Primary Corridor Transportation Project

DELIVERABLE 8-1
TECHNICAL MEMORANDUM ON THE EVALUATION OF ALTERNATIVES (DRAFT) AND

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Prepared for:

City and County of Honolulu
Department of Transportation Services

Prepared by:

Parsons Brinckerhoff Quade & Douglas, Inc.

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1.1 OVERVIEW

This report compares how and the degree to which the alternatives satisfy the project purposes and needs. It discusses the financial and environmental costs of satisfying these needs. Finally, this Chapter reports the cost-effectiveness and equity of each alternative; these are two criteria that FTA considers in deciding whether to qualify a new transit system for federal funding.

The comparison process included a comprehensive assessment of the alternatives against cost, mobility, growth-shaping, land use, quality of life, environmental impact, cost-effectiveness, and equity criteria. Table 1 summarizes evaluation findings for those criteria where there are significant differences among the alternatives. This is meant only to assist in the selection of a Locally Preferred Alternative (LPA).

The basic conclusion is that all alternatives have a substantial cost, even the No-Build. As the cost of the alternative increases, the project purposes become more fully satisfied. The No-Build would entail substantial cost, while doing little towards achieving the vision for the future of Oahu or helping to create a more sustainable community. By selecting one of the build alternatives (TSM, BRT or BRT/SISP), Oahu can develop a balanced transportation infrastructure in the primary transportation corridor. This would well position it for current and future travel demands, and set it firmly towards achievement of the goals inherent in the people's vision for the future. These proactive steps can be taken at an affordable cost.

1.2 ORGANIZATION

Chapter 2 compares the four alternatives (No-Build, TSM, BRT and BRT/SISP) against five project purposes and needs. Chapter 3 summarizes their impacts, and Chapter 4 discusses their costs and cost-effectiveness. Chapter 5 recaps the analysis for each alternative, across the range of criteria.

2 COMPARISON OF ALTERNATIVES AGAINST PROJECT PURPOSES AND NEEDS

The purposes and needs to be addressed by a major transportation investment in the primary transportation corridor are listed below:

1. Increase the people-carrying capacity of the transportation system in the primary transportation corridor;
2. Provide attractive alternatives to the private automobile;
3. Support desired development patterns;
4. Improve the transportation linkage between Kapolei and Honolulu's Urban Core; and
5. Improve access to the eastern portions of the PUC, including Waikiki, from areas west of Middle Street.

TABLE 1
SUMMARY OF KEY EVALUATION MEASURES

Measures	No-Build	TSM	BRT	BRT/SISP
CAPITAL AND O&M COSTS				
Capital Cost (Millions of 1998 $)	$316.9	$506.5	$1,076.2	$1,438.0
Annual Operating and Maintenance Cost at Full System Operation (Millions of 1998 $)	$125.1	$137.4	$175.2	$137.3
MOBILITY				
Daily Transit Trips (2025) (Daily Linked Trips)	286,700	296,500	333,000	310,200
Daily Transit Mode Share (2025) (Work Trips)	14.7%	15.7%	18.4%	16.8%
Projected Vehicle Hours of Delay (2025) (Total Peak Period Per Day)	251,970	236,744	243,568	232,971
Projected Transit Travel Time between Downtown-Waikiki (2025) (minutes)	18.7	15.8	13.7	13.7
Projected Transit Travel Time between Downtown-UH-Manoa (2025) (minutes)	27.8	23.7	14.2	14.2
Projected Transit Travel Time between Downtown-Kalihi (2025) (minutes)	7.9	6.8	5.1	5.1
Vehicle Miles Traveled (2025) (Total Peak Period Per Day)	9,612,111	9,567,872	9,465,408	9,504,566
GROWTH-SHAPING AND LAND USE				
Supports Growth-Shaping/Land Use Goals	No	No	Yes	Yes
QUALITY OF LIFE AND LIVABILITY				
Number of Receptor Structures Requiring Noise Mitigation	0	0	Regional BRT: Section of H-1 Freeway; In-Town BRT: 2 locations with hybrid diesel/elect. vehicles; none with use of imbedded plate technology	Regional BRT: Section of H-1 Freeway; In-Town BRT: 2 locations with use of hybrid diesel/electric vehicles; none with use of imbedded plate technology; SISP: 3 locations on Sand Island
Air Quality Emissions	Increase	Increase	Decrease	Decrease
ENVIRONMENTAL IMPACTS				
Number of Businesses Totally Displaced	0	8-12	8-12	57-79
Known Historic, Archaeological, and Cultural Sites/Districts Potentially Adversely Affected	0	0	4	5
Potential Section 4(f) Sites (Parklands)	1	1	1	3
COST-EFFECTIVENESS				
Cost Per New Rider (compared to TSM Alternative)	N/A	N/A	$7.16	$15.84
EQUITY				
Impacts/benefits for minority or low-income populations	No impacts/No increased benefits	No impacts/ Some improved transit service	No impacts/ Increased transit service	No impacts/ Increased transit service

Source: Parsons Brinckerhoff, Inc., March 2000.

2.1 INCREASE THE PEOPLE-CARRYING CAPACITY OF THE TRANSPORTATION SYSTEM IN THE PRIMARY TRANSPORTATION CORRIDOR

Six measures of enhanced mobility are used to compare the alternatives:

- Person-carrying capacity of the roadway system;
- Increased transit usage islandwide;
- Increased transit usage within key travel markets;
- Improved transportation service;
- Reduce traffic congestion; and
- Improvement to other level of service indicators.

1) Person Carrying Capacity of the Existing Roadway System

The TSM, BRT, and BRT/SISP Alternatives would increase person-carrying capacity by enhancing the level of transit service. The BRT/SISP Alternative would also increase roadway capacity.

The TSM, BRT and BRT/SISP Alternatives would enhance transit service and capacity by constructing new lanes for transit vehicles. Roadway lanes would become more efficient by reallocating them from general-purpose use to transit or ride-share use. The BRT and the BRT/SISP Alternatives would provide substantially more person-carrying capacity within the Urban Core than the TSM Alternative, due to their superior level of transit priority . The BRT/SISP Alternative would provide the largest overall increase in person carrying capacity between Middle Street and Downtown, due to the added capacity provided by the Sand Island Scenic Parkway.

Table 2 compares the a.m. peak-hour person throughput for selected screenlines within the Urban Core for each of the alternatives (the method of developing this analysis is presented in Chapter 4). Table 2 shows that the BRT and the BRT/SISP Alternatives would improve person carrying ability within the Urban Core by an average of 10 percent over the No-Build-Alternative. To get an equivalent increase in person-carrying capacity through road construction alone, the number of roadway lanes in the Urban Core would need to be increased by almost two lanes in each direction (four lanes total). This is not feasible without major displacement of existing land uses with accompanying adverse social and environmental impacts.

TABLE 2
PROJECTED 2025 A.M. PEAK HOUR-PERSON CARRYING CAPACITY AT SELECTED SCREENLINE LOCATIONS (PERSONS/HOUR)

Screenline Location	Alternative			
	No-Build	TSM	BRT	BRT/SISP
Ewa-bound at Ward Avenue	23,433	23,589	24,354	24,758
Ewa-bound at Punchbowl Street	18,915	20,036	22,151	22,458
Koko Head-bound at Liliha Street	25,421	24,755	29,785	30,834
Koko Head-bound at Bishop Street	25,746	24,448	26,123	26,420

Source: Parsons Brinckerhoff, Inc., March 2000.

The TSM Alternative would improve person-carrying capacity to a much lesser degree than either the BRT or the BRT/SISP Alternatives.

Transit elements have an additional advantage because they can provide still further person-carrying capacity and expansion potential. Each In-Town BRT vehicle has an assumed capacity of 120 persons (60 feet with single articulation). Use of higher capacity vehicles (bi-articulated vehicles) or a further increase in the frequency of BRT service would add more person-carrying capacity without the need for additional roadway construction. Therefore, the BRT and BRT/SISP Alternatives offer the potential to increase person-carrying capacity beyond that provided by the proposed operating plan for 2025, without additional construction. The Regional and In-Town BRT systems are investments that would efficiently serve growth in travel demand well into the future, beyond the 2025 planning horizon used in this document.

The BRT/SISP Alternative would offer the greatest person-carrying ability, and person-carrying capacity expansion potential, due to its combination of In-Town BRT (transit) and Sand Island Scenic Parkway (highway) components.

2) Increased Transit Usage Islandwide

Transit ridership is the number of trips taken on transit (not counting transfers). The measure "ridership" addresses key goals of increasing the number of people using transit, decreasing the number using individually driven automobiles, and increasing the number of patrons paying fares. Higher ridership indicates increased attractiveness of a transit system, otherwise transit patrons would choose another mode. Increased transit ridership amplifies the secondary benefits already enumerated for transit, such as reduced energy consumption, enhanced air quality, and support for desired land use development patterns.

Table 3 compares total daily transit ridership among the alternatives. The BRT/SISP Alternative is forecast to attract more transit ridership than the TSM or No-Build Alternatives, while the BRT Alternative, with the highest level of transit service, is forecast to attract the most transit ridership.

TABLE 3
RIDERSHIP FORECASTS ISLANDWIDE
(FORECAST YEAR 2025)

	No-Build	TSM	BRT	BRT/SISP
Total Transit Trips (Daily Linked Trips)	286,700	296,500	333,000	310,200
New Transit Trips compared with No-Build	Not Applicable	9,800	46,300	23,500
New Transit Trips compared with TSM	Not Applicable	Not Applicable	36,500	13,700
Transit Mode Share:				
All Trip Purposes	6.6%	6.9%	7.9%	7.3%
Work Trips	14.7%	15.7%	18.4%	16.8%

Source: Parsons Brinckerhoff, Inc., March 2000.

Transit mode share is the proportion of total trips taken on the transit system, indicating the contribution of the transit system towards satisfying total travel demand. The higher the transit mode share, the fewer the number of automobiles that will be on the roads. The BRT and BRT/SISP Alternatives would result in increased transit mode share compared to the other alternatives.

3) Increased Transit Usage Within Key Travel Markets

A major project purpose is to increase transit usage in the Downtown PUC where it is most difficult if not impossible to add automobile capacity. As shown in Table 4, the BRT and BRT/SISP Alternatives would attract additional transit riders both by improving mobility within the PUC, and strengthening the connections between the PUC and the rest of Oahu. This increase in ridership reflects the service benefits – particularly reduced travel time – that such a system would provide in the primary transportation corridor. While the TSM

Alternative would achieve some benefits, the benefits of a high capacity BRT system would be substantially greater, especially for travel within the PUC.

TABLE 4
TRANSIT RIDERSHIP FOR SELECTED TRAVEL MARKETS
(DAILY LINKED TRIPS IN 2025)

	No-Build	TSM	BRT	BRT/SISP
Total Transit Ridership within the Primary Urban Center	197,200	196,900	210,700	203,900
Transit Mode Share:				
All Trip Purposes	8.7%	8.7%	9.5%	9.1%
Work Trips	21.2%	21.4%	23.6%	22.7%
Total Transit Ridership between the Primary Urban Center and other areas of Oahu	54,700	59,000	73,500	63,900
Transit Mode Share:				
All Trip Purposes	7.9%	8.6%	11.2%	9.5%
Work Trips	12.4%	13.7%	19.1%	15.7%

Source: Parsons Brinckerhoff, Inc., March 2000.

The BRT Alternative is forecasted to have 333,000 average daily transit trips islandwide and 488,300 transit boardings (transit boardings include transfers) on an average weekday in 2025. This compares to average actual daily transit trips of 206,650 and daily boardings of 239,680 in 1991. The increase in daily ridership would be forecast to be 61 percent. As shown in Table 5, approximately 22 percent of the 330,000 daily transit trips islandwide would be projected to involve use of the In-Town BRT.

TABLE 5
TRANSIT RIDERSHIP BY SUB-MODE
(FORECAST YEAR 2025)

Transit Sub-Mode	Daily Transit Boardings	
	BRT	BRT/SISP
Boardings on Regional BRT and Local Buses	416,400	369,400
Boardings on In-Town BRT	71,900	74,900

Source: Parsons Brinckerhoff, Inc., March 2000.

For the BRT/SISP Alternative, its 310,200 average daily transit trips islandwide are forecast to account for 444,300 transit boardings on an average weekday in 2025. The forecasted increase in transit ridership would be 50 percent over the level in 1991. As shown in Table 5, approximately 24 percent of the 310,200 daily transit trips islandwide would be projected to involve use of the In-Town BRT.

4) Transit Level of Service

The BRT and BRT/SISP Alternatives are projected to result in better transit LOS within the Urban Core at the intersections analyzed. Due to roadway congestion and the provision of exclusive transitway lanes, the BRT and BRT/SISP Alternatives would provide faster transit travel times and more reliable service within the Urban Core than either the TSM or No-Build Alternatives. Estimated travel time differences for 2025 are shown in Table 6 for selected key origins and destinations.

TABLE 6
PROJECTED 2025 TRANSIT TRAVEL TIME WITHIN URBAN CORE (IN VEHICLE TIME)

	No-Build	TSM	BRT	BRT/SISP
	Travel Time (minutes)	Travel Time (minutes)	Travel Time (minutes)	Travel Time (minutes)
Downtown-Waikiki	18.7	15.8	13.7	13.7
Downtown-UH-Manoa	27.8	23.7	14.2	14.2
Downtown-Kalihi	7.9	6.8	5.1	5.1

Source: Parsons Brinckerhoff, Inc., March 2000.

5) Reduced Traffic Congestion

Restoration of a balance between automobile and transit modes is a prime objective within the primary transportation corridor. Transit improvements would be expected to encourage some people to modify their travel behavior by switching from private automobiles to transit, thereby decreasing traffic congestion. Under the BRT/SISP Alternative, congestion would be further reduced by the re-routing of traffic away from Downtown. Vehicle Miles of Travel (VMT) is a measure of roadway congestion. Higher VMT reflects more vehicle trips made (higher roadway demand and more congestion), and more circuitous travel as drivers "hunt" for less congested routes. This, in turn, affects neighborhoods, as streets meant to accommodate local traffic become through traffic routes as drivers seek ways to avoid congestion on major arterial roadways. Table 7 shows that in 2025, the BRT Alternative (which would provide the highest level of transit service) would be projected to have the lowest peak period VMT compared to the other alternatives, and the VMT associated with the BRT/SISP Alternative would be less than that for the TSM Alternative.

TABLE 7
PROJECTED YEAR 2025 PEAK PERIOD VMT/VHD

Alternative	Time Period	VMT	VHD	Vehicle Trips Assigned
No-Build	A.M.	4,574,657	122,519	556,572
	P.M.	5,037,454	129,451	671,402
	Total Peak	9,612,111	251,970	1,227,974
TSM	A.M.	4,548,195	112,708	553,802
	P.M.	5,019,677	124,036	669,079
	Total Peak	9,567,872	236,744	1,222,881
BRT	A.M.	4,480,203	114,930	548,069
	P.M.	4,985,205	128,639	664,116
	Total Peak	9,465,408	243,568	1,212,185
BRT/SISP	A.M.	4,509,044	110,977	550,093
	P.M.	4,995,522	121,994	665,768
	Total Peak	9,504,566	232,971	1,215,861

Source: Parsons Brinckerhoff, Inc., 2000.
Notes: VMT = vehicle miles traveled
VHD = vehicle hours of delay

Lower peak period VMT for the BRT and BRT/SISP Alternatives reflects increased use of travel modes such as transit as opposed to single-occupant vehicles (SOVs), and less congestion on non-primary roadways.

This finding is consistent with the lower number of vehicle trips projected to occur with the BRT and BRT/SISP Alternatives (because there are more transit trips) than with the TSM or No-Build Alternatives, and has added benefits.

Another indicator of regional roadway performance is Vehicle Hours of Delay (VHD) which is the difference in total hours of travel between that associated with free-flow traffic conditions, and that associated with projected levels of roadway congestion (see Table 7). Lower VHD indicates that the roadway network is handling travel demand more efficiently, with less aggravation and frustration for travelers. The BRT, BRT/SISP and TSM Alternatives are projected to have substantially lower daily VHD than the No-Build Alternative in 2025, with the BRT/SISP Alternative having the lowest VHD. The BRT/SISP Alternative would have the lowest VHD because of the added roadway capacity between Middle Street and Downtown provided by Sand Island Scenic Parkway, combined with the benefits of the In-Town BRT. While the BRT Alternative would provide a greater amount of person-carrying capacity than the TSM or No Build Alternatives, it would create more VHD for motorists than the BRT/SISP or TSM Alternatives since some general traffic lanes would be used to provide exclusive transit lanes. It is expected, however, that the resultant delay on roadways would encourage even more people to switch to transit than indicated by the transportation modeling conducted for this MIS/DEIS.

6) Improvement to Other Level of Service Indicators

The ridership forecasting results can be used to compute several other indicators of the level of service provided by each alternative. These measures are presented in Table 8 and discussed below.

TABLE 8
OTHER MEASURES OF SERVICE
(FORECAST YEAR 2025)

Measure	No-Build	TSM	BRT	BRT/SISP
Average Weekday Boardings	355,100	375,700	488,300	444,300
Boardings per Linked Trip (Transfer Rates)	1.24	1.27	1.47	1.43
Passenger per Seat at Peak Load Point (Comfort)	1.31	1.01	0.86	0.95

Source: Parsons Brinckerhoff, Inc., March 2000.

One indicator of the level of service is the number of transfers a typical rider must make to complete a trip. Riders prefer not to transfer, unless transferring produces a shorter total travel time. In Table 8, the amount of transferring is expressed in terms of the number of boardings per linked transit trip. The BRT Alternative, followed by the BRT/SISP Alternative, would require the greatest amount of transferring because many riders would access the BRT systems by feeder bus. In the No-Build and TSM Alternatives, more riders would have a one-seat ride from origin to destination. The additional transferring in the BRT and BRT/SISP Alternatives would be offset, however, by the more frequent, more comfortable, and more reliable service provided, and in many cases, by a shorter total travel time.

2.2 PROVIDE ATTRACTIVE ALTERNATIVES TO THE PRIVATE AUTOMOBILE

The previous discussion of the number of new transit riders that would be produced by each alternative measures the attractiveness of transit as an alternative to the private automobile. The BRT Alternative, followed by the BRT/SISP Alternative, would produce the most new transit riders (see above). Therefore, these alternatives would provide the most attractive alternatives to the private automobile as measured by new transit riders.

Reliability, comfort and travel time savings measure attractiveness.

Since transit service in mixed traffic is subject to delays caused by traffic congestion, the reliability of transit service is correlated to the extent of the system that utilizes exclusive travel lanes (which would not be affected by the congestion on general purpose lanes). Since the BRT and BRT/SISP Alternatives would provide substantially more miles of exclusive transitway lanes, they would offer the most reliable service.

One measure of comfort is the probability of getting a seat on a transit vehicle during the peak hour. As shown in Table 8, the projected ridership in 2025 exceeds the number of available seats by over 30 percent under the No-Build Alternative. Over 30 percent of all riders would be required to stand, sacrificing comfort and decreasing the attractiveness of travel by transit. Worse, buses would be full and pass by riders waiting at stops in some instances.

The number of available seats under the TSM Alternative would be about equal to the demand. On an average weekday, there would typically be a seat for every rider, even at the most heavily used part of the system.

The number of available seats under the BRT and BRT/SISP Alternatives would be slightly greater than the demand, increasing the probability that a rider would find a seat and have a comfortable ride. The availability of surplus seats also reflects the ability of the BRT and BRT/SISP Alternatives to accommodate even further increases in ridership growth without having to increase the number of vehicles. The BRT and BRT/SISP Alternatives would provide the most travel time savings for transit patrons.

2.3 SUPPORT DESIRED DEVELOPMENT PATTERNS

Chapter 5 provides detailed information on the growth-shaping attributes of the alternatives.

The No-Build and TSM Alternatives would not encourage land use development in desired patterns or support implementation of an urban growth strategy that integrates land use and transportation elements.

The BRT and BRT/SISP Alternatives would substantially increase the people-carrying capacity within the corridor and help focus growth along the alignment of the In-Town BRT. Because of the permanency of the fixed facilities that would be constructed under these alternatives, they would be highly effective in supporting implementation of an urban growth strategy that integrates land use and infrastructure planning. They would help facilitate desired land use development patterns consistent with the vision for the island. Transit centers and transit stops would serve as focal points for transit-oriented development, and would be designed to maintain or improve visual conditions through cohesively designed structures, street furniture, landscaping and lighting. These Alternatives would improve the quality of urban living by enhancing transportation service within the Urban Core, and reducing air and noise emissions in comparison to the diesel buses in the No-Build and TSM Alternatives. Because the BRT and BRT/SISP Alternatives would reduce automobile travel, regional air emissions would be less.

The BRT/SISP Alternative would go even further than the BRT Alternative to increase people-carrying capacity within the corridor, reduce through traffic in Downtown, improve the connection between Keehi Interchange and Kakaako/Waikiki, provide improved access/egress for Sand Island industrial and recreational sites, and facilitate desired land use development patterns consistent with the vision for the island. This vision includes the linkage of Chinatown and Downtown with the urban waterfront by enabling the conversion of Nimitz Highway to Nimitz Boulevard, and redevelopment of the Keehi Lagoon shoreline.

SISP would be a scenic gateway to the Kakaako/Waikiki area. It would create new view planes for motorists. Marina Road would substantially improve the view of Keehi Lagoon, and the view of Kalihi Kai from Keehi Lagoon Park, the Airport Viaduct, and Nimitz Highway. Conversion of Nimitz "Highway" to a "Boulevard" would harmonize the highway with its waterfront setting, and establish visual connectivity between the waterfront and Downtown. Because of the use of electric vehicles, and because of the reduction in automobile travel, noise and air emission benefits with the BRT/SISP Alternative would generally be similar to the BRT Alternative.

SISP would use land along the border of the future Kalihi Kai Park. The majority of the property to be used for the park would remain untouched. Marina Road would provide direct access to this property enhancing its recreational usefulness.

2.4 IMPROVE THE TRANSPORTATION LINKAGE BETWEEN KAPOLEI AND HONOLULU'S URBAN CORE

The TSM, BRT and BRT/SISP Alternatives would each improve the linkage between Kapolei and the Urban Core to a much greater degree than the No-Build Alternative. The TSM Alternative would provide express and hub-and-spoke services between these areas, and the BRT and BRT/SISP Alternatives would provide a hub and spoke bus system plus the Regional BRT system. These three alternatives would provide more person-carrying capacity between Kapolei and the Urban Core, and substantial travel time savings in comparison to the No-Build Alternative.

The BRT and BRT/SISP Alternatives would offer the additional benefits of the In-Town BRT system for mobility and travel times within the Urban Core, and the reliability offered by the exclusive lanes of the Regional BRT system.

SISP would substantially improve access to Kakaako and Waikiki as well.

2.5 IMPROVE ACCESS TO SAND ISLAND AND THE KOKO HEAD END OF THE PUC, INCLUDING WAIKIKI

The BRT/SISP Alternative would be superior to the others in terms of enhancing access to Sand Island. It would provide a substantial increase in roadway capacity to Sand Island, and open up a new access route between Kakaako and Sand Island. Travel times between Keehi Interchange and Kakaako/Waikiki would be substantially decreased for those using SISP.

3 IMPACTS OF ALTERNATIVES

Having discussed how the alternatives compare in terms of satisfaction of the original project purposes, this section summarizes the environmental consequences associated with them. Selection of a preferred alternative must consider environmental impacts as well as the degree to which an alternative satisfies the project purposes. Chapter 3 describes the existing environmental conditions, and Chapter 5 provides more detailed information on the environmental impacts of the alternatives.

3.1 NO-BUILD ALTERNATIVE

The No-Build Alternative would rely on conventional diesel buses, at least for the immediate future, and continue the present focus on automobiles for transportation. Consequently, regional air pollutant emissions would increase about 20 percent by 2025. Localized air quality (worst-case 1-hour microscale concentrations) would deteriorate at 11 of 17 locations studied. Noise levels along streets would remain similar to present levels, even with an increase in the number of diesel buses and vehicles, because the vehicles would be moving more slowly ("passby" noise increases with speed).

Impacts to ecosystems and visual, historic, water and park resources would generally be limited to localized impacts associated with the construction of roadway and other transportation improvements anticipated over the next three years. The No-Build Alternative would not require any business or residential displacements.

3.2 TSM ALTERNATIVE

Air pollution emissions due to increased diesel buses and private vehicles with the TSM Alternative would increase about 20 percent. Noise levels would not increase because of the trade-off between more vehicles and slower speeds.

Impacts to neighborhoods, historic resources, ecosystems, water resources, and parklands would be similar to those under the No-Build Alternative. These impacts would be associated with the construction of transportation projects expected over the next three years.

Business displacements could be completely avoided under the TSM Alternative. However, sites are still being considered for the expansion of the Kalihi-Palama Bus Maintenance Facility/Middle Street Transit Center and the Iwilei Transit Center that would entail the displacement of up to 12 businesses and institutions. If displacements are required, landowners would be compensated and affected businesses would be provided with relocation assistance. A benefit of the expansion of the maintenance facility is that it would improve the visual appearance of this industrially zoned area by providing landscaping and an attractive design.

Under the TSM Alternative, an estimated 2,361 meters (7,747 feet) of loading zones would be affected. About 1,969 meters (6,460 feet) would be in Waikiki. Buses would operate on Kuhio Avenue in semi-exclusive lanes, affecting both mauka and makai curbside loading zones. The total impact is the equivalent of 48 loading zones, of which 41 are peak and off-peak loading zones for commercial vehicles with permits.

3.3 BRT ALTERNATIVE

Through the use of electric bus technology, the BRT Alternative would reduce air and noise emissions in comparison to the diesel buses in the No-Build and TSM Alternative. Because the BRT Alternative would reduce automobile travel, regional air emissions would be less. Also, the electric buses would generally be quieter than conventional diesel buses. However, the Regional BRT system would create a noise impact along a section of H-1 that would require noise mitigation.

Impacts to neighborhoods, ecosystems, and water resources would be similar to the No-Build and TSM Alternatives.

The construction-phase impacts of the BRT Alternative would be greater than those of the TSM Alternative because of the larger scale of construction. For example, a transitway would be constructed along the alignment of the In-Town BRT system. Construction impacts would be temporary and detailed mitigation plans would be developed, including a maintenance of traffic plan.

The BRT Alternative could avoid business displacements depending upon which sites are selected for transit centers. Transit center impacts will be separately analyzed in a subsequent phase since there are multiple alternative sites for each location. Under a worst case condition, the BRT Alternative could potentially displace up to 12 businesses. Up to two partial displacements are also possible.

The on-street parking impacts of this alternative would be greater than under the TSM Alternative with between 386 to 460 unrestricted parking spaces and 540 to 570 parking spaces currently restricted by time of day affected depending on the options selected. Fewer loading zones would be affected in comparison to the TSM Alternative.

3.4 BRT/SISP ALTERNATIVE

The visual impacts of SISP would be positive. SISP would be a scenic gateway to the Kakaako/Waikiki area, and create new viewing opportunities for motorists of the ocean. Marina Road would substantially improve the view of Keehi Lagoon, and the view of Kalihi Kai from Keehi Lagoon Park, the Airport Viaduct and Nimitz Highway. Conversion of Nimitz Highway to a "boulevard" would harmonize the highway with its waterfront setting, and establish visual connectivity between the waterfront and Downtown. However, the portals of Fort Armstrong Tunnel would need to be designed to blend with the environment as much as possible. Also, the grade-separations included in the BRT/SISP Alternative would introduce visual intrusions in certain view planes. The visual impacts of the Regional and In-Town BRT systems associated with the BRT Alternative would also occur under the BRT/SISP Alternative.

Because of the use of electric vehicles, and because of the reduction in automobile travel, improvement of noise and air pollutant emissions with the BRT/SISP Alternative would generally be similar to the BRT Alternative. However, because SISP would cause a noise impact at Sand Island State Recreation Area, noise mitigation would be required.

Under the BRT/SISP Alternative, there would be between 51 to 77 total business displacements, depending on the options selected. These impacts would be caused primarily by SISP, and include the zero to twelve displacements common to the TSM and BRT Alternatives. The parking impacts would be greater than those described in the BRT Alternative, due to SISP-related impacts in Kalihi Kai (on-street parking) and on Ala Moana Boulevard (off-street parking). The same loading zones as those under the BRT Alternative would be affected.

The BRT/SISP Alternative would affect a remaining segment of wall from the original Fort Armstrong. If this wall segment is determined to be a historic resource, it would be reconstructed.

Should Option C be selected on Sand Island, there would be a Section 4(f) use of Sand Island State Recreation Area. However, Option B would create substantial business displacement impacts, and may therefore not be prudent. SISP would also use land along the border of the planned Kalihi Kai Park. However, the majority of the property to be used for the park would remain untouched, and Marina Road would provide direct access to this property, enhancing its recreational usefulness.

The construction impacts of the BRT/SISP Alternative would be similar to the BRT Alternative with the addition of construction related to SISP, including Fort Armstrong Tunnel. Because of the need to maintain efficient port operations, construction would be conducted in a manner which minimizes impacts to cargo operations during construction of the Fort Armstrong Tunnel. Turbidity would temporarily increase during dredging and backfilling of the tunnel. Excavated material would be disposed or saved for future projects.

4 COST-EFFECTIVENESS AND EQUITY OF ALTERNATIVES

Cost-effectiveness, the measure used by FTA to compare the cost of a transit investment in relation to its ability to attract new riders to transit, is discussed in this chapter. This chapter also addresses equity, which is the distribution of costs, impacts and benefits.

4.1 COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness relates the ability of an alternative to attract new riders to its costs. The FTA has established a cost-effectiveness index (CEI) for evaluating the relative merits of fixed guideway or transitway alternatives within a corridor. FTA also uses the index as input into its rating system which compares projects across the country, and identifies those most worthy of federal funding. The CEI analysis is used by FTA for comparative purposes. It is not an absolute indicator of costs and benefits because of its narrow focus on projected new ridership.

The index measures the additional cost of proposed transit investments, using the cost per additional rider projected under the No-Build and TSM Alternatives as the measure against which the BRT and BRT/SISP Alternatives are compared. Specifically, the cost effectiveness index as computed as follows:

$$\text{CE Index} = \frac{\Delta\ \$CAP + \Delta\ \$O\&M}{\Delta\ RIDERS}$$

where:

Δ	=	changes as compared to the No-Build and the TSM Alternatives
$CAP	=	annualized capital costs
$O&M	=	annual O&M costs
RIDERS	=	annual transit ridership, measured in "linked" trips.

The cost effectiveness analysis translates the capital costs of the alternatives into equivalent uniform annual costs. These uniform annual capital costs reflect assumptions about the economic life of the capital components in each alternative (based on federal guidelines) and the cost of capital (i.e., the discount rate). Uniform annual capital costs are combined with annual O&M expenses and then compared to additional transit patronage to arrive at a cost-effectiveness index for the alternatives.

Because all costs used in the analysis are in constant dollars, the effects of inflation are already taken into account; the discount rate used in the analysis is a "real" discount rate that reflects prevailing interest rates net of the effect of inflation. Following recommended FTA practice, a real discount rate of 7 percent was used.

Assumptions about the effective useful lives of major cost components correspond to the economic lives of the major categories of capital cost. The economic life of heavy construction items, for instance, is assumed to be 50 years, while buses and BRT vehicles are assumed to have a useful economic life of 12 years before needing replacement.

When alternatives are compared in terms of the CEI parameter, the one with the lower cost per new rider represents the more cost-effective alternative. As shown in Tables 9A and 9B, the cost per new rider for the BRT Alternative is $7.71 compared to the No-Build Alternative. The cost per new rider for the BRT/SISP Alternative is **$13.60**, compared to the No-Build Alternative. The cost per new rider when compared to the TSM Alternative is $7.16 for the BRT Alternative and **$16.36** for the BRT/SISP Alternative.

The marked difference between the BRT and BRT/SISP Alternatives stems from the fact that the CEI parameter compares the cost of an alternative only to a single component of project benefit, new transit riders.

Thus the many non-transit-related benefits of the SISP are not considered, though the entire capital cost of the alternative is included in developing the measure.

TABLE 9A
FTA COST-EFFECTIVENESS INDEX

	ALTERNATIVE			
Factor	**No-Build**	**TSM**	**BRT**	**BRT/SISP**
Annualized Capital Cost (1998 dollars)	$ 24,123,000	$ 41,167,000	$ 83,900,000	$ 110,320,000
Total Systemwide Annual Operating and Maintenance Cost (1998 year dollars)	$ 125,068,000	$ 137,424,000	$ 175,194,000	**$ 137,312,000**
Total Annualized Cost in Forecast Year (1998 year dollars)	$ 149,191,000	$ 178,591,000	$ 259,094,000	**$ 247,632,000**
Total Annual Ridership (forecast year)	88,303,600	91,322,000	102,564,000	95,541,600

Source:Parsons Brinckerhoff, Inc., March 2000.

TABLE 9B
FTA COST-EFFECTIVENESS INDEX

	Comparison				
Factor	**TSM vs. No-Build**	**BRT vs. No-Build**	**BRT vs. TSM**	**BRT/SISP vs. No-Build**	**BRT/SISP vs. TSM**
Incremental Annualized Cost	$ 29,400,000	$ 109,903,000	$ 80,503,000	**$ 98,441,000**	**$ 69,041,000**
Incremental Annual Ridership	3,018,400	14,260,400	11,242,000	7,238,000	4,219,600
Cost-Effectiveness (incremental cost per new rider)	$ 9.74	$ 7.71	$ 7.16	**$13.60**	**$16.36**

Source: Parsons Brinckerhoff, Inc., March 2000.

4.2 EQUITY

Equity is defined as the fairness of the distribution of costs, benefits, and impacts across various population subgroups. Fairness is determined by the extent to which the costs and impacts are distributed in a way that is consistent with regional goals.

1) Impact on Low Income Areas

Certain areas within the primary transportation corridor contain concentrations of minority and low-income populations. Input from community residents and business owners serving the minority and low-income populations has been actively solicited throughout project planning through the community based planning program. None of the alternatives would cause a disproportionately high and adverse health or environmental effect on any population group, including minority and low-income populations. Benefits to these groups would be substantial.

2) Environmental/Socioeconomic Equity and Benefit

An analysis of equity and benefit from an environmental and socioeconomic perspective was developed was based on the relative balance between environmental and/or socioeconomic impacts and change in transit accessibility. The BRT and BRT/SISP Alternatives would result in improved transit accessibility relative to the No-Build and TSM Alternatives. The BRT and BRT/SISP Alternatives would increase daily transit trips by 16.2 and 8.2 percent, respectively, over the No-Build Alternative. The BRT and BRT/SISP Alternatives produce 12.3 and 4.6 percent increases in daily transit trips, respectively, over the TSM Alternative.

The BRT and BRT/SISP Alternatives would provide greater support for desired land use development patterns in comparison to the No-Build and TSM Alternatives.

3) Local Financing Options Equity and Burden

No new local revenue sources or tax increases would be required for any alternative. The City's would provide its portion of the local funding with existing City funding lines and General Obligation (GO) bonds. Federal Transit Administration (FTA) formula and discretionary grants also would be used. Transit related components on State highway facilities would be funded with State and federal highway funds. SISP would be funded with toll revenue bonds and State and federal highway funds, supplemented by City General Obligation bonds.

No geographic or socioeconomic group would pay a disproportionate share of the project's costs.

5 SUMMARY BY ALTERNATIVE

Table 1 summarizes the evaluation measures from the previous sections of this report.

1) No-Build Alternative

The level of environmental impact of the No-Build Alternative would be the least of all the alternatives studied, although air emissions would increase. It would also be the least expensive.

However, the No-Build Alternative would poorly support the purposes and needs of the project. It would not provide a transportation system that would effectively handle present or future levels of travel demand. It would not maintain even current levels of mobility. It would not develop attractive travel alternatives to the private automobile, encourage land use development in desired patterns, support implementation of an urban growth strategy that integrates land use and infrastructure planning, nor maintain the existing quality of life. It would only minimally increase the linkage between Kapolei and the Urban Core, and would not improve access to Sand Island and the Koko Head end of the PUC or Waikiki.

The No-Build Alternative would cost $316.9 million in 1998 dollars which includes the replacement of buses over a 25-year period. Its annualized capital cost would be $24.1 million.

2) TSM Alternative

In comparison to the No-Build Alternative, the TSM Alternative, with its emphasis on enhancing and restructuring bus service, would provide some support to the project's purposes and needs in terms of enhancing people-carrying capacity within the corridor. However, this alternative would not go far in developing attractive alternatives to the private automobile, or in enhancing desired land use development patterns or the City's urban growth strategy that integrates land use and infrastructure planning. There would be some improvement in the linkage between Kapolei and the Urban Core. It would not provide improved access to Sand Island or the Koko Head end of the PUC, including Waikiki.

The level of environmental impact would be greater than under the No-Build Alternative to a degree that depends on the final selection of sites for the Middle Street and Iwilei Transit Centers. Depending on the sites selected, some businesses could be displaced. This alternative would limit the use of 326 parking spaces, mostly on King and Beretania Streets, and affect a substantial number of loading zones. Air and noise emissions would increase.

This Alternative would cost $506.5 million in 1998 dollars which includes the replacement of buses over a 25-year period. Its annualized capital cost would be $41.2 million.

<u>3) BRT Alternative</u>

The BRT Alternative represents a major improvement over the TSM Alternative in terms of meeting the project purposes and needs. It would substantially increase people-carrying capacity within the corridor and help focus growth along the alignment of the In-Town BRT system. Higher density redevelopment in a transit-supportive manner, particularly at transit centers and transit stops, would be encouraged. This alternative would be more effective than the TSM and No-Build Alternatives in supporting implementation of an urban growth strategy that integrates land use and infrastructure planning. It would help facilitate desired land use development patterns consistent with the vision for the island.

As part of the BRT Alternative, transit centers, transit stops, and other project elements would be designed to maintain or improve visual conditions through cohesively designed structures, street furniture, landscaping and lighting. The quality of urban living would increase.

This Alternative would establish transit as an attractive, viable alternative to the automobile. Transit patrons would reap travel time savings. However, this alternative would cause more motorist delay than any other, which is expected to accelerate a switch in travel behavior from automobiles to transit. It would establish an attractive, high capacity linkage between Kapolei and the Urban Core. It would improve access to Waikiki because of the Kakaako/Waikiki Branch of the In-Town BRT system. However, it would do little to improve access to Sand Island.

Potential displacement impacts of the BRT Alternative would be similar to the TSM Alternative, and associated with final site selection for certain transit centers. Parking losses would be greater, although interference with loading zones would be less. Regional air and noise emissions would decrease, and historical impacts would be relatively minor. Impacts during project construction would be substantially greater than for the TSM Alternative because of the greater scope and duration of construction, particularly building the In-Town BRT system transitway on arterial streets.

The cost of this alternative would be $1,076.2 million in 1998 dollars which includes the replacement of buses and In-Town BRT vehicles over a 25-year period. Its annualized capital cost would be $83.9 million.

<u>4) BRT/SISP Alternative</u>

The BRT/SISP Alternative would address the project's purposes and needs to the greatest degree. It would go the furthest in establishing a balanced transportation system.

It would increase people-carrying capacity within the corridor, reduce through traffic in Downtown, improve the connection between Keehi Interchange and Kakaako/Waikiki, provide improved access/egress for Sand Island industrial and recreational sites, and facilitate desired land use development patterns consistent with the vision for the island. This vision includes the linkage of Chinatown and Downtown with the urban waterfront by enabling the conversion of Nimitz Highway to Nimitz Boulevard, and redevelopment of the Keehi Lagoon shoreline. Visual impacts would be quite positive in most areas.

The Regional and In-Town BRT systems and their associated transit feeder services would be attractive travel alternatives to the private automobile. The transportation linkage between Kapolei and the Urban Core would be substantially improved.

SISP would greatly improve access to Sand Island and the Koko Head side of the PUC, including Waikiki. SISP would be a scenic gateway to the Kakaako/Waikiki area. It would create new view planes for motorists. Marina Road would substantially improve the view of Keehi Lagoon, and the view of Kalihi Kai from Keehi Lagoon Park, the Airport Viaduct, and Nimitz Highway. Conversion of Nimitz Highway to a "boulevard" would harmonize the highway with its waterfront setting, and establish visual connectivity between the waterfront and Downtown.

The BRT/SISP Alternative would have substantially more displacements than any other alternative, because of SISP. Parking impacts would be greater than the BRT Alternative, again because of SISP. Historic impacts would be relatively minor.

Because of the use of electric vehicles, and because of the reduction in automobile travel, noise and air emissions with the BRT/SISP Alternative would generally be similar to the BRT Alternative. However, SISP would result in a noise impact at Sand Island State Recreation Area.

SISP would use land along the border of the future Kalihi Kai Park. The majority of the property to be used for the park would remain untouched. Marina Road would provide direct access to this property enhancing its recreational usefulness. In addition, should Option C be selected on Sand Island, there would be a small taking of a portion of the Sand Island State Recreation Area. By comparison, Option B would create substantial business displacement impacts.

Impacts during construction would be similar to the BRT Alternative, with the addition of the construction impacts associated with SISP, which would be mitigated.

The cost of this alternative would be $1,438.0 million in 1998 dollars which includes the replacement of buses and In-Town BRT vehicles over a 25-year period. The annualized cost would be $110.3 million.