BEFORE THE COUNCIL OF THE
METROPOLITAN SERVICE DISTRICT

FOR THE PURPOSE OF AUTHORIZING SUPPLEMENTAL FEDERAL-AID URBAN FUNDS FOR LRT COMPATIBILITY OF THE HAWTHORNE BRIDGE	)	RESOLUTION NO. 90-1369 Introduced by George Van Bergen, Chair Joint Policy Advisory Committee on Transportation

WHEREAS, Metro Resolution No. 90-1200 allocated Federal-Aid Urban Funds to the Hawthorne Bridge Transition Structure Replacement Project; and

WHEREAS, These funds in the amount of $290,000 were to cover Preliminary Engineering to determine LRT compatibility of the bridge and a reserve for construction if LRT-compatible; and

WHEREAS, Evaluation of the bridge for LRT use has been completed with consultant findings appearing in Attachment A to the Staff Report; and

WHEREAS, Additional Federal-Aid Urban funds will be needed to strengthen the bridge for LRT with significant cost savings if implemented during bridge reconstruction; now, therefore,

BE IT RESOLVED,

1. That the Council of the Metropolitan Service District hereby allocates $60,000, split between the region and Portland, from the Federal-Aid Urban Regional Reserve to the Hawthorne Bridge Transition Structure Replacement Project to supplement funds for additional structural support for LRT.

2. That the Transportation Improvement Program be amended to incorporate these allocations and project changes.

3. That this action is consistent with the Regional Transportation Plan and affirmative Intergovernmental Project Review is hereby given.

ADOPTED by the Council of the Metropolitan Service District this 27th day of December, 1990.

Tanya Collier, Presiding Officer

WHP:mk
90-1369.RES
12-04-90

INTERGOVERNMENTAL RELATIONS COMMITTEE REPORT

RESOLUTION NO. 90-1369, AUTHORIZING SUPPLEMENTAL FEDERAL-AID URBAN FUNDS FOR LRT COMPATIBILITY OF THE HAWTHORNE BRIDGE

Date: December 12, 1990 Presented by: Councilor Bauer

COMMITTEE RECOMMENDATION:

At its December 11, 1990 meeting, the Intergovernmental Relations Committee voted 3 - 0 (Councilors Devlin, Gardner, and McFarland in favor) to recommend Council adopt Resolution No. 90-1369.

EXPLANATION

Resolution No. 90-1369 transfers $60,000 from the regional and Portland Federal-Aid Urban Reserve to the Hawthorne Bridge East Approach Ramps Replacement Project.

These funds, when combined with the $190,000 previously allocated, will enable constructing additional structural support on the Bridge.

Accommodation for LRT can be made at a lower cost now if combined with the design and reconstruction of the bridge ramps rather than retrofitting the ramps at a future date if the bridge becomes an LRT corridor.

In January, 1990, JPACT approved $100,000 in preliminary engineering funds to determine preferred track alignment and cost to retrofit the Hawthorne Bridge for LRT. The study determined a preferred alignment on the bridge, the cost of adding required structural support, and the rough cost of retrofitting at a later time ($2 million) and of building a separate bridge ($30 million for the bridge structure alone).

COMMITTEE DISCUSSION

Making these structural improvements will not prejudice the choice of an LRT route to the southeast, because the $250,000 investment will be insignificant compared with the overall costs and other considerations pertaining to deciding among possible routes. Further, a proposal exists for routing vintage trolley across the Hawthorne Bridge.

STAFF REPORT

CONSIDERATION OF RESOLUTION NO. 90-1369 FOR THE PURPOSE OF AUTHORIZING SUPPLEMENTAL FEDERAL-AID URBAN FUNDS FOR LRT COMPATIBILITY OF THE HAWTHORNE BRIDGE

Date: December 4, 1990 Presented by: Andrew C. Cotugno

PROPOSED ACTION

This resolution would transfer $60,000 from the regional and Portland Federal-Aid Urban Reserve to the Hawthorne Bridge East Approach Ramps Replacement Project. These funds, when combined with those previously allocated, will enable constructing additional structural support to accommodate a future LRT corridor. Accommodation for LRT can be made at a lower cost now if combined with the design and reconstruction of the bridge ramps rather than retrofitting the ramps at a future date.

FACTUAL BACKGROUND AND ANALYSIS

In January 1990, JPACT approved preliminary engineering funds to resolve the issue of accommodating light rail transit (LRT) as part of Multnomah County's Hawthorne Bridge Transition Structure Replacement Project. The amount allocated was $100,000 for PE to determine preferred track alignment and cost to retrofit the entire Hawthorne Bridge for LRT. An additional amount ($190,000) was set aside in a reserve account for future construction upon determination of specific alignment (inside/outside lanes) and in the event that the PE concluded that LRT compatibility was preferred to a future option of constructing a separate LRT bridge.

CH2M Hill was retained to answer the structural and operational questions of accommodating LRT on the main span of the bridge and has documented their findings in Attachment A. The results suggest that conversion of the outside lanes for use by LRT would cost $60,000 additional to augment the $190,000 previously allocated. This funding would be provided on a pro-rata basis by Portland and the region as follows:

Portland	$25,440
Regional Reserve	34,560
	$60,000

This funding used now to strengthen the structure in anticipation of LRT would make it easier and cheaper to retrofit the bridge for LRT in the future. To wait and retrofit the transition for this purpose at a later date would cost $2.0 million. To construct a separate bridge would cost in excess of $30 million. To allow LRT conversion on the transition structure on any possible future LRT alignment (i.e., both inside and outside lanes) would cost in excess of $500,000.

EXECUTIVE OFFICER'S RECOMMENDATION

The Executive Officer recommends approval of Resolution No. 90-1369.

HAWTHORNE BRIDGE MAIN SPANS LIGHT RAIL FEASIBILITY AND COST STUDY

STUDY BACKGROUND

The transition structure portion of the Hawthorne Bridge connects the main spans to the eastside approach structures. The Transition Structure extends from the east bank of the Willamette River to Water Avenue. Extensive maintenance has been required on the transition structure, and Multnomah County has initiated a project to design and build a replacement structure.

The Hawthorne Bridge has often been mentioned as a possible river crossing option for the extension of the Light Rail Transit (LRT) system from downtown Portland to Milwaukie. During the preliminary engineering effort on the Transition Structure, the issue of whether or not to accommodate a possible future LRT line on the new structure was raised. Accommodations could be built into that structure that would make it easier and cheaper to retrofit LRT in the future if the decision were made to use the Hawthorne Bridge. Those accommodations would cost from $255,000 if the outside lanes of the Main Spans were used for LRT, to $315,000 if the center lanes were used for LRT, and to $590,000 if the transition structure were built to accept any LRT alignment on the main spans. If no provisions are made in the near-term reconstruction, it would cost $2.0 million (in 1990 dollars) to rebuild the deck and superstructure should the Hawthorne Bridge be chosen as the Willamette River crossing option.

Any funds expended on these LRT accommodations would have to come from the Portland Metropolitan Region's E-4 or Federal Aid Urban (FAU) allocation, since the LRT system is a regionwide issue. The authority to commit the E-4 or FAU funds rests with the Metro Council. The Joint Policy Advisory Committee on Transportation (JPACT) will make the decision recommendation to the Council.

LRT on the Hawthorne Bridge is not a given; that question will not be answered until the Alternatives Analysis and Environmental Impact Statement for the Milwaukie line are completed in the future. To help assess whether an LRT investment in the Transition Structure is wise, it was decided that the feasibility and cost of retrofitting LRT on the main spans should be studied. This study will help decision-makers quantify the probability of LRT being carried on the Hawthorne Bridge as well as provide useful information input to the Alternatives Analysis.

LRT OPTIONS

The Hawthorne Bridge has six main spans. Three of these are 209 feet long and three are 244 feet long. One of the 244-foot spans is a vertical lift opening span. All of the spans are riveted steel trusses built in 1910. The bridge carries one lane of westbound traffic and one lane of eastbound traffic through the 20.8-foot wide trusses and one lane in each direction outside of the trusses.

Four alternatives for LRT alignments were assumed for this study:

- Two LRT tracks in the center lanes with vehicular traffic operating in the outside lanes at the same time
- One LRT track in the center lanes, one LRT track in an outside lane and vehicular traffic in the other outside lane
- An LRT track in each outside lane with vehicular traffic using the center lanes at the same time
- Two LRT tracks in the center lanes with vehicular traffic restricted from the bridge while LRT is on the bridge

In Options 1, 2, and 3, traffic can operate in all lanes when LRT is not present.

TRAFFIC OPERATIONS

Existing Conditions

The traffic operations analysis began with a review and update of a similar study conducted by JHK & Associates for the Metropolitan Service District (Metro) in 1985. Traffic counts were performed for morning and evening peak hour conditions. During current weekday evening peak hour conditions, approximately 1,680 vehicles used the Hawthorne Bridge in the eastbound (peak) direction, and approximately 1,100 traveled in the westbound direction. During the morning peak hour, these volumes were generally reversed. Approximately four-percent of the peak hour, peak direction traffic on the Hawthorne Bridge was classified as trucks, and another four percent was classified as buses.

On this basis and following procedures that are consistent with those employed in the JHK study, the capacity of the inside lanes is calculated to be 1,125 vehicles per hour; because of the presence of trucks and buses on the outside lanes, their capacity is slightly lower at 1,100 vehicles per hour. Thus, the total capacity of the bridge is estimated to be 2,225 vehicles per hour in each direction of travel. While this appears to be ample capacity in light of existing traffic volumes, it should be noted that the existing bottlenecks are at the signalized intersections located at either end of the bridge. These signalized intersections effectively meter traffic onto and off the bridge, and do not currently have the capacity to accommodate much more traffic than the peak hour volumes already being observed (i.e., about 1,700 vehicles per hour in the peak travel direction).

Analysis of LRT Alignment Options

From the perspective of traffic operations, the four LRT alignment alternatives identified earlier can be simplified into two basic options:

- Those alternatives that include an LRT track on an outside travel lane of the Hawthorne Bridge
- Those alternatives that include a single LRT track on the inside travel lanes

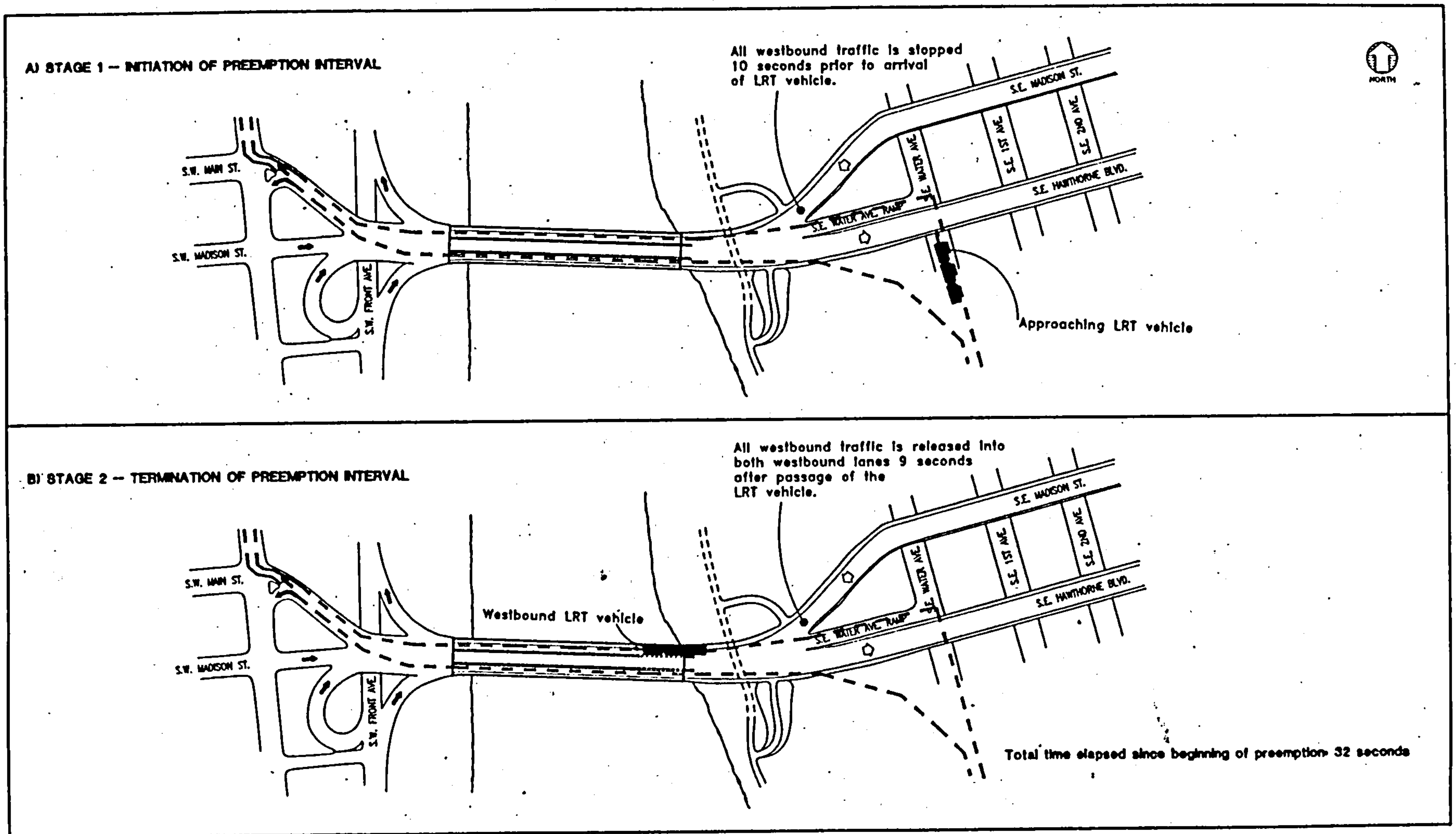
Outside Lane LRT Alignment. Figure 1 illustrates the preemption stages that will be necessary should the LRT tracks use the outside travel lanes. For illustrative purposes, it is assumed that the preemption is caused by a westbound LRT vehicle approaching from the east side; however, there is complete symmetry in the discussion that follows with regard to eastbound LRT vehicles approaching from the west side.

As Part A of Figure 1 illustrates, the first stage of the preemption strategy occurs 10 seconds prior to the arrival of the LRT vehicle, when all westbound traffic on S.E. Madison Street is directed (through signalization or gates) to stop east of the point where the LRT vehicle moves on to the transition structure. Part B illustrates that these vehicles are held for 32 seconds, or approximately 9 seconds after the passage of the LRT vehicle. They are then allowed to continue and to "trail" the LRT vehicle as it completes its passage across the bridge.

The total delay time of 32 seconds is sufficient to avoid long delays or congestion at either the upstream or the downstream ends of the bridge structure. It is also long enough to avoid significant interference with the operating characteristics of the upstream or downstream traffic signals. Therefore, it is concluded that operation of the LRT vehicles across the Hawthorne Bridge on an outside lane alignment can be accommodated without significant adverse operational or safety consequences.

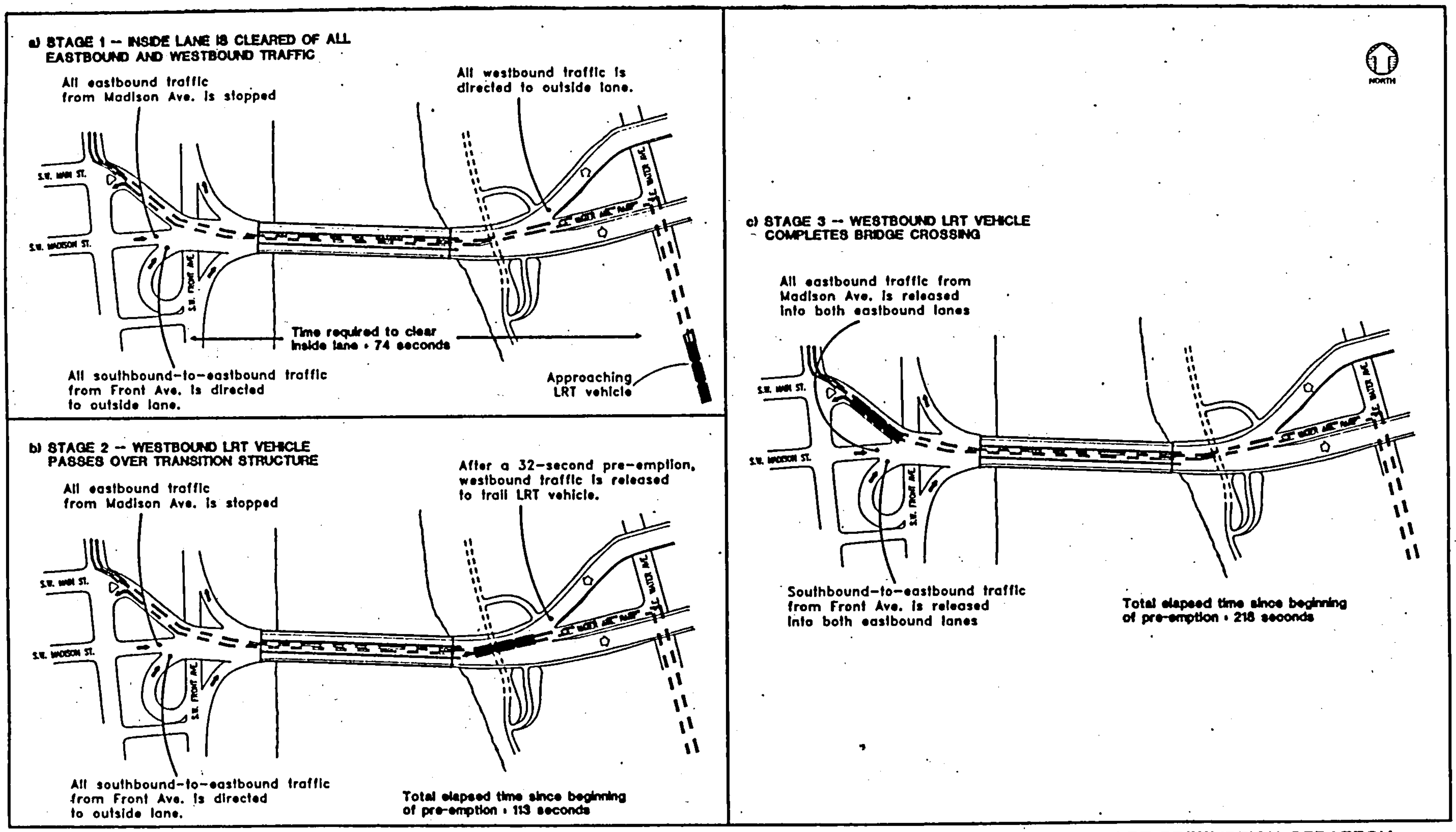
Inside Lane LRT Alignment. Figure 2 illustrates the preemption stages that will be necessary in the event that the LRT uses the inside travel lanes. The operational strategy for an inside lane LRT alignment is considerably more complex than for an outside lane alignment because the inside lanes are too narrow to allow simultaneous traffic or LRT movements in the same or opposite direction. In the case of Figure 2, the preemption is assumed to be caused by a westbound LRT vehicle approaching from the east side during the evening peak hour; nearly identical findings apply in the event of an eastbound LRT vehicle approaching from the west side during the morning peak hour.

Figure 2 shows that the preemption must occur in three basic stages. During the first stage, the inside travel lanes (between the west end and S.E. Water Avenue) must be cleared of all vehicular traffic in both directions prior to the arrival of the LRT vehicle (see Figure 2, Part A). Next, the LRT vehicle must travel across the bridge (see Part B). During this stage, both directions of traffic can continue to use the outside travel lanes, and same direction traffic can trail the LRT vehicle; however, opposite-direction vehicular



LRT PREEMPTION STRATEGY:
OUTSIDE LANE ALIGNMENT

HAWTHORNE BRIDGE - PHASE 2 TRAFFIC IMPACT ANALYSIS	Figure 1
November 1990	



LRT PREEMPTION STRATEGY: INSIDE LANE ALIGNMENT

HAWTHORNE BRIDGE - PHASE 2
TRAFFIC IMPACT ANALYSIS
November 1990

Figure 2

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traffic must continue to be excluded from the inside lanes. Only after the LRT vehicle has passed completely over the bridge structure can opposite-direction traffic be released into the inside travel lane (see Part C). The total estimated preemption time required for opposite-direction traffic as shown in Parts A, B, and C of Figure 2 is 218 seconds or slightly over 3.5 minutes.

Under existing evening peak hour traffic volume conditions and for the preemption strategy shown in Figure 2, there would be at least 44 eastbound vehicles waiting on S.W. Madison Street by the end of the preemption interval. This queue of vehicles could be expected to extend westward from the bridgehead to about S.W. Third Avenue. The queue would continue to extend in length for some time after the end of the preemption interval, so that the ultimate back-of-queue could be expected to be somewhere between S.W. Fourth Avenue and S.W. Fifth Avenue.

For the purposes of this analysis, it has been assumed that LRT vehicles will be moving during the morning and evening peak hours at average headways of 7.5 minutes in each direction of travel. With respect to evening peak hour conditions this means that, in order to avoid an unstable growing queue, the transportation system must be able to release 91 vehicles from S.W. Madison Street prior to the arrival of the next westbound LRT vehicle (consisting of 44 vehicles delayed by the passage of the LRT vehicle during the first 218 seconds, and 47 additional vehicles expected to arrive during the remaining 232 seconds). But the signalized grid making up the surface street system in the downtown core area is only able to release approximately 16 vehicles each minute. Therefore, 360 seconds will be required to fully dissipate the queue of vehicles on S.W. Madison Street, but only 232 seconds remain until the beginning of the next preemption. Thus, the queue will not be fully dissipated and will continue to grow. Without mitigation, this condition could cause other upstream intersections to fail with the next preemption, and ultimately have a mushrooming effect throughout the downtown area until sometime after the end of the evening peak hour.

If an inside lane alignment is chosen for the LRT, then it will be necessary to identify mitigation measures that eliminate the potential for queue buildup on the west end. Several options that have been identified through this analysis include the following:

- Increase the headway between LRT vehicles to at least 10 minutes. This would provide sufficient time between preemptions to dissipate the vehicle queues that are expected on the west end before the beginning of the next preemption.

- Prohibit vehicle usage of the S.E. Water Avenue ramp on the east end of the transition structure. By itself, this mitigation measure does not completely resolve the deficiency noted above, but it does have the effect of reducing the total required preemption time by nearly 33 seconds. This mitigation measure also would have no appreciable effect on morning peak hour queuing deficiencies caused by eastbound LRT vehicles.

- Through operational and geometric modifications, it may be possible to keep the curb lane on S.W. Madison Street open during a preemption by a westbound LRT vehicle, providing that all curb lane traffic is directed into the outside travel lane. Unfortunately, this mitigation measure would not, by itself, be sufficient to resolve the deficiency identified above. Northbound-to-eastbound and southbound-to-eastbound traffic from S.W. Front Avenue will combine to take up most of the available capacity of the outside lane during a westbound LRT vehicle preemption, and so very little additional volume could be accommodated from S.W. Madison Street. Specifically, it is expected that no more than 10 vehicles from S.W. Madison Street could be accommodated through this mitigation measure, saving no more than 15 to 30 seconds in total time required to dissipate the queue. Also, this mitigation measure will have no appreciable effect on morning peak hour queuing deficiencies cause by eastbound LRT vehicles.

- Do not allow any vehicular access to the Hawthorne Bridge on the west end except via S.W. Front Avenue. Buses and trucks could probably be allowed to continue to use S.W. Madison Street and S.W. Main Street, but all other private vehicles would be prohibited from using these streets for bridge access/egress, at least during the peak hours. The effects of this mitigation measure would include revising downtown traffic circulation patterns and increasing the potential for congestion on S.W. Front Avenue. An analysis of the extent of these effects is beyond the scope of this effort, but should be completed prior to implementing this mitigation measure.

- Reduce the demand for travel onto and off the Hawthorne Bridge via S.W. Madison Street and S.W. Main Street by an amount sufficient to eliminate the queue dissipation problem. Specifically, the diversion of approximately 300 vehicles per hour from SW Madison Avenue would resolve the identified weekday evening peak hour deficiency. This volume reduction could be accomplished either by diversion of these vehicles to other bridges and/or by diversion to alternate transportation modes (pedestrian, bicycle, carpool, bus, or LRT).

STRUCTURAL ANALYSIS

The first task was to review two previous studies. A 1984 study by ABAM Engineers took a cursory look at the feasibility and impacts of LRT on the Hawthorne Bridge. A 1986 study by Sverdrup and Parcel included a detailed analysis of the river spans for vehicular loads. That study considered the question of LRT loads in less detail than the ABAM study. The 1986 study was valuable in that it included a detailed structural analysis of the river spans and an evaluation of the lift span mechanical-electrical system. This review confirmed the earlier findings and provided a firm foundation for this study.

Several revisions need to be made to physically accommodate the LRT retrofit:

- Remove the existing deck
- Add new stringers under the proposed LRT alignment
- Provide a trough to electrically isolate the LRT rails
- Provide a new, half-filled concrete steel grid deck

Several samples of the structural steel were laboratory tested and found to be 20 percent stronger than would normally be assumed based on the age of the bridge.

With all of the LRT alternatives, the top chord and some of the vertical and diagonal members were over stressed in all of the spans. That degree of stress varied somewhat between the LRT alternatives and the strengthening requirements are reflected in the following cost estimates. These costs include the reinforcement and the revisions outlined above to physically accommodate the LRT rail.

Alternative 1	$6.8 million
Alternative 2	7.4 million
Alternative 3	6.8 million
Alternative 4	6.4 million

FATIGUE ANALYSIS

The historical loads on the structure were documented, including the earlier streetcar traffic and vehicular traffic since the original construction. Future loading including LRT was projected and used in the fatigue analysis. According to that analysis, there is no significant fatigue problem nor will there be with the design loading.

There were, however, two minor problems. One is at the railing connection locations. This problem will be corrected with the County's Emergency Repair, Phase 2 project in 1991. The riveted joints supporting the outriggers that, in turn, support the outside lanes are also identified as a fatigue problem if LRT is placed in the outside lanes. This problem can be solved by replacing the rivets with high-strength bolts as a maintenance activity or as a minor part of a LRT project. The cost of this repair is not significant enough to be a part of this cost estimating effort.

LIFT SPAN EVALUATION

Several elements of the existing lift span mechanical-electrical system are only marginally acceptable now. Strengthening of the trusses and adding the LRT accommodation elements add 306,000 pounds of dead load to each 209-foot span and 374,000 pounds to each 244-foot span. This added weight applies to all of the LRT alternatives. The additional 374,000 pounds cannot be tolerated by the existing lift system. The wire ropes connecting the lift span to the counterbalance and the drive system must be replaced with higher strength cables. The connections between the counterbalance weights and the ropes will also be overstressed and must be replaced.

Some of the stress in the existing system comes from the sheave bearings at the top of the lift towers. These bearings must be replaced with non-friction bearings to lower the stresses to a level that can be tolerated by the new ropes and connections. Also, the capacity of the emergency drive unit must be increased to accommodate the increased loads.

The cost to make these improvements is $3.0 million.

SEISMIC EVALUATION

A cursory evaluation of the current AASHTO design seismic forces was done. The existing piers are acceptable under these forces. The anchor bolts connecting the spans to the tops of the piers would likely shear, but the tops of the piers are sufficiently wide that collapse of the spans is unlikely. Except as described in the next paragraph, the river spans would be expected to withstand the design earthquake.

Enough investigation was done to determine that the lift towers would fail under the design seismic forces. A detailed investigation that is well beyond the scope of this study would be required to determine with a high level of confidence what improvements would need to be made to the towers to allow them to withstand the design earthquake. It is likely, however, that the two towers would have to be entirely rebuilt.

The towers are braced by a member connected to the tops of the adjacent span trusses. It is likely that the top chords of these trusses would have to be additionally reinforced as well as several of the vertical and diagonal members.

A level of magnitude estimate for this cost is probably in the $5-8 million range.

EASTSIDE LRT APPROACH MAP

With LRT Alternative 3 where LRT is using the eastbound outside lane, a separate structure must be provided so that LRT can exit the Hawthorne Bridge on the right and descent to ground level. This is required because of the undesirable reverse curve that would be required for an LRT vehicles to get from the outside lane to the Water Avenue ramp. The cost of providing that structure is $400,000.

WESTSIDE APPROACH

Retrofitting LRT on this approach would require removing part of the deck, building new stringers at a lower level, and building a new deck. This investigation was a cursory one, and the cost estimate for accommodating LRT based on it is $1.2 million.

HAWTHORNE BRIDGE LRT COST ESTIMATE

In summation, the cost to accommodate the LRT rails on the main spans, strengthen the main spans, increase the capacity of the lift span mechanism, bring the towers up to earthquake standards, provide an approach structure for Alternate 3, and revise the west approach is estimated to be as follows:

LRT Alternative 1	$16.0 - 19.0 million
LRT Alternative 2	$16.6 - 19.6 million
LRT Alternative 3	$16.4 - 19.4 million
LRT Alternative 4	$15.6 - 18.6 million

These revisions provide some new elements as discussed, but would not extend the service life of the piers or basic superstructure.

SEPARATE LRT RIVER CROSSING STRUCTURE

Cost estimates were developed for two options for a separate LRT river crossing. For study purposes, a location was assumed just upriver (south) of the Hawthorne Bridge.

One option was a high-level fixed structure. The clearance to the water surface would be 75 feet to match the clearance of the Hawthorne lift span. The LRT profile would be 5 1/2 to 6 percent approaching the mid-river crest. The touch-down point on the west side would probably be near Second Avenue, which would certainly be an issue considering downtown development. The cost of this structure would be $16 million exclusive of approach and right-of-way costs.

The other option is a low-level, opening structure. The construction cost of this structure is $27 million. The ongoing operational cost associated with an opening structure is not included.