5. FREEWAY-TO-FREEWAY HOV CONNECTIONS

One of the considerations of this project was that people often use more than one freeway to get from one place to another. Travelers on HOV lanes should be able to get on an HOV lane in one part of the region, and stay in an HOV lane all the way to their destination. To create this "integrated" system, HOV lanes on intersecting freeways need direct ramps to connect them.

This kind of ramp can be very expensive. Freeway interchanges are often the hardest places to find room for new ramps; so major modifications are often needed. To allow every possible traffic movement, up to eight ramps are needed in an interchange or four pairs of ramps, one in each "quadrant" of the interchange. On average, to provide HOV connector ramps in each direction for one quadrant of an interchange, it costs about $60 million. To provide for all movements can cost up to $250 million.

The Puget Sound HOV Pre-Design Studies analyzed freeway-to-freeway connections of center HOV lanes in order to compile a list of potential projects, determine their geometric feasibility, cost, and relative benefit, as well as to expedite planning for recommended projects for future design report documents.

5.1. STUDY PROCESS

The alternatives evaluation for this study were performed on the basis of feasibility, function, and cost, rather than measurement against a set of Measures of Effectiveness (MOEs).

The following interchanges areas were studied for direct HOV connection in Phase I:

- Everett: I-5 / SR 2
- Factoria: I-405 / I-90
- Renton: I-405 / SR 167
- Swamp Creek: I-5 / I-405 / SR 525

Other existing studies that were referenced in this report include:

- Everett: I-5 / SR 526
- Seattle: I-5 / SR 520
- Tukwila: I-5 / I-405 / SR 518

The Phase I process for this study involved existing conditions data collection, determination of the universe of HOV connector options for the identified interchanges, an initial fatal flaw screen consisting of horizontal and vertical geometric feasibility, preparation of a conceptual cost estimate for the remaining alternatives, and development of recommendations for each interchange location. A summary is provided below; the reader is referred to the finalized document, *Freeway-to-Freeway HOV Connections Study, Task Report,* ICF Kaiser (formerly Tudor Engineering Company), Seattle WA, June 1995, for further detail. In Phase II, an additional analysis was conducted evaluating HOV connections at the I-405/SR 520 Interchange. An evaluation of the I-5/SR 16 Interchange in Tacoma was also incorporated from a separate study. Cost estimates for all alternatives were reviewed and refined as necessary in Phase II, and an estimate of HOV travel time savings per improvement was developed as well.

5.2. ALTERNATIVES CONSIDERED

The following discusses the freeway-to-freeway direct HOV connections carried forward into the Phase II evaluation. These alternatives incorporate those assessed in the Phase I study, those looked at as part of the initial Phase II work, and those analyzed as part of other studies.

TACOMA: SR 16 / I-5

The preferred alternative for the SR 16 interchange was the Alternative B configuration which was originally presented in the Pierce County I-5 Corridor Study Report, published by WSDOT in March 1993. This alternative uses a directional design. The intent of the improvements to this interchange is to eliminate the existing weaving movements and to provide direct HOV lane connections between I-5 and SR 16 are also a major component of this alternative. Cross over ramps will carry HOV traffic from the inside of the I-5 lane configuration over mainline traffic. These ramps will continue to and from SR 16 via a structure paralleling the Nalley Valley viaduct which will tie back into existing SR 16 at a point west of the Nalley Valley. Northbound SR 5 to westbound SR 16 general purpose traffic will also use a portion of this new structure over the Nalley Valley.

Features

- Connections between SR 16 and I-5 northbound and southbound.
- Costs: NW Quadrant: $40.0 M
  SE Quadrant: $37.0 M

Trade-Offs and Considerations

- Should funds not be available for all the elements of the preferred alternative, another approach was developed to provide HOV connections between SR 5 and SR 16 in this interchange. Details of this alternative approach can be seen in the Technical Memorandum entitled, 38th Street / SR 16 interchange and SR 16 Corridor Traffic Analysis, dated July 29, 1994.

Phase II Refinements and Final Recommendations

- As a result of the Phase II evaluation, the northwest quadrant of this interchange is recommended for implementation. The costs for both quadrants, however, are currently included in cost estimates for the I-5 Pierce County HOV lanes.

TUKWILA: I-5 / I-405 / SR 518

This alternative was first assessed as part of an earlier study and incorporated into this study as part of the Phase I process.

Features

- All movements except east to south and north to west are accommodated from median to median, with structures crossing both under and over the existing configuration.
- Costs: NW Quadrant: $45.1 million.
  SE Quadrant: $45.9 million.

Trade-Offs and Considerations

- To make room for the NW quadrant ramps, a new EB SR 518 to NB I-5 general purpose connector ramp would need to be built.

Phase II Refinements and Final Recommendations

- Following the Phase II evaluation, the NW quadrant connection was highly recommended due to its facilitation of traffic destined for Sea-Tac Airport from the I-5 corridor. The SE quadrant rated as a secondary priority "possible" recommendation.

- Updated cost estimates were prepared for this option during the Phase II evaluation, and it was determined that the NW quadrant connector would be highly beneficial for the region in terms of facilitating HOV access to and from Sea-Tac International Airport; hence they are recommended. The SE quadrant ramps are only "conditionally" recommended contingent upon available funding.

RENTON: I-405 / SR 167

This alternative was analyzed as part of the Phase I freeway-to-freeway HOV connection study.

Features

- Fly-over ramps connecting the center HOV lanes from northbound and southbound I-405 to southbound SR 167, and from northbound SR 167 to northbound and southbound I-405.
- Ramps would be constructed over the existing cloverleaf interchange and the existing Lind Avenue overpass.
- The southwest quadrant of the existing interchange would be re-aligned to accommodate the mainline widenings.
- HOV access would also be provided from eastbound SW 27th Street to southbound SR 167, and from northbound SR 167 to westbound SW 27th Street. Drop ramps would pass underneath the southbound SR 167 lanes to meet SW 27th Street at-grade.
- Costs: SW Quadrant: $74.1 million.
  SE Quadrant: $68.5 million.

Trade-Offs and Considerations

- Current construction includes HOV ramps to I-405, HOV lanes on the I-405 S-curves to the east of this interchange, and HOV lanes for both directions on SR 167.
- Further engineering study is required to determine if construction of the SE quadrant would conflict with construction of direct access ramps to Talbot Road.
- Construction of the SW quadrant would conflict with construction of direct access ramps to Lind Avenue.

- Interchange serves Rainier Avenue, the South Renton Park-and-Ride, and the Renton CBD.
- This is a major interchange for north / south commuters, currently experiencing high levels of congestion during the peak periods.
- SW 27th Street access was requested by the City of Renton.
- Construction of the SE quadrant may also benefit general purpose traffic operations at this interchange.

Phase II Refinements and Final Recommendations

- Neither quadrant scored very high in the Phase II evaluation; however, the SE quadrant was given a "possible" recommendation (i.e., second priority because it would allow HOVs to bypass peak hour queues.)

FACTORIA: I-405 / I-90

Alternatives at this interchange were analyzed as part of the Phase I Freeway-to-Freeway Connections Study.

Features

- All movements in each of the four quadrants are accommodated from median to median, with structures crossing both under and over the existing configuration. The only exception is the east to north movement, which diverges I-90 from the C-D lane.
- The south to west movement will be served by a ramp that connects to the new Bellevue Transit Access ramp, currently under construction.
- Costs: NW Quadrant: $43.1 M
  NE Quadrant: $38.3 M
  SW Quadrant: $56.6 M
  SE Quadrant: $60.7 M

Trade-Offs and Considerations

- The east to south ramp could be built as a single reversible lane, operating as an extension of the existing I-90 reversible operation. It could also be built as a two-lane ramp in anticipation of future development on I-90.
- HOV direct access from I-405 to westbound I-90 is in the process of being completed through the ramp connection to I-405 will need to be re-aligned to connect to the inside when HOV lanes are ultimately moved from the right to left side on I-405.
- This is a main Eastside interchange, with existing high traffic volumes and weaving movements, and a high level of congestion.
- The existing bridges over Richards Road will need to be modified to accommodate the ramp tapers for merging with the HOV lanes in the I-90 median.
- A more refined study is necessary to investigate the location of the piers and necessary horizontal clearances.

Phase II Refinements and Final Recommendations

- Three out of the four quadrants—NW, NE and SW—are recommended as a result of the Phase II evaluation. The NW quadrant is critical in terms of serving the major I-405

transit movements and allowing effective use of the HOV direct access ramps proposed on I-405 north of I-90.

BELLEVUE: I-405 / SR 520

Alternatives at this interchange were analyzed as a supplemental pre-design task in the Phase II study. A feasibility screening was conducted to determine which ramps of each of the four quadrants merited further development. Feasibility screening criteria included financial viability, geometric feasibility, functional adequacies (travel time savings, constructibility and freeway traffic impacts), public acceptability and safety. Based on the feasibility screening, two quadrants, the northwest and southeast, were carried forward for further development. For a more detailed discussion, see the *HOV Pre-Design Studies, Phase II, I-405/SR 520 Freeway-to-Freeway Connection Technical Memorandum* prepared by HNTB of Bellevue, WA dated March 22, 1996.

Features

- The SW and NE HOV ramps would be combined on a single roadway.
- The existing ramp bridge structure over the SR 520 mainline roadways would be replaced.
- WB SR 520 and NB I-405 would be shifted to provide a merge/diverge area for the proposed HOV ramps.
- Costs: NW Quadrant: $66.3 M
  SE Quadrant: $90.8 M

Trade-Offs and Considerations

- Connections between inside HOV lanes in the NW and the SE quadrants would allow HOV traffic to bypass bottlenecks occurring along SR 520 and I-405 in addition to yielding travel time savings due to a reduction in HOV weaving movements.
- Some additional stormwater runoff control and treatment measures would be required.
- There could be some potential for noise impacts.
- Some additional right-of-way could be required on the north side of SR 520 due to the proximity of the existing right-of-way limits.
- These improvements will not be needed until the existing HOV lanes on SR 520 are moved to the inside, which is dependent on completing HOV lanes across the Evergreen Point floating bridge.

Phase II Refinements and Final Recommendations

- The northwest quadrant is conditionally recommended as a result of Phase II evaluation. Whether it would connect with the inside or outside of SR-520 is dependent upon whether or not inside HOV lanes are implemented on SR 520 in the future west of I-405. The southeast quadrant is also conditionally recommended contingent upon implementation of inside HOV lanes on SR-520 east of I-405.

SEATTLE: I-5 EXPRESS LANES / SR 520

This alternative has been analyzed as part of several previous studies. It was revisited as part of the Central Seattle HOV Corridor studies conducted in both Phase I and Phase II.

Features

- A reversible HOV lane on a fly-over ramp connecting the Express Lanes on I-5 with 520 from and to the south only.
- A new ramp bridge structure over the I-5 northbound mainline and express lane roadways.
- Retaining wall modification near the existing SR 520 ramp.
- Replacement of shoulder paving.
- Cost: $11.1 M

Trade-Offs and Considerations

- Requires further discussion as to whether this facility would be HOV-only or open to general purpose traffic as well.
- Primary benefit is to peak period transit traveling in the peak direction that use the downtown Seattle bus tunnel, with travel time savings ranging between five and 15 minutes.
- Other HOV traffic would be able to avoid the Mercer weave problems.
- Adjacent neighborhoods have been opposed to this improvement in the past.

Phase II Refinements and Recommendations

- This alternative rated the highest overall of all freeway-to-freeway connectors and is highly recommended.

SWAMP CREEK: I-5 / I-405 / SR 525

This interchange was analyzed as part of the Phase I Freeway-to-Freeway HOV Connections Study. Connections between three out of the four quadrants were investigated in detail.

Features

- Provides median to median connections with the exception of the south to west and east to north movements, i.e., the northwest quadrant.
- The ramps in the I-5 median to the north of I-405 are separated to provide space for the proposed RTA trackage.
- Costs: NE Quadrant: $71.8 M
  SW Quadrant: $58.1 M
  SE Quadrant: $59.1 M

Trade-Offs and Considerations

- Existing heavy traffic and congestion.
- 195th to 164th project currently under construction, involving the widening of I-5 through this interchange for HOV lane accommodation.

Phase II Refinements and Final Recommendations

- The NE quadrant was "possibly" recommended, depending on funding. This would provide HOV continuity for North-South through traffic using I-5 and I-405. The other two quadrants analyzed, SW and SE, are not recommended at this time.

EVERETT: I-5 / SR 526

This interchange was analyzed as part of two previous studies. Alternatives focused on connecting SR 526 with I-5 to and from the south.

Features

- Elevated ramps to the SR 526 overpass.
- Cost: $ 9.62 M

Trade-Offs and Considerations

- Would serve carpools, vanpools and transit destined for the Everett Boeing site.
- Due to geometric and right-of-way constraints, access ramps to and from the north at this location would be difficult and costly to construct.
- Transit and HOVs using this access would still need to pass through an at-grade signalized intersection at SR 526 and SR 99.
- Delays at this intersection could be minimized through implementation of signal priority treatments. It is likely that this would only be feasible for transit in the near future.

Phase II Refinements and Final Recommendations

- Conditionally recommended, depending on funding.

EVERETT: I-5 / SR 2

This interchange was analyzed as part of the Phase I Freeway-to-Freeway HOV Connection Study. Two alternatives exist for this location: 4B and 4C. Both alternatives provide for north to east and west to south movements only. WSDOT has current plans to replace the low-level Snohomish River bridge with a new high-level bridge to carry eastbound traffic. The existing high-level bridge will carry westbound traffic.

Alternative 4B:

Features

- Median to median connections for both movements with a single aerial structure over the existing configuration.
- Will provide all-day HOV service.
- HOV direct access to Everett via drop ramps to existing HOV lanes on Pacific Avenue for access to and from the south.
- Cost: $87 M.

Trade-Offs and Considerations

- Existing traffic is intermittently slow during the peak periods.

Phase II Refinements and Final Recommendations

- Not recommended due to its high cost and low estimated benefits.

Alternative 4C:

Features

- Median to median connections for both movements with two separated aerial structures over the existing configuration.
- Uses the alignment of the new bridge.
- HOV direct access to Everett via drop ramps to existing HOV lanes on Pacific Avenue for access to and from the south.
- Cost: $93 million.

Trade-Offs and Considerations

- Existing traffic is intermittently slow during the peak periods.

Phase II Refinements and Final Recommendations

- Not recommended due to its high cost and low estimated benefits.

5.3. SYSTEM EVALUATION

The Puget Sound HOV Pre-Design Studies approach to freeway-to-freeway connections was to look at each quadrant of each interchange separately in Phase I (or as part of other previous studies), and then prioritize the connections in Phase II relative to each other throughout the entire system. Ramps that would have very low volumes and high costs scored low in the analysis; ramps with higher volumes, bigger travel time savings and lower cost scored high. Table 5-1 summarizes the evaluation results for the freeway-to-freeway connection system evaluation analysis. Nine freeway-to-freeway interchanges and a total of 18 quadrants were analyzed.

This project provides a basis to prioritize HOV freeway-to-freeway connections, but how much to spend overall on connections is a policy choice, not a technical decision. Therefore, recommendations are grouped into "definite" and "possible" or "conditionally recommended" categories, depending on funding. Out of almost $1 billion in possible freeway-to-freeway projects, about $235 million are "definitely" recommended, and another $190 million are "possibly" or "conditionally" recommended.

5.4. FREEWAY-TO-FREEWAY CONNECTION RECOMMENDATIONS

This section contains brief descriptions of the freeway-to-freeway HOV connection alternatives recommended along with a graphical depiction of the option. A map depicting the location of these recommended connectors can be found in Chapter 2: Summary Project Digest, Page 3.

Table 5-1
Freeway-to-Freeway Connection Evaluation Analysis Results

MOE RANKING

1	2	3	4	5
○	◔	◑	◕	●
Least Effective				Most Effective

Measures of Effectiveness (MOEs)

Location	Quadrant / Improvement Type	Travel Time Savings: Transit	Travel Time Savings: HOV	Cost: Cost ($ Mil)	Cost: Cost Effectiveness ($/Per-min Saved)	Facilitates Regional Transit	Safety	Environmental	General System Enhancement	Definite Recommendation	Possible Recommendation	Cost ($ Millions)
I-405 / SR 167 Interchange	SE Quad.	◑	◑	◔	◑	○	◕	○	◕		✓	$ 68.51
I-405 / SR 167 Interchange	SW Quad	○	○	◔	○	◔	◑	◕	◑			$ 74.13
I-90 / I-405 Interchange	SE Quad.	○	◑	◑	◑	○	◑	◕	◑			$ 60.70
I-90 / I-405 Interchange	SW Quad.	●	◔	◑	◑	◔	◕	◑	◑	✓		$ 56.57
I-90 / I-405 Interchange	NE Quad.	◑	◑	◕	◕	◑	◑	◕	●	✓		$ 38.25
I-90 / I-405 Interchange	NW Quad.	●	◕	◕	●	◕	◑	◑	●	✓		$ 43.07
I-5 / I-405 / SR 525 Interchange	SW Quad.	◑	○	◑	○	◑	◑	◕	◑			$ 58.12
I-5 / I-405 / SR 525 Interchange	NE Quad.	◑	◔	◔	◔	◑	◑	◕	◕		✓	$ 71.75
I-5 / I-405 / SR 525 Interchange	SE Quad.	◔	◔	◑	○	◔	◑	◕	○			$ 59.10
I-5 / SR 2 Alt 4b	SE Quad.	◔	◑	○	◔	○	◕	◑	◑			$ 108.14
I-5 / SR16 Interchange	NW Quad.	●	●	◕	●	◑	◕	◑	●	✓		$ 40.00
I-5 / SR16 Interchange	SW Quad	○	◔	◕	◑	○	◑	◑	◕			$ 37.00
I-5/ I-405 / SR 518	NW Quad.	◕	◔	◑	◔	◔	◕	◕	●	✓		$ 45.14
I-5/ I-405 / SR 518	SE Quad.	○	◑	◑	◕	○	◑	◔	◕		✓	$ 45.93
I-5 / SR 526	SW Quad.	◑	○	●	◑	◔	◑	◕	◑		✓	$** 9.62
I-405 / SR 520	NW Quad.	●	◑	◑	●	◑	◑	◔	●	★		$ 66.26
I-405 / SR 520	SE Quad.	●	●	○	◕	◑	◑	◔	●	★		$ 90.79
I-5/ SR 520	Reversible Ramp	●	●	●	●	●	●	◕	●	✓		$ 11.12

TOTAL (Definite Recommendations) $ 234.15
TOTAL (Possible Recommendations) $ 195.81

Note:

* SR 520/I-405 connections rate high. The SE Quadrant is not recommended until the SR 520 HOV lane can be moved to the inside lane. Investigation of the NW Quadrant is continuing to determine the feasibility of designing it initially for a right side connection convertible to a left side connection.

** This cost estimate has been updated subsequent to the printing of the Summary Project Digest contained in Chapter 2.

TACOMA: SR 16 / I-5 INTERCHANGE

The preferred alternative for the SR 16 interchange provides direct ramp connections via cross over ramps to carry HOV traffic from the inside of I-5 up and over mainline traffic, as shown in Figure 5-1. These ramps will continue to and from SR 16, using a structure paralleling the Nalley Valley viaduct which will tie back into existing SR 16 at a point west of the Nalley Valley. Northbound I-5 to westbound SR 16 general purpose traffic will also use a portion of this new structure over the Nalley Valley. Although only the northwest quadrant ramps are recommended by the HOV Pre-Design Studies project, connecting SR 16 HOV lanes to and from the north on I-5, current plans for the Pierce County I-5 HOV lanes also include ramps in the southwest quadrant, connecting to and from the south on I-5.

Cost Estimate Summary

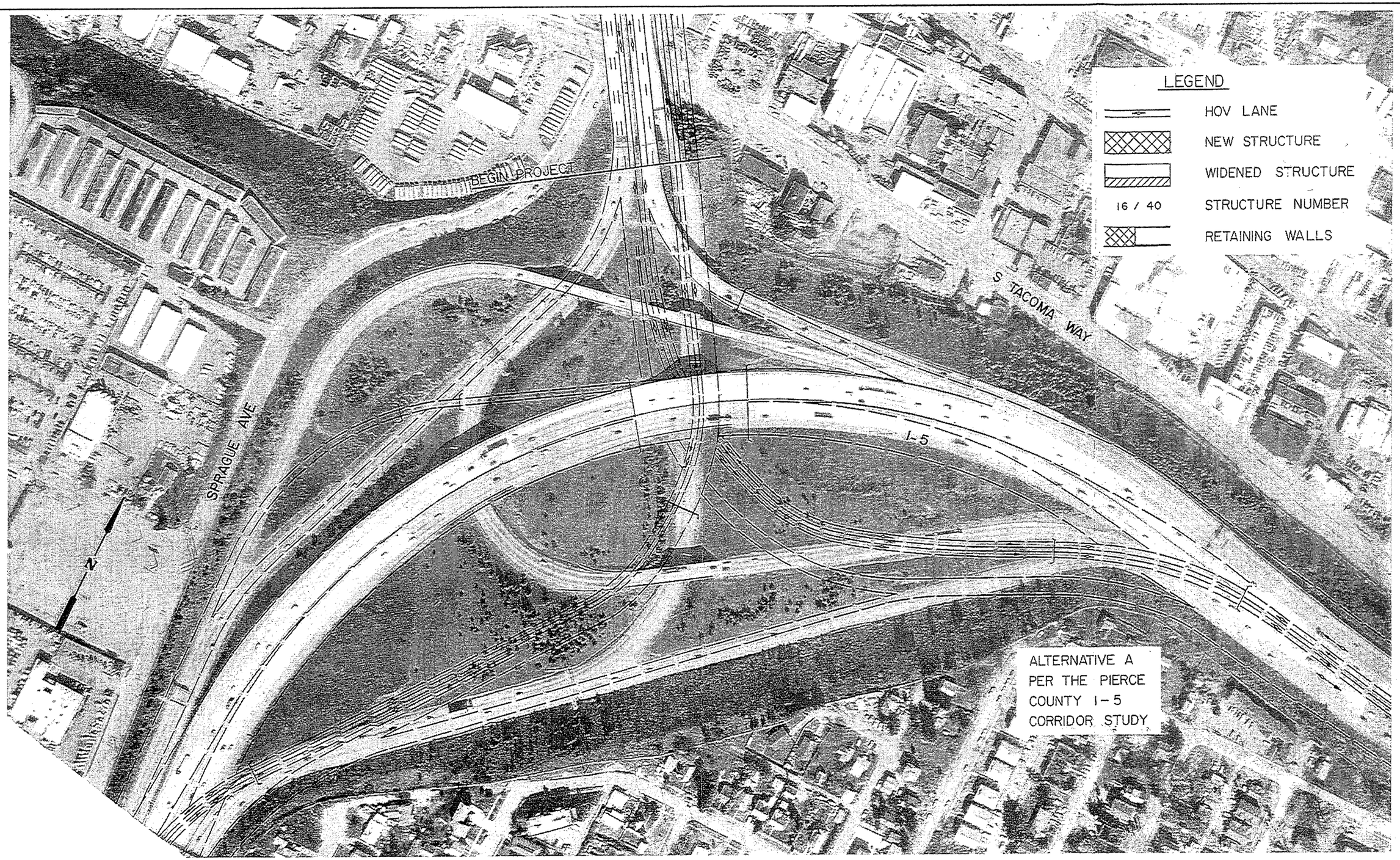
- Total Estimated Cost NW Quadrant: $40.0 M.
- Total Estimated Cost SW Quadrant: $37.0 M.

Significant Benefits

Direct ramp connections would eliminate existing weaving movements across the Nalley Valley viaduct and provide direct HOV lane connections between I-5 and SR 16. This option rated high regionally in both transit and 3+ HOV travel time savings, as well as cost effectiveness and general system enhancement.

Significant Impacts and Outstanding Issues

This option is relatively expensive, and would be most effectively completed as part of an entire interchange improvement reconstruction.



Source: SR-16 HOV Facility Design Study Memorandum #4 Washington State Department of Transportation

SR16/I-5 Interchange

Puget Sound HOV Pre-Design Studies

Final Report

FIGURE 5-1

TUKWILA: I-5 / I-405 / SR 518 INTERCHANGE

This improvement provides a direct HOV connection in the NW quadrant of the interchange between the southbound I-5 inside HOV lane and westbound SR 518 as well as a connection in the SE quadrant directly linking the I-5 HOV lanes to and from the east, as shown in Figure 5-2. Implementation of this alternative would require relocation of the East-to-North general purpose ramp

Cost Estimate Summary

- Total Estimated Cost NW Quadrant: $45.14 M.
- Total Estimated Cost SE Quadrant: $45.93 M.

Significant Benefits

Coming from the airport on SR 518 and heading north on I-5 is not a problem for HOV traffic, since the on-ramp to I-5 is on the left side. But to get from the HOV lane on I-5 southbound to SR 518 towards the airport, you have to cross six lanes of traffic. The NW quadrant ramp would allow south to west movement from the I-5 HOV lane. This ramp is recommended, in part, because existing all-day transit service to and from the airport makes use of it, as do airport shuttles services. If transit service to and from the airport is shifted to SR 509, this ramp would still be recommended due to the benefits to carpools, taxicabs and shuttle services heading towards the Sea-Tac International Airport. The NW quadrant ramp rated especially high in general transportation system enhancement.

The SE quadrant connector ramps allow HOV traffic to flow directly between southbound I-5 and northbound I-405 without having to exit the HOV lanes. These ramps rate moderately high in cost effectiveness and general system enhancement.

Significant Impacts and Outstanding Issues

Construction of the NW quadrant ramp will pose some maintenance of traffic impacts to southbound I-5 mainline traffic. Due to marginal transit and only moderate HOV travel time savings, the SE quadrant ramps are only "possibly recommended," depending upon funding.

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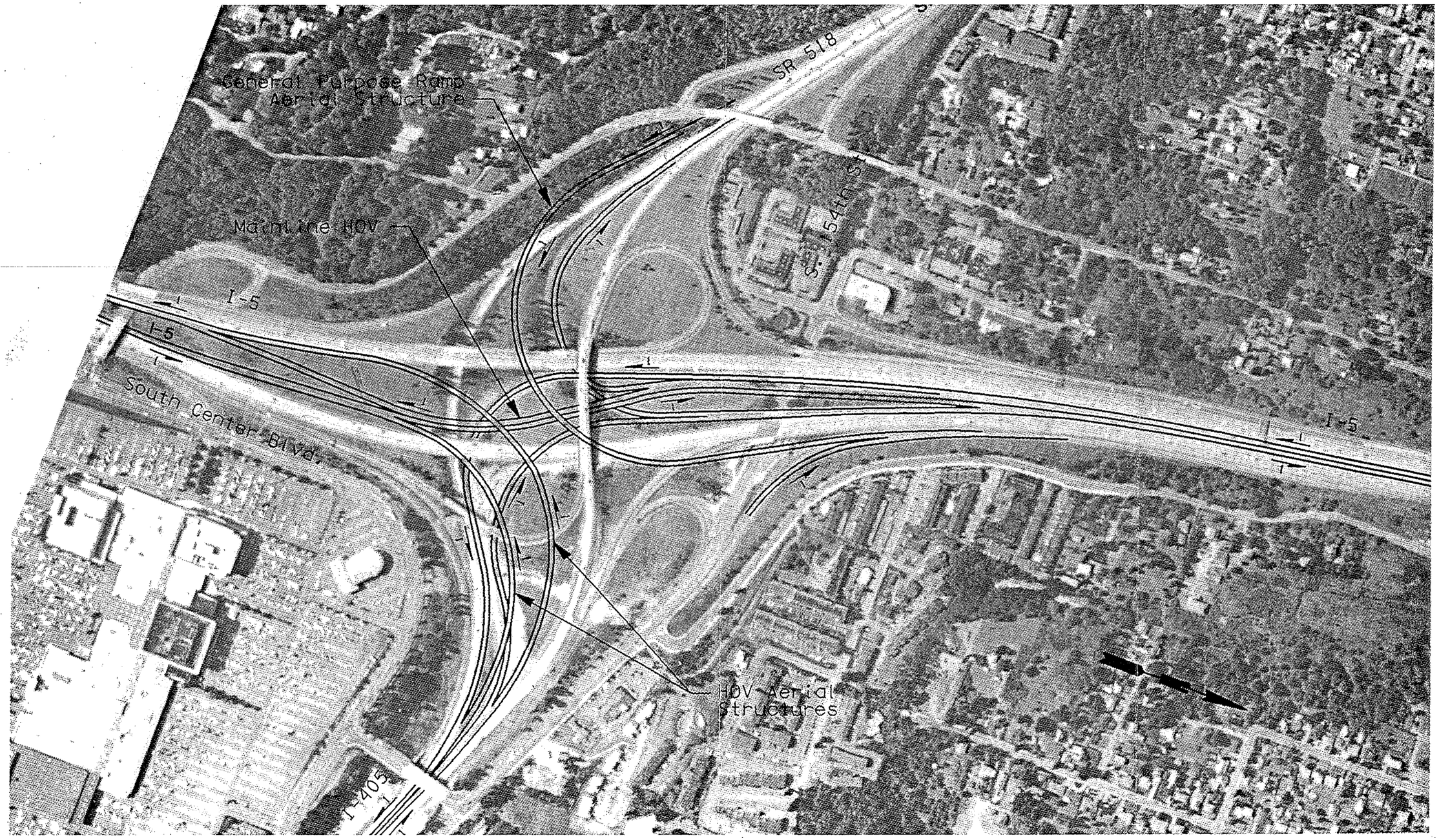

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I-5 /I-405 / SR 518 Interchange
Puget Sound HOV Pre-Design Studies
Final Report
FIGURE 5-2

RENTON: I-405 / SR 167 INTERCHANGE

Ramps built in the SE quadrant of the interchange would connect from the center lanes of SR 167 to the center lanes of I-405, allowing HOV traffic traveling northbound on SR 167 to continue northbound on I-405, and visa-versa, as shown in Figures 53-A and 5-3B.

Cost Estimate Summary

- Total Estimated Cost SE Quadrant: $68.51 M.

Significant Benefits

Currently the general purpose ramps connecting northbound SR 167 with northbound I-405 experience significant congestion and sizable traffic queues. This direct connection of inside HOV lanes would allow HOVs to bypass this general purpose congestion. This option rates high in promoting safer interchange operations as well as general transportation system enhancement.

Significant Impacts and Outstanding Issues

Although not of high priority, the SE quadrant was recommended should funding become available. If a freeway-to-freeway connection is selected to be built at this interchange, then the design should examine how to improve general purpose connections between these two freeways, in addition to making the HOV connection.

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I-405 / SR-167 Interchange
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FIGURE 5-3A