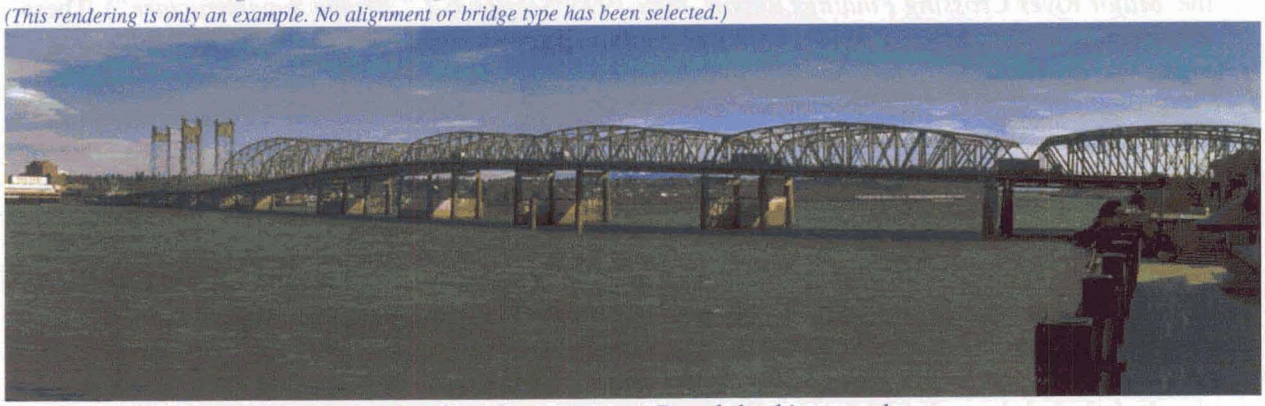
Construction Considerations

- *Superstructure Type* - The superstructure section could be a Bow String Arch type with a vertical lift span at the main river navigation channel. The cross section would have a constant deck thickness and arch ribs mirroring the truss lines of the existing bridges. This structure type would fit with the existing I-5 Bridge by having the main structural element above deck, allowing the LRT profile to be as tight as possible to the control river vertical clearance requirements . For clearance calculations, 1'6" would be required from the top of the deck to the top of the rail for ballast or direct fixation rail details. The Bow String Arch would hold a thin deck line with sweeping arches overhead blending with the above deck truss of the existing I-5 bridges. Alternatively, a concrete segmental bridge type could have the same pier spacing, but utilizing a bascule lift span over the main channel. This bridge

type would require a slightly higher profile because the main structural elements are below the deck surface.



Simulated Bow Sting Arch LRT Bridge, Down Stream of the Existing I-5 Bridges
(This rendering is only an example. No alignment or bridge type has been selected.)



Existing I-5 Columbia River Bridges from Jantzen Beach looking north

- *Column Type* - The river pier columns could match the type and spacing of the existing I-5 Bridges for the Bow String Arch Bridge Type. For a concrete segmental bridge, the piers could be arranged as twin walls, which would provide sufficient flexibility for final service conditions and provide the stability required for balanced cantilever construction. These walls would be 20 feet long and 2 feet 6 inches thick, and be set apart 26 feet, or 13 feet from the centerline of the pier to each wall.

- *Foundations* - The two end transition piers would be on land at the riverbanks, and the interior piers would all be in the river. For the river piers, a footing plan size of approximately 32' X 52' would be required for the Bow String Arch option and 54' X 56' would be needed for the Concrete Segmental bridge type. Deep foundation elements could be either driven piles or drilled shafts. Larger diameter drilled shafts may be preferable to limit the construction impacts of noise and vibration normally associated with driven piles.

- *Construction Procedures* - The river piers could be constructed by conventional methods using cofferdams. This features braced sheet piling walls, driven piles, underwater tremie concrete pours, and extensive pumping of the water inside the cofferdam to allow construction of the remainder of the pier footing and columns in the dry. This foundation type features footings that are founded below the river bottom. Because contractors assume significant risk with this type of foundation construction, costs are generally high for cofferdams.

  The river piers could also be constructed as water level foundations. This foundation makes use of a precast concrete lost footing form. The form has a bottom and four sides approximately 15' high. The bottom has holes for piling or in this case, large diameter drilled shafts. The drilled shafts are installed

with permanent casings from the water level down below the bottom of the river. The precast footing form is lifted and placed over the top of the shaft casings and supported by hangers from the casings. Underwater tremie concrete is placed in the bottom of the form to allow pumping out the water to construct the remainder of the footing in the dry. However, in this configuration, the bottom of the footing is at a much higher elevation, requiring a smaller tremie pour due to the reduced hydrostatic head. This type of foundation is generally less costly, because contractor risk is reduced.

The Bow String Arch superstructure would be fabricated off site, and the finished spans would be barged to the site and lifted into position. A concrete deck would then be poured in place after the finished Bow Sting Arches were all in place.

A Concrete Segmental Bridge would be constructed of either precast or cast-in-place concrete units. Both methods could use conventional overhead travelers and employ balance cantilever construction methods. These methods would eliminate the need for formwork to be placed across the river (refer to the *Major River Crossing Findings Report, May 1995, Section 6.2 " Bridge Superstructure"*). These construction methods were employed for the Glenn Jackson Bridge.

Option Package 3b

The new 4 lane bridge with LRT is conceptualized as a double deck steel truss type with a vertical moveable span over the navigation channel. The Span layout could be comprised of (south bank to north bank) 260'-540'-270'-540'-540'-280'(Vertical lift Span)-320' sections. Currently, the existing dual bridges provide a horizontal clearance of 263 feet between the lift spans piers over the main navigation channel. The lift span provides a 39-foot vertical clearance above the Columbia River Datum (also referred to as zero gage or low water) when closed, and a maximum of 178 feet when fully raised. An increased vertical clearance of 58 feet is provided at the alternate barge channel beneath the bridge's fixed 531-foot truss span. South of the 531-foot span, a vertical clearance of 72 feet is provided between piers 6 and 7 and piers 7 and 8; these spans are outside of the maintained channel limits.

The 4-lane bridge with LRT would have an the upper deck elevation over the navigation channel of 145 feet in the closed position. The lower deck with LRT and HOV would be approximately 45 feet lower (100' lower deck elevation in closed position). This is compared to the existing twin I-5 bridges, which have a deck elevation of 45'feet (+-) in the closed position. The 4 lane bridge would function with the exiting I-5 bridges in operation. The new bridge is conceptualized to have a vertical lift moveable span, that when open, would match existing vertical clearances. The deck elevation of 145 feet was assumed based on the vertical restriction associated with Pearson Airpark. The airpark airspace height restriction is approximately at 175 feet; a deck at 145 feet should allow lights, signs and trucks to pass without infringing into the airspace. The two decks, at the movable span location, would open independently for lift span operations.

Construction Considerations

- *Superstructure Type* - The superstructure section could be a double deck truss, similar to the Marquam or Fremont bridges. The cross section could vary in depth from maximum depths over the interior piers to $1/10^{th}$ the span length at mid-section (for a truss, arches and other types would have different depth to span ratios). A suggested depth-to-span ratio would be 1/8 at the pier, and 1/10 at the midspan.

- *Column Type* - The river pier columns could match the type and spacing of the existing I-5 bridges.

- *Foundations* - The two end transition piers are on land at the riverbanks, and the interior piers are all in the river. For the river piers, a footing plan size of approximately 32' X 52' for the double deck truss may be required. Deep foundation elements may be either driven piles or drilled shafts. Larger diameter drilled shafts may be preferable to limit noise and vibration construction impacts.

- *Construction Procedures* - The river piers could be constructed by conventional methods using cofferdams. This features braced sheet piling walls, driven piles, underwater tremie concrete pours, and extensive pumping of the water inside the cofferdam to allow construction of the remainder of the pier footing and columns in the dry. This foundation type features footings that are founded below the river bottom. Because contractors assume significant risk with this type of foundation construction, costs are generally high.

  The river piers could also be constructed as water level foundations. This foundation makes use of a precast concrete lost footing form. The form has a bottom and four sides approximately 15' high. The bottom has holes for piling or in this case, large diameter drilled shafts. The drilled shafts are installed with permanent casings from the water level down below the bottom of the river. The precast footing form is lifted and placed over the top of the shaft casings and supported by hangers from the casings. Underwater tremie concrete is placed in the bottom of the form to allow pumping out the water to construct the remainder of the footing in the dry. However, in this configuration, the bottom of the footing is at a much higher elevation, requiring a smaller tremie pour due to the reduced hydrostatic head. This type of foundation is generally less costly, because contractor risk is reduced.

  The double deck truss superstructure construction would be fabricated off site, and finished spans would be barged to the site and lifted into position. A concrete deck would then be poured in place after the finished trusses were all in place.

ROW

Option Package 3a: The proposed LRT loop system would require approximately 74 acres of new right of way acquisition. Approximately 15.7 acres would be required along the I-5 corridor and broken down as follows:

Commercial	4.4 Acres
Open Land	11.2 Acres
Railroad	0.1 Acres

Approximately 21.2 acres would be required along the SR-500 corridor and broken down as follows:

Commercial	8.7 Acres
Open Land	12.3 Acres
Residential	0.2 Acres (with 21 residential displacements)

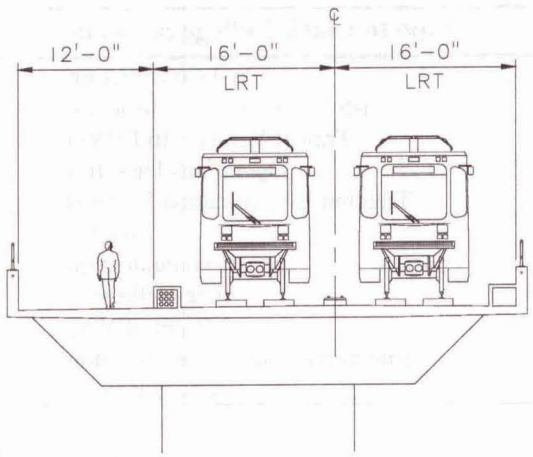
Approximately 33.5 acres would be required along the I-205 corridor and broken down as follows:

Commercial	11.1 Acres
Open Land	21.1 Acres
Residential	1.2 Acres (with 4 residential displacements)
Railroad	0.1 Acres

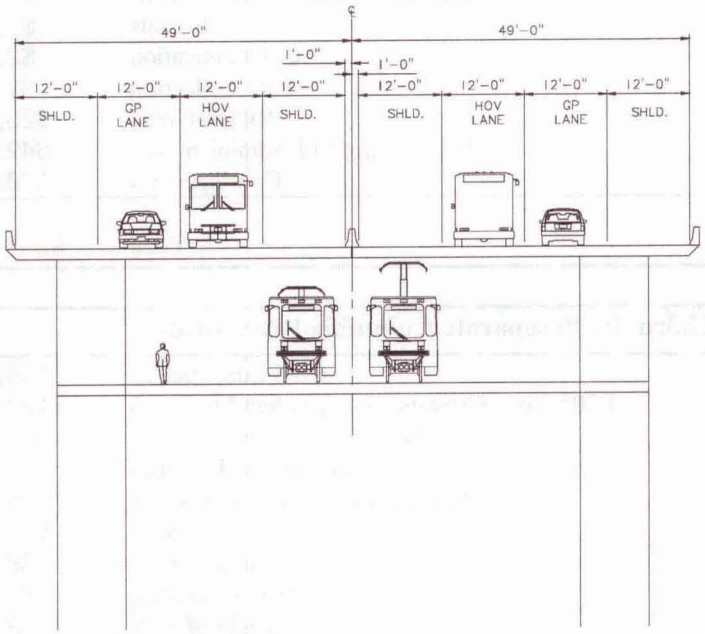
Option Package 3b: The proposed four-lane bridge with LRT would require about 17 acres of new right of way acquisition, comprised of approximately 60% commercial lands and 40% open or

undeveloped lands. The affected commercial land primarily includes parking areas and few buildings, while the majority of the open land is classified as wetland or existing private roads.

TYPICAL SECTIONS



LIGHT RAIL BRIDGE SECTION



4-LANE BRIDGE WITH LRT

COSTS

All estimates are based on 2001 unit costs: These estimates do NOT include the cost to purchase any businesses on Hayden Island. Commercial land value has been included in this estimate.

Option Package 3a: Light Rail Loop

Expo to Clark College Segment	
Civil Construction	$52,297,231
I-5 River Crossing Structure	$82,778,627
Transit Vehicles (6 LRVs)	$18,086,751
Operations Facilities	$3,702,430
Traction Electrification Systems	$5,486,224
Signals	$5,958,019
Communication	$1,679,102
Fare Collection	$1,488,007
Right of Way	$19,125,445
Engineering and Administration	$51,143,046
Contingencies	$49,431,232
Total	$291,176,114

Clark College to Vancouver Mall via SR 500 Segment	
Civil Construction	$103,228,355
Transit Vehicles (6 LRVs)	$24,115,668
Operations Facilities	$4,936,573
Traction Electrification Systems	$7,716,536
Signals	$7,003,341
Communication	$2,627,100
Fare Collection	$1,736,008
Right of Way	$25,044,430
Engineering and Administration	$42,059,781
Contingencies	$38,656,128
Total	$257,123,920

Airport Junction to NE 83rd (with separate Columbia River Bridge)	
Civil Construction	$136,602,881
I-205 River Crossing (Independent Structure)	$168,454,946
Transit Vehicles (6 LRVs)	$57,274,711
Operations Facilities	$11,724,361
Traction Electrification Systems	$16,465,297
Signals	$15,997,063
Communication	$5,167,020
Fare Collection	$1,321,846
Right of Way	$22,519,469
Engineering and Administration	$119,820,191
Contingencies	$118,001,527
Total	$673,349,312

Total Option 3a: LRT Loop $1,221,649,346

Option Package 3b:

All costs are August 2001.

Four Lane Bridge (Victory to Mill Plain) with LRT on bridge	
Right of Way	$14,564,061
Utility Relocations	$4,500,000
Excavation	$546,714
Surfacing	$2,618,837
Roadside Development	$3,722,500
Traffic Services	$3,181,800
Columbia River Crossing (Structure)	$391,057,948
*LRT System (Expo to Washington Street)	$69,354,500
Mobilization	$32,450,224
Contingencies	$140,184,967
Engineering and Administration	$144,565,748
* Includes 4 LRVs and operation facilities	
Total	$806,747,300

LRT Washington Street to VA	
Civil Construction	$81,678,651
Transit Vehicles (4 LRVs)	$6,028,917
Operations Facilities	$1,694,774
Traction Electrification Systems	$3,185,104
Signals	$4,326,129
Communication	$1,066,946
Fare Collection	$1,240,006
Right of Way	$5,571,582
Engineering and Administration	$29,795,833
Contingencies	$29,580,875
Total	$164,168,817

Interchange Modifications (Mill Plain to SR-500)	
Right of Way	$ 8,701,589
Utility Relocations	6,150,000
Excavation	2,926,560
Surfacing	6,248,970
Roadside Development	4,100,000
Traffic Services	1,481,375
Structures	26,639,112
Mobilization	3,803,681
Contingencies	16,431,903
Engineering and Administration	16,945,400
Total	$93,428,591

Total Option 3b: $1,064,344,708

FIGURES

Note to reviewers: Figure 3-1 would be similar to figure 3-3 of the graphics package.
Figure 3-2 would be similar to figure 5-3 of the graphics package.
Figure 3-3 would be similar to figure 5-2 of the graphics package.
Figure 3-4 would be similar to figure 4-6 of the graphics package.
Figure 3-5 would be similar to figure 4-7 of the graphics package.

I-5 Transportation and Trade corridor Partnership
Draft Costs by Option Package
October 16, 2001

Costs by Option Package	Unique Costs	Park and Ride Lots	Baseline Road Costs	Baseline Transit Costs	Rose Quarter Widening	Delta Park to Lombard	Vancouver Interchange Modifications	Add North Ramps to Columbia	No Bridge - Access to Hayden island through Marine Drive	LRT only Columbia River Bridge	4-lane supplemental Bridge	6-lane supplemental Bridge	10-lane supplemental Bridge	4-lane supplemental Tunnel	Total
Baseline					$300	$41	$93								$434
West Arterial	$947				$300	$41	$93								$1,381
3 Lanes (with a 4-lane Bridge)		$52			$300	$41	$93				$596				$1,083
Add a 4th Lane (with 6 lane bridge)	$465	$52			$300							$940			$1,757
Add a 4th Lane (with 10 lane bridge)	$465	$52			$300								$1,117		$1,933
Add a 4th Lane (with 4 lane tunnel)	$465	$52			$300									$807	$1,624
Light Rail Loop/3 lane [1, 2]	$1,082				$300	$41	$93			$140	$596				$2,252
Light Rail Loop/add a 4th lane [1,2]	$1,546				$300					$140		$940			$2,926

notes: 1. Assume separate LRT bridge
2. Park and Ride facilities inclused in "Unique costs"

I-5 Transportation and Trade corridor Partnership
Draft Costs by Decision Point
October 16, 2001

Costs by Decision Point	Unique Costs	Park and Ride	Baseline Road Costs	Baseline Transit Costs	Rose Quarter Widening	Delta Park to Lombard	Vancouver Interchange Modifications	Add North Ramps to Columbia	No Bridge - Access to Hayden island through Marine Drive	Total
Baseline					$300	$41	$93	$111	$76	$621
West Arterial	$947									$947
3 Lanes (with a 4-lane Bridge)	$596	$52			$300	$41	$93	$111		$1,193
Add a 4th Lane (with 6 lane bridge)	$1,405	$52			$300					$1,757
Light Rail Loop [1]	$1,222									$1,222
Express Bus - Short [2]	$199	$52				$41				$292
Express Bus- long [3]	$351	$52								$403
LRT only Columbia River Bridge	$140									$140
4-lane Supplemental Bridge (Victory to Mill Plain)	$596									$596
6-lane Supplemental Bridge (Victory to Mill Plain)	$940									$940
10-lane Supplemental Bridge (Victory to Mill Plain)	$1,117									$1,117
4-lane Supplemental Tunnel (Victory to Mill Plain)	$807									$807

Notes: 1. Park and Ride facilities included in "Unique costs"
2. Assume cost is 1/3 of 3-lane option
3. Assume cost is 1/4 of 4-lane option