14th / 16th AVENUE SOUTH BRIDGE

REHABILITATION / REPLACEMENT

DESIGN REPORT

Prepared For:

KING COUNTY

DEPARTMENT OF PUBLIC WORKS

By:

SVERDRUP

November 1994

FOREWARD

Pursuant to the Supplemental Agreements No. 2 and No. 3 dated May 5, 1992 and November 10, 1992, respectively, between King County and Sverdrup Corporation, Sverdrup has previously provided engineering services for: an operational study of the existing 14th/16th Avenue South Bridge mechanical and electrical systems; and a life cycle cost analysis of rehabilitation of the existing bascule bridge versus replacement with a low to intermediate fixed span bridge. This Design Report incorporates the results of those previous investigations and summarizes an alternative alignment and bridge type preliminary engineering study for the construction of fixed and movable replacement bridge alternatives. The Design Report also summarizes investigation undertaken to determine the effects of permanent bridge closure.

We wish to express our appreciation to King County and City of Tukwila personnel who provided assistance during our investigations and analyses.

SCOPE OF WORK

Sverdrup's scope of services for the previous investigation of the existing bridge mechanical and electrical systems operational study included:

1. Evaluating the relationship between existing mechanical and electrical deficiencies and ongoing operational difficulties;

2. Determining the necessary mechanical and electrical repairs along with associated costs to maintain the existing bridge in reliable service for the next ten years until a replacement structure is built;

3. Determining the necessary mechanical and electrical repairs along with associated costs to retrofit the existing bridge to sustain an additional fifty year life; and

4. Determining the necessary work to perform precision balancing of the existing movable spans for an additional fifty year service life.

Sverdrup's scope of services for the previous life cycle cost analysis study comparing bridge rehabilitation versus replacement included:

1. Preliminary engineering for the replacement structure considering alignment, profile, navigational clearance, span length, and structure type.

2. Updating of cost estimates for rehabilitation and replacement from those presented in the July 1987 "16th Avenue South Bridge Investigation Report" and October 1991 "14th/16th Avenue South Bridge Foundation Design Report - North Pier".

3. Determining operation and maintenance costs for each alternative.

4. Performing a survey of waterway users and determining costs associated with impacts to waterway users from a low to intermediate level fixed span replacement bridge.

5. Assisting the County in coordination with the U.S. Coast Guard and U.S. Army Corps of Engineers.

6. Developing schedules for rehabilitation and replacement alternatives including associated activities such as permit processes and environmental reviews.

7. Performing a life cycle cost analysis comparing costs for rehabilitation of the existing bridge versus costs for a low to intermediate level fixed bridge considering all relevant factors identified herein.

8. Analyzing other factors which might influence the decision to repair or replace the existing bridge including safety, seismic event survivability, historic significance, and environmental concerns.

Sverdrup's Scope of services for the alternative alignment and bridge type study included:

1. Preliminary engineering to establish alignment, grade and vertical clearance for a maximum of three alternatives; to establish lengths for main span, approach spans and approach roadways for each alternative; to establish bridge type and typical section for main span and approach spans for each alternate; to determine right-of-way requirements for each alternative; and to develop cost estimates for each alternative.

2. Comparing of construction impacts for each alternative including traffic circulation during construction, potential for damage to existing structures, and duration of construction.

3. Evaluating of the impacts of the alternative alignment options on the local transportation network including analysis of long term circulation impacts associated with bridge closure and evaluation of the potential to convert the existing bridge into a three lane facility.

4. Identifying of all other factors, if any, which may influence a final decision on bridge replacement versus rehabilitation.

5. Preparing of a Design Report that combines the information from the alignment investigation and the previous studies including an analysis of alternatives and a final recommendation for the type and location of a replacement bridge.

The results, findings, conclusions, and recommendations of these investigations and analyses are summarized in this Design Report.

SUMMARY

Project Description

This Design Report presents a summary of investigations that compares rehabilitation of the existing 14th/16th Avenue South Bridge versus replacement with either an intermediate, or high level fixed span bridge, a movable bridge, or permanent closure of the bridge.

The 14th/16th Avenue South Bridge was originally constructed in 1931 and consists of a Scherzer Rolling Lift double leaf bascule span with steel truss and concrete approach spans on each side. Both the north and south bascule piers supporting the movable span have incurred cracking and deterioration with cracking and deterioration of the north pier more severe. Survivability of the north and south bascule piers in a major seismic event is also suspect due to the potential for liquefaction of the soils at the location of the piers and the significant cracking of the piers.

A mechanical and electrical systems operational study has identified several problem areas and safety concerns with the existing bridge as identified in the "14th/16th Avenue South Bridge Operational Study and Life Cycle Cost Analysis" dated April 1993. These problems could result in severe damage to the machinery making the bridge inoperable. Electrically the bridge is functional but many of the components are outdated making maintenance difficult. Eventually replacement parts will become unavailable.

Repair and renovation recommendations to maintain the existing bridge in reliable service for the next ten years until a replacement structure is built versus repair and renovation recommendations to sustain the existing bridge for an additional fifty year service life have been developed. The seismic survivability of the existing bridge has also been reviewed and recommendations developed for retrofit of the existing bridge. However, the machinery could be inoperable after a major seismic event even if the retrofit is performed.

Three replacement bridge alternatives were investigated. They included an intermediate level 1,580-foot-long fixed span replacement bridge with 60 feet of vertical clearance at mean high water (MHW); a high level 2,524-foot-long fixed replacement bridge with 100 feet of vertical clearance at (MHW); and a movable replacement bridge with unlimited vertical clearance in the open position and 1,310-foot-long overall length.

Construction Impacts - Environmental and Related Consideration

Permits and environmental documentation are required for either the renovation or replacement of the existing bridge. The permits are largely administrative in nature for the repair and renovation of the existing bridge. For a replacement bridge, a U.S. Coast Guard (U.S.C.G.) permit is required and any reduction in clearance from the present unlimited clearance will require justification and mitigation of impacts to waterway users. The existing bascule bridge is listed in the National Register of Historic Places principally due to its type of operating mechanism, a Scherzer Rolling Lift. Any removal of the existing bridge will require mitigation against the loss.

A waterway users study and comments to a U.S. Coast Guard public notice has indicated that a vertical clearance less than 100 feet will have an impact to mooring boats at the Duwamish Yacht Club, to Delta Marine Industries, and Manson Construction and Engineering Company. Mitigation of these impacts will be required. A waterway users economic study has recently been completed by BST Associates. They have determined that it is economically feasable to allow a vertical clearance of 60 feet.

Other related factors affecting a decision on whether to repair or replace the existing bascule bridge include: environmental considerations associated with excavation of possible contaminated sediments for the replacement bridge foundation and associated with disposal of the existing bridge; permitting; navigation clearances; and traffic and safety considerations.

Traffic Impacts

Although the existing bridge is narrow in width and the bascule span grating is slippery especially when wet, the accident history does not suggest a significant traffic safety concern at the present time. The renovation of the existing bridge would require a waiver for non-compliant roadway width. It is possible to increase lane widths to 10 feet by reducing sidewalk widths 1 foot on each side of the existing bridge, thereby meeting minimum 3-R standards. However, the existing four lane bridge does not have the available capacity due to the narrow lanes and the high volume of truck traffic in the corridor. A better alternative for the existing structure seems to be the three lane conversion with 2 lanes northbound and 1 lane southbound. The replacement of the existing structure with a fixed or movable structure will improve safety, and will have somewhat greater traffic carrying capabilities.

Any closure of the existing bridge for repair or renovation will impact local traffic requiring a detour. The permanent bridge closure alternative is not feasible due to the inability of the adjacent facilities to absorb the additional traffic.

Evaluation of Alternatives

A Life Cycle Cost Analysis (LCCA) was performed comparing each of the replacement bridge alternatives including the 60-foot clearance fixed span bridge replacement (FBR60), the 100-foot clearance fixed span bridge replacement (FBR100), and the bascule movable bridge replacement (MBR) with the repair and rehabilitation of the existing bascule bridge (RBB) using present value methods. The LCCA was based on the present values of the sum of the capital construction costs, major maintenance and improvement costs, annual maintenance and operation costs, salvage or residual values, waterway users compensation costs, and right-of-way acquisition costs. A discount rate (interest rate of an investment minus the inflation rate) of 3 percent was utilized for the LCCA. Permanent closure of the bridge would lead to serve adverse traffic problems and was therefore not considered feasible or included in the LCCA.

It is anticipated that each of the replacement alternatives, FBR60, FBR100 and MBR have 100 years of useful life, whereas the RBB alternative has only 50 years. To compare equivalent life cycle costs it is necessary to use the same time span for each alternative. In this analysis a time span of 50 years was chosen. To compensate for differences in the useful life, the replacement alternatives are given a salvage value of 50 percent of their original value at the end of 50 years of service. The RBB alternative is given no salvage value.

A summary of the LCCA present value cost based on a 50 year time span for each alternative is given below:

Bridge Alternative	Present Value Costs
FBR60	$22,602,000 incl. ROW $21,146,000 excl. ROW
FBR100	$34,420,000 incl. R.O.W. $29,956,000 excl. R.O.W
MBR	$48,847,000 incl. ROW $46,948,000 excl. R.O.W
RBB	$21,106,000 incl. R.O.W. $21,106,000 excl. R.O.W.

After 50 years of service, a new bridge will be required to replace the RBB alternative. As a result, the life cycle cost of the RBB alternative increases significantly for time spans greater than 50 years. Similarly, the life cycle costs of the FBR60, FBR100, and MBR alternatives increase significantly for time spans greater than 100 years. Graph 1 illustrates the changes of life cycle cost as a function of time span.

All alternatives would have to compete for limited available federal, state and local funding. The most likely federal participation will involve Intermodal Surface Transportation Efficiency Act (ISTEA) legislation which will likely not exceed $15 million. Since present ISTEA legislation will expire in three years, it is important to pursue those funds immediately. With this limited funding, only the RBB and FBR60 alternatives are feasible.

We recommend replacing the existing 14th/16th Avenue South Bridge with the FBR60 alternative. This alternative offers the advantage of relative low costs, superior traffic capacities and minimum maintenance. If permitting for the 60-foot vertical clearance replacement bridge is not granted, we recommend, as our second choice, the rehabilitated bridge alternative (RBB).

It is important to act as soon as possible in selecting the recommended alternative since delaying the decision to replace the existing bridge only increases the repair and replacement costs of the bridge.

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I. INTRODUCTION

The 14th/16th Avenue South Bridge consists of a Scherzer Rolling Lift double leaf bascule span with steel truss and concrete approach spans on each side. Both the north and south bascule piers supporting the movable span have incurred cracking and deterioration with cracking and deterioration of the north pier more severe. Survivability of the north and south bascule piers in a major seismic event is also suspect due to the potential for liquefaction of the soils at the location of the piers and the significant cracking of the piers.

The mechanical and electrical systems operational study included in the April 1993 "14th/16th Avenue South Bridge Operational Study and Life Cycle Cost Analysis" has identified several problem areas and safety concerns with the existing bridge.

Repair and renovation recommendations to maintain the existing bridge in reliable service for the next ten years until a replacement structure is built versus repair and renovation recommendations to sustain the existing bridge for an additional fifty year service life were also developed in that study. In addition, the seismic survivability of the existing bridge was reviewed and recommendations developed for retrofit of the existing bridge.

This Design Report completes the bridge alternative study begun in the April 1993 report. In addition to analyzing the rehabilitation of the existing bridge and two fixed span replacement bridge alternatives, this report includes an evaluation of a movable replacement bridge alternative and the effects on traffic of permanently closing the 14th/16th Avenue South Bridge.

The evaluation of each of the four bridge alternatives was based on establishing 1) alignment, grade and vertical navigational clearance; 2) lengths for main span, approach spans and approach roadways; 3) bridge type and typical section for main span and approach spans; 4) determining right-of-way requirements and 5) preparing cost estimates.

Each alternative was also evaluated comparing traffic circulation during construction, potential for damage to existing structures during construction, and duration of construction.

In addition, an evaluation of traffic for a 4-lane roadway and the conversion of the existing bridge into a 3-lane roadway was also completed. Other factors considered in the evaluation of each bridge alternative included ease of permitting, environmental impacts, pier protection, and long term traffic impacts.

II. PROJECT DESCRIPTION

A. EXISTING CONDITIONS

The 14th/16th Avenue South Bridge crosses the Duwamish waterway in the South Park area of the Seattle metropolitan area (See Figure 1 for Bridge Vicinity Map). The present structure was constructed during the 1930 - 1931 period and consists of a Scherzer Rolling Lift double leaf bascule movable span flanked each side by two deck truss and twelve concrete slab approach spans, resulting in an overall length of 1,285 feet (See Figure 2 for Existing Bridge Elevation). The double leaf bascule movable span has a center-to-center distance between the front bearings of 190 feet with length of roll equal to 18 feet for each leaf. Trusses are of riveted steel construction common to the era when constructed with center-to-center spacing between trusses of 36 feet.

The bridge presently accommodates an average daily traffic volume of approximately 21,800 vehicles in four lanes with a total roadway width of 38 feet. Maximum vertical clearance for the bridge is limited to 32 feet at Mean Higher High Water MHHW with three to five openings per day on average required to accommodate waterway traffic.

The bascule spans are supported on reinforced concrete piers founded on timber piling. The two bascule piers also support the counterweights, track supports and racks for the rolling lift, and house the operating machinery, electrical equipment, and operator's control room.

The bascule piers were transversely post-tensioned in 1982 to limit further outward movement of pier walls due to cracking of the concrete near bascule track supports and racks. The bascule center locking device was modified in 1985 to reduce up and down movement of bascule leafs due to live loading.

B. SUMMARY OF PREVIOUS INVESTIGATIONS

Sverdrup previously inspected and evaluated the bridge in 1987. See the "16th Avenue South Bridge Investigation Engineering Report" dated July, 1987 for further description of the bridge and specific inspection findings. Based on the previous inspection and evaluation, additional investigation of the north bascule pier and foundation were recommended to determine the cause and possible corrective measures for operational difficulties associated with opening and closing predominantly the north bascule leaf. These operational difficulties consist of binding or rubbing of the segmental track girders on lugs on the track supports resulting in the lugs being ground down to allow free movement.

Sverdrup completed the additional investigation and evaluation of the north bascule pier in 1991. See the "14th/16th Avenue South Bridge Foundation Design Report North Pier", dated October, 1991 for a description of these geotechnical and structural investigations and analyses. Results of the geotechnical investigation and analysis indicated that the vertical load capacity of the north pier foundation is only slightly greater than applied loads, that significant settlement of the north pier has likely occurred in the past resulting in the pier cracking, and that liquefaction of the foundation soils is likely to occur in a seismic event. However, this is not the case at the south bascule pier except for the liquefaction potential of the upper soil layers in a seismic event.

In addition, a location survey of the bascule track girder supports and pinion racks indicated that an overall misalignment of more than 1-1/2 inches currently exists between the track girder supports and pinion racks for the north bascule while for the south bascule there is negligible overall misalignment. However, the track girder supports are nearly parallel for the north bascule but for the south bascule they have a 7/8-inch misalignment.

Movement or tilting of both the north and south bascule piers was monitored parallel and perpendicular to the bridge for a ten month period. Two tiltmeters were mounted on each pier to measure tilting and to determine if any significant differential movement was occurring in the piers. Although recent review of the movement data for this study indicates that an incorrect scale factor had been utilized in the conversion of measured tilt in millivolts to microradians (magnitude of movements are approximately 1-inch in the direction of opening and closing of the bascule leaf and not 0.001-inch) the results as indicated in the October, 1991 report remain unchanged. Movements of both the north and south bascule piers are predictable and elastic in nature, they are approximately the same order of magnitude, and negligible differential movement occurs between the east and west sides of the piers. The bascule piers do not exhibit significant ongoing long-term differential settlement and appear to be stable. However, the bascule piers are subject to horizontal movements of 1-inch or more at the track girder support level during operation of the bridge which may have an impact on the bridge operation.

Sverdrup then completed a mechanical and electrical systems operational study and a life cycle cost analysis that compare rehabilitation of the existing 14th/16th Avenue South Bridge versus replacement with an intermediate level fixed span bridge in April 1993. See "14th/16th Avenue South Bridge Operational Study and Life Cycle Cost Analysis Comparing Bridge Replacement Versus Rehabilitation".

The mechanical and electrical systems operational study identified several problem areas and safety concerns with the existing bridge. The primary mechanical system concerns include: rotation of the rack pinion gear bushings in their housings; differentials in both spans not working properly so that loads associated with opening and closing the spans are not distributed equally to the machinery; and wear of the tracks leading to possible bottoming of the pinions gears in the racks. Electrically the bridge was found functional but many of the

components are outdated making maintenance difficult. Primary safety concerns include improper protection of the main distribution switchboard and generator controls and lack of a grounding system for the bridge.

Repair and renovation recommendations to maintain the existing bridge in reliable service for the next ten years until a replacement structure is built versus repair and renovation recommendations to sustain the existing bridge for an additional fifty year service life was developed. The seismic survivability of the existing bridge was also reviewed and recommendations developed for retrofit of the existing bridge.

Permits and environmental documentation required for either the renovation or replacement of the existing bridge were identified. For a replacement bridge, a U.S. Coast Guard permit is required and any reduction in clearance from the present unlimited clearance will require justification and mitigation of impacts to waterway users.

A 1,580-foot-long fixed span replacement bridge with 60 feet of vertical clearance at mean high water (MHW) was proposed as the replacement bridge. A waterway users study and comments to a U.S. Coast Guard public notice indicated that such a clearance will have an impact to several boaters mooring their boats at the Duwamish Yacht Club, to Delta Marine Industries, and to Manson Construction and Engineering Company. Mitigation of these impacts is included in a study "14th/16th Avenue South Bridge - Impact Analysis" by BST Associates completed in November 1994.

A Life Cycle Cost Analysis (LCCA) was performed in a previous study comparing fixed span bridge replacement (FBR55) versus repair and renovation of the existing bascule bridge (RBB) using present value methods. Results of the LCCA analysis indicated that renovation of the existing bascule bridge has a slightly lower present value cost.

C. DESIGN PARAMETERS

1. DESIGN CRITERIA

The following criteria establish parameters for the design of the rehabilitation/ replacement of 14th/16th Avenue South Bridge:

a. General

(1) Design and Construction

(a) Design will be in accordance with the AASHTO Standard Specifications for Highway Bridges, 1993 edition, and Standard Specifications for Movable Highway Bridges, 1988 edition, except as modified by the provisions, exceptions, and interpretations noted in the following paragraphs.

(b) Construction will be in accordance with the Washington State Department of Transportation Standard Specifications for Road, Bridge, and Municipal Construction, 1994 edition, except as modified by the project Special Provisions.

(2) Alignment and Grade

The maximum grade will not exceed 5 percent in the movable replacement bridge and 8 percent for the fixed replacement bridge alternatives.

(3) Tidal Elevations (County Datum EL = 0.00 = MLLW Datum EL = 7.00)

Estimated Highest Water (EHW)	=	+11.0 Feet
Mean Higher High Water (MHHW)	=	+5.98 Feet
Mean High Water (MHW)	=	+4.1 Feet
Mean Low Water (MLW)	=	-3.7 Feet
Mean Lower Low Water (MLLW)	=	-7.0 Feet

b. Design Loads

(1) Dead Load

The following unit weights will be used:

Concrete	160 pcf
Timber	50 pcf
Structural Steel	490 pcf

(2) Live Load

AASHTO HS-25 Loading

Note however a load rating will be required on the rehabilitated existing bascule bridge to verify its live load capacity.

Impact and distribution of live loads will be in accordance with AASHTO

(3) Snow

20 psf

(4) Wind

80 MPH in any direction

(5) Current

2 knot maximum

(6) Seismic Forces

Seismic forces will be determined in accordance with AASHTO Division I-A with acceleration of 0.3g.

c. Design Stresses

(1) Concrete

Precast Prestressed Concrete	f'c = 6,000 - 8,000 psi
Precast Non-Prestressed and Cast-in-Place Concrete	f'c = 4,000 psi

(2) Non-Prestressing Reinforcement

ASTM A615, Grade 60	fy = 60,000 psi

(3) Prestressing Reinforcement

7-wire strand - ASTM A416, Grade 270, Low relaxation

Ultimate Strength	fs = 270,000 psi
Yield Strength	fy = 229,000 psi
Jacking Strength	0.7 fs = 189,000 psi

(4) Steel

Mild Steel Shapes and Plate - ASTM A36	Fy = 36,000 psi
High Strength Steel Shapes and Plate - ASTM A572, GR 50	Fy = 50,000 psi
Pipe Piles - ASTM A252, Grade 2 or 3	Fy = 35,000 or 45,000 psi

High Strength Bolts - ASTM A325

All steel shall be painted or galvanized.

(5) Welding

All welding will be in accordance with the current American Welding Society Structural Welding Code - Steel.

d. Foundations

Pile downward and upward load capacities and embedment criteria to be determined.

e. Hydraulic System

(1) The operational pressures: In accordance with AASHTO "Standard Specifications For Movable Highway Bridges"

(2) Hydraulic Fluid: In accordance with AASHTO "Standard Specifications For Movable Highway Bridges"

(3) Materials: In accordance with AASHTO "Standard Specifications For Movable Highway Bridges"

2. DESIGN YEAR ADT AND SPEED

a. ADT

The ADT is 33,000 for 2010 design year.

b. Design Speed

The design speed is 35 MPH.

D. ALTERNATIVES

1. REHABILITATION OF EXISTING BRIDGE

The present overall condition of the 14th/16th Avenue South Bridge is generally fair to good. Repair and maintenance of the bridge over the years has generally been good in most areas. However, there are areas that need closer maintenance attention and repairs or rehabilitation if the bridge is to either remain in reliable service for the next ten years until a replacement structure is built or is to sustain an additional fifty year service life.

a. Ten-Year Life

The bridge continues to experience mechanical and electrical operational difficulties on a somewhat random occurrence. The bridge should be monitored for any pattern of reoccurrence of a particular problem so that the cause may be determined and a corrective action undertaken if deemed necessary. Recommended mechanical, electrical, and structural repairs to maintain the bridge in reliable service

for the next ten years are as follows. Estimated costs for these repairs are included in the Life Cycle Cost Analysis section of the report.

(1) Mechanical

(a) The bushings in bearings B1N-north span and B20S-south span should be replaced. At the time of replacement, the rack pinion shafts should be inspected and the journal should be remachined or polished to an 8-micro-inch surface finish. The new bushing should be made to provide a RC-6 fit with the journal and a FN-2 fit in the housing.

(b) Add four additional bolts to the flanges of the bushings in bearings B20N-north span and B1S-south span. The bolts should be of the same size as the existing bolts.

(c) Disassemble the differential on both span drives. Free up all rotating parts. Be sure that there are lubrication provisions for all bearings in each assembly. Add lube fitting for any bearing that does not have one. Lubricate monthly.

(d) The depth of the three cracks found in Gear G13S-south span should be determined. Each crack should be ground out completely. Magnetic particle inspection should be used to be sure that the entire crack has been removed. An analysis should be made of the material to determine the weldability. Any crack that extends more than 1/4-inch into the gear should be weld-repaired if the material is found to be readily weldable. A proper welding procedure must be developed for welding, based on the chemical analysis of the metal. If any additional cracks are found in any of the gears, the same procedure should be followed. Do not assume that the chemical analysis will be the same for any two gears. Any cracked gear that cannot be weld-repaired should be replaced.

(e) All of the gears in the span drive systems should be cleaned thoroughly and inspected for cracks.

(f) Monitor the wear at the racks and pinions on a yearly basis. If the wear progresses to a point where the backlash has been reduced to less than 0.015-inch or the clearances at the tips of the teeth is eliminated at any position of any of the rack and pinion sets, an analysis must be made as to the fix required to extend the useful life of the sets until the replacement bridge is erected.

(g) The corners of the track pockets that contact the fillets at the bases of the fillets should be ground to eliminate contact at the fillets. In addition, it would be well to carefully grind all of the sides of the lugs that are in such hard contact that the metal on the sliding surfaces has flowed, causing ripples on the surfaces. Then, only the near vertical surface of the lugs should be lubricated with an open gear lubricant. Care must be taken to prevent the lubricant from flowing onto the rolling surfaces of the tracks.

(h) Drill a 1/2-inch diameter hole beyond the end of the crack in the west curved tread-south span. The hole must extend entirely through the tread to prevent the crack from propagating.

(i) Readjust, west motor brake-north span, west motor brake-south span and east emergency brake-south span to bring each brake shoe into firm contact with the brake wheel when the brakes are set.

(j) Provide three limit switches on each brake in the span drive systems:

i. One limit switch should be used to provide an interlock in the control circuit to prevent an opening cycle from commencing if any brake is in the hand released position.

ii. One limit switch should be used to provide an interlock in the control circuit to prevent the drive motors from being energized unless all brakes are released.

iii. One limit switch should be used to provide an interlock in the control circuit to prevent the traffic gates from being opened unless all of the brakes are set.

(k) Provide a limit switch to indicate that gears G10N and G10S are fully disengaged and to prevent the main motors from operating if these pinions are not fully disengaged.

(l) Lubricate the mechanical pivot points on all brakes (emergency and motor). Only a small amount of oil is required 3 to 4 times per year to keep the brakes operating smoothly. Care must be taken to avoid getting any oil onto the brake wheel or the brake shoes.

(m) Clean and paint the emergency brakes on the south span.

(n) Install guards over the brakes, over the motor couplings and over the spur gearsets in the auxiliary drives.

(o) Clean all road debris and corrosion from the tread plates and the structural steel they are attached to. Replace any severely corroded fasteners. Road debris should be removed from these areas on a regular basis.

(p) Clean road debris and corrosion from structural steel adjacent to the live load reactions and repaint to prevent corrosion.

(2) Electrical

(a) Provide a grounding system throughout the bridge.

(b) Replace existing wood enclosures for the main switchboard and the generator controls with metal enclosures.

(c) Clean and inspect the main and emergency drive motors.

(d) Overhaul the engine of the emergency generator; clean and inspect the generator, exciter and controls; and replace fuel tank and fuel lines to the engine.

(e) Clean and inspect main and emergency drive resistor banks.

(f) Clean relay, contactor and drum controller contacts regularly.

(3) Structural

(a) Due to the significant cracking of the bascule piers and the possible effect on the operation of the bridge mechanical systems, continue monitoring of the pier movements by the previously installed tiltmeters on a regular basis until the replacement bridge is constructed.

(b) Remove delaminated and spalling concrete from underside of sidewalk support beams and add hangers for supports at locations of expansion joints.

(c) Grind tips and roots of interlocking fingers at center expansion joint in the bascule span to prevent contact when bridge expands due to temperature.

(d) The concrete approach spans require continued testing and repair. Core, test, and infrared thermography the slab spans and the pier caps. Remove and repair miscellaneous concrete spalling, repair the damaged concrete railing section, and repair the concrete deck adjacent to expansion joints.

(e) Reinspect the bascule piers for evidence of continued cracking, spalling, and deterioration, and perform a more in-depth underwater inspection of the piers.

(f) Repair existing expansion joints on the existing approach span deck.

b. Fifty-Year Life

Recommended mechanical, electrical, and structural repairs to sustain an additional fifty year service life follows. Estimated costs for the rehabilitation and replacements are included in the Life Cycle Costs Analysis section of the report.

(1) Mechanical

(a) The bushings in bearings B1N-north span and B20S-south span should be replaced. Since the span must be taken out of service to accomplish this work, it would be wise to replace the bushings in bearings B20N-north span and B1S-south span at the same time. At the time of replacement, the rack pinion shafts should be inspected and the journal should be remachined or polished to an 8 micro-inch surface finish. The new bushings should be made to provide an RC-6 fit with the journal and an FN-2 fit in the housing.

(b) Replace the existing differentials in the span drives with enclosed industrial differential speed reducers. These speed reducers would need to be properly engineered for this specific application.

(c) Machine the bottoms of the racks to provide proper clearances between the tips of the rack and pinion teeth and the roots of the mating teeth. It would be advisable to remove an extra 0.050-inch and insert shims under each rack. The shims could then be removed at a later date when the clearances are again reduced to unacceptable levels.

(d) Energy absorbing traffic barriers should be installed on each approach span.

(e) Replace the center locks, with mechanical-electrical locks that can be disengaged completely before an opening cycle starts. The locks can also be disengaged and one leaf opened if necessary. Also, this type of lock will eliminate the necessity for closely coordinated movement of the two leaves during closing of the bridge. Provide access to permit inspection and maintenance to new center locks.

(f) The depth of the three cracks found in Gear G13S-south span should be determined. Each crack should be ground out completely. Magnetic particle inspection should be used to be sure that the entire crack has been removed. An analysis should be made of the material to determine the weldability. Any crack that extends more than 1/4-inch into the gear should be weld-repaired if the material is found to be readily weldable. A proper welding procedure must be developed for welding, based on the chemical analysis of the metal. If any additional cracks are found in any of the gears, the same procedure should be followed. Do not assume that the chemical analysis will be the same for any two gears. Any cracked gear that cannot be weld-repaired should be replaced.

(g) All of the gears in the span drive systems should be cleaned thoroughly and inspected for cracks.

(h) The corners of the track pockets that contact the fillets at the bases of the fillets should be ground to eliminate contact at the fillets. In addition, it would be well to carefully grind all of the sides of the lugs that are in such hard contact that the metal on the sliding surfaces has flowed, causing ripples on the surfaces. Then, only the near vertical surface of the lugs should be lubricated with an open gear lubricant. Care must be taken to prevent the lubricant from flowing onto the rolling surfaces of the tracks.

(i) Drill a 1/2-inch diameter hole beyond the end of the crack in the west curved tread-south span. The hole must extend entirely through the tread to prevent the crack from propagating.

(j) Readjust, west motor brake-north span, west motor brake-south span and east emergency brake-south span to bring each brake shoe into firm contact with the brake wheel when the brakes are set.

(k) Provide three limit switches on each brake in the span drive systems:

i. One limit switch should be used to provide an interlock in the control circuit to prevent an opening cycle from commencing if any brake is in the hand released position.

ii. One limit switch should be used to provide an interlock in the control circuit to prevent the drive motors from being energized unless all brakes are released.

iii. One limit switch should be used to provide an interlock in the control circuit to prevent the traffic gates from being opened unless all of the brakes are set.

(l) Provide a limit switch to indicate that gears G10N and G10S are fully disengaged and to prevent the main motors from operating if these pinions are not fully disengaged.

(m) Lubricate the mechanical pivot points on all brakes (emergency and motor). Only a small amount of oil is required 3 to 4 times per year to keep the brakes operating smoothly. Care must be taken to avoid getting any oil onto the brake wheel or the brake shoes.

(n) Clean and paint the emergency brakes on the south span.

(o) Install guards over the brakes, over the motor couplings and over the spur gearsets in the auxiliary drives.

(p) Clean all road debris and corrosion from the tread plates and the structural steel they are attached to. Replace any severely corroded fasteners. Road debris should be removed from these areas on a regular basis.

(q) Clean road debris and corrosion from structural steel adjacent to the live load reactions and repaint to prevent corrosion.

(2) Electrical

(a) Replace the main power distribution switchboard with a modern motor control center.

(b) Replace the emergency generator and controls.

(c) Replace control console, including all limit switches, indicators, and interlocks.

(d) Refurbish the main and emergency drive motors by disassembling, cleaning and redipping, and baking. Inspect bearings and replace as required.

(e) Replace submarine cables.

(f) Replace control tower and equipment rooms lighting, and heating system.

(g) Replace conduit, fittings and wiring throughout the bridge.

(h) Provide a complete grounding and lightning protection system.

(i) Replace all main and emergency resistor banks.

(3) Structural

(a) Due to the significant cracking of the bascule piers and the possible effect on the operation of the bridge mechanical systems, continue monitoring of the pier movements by the previously installed tiltmeters on a regular basis until rehabilitation is completed.

(b) Perform compaction grouting of the soils around the north and south bascule piers foundations to improve pile bearing capacity and reduce seismic liquefaction potential.

(c) Replace north and south steel truss approach span concrete roadway deck, sidewalks, and barriers.

(d) Replace bascule span roadway grating, sidewalks, and barriers. Grind tips and roots of interlocking fingers at center expansion joint in the bascule span. Adjust counterweight balance as required.

(e) Seismic retrofit north and south steel truss approach spans by adding restrainers, strengthening bearings and strengthening end diaphragms. Perform a detailed seismic study to determine the requirements for seismic retrofiting both the superstructure and substructure.

(f) Repair north and south bascule pier cracking and seismic retrofit by adding reinforced concrete walls around perimeter of piers and epoxy injecting of cracks above machinery level.

(g) Replace north and south concrete approach spans including superstructure and substructure.

(h) Prior to concrete approach span replacement, the existing concrete approach spans require continued testing and repair. Core, test, and infrared thermography the slab spans and the pier caps. Remove and repair miscellaneous concrete spalling, repair the damaged concrete railing section, and repair the concrete deck adjacent to expansion joints.

(i) Reinspect bascule piers for evidence of continued cracking, spalling, and deterioration and perform a more in-depth underwater inspection of the piers. Injection grout the concrete crack below the water line. Install siltation screens to prevent contamination during grouting operations.

(j) Local Agency Guidelines under Urban Design Standards for 3-R Projects require 10-foot minimum lane widths for two-way undivided traffic, or a 40-foot roadway width curb-to-curb for four lanes. The existing bridge has a 38-foot of roadway width with 6-foot sidewalks on each side. A 40-foot total roadway width can be achieved without increasing the overall bridge width by removing 2 feet from one of the sidewalks or 1 foot from each sidewalk. No other changes other than reducing sidewalk width are anticipated.

(k) It is anticipated that existing pier protection will deteroriate over useful life of rehabilitated bridge alternative. Replace and/or repair the existing pier protection as conditions warrant.

2. FIXED BRIDGE REPLACEMENT

Two fixed span bridge alternative structures were investigated as replacements for the existing bascule bridge. The fixed span replacement bridges were considered for study because they represented an economical alternative to the rehabilitation of the existing bascule bridge and/or to the construction of a replacement movable bridge. They include the 60-foot vertical clearance fixed bridge and the 100-foot vertical clearance fixed bridge. The 35-foot vertical clearance alternative introduced in the April 1993 "14th/16th Avenue South Bridge Operational Study and Life Cycle Cost Analysis" is not considered feasible due to its limited vertical clearance. The 100-foot vertical clearance fixed bridge satisfies the preliminary findings of the U.S. Coast Guard for navigational clearance. However, a recently concluded economic analysis indicated that the 60-foot vertical clearance alternative is feasible and impacts are minimal to existing businesses and waterway users.

a. Alignment and Geometrics

The proposed fixed span bridge alignments, are located parallel to and 75 feet west of the existing bascule bridge. See Figures 3 and 4 for the Bridge Plan and Elevation. These alignments allow the existing bridge to remain open to traffic for the majority of the time during the construction of either of the fixed span bridge alternatives.

The proposed alignment for the 60-foot vertical clearance bridge alternative is such that the north intersection with the existing 16th Avenue South alignment occurs approximately 300 feet south of the present East Marginal Way intersection. South of the bridge, the proposed alignment is along 14th Avenue South with the intersection with the existing alignment occurring just to the north of the present Cloverdale Street.

The proposed alignment for the 100-foot vertical clearance bridge alternative is such that the north intersection with the existing 16th Avenue South alignment occurs approximately 150 feet south of existing East Marginal Way intersection. South of the bridge the proposed alignment is along 14th Avenue South with the intersection with the existing alignment occurring approximately 400 feet south of the existing South Cloverdale Street intersection and 14th Avenue South intersection. The intersections of the alignments for both fixed span alternatives utilize horizontal curves with a radius of 1,146 feet.

Alternative horizontal alignments for both fixed bridge alternatives were also considered. These alternatives include: 1) locating the replacement bridge immediately north of the existing alignment, 2) matching the existing alignment, or 3) locating the northbound and southbound lanes on separate structures. Due to the proximity of the recently constructed Boeing buildings north of the existing alignment, locating a replacement bridge north of the existing bridge would require removal of these buildings and therefore is not considered economically feasible. Locating the southbound traffic on the existing alignment and the northbound traffic on a separate structure requires two bridges. As a result this alignment configuration is also not economically feasible. And finally, the alignment which matches the existing alignment requires closure of the existing bridge throughout construction of the replacement bridge and therefore is also not considered feasible.

The profile for both proposed fixed replacement alternatives is set at 8 percent maximum grade to provide either 60 or 100 feet minimum vertical clearance at mean high water (MHW) for the 125-foot-wide navigation channel. Length of vertical curves is set to provide minimum stopping sight distances for a 35 MPH design speed. The overall length from beginning to end of project is approximately 2,600 feet and 3,000 feet respectively, for the 60-foot and 100-foot vertical clearance fixed replacement bridge alternatives.

b. <u>Bridge Type</u>

The proposed fixed span replacement bridge alternative consist of three steel plate girder main spans that cross over the Waterway and are flanked on each side by prestressed concrete girder approach spans. Adjacent to each abutment are fills which are contained by concrete retaining walls. As an alternate for the main spans, a structure utilizing prestressed concrete girder drop-in spans with cast-in-place box girder sections over the river piers could be utilized. The structure would be post-tensioned together for continuity but would require falsework support from the waterway piers to construct the 90-foot-long box girder sections at the piers. Such a structure may not be as cost effective as steel plate for the main spans. Cost estimates and typical sections have been developed for the steel plate girder main spans with prestressed girder approach spans.

Overall length of the 60-foot clearance bridge structure is 1,580 feet with 260 feet of retained fills at each end. Overall length of the 100-foot clearance bridge structure is 2,524 feet with approximately 250 feet of retained fill. Roadway width will be 48 feet with 8-foot-wide sidewalks on each side resulting in a total bridge width of 66 feet. See Figures 3 and 4 for Typical Sections.

The fixed span bridge alternatives are skewed approximately 30 degrees to the waterway resulting in the need for a 240-foot-long main span in order to accommodate the 125-foot-wide navigation channel. In order to satisfy Department of Fisheries requirements, the spans on each side of the main span are 190 feet long so that only two piers are located within the Waterway. The two piers within the Waterway will require cofferdams and seals for construction resulting in the need to dispose of a significant volume of excavated sediments which are likely to be contaminated.

The main and approach span superstructure will have reinforced cast-in-place concrete deck slabs, sidewalks, and barriers. Piers and footings will also be reinforced cast-in-place concrete and be supported by piling. Retaining walls will be reinforced cast-in-place concrete supported on spread footings.

3. MOVABLE BRIDGE REPLACEMENT

A new movable bridge was investigated as an alternative to the existing Scherzer rolling lift bascule bridge. The proposed movable bridge is a hydraulically driven double leaf movable bridge similar to the new First Avenue South Bridge currently under design by WSDOT and Sverdrup. The movable replacement bridge was considered for study because it offered an alternative to both the rehabilitation of the existing bascule bridge and the construction of a fixed span replacement bridge.

a. Alignment and Geometrics

The alignment of the proposed movable bridge is located approximately parallel to and 95 feet west of the existing bascule bridge at the center of the channel. See Figure 5 for the Bridge Plan and Elevation. This location allows the existing bridge to remain open to traffic for the majority of the time during the construction of the movable bridge. This alignment also requires that a portion of the pier protection for the replacement movable bridge located within the footprint of the existing bridge not be completed until the existing bridge is demolished.

The north intersection of the proposed replacement movable bridge alignment with the existing 16th Avenue South alignment occurs approximately 300 feet south of the present East Marginal Way intersection. South of the bridge, the proposed alignment intersects the existing alignment just to the north of the present Cloverdale Street intersection. The intersections of the alignments utilize horizontal curves with a radius of 1,200 feet.

An alternate horizontal alignment which matches that of the existing bascule bridge was also considered. This alignment results in closure of the 14th/16th Avenue crossing throughout the duration of construction of the replacement movable bridge.

The profile of the proposed movable bridge is set at a maximum 5 percent grade. The maximum vertical clearance for the 125-foot-wide channel is 32 feet at mean high high water (MHHW) and equal to that of the existing bridge. The lengths of vertical curves are set to provide minimum stopping sight distance for a 35 mph design speed.

b. <u>Bridge Type</u>

The replacement movable double leaf fixed trunnion bascule bridge superstructure, which spans over the Waterway channel, consists of two main counterweighted steel trusses supporting a system of steel floor beams, stringers. and a partially concrete filled steel grid deck. Each leaf of the bascule superstructure is supported on a large reinforced concrete pier of sufficient size to accommodate the counterweight movement, the trunnion hydraulic cylinders, and the operators' tower. The piers are supported on composite concrete filled steel cased piling.

The movable double leaf bascule bridge is flanked on each side by a steel plate girder approach span, three prestressed concrete girder approach spans, and a concrete retaining wall fill. The overall length of the bridge structure is 1,310 feet. The length of the retained fills at each end of the bridge structure is 240 feet. The bridge superstructure is 66 feet wide, which includes a 48-foot-wide roadway with 8-foot-wide sidewalks and 1-foot-wide barriers on each side.

The movable double leaf bascule bridge is skewed approximately 30 degrees with respect to the centerline of the waterway channel. In order to accommodate the skewed 125-foot-wide navigation channel, fender protection for the piers, and the length required between the live load shoes and the trunnion; the overall span length of the double leaf bascule is 250 feet measured from center to center of the trunnions. The spans on each side of the movable span are set in order to satisfy Department of Fisheries requirements that only two piers are located within the Waterway. The construction of the bascule piers utilize cofferdams and seals which likely result in disposal of a significant volume of excavated contaminated sediments.

The superstructure for the approach spans consists of reinforced cast in place concrete deck slabs composite with both the steel plate and prestressed concrete girders. The sidewalk and barriers are also concrete. The approach span piers and footings are also reinforced cast in place concrete supported on prestressed concrete piling. The retaining walls are reinforced cast-in-place concrete supported on spread footings.

4. CLOSURE

Permanent closure and demolition of the existing bascule bridge is as an alternative to either rehabilitating or replacing the existing bridge. This alternative would require permanent re-routing traffic to either the 1st Avenue South Bridge or to Pacific Avenue South (South Boeing Access) significantly adding to the congestion at both crossings. See Traffic Impacts section of the Design Report for further discussion of traffic issues. Demolition of the existing bridge risks encountering and clean-up of potentially contaminated sediments during removal of the existing piers. The cost of demolition could be partially mitigated by selling of existing right of way.

E. RIGHT-OF-WAY CONSIDERATIONS

1. Rehabilitation of Existing Bridge

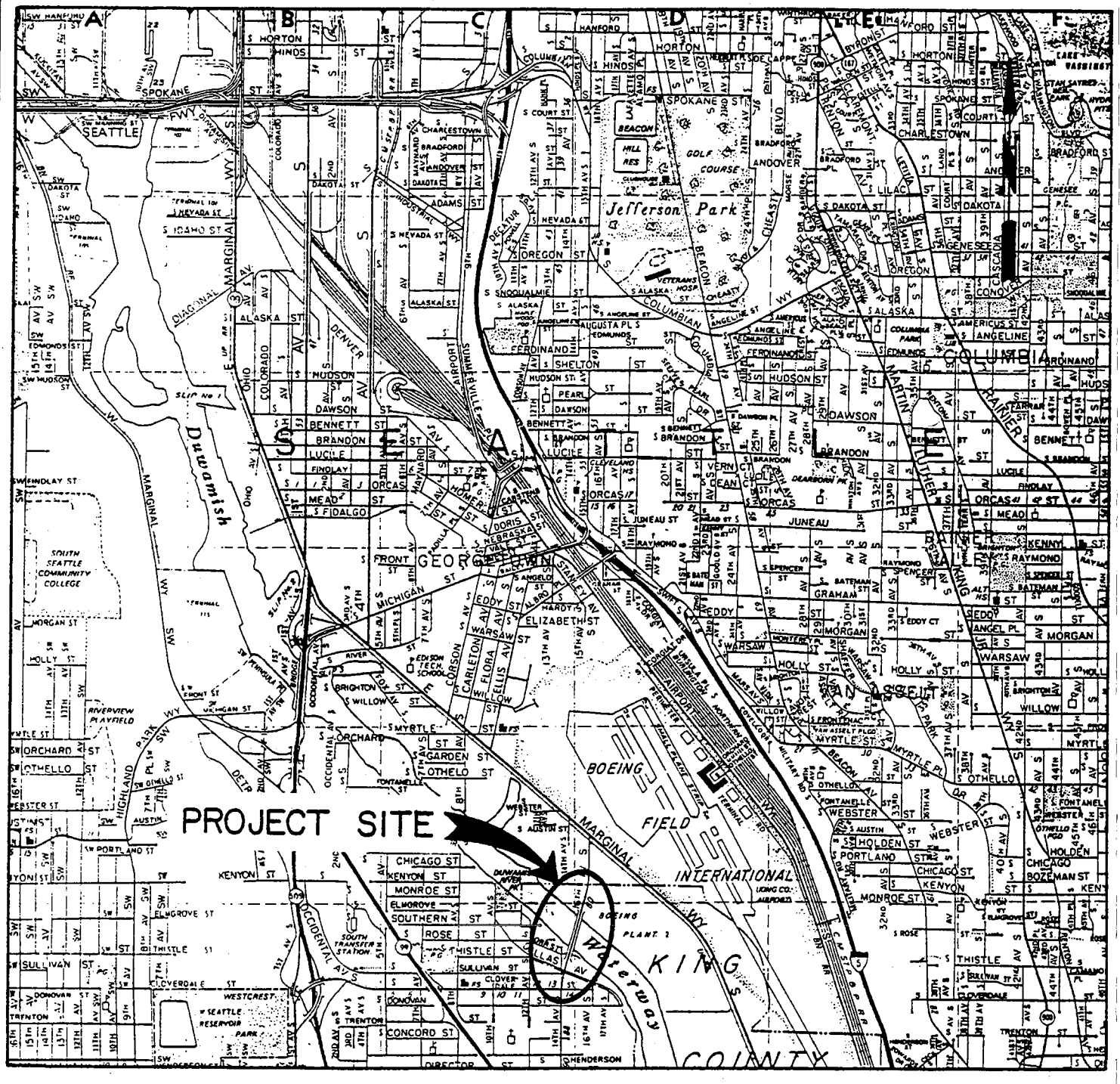
The rehabilitation of the existing bridge will not require acquisition of any additional right-of-way. Some construction easements may be necessary, however, to provide access to the bridge. No additional right-of-way acquisition costs were included in the Life Cycle Cost Analysis for the rehabilitation to the existing bridge.

2. Fixed Bridge Replacement

Both the fixed span replacement alternatives will require acquisition of property on both sides of the Duwamish Waterway. King County personnel have determined a cost for acquiring right-of-way for the 60-foot vertical clearance fixed replacement bridge alternative. The Right-of-Way Cost Estimate prepared by King County is included in Appendix D. Estimates of right-of-way cost for both 60-foot and 100-foot vertical clearance fixed span replacement bridge alternatives are also included in the Life Cycle Cost Analysis. The right-of-way fixed span cost for the 100-foot clearance alternative includes consideration for the relocation of the Cloverdale Street intersection.

3. Movable Bridge Replacement

The movable bridge replacement alternative also will require acquisition of property on both sides of the Duwamish Waterway. The movable bridge replacement alternative will require approximately 20 feet more width of right-of-way than the 60-foot clearance fixed span alternative. The right-of-way cost for the movable replacement bridge is included in the Life Cycle Cost Analysis.



VICINITY MAP

FIGURE 1

Figure

2-5

III. CONSTRUCTION IMPACTS

A. TRAFFIC DURING CONSTRUCTION

1. REHABILITATION OF EXISTING BRIDGE

Construction of the rehabilitation alternative will be divided into two phases. During the first phase, construction will be limited to the stabilization of the bascule piers and the mechanical and electrical repairs to improve the bridge operation. This work is anticipated to take approximately one year. During this phase, there will be periodic short term bridge closures that typically will occur over a weekend or late at night. In rare cases closures to vehicular and pedestrian traffic may last up to a week. During the second phase, construction will involve replacement of the concrete approach spans, the replacement of truss approach span concrete deck and the bascule span deck grating, seismic retrofit of the truss approach spans, and new center locks for the bascule span. The second phase construction is also anticipated to take approximately one year. This work will require closure of at least two lanes of the bridge to traffic throughout the duration of this phase of construction.

2. FIXED OR MOVABLE BRIDGE REPLACEMENT

Two alignment alternatives were considered for both the fixed and movable bridge replacement alternatives. They include 1) utilizing the existing bridge horizontal alignment and 2) providing a new alignment located just west of the existing bridge. In the case where the horizontal alignment of the replacement bridges matches that of the existing bridge, the bridge will be closed a minimum of two years throughout the duration of construction. Total closure of the bridge for this length of time is not considered feasible. In the case where horizontal alignment of the replacement bridge is located to the west of the existing bridge alignment, only a single traffic closure will occur. This closure will be limited to weekends for final paving and striping where both the north and south ends of the new alignment matches into the existing alignment.

B. POTENTIAL DAMAGE TO EXISTING STRUCTURE

1. REHABILITATION OF EXISTING BRIDGE

The rehabilitation of the existing 14th/16th Avenue Bridge is not without risk. The "14th/16thAvenue South Bridge Foundation Design Report - North Pier", indicated that the vertical load capacity of the north pier foundation is only slightly greater than the applied loads. Furthermore, under current operations horizontal movements of 1-inch have been measured indicating the sensitivity of the pier to external forces. Movements of more than an inch

may adversely impact bridge operations. During construction of the rehabilitation, compaction grouting in the vicinity of the bascule piers and/or driving piles for the approach piers may cause movements that may either damage the bridge or adversely affect its operations requiring corrective actions. Also, replacing the bascule span roadway grating, sidewalks, and barriers may require significant adjustment of the counterweight balance. Adjustment of the balance also introduces possible risk to damaging the bridge.

In addition to potential risk of damage during rehabilitation, there is not sufficient horizontal clearance available within the channel to provide fender protection that meets current design practice. As a result, the rehabilitated 14th/16th Avenue Bascule Bridge will be more vulnerable to damage due to waterway traffic collisions than the replacement bridge alternatives.

2. FIXED OR MOVABLE BRIDGE REPLACEMENT

Some degree of risk of damage to the existing bridge does occur as a result of the close proximity between the fixed or movable replacement bridge alignment and the existing bascule bridge. This risk is important if the existing bridge is to remain operational during the construction of the replacement bridge. The primary risk will result from pile driving. Pile driving has the potential to cause settlement, heaving and vibration which may adversely affect operation of the existing bridge. Since the movable replacement bridge will require the greatest number and largest size of piling, construction of this alternative presents a greater risk of damage to the existing bridge than construction of the fixed replacement bridge alternatives.

A risk also occurs during handling and erection of the replacement bridge superstructure in that the existing bridge may be struck. Although this risk is low, the movable replacement bridge alternative has the most potential for causing damage since its superstructure will likely be erected in the upright position.

Finally, the portions of fender systems located between existing piers and replacement piers will not be completed until demolition of the existing bridge. Therefore, during the time period between removal of the existing bascule piers and the installation of the remaining portion of the new pier fender system, the eastern portions of new piers will be subject to potential damage. This may be mitigated by installing temporary fendering.

C. DURATION OF CONSTRUCTION

1. REHABILITATION OF EXISTING BRIDGE

A proposed Project Schedule to complete the repairs and rehabilitation of the bridge is included in Figure 6. This schedule is based on many assumptions with the first being that a definitive decision will be made during 1994 regarding whether to repair and rehabilitate or to replace. The next assumption is that a commitment to funding can be secured within the following one to two years.

Finally, the assumption is made that the design and construction of the repairs and rehabilitation will be divided into two packages. One package will involve work that doesn't require closure of the bridge to roadway and vehicular traffic except for possibly short time periods (over a weekend, late at night, or only a few days to a week). This work includes stabilization of the bascule piers and the mechanical and electrical repairs and replacements that will improve the operation of the bridge. The second package will involve work that will require closure of the bridge to vehicular and pedestrian traffic for at least half the bridge (two lanes) during construction. This work includes replacement of the concrete approach spans, replacement of the truss approach span concrete deck and bascule span deck grating, seismic retrofit of truss approach spans, and new center locks for the bascule span.

The possibility exists that the two packages could be combined into one large package or broken into smaller packages depending on funding. However, completing the overall project as several small projects would likely increase the time to complete the project and increase the overall cost of the project.

2. FIXED BRIDGE REPLACEMENT

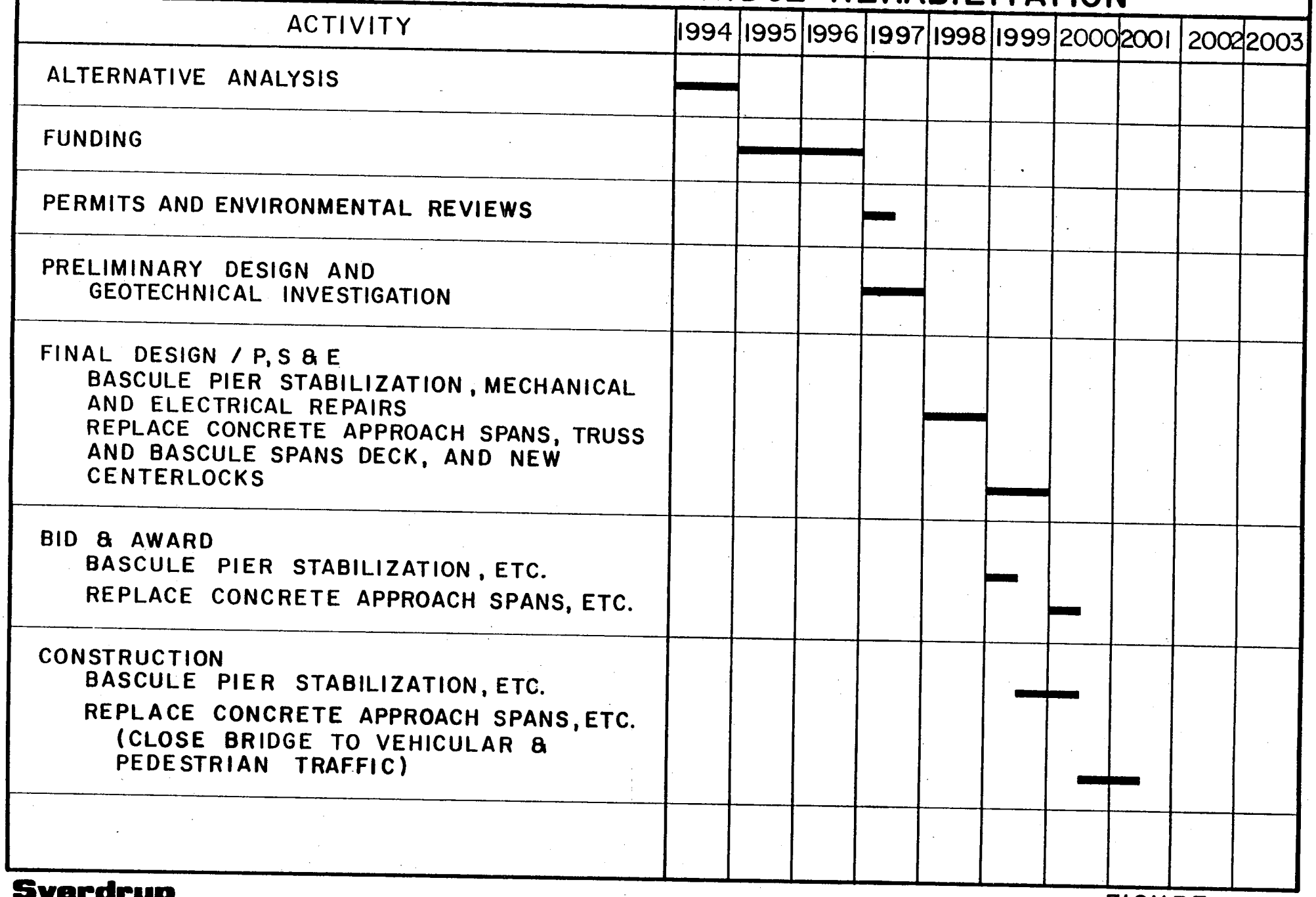
Proposed Project Schedules for the 60-foot clearance and the 100-foot clearance fixed bridge alternatives are included in Figures 7 and 8, respectively. The schedules are based on many assumptions with the first being that a definitive decision will be made during 1994 regarding whether to repair and rehabilitate or to replace. The next assumption is that a commitment to funding can be secured within the following one to two years.

Finally, the assumption is made that the U.S. Coast Guard will make a decision on the fixed span navigation channel minimum vertical clearance in a timely manner so as to not delay permitting and environmental reviews, and that measures to mitigate the historical significance of the existing bridge can also be developed in a timely manner.

3. MOVABLE BRIDGE REPLACEMENT

The proposed Project Schedule to replace the existing bridge with the movable bridge alternative is included in Figure 9. This Schedule is based on the assumption that the funding commitment can be secured within 2 years and that the decision to rehabilitate or to replace will be made in 1994.

PROJECT SCHEDULE
14th/16th AVENUE SOUTH BRIDGE REHABILITATION



Sverdrup

FIGURE 6

PROJECT SCHEDULE
14th/16th AVENUE SOUTH BRIDGE REPLACEMENT

FIXED BRIDGE 60FT CLEARANCE

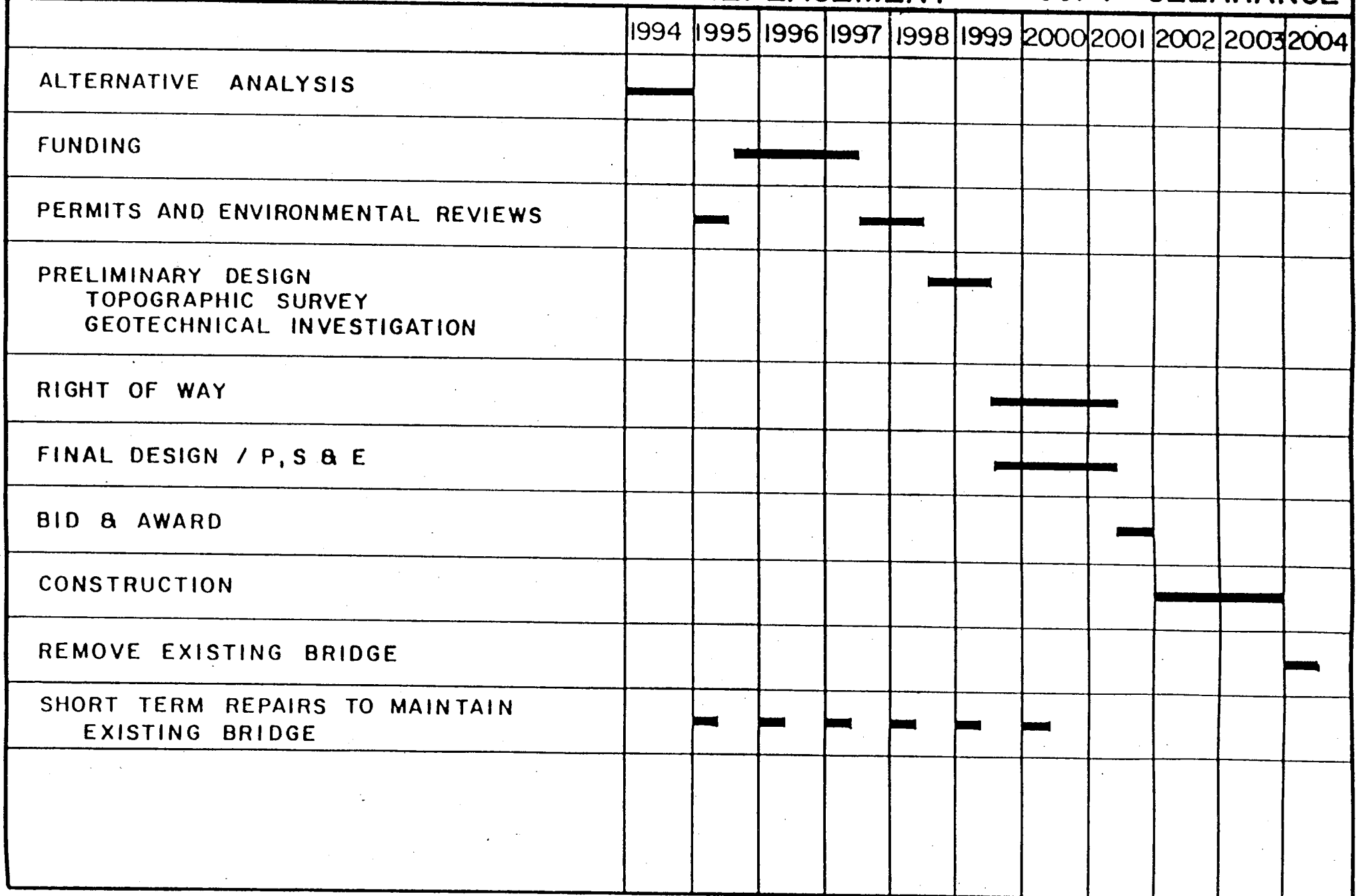


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FIGURE 7

PROJECT SCHEDULE
14th/16th AVENUE SOUTH BRIDGE REPLACEMENT
FIXED BRIDGE 100 FT CLEARANCE

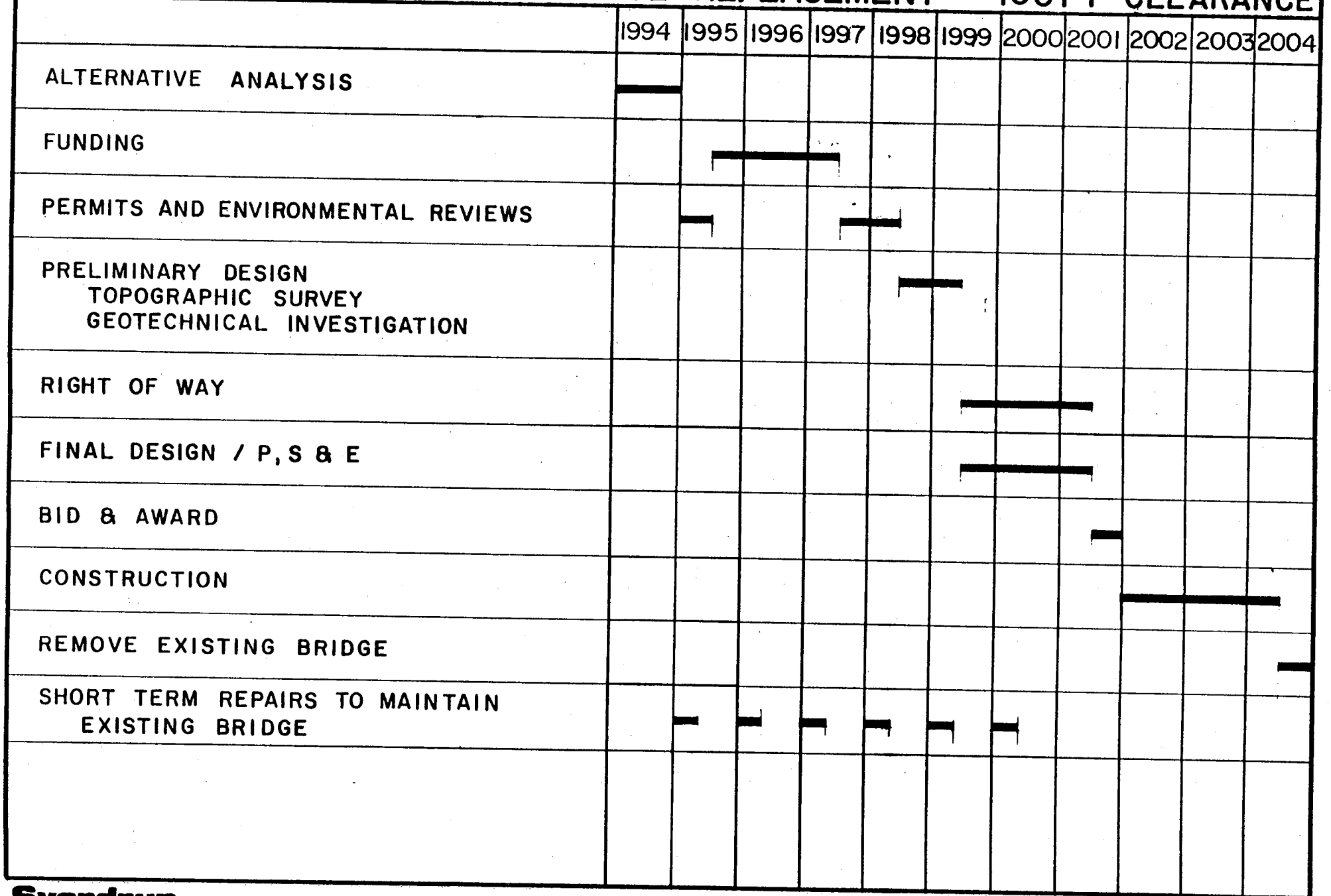

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FIGURE 8

PROJECT SCHEDULE
14th/16th AVENUE SOUTH BRIDGE REPLACEMENT

MOVABLE BRIDGE

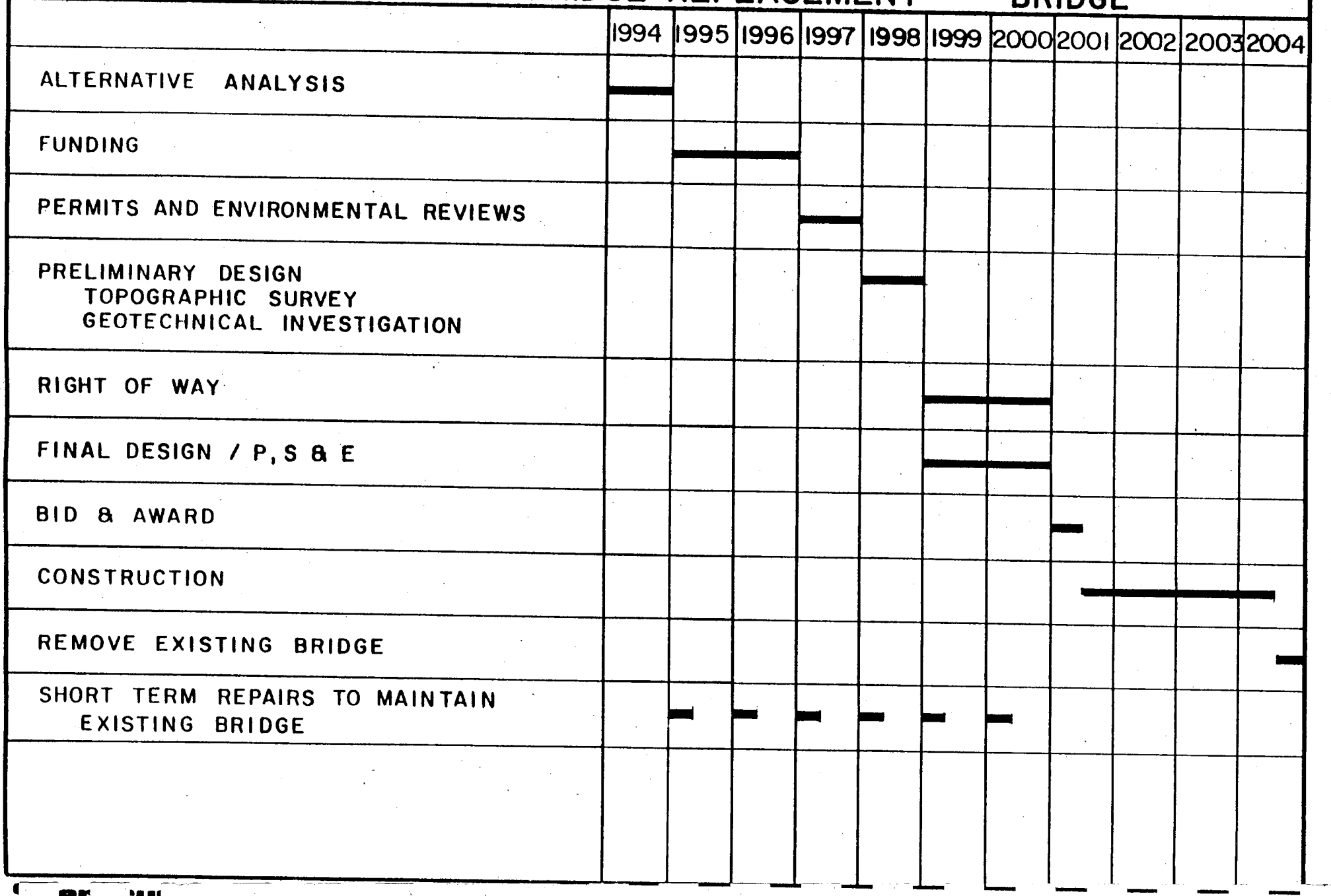


FIGURE 6

IV. TRAFFIC IMPACTS

A. INTRODUCTION

An analysis of the traffic conditions in the vicinity of the 14th/16th Avenue South Bridge was performed to compare alternative design configurations. The design alternatives investigated include:

Four Lane Alternatives

Existing conditions

Replacement with a new movable structure

Replacement with a new fixed structure

Three Lane Alternatives

Two lanes northbound with one lane southbound for existing bridge

Two lanes southbound with one lane northbound for existing bridge

The alternatives were compared for traffic impacts based upon location of existing and projected congestion and/or bottlenecks. Signalized intersections are often the point of congestion on urban arterials. Therefore, impacts of the various design alternatives to traffic capacity at identified signalized intersections allow a comparison of alternatives for projected traffic flow. Due to the various possible configurations of the 14th/16th Avenue South Bridge, the through capacity across the structure is calculated for each alternative.

The 1st Avenue South corridor is currently proposed for major modification including the addition of a parallel movable bridge and HOV lanes in each direction. The improvements on 1st Avenue South were considered complete for this analysis in the year 2010. The improved 1st Avenue South Bridge was analyzed for through capacity, considering the lanes on the dual structures to be configured with three through lanes and one HOV lane in each direction for the various scenarios at the 14th/16th Avenue South Bridge.

Capacity at the Pacific Highway structures over the Duwamish Waterway is limited by the capacity of the intersection of East Marginal Way / South Boeing Access Road. Analysis of this critical intersection provides a comparison of the various scenarios at the 14th/16th Avenue South Bridge.

Traffic projections have been prepared by King County for the year 2010 for the various bridge alternatives. EMME/2 runs prepared for the various alternative scenarios and turning movements provided at key intersections are included in Appendix A.

B. FOUR LANE ALTERNATIVES

Existing Bridge

Existing 14th/16th Avenue South consists of two through lanes in each direction on a movable bridge structure. This section summarizes the traffic capacities and impacts for the existing four lane structure, or replacement with a similar fixed or movable structure. The current bridge lanes are substandard in width (9.5 ft). Replacement of the bridge would include wider lanes and provide better safety for the bridge, but would not appreciably alter the traffic and capacities of the nearby signalized intersections. The current configuration of the lanes at the signalized intersections in the vicinity of the bridge are reflected in Figure 10. 1990 Average Daily Traffic (ADT) are shown in Figure 11, and projected 2010 ADT volumes are reflected in Figure 12.

Intersection Capacities

Delay, level of service (LOS) and volume to capacity ratio (V/C) for the year 2010 traffic volumes for the current bridge lane configurations at identified signalized intersections are indicated as follows:

Intersection/Approach	AM Delay (LOS)/v/c	PM Delay (LOS)/v/c
E. Marginal Way/16th Ave. S.	**25.6(D)/.987**	**33.3 (D)/1.014**
	24.4 (C)	36.4 (D)
Westbound	17.3 (C)	25.5 (D)
Northbound	30.0 (D)	43.7 (E)
S. Cloverdale Street/14th Ave S.	**(*)/1.456**	**(*)/1.688**
Eastbound	(*)	(*)
Westbound	12.4 (B)	26.7 (D)
Northbound	118.3 (F)	(*)
Southbound	8.8 (B)	(*)
E. Marginal Way/S. Boeing Access	**40.5 (E)/1.357**	**65.5 (F)/1.233**
Eastbound	51.0 (E)	92.6 (F)
Westbound	35.5 (D)	74.9 (F)
Northbound	28.9 (D)	99.6 (F)
Southbound	28.0 (D)	45.1 (E)

*v/c for individual approach > 1.2 (delay and LOS not meaningful)

The delay and LOS calculated above are based upon the existing channelization and signal configuration with each signal operation optimized, with the exception of the Cloverdale Street/14th Avenue South intersection where the Southbound left has been prohibited in the peak hours. Due to the spacing between signals, no coordinated signal operation between signalized intersections was utilized.

Existing Bridge Capacity

The existing bridge consists of four 9.5-foot-wide lanes, without additional shy distance to the bridge rail. The following is the calculation for through capacity of the two through lanes in each direction based upon the 1985 HCM methods for multi-lane highways:

SF_i = $MSF \times N \times f_w \times f_{HV} \times f_p$ (Eq. 7-1, HCM)

SF_i = service flow rate

MSF = maximum service flow rate (for LOS E, v/c = 1.0, 50 MPH), 1900 pcphpl

N = number of lanes, 2 lanes

f_w = factor for lane width and lateral clearance, 0.75 (9 ft lane assumed)

f_{HV} = factor for heavy vehicles (12% trucks, 5% Grade, E_T = 6), 0.63

f_p = factor for driver population, 1.00

SF_i = 1900 x 2 x 0.75 x 0.63 x 1.0

SF_i = 1796 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

Traffic projections for the year 2010 result in the following vehicles per hour (vph), levels of service (LOS), and volume to capacity ratio (v/c) for the through volume across the structure:

		vph	LOS	v/c			vph	LOS	v/c
AM	NB	1490	E*	.83	PM	NB	1110	D	.62
	SB	910	C	.51		SB	2950	F*	1.64

* congested conditions, results are highly variable

For a replacement bridge with four 12 foot lanes, the nearby signalized intersection capacities would remain as indicated above, but the through capacity of the bridge would increase as indicated below:

Movable Bridge Capacity

f_w = 1.00

SF_i = 2395 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

		vph	LOS	v/c			vph	LOS	v/c
AM	NB	1490	D	.62	PM	NB	1110	C	.46
	SB	910	B	.38		SB	2950	F*	1.23

* congested conditions, results are highly variable

Fixed Bridge Capacity

f_w = 1.0

f_{HV} = 0.58, (12% trucks, 8% Grade, E_T= 7)

SF_i = 2204 pcph

		vph	LOS	v/c			vph	LOS	v/c
AM	NB	1490	D	.68	PM	NB	1110	C	.50
	SB	910	B	.41		SB	2950	F*	1.34

* congested conditions, results are highly variable

The projected southbound PM peak hour volume exceeds the through capacity of the structure for the existing bridge and replacement with either a movable or a fixed structure. The existing capacity is constrained by narrow width across the structure and capabilities of the replacement structures are an improvement but still cannot handle the high projected southbound PM volume. Steep vertical grades necessary to achieve vertical clearance over the waterway restrict the capacity of all alternatives and are worse for the fixed bridge alternative due to the 8 percent grades. Opening and closing of the structure during peak hours for the existing or replacement movable bridge would reduce the traffic carrying capacity of the structure.

1st Avenue South Bridge Capacity

SF_i = $MSF \times N \times f_w \times f_{HV} \times f_p$ (Eq. 7-1, HCM)

SF_i = service flow rate
MSF = maximum service flow rate (for LOS E, v/c = 1.0), 1900 pcphpl
N = number of lanes, 3 lanes
f_w = factor for lane width and lateral clearance, 0.92
f_{HV} = factor for heavy vehicles (10% trucks, 5% Grade, E_T =5)
f_p = factor for driver population, 1.00

SF_i = 1900 x 3 x 1.0 x 0.71 x 0.92

SF_i = 3723 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

Traffic projections for the year 2010 result in the following vehicles per hour (vph), levels of service (LOS), and volume to capacity ratio (v/c) for the through volume across the structure for the general purpose lanes (the HOV lanes will operate at an acceptable LOS):

		vph	LOS	v/c
PM	NB	3010	E	.81
	SB	4710	F*	1.27

* congested conditions, results are highly variable

C. CONVERSION TO THREE LANES

This section evaluates the conversion of the existing bridge, currently configured to carry four narrow lanes, to three lanes. Two scenarios were examined: 2 lanes northbound with 1 lane southbound, and 2 lanes southbound with 1 lane northbound. For both scenarios, the 3 lane section will only apply to the structure and approaches. Lane configurations at the signalized intersections north and south of the bridge will remain as in the existing condition. Lanes are assumed to be 12 feet wide without additional lateral clearance for each scenario. Due to the constraint imposed by the loss of a lane, the traffic projections will differ from the existing condition as traffic must find alternative routes where capacity has been reduced.

2 NORTHBOUND LANES - 1 SOUTHBOUND LANE

Intersection Capacities

Traffic delay and level of service (LOS) and volume/capacity (V/C) for the year 2010 traffic volumes for the 2 lanes northbound and 1 lane southbound configuration at identified signalized intersections are as follows:

Intersection/Approach	AM Delay (LOS)/v/c	PM Delay (LOS)/v/c
E. Marginal Way/16th Ave. S.	**19.9 (C)/.906**	**30.0 (D)/1.020**
Eastbound	23.2 (C)	29.0 (D)
Westbound	10.3 (B)	25.8 (D)
Northbound	19.7 (C)	39.7 (D)
S. Cloverdale Street/14th Ave. S.	**65.5 (F)**	**(*)/1.828**
Eastbound	130 (F)	(*)
Westbound	8.6 (B)	28.2 (D)
Northbound	55.1 (E)	(*)
Southbound	10.0 (B)	36.8 (D)
E. Marginal Way/S. Boeing Access	**30.5 (D)/1.241**	**68.1(F)/1.197**
Eastbound	30.4 (D)	124.6 (F)
Westbound	32.4 (D)	61.1 (F)
Northbound	26.7 (D)	93.7 (F)
Southbound	27.7 (D)	44.5 (E)

Bridge Capacity

The rechannelization of the bridge to **2 lanes northbound and 1 lane southbound** would change the through capacities of the bridge as calculated below:

$SF_i\ (NB)$ = $MSF \times N \times f_w \times f_{HV} \times f_p$ (Eq. 7-1, HCM)

SF_i = service flow rate

MSF = maximum service flow rate(for LOS E, v/c = 1.0), 1900 pcphpl

N = number of lanes, 2 lanes northbound, 1 lane southbound

f_w = factor for lane width and lateral clearance, 0.88 (12 ft. lanes)

f_{HV} = factor for heavy x (12% trucks, 5% Grade, $E_T = 6$), 0.63

f_p = factor for driver population, 1.00

SF_i (NB) = 1900 x 2 x 0.88 x 0.63 x 1.0

SF_i (NB) = 2106 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

SF_i (SB) = 2800 x $(v/c)e$ x f_d x f_w x f_g x f_{HV} (Eq. 8-3, HCM)

SF_i = service flow rate
$(v/c)_e$ = volume to capacity ratio for LOS E, 0.78
f_d = factor for directional distribution, 0.5
f_w = factor for narrow lane width and lateral clearance, 0.93
f_g = factor for effect of grades on cars, 0.98
f_{HV} = factor for heavy vehicles, 0.88

SF_i (SB) = 2800 x 0.78 x 0.5 x 0.93 x 0.98 x 0.88

SF_i (SB) = 876 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

		vph	LOS	v/c			vph	LOS	v/c
AM	NB	1465	D	.70	PM	NB	1070	C	.51
	SB	475	E	0.54		SB	2375	F*	2.71

1st Avenue South Bridge Capacity

SF_i = 3723 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

Traffic projections for the year 2010 result in the following vehicles per hour (vph), levels of service (LOS), and volume to capacity ratio (v/c) for the through volume across the structure for the general purpose lanes (the HOV lanes will operate at an acceptable LOS):

		vph	LOS	v/c
PM	NB	3060	E	.82
	SB	4780	F*	1.28

* congested conditions, results are highly variable

The 2 lanes northbound, and 1 lane southbound configuration on 14th/16th Avenue South improves northbound traffic conditions but causes additional congestion southbound. There is little impact to traffic on adjacent corridors.

2 LANES SOUTHBOUND - 1 LANE NORTHBOUND

Intersection Capacities

Traffic delay and level of service (LOS) and volume/capacity (V/C) for the year 2010 traffic volumes for the 2 lanes southbound and 1 lane northbound configuration at identified signalized intersections are as follows:

Intersection/Approach	AM Delay (LOS)/v/c	PM Delay (LOS)/v/c
E. Marginal Way/16th Ave. S	**18.5 (C)/.810**	**30.2 (D)/1.008**
Eastbound	21.5 (C)	38.8 (D)
Westbound	13.7 (B)	22.8 (C)
Northbound	17.0 (C)	31.5 (D)
S. Cloverdale Street/14th Ave. S.	**84.5 (F)/1.186**	**(*)/1.654**
Eastbound	133.3 (F)	(*)
Westbound	7.4 (B)	26.6 (D)
Northbound	110.2 (F)	(*)
Southbound	15.0 (B)	(*)
E. Marginal Way/S. Boeing Access	**36.2 (D)/1.317**	**59.8 (E)/1.426**
Eastbound	43.5 (E)	74.8 (F)
Westbound	29.3 (D)	61.5 (F)
Northbound	36.1 (D)	91.7 (F)
Southbound	29.4 (D)	45.8 (E)

Bridge Capacity

The rechannelization of the bridge to 2 lanes southbound and 1 lane northbound change the through capacities of the bridge as calculated below:

SF_i (NB) = 876 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

SF_i (SB) = 2106 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

		vph	LOS	v/c			vph	LOS	v/c
AM	NB	1390	F*	1.59	PM	NB	1000	F*	1.14
	SB	885	B	.42		SB	2915	F*	1.38

1st Avenue South Bridge Capacity

SF_i = 3723 pcph (opening and closing of the bridge during peak hour would reduce the capacity)

Traffic projections for the year 2010 result in the following vehicles per hour (vph), levels of service (LOS), and volume to capacity ratio (v/c) for the through volume across the structure for the general purpose lanes (the HOV lanes will operate at an acceptable LOS):

		vph	LOS	v/c
PM	NB	3075	E	0.83
	SB	4700	F*	1.26

* congested conditions, results are highly variable

The 2 lanes southbound, and 1 lane northbound configuration does not appreciably degrade the traffic conditions at any of the signalized intersections or roadway segments analyzed. The redistributed traffic is able to utilize some excess capacity in the adjacent facilities but the already congested northbound AM peak hour traffic across 14th/16th Avenue South Bridge will be worse. Forecast AM peak hour volumes were not available for the 1st Avenue South Bridge. The northbound volume could increase, and the LOS decrease due to the loss of a northbound lane on 14th/16th Avenue South.

D. BRIDGE CLOSURE

The following analysis addresses the impacts due to the closure of the 14th/16th Avenue South Bridge and the resulting redistribution of traffic to alternate facilities. Figure 13 indicates the direction and distribution of the traffic from the 14th/16th Avenue South Bridge.

The major alternates available to traffic projected to utilize the 14th/16th Avenue South Bridge are 1st Avenue South Bridge and Pacific Highway South. Both facilities provide crossings of the Duwamish waterway and access to SR 99 and I 5. The critical bottleneck location for traffic attempting to divert to Pacific Highway South is the East Marginal Way/South Boeing Access Road intersection. The 1st Avenue South corridor is proposed for reconstruction and will be improved by the addition of a parallel movable bridge and improvements to the intersections and ramps leading to the structures over the Duwamish Waterway. The through capacity at the new structures were analyzed to compare the traffic impacts.

Intersection/Approach	AM Delay (LOS)/v/c	PM Delay (LOS)/v/c
E. Marginal Way/S. Boeing Access	**58.1 (E)/1.444**	**(*)/1.230**
Eastbound	70.9 (F)	72.8 (F)
Westbound	40.9 (E)	55.8 (E)
Northbound	118.1 (F)	(*)
Southbound	37.0 (D)	47.1 (E)

*congested conditions, results are highly variable

1st Avenue South Bridge Capacity

SF_i = 4047 pcph (opening and closing of the bridge during peak hour would reduce the capacity) f_w = 1.0 (12 ft. lanes)

Traffic projections for the year 2010 result in the following vehicles per hour (vph), levels of service (LOS), and volume to capacity ratio (v/c) for the through volume across the structure for the general purpose lanes (the HOV lanes will operate at an acceptable LOS):

		vph	LOS	v/c
PM	NB	3220	E	0.80
	SB	5010	F*	1.24

* congested conditions, results are highly variable

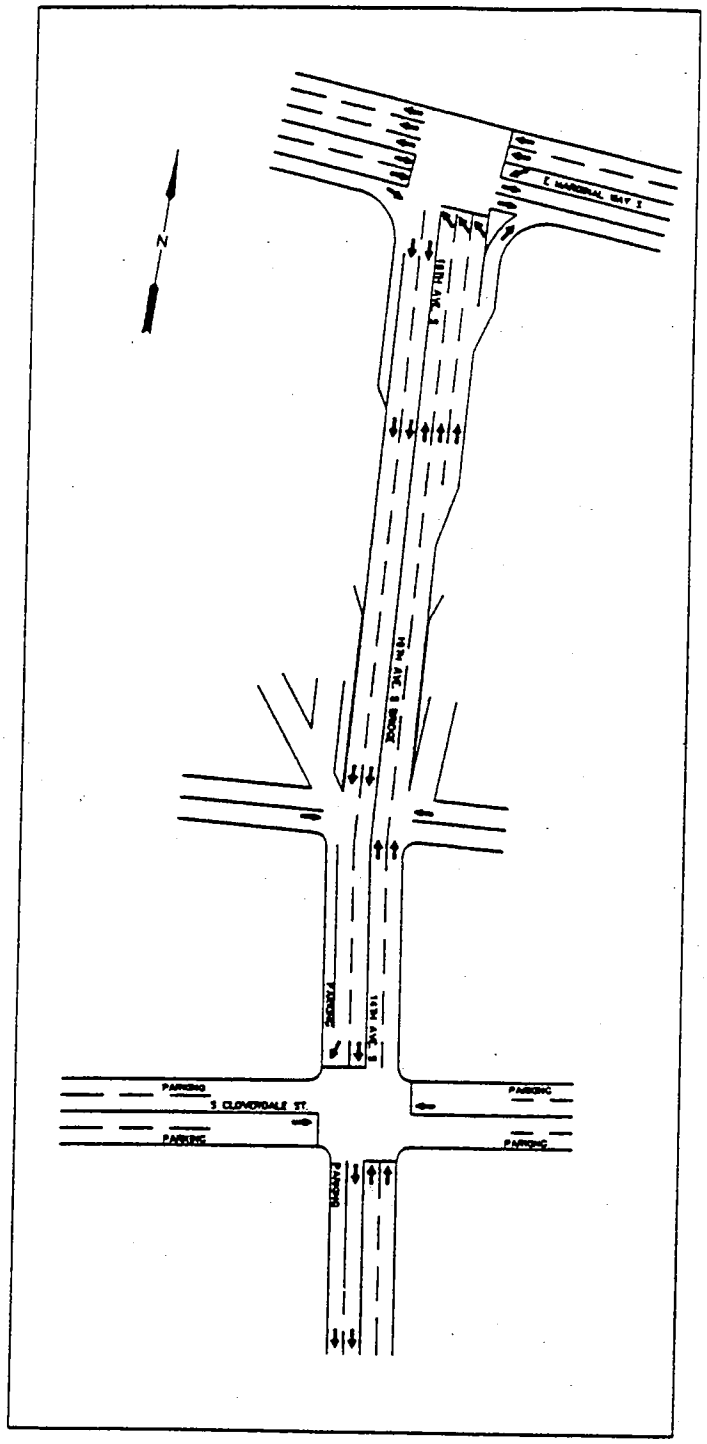
The traffic redistribution due to the closure of the 14th/16th Avenue South Bridge causes increased congestion to the already congested alternate routes to the bridge. The increased congestion due to the traffic makes closure of the structure not practicable, without major improvements to the alternate routes.

E. SUMMARY

A summary of the result analyses comparing traffic conditions for the alternatives is included in Table I.

The bridge closure alternative does not appear feasible due to the inability of the adjacent facilities to absorb the additional traffic. The existing four lane bridge does not have the available capacity due to the narrow lanes and the high volume of truck traffic in the corridor. The 2 lanes northbound, and 1 lane southbound seems to be the better alternative for the three lane conversion of the existing structure. The replacement of the existing structure with a fixed or movable structure have similar traffic carrying capabilities as the existing structure.

The replacement structure alternatives are preferred for their traffic capacities provided funding is available. The 2 lane northbound, 1 lane southbound configuration is recommended for any rehabilitation of the existing structure.



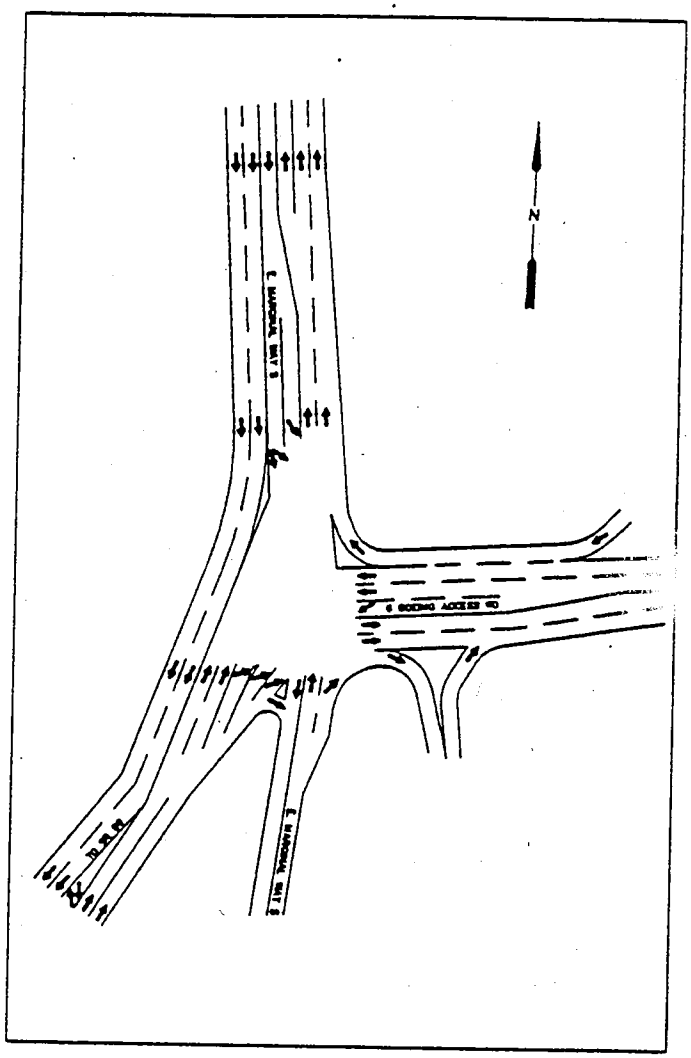
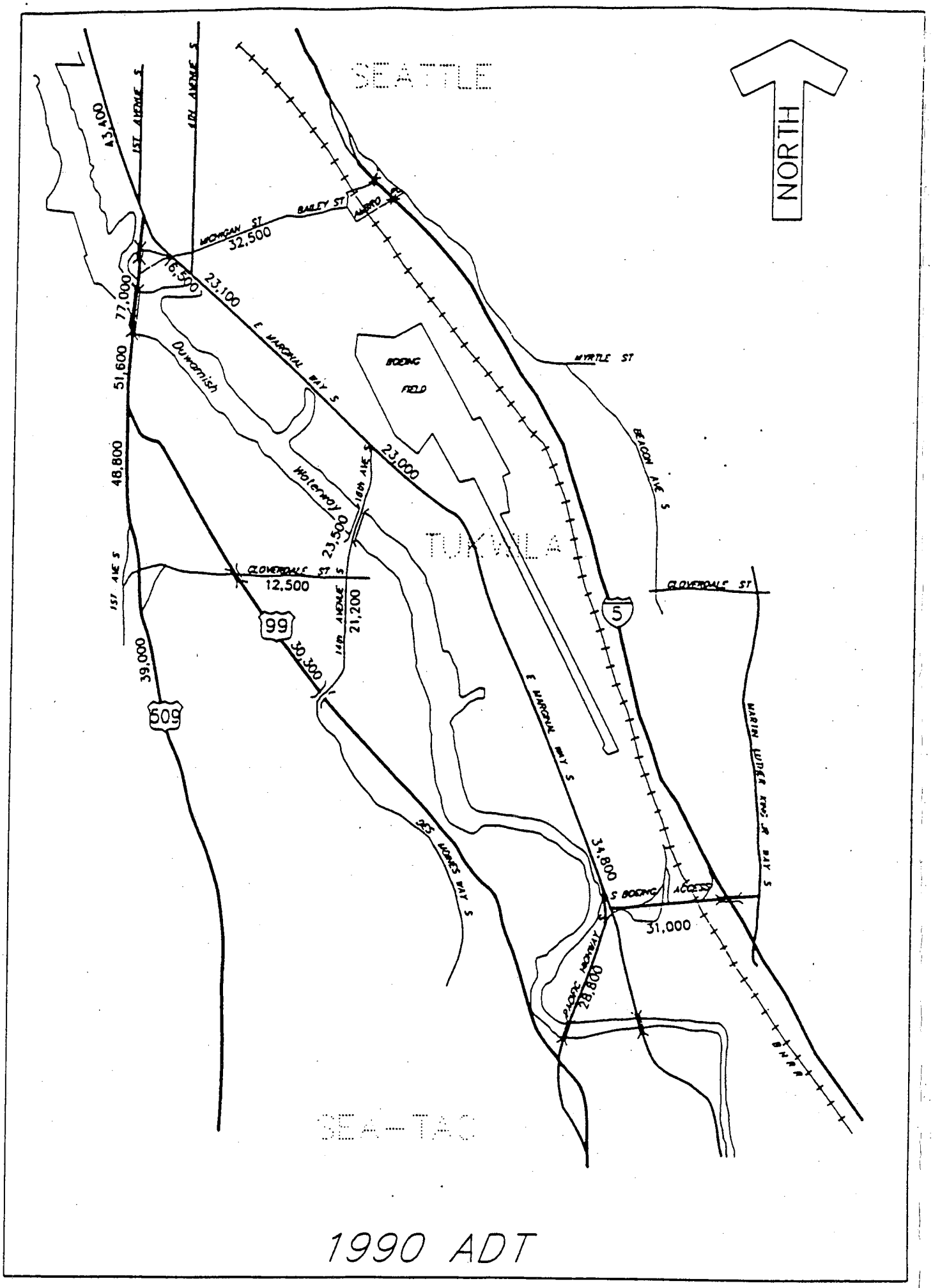


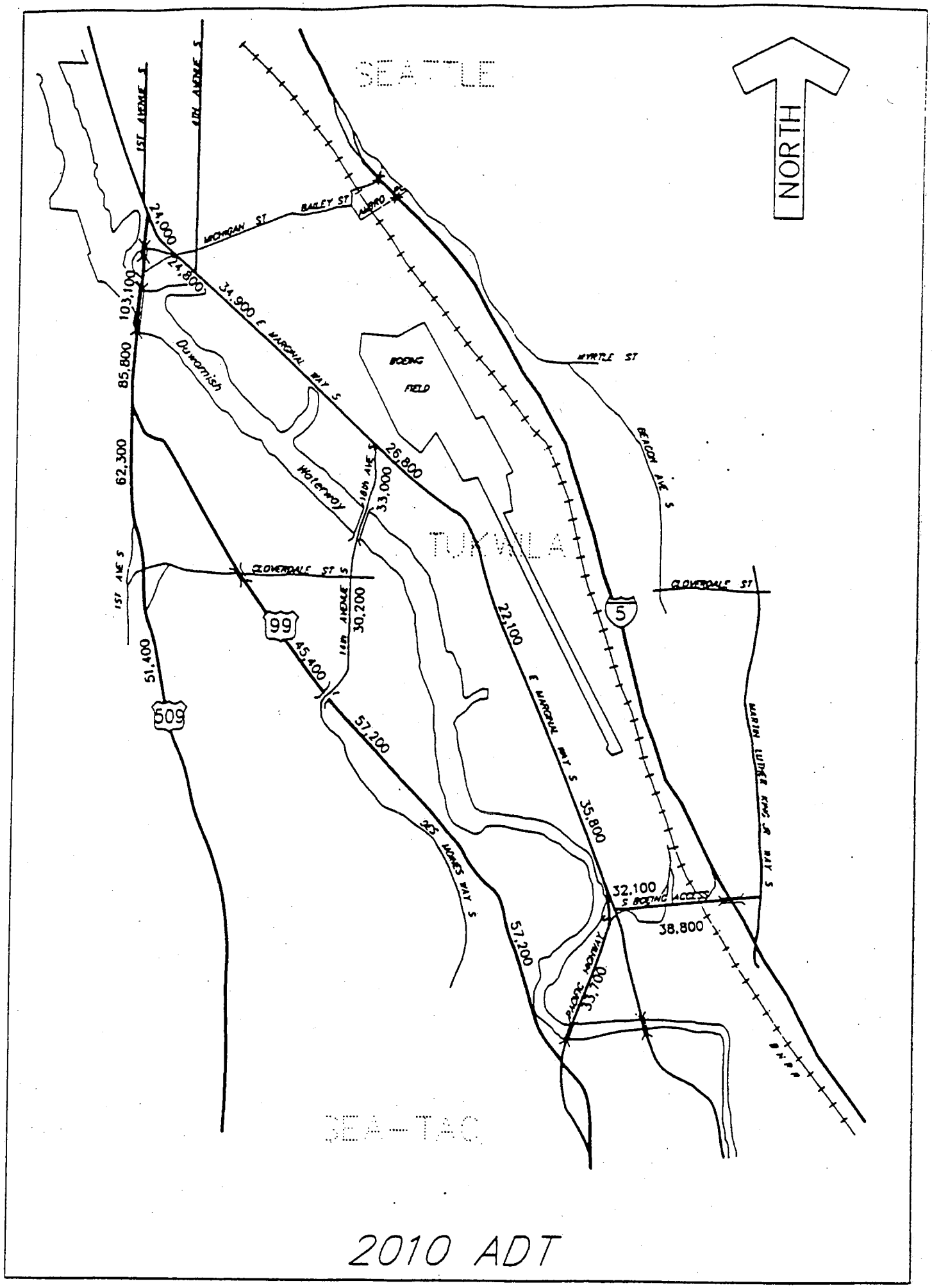
FIGURE 10 EXISTING CHANNELIZATION PLANS

Sverdrup CORPORATION



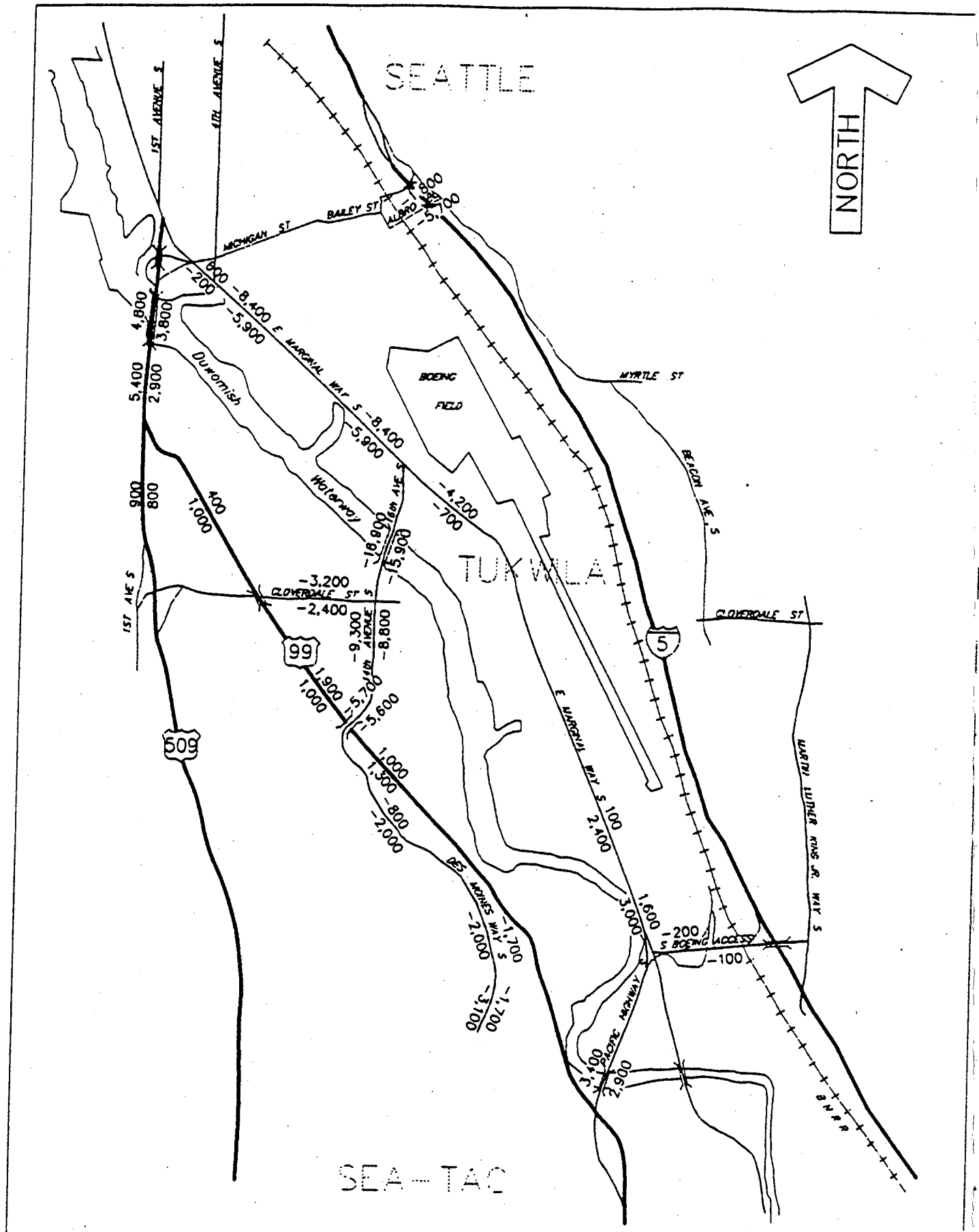
1990 ADT

Figure 11



2010 ADT

Figure 12



Bridge Closure
Traffic Redistribution (ADT)

Figure 13

TABLE 1

14th/16th Avenue South Alternatives
Summary of Traffic Impacts

INTERSECTIONS	Peak Period	Four Lane Bridge			Three Lane Bridge		Bridge Closure
		Existing	Movable	Fixed	2 NB / 2 SB	2 SB / 1 NB	
		Delay (los)/v/c					
E. Marginal Way/ 16th Ave. S	AM PM	25.6 (D)/.987 33.3 (D)/1.014	25.6 (D)/.987 33.3 (D)/1.014	25.6 (D)/.987 33.3 (D)/1.014	19.9 (C)/.906 30.0 (D)/1.020	18.5 (C)/.810 30.2 (D)/1.008	
S. Cloverdale St./ 14th Ave. S	AM PM	(*) /1.456 (*) /1.688	(*) /1.456 (*) /1.688	(*) /1.456 (*) /1.688	65.5 (F)/1.13 (*)/1.828	84.5 (F)/1.186 (*)/1.654	
E. Marginal Way/ S. Boeing	AM PM	40.5 (E)/1.357 65.5 (F)/1.233	40.5 (E)/1.357 65.5 (F)/1.233	40.5 (E)/1.357 65.5 (F)/1.233	30.5 (D)/1.241 68.1(F)/1.197	36.2 (D)/1.137 59.8 (E)/1.426	58.1 (E)/1.444 (*)/1.230
ROADWAY SEGMENTS	LOS/v/c						
14th/ 16th Ave. S. Bridge NB	AM PM	E/.83 D/.62	D/.62 C/.46	D/.68 C/.50	D/.70 C/.51	F*/1.59 F*/1.14	
14th/ 16th Ave. S. Bridge SB	AM PM	C/.51 F*/1.64	B/.38 F*/1.23	B/.41 F*/1.34	E/.54 F*/2.71	B/.42 F*/1.38	
1st Ave. S. Bridge NB 1st Ave. S. Bridge SB	AM PM	E/.81 F*/1.27	E/.81 F*1.27	E/.81 F*/1.27	E/.82 F*/1.28	E/.83 F*1.26	E/.80 F*/1.24

* Results not meaningful

V. ENVIRONMENTAL AND RELATED CONSIDERATIONS

A. PERMIT PROCESSES AND ENVIRONMENTAL REVIEWS

One of the major factors affecting the permit process and environmental reviews is the fact that the bridge is split in half between two governmental jurisdictions. Both the City of Tukwila and King County have jurisdiction over the bridge with the northern half within the City of Tukwila's jurisdiction and the southern half within the jurisdiction of King County.

One of the two agencies will have to be designated the lead agency for permits and environmental reviews. The City of Tukwila would not be adverse to being the lead agency for permitting and environmental reviews.

Since the bridge is located within 200 feet of a shoreline, a Shoreline Substantial Development Permit is required. Either rehabilitation of the existing or replacement for an existing bridge should result in the Shoreline Substantial Development Permit being largely administrative in nature. However, the historical significance of the existing bridge and measures to mitigate its loss will need to be well documented.

An expanded SEPA Environmental Checklist will also be required. This checklist will need to include evaluations of impacts for excavation of possible contaminated soils from the Waterway associated with the new pier foundations; from demolition and disposal of the existing bridge; from any closure of the bridge to vehicular and pedestrian traffic during construction; and from construction activities such as noise and air pollution. Soil borings will be required to determine the extent of river bottom contamination. In addition, timing of the closure of the bridge will have to be coordinated with other proposed major bridge and roadway projects at the 1st Avenue South Bridge and on Pacific Highway South.

The U.S. Coast Guard (U.S.C.G.) must also grant a permit for the replacement bridge. The vertical clearance of the bridge above the main navigation channel will be the U.S.C.G.'s primary concern although they are the lead federal agency for coordination of all federal environmental reviews and historical significance considerations. The U.S.C.G. will require further investigation of the proposed clearance including public hearings and an economic study of the impact that a fixed span bridge with a limited clearance will have on current and possible future users of the Waterway. This study is currently being completed by others.

In addition, a Hydraulic Project Approval (HPA) must be obtained from the Department of Fisheries for all work within the Waterway. Based on previous projects, it is likely that no in-water work will be permitted during the March 15 to June 15 time period of any year.

Time required to complete the permit process and environmental reviews for the replacement is estimated to be one year unless some objection is raised to the project.

B. HISTORICAL SIGNIFICANCE

According to the Washington State Inventory of Cultural Resources, the 14th/16th Avenue South Bridge is listed in the National Register of Historic Places. The bridge is listed on the National Register principally due to its type of operating mechanism, a Scherzer Rolling Lift, and the bridge is the only Scherzer Rolling Lift Bascule Bridge within the State of Washington. The State of Washington Office of Archaeology and Historic Preservation has recommended that alternatives to removal of the bridge be explored and that an alternative be selected which has the least impact upon the bridge's significance. See Appendix B for Cultural Resources and Historical Significance Study.

Any repair or rehabilitation of the bridge will require that the repairs or rehabilitation be completed so as to not impact the "rolling lift" operating mechanism of the bridge or alter significantly the appearance. In order for removal and replacement of the bridge to occur, measures will need to be identified that mitigate against the loss. It is anticipated that the King County Engineering Department will coordinate with the historical resource group to arrive at the most feasible approach in preserving the appearance and operation of the bridge. Concerned federal and state agencies will need to define the mitigating steps required. Such mitigation as a minimum likely would include preparing picture and video documentation of the bridge and operating mechanism along with a biography.

C. WATERWAY USERS STUDY

A waterway users study was performed to assess the needs of the users of the Duwamish Waterway upstream of the existing movable bridge. A movable bridge allows an unrestricted height clearance for marine traffic. A fixed intermediate level replacement bridge with a 55- to 60-foot clearance above mean high water (MHW), a fixed high level replacement bridge with 100-foot clearance above MHW, and a movable replacement bridge are proposed as alternatives to the rehabilitation of the existing bridge. A fixed span intermediate level replacement bridge could possibly create a height restriction to waterway users and limit use of the Waterway upstream from the bridge.

The U.S. Coast Guard published a public notice to solicit comments from interested parties on navigation clearances to be provided by a fixed span replacement bridge. Comments received by the U.S. Coast Guard and a letter from the U.S. Coast Guard regarding the required fixed span clearance is included in Appendix C.

A brief description of the existing and possible future waterway users upstream of the 14th/16th Avenue South Bridge, and potential impacts of a fixed replacement bridge to their operations are as follows:

1. SOUTH PARK MARINA

There are currently 150 boats moored at the South Park Marina which is located immediately upstream of the 14th/16th Avenue South Bridge. The maximum boat height is approximately 60 feet and only two or three boats are greater than 50 feet in height. The tenants displaced by a height restriction could be replaced without hardship. Therefore, the impacts to the South Park Marina would be negligible although the proposed 55 feet height would limit the time when the taller boats could pass beneath the bridge to lower tides.

In addition, the marina owner operates a side business, Southpark Boat Yards, in which he operates a boat launch, and provides a facility where owners self-service their boats. A height restriction would not affect this operation.

2. CONSTRUCTORS PAMCO

Constructors Pamco is a marine construction company. Their use of the waterway is to transport construction equipment to and from their equipment yard located on the southwest bank of the turning basin at the navigation head. They have indicated that the maximum vertical clearance they require is 40 feet, which would accommodate a Manitowoc 4000 mobile crane, with the boom lowered, loaded unto a barge. Therefore, they do not anticipate any impact to their operations due to a height restriction of 55 to 60 feet.

3. DUWAMISH YACHT CLUB

The Duwamish Yacht club is a marina in which the slips are privately owned with condominium rights. There are a total of 106 slips of which 64 are covered, and 42 uncovered. The covered slips restrict the height of moorage to 22 feet. As a result, there are 42 slips which could be impacted by a height restriction from a fixed replacement bridge. Currently, the maximum vessel height is 68 feet. Based on the current slip and boat ownership as reported by the Commodore of the Yacht Club, all uncovered slips would be affected by a 55 foot bridge, and 13 slips by a 60 foot height restriction. The slips belonging to impacted boat owners probably would need to be purchased, but they could be resold at cost minus fees. The fair market price for a slip at this location is estimated to be $25,000 to $30,000. The boat owners that did elect to relocate or even those who choose to stay could also seek compensation due to the impact of the restricted clearance, the magnitude of which is difficult to ascertain. However, some of the taller boats could still pass beneath the bridge at low tides.

4. DELTA MARINE INDUSTRIES, INCORPORATED

Delta Marine Industries is a boat-building and boat-repair business that specializes in fishing boats and yachts. Much of the marine traffic at the 14th/16th Avenue South Bridge is generated by Delta Marine's operations. Their average vessel height is 60 feet; most of their yachts are about 70 feet; and on rare occasions they build vessels with a height of 120 feet or more. They are currently building a vessel which will require low tides to pass under the West Seattle Freeway High Level Bridge which has a vertical clearance of 130 feet above MHW.

Presently, Delta Marine contracts with Manson Construction Company to provide them with floating crane heavy lifting services. In servicing Delta Marine Industries, Manson Construction brings in one of their large floating cranes to lift and launch Delta Marine's vessels. Delta Marine does not currently have any other method to launch their large craft. Vessel weights are in the 300 to 400 ton class which require a large crane lifting capacity. Manson Construction's crane, requires a 97-foot clearance for the A-frame on top of the operator's cab and barge spuds. The use of a land-based crawler crane has not been deemed feasible for this lifting operation. This is likely because of the concern for overloading of the adjacent roads, yard areas, and the shoreline bulkhead by the crawler crane. Overland transportation of the vessels to be launched at a location downstream of the bridge would also be unfeasible due to oversize width, height, and weight restrictions.

A height restriction from a fixed replacement bridge would also restrict the building and servicing of certain vessels. In order to continue their current business practices, Delta Marine would need to fit top portions of masts and antennas to their vessels downstream of the 14th/16th Avenue South Bridge. They would also need to improve their shoreline bulkhead to accommodate use of a land-based crawler crane. This could be accomplished by the construction of a pile-supported foundation trestle that would terminate at the face of the bulkhead. For this impact to their normal operations and the construction costs they would incur, they would likely require compensation. A fixed bridge would not, however, prohibit them from pursuing their boat building and repair business. Estimated cost impact to Delta Marine could be $2,000,000 or more. In addition, Manson Construction would loose the revenue that they currently receive from Delta Marine.

5. MISCELLANEOUS USES

In addition to the businesses described above, there is also marine traffic generated by the maintenance dredging of the waterway up to the turning basin, which is used for navigational purposes.

Almost annually, a marine construction company dredges the turning basin and adjacent portions of the navigable channel for the United States Army Corps of Engineers (USACOE). The equipment required to do this work must access the turning basin by passing beneath the 14th/16th Avenue South Bridge. The vertical height requirements for the dredging equipment is determined by the fixed equipment on the barge, and/or the spuds used to anchor the barge at the dredging site.

Hurlen Construction Company, a contractor who has done this work for the USACOE in the past, estimates that a 55 to 60 feet height restriction would require some modifications to the dredging equipment and operation such as: lowering or removing the spuds, traveling at low tide, using equipment with lower fixed frames, etc. This, however, would not preempt the dredging operation but would increase the dredging cost to the USACOE. Hurlen Construction Company estimates this additional dredging cost to be $5,000 per event, if the option to remove spuds were pursued. However, there should be minimal additional cost for simply lowering the spuds for the equipment to pass beneath the bridge.

Manson Construction and Engineering Company has also performed dredging upstream of the existing bridge. The equipment that they normally use for dredging requires 65- to 75-foot clearance for the A-frame, although they do have smaller cranes which would require not more than a 55-foot clearance if the spuds are removed. However, Manson Construction feels that it would put them at a competitive disadvantage for the dredging work if they were forced to use the smaller floating cranes.

In addition to the heavy lifts for Delta Marine as described above, Manson Construction has also provided two heavy lifts for Boeing in the past year upstream of the existing bridge. Manson Construction believes similar services will be required in the future for Boeing and other facilities upstream of the existing bridge.

6. FUTURE USES

The portion of the Duwamish Waterway upstream from the 14th/16th Avenue South Bridge is relatively shallow, and therefore, practically prohibits uses and vessels which require a deeper draft. However, a potential use which might be impacted is containerized cargo barge shipping. The USACOE's outlook for the waterway ([1]) predicts an influx of more lucrative uses, requiring a deeper draft, downstream of the 1st Avenue South Bridge, and consequent displacement of other uses such as container barges to shallower areas upstream of the 1st Avenue South and 14th/16th Avenue

1 "East, West, and Duwamish Waterways Navigation Study: Final Feasibility Report and Final Environmental Impact Statement"; by The United States Army Corps of Engineers; January 1983.

South Bridges. However, the heavier uses anticipated in the lower Duwamish area have not materialized to date, and neither have the lighter uses relocated upstream.

If a containerized cargo company were to relocate to the area upstream of the 14th/16th Avenue South Bridge (currently a permitted use by King County zoning ordinance), there would be limitations to the height of containers that the barge could carry on each trip. Based on the findings of the navigation study performed by the City of Seattle ([2]), over 80 percent of container barge traffic currently negotiating the lower reaches of this waterway could be accommodated. The only barges affected by the height restriction would be vessels stacked six containers high (63-foot clearance required), and vessels carrying a crane.

D. IMPACT ANALYSIS

BST Associates completed an economic study in November 1994 that detailed the impacts of constructing a 55 to 60 foot vertical clearance fixed span replacement for the 14th/16th Avenue South Bridge. They concluded that constructing such a fixed span bridge at 14th/16th Avenue would have minimal impact to waterway users if approprite mitigation is undertaken.

This study indicated that the only identifiable adverse impact would restrict the launching capabilities of large purse seiners from Delta Marine Industries (DMI). Currently, Manson's 90-foot-high derricks provide lifting service for launching DMIs large purse seiners. These derricks would not be able to pass under the 60-foot vertical clearance span. To mitigate the affects of the 60-foot clearance span, several alternative launching methods were identified. BST indicated that the best alternative would be to compensate DMI for a marine lift and shiplift at an estimated cost of $2.1 to $2.8 million. This cost is included as Waterway User (Allowance) Item in the LCCA for the FBR60 alternative.

E. CONCLUSIONS

The findings of the waterway users study and the BST impact analysis both concluded that a 60-foot vertical clearance fixed replacement for the 14th/16th Avenue South Bridge is feasible. Only two existing business, Delta Marine Industries, and Manson Construction and Engineering Company would be impacted and these impacts can be economically mitigated. All other current uses and operations could continue with negligible impacts.

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2 "First Avenue South Bridge Over the Duwamish Project: Draft Navigation Study Report"; by The City of Seattle Engineering Department; November 1990.

The U.S. Coast Guard has recommended a high level vertical clearance fixed replacement bridge of at least 100 feet at MHW (See U.S.C.G. letter dated September 21, 1992 in Appendix B). However, based on the findings of the waterway users study and the recently completed BST economic analysis, we believe a fixed replacement bridge with 60 feet vertical clearance above MHW is now feasible. The 60 feet clearance would allow virtually unlimited waterway use by recreational craft, and any encumbrance to commercial traffic could be economically compensated.

VI. EVALUATION OF ALTERNATIVES

A. LIFE CYCLE COST ANALYSIS

A life cycle cost analysis (LCCA) was performed on the four distinct alternatives: two fixed span replacement bridge alternatives, a movable replacement bridge alternative and rehabilitation of the existing bascule bridge.

1. DEFINITION OF FOUR ALTERNATIVES

Four alternatives have been identified for comparison purposes in the LCCA. Alternative No. 1 is the 60-foot Vertical Clearance Fixed Bridge Replacement (FBR55), Alternative No. 2 is the Rehabilitated Bascule Bridge (RBB), Alternative No. 3 is the 100-foot vertical clearance Fixed Bridge Replacement (FBR100), and Alternative No. 4 is the Movable Bridge Replacement (MBR).

The replacement bridge alternatives, FBR60, FBR100, MBR, assume that the existing bascule bridge will undergo short-term repairs as needed to allow it to operate for approximately the next ten years. During this time, the bridge will be kept in operation and partially maintained. By the end of the ten years, a replacement bridge will have been constructed at the site and put into service. The existing bascule bridge will then be demolished. The replacement bridges will have an estimated 100 years of service life.

The RBB alternative assumes that the existing bascule bridge will undergo short-term repairs as needed to allow it to operate for approximately the next ten years while a major renovation occurs. By the end of the tenth year the bridge will have been renovated as required to sustain an additional fifty year service life. After 50 years, the bascule bridge will be taken out of service or replaced.

2. METHODS OF ANALYSIS

The life cycle cost analysis was performed using present value methods. Present value assumes that all future expenditures can be evaluated at their present worth, and therefore, they can be compared directly.

Present values were calculated using a real discount rate of 3 percent as recommended by King County. This discount rate is defined as the interest rate of an investment minus the inflation rate. Therefore, inflation of future costs are covered inherently in the discount rate.

Present worth of a single future payment was calculated by the following formula:

$$P = F * [1/(1+i)^n],$$

where P = present worth,
F = future payment,
i = discount rate, and
n = no. of periods.

Present worth of a series of future payments was calculated by the following formula:

$$P = A * \{[(1+i)^n-1]/[i*(1+i)^n]),$$

where P = present worth,
A = uniform series payment,
i = discount rate, and
n = no. of periods.

3. ASSUMPTIONS AND LIMITATIONS

A life cycle cost analysis is a suitable tool for comparing two or more well defined alternatives. The results are usually appropriate for selecting which alternative is most economically attractive. There are, however, some limitations on its applicability.

Present values for this analysis were calculated on capital construction costs, major maintenance or improvement costs, annual maintenance and operations costs, salvage or residual values, waterway users compensation costs, and right-of-way acquisition costs. Costs were not calculated on other economic impacts outside of the scope of this study such as potential tax revenue changes, costs assigned to traffic delays, etc. The impacts of these other costs should be evaluated before selecting the best alternative.

The effect of using a specific discount rate over another may have an impact on the results of the analysis. In this study, a discount rate of 3 percent was chosen by King County and is assumed as the most reasonable value for a project with a fifty year life. However, it is impossible to predict the economic forces over a fifty year time span therefore the interest rate of investments, the inflation of costs, and the resulting discount rate should not be considered anything more than an educated guess.

A major assumption was made regarding the time span to be evaluated for the LCCA. The present value calculations require that a similar time period be used for each alternative, therefore, calculations were performed using a 50-year comparison period. The use of a 50-year time period required that an adjustment be made for the FBR60, FBR100, and MBR alternatives which have a useful life of 100 years assuming proper maintenance. The RBB alternative has a useful life of 50 years. In order to compare each alternative for over a 50-year time period, it was necessary to assign a salvage value to the FBR60, FBR100, and MBR alternatives, whereby at the end of 50 years, they will have depreciated to one-half their original value. It does not appear likely that the replacement bridge can actually be salvaged at the end of 50 years and half their value recovered. However, this costing technique was used to give the two alternatives an equal time span for the present worth evaluation.

4. RESULTS OF ANALYSES

Table II includes the capital construction cost to repair the existing bascule bridge for a 10-year service life associated with either the FBR60, FBR100 or and MBR alternatives. Table III includes the capital construction to repair and renovate the existing bascule bridge for the 50-year service life associated with the RBB alternative. Tables IV, V and VI include the capital construction cost to construct the FBR60, FBR100, and MBR Alternatives, respectively, which includes demolishing the existing bascule bridge. Back-up for the capital construction cost estimates utilized for the FBR60, FBR100, and MBR Alternatives are included in Appendix E.

Capital cost for the bascule structure, mechanical, electrical, and machinery associated with MBR alternative was based on the recent design of the new First Avenue South Bridge. Quantities were adjusted for actual span length and bridge width where applicable.

Costs for reasonable bascule bridge maintenance were obtained from the City of Seattle Engineering Department (SED). The City of Seattle operates and maintains two bascule bridges over the Duwamish Waterway, and four bascule bridges over the Lake Washington Ship Canal. They have a great amount of experience in proper maintenance and upkeep of bascule bridges. These costs are considerably higher than those presently incurred by the King County on the 14th/16th Avenue South Bridge. It is recommended that the King County plan to expend maintenance costs at or near the level of SED's cost in order to properly maintain the RBB or the MBR alternatives, and therefore, these costs were used for this LCCA.

Right-of-way costs included in the analysis were determined by King County based on the proposed FBR60 alignment located immediately to the west of the existing alignment. The right-of-way cost for FBR100 and MBR alternative were estimated from the King County FBR60 analysis. The True Cost Estimate prepared for the FBR60 alternative by the King County Property Division is included in Appendix D.

The results of the LCCA may be found in Table VII for a discount rate of 3 percent. The RBB alternative is significantly more economical than the FBR100 and MBR alternative whether right-of-way costs are included or excluded. When Life Cycle Costs of RBB is compared with the FBR60 the cost difference is small.

B. FUNDING FOR REHABILITATION OR REPLACEMENT

The funding for a major bridge rehabilitation or replacement project can be a lengthy and complex process. This process has been changed somewhat by a recent legislation - the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The County has proceeded toward the resolution of funding for rehabilitation/replacement of the 14th/16th Avenue South Bridge by conducting several engineering studies to identify concerns and establish need. This Design Report provides the basis for the next steps required in the procurement of funding for this bridge.

The contacts Sverdrup has made along with those made by King County have responded positively concerning the possibilities of funding to address the concerns about this bridge. It appears that funding is possible at the federal level through the life of the ISTEA legislation - through Federal Fiscal Year 1997 - with increasing amounts being available later in this six year program. Also, if federal legislation is passed to "stimulate the economy" there will be additional funds available for infrastructure improvements, including major urban bridges. ISTEA funds, except for Federal Bridge Replacement and Rehabilitation Funds, are not specifically earmarked for bridges.

Sverdrup has contacted several of the agencies involved in infrastructure funding, especially bridges. The contacts have included:

- WSDOT - Local Programs, both at District 1 and Headquarters, Olympia
- TRANSPORTATION IMPROVEMENT BOARD
- WASHINGTON STATE DEPARTMENT OF COMMUNITY DEVELOPMENT - Public Works Trust Fund

There is consensus from these agencies that "creativity" is the approach needed to obtain funding for continued planning, and the design and construction phases to provide a new or rehabilitated facility. This normally means a combination of funding sources. Possible funding sources for this project are as follows:

Local Funds. These are funds generated by bonding, local option gas taxes, other local option taxes, etc. This includes any local funds generated for transportation improvements by King County and/or the City of Tukwila.

Transportation Improvement Account Funds and/or Urban Arterial Account Funds. These state funds are administered by the Transportation Improvement Board (TIB). These funds are presently very limited, and the project must compete on a regional basis. However, the prospects are good that this program will receive additional funding by the state legislature in the next two years. In addition, a multi-agency project has a good chance of competing especially if it is also multi-modal and/or enhances other transportation modes (i.e. pedestrian, bicycles, or transit).

Surface Transportation Program Funds. These federal funds are administered by Transportation Management Area (i.e. Puget Sound Regional Council) and are available through regional competition. ISTEA funds available for the Puget Sound Region were $11.2 million in Federal Fiscal Year (FFY) 1992 and will increase each year to $32.2 million in FFY 1997. Funds are also available for statewide competition. These funds were not available in FY 1992 but will increase to $27.9 million in FFY 1997.

Federal Bridge Replacement and Rehabilitation Program Funds. These federal funds provide 80 percent with 20 percent local match. To be eligible for these funds, the bridge must demonstrate a sufficiency rating of 50 or less for rehabilitation and 80 or less for replacement and be considered structurally deficient or functionally obsolete. The existing bridge has at this time sufficiency a rating is 20.58 and therefore is eligible for this funding. These funds are included in the ISTEA legislation and are available. The Local Program's share has historically been approximately $17 million per year. This has been recently increased to approximately $30 million per year. However, the Bridge Replacement Advisory Committee (BRAC) traditionally has limited the funding for a project to $10 million ($8 million federal funds and $2 million matching funds). In special cases projects have been funded over $10 million limit. However, federal participation over $10 million has been limited to 50 percent.

Public Works Trust Fund (PWTF). These state funds are administered through the Washington State Department of Community Development. These funds are available as low interest loans and they can be utilized for design. Maximum funding available to a jurisdiction is $3.5 million with a 10 percent minimum match.

Bridge Discretionary Funds. Bridges funded by this source take funds away from other ISTEA funded projects. Therefore the State of Washington has at this time decided not to authorize any future projects using Bridge Discretionary Funds.

Demonstration Funds. This funding has historically been introduced by federal legislation for special projects. This funding is separate from ISTEA funding. However, because of federal budget restraints current federal administration has demonstrated opposition to this type of funding.

A proposed course of action to obtain funding for this project based upon the preceding discussion might be as follows:

1. Select the desired renovation or replacement option and prepare a Design Report.

2. Apply for portions of funding through all available sources.

3. Pursue local matching funding options.

4. Perform C3R report if required.

5. If project direction changes as a result of further studies, funding effort direction can change.

Based on existing funding as envisioned under ISTEA and other existing programs, this project is competing with other projects for approximately $60 million per year of federal funds. Local funds, state TIB funds, and PWTF funds may be used for the local match.

The sources we have contacted have stated that the decision for rehabilitation or replacement is strictly a local decision based on an engineering evaluation and economics. It must be cautioned that it is difficult to receive federal or state funding for a facility that has received federal funds in the past, therefore, the rehabilitation option must be carefully evaluated to be as complete and extend the life (functionally and structurally) as much as possible. In other words, if the bascule bridge is rehabilitated now with federal funds, it will not compete well for federal funds in the future.

Another consideration in the funding equation is the issue of the sufficiency rating of the bascule bridge. In order to receive federal funds to renovate the bridge, the bascule bridge's sufficiency rating must be improved to above an 80 rating, and the roadway width must be increased to 48-foot. Widening of an existing bascule bridge of this type is very difficult, therefore, a waiver of this criteria must be obtained. While the funds are available without discrimination to renovate the bascule bridge or to construct a replacement structure, it appears that obtaining funding for a replacement structure may be more attainable.

A combination of Bridge Replacement Funds, Surface Transportation Program Funds, Transportation Improvement Board Funds, Local and Private Funds have been used to pay for bridge construction projects costing approximately $20 million or less. This funding approach is apparently being used for the Lincoln Street Bridge Project in Spokane. As noted earlier, Federal Bridge Replacement Funding has been traditionally limited to 80 percent participation for a project that costs less than $10 million. Above the $10 million threshold the Federal Bridge Replacement Funding participation drops to 50 percent. Above the $15 million to $20 million threshold, historically ISTEA funding has not been available. To fund the bridge alternatives that cost over $20 million, federal participation would most likely be to a Demonstration Project. However, since the federal administration considers these types of projects budget "busting", it is very uncertain that these alternatives could be substantially funded with federal dollars.

The likelihood of receiving federal or state funding for the 14th/16th Avenue South Bridge is best if pursued during the ISTEA "window". The chances of obtaining funding for this project cannot be readily determined without more in-depth study of the competing projects, which is outside the scope of this study.

The project schedules presented in this report, see Figures 6, 7, 8 and 9, indicate a substantial period of time needed to develop funding support. It appears that accelerating the funding process as much as possible is prudent to access potential federal and state funds as they become available under the life of the present ISTEA legislation.

C. COMPARISON OF ADVANTAGES VERSUS DISADVANTAGES

The following is a listing of the primary advantages and disadvantages for each alternative. Note that closure of 14th/16th Avenue South Bridge is not considered a feasible alternative, and therefore is not included.

RBB Alternative - Rehabilitated Bascule Bridge

Advantages

1. Least estimated construction costs of all alternatives.
2. Provides unlimited vertical navigational clearance.
3. Minimizes permitting requirements.
4. Likely to produce least impact on environment.
5. No additional right-of-way acquisition required.
6. Minimum time for construction.

Disadvantages

1. Minimum roadway lane widths that do not meet current standards.

2. High maintenance cost.

3. Risk that repairs may not entirely eliminate bridge operational problems.

4. Most vulnerable to damage from ship impact with existing fender system.

5. Significant disruption to traffic during construction.

FBR55 Alternative - 55-Foot Vertical Clearance Fixed Span Replacement Bridge

Advantages

1. Meets current standards for roadway lane widths.

2. Estimated construction costs and Life Cycle Cost comparable to Rehabilitated Bascule Bridge.

3. Lowest estimated cost for bridge replacement alternatives.

4. Minimizes maintenance costs.

5. Minimizes disruption to traffic during construction.

6. Recently concluded economic study indicated that impacts to waterway users are minimal.

Disadvantages

1. May require disposal of significant amount of contaminated sediments.

2. Requires additional right-of-way acquisition.

3. Designed with 8 percent profile grades which are approximately 3 percent steeper than the profile grades of the existing bridge.

4. Construction activities such as pile driving may damage existing bridge.

5. U.S. Coast guard has not granted permit.

FBR100 Alternative - 100-Foot Vertical Clearance Fixed Span Replacement Bridge

Advantages

1. Satisfies U.S.C.G. minimum vertical navigational clearance requirement of 100 feet.

2. Meets current standards for roadway lane widths.

3. Minimizes maintenance costs.

4. Minimizes disruption to traffic during construction.

Disadvantages

1. High construction costs and funding availability uncertain without obtaining demonstration funding.

2. Requires relocation of Cloverdale Street intersection and rerouting arterial through existing residential streets.

3. Requires additional right-of-way acquisition.

4. Requires minimum of 8 percent profile grade on bridge or approximately 3 percent steeper grade than existing bridge.

5. Time for construction likely to exceed 2 years.

6. May require disposal of significant amount of contaminant sediments.

7. Construction activities such as pile driving may damage existing bridge.

MBR Alternative - Movable Bascule Replacement Bridge

Advantage

1. Provides unlimited vertical navigational clearance.

2. Meets current standards for roadway lane widths.

3. Minimizes disruption to traffic during construction.

4. Does not exceed profile grade of existing bridge.

Disadvantages

1. Highest construction costs of all alternatives. Funding availability uncertain without obtaining large amounts of demonstration funding.

2. Continued high operational costs.

3. May require disposal of a significant amount of contaminated sediments.

4. Requires additional right-of-way acquisition.

5. Construction activities such as pile driving may damage existing bridge.

D. CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

Costs

The life cycle cost analysis comparing rehabilitation versus replacement for the 100-foot vertical clearance fixed bridge or new movable bridge has indicates that rehabilitation is significantly more economical than replacement over a 50 year life. The result is the same whether right-of-way costs are included or excluded. However, based on a 50 year time span and a 3 percent discount rate, the life cycle cost for the fixed span replacement bridge with 60-foot vertical clearance is only sightly more than the cost to rehabilitate the existing bridge. The estimated mitigation cost to compensate upstream users due to 60-feet of vertical clearance is included.

Navigational Clearance

All alternatives match or exceed the horizontal clearance of the existing channel. Both the rehabilitation of the existing bridge and the movable replacement bridge alternatives in their open position offer unlimited vertical clearance. In the closed position their vertical clearances match or exceed the existing conditions. Based on the U.S. Coast Guard preliminary findings, the 100-foot vertical clearance fixed replacement bridge alternative satisfies navigation clearance requirements. The 60-foot vertical clearance fixed replacement bridge alternative restricts two existing business upstream of the bridge and potential future waterway users from fully utilizing their facilities. However, the results of a recently conducted economic study has found that the impacts to these businesses and users are minimal.

Traffic Impacts

The permanent closure of the 14th/16th Avenue South Bridge would severely impact local traffic from the 1st Avenue Bridge to Pacific Highway South. Therefore this alternative is not considered feasible. Similarly, it is not feasible to locate either the fixed or the movable replacement bridge on the existing bridge alignment. Construction of either of these new bridge alternatives on the existing alignment would close 14th/16th Avenue South Bridge for more than 2 years.

Rehabilitation of the existing bridge will impact local traffic most significantly during the last year of reconstruction. This impact may be partially mitigated by limiting closure at any given time to two of the four available lanes. Rehabilitation of the bridge roadway allows for either 4 undivided traffic lanes or conversion to 3 lanes. Recent accident data indicates few safety concerns with the existing four 9.5-foot-wide traffic lanes. However, the lane widths can be increased to 10 feet by reducing the width of the sidewalks 2 feet in order to satisfy the Urban Design Standards for 3-R projects. In this way the 3-R standards are met regarding width of traffic lanes with a four lane traffic configuration on the bridge. On the other hand, conversion to three lanes permits lane widths to be increased to 11 or 12 feet with a median and/or shoulders with 2 lanes northbound and 1 lane southbound.

Both the fixed and movable replacement bridges provide four 12-foot-wide lanes with two 8-foot-wide sidewalks. The width of the sidewalks and traffic lanes can be reduced somewhat to provide for shoulders and/or medians without increasing the overall width of the bridge. The feasible alignment alternatives for both fixed and movable replacement bridges are located west of the existing bridge. These alignments permit construction of the replacement bridges without requiring any significant closures of the existing bridge. However, the 100-foot vertical clearance fixed replacement bridge will require relocating the Cloverdale Street intersection 400 feet south of existing location.

The replacement bridge alternatives will offer greater roadway lane and sidewalk widths and somewhat greater traffic capacities than the rehabilitation alternative, and thereby provide greater safety and less congestion. In addition, the fixed replacement bridge alternatives are not impacted by bridge openings. However, the maximum grades on the fixed bridge structures are 8 percent as compared with the 5 percent grades on the existing or replacement bascule structures, which reduces capacity.

Ship Collision/Damage

The 100-foot vertical clearance fixed bridge is the least vulnerable alternative to ship impact. This alternative offers the maximum necessary navigational clearance. If the U.S. Coast Guard approves the 60-foot vertical clearance fixed bridge, more restrictive shipping heights will be required. The movable bridge alternatives rely on operators and mechanical and electrical systems to open the bridge. These systems are subject to error and therefore the movable bridges are more likely to be struck than the fixed bridge. An energy absorbing fender system will be provided at each pier to reduce the risk of significant damage to the bridge in the event of ship impact. However even with a fender system, there is some risk that a ship impacting a movable bridge may render the mechanical or electrical systems inoperable. The fixed bridge is much less likely to incur significant damage.

The existing bridge cannot accommodate a fender system equivalent to the replacement bridge alternatives without encroaching on the channel width. Therefore, even after rehabilitation, the existing bridge will remain the most susceptible to damage as a result of ship impact.

The fixed bridge is inherently more durable and reliable than the movable bridges. Apart from painting and maintenance of the roadway the fixed bridge repairs and maintenance should be minimal. The movable bridge with its more complex structure, mechanical and electrical systems will likely require more frequent inspections and repairs.

Environment

The rehabilitation of the existing bridge will likely produce the least impact on the environment. Except for compaction grouting at the bascule piers no work will be done within the Duwamish Waterway. Replacement of the approach spans will require pile driving and footing construction which should cause limited impacts. The replacement bridge alternatives will require removal of the existing bridge which will likely involve disposal of contaminated sediments. In addition, the construction of new pile supported foundations will also involve some excavation of possible contaminated sediments. Furthermore, to minimize impacts on fisheries, foundation construction will likely be limited to specified times of this year.

Permits

All alternatives will require a U.S. Coast Guard permit, Dept. of Fisheries permit, Washington State Shoreline Management permit, King County Building permit, Deptartment of Ecology approval, and Historical Society approval and other permits and approvals. We believe the favorable results of the recently completed economic study that assessed impact of vertical clearance upon waterway users makes it much more likely that the U.S. Coast Guard will now grant a permit for the 60-foot vertical clearance fixed bridge.

2. RECOMMENDATIONS

We recommend that the 60-foot vertical clearance fixed bridge alternative (FBR60) replace the existing 14th/16th Avenue South Bridge. At 3 percent discount rate, the LCCA indicates that the FBR60 alternative is only slighty more costly than the rehabilitated bridge alternative (RBB). The advantages of greatly superior traffic capacities and safety, minimal maintenance, and low construction cost make the FRB60 the preferable alternative. In the unlikely event that the U.S. Coast Guard requires greater than 60 feet of vertical clearance, our second choice is the RBB Alternative.

Our recommended alternative will have to compete for limited available federal, state and local funding. The most probable source for federal participation will involve ISTEA legislation which at this time appears not likely to exceed $15 million. Since present ISTEA legislation will expire in three years it is important to pursue those funds immediately. Even with federal funding, it appears that substantial local, private, and state funds will be necessary. It is also important to note that experience has shown that delaying the decision to replace this bridge will only lead to significant increases in the cost of repair of the existing bridge and consequently increased overall cost of this project.

TABLE II
Capital Construction Cost Estimate
Short Term Repairs to Bascule Bridge
To Maintain Bridge in Reliable Service for 10 Years

NO.	ITEM		ESTIMATED COST
STRUCTURAL			
1	Continue monitoring pier movements.		10,000
2	Add Hangers to sidewalk beams on concrete approach structures.		30,000
3	Grind tips and roots at center expansion joint in bascule span.		10,000
4	Core, test, and repair concrete approach spans.		250,000
5	Perform in-depth underwater inspection of bascule piers reinspect for cracking		300,000
5	Deck expansion joint repairs		90,000
Subtotal Structural			**690,000**
MECHANICAL			
1	Clean and perform complete in-depth inspection of drive gears.		25,000
2	Determine depth of cracks in Gear 13S and grind out or weld repair. Repair other gears as required.		10,000
3	Replace rack pinion bushings on west side of the north span and the east side of the south span.		90,000
4	Add four additional bolts to the rack pinion bushing flanges on the east side of the north span and west side of the south span.		10,000
5	Rehabilitate the differentials on the north and south span drives.		25,000
6	Grind corners of track pockets at the bases of the fillets to eliminate contact at the fillets		5,000
7	Install three limit switches on each span drive brake to provide interlocks with brakes and traffic gates.		5,000
8	Install limit switch to indicate that main drive gears are engaged.		2,000
9	Monitor wear at the racks and pinions on a yearly basis.		30,000
10	Move rack cover frame work on south span.		5,000
11	Drill a 1/2" diameter hole in west curved girder track tread at the North Bascule Pier.		1,000
12	Adjust west motor brake on the north span, east motor brake on the south span, and east emergency brake on the south span.		2,000
13	Install guards over brakes, motor couplings, and spur gear sets in auxiliary drives.		10,000
Subtotal Mechanical			**220,000**
ELECTRICAL			
4	Provide a grounding system throughout the bridge.		6,000
2	Replace enclosures for switchboard and generator controls.		5,000
3	Clean and inspect main and emergency drive motors.		7,000
4	Overhaul emergency generator engine, clean and inspect the generator, excitator and controls, and replace fuel tank and fuel lines.		10,000
5	Clean and inspect main and emergency drive resistor banks.		1,000
6	Clean relay, contactor, and drum controller contacts on a regular basis.		1,000
Subtotal Electrical			**30,000**
SUBTOTAL			940,000
Contingencies		20%	188,000
Subtotal			1,128,000
Engineering		30%	338,000
TOTAL			**$1,466,000**

TABLE III
Capital Construction Cost Estimate
Bascule Bridge Renovation
To Sustain Additional 50-Year Service Life

NO.	ITEM	ESTIMATED COST
STRUCTURAL		
1	Continue monitoring pier movements.	10,000
2	Compaction grouting of north and south bascule pier foundations.	1,260,000
3	Replace truss approach span concrete deck.	600,000
4	Replace steel grating for bascule spans, grind tips and roots at center expansion joint in bascule span, and counterweight adjustments.	960,000
5	Seismic retrofit of truss approach spans.	80,000
6	Seismic retrofit of bascule piers	800,000
7	Replace concrete approach spans.	3,000,000
8	Core, test, and repair concrete approach spans prior to replacement.	250,000
9	Injection grout cracks in bascule piers, and install siltation screen during grouting.	400,000
10	Pier protection repair	250,000
Subtotal Structural		**7,610,000**
MECHANICAL		
1	Clean and perform more in-depth inspection of drive gears.	25,000
2	Determine depth of cracks in Gear 13S and grind out or weld repair. Repair other gears as required.	10,000
3	Replace all rack pinion bushings.	110,000
4	Replace existing differential with enclosed industrial differential speed reducers.	230,000
5	Machine bottom of racks to provide proper clearances between rack and pinion teeth.	65,000
6	Install energy absorbing traffic barrier gates.	250,000
7	Replace existing center locks with mechanical/electrical center locks and rebalance span.	250,000
8	Grind corners of track pockets at the bases of the fillets to eliminate contact at the fillets.	5,000
9	Install three limit switches on each span drive brake to provide interlocks with brakes and traffic gates.	5,000
10	Install limit switch to indicate that main drive gears are engaged.	2,000
11	Replace rack covers and supporting framework.	10,000
12	Drill a 1/2" diameter hole in the west curved girder track tread of the North Bascule Pier.	1,000
13	Adjust west motor brake on the north span, east motor brake on the south span, and east emergency brake on the south span.	2,000
14	Install guards over brakes, motor couplings, and spur gear sets in auxiliary drives.	10,000
Subtotal Mechanical		**975,000**

TABLE III
Capital Construction Cost Estimate
Bascule Bridge Renovation
To Sustain Additional 50-Year Service Life

NO.	ITEM		ESTIMATED COST
ELECTRICAL			
1	Replace the main power distribution switchboard with a motor control center.		30,000
2	Replace the emergency generator and controls.		150,000
3	Replace the control console including limit switches, indicators, and interlocks.		100,000
4	Refurbish the main and emergency drive motors.		30,000
5	Replace the submarine cables.		65,000
6	Replace the control tower and equipment room lighting and heating systems.		10,000
7	Replace conduit, fittings, and wiring throughout the bridge.		30,000
8	Install a complete grounding system and lightning protection system.		15,000
9	Replace the main and emergency resistor banks.		10,000
Subtotal Electrical			**440,000**
SUBTOTAL			9,025,000
Contingencies		20%	1,805,000
Subtotal			10,830,000
Engineering		30%	3,249,000
TOTAL			**$14,079,000**

TABLE IV
Capital Construction Cost Estimate
Fixed Bridge Replacement - 60-Foot Vertical Clearance

NO	ITEM	UNIT	QUANTITY	UNIT COST	AMOUNT
ROADWAY					
1	Composite Surface Removal	CY	2,560	6	15,400
2	Urban Clearing	LS			10,000
3	ACP Paving	TON	2,250	32	72,000
4	Crushed Surfacing Top Course	TON	1,610	17	27,400
5	Gravel Base	TON	4,630	10	46,300
6	Sidewalk	SY	6,450	16	103,200
7	Curb and Gutter	LF	4,730	8	37,800
8	Storm Drain, Concrete, 12"	LF	2,150	35	75,300
9	Catch Basin	EA	10	800	8,000
10	Water Quality Features	LS			15,000
11	Traffic Signals	EA	10,000	2	20,000
12	Lighting	EA	17	1500	25,500
13	Striping	LF	15,000	0.10	1,500
14	Signing	SF	50	12	600
15	Traffic Control	LS			50,000
16	Flagging	HRS	2,000	25	50,000
Roadway Total					**558,000**
STRUCTURE					
17	Structure Excavation Class A	CY	10,504	20	210,100
18	Hazardous Waste Haul & Disposal	CY	4,788	100	478,800
19	Cofferdam	SF	36,804	22	809,700
20	Shoring & Cribs or Xtra Exc Cl A	SF	32,872	10	328,700
21	Furnishing Piling, Concrete - 80 Ton	LF	48,900	18	880,200
22	Driving Piles, Concrete	EA	610	600	366,000
23	Steel Reinforcing Bars	LB	1,654,171	0.50	827,100
24	Epoxy Coated Steel Reinforcing Bars	LB	964,599	0.65	627,000
25	Concrete Class 3000 (Tremie Seals)	CY	3,015	125	376,800
26	Concrete Class 3000 (Footings)	CY	4,108	200	821,600
27	Concrete Class 4000 (Abut & Ret. Walls)	CY	387	250	96,800
28	Concrete Class 4000 (Capbeams)	CY	1,138	300	341,300
29	Concrete Class 4000 (Columns)	CY	1,376	300	412,800
30	Concrete Class 4000 (Deck Slabs)	CY	3,833	350	1,341,500
31	Elastomeric Bearing Pads	EA	126	75	9,500
32	Steel Bearings	EA	42	1200	50,400
33	Prestressed Concrete Girder - Series 14	LF	8,640	95	820,800
34	Structural Low Alloy Steel	LB	1,546,776	1.25	1,933,500
35	Expansion Joint System - Strip Seal	LF	264	150	39,600
36	Bridge Drains	EA	12	400	4,800
37	Traffic Barrier	LF	4,360	70	305,200
38	Metal Railing	LF	4,360	45	196,200
39	Membrane Deck Waterproofing	SY	11,953	10	119,500
40	Embankment	CY	8,898	10	89,000
Structure Total					**11,486,900**
Remove Existing Bridge		LS			2,500,000
SUBTOTAL					14,544,900
Contingencies			20%		2,909,000
Subtotal					17,453,900
Engineering			24%		4,188,900
TOTAL					**$21,643,000**

TABLE V
Capital Construction Cost Estimate
Fixed Bridge Replacement - 100-Foot Vertical Clearance

NO	ITEM	UNIT	QUANTITY	UNIT COST	AMOUNT
ROADWAY					
1	Composite Surface Removal	CY	2,560	6	15,400
2	Urban Clearing	LS			10,000
3	ACP Paving	TON	2,250	32	72,000
4	Crushed Surfacing Top Course	TON	1,610	17	27,400
5	Gravel Base	TON	4,630	10	46,300
6	Sidewalk	SY	6,450	16	103,200
7	Curb and Gutter	LF	4,730	8	37,800
8	Storm Drain, Concrete, 12"	LF	2,150	35	75,300
9	Catch Basin	EA	10	800	8,000
10	Water Quality Features	LS			15,000
11	Traffic Signals	EA	10,000	2	20,000
12	Lighting	EA	17	1500	25,500
13	Striping	LF	15,000	0.10	1,500
14	Signing	SF	50	12	600
15	Traffic Control	LS			50,000
16	Flagging	HRS	2,000	25	50,000
17	Intersection Relocation	LS	LS	2,000,000	2,000,000
Roadway Total					**2,558,000**
STRUCTURE					
18	Structure Excavation Class A	CY	21,293	20	425,900
19	Hazardous Waste Haul & Disposal	CY	8,400	100	840,000
20	Cofferdam	SF	48,260	22	1,061,700
21	Shoring & Cribs or Xtra Exc Cl A	SF	55,048	10	550,500
22	Furnishing Piling, Concrete - 80 Ton	LF	90,660	18	1,631,900
23	Driving Piles, Concrete	EA	1,074	600	644,400
24	Steel Reinforcing Bars	LB	4,580,591	0.50	2,290,300
25	Epoxy Coated Steel Reinforcing Bars	LB	1,526,191	0.65	992,000
26	Concrete Class 3000 (Tremie Seals)	CY	4,500	125	562,500
27	Concrete Class 3000 (Footings)	CY	10,743	200	2,148,600
28	Concrete Class 4000 (Abut & Ret. Walls)	CY	387	250	96,800
29	Concrete Class 4000 (Capbeams)	CY	2,351	300	705,400
30	Concrete Class 4000 (Columns)	CY	4,859	300	1,457,600
31	Concrete Class 4000 (Deck Slabs)	CY	6,079	350	2,127,700
32	Elastomeric Bearing Pads	EA	252	75	18,900
33	Steel Bearings	EA	42	1200	50,400
34	Prestressed Concrete Girder - Series 14	LF	17,136	95	1,627,900
35	Structural Low Alloy Steel	LB	1,546,776	1.25	1,933,500
36	Expansion Joint System - Strip Seal	LF	396	150	59,400
37	Bridge Drains	EA	16	400	6,400
38	Traffic Barrier	LF	6,248	70	437,400
39	Metal Railing	LF	6,248	45	281,200
40	Membrane Deck Waterproofing	SY	18,876	10	188,800
41	Embankment	CY	8,900	10	89,000
Structure Total					**20,228,200**
Remove Existing Bridge		LS			2,500,000
SUBTOTAL					25,286,200
Contingencies			20%		5,057,200
Subtotal					30,343,400
Engineering			24%		7,282,400
TOTAL					**$37,626,000**

TABLE VI
Capital Construction Cost Estimate
Movable Bridge Replacement

NO	ITEM	UNIT	QUANTITY	UNIT COST	AMOUNT
ROADWAY					
1	Composite Surface Removal	CY	2,560	$6.00	$15,400
2	Urban Clearing	LS	01	LS	$10,000
3	ACP Paving	TON	2,250	$32.00	$72,000
4	Crushed Surfacing Top Course	TON	1,610	$17.00	$27,400
5	Gravel Base	TON	4,630	$10.00	$46,300
6	Sidewalk	SY	6,450	$16.00	$103,200
7	Curb and Gutter	LF	4,730	$8.00	$37,800
8	Storm Drain, Concrete, 12"	LF	2,150	$35.00	$75,300
9	Catch Basin	EA	10	$800.00	$8,000
10	Water Quality Features	LS	01	$15,000.00	$15,000
11	Traffic Signals	EA	10,000	$2.00	$20,000
12	Lighting	EA	17	$1,500.00	$25,500
13	Striping	LF	15,000	$0.10	$1,500
14	Signing	SF	50	$12.00	$600
15	Traffic Control	LS			$50,000
16	Flagging	HRS	2,000	$25.00	$50,000
Roadway Total					**558,000**
APPROACH STRUCTURE					
17	Structure Excavation Class A	CY	4,614	$20.00	$92,000
18	Shoring & Cribs or Xtra Exc Cl A	SF	28,296	$10.00	$283,000
19	Furnishing Piling, Concrete - 80 Ton	LF	33,780	$18.00	$608,000
20	Driving Piles, Concrete	EA	442	$600.00	$265,000
21	Steel Reinforcing Bars	LB	747,592	$0.50	$374,000
22	Epoxy Coated Steel Reinforcing Bars	LB	667,238	$0.65	$434,000
23	Concrete Class 3000 (Tremie Seals)	CY	00	$125.00	$0
24	Concrete Class 3000 (Footings)	CY	2,487	$200.00	$497,000
25	Concrete Class 4000 (Abut & Ret. Walls)	CY	387	$250.00	$97,000
26	Concrete Class 4000 (Capbeams)	CY	683	$300.00	$205,000
27	Concrete Class 4000 (Columns)	CY	205	$300.00	$62,000
28	Concrete Class 4000 (Deck Slabs)	CY	2,643	$350.00	$925,000
29	Elastomeric Bearing Pads	EA	96	$75.00	$7,000
30	Steel Bearings	EA	28	$1,200.00	$34,000
31	Prestressed Concrete Girder - Series 14	LF	5,280	$95.00	$502,000
32	Structural Low Alloy Steel	LB	929,280	$1.25	$1,162,000
33	Expansion Joint System - Strip Seal	LF	264	$150.00	$40,000
34	Bridge Drains	EA	10	$400.00	$4,000
35	Traffic Barrier	LF	3,760	$70.00	$263,000
36	Metal Railing	LF	3,760	$45.00	$169,000
37	Membrane Deck Waterproofing	SY	8,202	$10.00	$82,000
38	Approach Embankment	CY	8,898	$10.00	$89,000
Approach Structure Total					**6,194,000**

TABLE VI
Capital Construction Cost Estimate
Movable Bridge Replacement

NO	ITEM	UNIT	QUANTITY	UNIT COST	AMOUNT
BASCULE STRUCTURE					
1	Structure Excavation, Class A	CY	4,000	$20.00	$80,000
2	Class A Hazardous Waste Haul & Disposal	CY	2,000	$100.00	$200,000
3	Shoring & Cribs or Xtra Exc. CL A	SF	00	$22.00	$0
4	Coffer Dam - Pier 5	SF	24,000	$30.00	$720,000
5	Coffer Dam - Pier 6	SF	24,000	$30.00	$720,000
6	Rock Fill	CY	10,600	$25.00	$265,000
7	Fender System	LS	01	LS	$3,500,000
8	Furnish Drive Concrete Filled Steel Pipe Test Pile	EA	04	$8,000.00	$32,000
9	Furnish Steel Pipe Piles	LF	20,800	$75.00	$1,560,000
10	Drive Steel Pipe Piles	EA	160	$2,000.00	$320,000
11	Concrete Fill for Piles - 4000 W	CY	2,500	$120.00	$300,000
12	Steel Reinforcing Bar for Piles	LB	1,700,000	$0.40	$680,000
13	Steel Pipe Tip	EA	160	$350.00	$56,000
14	Concrete Class 4000W For Bridge (Seal)	CY	1,600	$90.00	$144,000
15	Concrete Class 4000 For Bridge	CY	7,872	$225.00	$1,771,000
16	Steel Reinforcing Bar For Bridge	LB	1,164,000	$0.40	$466,000
17	Structural Carbon Steel	LB	540,000	$1.00	$540,000
18	Structural Low Alloy Steel	LB	1,170,000	$1.50	$1,755,000
19	Walkway	LB	35,000	$3.00	$105,000
20	Grid Deck	SF	17,824	$22.00	$392,000
21	Modified Concrete Grid Deck	CF	5,000	$25.00	$125,000
22	Furnishing & Curing MCC Overlay	SF	17,200	$10.00	$172,000
23	Concrete Class CTWT	CY	810	$400.00	$324,000
24	High Strength Bar	LB	4,500	$2.50	$11,000
25	Control Tower	EA	1	$200,000.00	$200,000
26	Mobilization @ 5%	LS	1	$721,900.00	$721,900
Bascule Structure Total					**15,159,900**
BASCULE - MECHANICAL/ELECTRICAL					
27	Mechanical	LS	01	LS	544,000
28	Electrical	LS	01	LS	1,274,000
29	Controls	LS	01	LS	518,000
30	Bridge Mechanical	LS	01	LS	9,271,000
31	Site Unit	LS	01	LS	251,000
Bascule - Mechanical/Electrical Total					**11,858,000**
Bridge Total					$33,211,900
Remove Existing Bridge		LS			$2,500,000
Roadway Total					$558,000
SUBTOTAL					$36,269,900
Contingencies			20%		$7,253,980
Subtotal					$43,523,880
Engineering			24%		$10,445,731
TOTAL					**$53,969,611**

VII. APPENDICES

APPENDIX A

TRAFFIC CAPACITY ANALYSIS

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) EAST MARGINAL WAY (N-S) 16TH AVE. S.
Analyst: XL File Name: JC16AMEX.HC9
Area Type: Other 1-3-94 AM
Comment: 4 LANE BRIDGE REPLACEMENT

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		2	1	1	2		3		1			
Volumes		1350	450	65	440		775		715			
Lane Width		12.0	12.0	12.0	12.0		12.0		12.0			
RTOR Vols			246			0			130		—	

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	*			
	Thru	*					Thru				
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left				
	Thru	*	*				Thru				
	Right						Right				
	Peds						Peds				
NB	Right		*			EB	Right	*			
SB	Right					WB	Right				
Green		55P	6P			Green		45P			
Yellow/A-R		3	3			Yellow/A-R		3			
Lost Time		3.0	3.0			Lost Time		3.0			

Cycle Length: 115 secs Phase combination order: #1 #2 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	T	3391	1622	0.92	0.48	27.7	D	24.4	C
	R	1441	1253	0.17	0.87	0.9	A		
WB	L	1611	84	0.81	0.05	68.8	F	17.3	C
	T	3391	1887	0.26	0.56	10.0	B		
NB	L	4324	1692	0.53	0.39	20.7	C	30.0	D
	R	1441	639	0.96	0.44	43.5	E		

Intersection Delay = 25.6 (sec/veh) Intersection LOS = D

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) EAST MARGINAL WAY (N-S) 16TH AVE. S.
Analyst: XL File Name: JC16PMEX.HC9
Area Type: Other 1-3-94 PM
Comment: 4 LANE BRIDGE REPLACEMENT

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		2	1	1	2		3		1			
Volumes		935	1435	570	1490		865		245			
Lane Width		12.0	12.0	12.0	12.0		12.0		12.0			
RTOR Vols			678			0			100			

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	*			
	Thru	*					Thru				
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left				
	Thru	*	*				Thru				
	Right						Right				
	Peds						Peds				
NB	Right		*			EB	Right	*			
SB	Right					WB	Right				
Green		28P	30P			Green		20P			
Yellow/A-R		3	3			Yellow/A-R		3			
Lost Time		3.0	3.0			Lost Time		3.0			

Cycle Length: 87 secs Phase combination order: #1 #2 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	T	3391	1091	0.95	0.32	33.6	D	36.4	D
	R	1441	795	1.00	0.55	40.0	D		
WB	L	1611	556	1.08	0.34	77.9	F	25.5	D
	T	3391	2378	0.69	0.70	6.4	B		
NB	L	4324	994	1.01	0.23	49.4	E	43.7	E
	R	1441	828	0.18	0.57	6.7	B		

Intersection Delay = 33.3 (sec/veh) Intersection LOS = D

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S. CLOVERDALE ST. (N-S) 14TH AVE. S.
Analyst: XL File Name: JC14THAM.HC9
Area Type: Other 12-29-93 AM
Comment: 4 LANE BRIDGE REPLACEMENT

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		> 1	<		> 1	<		> 2	<		2	<
Volumes	590	10	95	10	10	10	70	1650	10		720	19(
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			0			0			0			0

Signal Operations

Phase combination	1	2	3	4		5	6	7	8
EB Left	*				NB Left	*			
Thru	*				Thru	*			
Right	*				Right	*			
Peds	*				Peds	*			
WB Left	*				SB Left	*			
Thru	*				Thru	*			
Right	*				Right	*			
Peds	*				Peds	*			
NB Right					EB Right				
SB Right					WB Right				
Green	27A				Green	43P			
Yellow/A-R	3				Yellow/A-R	3			
Lost Time	3.0				Lost Time	3.0			

Cycle Length: 76 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1098	390	1.88	0.36	*	*	*	*
WB	LTR	1080	384	0.09	0.36	12.4	B	12.4	B
NB	LTR	2836	1605	1.19	0.57	118.3	F	118.3	F
SB	TR	2923	1654	0.61	0.57	8.8	B	8.8	B

Intersection Delay = * (sec/veh) Intersection LOS = *

* Delay and LOS not meaningful when any v/c is greater than 1.2

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S. CLOVERDALE ST. (N-S) 14TH AVE. S.
Analyst: XL File Name: JC14THPM.HC9
Area Type: Other 12-29-93 PM
Comment: 4 LANE BRIDGE REPLACEMENT

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		> 1	<		> 1	<		> 2	<		2	<
Volumes	305	15	145	30	30	10	105	840	15		1950	100
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			0			0			0			0

Signal Operations

Phase combination	1	2	3	4	5	6	7	8
EB Left	*				NB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
WB Left	*				SB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
NB Right					EB Right			
SB Right					WB Right			
Green	15A				Green	64P		
Yellow/A-R	3				Yellow/A-R	3		
Lost Time	3.0				Lost Time	3.0		

Cycle Length: 85 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1138	201	2.44	0.18	*	*	*	*
WB	LTR	822	145	0.52	0.18	26.7	D	26.7	D
NB	DfL	107	81	1.38	0.75	*	*	*	*
	TR	1691	1273	0.71	0.75	5.5	B		
SB	TR	2865	2157	1.51	0.75	*	*	*	*

Intersection Delay = * (sec/veh) Intersection LOS = *
* Delay and LOS not meaningful when any v/c is greater than 1.2

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEMBOEX.HC9
Area Type: Other 1-3-94 AM
Comment: 4 LANE BRIDGE REPLACEMENT

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	1080	470	15	230	500	1050		280	145	130	95	235
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			300			30			50

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left	*							
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru		*						
	Right		*						
	Peds								
NB	Right		*						
SB	Right	*							
Green		32P	19P						
Yellow/A-R		3	3						
Lost Time		3.0	3.0						

		5	6
NB	Left		
	Thru	*	
	Right	*	
	Peds	*	
SB	Left		*
	Thru		*
	Right	*	*
	Peds		
EB	Right	*	*
WB	Right	*	*
Green		19P	8P
Yellow/A-R		3	3
Lost Time		3.0	3.0

Cycle Length: 90 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	3120	1109	1.08	0.36	67.6	F	51.0	E
	T	5087	1809	0.30	0.36	15.9	C		
	R	1441	993	0.02	0.69	3.3	A		
WB	L	1611	340	0.71	0.21	29.7	D	35.5	D
	T	3391	716	0.77	0.21	29.0	D		
	R	1441	785	1.01	0.54	41.8	E		
NB	T	1696	358	0.82	0.21	35.7	D	28.9	D
	R	1441	608	0.20	0.42	12.5	B		
SB	L	1611	143	0.81	0.09	49.4	E	28.0	D
	LT	1681	149	0.81	0.09	48.8	E		
	R	2543	1752	0.12	0.69	3.6	A		

Intersection Delay = 40.5 (sec/veh) Intersection LOS = E

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEMBPM.HC9
Area Type: Other 1-3-94 PM
Comment: 4 LANE BRIDGE REPLACEMENT

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1 >	1	2
Volumes	470	600	25	275	470	460		225	310	940	485	18 5
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			150			150			600

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left	*							
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru		*						
	Right		*						
	Peds								
NB	Right		*						
SB	Right	*							
Green		14P	15P			12P	47P		
Yellow/A-R		3	3			3	3		
Lost Time		3.0	3.0			3.0	3.0		

		5	6
NB	Left		
	Thru	*	
	Right	*	
	Peds	*	
SB	Left		*
	Thru		*
	Right	*	*
	Peds		
EB	Right	*	*
WB	Right	*	*

Cycle Length: 100 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LO
EB	L	3120	437	1.19	0.14	149.7	F	92.6	F
	T	5087	712	0.98	0.14	53.3	E		
	R	1441	1095	0.02	0.76	2.2	A		
WB	L	1611	242	1.20	0.15	166.8	F	74.9	F
	T	3391	509	1.02	0.15	69.1	F		
	R	1441	1110	0.29	0.77	2.6	A		
NB	T	1696	204	1.16	0.12	153.6	F	99.6	F
	R	1441	389	0.43	0.27	23.4	C		
SB	L	1611	757	1.18	0.47	122.1	F	45.1	E
	LT	1682	791	0.77	0.47	20.0	C		
	R	2543	1933	0.69	0.76	5.4	B		

Intersection Delay = 65.5 (sec/veh) Intersection LOS = F

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) EAST MARGINAL WAY (N-S) 16TH AVE. S.
Analyst: XL File Name: JC16AM2N.HC9
Area Type: Other 1-3-94 AM
Comment: 2NB & 1SB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		2	1	1	2		3		1			
Volumes		1475	220	60	455		765		700			
Lane Width		12.0	12.0	12.0	12.0		12.0		12.0			
RTOR Vols			132			0			300			

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left								
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru	*	*						
	Right								
	Peds								
NB	Right		*						
SB	Right								
Green		44P	5P			29P			
Yellow/A-R		3	3			3			
Lost Time		3.0	3.0			3.0			

		5
NB	Left	*
	Thru	
	Right	*
	Peds	*
SB	Left	
	Thru	
	Right	
	Peds	
EB	Right	*
WB	Right	

Cycle Length: 87 secs Phase combination order: #1 #2 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	T	3391	1715	0.95	0.51	24.5	C	23.2	C
	R	1441	1209	0.08	0.84	0.9	A		
WB	L	1611	93	0.68	0.06	42.5	E	10.3	B
	T	3391	2027	0.25	0.60	6.3	B		
NB	L	4324	1441	0.61	0.33	19.1	C	19.7	C
	R	1441	563	0.75	0.39	21.1	C		

Intersection Delay = 19.9 (sec/veh) Intersection LOS = C

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) EAST MARGINAL WAY (N-S) 16TH AVE. S.
Analyst: XL File Name: JC16PM2N.HC9
Area Type: Other 1-3-94 PM
Comment: 2NB & 1SB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		2	1	1	2		3		1			
Volumes		1105	1130	500	1510		850		220			
Lane Width		12.0	12.0	12.0	12.0		12.0		12.0			
RTOR Vols			426			0			50			

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	*			
	Thru	*					Thru				
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left				
	Thru	*	*				Thru				
	Right						Right				
	Peds						Peds				
NB	Right		*			EB	Right	*			
SB	Right					WB	Right				
Green		32P	26P			Green		20P			
Yellow/A-R		3	3			Yellow/A-R		3			
Lost Time		3.0	3.0			Lost Time		3.0			

Cycle Length: 87 secs Phase combination order: #1 #2 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	T	3391	1247	0.98	0.37	36.1	D	29.0	D
	R	1441	861	0.86	0.60	17.3	C		
WB	L	1611	481	1.09	0.30	87.0	F	25.8	D
	T	3391	2378	0.70	0.70	6.5	B		
NB	L	4324	994	0.99	0.23	45.4	E	39.7	D
	R	1441	762	0.23	0.53	8.4	B		

Intersection Delay = 30.0 (sec/veh) Intersection LOS = D

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S. CLOVERDALE ST. (N-S) 14TH AVE. S.
Analyst: XL
File Name: JC14AM2N.HC9
Area Type: Other
12-29-93 AM
Comment: 2 NB 1 SB

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		> 1	<		> 1	<		> 2	<		2	<
Volumes	580	10	105	10	10	10	95	1310	10		430	45
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			0			0			0			0

Signal Operations

Phase combination	1	2	3	4		5	6	7	8
EB Left	*				NB Left	*			
Thru	*				Thru	*			
Right	*				Right	*			
Peds	*				Peds	*			
WB Left	*				SB Left	*			
Thru	*				Thru	*			
Right	*				Right	*			
Peds	*				Peds	*			
NB Right					EB Right				
SB Right					WB Right				
Green	35A				Green	35P			
Yellow/A-R	3				Yellow/A-R	3			
Lost Time	3.0				Lost Time	3.0			

Cycle Length: 76 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1335	615	1.19	0.46	130.0	F	130.0	F
WB	LTR	1337	616	0.05	0.46	8.6	B	8.6	B
NB	LTR	3180	1464	1.07	0.46	55.1	E	55.1	E
SB	TR	3345	1540	0.34	0.46	10.0	B	10.0	B

Intersection Delay = 65.5 (sec/veh) Intersection LOS = F

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S. CLOVERDALE ST. (N-S) 14TH AVE. S.
Analyst: XL File Name: JC14PM2N.HC9
Area Type: Other 12-29-93 PM
Comment: 2 NB 1 SB

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		> 1	<		> 1	<		> 2	<		2	<
Volumes	290	15	155	30	30	10	135	815	15		1570	80
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			0			0			0			0

Signal Operations

Phase combination	1	2	3	4	5	6	7	8
EB Left	*				NB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
WB Left	*				SB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
NB Right					EB Right			
SB Right					WB Right			
Green	13A				Green	66P		
Yellow/A-R	3				Yellow/A-R	3		
Lost Time	3.0				Lost Time	3.0		

Cycle Length: 85 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1448	221	2.19	0.15	*	*	*	*
WB	LTR	920	141	0.53	0.15	28.2	D	28.2	D
NB	DfL	104	81	1.76	0.78	*	*	*	*
	TR	1691	1313	0.67	0.78	4.3	A		
SB	TR	3218	2499	1.05	0.78	36.8	D	36.8	D

Intersection Delay = * (sec/veh) Intersection LOS = *
* Delay and LOS not meaningful when any v/c is greater than 1.2

HCM: SIGNALIZED INTERSECTION SUMMARY

Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBAM2N.HC9
Area Type: Other 1-4-94 AM
Comment: 2 NB & 1 SB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1 >	1	2
Volumes	1085	475	15	250	495	1040		245	105	115	100	350
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			400			50			50

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left	*				NB	Left				
	Thru	*					Thru	*			
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left		*		
	Thru		*				Thru		*		
	Right		*				Right	*	*		
	Peds						Peds				
NB	Right		*			EB	Right	*	*		
SB	Right	*				WB	Right	*	*		
Green		35P	17P			Green		19P	7P		
Yellow/A-R		3	3			Yellow/A-R		3	3		
Lost Time		3.0	3.0			Lost Time		3.0	3.0		

Cycle Length: 90 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	3120	1213	0.99	0.39	38.1	D	30.4	D
	T	5087	1978	0.28	0.39	14.3	B		
	R	1441	1025	0.02	0.71	2.9	A		
WB	L	1611	304	0.86	0.19	42.0	E	32.4	D
	T	3391	641	0.85	0.19	34.5	D		
	R	1441	737	0.92	0.51	26.9	D		
NB	T	1696	358	0.72	0.21	29.8	D	26.7	D
	R	1441	576	0.10	0.40	12.8	B		
SB	L	1611	125	0.92	0.08	70.6	F	27.7	D
	LT	1691	132	0.84	0.08	55.8	E		
	R	2543	1808	0.18	0.71	3.3	A		

Intersection Delay = 30.5 (sec/veh) Intersection LOS = D

HCS: Signalized Intersection Version 2.1

Sverdrup Corporation
3300 Carillon Point
Kirkland, WA 98033-2083 (206) 822-3300

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBAM2N.HC9
Area Type: Other 1-4-94 AM
Comment: 2 NB & 1 SB LANES

Traffic and Roadway Conditions

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	1085	475	15	250	495	1040		245	105	115	100	350
PHF or PK15	0.95	0.95	0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	0.95
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12
Grade		0			0			0			0	
% Heavy Veh	12	12	12	12	12	12		12	12	12	12	12
Parking	(Y/N)	N		(Y/N)	N		(Y/N)	N		(Y/N)	N	
Bus Stops			0			0			0			
Con. Peds			0			0			0			0
Ped Button	(Y/N)	N		(Y/N)	N		(Y/N)	N		(Y/N)	N	
Arr Type	3	3	3	3	3	3		3	3	3	3	
RTOR Vols			0			400			50			50

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left	*				NB	Left				
	Thru	*					Thru	*			
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left		*		
	Thru		*				Thru		*		
	Right		*				Right	*	*		
	Peds						Peds				
NB	Right		*			EB	Right	*	*		
SB	Right	*				WB	Right	*	*		
Green		35P	17P			Green		19P	7P		
Yellow/A-R		3	3			Yellow/A-R		3	3		
Lost Time		3.0	3.0			Lost Time		3.0	3.0		

Cycle Length: 90 secs Phase combination order: #1 #2 #5 #6

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBAM2N.HC9
Area Type: Other 1-4-94 AM
Comment: 2 NB & 1 SB LANES

Volume Adjustment Worksheet

Direction/ Mvt	Mvt Vol	PHF	Adj Vol	Lane Grp	Lane Grp Vol	No. Ln	Lane Util Fact	Growth Fact	Adj Grp Vol	Prop LT	Prop RT
EB											
Left	1085	0.95	1142	L	1142	2	1.050	1.000	1199	1.00	0.00
Thru	475	0.95	500	T	500	3	1.100	1.000	550	0.00	0.00
Right	15	0.95	16	R	16	1	1.000	1.000	16	0.00	1.00
WB											
Left	250	0.95	263	L	263	1	1.000	1.000	263	1.00	0.00
Thru	495	0.95	521	T	521	2	1.050	1.000	547	0.00	0.00
Right	1040	0.95	674	R	674	1	1.000	1.000	674	0.00	1.00
NB											
Thru	245	0.95	258	T	258	1	1.000	1.000	258	0.00	0.00
Right	105	0.95	58	R	58	1	1.000	1.000	58	0.00	1.00
SB											
Left	115	0.95	121	L	115	1	1.000	1.000	115	1.00	0.00
Thru	100	0.95	105	LT	111	1	1.000	1.000	111	0.05	0.00
Right	350	0.95	315	R	315	2	1.050	1.000	331	0.00	1.00

Saturation Flow Adjustment Worksheet

Direction/ LnGrp	Ideal Sat Flow	No. Lns	f W	f HV	f G	f p	f BB	f A	f RT	f LT	Adj Sat Flow
EB											
L	1800	2	1.00	0.94	1.00	1.00	1.00	1.00	1.00	0.92	3120
T	1800	3	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	5087
R	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	0.85	1.00	1441
WB											
L	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	0.95	1611
T	1800	2	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	3391
R	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	0.85	1.00	1441
NB											
T	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1696
R	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	0.85	1.00	1441
SB											
L	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	0.95	1611
LT	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1691
R	1800	2	1.00	0.94	1.00	1.00	1.00	1.00	0.75	1.00	2543

HCS: Signalized Intersection Version 2.1

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBAM2N.HC9
Area Type: Other 1-4-94 AM
Comment: 2 NB & 1 SB LANES

Capacity Analysis Worksheet

Direction/ LnGrp	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	Lane Group Capacity (c)	v/c Ratio
EB						
L	1199	3120	0.384	0.389	1213	0.988 *
T	550	5087	0.108	0.389	1978	0.278
R	16	1441	0.011	0.711	1025	0.016
WB						
L	263	1611	0.163	0.189	304	0.864
T	547	3391	0.161	0.189	641	0.854
R	674	1441	0.468	0.511	737	0.915 *
NB						
T	258	1696	0.152	0.211	358	0.721 *
R	58	1441	0.040	0.400	576	0.101
SB						
L	115	1611	0.071	0.078	125	0.918 *
LT	111	1691	0.066	0.078	132	0.844
R	331	2543	0.130	0.711	1808	0.183

Cycle Length, C = 90.0 sec. Sum (v/s) critical = 1.076
Lost Time Per Cycle, L = 12.0 sec. X critical = 1.241

Level of Service Worksheet

Direction/ LnGrp	v/c Ratio	g/C Ratio	Cycle Len	Delay d 1	Lane Group Cap	Delay d 2	Prog Fact	Lane Grp Delay	Lane Grp LOS	Delay By App	LOS By App
EB											
L	0.99	0.389	90.0	20.7	1213	17.4	1.00	38.1	D	30.4	D
T	0.28	0.389	90.0	14.3	1978	0.0	1.00	14.3	B		
R	0.02	0.711	90.0	2.9	1025	0.0	1.00	2.9	A		
WB											
L	0.86	0.189	90.0	26.9	304	15.1	1.00	42.0	E	32.4	D
T	0.85	0.189	90.0	26.8	641	7.6	1.00	34.5	D		
R	0.92	0.511	90.0	15.4	737	11.5	1.00	26.9	D		
NB											
T	0.72	0.211	90.0	25.1	358	4.7	1.00	29.8	D	26.7	D
R	0.10	0.400	90.0	12.8	576	0.0	1.00	12.8	B		
SB											
L	0.92	0.078	90.0	31.3	125	39.3	1.00	70.6	F	27.7	D
LT	0.84	0.078	90.0	31.1	132	24.7	1.00	55.8	E		
R	0.18	0.711	90.0	3.3	1808	0.0	1.00	3.3	A		

Intersection Delay = 30.5 (sec/veh) Intersection LOS = D

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBPM2N.HC9
Area Type: Other 1-4-94 PM
Comment: 2 NB & 1 SB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	400	600	25	305	470	450		190	310	925	495	1970
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			150			100			700

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left	*				NB	Left				
	Thru	*					Thru	*			
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left		*		
	Thru		*				Thru		*		
	Right		*				Right	*	*		
	Peds						Peds				
NB	Right		*			EB	Right	*	*		
SB	Right	*				WB	Right	*	*		
Green		12P	17P			Green		10P	49P		
Yellow/A-R		3	3			Yellow/A-R		3	3		
Lost Time		3.0	3.0			Lost Time		3.0	3.0		

Cycle Length: 100 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	3120	374	1.18	0.12	147.3	F	124.6	F
	T	5087	610	1.14	0.12	114.8	F		
	R	1441	1066	0.02	0.74	2.6	A		
WB	L	1611	274	1.17	0.17	148.0	F	61.1	F
	T	3391	576	0.90	0.17	43.3	E		
	R	1441	1138	0.28	0.79	2.2	A		
NB	T	1696	170	1.18	0.10	169.1	F	93.7	F
	R	1441	389	0.57	0.27	25.4	D		
SB	L	1611	789	1.17	0.49	118.8	F	44.5	E
	LT	1688	827	0.69	0.49	16.6	C		
	R	2543	1882	0.75	0.74	6.9	B		

Intersection Delay = 68.1 (sec/veh) Intersection LOS = F

Sverdrup Corporation
3300 Carillon Point
Kirkland, WA 98033-2083 (206) 822-3300

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBPM2N.HC9
Area Type: Other 1-4-94 PM
Comment: 2 NB & 1 SB LANES

Traffic and Roadway Conditions

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1 >	1	2
Volumes	400	600	25	305	470	450		190	310	925	495	19[illegible]
PHF or PK15	0.95	0.95	0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	0.[illegible]
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
Grade		0			0			0			0	
% Heavy Veh	12	12	12	12	12	12		12	12	12	12	[illegible]
Parking	(Y/N)	N		(Y/N)	N		(Y/N)	N		(Y/N)	N	
Bus Stops			0			0			0			[illegible]
Con. Peds			0			0			0			[illegible]
Ped Button	(Y/N)	N		(Y/N)	N		(Y/N)	N		(Y/N)	N	
Arr Type	3	3	3	3	3	3		3	3	3	3	3
RTOR Vols			0			150			100			70[illegible]

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left	*							
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru		*						
	Right		*						
	Peds								
NB	Right		*						
SB	Right	*							
Green		12P	17P						
Yellow/A-R		3	3						
Lost Time		3.0	3.0						

		5	6	7	8
NB	Left				
	Thru	*			
	Right	*			
	Peds	*			
SB	Left		*		
	Thru		*		
	Right	*	*		
	Peds				
EB	Right	*	*		
WB	Right	*	*		
Green		10P	49P		
Yellow/A-R		3	3		
Lost Time		3.0	3.0		

Cycle Length: 100 secs Phase combination order: #1 #2 #5 #6

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBPM2N.HC9
Area Type: Other 1-4-94 PM
Comment: 2 NB & 1 SB LANES

Volume Adjustment Worksheet

Direction/ Mvt	Mvt Vol	PHF	Adj Vol	Lane Grp	Lane Grp Vol	No. Ln	Lane Util Fact	Growth Fact	Adj Grp Vol	Prop LT	Prop RT
EB											
Left	400	0.95	421	L	421	2	1.050	1.000	442	1.00	0.00
Thru	600	0.95	632	T	632	3	1.100	1.000	695	0.00	0.00
Right	25	0.95	26	R	26	1	1.000	1.000	26	0.00	1.00
WB											
Left	305	0.95	321	L	321	1	1.000	1.000	321	1.00	0.00
Thru	470	0.95	495	T	495	2	1.050	1.000	520	0.00	0.00
Right	450	0.95	316	R	316	1	1.000	1.000	316	0.00	1.00
NB											
Thru	190	0.95	200	T	200	1	1.000	1.000	200	0.00	0.00
Right	310	0.95	221	R	221	1	1.000	1.000	221	0.00	1.00
SB											
Left	925	0.95	974	L	925	1	1.000	1.000	925	1.00	0.00
Thru	495	0.95	521	LT	570	1	1.000	1.000	570	0.09	0.00
Right	1970	0.95	1337	R	1337	2	1.050	1.000	1404	0.00	1.00

Saturation Flow Adjustment Worksheet

Direction/ LnGrp	Ideal Sat Flow	No. Lns	f W	f HV	f G	f p	f BB	f A	f RT	f LT	Adj Sat Flow
EB											
L	1800	2	1.00	0.94	1.00	1.00	1.00	1.00	1.00	0.92	3120
T	1800	3	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	5087
R	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	0.85	1.00	1441
WB											
L	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	0.95	1611
T	1800	2	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	3391
R	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	0.85	1.00	1441
NB											
T	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1696
R	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	0.85	1.00	1441
SB											
L	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	0.95	1611
LT	1800	1	1.00	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1688
R	1800	2	1.00	0.94	1.00	1.00	1.00	1.00	0.75	1.00	2543

HCS: Signalized Intersection Version 2.1

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBPM2N.HC9
Area Type: Other 1-4-94 PM
Comment: 2 NB & 1 SB LANES

Capacity Analysis Worksheet

Direction/ LnGrp	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	Lane Group Capacity (c)	v/c Ratio
EB						
L	442	3120	0.142	0.120	374	1.181 *
T	695	5087	0.137	0.120	610	1.139
R	26	1441	0.018	0.740	1066	0.024
WB						
L	321	1611	0.199	0.170	274	1.172
T	520	3391	0.153	0.170	576	0.902
R	316	1441	0.219	0.790	1138	0.278 *
NB						
T	200	1696	0.118	0.100	170	1.179 *
R	221	1441	0.153	0.270	389	0.568
SB						
L	925	1611	0.574	0.490	789	1.172 *
LT	570	1688	0.338	0.490	827	0.689
R	1404	2543	0.552	0.740	1882	0.746

Cycle Length, C = 100.0 sec. Sum (v/s) critical = 1.053
Lost Time Per Cycle, L = 12.0 sec. X critical = 1.197

Level of Service Worksheet

Direction/ LnGrp	v/c Ratio	g/C Ratio	Cycle Len	Delay d 1	Lane Group Cap	Delay d 2	Prog Fact	Lane Grp Delay	Lane Grp LOS	Delay By App	LOS By App
EB											
L	1.18	0.120	100.0	34.3	374	113.0	1.00	147.3	F	124.6	F
T	1.14	0.120	100.0	34.1	610	80.7	1.00	114.8	F		
R	0.02	0.740	100.0	2.6	1066	0.0	1.00	2.6	A		
WB											
L	1.17	0.170	100.0	32.7	274	115.3	1.00	148.0	F	61.1	F
T	0.90	0.170	100.0	30.9	576	12.4	1.00	43.3	E		
R	0.28	0.790	100.0	2.1	1138	0.0	1.00	2.2	A		
NB											
T	1.18	0.100	100.0	34.9	170	134.2	1.00	169.1	F	93.7	F
R	0.57	0.270	100.0	23.9	389	1.5	1.00	25.4	D		
SB											
L	1.17	0.490	100.0	23.2	789	95.6	1.00	118.8	F	44.5	E
LT	0.69	0.490	100.0	14.9	827	1.7	1.00	16.6	C		
R	0.75	0.740	100.0	5.7	1882	1.2	1.00	6.9	B		

Intersection Delay = 68.1 (sec/veh) Intersection LOS = F

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) EAST MARGINAL WAY (N-S) 16TH AVE. S.
Analyst: XL File Name: JC16AM2S.HC9
Area Type: Other 1-3-94 AM
Comment: 1NB & 2SB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		2	1	1	2		3		1			
Volumes		1390	430	60	525		820		570			
Lane Width		12.0	12.0	12.0	12.0		12.0		12.0			
RTOR Vols			246			0			250			

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left					NB	Left	*			
	Thru	*					Thru				
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left				
	Thru	*	*				Thru				
	Right						Right				
	Peds						Peds				
NB	Right		*			EB	Right	*			
SB	Right					WB	Right				
Green		42P	4P			Green		32P			
Yellow/A-R		3	3			Yellow/A-R		3			
Lost Time		3.0	3.0			Lost Time		3.0			

Cycle Length: 87 secs Phase combination order: #1 #2 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	T	3391	1637	0.94	0.48	24.1	C	21.5	C
	R	1441	1226	0.16	0.85	0.9	A		
WB	L	1611	74	0.85	0.05	69.4	F	13.7	B
	T	3391	1910	0.30	0.56	7.6	B		
NB	L	4324	1590	0.60	0.37	17.4	C	17.0	C
	R	1441	596	0.57	0.41	15.8	C		

Intersection Delay = 18.5 (sec/veh) Intersection LOS = C

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) EAST MARGINAL WAY (N-S) 16TH AVE. S.
Analyst: XL File Name: JC16PM2S.HC9
Area Type: Other 1-3-94 PM
Comment: 1NB & 2SB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		2	1	1	2		3		1			
Volumes		995	1410	560	1600		800		200			
Lane Width		12.0	12.0	12.0	12.0		12.0		12.0			
RTOR Vols			690			0			50			

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left								
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru	*	*						
	Right								
	Peds								
NB	Right		*						
SB	Right								
Green		28P	30P						
Yellow/A-R		3	3						
Lost Time		3.0	3.0						

		5
NB	Left	*
	Thru	
	Right	*
	Peds	*
SB	Left	
	Thru	
	Right	
	Peds	
EB	Right	*
WB	Right	
Green		20P
Yellow/A-R		3
Lost Time		3.0

Cycle Length: 87 secs Phase combination order: #1 #2 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	T	3391	1091	1.01	0.32	45.1	E	38.8	D
	R	1441	795	0.95	0.55	29.7	D		
WB	L	1611	556	1.06	0.34	70.0	F	22.8	C
	T	3391	2378	0.74	0.70	7.1	B		
NB	L	4324	994	0.93	0.23	35.7	D	31.5	D
	R	1441	828	0.19	0.57	6.7	B		

Intersection Delay = 30.2 (sec/veh) Intersection LOS = D

TABLE VII
Life Cycle Cost Analysis
Three Percent Discount Rate

No.	Item	Start Year	Years of Service	Alternative FBR100 Fixed Bridge Replacement 100-Foot Clearance		Alternative MBR Movable Bridge Replacement	
				1993 Cost $1,000	Present Value $1,000	1993 Cost $1,000	Present Value $1,000
1	**Capital Construction Costs**						
	1. Fixed Bridge Replacement	8		37,626	29,702		
	2. Right-of-Way Costs.	7		6,000	4,879	3,000	2,439
	3. Movable Bridge Replacement	8				53,970	42,604
2	**Salvage Value**						
	1. Right-of-Way	58		(2,300)	(414)	(3,000)	(540)
	2. Salvage	58		(18,813)	(3,388)	(26,985)	(4,859)
3	**Annual Maintenance & Operation**						
	1. Existing Bascule Bridge Operators		10	221	1,881	221	1,881
	2. Existing Bascule Bridge Maintenance		10	27	227	27	227
	3. FBR100 Maintenance	10	50	10	191		
	4. MBR Operators	10	50			221	4,222
	5. MBR Maintenance	10	50			80	1,532
4	**Major Maintenance**						
	1. Short Term Improvements to Existing Bascule	3		1,466	1,342	1,466	1,342
5	**Grand Total including RW Costs**				34,420		48,847
6	**Grand Total excluding RW Costs**				29,956		46,948

Notes

1 Salvage value of the FBR100 or MBR is based on a straight line depreciation of it's value at it's expected life.
2 The existing bascule bridge must remain in operation until the FBR100 or MBR is built.
3 The useful life of the FBR100 of MBR is assumed to be 100 years.
4 The useful life of the RBB is assumed to be 50 years.

TABLE VII
Life Cycle Cost Analysis
Three Percent Discount Rate

No.	Item	Start Year	Years of Service	Alternative FBR60 Fixed Bridge Replacement 60-Foot Clearance		Alternative RBB Rehabilitated Bascule Bridge	
				1993 Cost $1,000	Present Value $1,000	1993 Cost $1,000	Present Value $1,000
1	**Capital Construction Costs**						
	1. Fixed Bridge Replacement	8		21,643	17,085		
	2. Right-of-Way Costs.	7		2,300	1,870		
	3. Waterway Users (ALLOWANCE)	8		3,000	2,368		
	4. Renovated Bascule Bridge	7				14,079	11,448
2	**Salvage Value**						
	1. Right-of-Way	58		(2,300)	(414)		
	2. FBR60 Salvage	58		(10,822)	(1,949)		
3	**Annual Maintenance & Operation**						
	1. Bascule Bridge Operators		10	221	1,881		
	2. Bascule Bridge Maintenance		10	27	227		
	3. FBR55 Maintenance	10	50	10	191		
	4. Bascule Bridge Operators		60			221	6,102
	5. Bascule Bridge Maintenance		60			80	2,214
4	**Major Maintenance**						
	1. Short Term Improvements to Bascule	3		1,466	1,342	1,466	1,342
5	**Grand Total including RW Costs**				22,602		21,106
6	**Grand Total excluding RW Costs**				21,146		21,106

Notes

1 Salvage value of the FBR60 is based on a straight line depreciation of it's value at it's expected life.
2 The existing bascule bridge must remain in operation until the FBR60 is built.
3 The useful life of the FBR60 is assumed to be 100 years.
4 The useful life of the RBB is assumed to be 50 years.

HCM: SIGNALIZED INTERSECTION SUMMARY

Sverdrup Corporation

Streets: (E-W) S. CLOVERDALE ST. (N-S) 14TH AVE. S.
Analyst: XL File Name: JC14AM1N.HC9
Area Type: Other 12-29-93 AM
Comment: 1 NB 2 SB

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		> 1	<		> 1	<		> 2	<		2	<
Volumes	610	10	135	10	10	10	80	1030	10		700	185
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			0			0			0			0

Signal Operations

Phase combination	1	2	3	4	5	6	7	8
EB Left	*				NB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
WB Left	*				SB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
NB Right					EB Right			
SB Right					WB Right			
Green	38A				Green	32P		
Yellow/A-R	3				Yellow/A-R	3		
Lost Time	3.0				Lost Time	3.0		

Cycle Length: 76 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1325	662	1.20	0.50	133.3	F	133.3	F
WB	LTR	1307	654	0.05	0.50	7.4	B	7.4	B
NB	LTR	2514	1059	1.17	0.42	110.2	F	110.2	F
SB	TR	3284	1383	0.71	0.42	15.0	B	15.0	B

Intersection Delay = 84.5 (sec/veh) Intersection LOS = F

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S. CLOVERDALE ST. (N-S) 14TH AVE. S.
Analyst: XL File Name: JC14PM1N.HC9
Area Type: Other 12-29-93 PM
Comment: 1 NB 2 SB

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes		> 1	<		> 1	<		> 2	<		2	<
Volumes	280	15	195	30	30	5	120	800	15		1925	99
Lane Width		12.0			12.0			12.0			12.0	
RTOR Vols			0			0			0			0

Signal Operations

Phase combination	1	2	3	4	5	6	7	8
EB Left	*				NB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
WB Left	*				SB Left	*		
Thru	*				Thru	*		
Right	*				Right	*		
Peds	*				Peds	*		
NB Right					EB Right			
SB Right					WB Right			
Green	15A				Green	64P		
Yellow/A-R	3				Yellow/A-R	3		
Lost Time	3.0				Lost Time	3.0		

Cycle Length: 85 secs Phase combination order: #1 #5

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	LTR	1434	253	2.04	0.18	*	*	*	*
WB	LTR	773	136	0.51	0.18	26.6	D	26.6	D
NB	DfL	107	81	1.56	0.75	*	*	*	*
	TR	1691	1273	0.67	0.75	5.0	B		
SB	TR	3218	2423	1.33	0.75	*	*	*	*

Intersection Delay = * (sec/veh) Intersection LOS = *
* Delay and LOS not meaningful when any v/c is greater than 1.2

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBAM2S.HC9
Area Type: Other 1-4-94 AM
Comment: 2 SB & 1 NB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	1125	500	30	200	475	1055		305	145	120	120	280
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			400			50			50

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left	*				NB	Left				
	Thru	*					Thru		*		
	Right	*					Right		*		
	Peds	*					Peds		*		
WB	Left		*			SB	Left	*			
	Thru		*				Thru	*			
	Right		*				Right	*	*		
	Peds						Peds				
NB	Right		*			EB	Right	*	*		
SB	Right	*				WB	Right	*	*		
Green		34P	17P			Green		8P	19P		
Yellow/A-R		3	3			Yellow/A-R		3	3		
Lost Time		3.0	3.0			Lost Time		3.0	3.0		

Cycle Length: 90 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	3120	1179	1.05	0.38	57.8	E	43.5	E
	T	5087	1922	0.30	0.38	15.0	B		
	R	1441	1025	0.03	0.71	2.9	A		
WB	L	1611	304	0.69	0.19	30.4	D	29.3	D
	T	3391	641	0.82	0.19	32.4	D		
	R	1441	753	0.92	0.52	26.5	D		
NB	T	1696	358	0.90	0.21	43.2	E	36.1	D
	R	1441	576	0.17	0.40	13.2	B		
SB	L	1611	143	0.84	0.09	53.1	E	29.4	D
	LT	1692	150	0.88	0.09	58.4	E		
	R	2543	1808	0.14	0.71	3.2	A		

Intersection Delay = 36.2 (sec/veh) Intersection LOS = D

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBPM2S.HC9
Area Type: Other 1-4-94 PM
Comment: 2 SB & 1 NB LANES

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	520	640	40	235	445	465		265	310	840	520	18[illegible]
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			150			50			60[illegible]

Signal Operations

Phase combination		1	2	3	4			5	6	7	8
EB	Left	*				NB	Left	*			
	Thru	*					Thru	*			
	Right	*					Right	*			
	Peds	*					Peds	*			
WB	Left		*			SB	Left		*		
	Thru		*				Thru		*		
	Right		*				Right	*	*		
	Peds						Peds	*			
NB	Right		*			EB	Right	*	*		
SB	Right	*				WB	Right	*	*		
Green		16P	14P			Green		14P	44P		
Yellow/A-R		3	3			Yellow/A-R		3	3		
Lost Time		3.0	3.0			Lost Time		3.0	3.0		

Cycle Length: 100 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Mvmts	Group: Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LO
EB	L	3120	499	1.15	0.16	122.8	F	74.8	F
	T	5087	814	0.91	0.16	41.6	E		
	R	1441	1110	0.04	0.77	2.1	A		
WB	L	1611	226	1.10	0.14	114.0	F	61.5	F
	T	3391	475	1.03	0.14	74.3	F		
	R	1441	1081	0.31	0.75	3.1	A		
NB	T	1696	237	1.18	0.14	154.6	F	91.7	F
	R	1441	403	0.68	0.28	27.4	D		
SB	L	1611	709	1.19	0.44	129.8	F	45.8	E
	LT	1689	743	0.80	0.44	22.5	C		
	R	2883	2133	0.66	0.74	5.6	B		

Intersection Delay = 59.8 (sec/veh) Intersection LOS = E

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBAMBC.HC9
Area Type: Other 1-3-94 AM
Comment: BRIDGE CLOSURE

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	1225	595	30	230	525	1050		265	145	240	165	585
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			300			50			50

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left	*							
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru		*						
	Right		*						
	Peds								
NB	Right		*						
SB	Right	*							
Green		38P	23P			14P	13P		
Yellow/A-R		3	3			3	3		
Lost Time		3.0	3.0			3.0	3.0		

		5	6
NB	Left		
	Thru	*	
	Right	*	
	Peds	*	
SB	Left		*
	Thru		*
	Right	*	*
	Peds		
EB	Right	*	*
WB	Right	*	*

Cycle Length: 100 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	3120	1186	1.14	0.38	100.0	F	70.9	F
	T	5087	1933	0.36	0.38	16.9	C		
	R	1441	980	0.03	0.68	4.0	A		
WB	L	1611	371	0.65	0.23	29.4	D	40.9	E
	T	3391	780	0.74	0.23	29.9	D		
	R	1441	764	1.03	0.53	52.5	E		
NB	T	1696	237	1.18	0.14	154.6	F	118.1	F
	R	1441	533	0.19	0.37	16.2	C		
SB	L	1611	209	0.96	0.13	71.2	F	37.0	D
	LT	1677	218	1.03	0.13	90.2	F		
	R	2543	1729	0.34	0.68	5.1	B		

Intersection Delay = 58.1 (sec/veh) Intersection LOS = E

HCM: SIGNALIZED INTERSECTION SUMMARY
Sverdrup Corporation

Streets: (E-W) S BOEING ACCESS RD. (N-S) EAST MARGINAL WAY
Analyst: XL File Name: JCEBPMBC.HC9
Area Type: Other 1-3-94 PM
Comment: BRIDGE CLOSURE

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	2	3	1	1	2	1		1	1	1	> 1	2
Volumes	655	760	40	280	435	460		240	310	765	575	228
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0	12.0	12.0	12.0
RTOR Vols			0			150			100			800

Signal Operations

Phase combination		1	2	3	4	5	6	7	8
EB	Left	*							
	Thru	*							
	Right	*							
	Peds	*							
WB	Left		*						
	Thru		*						
	Right		*						
	Peds								
NB	Right		*						
SB	Right	*							
Green		20P	16P			12P	40P		
Yellow/A-R		3	3			3	3		
Lost Time		3.0	3.0			3.0	3.0		

		5	6
NB	Left		
	Thru	*	
	Right	*	
	Peds	*	
SB	Left		*
	Thru		*
	Right	*	*
	Peds		
EB	Right	*	*
WB	Right	*	*

Cycle Length: 100 secs Phase combination order: #1 #2 #5 #6

Intersection Performance Summary

	Lane Group: Mvmts	Cap	Adj Sat Flow	v/c Ratio	g/c Ratio	Delay	LOS	Approach: Delay	LOS
EB	L	3120	624	1.16	0.20	122.9	F	72.8	F
	T	5087	1017	0.86	0.20	35.0	D		
	R	1441	1081	0.04	0.75	2.4	A		
WB	L	1611	258	1.14	0.16	134.3	F	55.8	E
	T	3391	543	0.89	0.16	42.7	E		
	R	1441	1023	0.32	0.71	4.2	A		
NB	T	1696	204	1.24	0.12	*	*	*	*
	R	1441	403	0.55	0.28	24.5	C		
SB	L	1611	644	1.19	0.40	133.6	F	47.1	E
	LT	1690	676	0.95	0.40	39.6	D		
	R	2543	1907	0.86	0.75	9.6	B		

Intersection Delay = * (sec/veh) Intersection LOS = *
* Delay and LOS not meaningful when any v/c is greater than 1.2

APPENDIX B

CULTURAL RESOURCES AND HISTORICAL SIGNIFICANCE STUDY

EASTERN
EASTERN WASHINGTON UNIVERSITY
CHENEY • SPOKANE

January 22, 1993

Mr. William S. Vlcek, P.E.
Manager, Engineering Services Section
King County Division of Roads and Engineering
King County Administration Building
500 Fourth Avenue - Room 900
Seattle, WA 98104-2339

Dear Mr. Vlcek:

As you know, your Division has requested a review of the known cultural resources within the area to be affected by the proposed 14th/16th Avenue South bridge project. This letter report contains information on the significance of the bridge, includes a statement of the project area's cultural resource potential, discusses the cultural resource regulations involved in replacement of the bridge, and makes recommendations for further work.

The 14th/16th Avenue S. bridge, erected in 1931, is in need of extensive repair. The project, as it is currently proposed by King County, would replace the bridge. At this time three possible alternatives are under study. The structure could be replaced (a) on the current alignment, (b) just west of and parallel to the existing alignment, or (c) further west with the western approach situated along 14th Avenue S.

The bridge spans the Duwamish River from South Park on the west bank to Boeing Plant #2 on the river's east bank. It is located in Section 32 of T24N, R4E. The area on the west bank is part of King County while the eastern bank is within Tukwila city limits (see Figure 1).

Archival review for the preliminary cultural resource study included search of the records filed at the Office of Archaeology and Historic Preservation in Olympia (OAHP), as well as those at the King County Cultural Resources Division and at King County archives. Pertinent historical, ethnographic and archaeological monographs and reports were also studied.

SIGNIFICANCE:

Construction of a bridge across the Duwamish was being considered as early as the first decades of this century. In a resolution dated August 17, 1914, the county called for bids for construction

ARCHAEOLOGICAL AND HISTORICAL SERVICES
Main Office • 313 Monroe Hall, Mail Stop 168, Cheney, WA 99004-2490 • (509) 359-2239, FAX (509) 359-6693
Bellevue Office • 14400 Bel-Red Road, Suite 101, Bellevue, WA 98007 • (206) 746-6097
Vancouver Office • 400 East Evergreen Blvd., Suite 220, Vancouver, WA 98660 • (206) 696-6121
EOE

of a drawbridge at the location of present day 14th Avenue S. The brick surface of the approach roadway on the south side of the river still exists. The old bridge was replaced by the county in 1931 with a Scherzer Rolling Lift Bascule structure at a cost of $538,058.46. The bridge, the only one of its type extant in the state, was designed by the Scherzer Rolling Lift Bridge Company of Chicago (Soderberg 1980).

The 14th/16th Avenue bridge is listed in the National Register of Historic Places (Washington State Department of Community Development 1991:13, Soderberg 1980) and is inventoried as part of the King County Historic Sites Survey (Bean 1985).

CULTURAL RESOURCE REGULATIONS:

Because of the structure's significance as a National Register property and the need to obtain Federal permits in order to accomplish the project, Section 106 of the National Historic Preservation Act becomes applicable. It states,

> The head of any Federal agency having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking in any State and the head of any Federal department of independent agency having authority to license any undertaking shall prior to the approval of the expenditure of any Federal funds in the undertaking or prior to the issuance of any license, as the case may be, take into account the effect of the undertaking on any district, site, building, structure or object that is included in or eligible for inclusion in the National Register [Section 106, National Historic Preservation Act of 1966, as amended (16 U.S.C. 470f)].

The initial step in the process involves King County. The county, in consultation with the State Historic Preservation Officer, would assess the effects of the project on the bridge as well as on any other structures of significance that would be impacted. Mitigation of the effects of the project on the bridge could take the form of Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) recordation. The National Historic Preservation Act, as amended in 1980, directed the Secretary of the Interior to develop a uniform process and standards for documenting historic properties for the purpose of incorporation into the architectural and engineering records collections maintained by the Library of Congress. The HABS/HAER program is administered by the National Park Service and its standards for recordation are consistent and lucid. Examination of the King County archives reveals the existence of some of the documentation that is normally required for HABS/HAER recordation.

CULTURAL RESOURCE POTENTIAL:

The information supplied to ethnographers by Indians of the area does not mention any villages or camps within the area occupied by the three alternatives. Nor, with the exception of the 14th/16th bridge, are there any archaeological sites or historical features recorded within the project area (OAHP 1992). Judging from the history of development of the region,it is unlikely

that any archaeological material could have survived intact because of the multiple modifications that have taken place since initial Euro-American settlement in 1851.

In the early years of this century, the Duwamish was rechannelized. It was a massive public works project that also involved dredging swampy places and filling the tidelands along its banks with a combination of dredge spoils and earth from the city's regrade projects. Since that time, buildings, paving, and utilities have been installed on both sides of the river. The east side of the river in the study area was most recently affected by the installation and improvements to the Boeing plant.

Preliminary examination of the study area reveals that several standing structures are near or perhaps, within the study area may possess historical significance. Further review of these structures will be required to assess their potential historic significance.

RECOMMENDATIONS:

A survey of the built environment to be affected by the project should be undertaken to determine the significance of buildings within the boundaries of the project. I have enclosed a copy of the publication Section 106: Step-by-Step for your information (see Attachment 1). In order to replace the bridge, the 106 review process should be initiated as soon as possible, beginning with assessment of effects of the project on the structure (Step 2).

Our professional staff will be pleased to provide expertise to help you meet the compliance requirements.

Sincerely,

Joan M. Robinson
ka

Joan M. Robinson
Archaeological Consultant

JMR:ku

Enclosures

cc: Mark Follett
Doug Jewett ✓

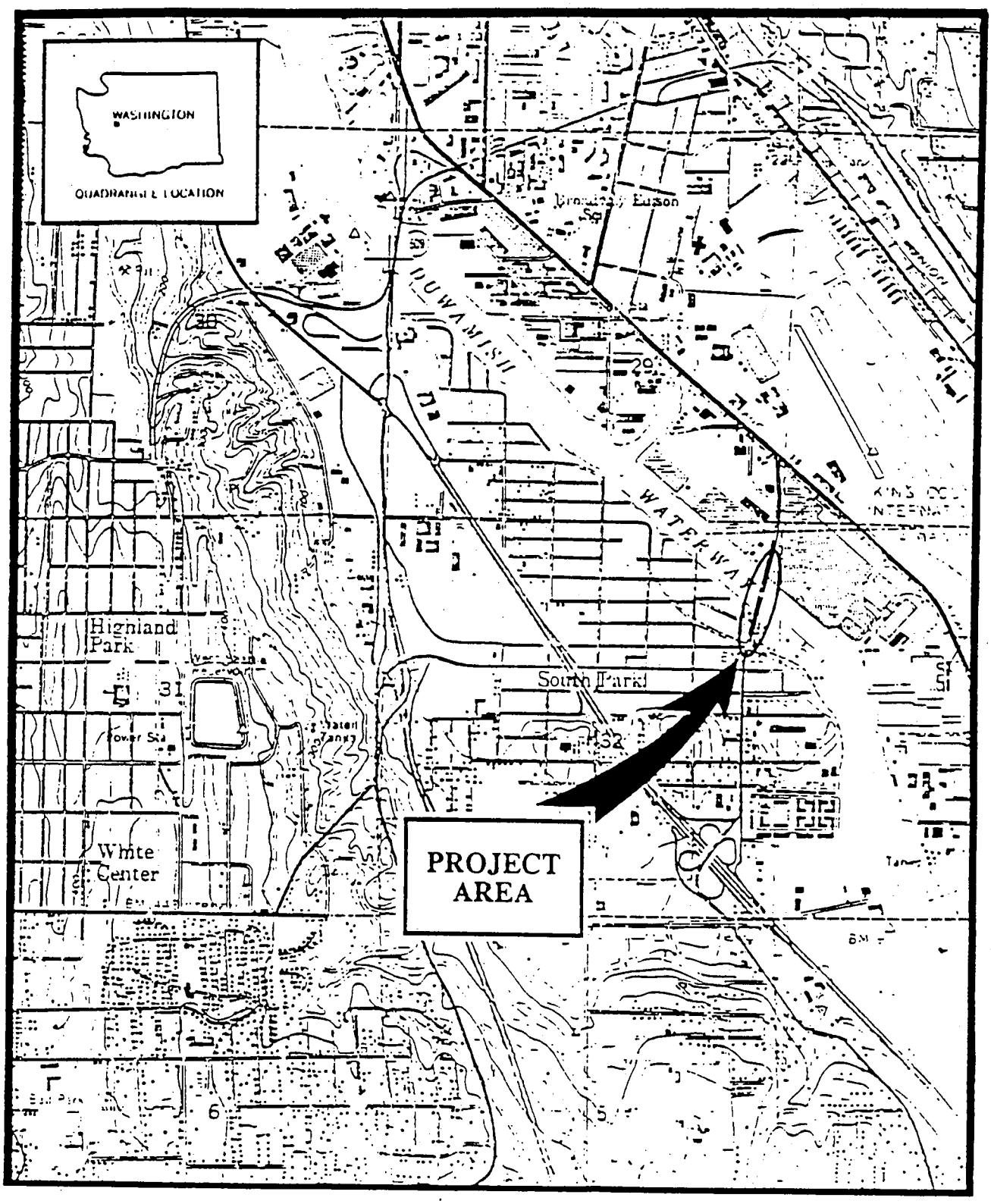
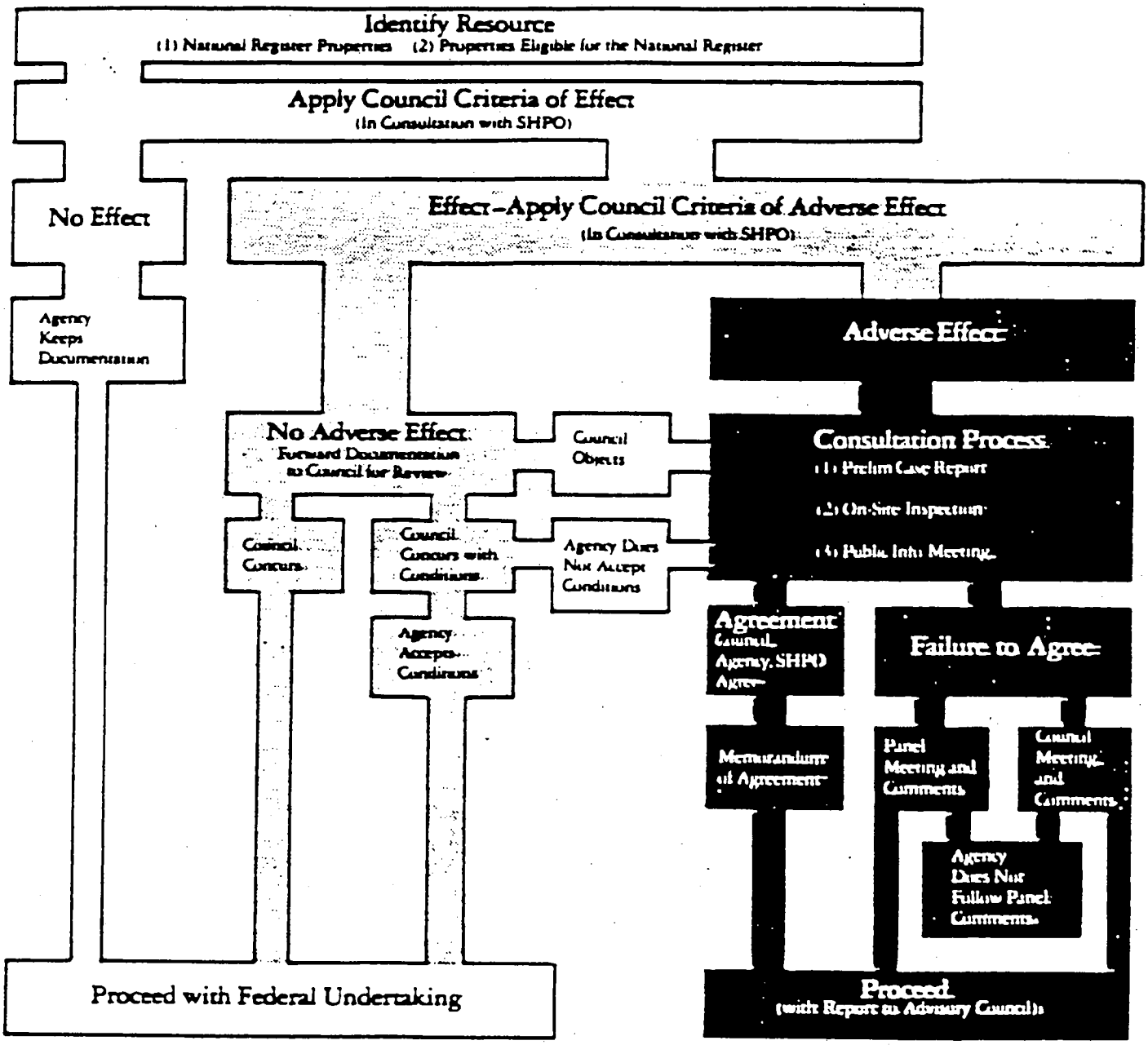


Figure 1. Map of project area.

ATTACHMENT 1

SECTION 106 REVIEW DIAGRAMMED



APPENDIX C

U.S. COAST GUARD PUBLIC NOTICE COMMENTS

Mike G. Dave C Dan J PJ

U.S. Department of Transportation
United States Coast Guard

Commander
Thirteenth Coast Guard District

915 Second Avenue
Seattle, WA 98174-1067
Staff Symbol: (ob)
Phone: (206)553-5864

16591
September 21, 1992

Mr. William S. Vlcek, P.E.
Manager, Engineering Services Section
King County
Department of Public Works
500 Fourth Avenue, Room 900
Seattle, Washington 98104-2339

RECEIVED
OCT 01 1992
PUBLIC WORKS CONSULTANT LIAISON

RE: 14/16 Avenue South Bridge
Duwamish Waterway

Dear Mr. Vlcek:

On August 14, 1992 we issued Public Notice 92-N-09 to solicit comments on vertical clearance requirements for a proposed replacement to the 14/16 Avenue South Bridge across the Duwamish Waterway. We received nine responses to the public notice, copies of which are enclosed for your information.

Of the responses, two were from federal resource agencies who routinely respond to our public notices. Both offered no comment to the proposal. A response from the International Terminal Company also had no comment on the proposed clearances.

Two towboat companies responded, Crowley and Foss. Both indicated that a 55 to 60 foot vertical clearance would accommodate their needs. The Corps of Engineers responded that the proposed clearance is adequate for their purposes. Manson Construction stated strong opposition to the proposed clearances and indicated that it would restrict the use of their heavy lift equipment, which has a physical height of 90 to 100 feet. Delta Marine Industries responded that they would be severely impacted by the proposed clearances. They requires the use of Manson's heavy lift cranes, which have a vertical clearance requirement of approximately 100 feet, for launching the vessels they build.

The Washington State Office of Archaeology and Historic Preservation did not comment on the clearances. However, they advised that the existing bridge is listed in the National Register of Historic Places and outlined the special procedures that must be followed if that bridge is to be replaced and demolished.

Based upon the current and potential use of the Duwamish Waterway upstream from the 14/16 Avenue South Bridge, it appears that the vertical clearance required for a fixed bridge would be at least

100 feet at mean high water. We hope this information will be useful for your planning purposes.

If you have any questions, or require further information, please do not hesitate to call me.

Sincerely,

John E. Mikesell
Chief, Bridge Section
By direction of the District Commander

Encl:
(1) Ltr, Corps of Engineers, 19 Aug 92
(2) Ltr, Crowley Marine Services, Inc., 21 Aug 92
(3) Ltr, U.S. Fish and Wildlife Service, 25 Aug 92
(4) Ltr, Washington State Office of Archaeology and Historic Preservation, 26 Aug 92
(5) Ltr, Manson Construction & Engineering Company, 26 Aug 92
(6) Ltr, U.S. National Marine Fisheries Service, 1 Sep 92
(7) Ltr, Delta Marine Industries, Inc., 10 Sep 92
(8) Ltr, Foss Maritime, 11 Sep 92
(9) Ltr, International Terminal Company, 14 Sep 92

APPENDIX D

RIGHT-OF-WAY TRUE COST ESTIMATE

King County Executive
TIM HILL
King County Courthouse
516 Third Avenue Room 400
Seattle, Washington 98104-3271
(206) 296-4040
FAX: (206) 296-0194

Mike G. 14
Dave C
Don J

December 11, 1992

TO: Louis J. Haff, P. E., County Road Engineer
Department of Public Works

ATTN: W. Vlcek, Engineering Services

FM: Pearl McElhern, Manager, Property Service Division

RE: True Cost Estimate for 16th Ave. So. Bridge

Attached is the True Cost Estimate for the above referenced project as you requested. Included in this estimate are Property Service Division force costs. The attached tabulation identifies each of the affected parcels. Items indicated with * or ** may require relocation cost estimates. Parcels 1/1 and 2/3 are improved with buildings near the proposed right of way. If a more detailed map indicates that these buildings are affected, the true cost estimate should be revised.

Total Property Costs:	$2,263,187
Total Administrative Costs:	22,743
Total Estimated Cost	$2,285,930

If litigation is necessary to acquire the property, additional cost will be incurred. An amount of 25% additional may be assumed.

TRUE COST ESTIMATE

14TH/16TH AVE. SO. BRIDGE

MAP/ PARCEL	LOCATION	TAX ACCOUNT NUMBER	ASSESSED VALUE LAND $	BUILDINGS $	TOTAL $	TOTAL PROPERTY COSTS $	TOTAL ADMINISTRATIVE COSTS $
1/1	NW CORNER 16TH AVE SO & DUWAMISH WATERWAY	218500-0005	1,850,800	1,137,500	2,988,300	430,250	1,897
1/2	1400 S. THISTLE ST	218500-0860	44,800	20,000	64,800	97,200	1,897 **
1/3	8456 DALLAS AV S	218500-1045	207,900	81,100	290,000	133,862	1,894 *
1/4	8507 14TH AVE SO	788360-7550	84,000	86,000	170,000	158,400	1,897 *
1/5	8515 14TH AVE SO	788360-7567	15,700	104,300	120,000	162,732	1,897 *
1/6	8517 14TH AVE SO	788360-7566	18,400	51,600	70,000	84,761	1,897 *
1/7	8525 14TH AVE SO	788360-7565	28,900	121,100	150,000	193,217	1,894 *
1/8	8520 14TH AVE SO	788360-8714	37,800	32,000	69,800	60,111	1,894 *
1/9	1403 SO THISTLE ST	218560-0080	22,600	29,900	52,500	78,715	1,894 **
2/1	7745 16TH AVE SO	292404-9098	33,000	287,000	320,000	439,489	1,894 *
2/2	7733 16 AVE SO	292404-9056	78,500	71,500	150,000	113,250	1,894 *
2/3	1200 SO WHIPPLE ST	002200-0005	12,671,000	1,663,000	52,662,000	311,200	1,894
TOTAL						2,263,187	22,743

* Building in take.

** Total take.

APPENDIX E

CAPITAL CONSTRUCTION COST ESTIMATE BACK-UP

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Unit Weight of Concr	160	pcf		
Traffic Barrier				
Unit Wt=	430	plf		
				USE
	Length		Tot Wt	**Total**
	ft	#	kips	**ft**
Approach Slab	300	2	0	600
Span 1	125	2	107.5	250
Span 2	125	2	107.5	250
Span 3	125	2	107.5	250
Span 4	125	2	107.5	250
Span 5	190	2	163.4	380
Span 6	240	2	206.4	480
Span 7	190	2	163.4	380
Span 8	115	2	98.9	230
Span 9	115	2	98.9	230
Span 10	115	2	98.9	230
Span 11	115	2	98.9	230
Approach Slab	300	2	0	600
TOTAL				**4360**

Prestressed Concrete Girders				
Use Series W74G girders at 8'-0" oc (8 girders)				
Girder Wt=	0.83	klf		
	Span			**USE**
	Length		Total W	**Girder**
	ft	gird	kips	**ft**
Appr Slab 0			277	
Span 1	125	9	2326	1125
Span 2	125	9	2326	1125
Span 3	125	9	2326	1125
Span 3	125	9	2326	1125
Span 4			0	0
Span 5			0	0
Span 6			0	0
Span 7	115	9	2140	1035
Span 8	115	9	2140	1035
Span 9	115	9	2140	1035
Span 9	115	9	2140	1035
Appr Slab 10			277	
TOTAL				**8640**

Total Wt includes Traffic Barrier Wt, Deck wt, and P/S girds

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Concrete Class AX - Deck Slab																
	Deck Slab			Sub	Concrete Walk		Sub	Girder Pads		Ave	Sub		USE			
	Width	Length	Thk	Total	Width	Thk	Total		Width	Thk	Total	Tot Wt	Total			
	ft	ft	in	CY	ft	in	CY	#	in	in	CY	kips	CY			
Appr Slab 0	64	25	13	64								277	64			
Span 1	66	125	8	204	18	8	56	9	44	3	38	1393	297			
Span 2	66	125	8	204	18	8	56	9	44	3	38	1393	297			
Span 3	66	125	8	204	18	8	56	9	44	3	38	1393	297			
Span 4	66	125	8	204	18	8	56	9	44	3	38	1393	297			
Span 5	66	190	8	310	18	8	84	7	30	4	41	2043	435			
Span 6	66	240	8	391	18	8	107	7	30	4	52	2581	550			
Span 7	66	190	8	310	18	8	84	7	30	4	41	2043	435			
Span 8	66	115	8	187	18	8	51	9	44	3	35	1281	274			
Span 9	66	115	8	187	18	8	51	9	44	3	35	1281	274			
Span 10	66	115	8	187	18	8	51	9	44	3	35	1281	274			
Span 11	66	115	8	187	18	8	51	9	44	3	35	1281	274			
Appr Slab 12	64	25	13	64								277	64			
TOTAL		1630											3833			
Total Wt includes Traffic Barrier Wt																

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Structural Steel							
Assume use of USS standard design for 190,240,190 span							
	Deck	Span	Steel		Deck	Total	**USE**
	Width	Length	nit W	Girds	Area	Wt	**Steel**
	ft	ft	psf	#	sf	Kips	**tons**
Appr Slab 0							
Span 1							
Span 2							
Span 3							
Span 4							
Span 5	**66**	**190**	**37.8**	**7**	12540	2517	237
Span 6	**66**	**240**	**37.8**	**7**	15840	3180	299
Span 7	**66**	**190**	**37.8**	**7**	12540	2517	237
Span 8							
Span 9							
Span 10							
Span 11							
Appr Slab 12							
TOTAL							**773**
Total Wt includes Traffic Barrier Wt, Deck wt, and steel girds							

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Concrete Class AX - Columns																
Use 0.1*f'c for sizing colu			400	psi	Lanes	4										
	Try	Use														
	Col Di	ol Dia		TO Ftg	Pr Gr	Col Ht	DL	LL	I	otal	/ co	A min	Tot Wt	**USE Col**		
	ft	ft	# cols	ft	ft	ft	kips	kips	kips	kips	kips	sq ft	kips	**CY**		
Ret Walls 1				10												
Abutment 1				10			1302	296	74				1519			
Bent 2	6.1	6	2	10	34	16	2818	424	85	3327	1663	29	2963	34		
Bent 3	6.1	6	2	10	42	24	2818	424	85	3327	1663	29	3035	50		
Bent 4	6.1	6	2	10	50	32	2818	424	85	3327	1663	29	3107	67		
Bent 5	6.2	6	2	10	58	40	2913	507	90	3510	1755	30	3275	84		
Pier 6	6.7	9	2	-40	66	98	3340	654	96	4091	2045	36	5335	462		
Pier 7	6.7	9	2	-40	66	98	3340	654	96	4091	2045	36	5335	462		
Bent 8	6.1	6	2	12	58	38	2820	494	89	3404	1702	30	3164	80		
Bent 9	5.9	6	2	12	50	30	2632	398	83	3113	1557	27	2903	63		
Bent 10	5.9	6	2	12	42	22	2632	398	83	3113	1557	27	2831	46		
Bent 11	5.9	6	2	12	34	14	2632	398	83	3113	1557	27	2758	29		
Abutment 12				12			1209	283	73				1209			
Ret Walls 12				12												
TOTAL																
Total Wt includes Traffic Barrier Wt, Deck wt, P/S and steel girds, capbeams, and columns														**1376**		

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Concrete, Class B - Footings, and Piling, 16-inch octagonal Prestressed																
Pile cap=	**80**	tons														
			Pile	Ftg	Ftg	Ftg								**USE**	**USE**	**USE**
	Try	Use	length	W	L	thk		Tot Wt	LL	ubtot	/ Ft	Ftg Wt	otal L	**Ftg**	**Piles**	**Piles**
	# pile	pile	ft	ft	ft	ft	# Ftgs	kips	kips	kips	kips	kips	kips	**CY**	**#**	**ft**
Ret. Walls 1	4.0	**50**	**60**	**8**	**250**	**2**	**2**					640	640	296	100	6000
Abutment 1	12.7	**25**	**90**	**10**	**69**	**2**	**1**	1519	296	1815	1815	221	2036	51	25	2250
Bent 2	14.6	**16**	**90**	**24**	**24**	**7**	**2**	2963	424	3387	1693	645	2338	299	32	2880
Bent 3	14.8	**16**	**90**	**24**	**24**	**7**	**2**	3035	424	3459	1729	645	2375	299	32	2880
Bent 4	15.1	**16**	**90**	**24**	**24**	**7**	**2**	3107	424	3531	1766	645	2411	299	32	2880
Bent 5	15.9	**16**	**90**	**24**	**24**	**7**	**2**	3275	507	3782	1891	645	2536	299	32	2880
Pier 6	25.6	**26**	**90**	**24**	**36**	**8**	**2**	5335	654	5989	2995	1106	4101	512	52	4680
Pier 7	25.6	**26**	**90**	**24**	**36**	**8**	**2**	5335	654	5989	2995	1106	4101	512	52	4680
Bent 8	15.5	**16**	**90**	**24**	**24**	**7**	**2**	3164	494	3658	1829	645	2474	299	32	2880
Bent 9	14.3	**16**	**90**	**24**	**24**	**7**	**2**	2903	398	3302	1651	645	2296	299	32	2880
Bent 10	14.1	**16**	**90**	**24**	**24**	**7**	**2**	2831	398	3229	1615	645	2260	299	32	2880
Bent 11	13.9	**16**	**90**	**24**	**24**	**7**	**2**	2758	398	3157	1578	645	2223	299	32	2880
Abutment 12	10.7	**25**	**90**	**10**	**69**	**2**	**1**	1209	283	1492	1492	221	1713	51	25	2250
Ret. Walls 10	4.0	**50**	**60**	**8**	**250**	**2**	**2**					640	640	296	100	6000
TOTAL														**4108**	**610**	**48900**

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Concrete, Class D - Seals																
Water El=	**6.1**	ft														
Pile Skin Fri	**6.03**	klf														
	Seal	TRY			Ftg	Ftg	Ftg	Seal				**USE**				
	W	thk	S.F.	Ftg	W	L	thk	L	eal W	Pile T	Bouy F	**Seal**				
	ft	ft	Bouy	ft	ft	ft	ft	ft	kips	kips	kips	**CY**				
Pier 5	**63**	**17**	1.06	-40	24	36	8	38	5901	5331	10621	1507				
Pier 6	**63**	**17**	1.06	-40	24	36	8	38	5901	5331	10621	1507				
TOTAL												**3015**				
Cofferdams																
	Sheets	Seal	Seal	Seal	Bot	Bot	Sheets	**USE**								
	Embed	W	L	Permtr	f Sea	f Cof	Ht	**Coff**								
	ft	ft	ft	lf	ft	ft	ft	**sf**								
Pier 5	**20**	63	38	202	-65	-85	91	18402								
Pier 6	**20**	63	38	202	-65	-85	91	18402								
TOTAL								**36804**								

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Shoring											
			Ftg	Ftg	Ftg						**USE**
	Grd El	TO Ftg	W	L	thk		Shr Ht	Shr W	Shr L	Permtr	**Shr**
	ft	ft	ft	ft	ft	# Ftgs	ft	ft	ft	ft	**SF**
Ret. Walls 1	**14**	10	8	250	2	2	6	10	252	524	6288
Abutment 1	**14**	10	10	69	2	1	6	12	71	166	996
Bent 2	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 3	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 4	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 5	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 8	**16**	12	24	24	7	2	11	26	26	104	2288
Bent 9	**16**	12	24	24	7	2	11	26	26	104	2288
Bent 10	**16**	12	24	24	7	2	11	26	26	104	2288
Bent 11	**16**	12	24	24	7	2	11	26	26	104	2288
Abutment 12	**16**	12	10	69	2	1	6	12	71	166	996
Ret. Walls 12	**16**	12	8	250	2	2	6	10	252	524	6288
TOTAL											**32872**

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Structure Excavation

	# Ftgs	Shr Ht ft	Shr W ft	Shr L ft	USE Exc CY
Ret. Walls 1	2	6	10	252	1120
Abutment 1	1	6	12	71	189
Bent 2	2	11	26	26	551
Bent 3	2	11	26	26	551
Bent 4	2	11	26	26	551
Bent 5	2	11	26	26	551
Pier 6	1	27	63	38	2394
Pier 7	1	27	63	38	2394
Bent 8	2	11	26	26	551
Bent 9	2	11	26	26	551
Bent 10	2	11	26	26	551
Bent 11	2	11	26	26	551
Abutment 12	1	6	12	71	189
Ret. Walls 12	2	6	10	252	1120
TOTAL					**10504**

Concrete Class AX - Capbeams

	Bm Width ft	Bm Depth ft	Bm Length ft	otal W kips	USE Capbm CY
Ret Walls 1					
Abutment 1				1302	
Bent 2	**6**	**8**	**64**	2818	114
Bent 3	**6**	**8**	**64**	2818	114
Bent 4	**6**	**8**	**64**	2818	114
Bent 4	**6**	**8**	**64**	2913	114
Pier 5	**6**	**8**	**64**	3340	114
Pier 6	**6**	**8**	**64**	3340	114
Bent 7	**6**	**8**	**64**	2820	114
Bent 8	**6**	**8**	**64**	2632	114
Bent 9	**6**	**8**	**64**	2632	114
Bent 10	**6**	**8**	**64**	2632	114
Abutment 10				1209	
Ret walls 10					
TOTAL					**1138**

Total Wt includes Traffic Barrier Wt, Deck wt, P/S and steel girds, and capbeams

Concrete Class AX - Walls

	Wall L ft	Ave Wall H ft	Wall T in	USE Conc CY
Ret. Walls 1	**260**	**7**	**16**	90
Abutment 1	**66**	**16**	**30**	98
Abutment 10	**66**	**17**	**30**	104
Ret. Walls 10	**260**	**7**	**17**	95
TOTAL				**387**

Approach Embankment

	Embk W ft	Embk L ft	Ave Embk H ft	USE Embk CY
Ret. Walls 1	**66**	260	7	4448.9
Ret. Walls 10	**66**	260	7	4448.9
TOTAL				**8897.8**

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Steel Reinforcing Bars									
Ftg Reinf=	**150**	lb per CY		Capbeam Reinf=		**300**	lb per CY		
Col Reinf=	**450**	lb per CY		Wall Reinf=		**200**	lb per CY		
									USE
	Ftg	Ftg	Col	Col	Cap	Cap	Wall	Wall	**Total**
	Conc	Rebar	Conc	Rebar	Conc	Rebar	Conc	Rebar	**Rebar**
	CY	tons	CY	tons	CY	tons	CY	tons	**tons**
Ret. Walls 1	296	22	0		0		90	9	31
Abutment 1	51	4	0		0		98	10	14
Bent 2	299	22	34	8	114	17	0		47
Bent 3	299	22	50	11	114	17	0		51
Bent 4	299	22	67	15	114	17	0		55
Bent 5	299	22	84	19	114	17	0		58
Pier 6	512	38	462	104	114	17	0		159
Pier 7	512	38	462	104	114	17	0		159
Bent 8	299	22	80	18	114	17	0		57
Bent 9	299	22	63	14	114	17	0		54
Bent 10	299	22	46	10	114	17	0		50
Bent 11	299	22	29	7	114	17	0		46
Abutment 12	51	4	0		0		104	10	14
Ret. Walls 12	296	22	0		0		95	10	32
TOTAL									**827**

TABLE E-II
Fixed Bridge Replacement
60 Foot Clearance -
Quantity Takeoff Back-Up

Steel Reinforcing Bars - Epoxy Coated					
Appr Slab Rei	**300**	lb per CY			
Deck Slab Rei	**250**	lb per CY			
					USE
	Appr	Appr	Deck	Deck	**Total**
	Conc	Rebar	Conc	Rebar	**Rebar**
	CY	tons	CY	tons	**tons**
Approach Slab	64	10			10
Span 1			297	37	37
Span 2			297	37	37
Span 3			297	37	37
Span 4			297	37	37
Span 5			435	54	54
Span 6			550	69	69
Span 7			435	54	54
Span 8			274	34	34
Span 9			274	34	34
Span 10			274	34	34
Span 11			274	34	34
Approach Slab	64	10			10
TOTAL					**482**

Bearings				
	P/S	**USE**	Stl	**USE**
	Girds	**Brgs**	Girds	**Brgs**
	#	**#**	#	**#**
Approach Slab 0				
Span 1	9	18	0	0
Span 2	9	18	0	0
Span 3	9	18	0	0
Span 4	9	18	0	0
Span 5	0	0	7	14
Span 6	0	0	7	14
Span 7	0	0	7	14
Span 8	9	18	0	0
Span 9	9	18	0	0
Sp 10	9	18	0	0
Sp 11	9	18	0	0
Approach Slab 10				
TOTAL		**126**		**42**

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Unit Weight of Concr		160	pcf	
Traffic Barrier				
Unit Wt=		430	plf	
				USE
	Length		Tot Wt	**Total**
	ft	#	kips	**ft**
Approach Slab	300	2	0	600
Span 1	138	2	118.68	276
Span 2	138	2	118.68	276
Span 3	138	2	118.68	276
Span 4	138	2	118.68	276
Span 5	138	2	118.68	276
Span 6	138	2	118.68	276
Span 7	138	2	118.68	276
Span 8	190	2	163.4	380
Span 9	240	2	206.4	480
Span 10	190	2	163.4	380
Span 11	134	2	115.24	268
Span 12	134	2	115.24	268
Span 13	134	2	115.24	268
Span 14	134	2	115.24	268
Span 15	134	2	115.24	268
Span 16	134	2	115.24	268
Span 17	134	2	115.24	268
Approach Slab	300	2	0	600
TOTAL				**6248**

Prestressed Concrete Girders

Use Series W74G girders at 7'-4" oc (9 girders)

Girder Wt= **0.83** klf

	Span Length		Total W	**USE Girder**
	ft	gird	kips	**ft**
Approach Slab 0			277	
Span 1	138	9	2568	1242
Span 2	138	9	2568	1242
Span 3	138	9	2568	1242
Span 4	138	9	2568	1242
Span 5	138	9	2568	1242
Span 6	138	9	2568	1242
Span 7	138	9	2568	1242
Span 8			0	0
Span 9			0	0
Span 10			0	0
Span 11	134	9	2494	1206
Span 12	134	9	2494	1206
Span 13	134	9	2494	1206
Span 14	134	9	2494	1206
Span 15	134	9	2494	1206
Span 16	134	9	2494	1206
Span 17	134	9	2494	1206
Approach Slab 18			277	
TOTAL				**17136**

Total Wt includes Traffic Barrier Wt, Deck wt, and P/S girds

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Concrete Class AX - Deck Slab																
	Deck Slab			Sub	Concrete Walk		Sub	Girder Pads		Ave	Sub		USE			
	Width	Length	Thk	Total	Width	Thk	Total		Width	Thk	Total	Tot Wt	Total			
	ft	ft	in	CY	ft	in	CY	#	in	in	CY	kips	CY			
Appr Slab 0	64	25	13	64								277	64			
Span 1	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 2	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 3	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 4	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 5	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 6	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 7	66	138	8	225	18	8	61	9	44	3	42	1537	328			
Span 8	66	190	8	310	18	8	84	7	30	4	41	2043	435			
Span 9	66	240	8	391	18	8	107	7	30	4	52	2581	550			
Span 10	66	190	8	310	18	8	84	7	30	4	41	2043	435			
Span 11	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Span 12	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Span 13	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Span 14	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Span 15	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Span 16	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Span 17	66	134	8	218	18	8	60	9	44	3	41	1493	319			
Appr Slab 18	64	25	13	64								277	64			
TOTAL		2574											6079			
Total Wt includes Traffic Barrier Wt																

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Structural Steel							
Assume use of USS standard design for 190,240,190 span							
	Deck	Span	Steel		Deck	Total	**USE**
	Width	Length	nit W	Girds	Area	Wt	**Steel**
	ft	ft	psf	#	sf	Kips	**tons**
Appr Slab 0							
Span 1							
Span 2							
Span 3							
Span 4							
Span 5							
Span 6							
Span 7							
Span 8	**66**	**190**	**37.8**	**7**	12540	2517	237
Span 9	**66**	**240**	**37.8**	**7**	15840	3180	299
Span 10	**66**	**190**	**37.8**	**7**	12540	2517	237
Span 11							
Span 12							
Span 13							
Span 14							
Span 15							
Span 16							
Span 17							
Appr Slab 18							
TOTAL							**773**
Total Wt includes Traffic Barrier Wt, Deck wt, and steel girds							

TABLE E-III

Fixed Bridge Replacement

100 Foot Clearance - Quantity Takeoff Back-Up

Concrete Class AX - Columns															
Use 0.1*f'c for sizing colu			400	psi	Lanes	4									
	Try	Use													
	Col Di	ol Dia		TO Ftg	Pr Gr	Col Ht	DL	LL	I	otal	/ co	A min	Tot Wt	**USE Col**	
	ft	ft	# cols	ft	ft	ft	kips	kips	kips	kips	kips	sq ft	kips	**CY**	
Ret Walls 1				10											
Abutment 1				10			1423	313	76				1423		
Bent 2	6.3	6	2	10	35	17	3060	457	87	3604	1802	31	3214	36	
Bent 3	6.3	6	2	10	45	27	3060	457	87	3604	1802	31	3304	57	
Bent 4	6.3	6	2	10	56	38	3060	457	87	3604	1802	31	3404	80	
Bent 5	6.3	6	2	10	67	49	3060	457	87	3604	1802	31	3503	103	
Bent 6	6.5	8	2	10	78	60	3224	457	87	3768	1884	33	4189	223	
Bent 7	6.5	8	2	10	89	71	3224	457	87	3768	1884	33	4366	264	
Bent 8	6.6	10	2	10	101	83	3362	524	91	3976	1988	35	5448	483	
Pier 9	7.1	12	2	-40	111	143	3831	654	96	4582	2291	40	9007	1198	
Pier 10	7.1	12	2	-40	111	143	3831	654	96	4582	2291	40	9007	1198	
Bent 11	6.6	10	2	12	101	81	3325	519	90	3934	1967	34	5360	471	
Bent 12	6.4	8	2	12	90	70	3149	447	86	3682	1841	32	4275	261	
Bent 13	6.4	8	2	12	79	59	3149	447	86	3682	1841	32	4098	220	
Bent 14	6.2	6	2	12	68	48	2985	447	86	3519	1759	31	3420	101	
Bent 15	6.2	6	2	12	57	37	2985	447	86	3519	1759	31	3320	77	
Bent 16	6.2	6	2	12	46	26	2985	447	86	3519	1759	31	3221	54	
Bent 17	6.2	6	2	12	36	16	2985	447	86	3519	1759	31	3130	34	
Abutment 18				12			1386	308	75				1386		
Ret Walls 18				12											
TOTAL														**4859**	
Total Wt includes Traffic Barrier Wt, Deck wt, P/S and steel girds, capbeams, and columns															

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Concrete, Class B - Footings, and Piling, 16-inch octagonal Prestressed																
Pile cap=	80	tons														
			Pile	Ftg	Ftg	Ftg								USE	USE	USE
	Try	Use	length	W	L	thk		Tot Wt	LL	ubtot	/ Ft	Ftg Wt	otal L	Ftg	Pile	Piles
	# pile	pile	ft	ft	ft	ft	# Ftgs	kips	kips	kips	kips	kips	kips	CY	#	ft
Ret Walls 1	4.0	50	60	8	250	2	2					640	640	296	100	6000
Abutment 1	12.2	25	90	10	69	2	1	1423	313	1735	1735	221	1956	51	25	2250
Bent 2	15.5	16	90	24	24	7	2	3214	457	3671	1835	645	2481	299	32	2880
Bent 3	15.8	16	90	24	24	7	2	3304	457	3761	1881	645	2526	299	32	2880
Bent 4	17.8	18	90	24	30	8	2	3404	457	3861	1930	922	2852	427	36	3240
Bent 5	18.1	20	90	24	30	8	2	3503	457	3960	1980	922	2902	427	40	3600
Bent 6	21.7	24	90	30	30	8	2	4189	457	4646	2323	1152	3475	533	48	4320
Bent 7	22.3	24	90	30	30	8	2	4366	457	4823	2411	1152	3563	533	48	4320
Bent 8	30.3	32	90	36	36	9	2	5448	524	5972	2986	1866	4852	864	64	5760
Pier 9	52.4	56	90	42	48	11	2	9007	654	9661	4831	3548	8379	1643	112	10080
Pier 10	52.4	56	90	42	48	11	2	9007	654	9661	4831	3548	8379	1643	112	10080
Bent 11	30.0	32	90	36	36	9	2	5360	519	5879	2940	1866	4806	864	64	5760
Bent 12	22.0	24	90	30	30	8	2	4275	447	4722	2361	1152	3513	533	48	4320
Bent 13	21.4	24	90	30	30	8	2	4098	447	4545	2273	1152	3425	533	48	4320
Bent 14	17.8	20	90	24	30	8	2	3420	447	3867	1933	922	2855	427	40	3600
Bent 15	17.5	18	90	24	30	8	2	3320	447	3767	1884	922	2805	427	36	3240
Bent 16	15.5	16	90	24	24	7	2	3221	447	3668	1834	645	2479	299	32	2880
Bent 17	15.2	16	90	24	24	7	2	3130	447	3577	1789	645	2434	299	32	2880
Abutment 18	12.0	25	90	10	69	2	1	1386	308	1693	1693	221	1914	51	25	2250
Ret Walls 18	4.0	50	60	8	250	2	2					640	640	296	100	6000
TOTAL														10743	1074	90660

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Concrete, Class D - Seals												
Water El=	**6.1**	ft										
Pile Skin Fri	**6.03**	klf										
	Seal	TRY			Ftg	Ftg	Ftg	Seal				**USE**
	W	thk	S.F.	Ftg	W	L	thk	L	eal W	Pile T	Bouy F	**Seal**
	ft	ft	Bouy	ft	ft	ft	ft	ft	kips	kips	kips	**CY**
Pier 9	**81**	**15**	1.04	-40	42	48	11	50	8809	10130	18221	2250
Pier 10	**81**	**15**	1.04	-40	42	48	11	50	8809	10130	18221	2250
TOTAL												**4500**
Cofferdams												
	Sheets	Seal	Seal	Seal	Bot	Bot	Sheets	**USE**				
	Embed	W	L	Permtr	f Sea	f Cof	Ht	**Coff**				
	ft	ft	ft	lf	ft	ft	ft	**sf**				
Pier 9	**20**	81	50	262	-66	-86	92	24130				
Pier 10	**20**	81	50	262	-66	-86	92	24130				
TOTAL								**48260**				

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Shoring											
			Ftg	Ftg	Ftg						**USE**
	Grd El	TO Ftg	W	L	thk		Shr Ht	Shr W	Shr L	Permtr	**Shr**
	ft	ft	ft	ft	ft	# Ftgs	ft	ft	ft	ft	**SF**
Ret. Walls 1	**14**	10	8	250	2	2	6	10	252	524	6288
Abutment 1	**14**	10	10	69	2	1	6	12	71	166	996
Bent 2	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 3	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 4	**14**	10	24	30	8	2	12	26	32	116	2784
Bent 5	**14**	10	24	30	8	2	12	26	32	116	2784
Bent 6	**14**	10	30	30	8	2	12	32	32	128	3072
Bent 7	**14**	10	30	30	8	2	12	32	32	128	3072
Bent 8	**14**	10	36	36	9	2	13	38	38	152	3952
Pier 9											
Pier 10											
Bent 11	**16**	12	36	36	9	2	13	38	38	152	3952
Bent 12	**16**	12	30	30	8	2	12	32	32	128	3072
Bent 13	**16**	12	30	30	8	2	12	32	32	128	3072
Bent 14	**16**	12	24	30	8	2	12	26	32	116	2784
Bent 15	**16**	12	24	30	8	2	12	26	32	116	2784
Bent 16	**16**	12	24	24	7	2	11	26	26	104	2288
Bent 17	**16**	12	24	24	7	2	11	26	26	104	2288
Abutment 18	**16**	12	10	69	2	1	6	12	71	166	996
Ret. Walls 18	**16**	12	8	250	2	2	6	10	252	524	6288
TOTAL											**55048**

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Structure Excavation							Concrete Class AX - Capbeams					
					USE			Bm	Bm	Bm		USE
		Shr Ht	Shr W	Shr L	Exc			Width	Depth	Length	otal W	Capbm
	# Ftgs	ft	ft	ft	CY			ft	ft	ft	kips	CY
Ret. Walls 1	2	6	10	252	1120		Ret Walls 1					
Abutment 1	1	6	12	71	189		Abutment 1				1423	
Bent 2	2	11	26	26	551		Bent 2	**6**	**8**	**64**	3060	114
Bent 3	2	11	26	26	551		Bent 3	**6**	**8**	**64**	3060	114
Bent 4	2	12	26	32	740		Bent 4	**6**	**8**	**64**	3060	114
Bent 5	2	12	26	32	740		Bent 5	**6**	**8**	**64**	3060	114
Bent 6	2	12	32	32	910		Bent 6	**8**	**8**	**64**	3224	152
Bent 7	2	12	32	32	910		Bent 7	**8**	**8**	**64**	3224	152
Bent 8	2	13	38	38	1391		Bent 8	**10**	**8**	**64**	3362	190
Pier 9	1	28	81	50	4200		Pier 9	**12**	**8**	**64**	3831	228
Pier 10	1	28	81	50	4200		Pier 10	**12**	**8**	**64**	3831	228
Bent 11	2	13	38	38	1391		Bent 11	**10**	**8**	**64**	3325	190
Bent 12	2	12	32	32	910		Bent 12	**8**	**8**	**64**	3149	152
Bent 13	2	12	32	32	910		Bent 13	**8**	**8**	**64**	3149	152
Bent 14	2	12	26	32	740		Bent 14	**6**	**8**	**64**	2985	114
Bent 15	2	12	26	32	740		Bent 15	**6**	**8**	**64**	2985	114
Bent 16	2	11	26	26	551		Bent 16	**6**	**8**	**64**	2985	114
Bent 17	2	11	26	26	551		Bent 17	**6**	**8**	**64**	2985	114
Abutment 18	1	6	12	71	189		Abutment 18				1386	
Ret walls 18	2	6	10	252	1120		Ret walls 18					
TOTAL					**21293**		TOTAL					**2351**

Total Wt includes Traffic Barrier Wt, Deck wt, P/S and steel girds, and capbeams

TABLE E-III

Fixed Bridge Replacement

100 Foot Clearance - Quantity Takeoff Back-Up

Concrete Class AX - Walls																
							Approach Embankment									
		Ave		USE						Ave	USE					
	Wall L	Wall H	Wall T	Conc				Embk W	Embk L	Embk H	Embk					
	ft	ft	in	CY				ft	ft	ft	CY					
Ret. Walls 1	260	7	16	90			Ret. Walls 1	66	260	7	4448.9					
Abutment 1	66	16	30	98			Ret. Walls 18	66	260	7	4448.9					
Abutment 18	66	17	30	104			TOTAL				8897.8					
Ret walls 18	260	7	17	95												
TOTAL				387												

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Steel Reinforcing Bars

Ftg Reinf= **150** lb per CY Capbeam Reinf= **300** lb per CY

Col Reinf= **450** lb per CY Wall Reinf= **200** lb per CY

	Ftg Conc CY	Ftg Rebar tons	Col Conc CY	Col Rebar tons	Cap Conc CY	Cap Rebar tons	Wall Conc CY	Wall Rebar tons	**USE Total Rebar tons**
Ret. Walls 1	296	22	0		0		90	9	31
Abutment 1	51	4	0		0		98	10	14
Bent 2	299	22	36	8	114	17	0		47
Bent 3	299	22	57	13	114	17	1		52
Bent 4	427	32	80	18	114	17	2		67
Bent 5	427	32	103	23	114	17	3		72
Bent 6	533	40	223	50	152	23	4		113
Bent 7	533	40	264	59	152	23	5		122
Bent 8	864	65	483	109	190	28	6		202
Pier 9	1643	123	1198	270	228	34	7		427
Pier 10	1643	123	1198	270	228	34	8		427
Bent 11	864	65	471	106	190	28	9		199
Bent 12	533	40	261	59	152	23	10		121
Bent 13	533	40	220	49	152	23	11		112
Bent 14	427	32	101	23	114	17	12		72
Bent 15	427	32	77	17	114	17	13		67
Bent 16	299	22	54	12	114	17	14		52
Bent 17	299	22	34	8	114	17	15		47
Abutment 18	51	4	0		0		104	10	14
Ret walls 18	296	22	0		0		95	10	32
TOTAL									**2290**

TABLE E-III
Fixed Bridge Replacement
100 Foot Clearance - Quantity Takeoff Back-Up

Steel Reinforcing Bars - Epoxy Coated					
Appr Slab Rei	300	lb per CY			
Deck Slab Rei	250	lb per CY			
					USE
	Appr	Appr	Deck	Deck	**Total**
	Conc	Rebar	Conc	Rebar	**Rebar**
	CY	tons	CY	tons	**tons**
Appr Slab 0	64	10			10
Span 1			328	41	41
Span 2			328	41	41
Span 3			328	41	41
Span 4			328	41	41
Span 5			328	41	41
Span 6			328	41	41
Span 7			328	41	41
Span 8			435	54	54
Span 9			550	69	69
Span 10			435	54	54
Span 11			319	40	40
Span 12			319	40	40
Span 13			319	40	40
Span 14			319	40	40
Span 15			319	40	40
Span 16			319	40	40
Span 17			319	40	40
Appr Slab 18	64	10			10
TOTAL					**763**

Bearings				
	P/S	**USE**	Stl	**USE**
	Girds	**Brgs**	Girds	**Brgs**
	#	**#**	#	**#**
Appr Slab 0				
Span 1	9	18	0	0
Span 2	9	18	0	0
Span 3	9	18	0	0
Span 4	9	18	0	0
Span 5	9	18	0	0
Span 6	9	18	0	0
Span 7	9	18	0	0
Span 8	0	0	7	14
Span 9	0	0	7	14
Span 10	0	0	7	14
Span 11	9	18	0	0
Span 12	9	18	0	0
Span 13	9	18	0	0
Span 14	9	18	0	0
Span 15	9	18	0	0
Span 16	9	18	0	0
Span 17	9	18	0	0
Appr Slab 18				
TOTAL		**252**		**42**

TABLE E-IV
Movable Bridge Replacement
Approach Spans - Quantity Takeoff Back-Up

Unit Weight of Concr		160	pcf	
Traffic Barrier				
Unit Wt=		430	plf	
				USE
	Length		Tot Wt	**Total**
	ft	#	kips	**ft**
Approach Slab	570	2	0	1140
Span 1	115	2	98.9	230
Span 2	115	2	98.9	230
Span 3	115	2	98.9	230
Span 4	160	2	137.6	320
Span 6	160	2	137.6	320
Span 7	105	2	90.3	210
Span 8	105	2	90.3	210
Span 9	105	2	90.3	210
Approach Slab	330	2	0	660
TOTAL				**3760**

Prestressed Concrete Girders				
Use Series W74G girders at 8'-0" oc (8 girders)				
Girder Wt=	0.83	klf		
	Span			**USE**
	Length		Total W	**Girder**
	ft	gird	kips	**ft**
Appr Slab 0			277	
Span 1	115	8	2045	920
Span 2	115	8	2045	920
Span 3	115	8	2045	920
Span 4			0	0
Span 6			0	0
Span 7	105	8	2073	840
Span 8	105	8	2073	840
Span 9	105	8	2073	840
Appr Slab 10			277	
TOTAL				**5280**

Total Wt includes Traffic Barrier Wt, Deck wt, and P/S girds

TABLE E-IV

Movable Bridge Replacement

Approach Spans - Quantity Takeoff Back-Up

Concrete Class AX - Deck Slab																
	Deck Slab			Sub	**Concrete Walk**		Sub	**Girder Pads**		Ave	Sub		**USE**			
	Width	Length	Thk	Total	Width	Thk	Total		Width	Thk	Total	Tot Wt	**Total**			
	ft	ft	in	CY	ft	in	CY	#	in	in	CY	kips	**CY**			
Appr Slab 0	**64**	**25**	**13**	64								277	64			
Span 1	**66**	**115**	**8**	187	**18**	**8**	51	**9**	**44**	**3**	35	1281	274			
Span 2	**66**	**115**	**8**	187	**18**	**8**	51	**9**	**44**	**3**	35	1281	274			
Span 3	**66**	**115**	**8**	187	**18**	**8**	51	**9**	**44**	**3**	35	1281	274			
Span 4	**66**	**160**	**8**	261	**18**	**8**	71	**7**	**30**	**4**	35	1721	366			
Span 6	**66**	**190**	**8**	310	**18**	**8**	84	**7**	**30**	**4**	41	2017	435			
Span 7	**66**	**125**	**8**	204	**18**	**8**	56	**9**	**44**	**3**	38	1375	297			
Span 8	**66**	**125**	**8**	204	**18**	**8**	56	**9**	**44**	**3**	38	1375	297			
Span 9	**66**	**125**	**8**	204	**18**	**8**	56	**9**	**44**	**3**	38	1375	297			
Appr Slab 10	**64**	**25**	**13**	64								277	64			
TOTAL		1120											**2643**			
Total Wt includes Traffic Barrier Wt																

TABLE E-IV
Movable Bridge Replacement
Approach Spans - Quantity Takeoff Back-Up

Structural Steel							
Assume use of USS standard design for 190,240,190 span							
	Deck	Span	Steel		Deck	Total	**USE**
	Width	Length	nit W	Girds	Area	Wt	**Steel**
	ft	ft	psf	#	sf	Kips	**tons**
Appr Slab 0							
Span 1							
Span 2							
Span 3							
Span 4	**66**	**160**	**44**	**7**	10560	2185	232
Span 6	**66**	**160**	**44**	**7**	10560	2482	232
Span 7							
Span 8							
Span 9							
Appr Slab 10							
TOTAL							**465**
Total Wt includes Traffic Barrier Wt, Deck wt, and steel girds							

TABLE E-IV

Movable Bridge Replacement

Approach Spans - Quantity Takeoff Back-Up

Concrete Class AX - Columns																
Use 0.1*f'c for sizing colu			400	psi	Lanes	5										
	Try	Use														
	Col Di	ol Dia		TO Ftg	Pr Gr	Col Ht	DL	LL	I	otal	/ co	A min	ot W	**USE Col**		
	ft	ft	# cols	ft	ft	ft	kips	kips	kips	kips	kips	sq ft	kips	**CY**		
Ret Walls 1				10												
Abutment 1				10			1161	354	91				1161			
Bent 2	5.9	6	2	10	30	12	2536	498	104	3138	1569	27	2645	25		
Bent 3	5.9	6	2	10	35	17	2536	498	104	3138	1569	27	2690	36		
Bent 4	6.0	6	2	10	41	23	2606	570	109	3285	1643	29	2815	48		
Bent 7	6.2	6	2	12	41	21	2769	634	112	3515	1757	31	2959	44		
Bent 8	5.9	6	2	12	35	15	2564	530	106	3200	1600	28	2700	31		
Bent 9	5.9	6	2	12	30	10	2564	530	106	3200	1600	28	2654	21		
Abutment 10				12			1175	370	93				1175			
Ret Walls 10				12												
TOTAL														**205**		
Total Wt includes Traffic Barrier Wt, Deck wt, P/S and steel girds, capbeams, and columns																

TABLE E-IV

Movable Bridge Replacement

Approach Spans - Quantity Takeoff Back-Up

Concrete, Class B - Footings, and Piling, 16-inch octagonal Prestressed																
Pile cap=	80	tons														
			Pile	Ftg	Ftg	Ftg								USE	USE	USE
	Try	Use	length	W	L	thk		Tot Wt	LL	ubtot	/ Ft	Ftg Wt	tal	Ftg	Piles	Piles
	# pile	pile	ft	ft	ft	ft	# Ftgs	kips	kips	kips	kips	kips	kips	CY	#	ft
Ret. Walls 1	4.0	50	60	8	250	2	2					640	640	296	100	6000
Abutment 1	10.8	25	90	10	69	2	1	1161	354	1515	1515	221	1736	51	25	2250
Bent 2	13.9	16	90	24	24	7	2	2645	498	3143	1571	645	2217	299	32	2880
Bent 3	14.0	16	90	24	24	7	2	2690	498	3188	1594	645	2239	299	32	2880
Bent 4	14.6	16	90	24	24	7	2	2815	570	3385	1692	645	2337	299	32	2880
Bent 7	15.3	16	90	24	24	7	2	2959	634	3593	1796	645	2442	299	32	2880
Bent 8	14.1	16	90	24	24	7	2	2700	530	3230	1615	645	2260	299	32	2880
Bent 9	14.0	16	90	24	24	7	2	2654	530	3184	1592	645	2237	299	32	2880
Abutment 10	11.0	25	90	10	69	2	1	1175	370	1545	1545	221	1766	51	25	2250
Ret. Walls 10	4.0	50	60	8	250	2	2					640	640	296	100	6000
TOTAL														2487	442	33780

TABLE E-IV
Movable Bridge Replacement
Approach Spans - Quantity Takeoff Back-Up

Shoring											
			Ftg	Ftg	Ftg						**USE**
	Grd El	TO Ftg	W	L	thk		Shr Ht	Shr W	Shr L	Permtr	**Shr**
	ft	ft	ft	ft	ft	# Ftgs	ft	ft	ft	ft	**SF**
Ret. Walls 1	**14**	10	8	250	2	2	6	10	252	524	6288
Abutment 1	**14**	10	10	69	2	1	6	12	71	166	996
Bent 2	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 3	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 4	**14**	10	24	24	7	2	11	26	26	104	2288
Bent 7	**16**	12	24	24	7	2	11	26	26	104	2288
Bent 8	**16**	12	24	24	7	2	11	26	26	104	2288
Bent 9	**16**	12	24	24	7	2	11	26	26	104	2288
Abutment 10	**16**	12	10	69	2	1	6	12	71	166	996
Ret. Walls 10	**16**	12	8	250	2	2	6	10	252	524	6288
TOTAL											**28296**

TABLE E-IV

Movable Bridge Replacement
Approach Spans - Quantity Takeoff Back-Up

Structure Excavation

	# Ftgs	Shr Ht ft	Shr W ft	Shr L ft	USE Exc CY
Ret. Walls 1	2	6	10	252	1120
Abutment 1	1	6	12	71	189
Bent 2	2	11	26	26	551
Bent 3	2	11	26	26	551
Bent 4	2	11	26	26	551
Bent 7	2	11	26	26	551
Bent 8	2	11	26	26	551
Bent 9	2	11	26	26	551
Abutment 10	1	6	12	71	189
Ret. Walls 10	2	6	10	252	1120
TOTAL					**4614**

Concrete Class AX - Capbeams

	Bm Width ft	Bm Depth ft	Bm Length ft	otal W kips	USE Capbm CY
Ret Walls 1					
Abutment 1				1161	
Bent 2	**6**	**8**	**64**	2536	114
Bent 3	**6**	**8**	**64**	2536	114
Bent 4	**6**	**8**	**64**	2606	114
Bent 7	**6**	**8**	**64**	2769	114
Bent 8	**6**	**8**	**64**	2564	114
Bent 9	**6**	**8**	**64**	2564	114
Abutment 10				1175	
Ret walls 10					
TOTAL					**683**

Total Wt includes Traffic Barrier Wt, Deck wt, P/S and steel girds, and capbeams

Concrete Class AX - Walls

	Wall L ft	Ave Wall H ft	Wall T in	USE Conc CY
Ret. Walls 1	**260**	**7**	**16**	90
Abutment 1	**66**	**16**	**30**	98
Abutment 10	**66**	**17**	**30**	104
Ret. Walls 10	**260**	**7**	**17**	95
TOTAL				**387**

Approach Embankment

	Embk W ft	Embk L ft	Ave Embk H ft	USE Embk CY
Ret. Walls 1	**66**	260	7	4448.9
Ret. Walls 10	**66**	260	7	4448.9
TOTAL				**8897.8**

TABLE E-IV

Movable Bridge Replacement

Approach Spans - Quantity Takeoff Back-Up

Steel Reinforcing Bars

Ftg Reinf=	**150**	lb per CY		Capbeam Reinf=		**300**	lb per CY		
Col Reinf=	**450**	lb per CY		Wall Reinf=		**200**	lb per CY		
									USE
	Ftg	Ftg	Col	Col	Cap	Cap	Wall	Wall	**Total**
	Conc	Rebar	Conc	Rebar	Conc	Rebar	Conc	Rebar	**Rebar**
	CY	tons	CY	tons	CY	tons	CY	tons	**tons**
Ret. Walls 1	296	22	0		0		90	9	31
Abutment 1	51	4	0		0		98	10	14
Bent 2	299	22	25	6	114	17	0		45
Bent 3	299	22	36	8	114	17	0		47
Bent 4	299	22	48	11	114	17	0		50
Bent 7	299	22	44	10	114	17	0		49
Bent 8	299	22	31	7	114	17	0		47
Bent 9	299	22	21	5	114	17	0		44
Abutment 10	51	4	0		0		104	10	14
Ret. Walls 10	296	22	0		0		95	10	32
TOTAL									**374**

TABLE E-IV
Movable Bridge Replacement Bascule Span - Quantity Take Off

NO	ITEM	LENGTH (FT)	WIDTH (NUMBER)	HEIGHT (THICK) (FT) UNO	VOLUME (CY) / (CF) LINERAL FEET (LF) SURFACE AREA (SF) WEIGHT (LB)	UNIT
BASCULE BRIDGE SUBSTRUCTURE (NORTH SPAN ONLY)						
	(SOUTH AND NORTH SPANS IDENTICAL)					
1	COFFERDAM	112	64	68	23,900	SF
2	ROCK FILL	112	64	20	5,300	CY
3	SEAL	112	64	3	800	CY
4	FOOTING	110	62	7	1,800	CY
5	EXTERIOR TRANSVERSE WALLS	220	1.58	48	600	CY
6	EXTERIOR LONGITUDINAL WALLS	128	1.33	48	300	CY
7	INTERIOR LONGITUDINAL WALLS	60	8	48	900	CY
8	FLOORS (2ND, 3RD,& RDWY DECK) TOTAL	64	81	1	200	CY
9	2 FT DIA STEEL CASING CONC. FILL PILING	130	80		10,400	LF
BASCULE BRIDGE SUPERSTRUCTURE (NORTH SPAN ONLY)						
	(SOUTH AND NORTH SPANS IDENTICAL)					
	PIER SLAB					
10	SLAB CLASS 4000	23	74	0.67	42	CY
11	CONCRETE CAST IN PLACE GIRDERS CLASS 4000	15	10	1.18	7	CY
12	CROSS BEAM CLASS 4000	74	5	5	69	CY
13	CANTILEVER DIAPHRAGM CLASS 4000	63	1	2	5	CY
14	END DIAPHRAGM CLASS 4000	74	1.83	2.5	13	CY
	FLOOR SYSTEM, TRUSS, & PLATE GIRDERS					
15	LIGHT WGT CONC. DECK (120#/CF) HALF DEPTH	135	53	0.22	1,600	CF
16	LIGHT WGT CONC. DECK (120#/CF) FULL DEPTH	135	11	0.6	900	CF
17	LIGHT WGT MCC OVERLAY 1 INCH THICK	135	64	0.083	8,600	SF
18	GRID DECK GRATING (25#/SF)	135	66	5 3/16IN	222,800	LB
19	FORM PAN	135	52	20 GAGE	12,000	LB
20	RAILING	954			18,000	LB
21	STRINGERS W24X76	440		24	33,400	LB
22	STRINGERS W24X55	910		24	50,100	LB
23	FLOOR BEAMS	548		VARIES	186,000	LB
24	TRUSS UPPER & LOWER CHORDS	117X2X2		VARIES	197,000	LB
25	TRUSS DIAGIONALS	VARIES		VARIES	53,000	LB
26	TRUSS VERTICALS	VARIES		VARIES	50,000	LB
27	PLATE GIRDER CHORDS	40X2X2		VARIES	37,000	LB
28	PLATE GIRDER WEB	40X2X2		VARIES	93,000	LB
29	BRACING	VARIES		VARIES	105,000	LB
30	CONNECTIONS @ 5% OF STEEL WEIGHT				50,000	LB
31	WALKWAY	157		VARIES	35,000	LB
32	COUNTERWGT - 1635 KIPS CLASS 4000 CONC	64			405	CY
37	TRAFFIC BARRIER	60		2.67	52,000	LB

TABLE E-IV
Movable Bridge Replacement
Approach Spans - Quantity Takeoff Back-Up

Steel Reinforcing Bars - Epoxy Coated															
Appr Slab Rei	**300**	lb per CY													
Deck Slab Rei	**250**	lb per CY					**Bearings**								
					USE										
	Appr	Appr	Deck	Deck	**Total**			P/S	**USE**	Stl	**USE**				
	Conc	Rebar	Conc	Rebar	**Rebar**			Girds	**Brgs**	Girds	**Brgs**				
	CY	tons	CY	tons	**tons**			#	**#**	#	**#**				
Approach Slab	64	10			10		Approach Slab 0								
Span 1			274	34	34		Span 1	8	16	0	0				
Span 2			274	34	34		Span 2	8	16	0	0				
Span 3			274	34	34		Span 3	8	16	0	0				
Span 4			366	46	46		Span 4	0	0	7	14				
Span 6			435	54	54		Span 6	0	0	7	14				
Span 7			297	37	37		Span 7	8	16	0	0				
Span 8			297	37	37		Span 8	8	16	0	0				
Span 9			297	37	37		Span 9	8	16	0	0				
Approach Slab	64	10			10		Approach Slab 10								
TOTAL					**334**		TOTAL		**96**		**28**				