Planning Process

The following represents the basic tasks that were performed in Phase II:

A. Establishment of Evaluation Criteria and Baseline Scenario;

B. Travel Demand Modeling;

C. Alternative Studies and Environmental Overview;

D. Alternatives Ranking and Identification of Preferred Alternative; and

E. Traffic Operations Analysis.

This section will discuss the process used for each of the above items and the technical results.

A. Establishment of Evaluation Criteria and Baseline Scenarios

Selection of a Baseline

Officials from the West Virginia Department of Transportation (WVDOT) and the Ohio Department of Transportation (ODOT) as well as staff from BHJ and the Consultant Team[2] set out to explore bridge alternatives that would address the region's evolving mobility needs for the public and private sectors. It was determined that a "no-build" Scenario would be the baseline Scenario for the project. This Scenario assumed that the useful life of both the Fort Steuben Bridge and the Market Street Bridge would end within the next 25 years and no action would be taken to replace or build any new bridges across the Ohio River. Additional Scenarios would be tested and compared against this baseline to evaluate their performance. The baseline assumptions for Year 2025 were:

- The Fort Steuben Bridge will no longer be in service;
- The Market Street Bridge will no longer be in service; and
- The Veterans Memorial Bridge, with some operational improvements, as discussed in a later part of this report, will be the only remaining Ohio River bridge structure in the Study Area.

The Baseline and other potential Scenarios were evaluated against each other using both quantitative and qualitative criteria related to mobility, environmental impacts, safety, cost effectiveness, and regional economic growth. The Federal Highway Administration's STEAM (Surface Transportation Efficiency Analysis Model) program and the region's travel demand model, jointly maintained by ODOT and the BHJ staff, provided the quantitative data. Qualitative data was developed from local input and professional experience. The qualitative method of analysis using the travel demand model is discussed later in this report.

[2] Edwards and Kelcey as prime consultant and Burgess & Niple as subconsultant.

Evaluation Criteria

In order to develop measurable criteria that could be used for evaluation, the Goals and Objectives were refined to look at mobility, environmental concerns, safety, cost effectiveness and regional economic growth. The BAC participated in this refinement and approved the application of the criteria. These criteria are listed below by category.

Mobility

1. **Vehicle Hours of Travel (VHT)** Total number of hours traveled by all vehicles within the planning area on a weekday.
2. **Vehicle Miles of Travel (VMT)** - Total vehicle miles of travel within the planning area in a year.
3. **Total Travel Time (Million Person Hours/Yr**.) – Total travel time per year for persons in the planning area.
4. **Average Travel Times, From Selected Gateways to Selected River and Rail Ports** – Travel time between selected gateways into the planning area and selected river and rail ports in both Ohio and West Virginia (see Figure 9 for Gateway Locations):
   - *West Virginia Gateways to Ohio – River and Rail Ports*
     - WV 27 to Wheeling-Pitt South Works River Port
     - US 22 to Wheeling-Pitt South Works River Port
     - WV 2 (south) to Wheeling-Pitt South Works River Port
     - WV 27 to Warrenton River Terminal
     - US 22 to Warrenton River Terminal
     - WV 2 (south) to Warrenton River Terminal
     - WV 27 to Norfolk & southern Railways/Wheeling & Lake Erie Railroad Facility
     - US 22 to Norfolk & southern Railways/Wheeling & Lake Erie Railroad Facility
     - WV 2 (south) to Norfolk & southern Railways/Wheeling & Lake Erie Railroad Facility
   - *Ohio Gateways to West Virginia – River and Rail Ports*
     - US 22 to Weirton Ice and Coal Water Port
     - SR 7 (south) to Weirton Ice and Coal Water Port
     - US 22 to Wheeling-Pitt Coke Plant River Port
     - SR 7 (south) to Wheeling-Pitt Coke Plant River Port
5. **Percent of System at each Level of Service** - This category uses the Highway Capacity Manual's rating system to illustrate what percentage of the overall transportation system functioning at the various Levels of Service (LOS) from A to E.

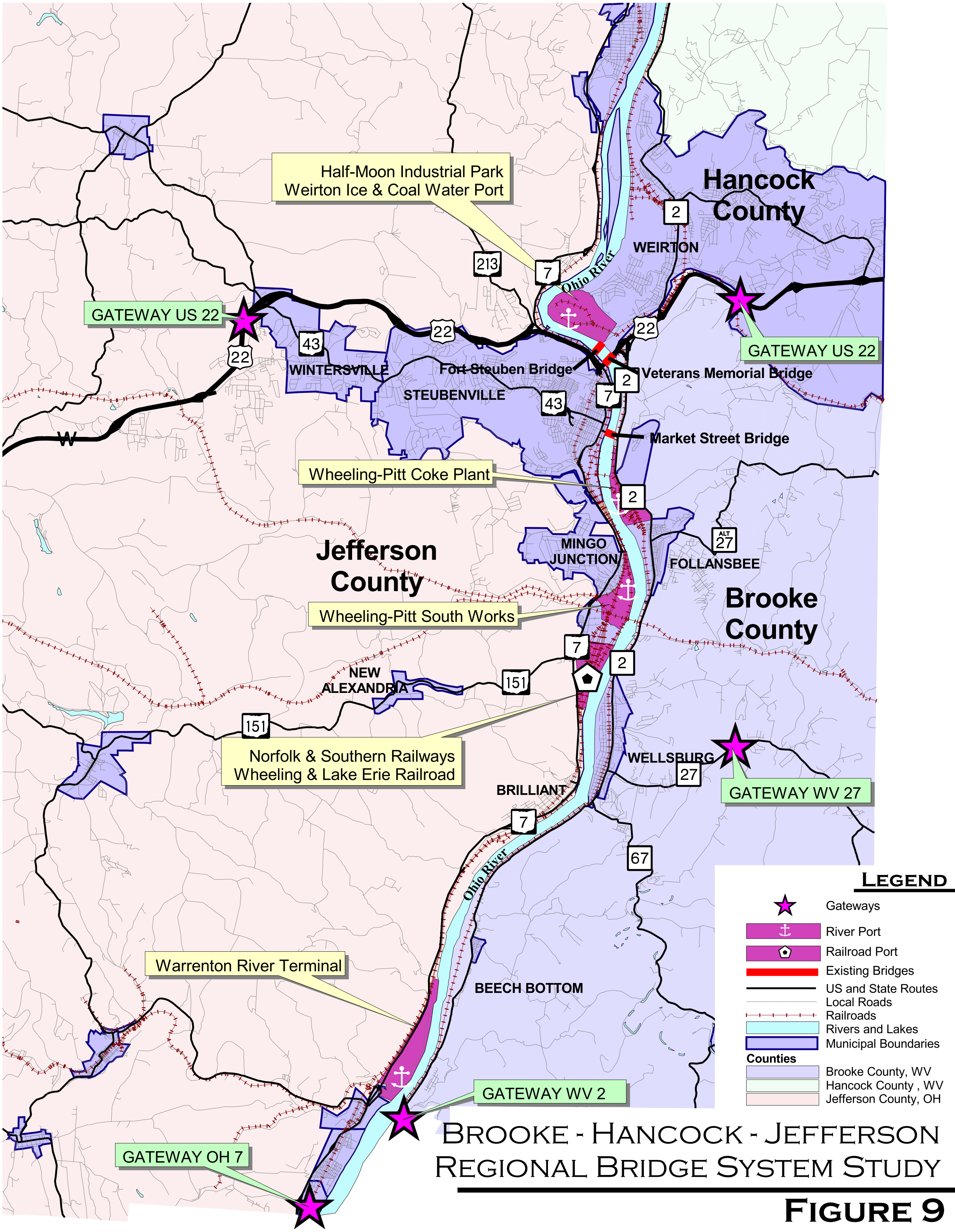

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FIGURE 9
SELECTED GATEWAYS TO RIVER AND RAIL PORTS

1 0 1 2 3 4 Miles

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Environmental

6. **Probability of Minimizing Potential Environmental Impacts** – Subjective determination of environmental impacts based on collected data related to natural environment factors (threatened and endangered species, wetlands, hazardous materials, floodplains) and social impacts (commercial and residential property and environmental justice issues).

7. **Estimated vehicle emissions (tons/yr)** – Calculation based on national averages of pollutants typically caused by automobiles including Hydro-Carbons (HC), Carbon Monoxide (CO), Nitrous Oxide (NOx), and Particulate Matter (PM10).

Safety

8. **Potential Annual Accidents** – Calculation based on accidents per 100 million vehicle miles traveled by roadway functional classification.

9. **Potential for Improved Emergency Response Times** – Developed from a goal to maximize safety. This is a qualitative rating based on improved access throughout the planning area due to the location of various bridge alternatives.

10. **Potential for Alternative River Crossings (Avoidance of Single Service Situations)** – Also developed from a goal to maximize safety. This rating is qualitative and is based on providing duplication in the transportation network and river crossing linkages. The more opportunities to cross the river the higher the rating.

Cost Effectiveness

11. **Capital Cost (Millions)** – Total estimated cost to do the environmental review, design, purchase right-of-way and construct each bridge alternative.

12. **Reduction in Total User Cost ($1000/year)** - Calculation of user cost reduction for the entire network from the base case Scenario. Travel time reduction play a major role in this calculation, national defaults were used in this calculation including a value of $8.90/person-hour for autos and $16.50/person-hour for commercial vehicles.

13. **Benefits and Cost Ratio** – Used to determine the ratio of benefits received from **reduction in total user cost** compared to **capital cost**. If the ratio exceeds 1.0, the overall improvements are generally considered to be financially feasible.

14. **Technical Feasibility** - Developed from the goal to identify and propose implemental solutions. This is a subjective engineering judgment based on the ease of construction (technical feasibility) of the alternative.

15. **Fiscal Likelihood** – Subjective, based on the cost of construction and likely funding available.

16. **Potential Land Use Impacts** – This measure was developed from a general goal to minimize negative impacts on land and associated users. It is an estimate of the total number of acres that may be potentially impacted by construction of a bridge as well as the total number of residential and commercial properties that may be affected.

Regional Economic Growth

17. **Ability to Maximize Accommodations of Heavy and Large Vehicles** - Subjective rating of the system to accommodate Heavy and Large Vehicles both crossing the river and to move about the planning area.
18. **Potential for Improved Access to Existing Industrial Sites** – Measure developed from the goal to improve access throughout the system for existing businesses. This is a subjective rating of each alternative and its ability to provide alternative routes for trucks, alleviate congestion and maintain an acceptable LOS.
19. **Potential for Improved Access to Future Industrial Sites** – Same definition as above with the exception that this is for proposed industrial expansion and new sites.

B. Travel Demand Modeling

Process Overview

BHJ's regional travel demand model was used in Phase II as the primary technical analysis tool. The model forecasts travel demand over the three-county BHJ region that includes Jefferson County in Ohio and Brooke and Hancock Counties in West Virginia. It is calibrated to the 1999 observed travel behavior of the region and validated against highway counts. Its purpose in this Study was to forecast the regional and corridor-level transportation impacts of various alternatives. A large portion of the evaluation criteria (and the corresponding performance measures) required data from two sources: the travel demand model and traffic operations analysis. The travel demand model also provided some of the data needed for traffic operations analysis.

For this part of the Study, the following technical assumptions were made:

1. The horizon year is 2025;
2. The Baseline Scenario was determined by the process described earlier in this report;
3. This study applied a single 2025 land use (i.e., socio-economic) data set. It is identical to the one used in the latest regional Long Range Transportation Plan;
4. The Consultant Team used the regional travel demand model validated by ODOT; and
5. Emissions calculations were computed using the STEAM model.

Baseline and Horizon Year Comparisons

Vehicle Trips

Currently, about 417,000 auto trips occur daily in the BHJ region. This figure is estimated to increase 3 percent by 2025. Almost one-quarter of all vehicle trips have at least one trip end outside the region. These external trips are estimated to grow 8 percent by 2025.

Internal trips begin and end inside the region and comprise 75 percent of all vehicle trips. They are estimated to grow by 1 percent between 1999 and 2025, reflecting the stability of the region.

Vehicle trip growth in the region is modest. Obviously, this reflects the low forecasts for population and employment. Should the demographics and economy of the region improve, then it will be important to revisit the trip forecast so as to better estimate transportation needs.

River Crossings

Trips that cross the Ohio River constitute about 11 percent of all trips in the region. The regional travel demand model estimates 48,300 river crossings in 1999. This is slightly higher than the number of trips (46,000) traveling between West Virginia and Ohio. The assignment models show a double river-crossing movement between the Half Moon Industrial Park area and central and southern Brooke County. This is because, according to the assignment, it is quicker to cross the Fort Steuben Bridge and Veterans Memorial Bridge than to connect with US 22 in West Virginia. This movement is not evident in field observations according to BHJ.

Table 1 – Daily Volumes on Ohio River Bridges

Bridge	1999 Base*	2025 Horizon Year	2025 Baseline
Fort Steuben	9,100	9,500	--
Veterans Memorial	28,100	31,300	49,200
Market Street	11,100	12,900	--
Total Ohio River Crossings	**48,300**	**53,700**	**49,200**

Source: BHJ Regional Travel Demand Model

Table 2 – Daily Volumes by Direction on Ohio River Bridges

Bridge	1999 Base*	2025 Horizon Year	2025 Baseline
Fort Steuben (Westbound)	4,500	4,400	0
Fort Steuben (Eastbound)	4,600	5,100	0
Veterans Memorial (Westbound)	14,100	16,000	24,600
Veterans Memorial (Eastbound)	14,000	15,300	24,600
Market Street (Westbound)	5,600	6,500	0
Market Street (Eastbound)	5,500	6,400	0
Total (Westbound)	**24,200**	**26,900**	**24,600**
Total (Eastbound)	**24,100**	**26,800**	**24,600**

Source: BHJ Regional Travel Demand Model. *These volumes are assigned by the demand model and are approximate when compared to actual traffic counts.

The model estimates river crossings to increase to 53,600 in 2025. Again, this is slightly higher than the number of trips (51,000) traveling between West Virginia and Ohio. The assignment model shows the same double river-crossing movement occurring in the 1999 model. The Veterans Memorial Bridge receives more than 50 percent of all river crossings. It has the largest vehicle capacity of the three bridges. Demand for Fort Steuben Bridge and Market Street Bridge is estimated to rise between 2000 and 2025. Demand for all bridges is equally distributed between westbound and eastbound movements.

Over 75 percent of the trips that cross the Ohio River originate in and return to West Virginia. This is because of the high number of external trips entering the region in West Virginia and traveling to (or through) Ohio. The remaining 20-25 percent originates and returns to the Ohio side of the river.

Table 3 – Vehicle Trip River Crossings

Trip Type	1999 Base	2025 Horizon Year	2025 Baseline
Internal-Internal Trips	23,900	25,700	24,000
External-Internal Trips	18,500	21,100	21,000
External-External Trips	3,500	4,200	4,200
Total Ohio River Crossings	**46,000**	**51,000**	**49,200**

Source: BHJ Regional Travel Demand Model

About 50 percent of vehicle trips between Ohio and West Virginia are internal-internal trips. These trips have both trip ends inside the BHJ region. They are the most sensitive to transportation alternatives in the region. Approximately 40 percent are external-internal trips. These trips have one trip end outside the region. External-external trips constitute about 8 percent of Ohio River Crossings. These trips have both their origin and destination outside the BHJ region. They are typically less sensitive to local transportation alternatives and probably would not alter their trip patterns significantly if the region's bridge system were modified.

Alternatives Analysis Using the Model

The alternatives studied in Phase II and listed later in this report were used to evaluate the effects of a combination of bridges (except the baseline case). The alternatives were studied to evaluate the effect of the bridge(s) on the following criteria: user benefits, LOS, regional traffic and accident criteria, and emissions. The team analyzed the results from the 2025 model runs under varying bridge conditions. The following section outlines the alternatives that were studied and provides the technical results of both the quantitative analysis completed using the model as well as the qualitative analysis completed.

C. Alternative Studies and Environmental Overview

A series of reasonable alternatives for new crossing locations within the Study Area were initially identified and reviewed with the BAC. A public meeting was also held to present the alternatives that were identified for review and comment. Listed below, and shown in Figure 10, is the final list of alternatives that were evaluated as well as the alternatives matrix that illustrates the model runs required to test this range of alternatives.

- **Veterans Memorial Bridge Only (Baseline).** The baseline alternative where only the Veterans Memorial Bridge is assumed to exist. (Alternative 1). This bridge connects SR 7 with WV 2 and is situated just south of Fort Steuben Bridge.
- **New Southern Bridge (south of Wellsburg) added to Baseline.** A new Southern Bridge south of Wellsburg is assumed to be open and operational in 2025 in addition to the Veterans Memorial Bridge. (Alternative 2)
- **New Southern Bridge (between Follansbee and Wellsburg) added to Baseline.** A new Southern Bridge located between Follansbee and Wellsburg is assumed to be open and operational in 2025 in addition to the Veterans Memorial Bridge. (Alternative 3)
- **New Market Street Bridge (in existing location) added to Baseline.** A new Market Street Bridge in its existing location is assumed to be open and operational in 2025 in addition to the Veterans Memorial Bridge (Alternative 4). This bridge would connect WV 2 with Market Street in Steubenville (Ohio side.).
- **New Market Street Bridge (with connection to SR 7) added to Baseline.** A new Market Street Bridge in its existing location with a high capacity connection to SR 7 is assumed to be open and operational in 2025 in addition to the Veterans Memorial Bridge (Alternative 4A). This bridge would provide high capacity connections between WV 2 and SR 7.
- **New Washington Street Bridge added to Baseline.** A new Washington Street Bridge connecting Washington Street with WV 2 is assumed to be open and operational in 2025 in addition to the Veterans Memorial Bridge. (Alternative 5)
- **New Fort Steuben Bridge (in existing location) added to Baseline.** A new Fort Steuben Bridge in its existing location with improved connections to the SR 7 and WV 2 is assumed to be open and operational in 2025 in addition to the Veterans Memorial Bridge (Alternative 6). This is the northernmost bridge.
- **2025 All Bridges.** This alternative assumes that all four bridges – Veterans Memorial Bridge, New Southern Bridge at preferred location, New Washington Street Bridge, and New Fort Steuben Bridge at existing location. (Alternative 7)
- **2025 Existing Fort Steuben Bridge Not Included.** This alternative assumes that Veterans Memorial Bridge, the New Southern Bridge and New Washington Street Bridge are open and fully operational in 2025. The existing Fort Steuben Bridge is closed to traffic. (Alternative 8)

- **2025 New Market Street Bridge Not Included.** This alternative assumes that Veterans Memorial Bridge, New Southern Bridge and New Fort Steuben Bridge are open and fully operational in 2025. (Alternative 9)
- **2025 New Southern Bridge Not Included.** This alternative assumes that only the Veterans Memorial Bridge, the New Washington Street Bridge and the new Fort Steuben Bridge are open and fully operational in 2025. (Alternative 10)

The Veterans Memorial Bridge was built in 1990 and is always assumed to be fully operable in 2025.

Table 4: Alternative Scenarios

Scenario	Veterans Memorial Bridge	New Southern Bridge	Market Street Bridge	Fort Steuben Bridge
Baseline 1	✔			
2	✔	✔ (South of Wellsburg)		
3	✔	✔ (Between Follansbee and Wellsburg)		
4	✔		✔ (New in existing location)	
4A	✔		✔ (New with connection to SR 7)	
5	✔		✔ (New connects Washington Street with WV 2)	
6	✔			✔ (New with improved connections to SR 7 and WV 2)
7	✔	✔ (South of Wellsburg)	✔ (New connects Washington Street with WV 2)	✔ (New with improved connections to SR 7 and WV 2)
8	✔	✔ (South of Wellsburg)	✔ (New connects Washington Street with WV 2)	
9	✔	✔ (South of Wellsburg)		✔ (New with improved connections to SR 7 and WV 2)
10	✔		✔ (New connects Washington Street with WV 2)	✔ (New with improved connections to SR 7 and WV 2)

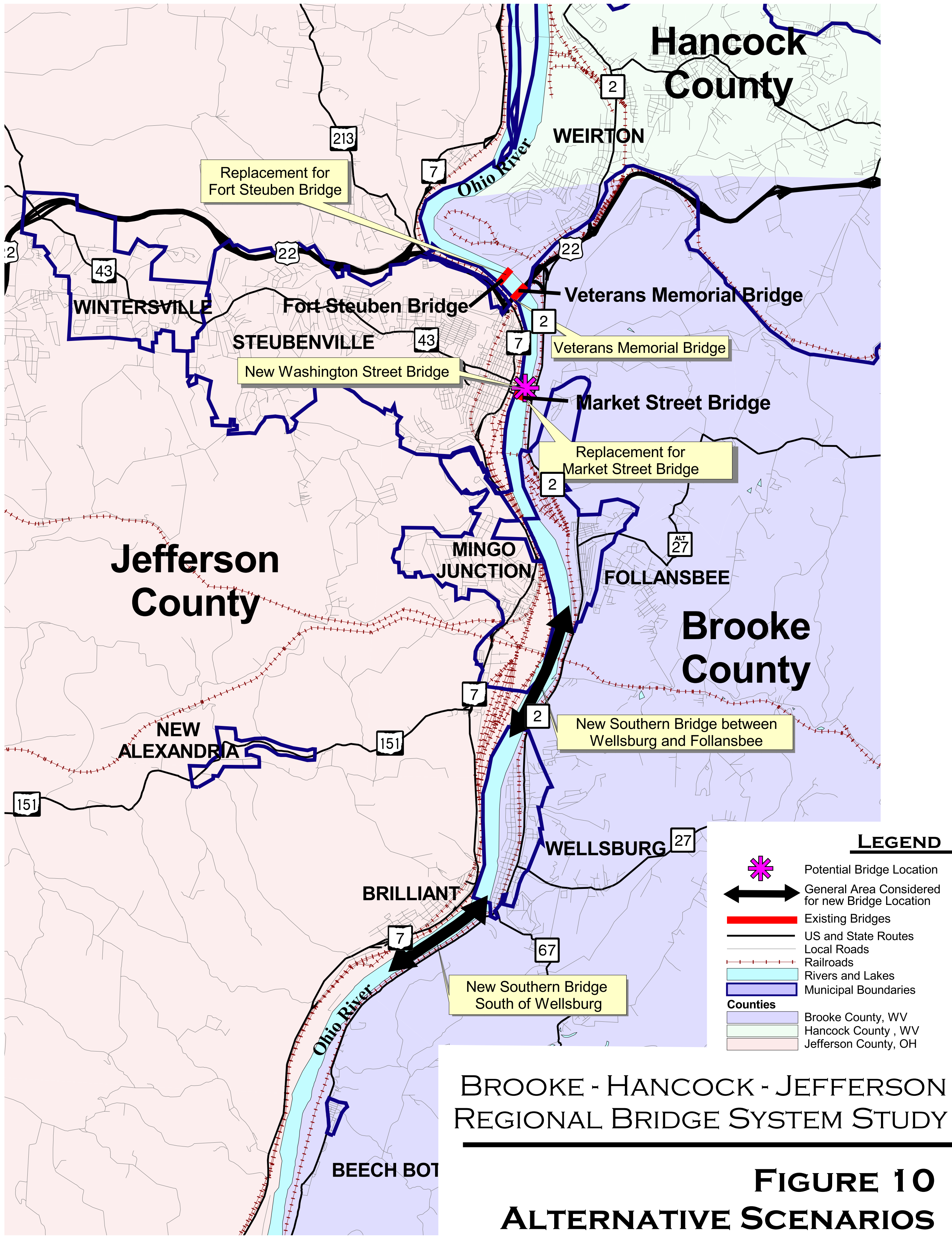

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FIGURE 10
ALTERNATIVE SCENARIOS

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D. Alternative Ranking and Identification of Preferred Alternative

Evaluation of Alternatives

The evaluation criteria outlined earlier in this report with the above alternatives were used in the evaluation process to conduct a "trade-off" analysis, which pulls together the key differences among the Scenarios. The trade-off analysis is designed to take the broadest view possible of the key differences among the Scenarios and highlight their differences to aid in decision-making. The information gathered to conduct the "trade-off" analysis was summarized and documented in a matrix and are discussed below. This helped to frame the decision on a preferred alternative in terms of the advantages and disadvantages of choosing one alternative versus another.

The evaluation consisted of both quantitative and qualitative components. The quantitative analysis used data from the travel demand model previously described. This included travel characteristics, traffic volumes and operating levels of service as well as "existing conditions" data on highway system capacities. The qualitative analysis used evaluation criteria related to the bridges that were drawn from the DOT's, the Bridge Advisory Committee, the MPO and the public. Specific measurable criteria (objectives) and are listed as follows:

Quantitative

- Number of Anticipated potential accidents and/or fatalities (annual)
- Percent of system at each Level of Service (LOS)
- Vehicle hours of Travel (VHT)
- Total travel time
- Vehicle miles of travel (VMT)
- Reduction in Total User Costs
- Average travel time, selected external gateways to selected internal sites
- Estimated vehicle emissions
- Potential land use impacts
- Benefits Cost Ratio

Qualitative

- Potential for improved emergency response times
- Potential for alternative river crossings
- Potential for improved access to existing industrial sites
- Potential for improved access to future industrial sites
- Technical Feasibility
- Fiscal Likelihood
- Probability to Minimize Potential Environmental Impacts

The first seven Scenarios included the Baseline and individual bridges combined with the Baseline. Scenarios 7 through 10 were combinations of bridges using the preferred northern and southern alternatives derived from the analysis of Scenarios 2 through 6.

Method of Analysis

The focus of the evaluation was on the long-term value of various river-crossing locations. Scenarios were compared to the 2025 baseline condition for this study, which assumes Veterans Memorial Bridge is the only operational Ohio River bridge. A multi step approach was developed by the project team to analyze the various Scenarios.

The Baseline Scenario established travel parameters with "no build" system characteristics. The next step involved analysis of alternatives related to establishing an optimum location in the southern portion of the Study Area (Scenarios 2 and 3). Then, a similar analysis was conducted for alternative locations in the northern portion (Scenarios 4, 4A, 5, and 6). Results of the analysis established a preferred location for a southern bridge (south of Wellsburg) and a preferred location for a northern bridge (a new bridge at Washington Street in Steubenville).

Using the preferred southern and northern locations, the combined Scenarios 7, 8, 9, and 10 were analyzed. The evaluation criteria were grouped into categories, which include effectiveness in improving mobility, effectiveness in minimizing environmental impacts, cost effectiveness, potential for improving safety, and effectiveness in supporting regional economic growth. The findings of the evaluation are discussed by category below and shown in Table 5:

Mobility

The southern Scenarios (2 and 3) both rate high in improving travel time throughout the region as well as lowering VMT and VHT. Both alternatives reduce by half the amount of travel time from WV Gateways to Ohio River and rail ports due to the central or southern location of many of the Ohio rail and river facilities. The improvements from Ohio Gateways to WV rail and river port are not as dramatic. This is due to most WV facilities being located either in the central planning area or in the northern portion of the planning area.

VHT system wide in a twenty-four hour period was reduced by 3,000 hours with Scenario two and 2,800 hours for Scenario three. VMT was reduced by 25,000 miles traveled over the baseline for Scenario 2 a 17,000 mile reduction for Scenario 3. Total travel is reduced by 870,000 hours per year hours for Scenario 2 versus 680,000 hours for Scenario 3.

It can be seen under the mobility ratings shown in Table 5 that Scenario 2 exceeds the performance of Scenario 3.

The northern Scenarios do not improve travel time, VMT and VHT as dramatically as the addition of a southern bridge, but when compared to the Baseline Scenario there are still noticeable improvements. A comparison of Scenarios shows that the three variations for replacing the Market Street Bridge (4, 4A, 5) improve travel times by several minutes to both WV and Ohio rail and river ports from selected gateways. Selected ports measured better travel times under Scenarios 4A and 5 due to their direct connection to SR 7. Scenario 6, the replacement of the Fort Steuben Bridge, provides no improvement in travel time to the rail and river ports over the Baseline Scenario.

The largest reduction in VHT over the Baseline is Scenario 5 (Washington Street). VHT for this Scenario is reduced by 700 hours per day over the Baseline. VHT for the Scenarios 4, 4A, and 6 are reduced by 100, 400, and 100 hours per day respectively. The largest reduction for VMT over the Baseline is 21,000 miles per day for both Scenarios 4A and 5, followed by Scenario 4 at 18,000 miles per day and Scenario 6 at 4,000 miles per day. The largest reduction of total travel time over the Baseline Scenario was Scenario 5, which resulted in a reduction of 230,000 person hours per year.

The mobility rating shown in Table 5 shows that, when looking at the northern Scenarios, Scenario 5 exceeds the performance of Scenarios 4, 4A, and 6.

For the combined Scenarios, Scenario 7 showed the greatest improvements in mobility. This Scenario included the existing Veterans Memorial Bridge as well as the construction of three additional bridges. Scenario 8 (Veterans Memorial Bridge, southern bridge near Wellsburg and a new bridge at Washington Street) also showed similar improvements in overall mobility.

Scenarios 7, 8, and 9 show the greatest improvement in gateway travel times. Scenario 10, only slightly improves travel time over the Baseline. For the remaining mobility criteria, (VHT, VMT, and total travel time) Scenario 7 has a significant advantage over the Baseline with reductions of 2,884 hours in VHT, 35,000 miles in VMT, and almost 1 minute in total travel time. This was followed closely by Scenario 8. Improvements in these measurements dropped off considerably with Scenarios 9 and 10.

Environmental Impacts

The Scenarios were reviewed to identify the relative potential impacts on the environment. This preliminary evaluation was generally qualitative. Data was reviewed related to the location of the 100-year floodplain, presence of threatened and endangered species, hazardous materials sites, historic sites, public facilities and wetlands. This data was used to develop a qualitative rating of the probability to minimize environmental impacts. Ratings ranged from 5 ✓'s being most desirable to 1 ✓ being the least desirable. Additionally, Surface Transportation Efficiency Analysis Model (STEAM) developed by FHWA was used to develop a quantitative number for emissions based on national averages.

Based on the qualitative ratings for environmental impacts the Baseline Scenario and the Scenarios that replaced bridges in their existing locations for Market Street and Fort Steuben ranked high.

The lowest rated Scenario to minimize potential environmental impacts for the southern Scenario was Scenario 3 due to its crossing an industrial area and the potential for hazardous waste impacts. For the northern alternatives, both Scenarios 4 and 6 rated equally high due to the lack of disruption associated with placing a structure on a new location. Scenarios 4A and 5 were slightly downgraded due to impacts associated with construction on new locations.

Estimated vehicle emissions (tons/yr) were calculated for each Scenario. For the southern Scenarios (2 and 3) a large reduction was seen for both Hydro-Carbons (HC) and Carbon Monoxide (CO) over the Baseline with Scenario 2 having largest reduction. The northern Scenarios didn't see the same amount of reduction in vehicle emissions as the southern. The largest reduction for northern Scenarios was Scenario 5.

The combined Scenario options do not fare as well as some of the other alternatives in this category due to the disruption of the physical environment resulting from the construction of three bridges. Scenario 7 does show reductions in vehicle emissions and improvements in air quality.

Overall, Scenario 2 was the most effective in terms of reducing environmental impacts for the southern area. For the northern Scenarios, both Scenarios 4 and 6 tied for least natural environmental concerns and Scenario 5 was the most effective for reduction in vehicle emissions. For the combined Scenarios, Scenarios 7 and 8 were the best performers for reductions in vehicle emissions (see Table 5).

Safety

To measure safety improvement, potential annual accidents, potential for improved emergency response times and potential for alternate river crossings (avoidance of single service situations) were evaluated. The potential for annual accidents was determined from the STEAM model. Emergency response times and alternate river crossings used a qualitative weighting.

For the southern Scenarios it was found that the biggest reduction, over the baseline Scenario for potential annual accidents, was with Scenario 2. It was also determined that qualitatively Scenario 2 outranked Scenario 3 for emergency response times and alternate river crossings. The reason for this was due to improved access to the southern portion of the planning area. Both southern Scenarios exceeded the ratings for the northern Scenarios due to redundancy caused by being located closer to the Baseline Scenario.

For the northern Scenarios, Scenario 4 showed the largest reduction of accidents followed closely by Scenarios 4A and 5. Scenario 6 showed no improvement over the Baseline in reduction of accidents. When reviewing improvements for emergency response times and alternate river crossings, each northern Scenario preformed equally well with no clear winner due to the close physical proximity to the Baseline Scenario.

Scenario 7 provided the greatest safety improvements of the combined Scenarios by having the largest reduction of annual accidents and emergency response times over the Baseline, as well as improving overall mobility in the region.

Cost Effectiveness

For cost effectiveness, capital cost, reduction in total user cost, and the benefits to cost ratio were evaluated. Capital cost included the replacement of the existing bridge or a bridge on new location, the required bridge approach work, right-of-way cost, and planning and design cost was also included in the estimates. The reduction in user cost was determined from the STEAM model on a system wide basis. Travel time reductions play a major role in this calculation; national defaults were used in this calculation including a value of $8.90/person-hours for autos and $16.50/person-hours for commercial vehicles.

The southern Scenarios both have major reductions in user cost but, when compared to all Scenarios, have a higher capital cost. Scenario 2 has a user cost reduction of $12.7 million dollars per year as compared to $9.2 million for Scenario 3. Capital cost is also lower for Scenario 2 with the estimated cost being $43.8 million for a two-lane structure and $51.5 million for a four-lane structure. Scenario 3 capital costs are $59.7 million and $71.4 million respectively. The benefits to cost ratio for both Scenarios 2 and 3 are very high. Scenario 2 ratio is 4.43 for a two lane facility versus 2.35 for Scenario 3.

For the northern Scenarios the reductions in user cost is not as dramatic with Scenario 5 having the greatest user cost reduction of $3.9 million per year. The Scenario with the least reduction in user cost is 6 with a reduction of $0.6 million per year. Conversely, the lowest capital cost is associated with Scenario 6, which has a cost of $31 million for a two-lane structure and $37 million for a four-lane structure. The highest capital cost is for Scenario 4A at $47.8 million for two-lanes and $54.6 million for a four-lane structure. The higher cost is due to potential impacts to adjacent land uses. The northern Scenario having the greatest benefits to cost ratio is Scenario 5 followed closely by Scenario 4. Scenario 6 had the lowest benefit to cost ratio.

For the combined Scenarios the greatest capital cost savings was associated with Scenario 10. The construction of three new bridges proposed in Scenario 7 is the most costly followed by 8 and 9 respectively. The reduction in total user cost was just the opposite with Scenario 7 having the largest reduction in total user cost of $13.9 million, followed by Scenario 8 at $13.7 million. Scenario 10 had a reduction of $3.5 million. To determine the preferred combined Scenario the benefits to cost ratio was calculated for the combined Scenarios with 8 giving the biggest return on investment.

Regional Economic Growth

This category looked at how additional river crossings and their location could improve regional economic growth. Items reviewed to determine this included the potential to improve access to existing industrial sites, potential to improve access to future industrial sites and the ability to maximize accommodations of heavy and large vehicles.

The analysis of southern Scenarios rated Scenario 2 slightly higher than 3 due to its location and functional ability to better accommodate heavy and/or large vehicles. Scenario 2 was rated higher because the more southern proximity enhanced the potential ability to serve the planning area more effectively. Scenarios 2 and 3 rated equally well on serving both existing and future industrial sites.

For the northern Scenarios, number 6 was rated highest. It serves future industrial sites slightly better than others. Scenarios 4 and 4A are downgraded due to pavement truck weight restrictions on Market Street in Steubenville.

Finally, for the combined Scenarios it was found that Scenario 7, construction of three bridges provided the largest economic benefit to the region when accommodating heavy and large vehicles and its ability to serve the planning area effectively. Very close behind was Scenario 8, which includes the construction of the preferred southern and northern alternatives.

Conclusions

Table 5 shows a listing of the 19 evaluation criteria used for the 10 alternative Scenarios. Comparison of each "cell" within the matrix provides a useful basis for selection of a preferred Scenario.

The evaluation of the alternative Scenarios suggests that no single solution is best in all measured categories for addressing all the transportation needs of the BHJ area. However, the results suggest that some of the Scenarios or combinations of Scenarios could be very effective and satisfy many of the critical needs of the region.

Based on the criteria used for evaluation in this Study, the best performers for each general category (not necessarily by priority) are:

- Southern Scenario 2 – new southern bridge located in Wellsburg or an area south of Wellsburg;
- Northern Scenario 5 – new Washington Street Bridge with high capacity connection to SR 7; and
- Scenario 8 – Veterans Memorial Bridge, with preferred southern and preferred northern alternatives.

Scenario 8 is the preferred alternative. It provides the advantages of both the preferred northern and southern Scenarios as well as maintaining a high benefits to cost ratio and the highest reduction of user costs. When Scenario 8 is reviewed in comparison to both the Baseline and other alternatives it is found to provide maximum benefit for minimum cost in all categories mobility, environmental impacts, safety, cost effectiveness and regional economic growth.

The preliminary estimated cost for construction of two new bridges with roadway approaches, as provided in Scenario 8, is approximately $98,310,000. Additional costs related to environmental issues, permitting, navigation, and preliminary engineering studies will likely increase the total cost to well over $100,000,000. Detailed engineering and location studies will be required in order to obtain a better construction cost estimate.

It is noted that strong efforts should be made to extend the life of the existing Market Street Bridge as long as possible, thus delaying the need for a new bridge at Washington Street.

Table 5
BHJ Alternatives Evaluation Matrix
12/10/2002 (revised 5/31/03)

	MEASURES	Base Scenario	Southern Scenarios		Northern Scenarios				Combined Scenarios			
		Vets only	Vets, New South of Wellsburg	Vets, New Between Follansbee and Wellsburg	Vets, New Market in Exist. Location	Vets, Market St c/w SR 7	Vets, Washington St.	Vets, new Ft. Steuben	All 4 Bridges	Vets, New Southern Bridge, Washington	Vets, New Southern Bridge, New Ft. Steuben	Vets, Washington, New Ft. Steuben
		Baseline	#2	#3	#4	#4A	#5	#6	#7	#8	#9	#10
	Mobility											
1	**Vehicle hours of travel (VHT)**	90,900	87,900	88,100	90,800	90,500	90,200	90,800	88016	88100	88800	90300
2	**Vehicle miles of travel (VMT)**	2,799,000	2,774,000	2,782,000	2,781,000	2,778,000	2,778,000	2,795,000	2,764,000	2,770,000	2,775,000	2,774,000
3	**Total Travel Time (Million Person Hours/Yr)**	36.05	35.18	35.37	35.90	35.86	35.82	36.00	35.11	35.15	35.33	35.84
4	**Average Travel Time, Selected Gateways to Selected River and Rail Ports.**											
	WV Gateways to OH River and Rail Ports											
	WV27 to WP S Works River Port	36	17	16	32	31	31	36	17	17	17	32
	US22 to WP S Works River Port	17	17	16	16	16	16	17	17	17	17	17
	WV2 (south) to WP S Works River Port	41	17	18	38	36	36	41	17	17	17	37
	WV27 to Warrenton River Term	51	25	29	47	46	46	51	25	25	25	47
	US22 to Warrenton River Term	32	32	32	32	32	32	32	32	32	33	32
	WV2 (south) to Warrenton River Term	56	24	31	53	51	51	56	24	24	24	52
	WV27 to NS/W&LE RR Facility	37	16	14	33	32	32	37	16	16	16	33
	US22 to NS/W&LE RR Facility	18	18	18	18	17	17	18	18	18	19	18
	WV2 (south) to NS/W&LE RR Facility	42	15	16	39	37	37	42	15	15	15	38
	OH Gateways to WV River and Rail Ports											
	US22 to Weirton I&C Water Port	25	25	25	25	25	25	21	21	25	21	21
	SR 7 (south) to Weirton I&C Water Port	29	29	29	29	28	28	24	25	28	25	25
	US22 to WP Coke Plant River Port	24	24	24	24	24	24	24	24	24	24	24
	SR 7 (south) to WP Coke Plant River Port	28	22	23	23	23	23	28	23	23	23	23
5	**Percent of System at each Level of Service.**											
	LOS "A"	83%	83%	83%	83%	84%	83%	83%	83%	83%	83%	83%
	LOS "B"	8%	9%	9%	9%	8%	9%	8%	9%	9%	9%	9%
	LOS "C"	3%	4%	4%	3%	4%	3%	3%	4%	4%	4%	4%
	LOS "D"	4%	3%	3%	3%	3%	3%	4%	3%	3%	3%	3%
	LOS "E"	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
	LOS "F"	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
	Environmental Impacts											
6	**Probability to Minimize Potential Environmental Impacts**	✓✓✓✓	✓✓✓	✓	✓✓✓✓	✓✓✓	✓✓✓	✓✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓
7	**Estimated vehicle emissions (ton/yr)**											
	Hydro-Carbons (HC)	846	833	836	843	842	842	845	831	832	835	841
	Carbon Monoxide (CO)	14,559	14,272	14,343	14,521	14,513	14,499	14,542	14,264	14,276	14,325	14,514
	Nitrous Oxide (NOx)	1,443	1,428	1,433	1,435	1,433	1,433	1,440	1,422	1,426	1,427	1,430
	PM10	57	56	57	57	57	57	57	56	56	56	56
	Safety											
8	**Potential Annual Accidents**	3,951	3,902	3,922	3,922	3,924	3,923	3,950	3,892	3,897	3,907	3,923
9	**Potential for Improved Emergency Response Times**	✓	✓✓✓✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓
10	**Potential for Alternate River Crossings (Avoidance of Single Service Situations)**	✓	✓✓✓✓✓	✓✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓
	Cost Effectiveness											
11	**Capital costs (Millions) 2ln/4ln**	0	\$43.8 / \$51.5	\$59.70 / \$71.38	\$31.92 / \$38.86	\$47.75 / \$54.55	\$40.03 / \$46.83	\$31.0 / \$37.0	\$114.81 / \$130.33	\$83.83 / \$98.31	\$74.78 / \$83.50	\$71.01 / \$78.85
12	**Reduction in Total User Costs (1000\$/yr)**	0	12,655	9,172	2,934	3,368	3,855	627	13,968	13,714	10,822	3,577
13	**Year 2025 Benefits Cost Ratio 2 ln / 4 ln**	0	4.43 / 3.77	2.35 / 1.97	1.41 / 1.16	1.08 / 0.95	1.48 / 1.26	0.31 / 0.26	1.86 / 1.64	2.51 / 2.14	2.22 / 1.99	0.77 / 0.70
14	**Technical Feasibility**	✓✓✓✓✓	✓✓✓✓	✓✓	✓✓✓✓	✓✓✓	✓✓✓	✓✓✓✓	✓✓✓✓	✓✓✓✓	✓✓✓	✓✓✓
15	**Fiscal Likelihood**	✓✓✓✓	✓✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓✓	✓✓	✓✓
16	**Potential Land Use Impacts**		Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV	Ohio / WV
	Total Number of Acres	0	3.01 / 3.31	17.65 / 3.87	3.60 / 0.00	4.00 / 0	4.50 / 4.10	0.00 / 0.00	7.51 / 7.41	7.51 / 7.41	3.01 / 3.31	4.50 / 4.10
	Residential Units	0	10 / 3	16 / 0	0 / 0	0 / 0	0 / 0	0 / 0	10 / 3	10 / 3	10 / 3	0 / 0
	Commercial Units	0	4 / 1	8 / 0	3 / 0	1 / 0	3 / 0	0 / 0	7 / 1	7 / 1	4 / 1	3 / 0
	Regional Economic Growth											
17	**Ability to Maximize Accommodation of Heavy and Large Vehicles**	✓✓✓	✓✓✓✓✓	✓✓✓✓	✓✓✓	✓✓✓	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓
18	**Potential for Improved Access to Existing Industrial Sites**	✓✓	✓✓✓✓	✓✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓	✓✓✓
19	**Potential for Improved Access to Future Industrial Sites**	✓✓	✓✓✓✓	✓✓✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓✓✓	✓✓✓✓	✓✓	✓✓

Notes: 1 - Qualitative rating with 5 ✓✓✓✓✓ being most desirable to 1✓ being the least desirable
2 - **STEAM** output is generated by using a fixed trip table (from BASE case)

E. Traffic Operations Analysis

With the adoption of a preferred alternative, the next step was to perform a traffic operations analysis to aid in project prioritization. The analysis determined the traffic impact improvements of the preferred Scenario 8 could be implemented prior to construction of any proposed Scenarios to improve traffic circulation and access.

Traffic volume counts, turning-movement counts, field observations and measurements were included in the work tasks. The traffic operations analysis is based on the following:

1) Bridge Advisory Committee Meetings;

2) Study area reconnaissance, traffic counts and field observations;

3) Reference to the Ohio Department of Transportation (ODOT) Location and Design Manual, the ODOT State Highway Access Management Manual, the West Virginia Department of Transportation Design Directives, and the Manual of Uniform Traffic Control Devices;

4) The Highway Capacity Software (HCS 2000) for signalized and unsignalized intersections (Release 4.1a); and

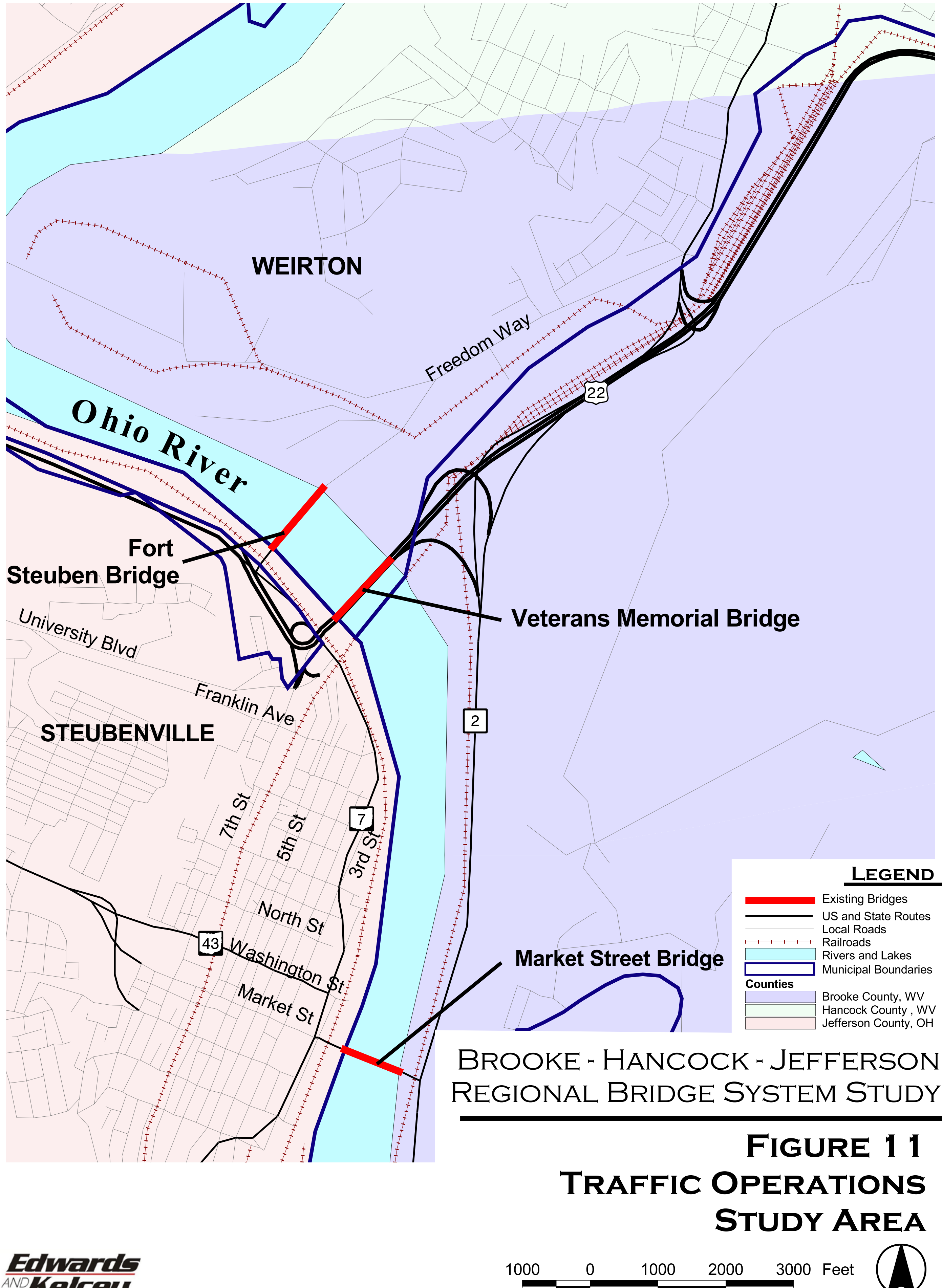
5) The application of accepted and normal traffic safety and engineering standards.

All traffic counts, capacity analyses, and accident data used for operations analysis are summarized in the Memorandum 5 Traffic Operations Analysis Final Report, dated February 2003, developed as part of the overall study. In some cases assumptions as to probable traffic distribution were made in order to analyze the impact of bridge closures on roadways and intersections. All these assumptions were made based on knowledge of the study area, field observations, and common traffic engineering practices. The reader is referred to Technical Memorandum 5 for details related to the traffic operations analysis.

Existing Traffic Conditions

The primary roadways included in the operations study area are SR 7, US 22, WV 2 and various streets in Steubenville adjacent to the bridge crossings. See Figure 11. For the purpose of this operational study, the Upper Ohio Valley Bridge System is defined as the three existing bridges currently located in the area, the access ramps and streets connecting to those bridges, and the principal arterial highways that are tied to the existing bridges.

The Market Street Bridge has a year 2002 average daily traffic (ADT) of 6,700 vehicles. The Fort Steuben Bridge has an average daily traffic of 5,500 vehicles and the Veterans Memorial Bridge has an ADT of 32,500 vehicles.



BROOKE - HANCOCK - JEFFERSON
REGIONAL BRIDGE SYSTEM STUDY

FIGURE 11
TRAFFIC OPERATIONS STUDY AREA

Edwards AND Kelcey

Manual turning movement counts were taken on December 3, 2002 through December 5, 2002, during the PM peak hour, at seventeen intersections within the study area. These traffic counts were performed in the downtown Steubenville grid system and at the intersection of Freedom Way/US 22/WV 2.

Washington Street Area Improvements

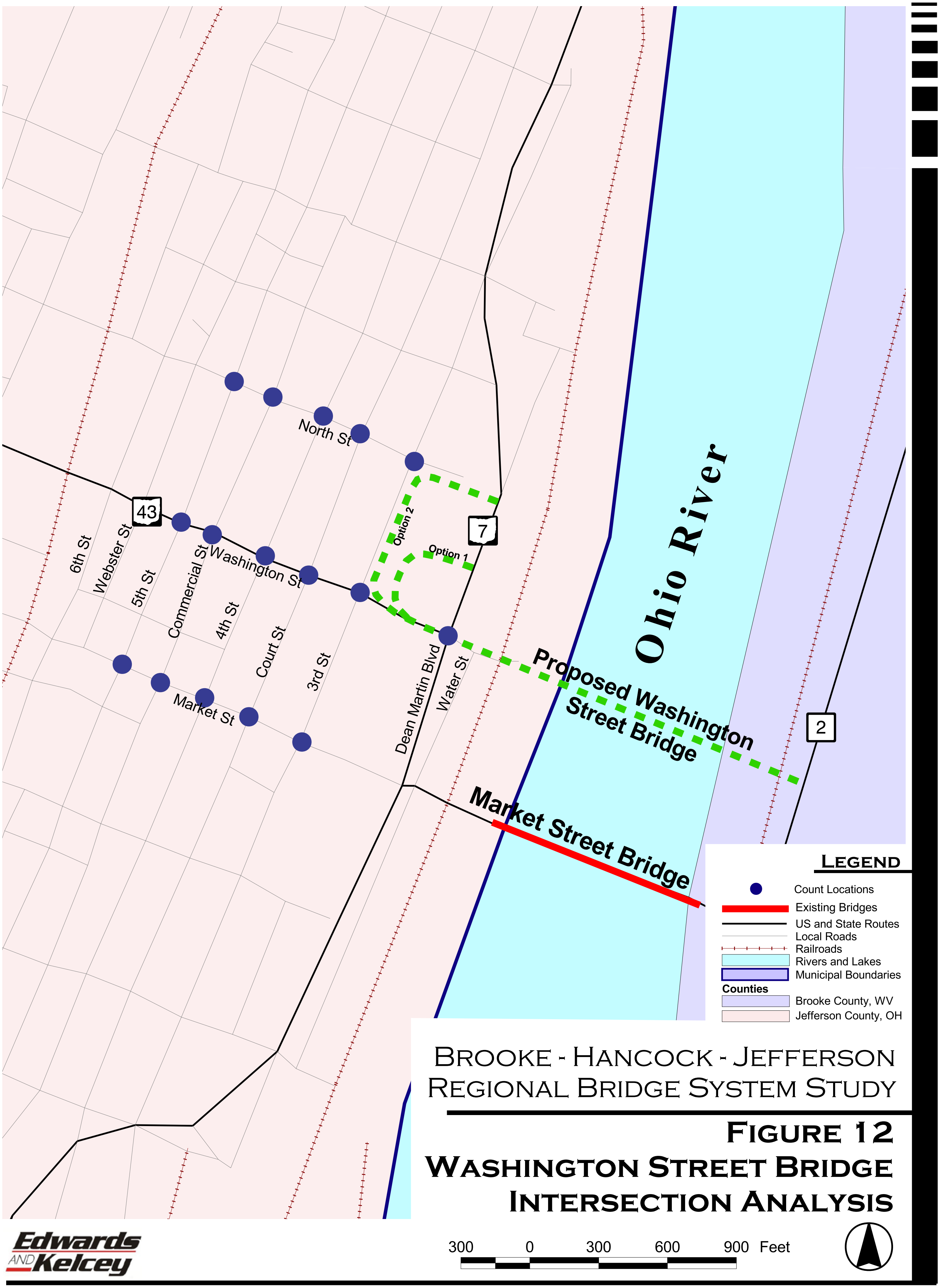
In order to determine if locating a proposed bridge at Washington Street was a feasible alternative, the sixteen intersections in Steubenville were analyzed under future traffic conditions (see Figure 12). The analysis was completed by manually reassigning traffic on the Market Street Bridge to the proposed bridge on Washington Street. This information was consistent with the travel demand model. Replacement of this bridge changes traffic flow patterns primarily in the eastern portion of Steubenville.

The capacity analyses resulted in satisfactory levels of service at all surveyed locations. However, the signal system will require an adjustment in signal timing. Certain intersections may require new turn phases to accommodate additional vehicle turning movements.

SR 7 and Washington Street will no longer intersect if the proposed Washington Street Bridge is installed. In order to provide a safe and efficient connection for motorists that have crossed the new Washington Street Bridge and desire to travel along SR 7, two options were evaluated. The first option is to provide a connection from Washington Street to SR 7 with a ramp that would be located approximately 100' east of the existing Washington Street/Third Street intersection. Advantages of the ramp would include a fast and efficient connection to SR 7 for vehicles making a right turn from Washington Street. The ability to make a right turn immediately after crossing the bridge would reduce delay time and fuel consumption for some vehicles that need to use SR 7. A disadvantage of this ramp connection would be the location of it in proximity to the Washington Street/Third Street intersection. Left and right turns to/from the ramp may be difficult at peak hours with signalization.

The second option for a connection to SR 7 is the installation of a westbound right turn lane on Washington Street at the intersection of Washington Street and Third Street. A connection to SR 7 from the Third Street and North Street intersection would also be needed. Third Street at North Street is a four-way intersection. However, the east side of North Street does not currently intersect SR 7. Under this option North Street could be extended to allow a connection to SR 7.

An advantage to this option would be that it provides access to SR 7 without adding a new access point on Washington Street or Third Street. Another advantage would be that the number of vehicle conflicting movements is less than the ramp option, which should result in fewer accidents. A disadvantage to this option would be that motorists would have to travel a longer distance to get to SR 7. Additional right-of - way would also be required. Signage directing motorists to SR 7 would be installed on Washington Street, Third Street and North Street (see Figure 12).



BROOKE - HANCOCK - JEFFERSON
REGIONAL BRIDGE SYSTEM STUDY

FIGURE 12
WASHINGTON STREET BRIDGE INTERSECTION ANALYSIS

Edwards and Kelcey

University Boulevard Improvements

SR 7/University Boulevard

The intersection of SR 7 and University Boulevard had the highest number of accidents at a single location, with 51 crashes in the three-year period. This translates to an accident rate of 1.6 accidents per million entering vehicles. Of these crashes, ten were angle type accidents, mostly involving northbound left-turning vehicles and southbound through vehicles. There were also seven rear-end type accidents at this location. Bad weather or slippery pavement was a factor in 42 percent of the crashes. There were a total of six injuries from two of these crashes. No fatalities occurred from accidents at this location.

University Boulevard/7th Street/US 22 Ramps

The intersection of University Boulevard and 7th Street/US 22 ramps was the site of thirteen accidents during the analysis period, with 85 percent of them occurring on dry pavement during clear weather. Nine (69 percent) of these accidents were angle type, seven of which were caused by eastbound vehicles turning left into the path of westbound traffic. There were no fatalities resulting from accidents at this intersection, but there were nine injuries from five of the crashes. The intersection of University Boulevard and 7th Street/US 22 ramps currently operates at LOS "B" with a delay of 12.5 seconds per vehicle. The University Boulevard intersections appear to be operating satisfactory.

These two intersections are interdependent; however, a LOS analysis alone does not adequately address the traffic operation issues. An important conflict of movements occurs between the southbound through traffic and the northbound left-turn traffic at University Boulevard/SR 7. The majority of northbound left-turn traffic onto University proceeds to the US 22 ramp across the Veterans Memorial Bridge. In addition, the northbound SR 7 left-turn queue to University Boulevard exceeds the storage length of the left-turn lane and often blocks the northbound through lane. The combination of the traffic flow path, high percentage of trucks, and short distances make this an awkward area, causing significant backups during peak traffic flow.

Westbound US 22 Ramps

The ramp from westbound Veterans Memorial Bridge to SR 7 experienced three overturned semi-trailers in the three-year period from 1996-1998. While this is a small percentage of the total accidents, due to the location and nature of the accidents there is the possibility of great impact on the surrounding area. These accidents can cause the Veterans Memorial Bridge to close, forcing all traffic to use either the Fort Steuben Bridge or the Market Street Bridge. Other accidents on this ramp include five one-vehicle accidents involving crashing into the concrete barrier and five rear-end type accidents near the merge with SR 7. A total of 23 accidents occurred during a three-year period along the ramp sections, for a rate of 0.77 accidents per million vehicles using the ramps. One of these accidents produced two injuries. There were no fatalities.

Truck accidents occur frequently at these types of interchanges, particularly on curved exit ramps. In fact, trucks overturning on exit ramps at interchanges account for five out of every 100 fatal truck accidents (Source: FHWA). Truck roll-over accidents can be very costly, in urban or rural areas, because these accidents usually result in fatalities and injuries, vehicle and roadway damage, and significant traffic delays. Losses are even greater when trucks carrying combustible or hazardous cargo ae involved. One way to prevent or at least reduce truck roll-over accidents on curved ramps would be to install an automatic warning system on these ramps to help truck drivers take preventive action. The system warns drivers when the truck, based on its load conditions and speed, would roll over if its speed were not reduced. In addition to this warning system, rumble strips could be used.

US 22 & WV 2/Freedom Way Improvements

These alternatives were evaluated in order to provide a solution to the permanent closure of the Fort Steuben Bridge. The Fort Steuben Bridge provides convenient access for vehicles that travel to and from Steubenville, Ohio and Weirton, West Virginia. Trucks account for about seventeen percent (17 percent) of the total traffic across this bridge each day. Many of the trucks travel to and from the nearby Half Moon Industrial Park in West Virginia. In order to prepare for this possible closure, alternatives were analyzed which would mitigate the impact of the Bridge closure.

The several alternatives, described below, were evaluated in detail. For example, the analysis of constructing a new full interchange included the preparation of preliminary engineering drawings showing ramp locations and profiles. Level of Service calculations were also made for peak hour conditions with emphasis on turning movements and lane capacity. The reader is referred to Technical Memorandum 5 for more information.

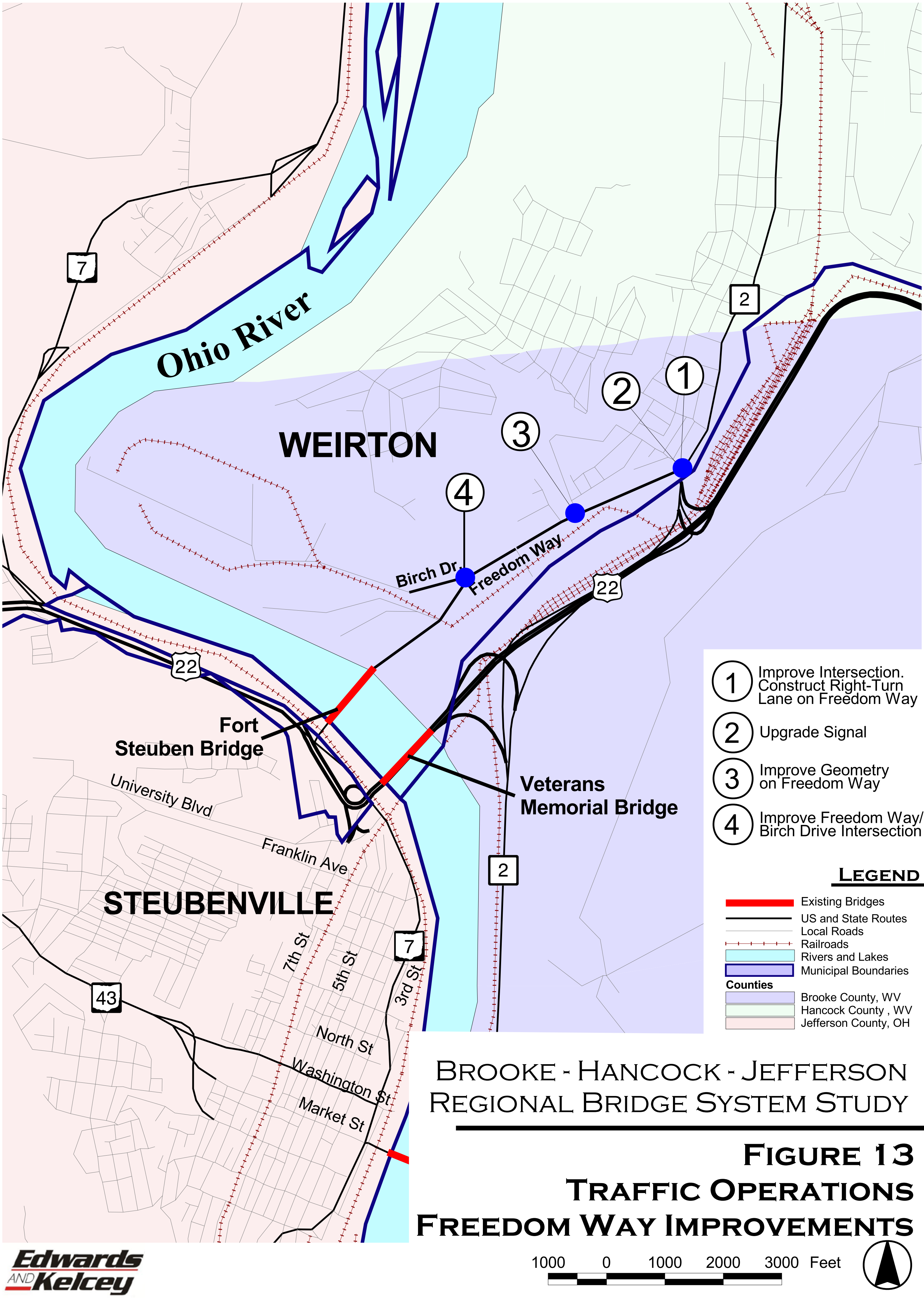
The first alternative included the construction of a new full interchange from Freedom Way to US 22 and WV 2. Five additional new ramps were included that would allow all movements between Freedom Way and US 22/WV 2. All ramps would meet present highway design standards.

The second alternative is similar to the first with an exception that a direct connection between Freedom Way and the east leg of US 22/WV 2 would not be provided. This was evaluated since the future demand for this movement may not justify the cost of construction of these ramps.

The third alternative evaluated improvements of the existing intersection. Included were additional turn lanes, pavement widening and signalization modifications. For example, operational changes in the existing signal, the construction of a dual eastbound left-turn lane on US 22, and the construction of a new continuous right-turn lane on Freedom Way were considered. Each component was evaluated separately and then they were considered together as an overall improvement. Detailed traffic flow capacity calculations were made in order to evaluate the effectiveness of these improvements.

The fourth alternative evaluated improvements to Freedom Way, between WV 2 and Birch Drive, and the intersection of Freedom Way/Birch Drive. Included were geometric changes at Birch Drive, upgrade and/or widening of the existing three lanes on Freedom Way, possible drainage improvements, and traffic operational changes at Birch Drive.

Figure 13 shows the recommended improvements.



Brooke - Hancock - Jefferson
Regional Bridge System Study

Figure 13
Traffic Operations
Freedom Way Improvements

Edwards and Kelcey

Conclusions

Recommended traffic operations improvements are:

Washington Street Improvements

Improvements assume the construction of a new 4-lane bridge over the Ohio River at Washington Street and connecting to WV 2.

1. Improve the Washington Street/Third Street intersection by adding a right-turn lane on the northbound approach to the intersection to accommodate vehicles that need access to SR 7 after crossing the new Washington Street Bridge.
2. Add a right-turn lane on Third Street at its intersection with North Street.
3. Extend North Street to provide a connection to SR 7. A traffic signal at the intersection of North Street/SR 7 may be necessary and should be installed if warranted.
4. Construct a new intersection at the new Bridge and WV 2 to provide motorists crossing the new Washington Street Bridge with a connection to WV 2. The intersection will need a northbound left-turn lane and a southbound right-turn lane on WV 2. An eastbound left-turn lane and a right-turn lane will be needed exiting the new Washington Street Bridge.
5. Install a new traffic signal at the intersection of the new Washington Street Bridge/WV 2 if warranted.
6. Adjust signal timing and phasing as outlined in the capacity analyses on Washington Street.
7. Install fiber optic cable, master controller and all other necessary equipment to allow for a closed loop signal system for the nineteen intersections in the Steubenville Downtown grid system.

It should be noted that the improvements described below recommended for the University Boulevard and Freedom Way area are directly related to the anticipated closing of the Fort Steuben Bridge. Since the date of the closing cannot be known, it is important that engineering design begin as soon as possible so that construction of the improvements will be completed before closing of the Bridge.

University Boulevard/US 22 Ramp Improvements/SR 7

1. Review signal timing of the interconnected system at the intersection of SR 7/University Boulevard to allow for additional green time on the northbound left turn movement in order to provide for better traffic flow and a possible reduction in angle type accidents. Provide additional left-turn lane capacity to minimize queue length, if practical, recognizing the existing physical constraints.

2. Resolve safety concerns related to truck overturning on existing ramps with signing, or advance warning devices. An Automated Truck Warning System to prevent truck rollovers on the ramps should be considered.

3. Improve or widen SR 7 at its intersection with University to faciltate truck turning movements.

US 22 and WV 2/Freedom Way Improvements

1. Improve the intersection of Freedom Way/US 22 and WV 2 to better accommodate the additional traffic, expected with the closure of the Fort Steuben Bridge. Construct a right-turn lane or continuous right-turn lane from Freedom Way to southbound WV 2, due to existing and anticipated traffic volumes and to better facilitate truck traffic out of the Half Moon Industrial Park. Construct a dual left-turn lane for eastbound traffic on US 22.

2. Consider adjusting signal phasing from split phase to concurrent side street movements so that Freedom Way and Walnut Street move at the same time. Signal upgrade or modification will be required as part of the roadway improvements at Freedom Way/US 22 and WV 2.

3. Improve Freedom Way to accommodate additional truck traffic. An additional lane is needed on Freedom Way for approximately 1,000', starting at its intersection with US 22 and WV 2 to receive the dual left turns from eastbound US 22.

4. Realign or improve the Freedom Way/Birch Drive intersection. When the Fort Steuben Bridge is closed, then southbound Freedom Way to Birch Drive could be a continuous movement, with a stop sign added on the northbound approach to the Freedom Way Birch Drive intersection.

Construction Costs

Preliminary construction cost estimates are shown in Table 6. Note that detailed engineering analysis will be required in order to establish an accurate cost estimate and to determine the feasibility of construction of the recommended improvements. Of particular concern are the restraints related to the location of the railroad bridge piers, south of University Boulevard. In addition, widening of SR 7 will impact access to existing businesses adjacent to SR 7.

Table 6
Cost Estimate for Traffic Operations Improvements

	Description	Cost
	Washington Street Improvements	
1	Right-Turn Lane Northbound at Washington Street/Third Street	$205,000
2	Right-Turn Lane Eastbound at Third Street/North Street	$205,000
3	North Street Extension to SR 7 and Related Intersection Improvements	$615,000
4	New Intersection of Washington Street/WV 2	$615,000
5	New Traffic Signal at Washington Street/WV 2	$80,000
6	Signal Timing Adjustments	$10,000
7	Fiber Optic Cable, Cameras, Master Controller for Closed Loop Signal System in Downtown Steubenville, Ohio	$400,000
	Subtotal	**$2,130,000**
	University Boulevard/US 22 Ramp Improvements/SR 7	
1	Signal Timing Adjustments/Extend Northbound Left-Turn Lane*	$147,000
2	Automated Truck Warning System	$160,000
3	Widen SR 7 at University Boulevard*	$300,000
	Subtotal	**$607,000**
	US 22 and SR 2/Freedom Way Improvements	
1	Improve Freedom Way/US 22 Intersection by Constructing Two Additional Turn Lanes	$305,000
2	Signal Upgrade/Modification due to Intersection Improvements. Signal Phasing and Timing Adjustments.	$80,000
3	Improve Freedom Way by Adding a lane 1,000' in Length	$410,000
4	Realign or improve Freedom Way/Birch Drive Intersection	$410,000
	Subtotal	**$1,205,000**
	Grand Total of All Traffic Improvements	**$3,942,000**

*Does not include potential cost associated with constraints of railroad bridge piers and impact on existing businesses along SR 7.

Note: This estimate does not include Right-of-Way or Utility Relocation Costs.