84-01

HALI 2000 STUDY ALTERNATIVES ANALYSIS

Final Report

PREPARED FOR
OAHU METROPOLITAN
PLANNING ORGANIZATION

Wilbur Smith and Associates

HALI 2000

ALTERNATIVES ANALYSIS STUDY

FOR THE

OAHU LONG-RANGE TRANSPORTATION PLAN UPDATE

JUNE 1984

PREPARED FOR

OAHU METROPOLITAN PLANNING ORGANIZATION

by

Wilbur Smith and Associates

The preparation of this report has been financed in part through a grant from the U.S. Department of Transportation, Urban Mass Transportation Administration, under the Urban Mass Transportation Act of 1964, as amended, and Federal Highway Administration, under Subsection (f) of Section 104 of Title 23, U.S. Code. The contents of this report do not necessarily reflect the official views or policy of the U.S. Department of Transportation.

CONTENTS

AR00050166

CONTENTS

CONTENTS

AR00050168

CONTENTS

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS

TABULATIONS

TABULATIONS

TABULATIONS

TABULATIONS

HALI 2000 STUDY

SUMMARY

The Hali 2000 Study provides an analysis of existing and future travel needs and conditions on Oahu, and an assessment of alternative future transportation projects and systems to serve these needs. This summary outlines the projects and programs included within each of the transportation alternatives, and identifies the public costs, significant travel and environmental impacts, and financial consequences of each alternative. Supporting documentation is provided in the "Hali 2000 Alternatives Analysis" Project Report.

STUDY PURPOSE AND APPROACH

The Hali 2000 Project is intended to update Oahu's Long-Range Transportation Plan, originally developed in 1967, to reflect the changed expectations regarding the location of future land use development, magnitude of population growth, and travel behavior. The purpose of this study is to assist elected officials, public agency staffs, and the public in determining Oahu's travel needs through the Year 2000.

The Hali 2000 Study addresses the transportation needs for Oahu on a regional scale, with the analyses confined to the major travel corridors. The study was not intended to identify travel needs on the specific facility. The study process has included the identification of transportation goals and objectives; estimation of travel demands which would result from anticipated future land use development; and the formulation and evaluation of six transportation alternatives.

The framework for the identification and evaluation of the alternatives was a set of transportation system objectives, which were formulated to complement the objectives and policies set forth in the State Transportation Plan and the City and County of Honolulu General Plan and Development Plans.

The alternatives' degree of attainment of these transportation goals and objectives were compared through measures describing system usage, travel conditions, costs, funding implications, and potential community and environmental impacts. Emphasis was placed on identifying key differences among the alternatives and the trade-offs to be weighed in the decision-making process.

OAHU GROWTH AND FUTURE TRANSPORTATION NEEDS

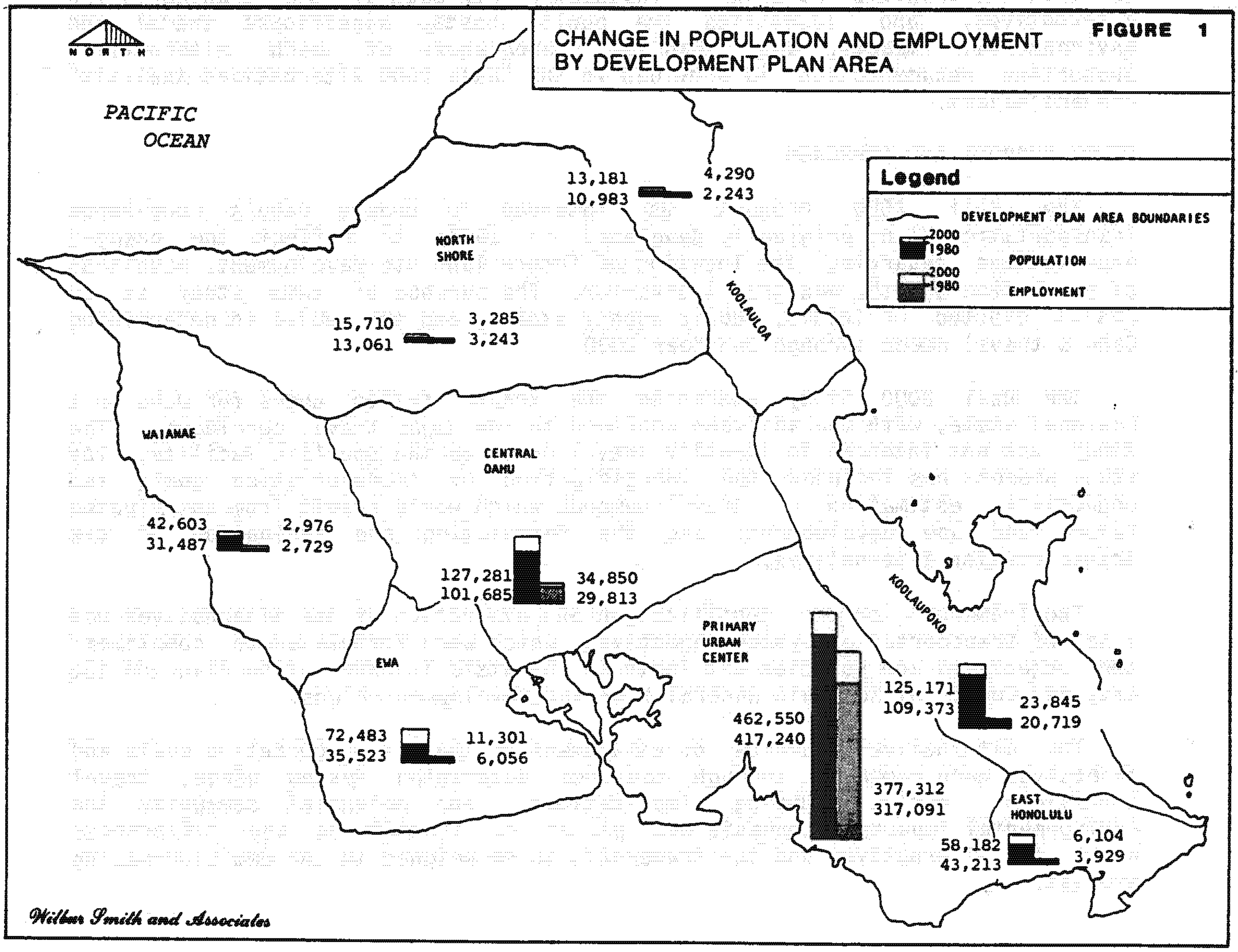
Future transportation system needs are based upon: 1) usage and problems on the present system facilities and services; 2) the additional system capacity which will be provided by projects now underway; and 3) travel increases which would result from the anticipated growth in population and economic activity.

Population and Employment Growth

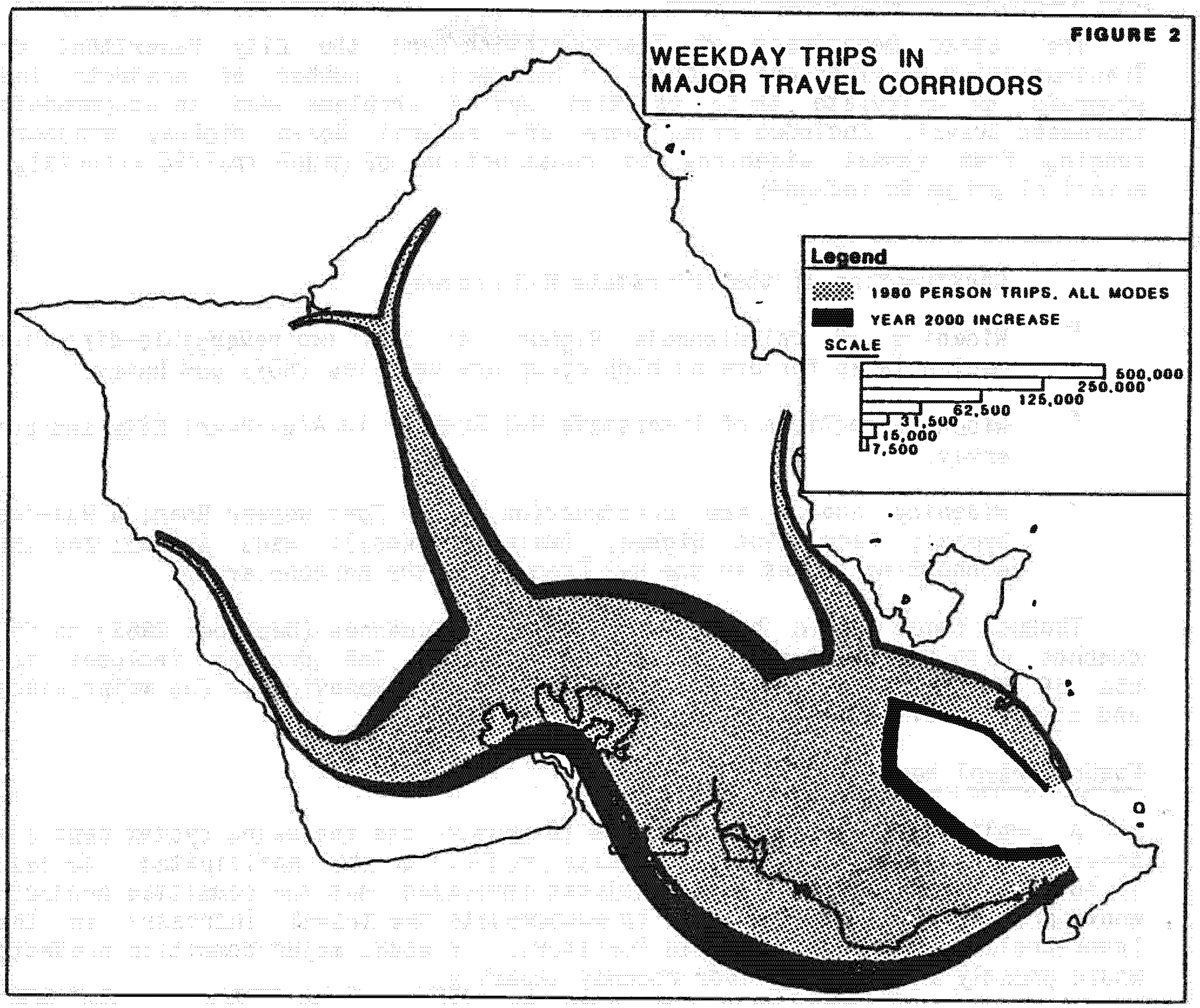
The State Department of Planning and Economic Development forecasts that Oahu population will increase from 762,565 in 1980 to 917,400 in the Year 2000, an increase of 20 percent. Year 2000 travel forecasts also reflect a similar 20 percent increase in employment, while tourist activity is anticipated to increase by 23 percent.

Location of the Year 2000 population and employment was projected by the Department of General Planning, City and County of Honolulu, based upon the guidelines provided by the City and County of Honolulu General Plan and the eight Area Development Plans. The increase in population and employment is depicted by Development Plan Area in Figure 1.

FIGURE 1
CHANGE IN POPULATION AND EMPLOYMENT BY DEVELOPMENT PLAN AREA



Wilbur Smith and Associates



Travel Growth

In the 1980 base year for this study, total weekday travel amounted to 2.5 million person trips. This weekday travel produced 1.5 million automobile and truck trips, while 205,000 passenger trips were made using public transit.

The 1980 weekday travel resulted in traffic congestion and delays within several of the major Oahu travel corridors during the peak traffic periods. Analyses of morning peak hour travel indicates that the most severe highway congestion and delays occurred on the major roadways in the East Honolulu Corridor, in the Leeward-Central Oahu Corridor from Pearl City into Downtown, and on the Trans-Koolau routes. Other more localized traffic problems were also present. The public transit system (TheBus) was heavily utilized and standing loads were typical for most routes in these major corridors during peak hours. This often results in buses being unable to accommodate additional passengers waiting at bus stops along many of the routes.

Based upon population, employment and tourism forecasts, weekday travel is projected to increase 25 percent to 3.2 million person trips in 2000. As shown in Figure 2, large increases in travel are projected to occur in those travel corridors and areas that currently suffer the most severe traffic congestion.

Committed Transportation Projects

The State Department of Transportation and the City Department of Transportation Services are planning to implement a number of projects and programs to alleviate these existing system problems and to accommodate increased travel. Included among these are several dozen highway projects ranging from street widenings to construction of major traffic arterials. Principal projects include:

- Construction of the Interstate H-3 Freeway.
- Widening of Kalanianaole Highway to add two reversible-direction median lanes for use by high occupancy vehicles (HOV) and buses.
- Widening sections of Interstate H-1 Freeway in Aiea-Pearl City and Ewa areas.
- Widening and/or new construction for: Fort Weaver Road; a Haleiwa bypass; Farrington Highway (Waianae-Makaha); Ward Avenue; and the connecting routes to the H-3 Freeway in the Kaneohe area.

TheBus fleet would be expanded from 416 coaches (December 1983) to 600 coaches, with a commensurate increase in services. The program includes the use of high-capacity articulated buses, and the expansion of bus maintenance and storage facilities.

Future Travel Needs

A preliminary analysis was made to compare the increased system capacity provided by the committed State and City projects to the anticipated increase in future travel. These initial analyses indicated that the committed projects would provide sufficient capacity to accommodate the travel increases in the Trans-Koolau and East Honolulu Corridors. In each, major committed projects would greatly increase corridor roadway capacity.

However, only limited increases in roadway capacity are planned for the Leeward/Central Oahu/Downtown Corridor, which is expected to experience the largest increase in travel. Without further improvements, this corridor would be expected to experience the most significant deterioration in travel conditions among the major travel corridors.

SUMMARY DESCRIPTION OF ALTERNATIVES

Six system-wide transportation alternatives were formulated to address anticipated travel needs for the Year 2000. These alternatives include system-wide programs which would benefit all areas, and individual projects which would benefit one particular corridor or area. Since the most significant future travel deficiencies are expected to occur in the Leeward/Central Oahu/Downtown Corridor, the alternatives include a series of major facilities to serve travel in this corridor. Each alternative offers sufficient potential capacity to accommodate the increased travel needs.

Comparative measures describing the six alternatives are presented in Table 1, while Figure 3 depicts the location of the major projects in each alternative. In addition to the six alternatives, a "Committed" transportation system was identified and evaluated.

Committed System

The Committed System serves as a baseline condition from which to measure the performance and costs of the Hali 2000 Alternatives. It includes the existing transportation facilities and services, as well as those new or modified facilities and services which have received agency commitments and can be reasonably expected to be in place by the Year 2000. (See "Committed Projects".)

Alternative A Transportation System Management (TSM)

The TSM alternative represents a series of low capital cost measures which increase the person-carrying capacity of existing transportation facilities through modifying facility operations or by encouraging use of buses and carpools. These measures include the addition of reserved high-occupancy vehicle (HOV) lanes on the H-1 Freeway and on the Pali and Likelike Highways, and a major expansion in the public bus fleet.

The use of travel demand management measures would be necessary to encourage a significant number of automobile drivers to shift to use of public transit or to participate in carpools. A road congestion pricing program was included which would levy a use charge (10 cents per mile in this analyses) on those vehicles traveling on congested roadways during morning and evening peak traffic periods.

Alternative B Highway Development Emphasis

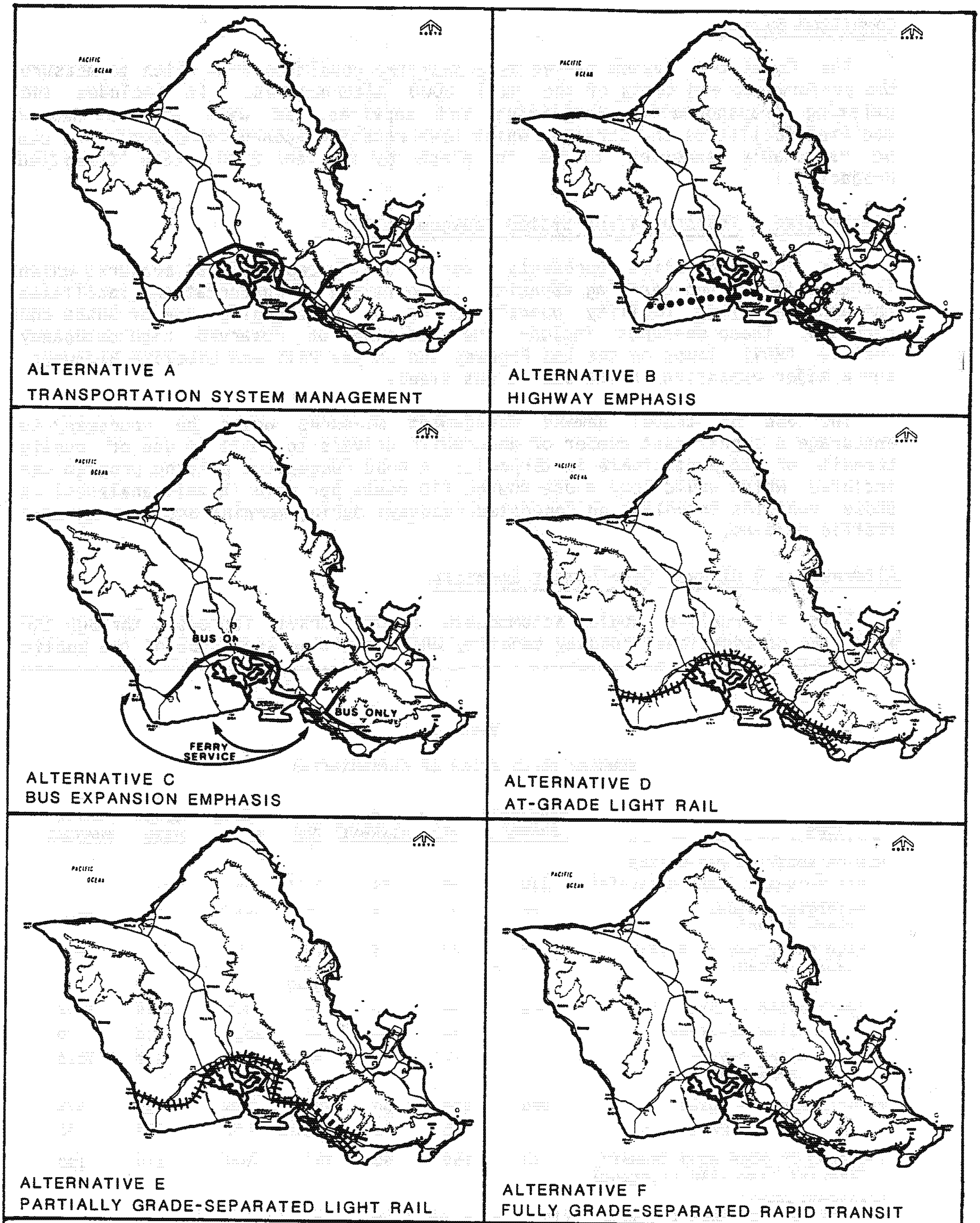
This alternative would accommodate future travel increases through the provision of additional roadway capacity while limiting expansion of the public

TABLE 1

SUMMARY DESCRIPTION OF ALTERNATIVES

ITEM	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
NEW OR MODIFIED FACILITIES							
New Roadways (Lane Miles)[a]	110	--	84	--	--	--	--
Reversible Lanes (Lane Miles)	--	--	6	--	--	--	--
High Occupancy Vehicle[a] Lanes (Miles)	9	23	5	28 (Bus only)	--	--	--
Route Miles of Rail Line	--	--	--	--	28.7	28.9	13.8
Miles At-Grade	--	--	--	--	28.1	23.2	0
Miles Grade-Separated	--	--	--	--	0.6	5.7	13.8
TRANSIT FLEET - Buses	600	880	600	800	430	440	520
Rail Cars	0	0	0	6[a]	102	104	53
INCREASE IN PEAK HOUR TRANSIT CAPACITY OVER 1980 (Percent)	80	150	80	130	100	110	120

(a) Facility mileage for alternatives is in addition to committed projects.
(b) Marine Ferries.



LEGEND
- HIGH OCCUPANCY VEHICLE LANES
- NEW ROADWAY
- REVERSIBLE TRAFFIC LANES
- AT-GRADE RAIL LINE
- GRADE-SEPARATED RAIL LINE

MAJOR PROJECT LOCATIONS
HALI 2000 ALTERNATIVES

FIGURE 3

transit system to a 600 bus fleet. Major projects would include: 1) construction of an Ewa Parkway with a six-lane tunnel crossing of the Pearl Harbor Channel entrance; 2) construction of an elevated four-lane roadway above Nimitz Highway and Ala Moana Boulevard; 3) operation of reversible direction traffic lanes on the Pali and Likelike Highways; and 4) extension of the Kalanianaole Highway HOV lane on the H-1 Freeway.

Alternative C Bus System Expansion Emphasis

Alternative C provides for a major expansion in bus fleet size and services beyond the committed levels, but without the automobile disincentives included in Alternative A. In addition to the expansion of TheBus services, Alternative C includes use of reserved bus lanes on the H-1 Freeway, Pali Highway and Likelike Highway, and the implementation of marine ferry services. The high speed, high-capacity ferry services would be initiated between the West Beach and Ewa Beach Marinas and Downtown on a 15 to 20 minute frequency during commute periods.

Alternative D At-Grade Light Rail System

This alternative is one of three fixed-guideway transit alternatives (D, E and F) assessed for providing service in the Leeward/Central Oahu/Downtown travel corridor. Together, these three alternatives establish the range of potential usage, costs and general impacts of a rail transit system on Oahu, with each representing a different degree of grade-separation, service quality, operating speeds, and number of station stops. (See Table 2.)

Light rail transit (LRT), proposed for both Alternatives D and E, is unique in that it can operate on grade-separated (elevated or subway) guideways, in reserved at-grade rights-of-way, within streets in mixed traffic flow, or a combination of these along a line. (See Figures 4 and 5.) At-grade operation is permitted by use of overhead trolley wires for its electric power supply. Light rail vehicles, which are similar in size and passenger capacity to "heavy" rail vehicles, can be operated as single units or coupled into trains. Operating speeds can vary from those typical of local buses to speeds similar to rapid transit lines, depending upon the degree of separation from traffic conflicts and the spacing between station stops.

FIGURE 4

LIGHT RAIL TRANSIT OPERATING AT-GRADE WITHIN STREET SAN FRANCISCO

FIGURE 5

LIGHT RAIL TRANSIT (2 CAR TRAM) OPERATING ALONG FORMER RAILROAD RIGHT-OF-WAY SAN DIEGO

FIGURE 6

GRADE-SEPARATED RAPID TRANSIT SAN FRANCISCO

TABLE 2

DESCRIPTION OF RAIL ALTERNATIVES

ALTERNATIVE	STATIONS Number	Type	Average Spacing (feet)	AVERAGE OPERATING SPEED (mph)		TRAINS	SERVICE FREQUENCY (Minutes)	PASSENGER CAPACITY AT PEAK LOAD POINT[(a)]
D At-Grade Light Rail	52	Shelter	2,200	22	Peak	2-3 Cars	4	7,000
					Off-Peak	1 Car	6-10	
E Partially Grade-Separated Light Rail	27 8	Shelter Multi-Level Building	3,500	24	Peak	2-3 Cars	4	7,500
					Off-Peak	1 Car	6-10	
F Fully Grade-Separated Rail Rapid Transit	18	Multi-Level Building	5,200	35	Peak	3-4 Cars	4	11,400
					Off-Peak	2 Cars	6-20	

(a) One-hour peak direction capacity (seated and standing) based on identified train size and service frequency.

Light rail Alternative D represents the lowest capital cost rail transit system for serving travel demands in the corridor. To minimize construction and right-of-way costs, the light rail line would be located at-grade and within existing transportation facility rights-of-way to the fullest extent possible.

The at-grade light rail line would extend between West Beach and the University of Hawaii-Manoa area, with a branch line extending through Waikiki. The line would be located within street rights-of-way from Manoa-Waikiki to Pearl Harbor, where it would then follow the former Oahu Railway and Land Company (OR&L) alignment to West Beach.

The public bus system would be modified to reduce or eliminate service on lines paralleling the rail line, and to reroute bus lines to provide "feeder" service to the rail line.

Alternative E Partially Grade-Separated Light Rail

The Alternative E light rail line would be located on an elevated guideway through the more congested traffic areas to permit faster train operating speeds and to avoid displacement of traffic lanes by the rail line. Approximately 5.7 miles of the 29-mile rail system would be elevated. The Alternative E alignment differs from that for Alternative D, with the grade-separated segments generally following the Alternative F Alignment.

Alternative F Fully Grade-Separated Rapid Transit

Rail rapid transit would operate on a guideway which would be grade-separated from all vehicular and pedestrian conflicts. The separation would be accomplished through use of elevated and subway alignments, and location within freeway rights-of-way. Stations would be spaced far apart to reduce stops and permit higher travel speeds.

TABLE 3

ALTERNATIVES CAPITAL AND OPERATING COSTS
(In Millions of 1983 Dollars)

COST ELEMENT	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL (29 mi.)	E LIGHT RAIL (29 mi.)	F RAPID TRANSIT (14 mi.)
1984-2000 CAPITAL COSTS							
Bus Facilities/ Vehicles	229.5	310.3	229.5	289.3	164.3	167.8	212.0
Rail Facilities/ Vehicles	0	0	0	42.0[c]	514.1	617.2	956.2
Subtotal Transit	229.5	310.3	229.5	331.3	678.4	785.0	1168.2
Roadways[a]	0	12.3	1,445.8	15.3	0	0	0
TOTAL	229.5	322.6	1,675.3	346.6	678.4	785.0	1168.2
YEAR 2000 OPERATING COSTS							
Bus System	86.5	117.8	86.5	106.8	52.2	54.4	62.7
Rail System	0	0	0	2.2[c]	13.9	14.7	12.5
Subtotal Transit	86.5	117.8	86.5	109.0	66.1	69.1	75.2
Roadway System[b]	0	0.4	1.8	0.4	0	0	0
TOTAL	86.5	118.2	88.3	109.4	66.1	69.1	75.2

(a) Roadway costs do not include $970 million for committed projects.
(b) Roadway costs do not include $30 million to maintain existing and committed facilities.
(c) Marine ferry system.

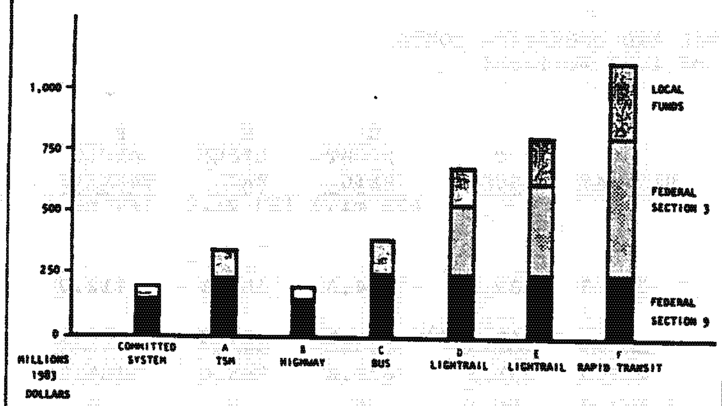
In general, the rapid transit line would follow the horizontal and vertical alignment identified during the Honolulu Area Rapid Transit (HART) studies. Whereas the HART Study proposed a subway in the Downtown area, the Hali 2000 analysis considers the costs for both an elevated and a subway alignment. The rail line would extend from Kahala to Aloha Stadium, with a possible four-mile extension to Pearl City.

Alternative F is based on the use of "heavy" rail vehicles, as depicted in Figure 6, although either light rail or Intermediate Capacity Transit System (80-90 passenger) vehicles could be used with little difference in capital and operating costs.

CAPITAL AND OPERATING COSTS

All capital and operating costs have been estimated using mid-1983 unit costs for the Honolulu area. Highway capital and maintenance costs in Table 3 include only those roadway, HOV and bus lane projects proposed in addition to the committed projects. The public transit system costs include all capital and operating expenditures for vehicles, guideways, stations, and maintenance facilities during the 1984-2000 period, including replacement costs for the bus fleet.

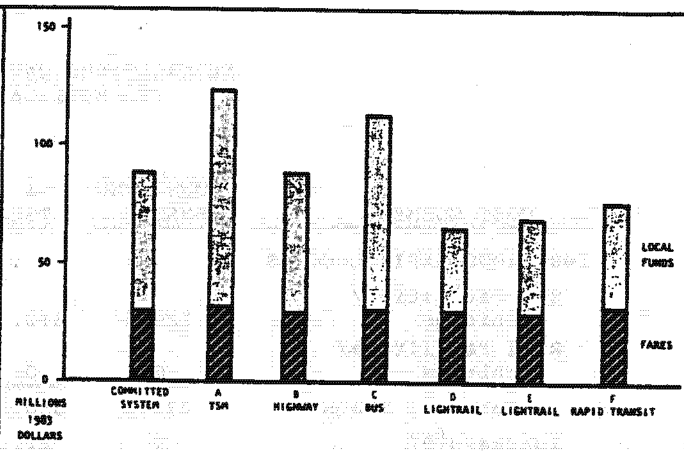
Highest capital costs are estimated for the Highway Alternative (B). For the transit element, the higher capital investments required for the rail alternatives (D, E and F) are estimated to result in significantly lower yearly operating and maintenance costs as compared to the all-bus alternatives.



PUBLIC TRANSIT CAPITAL COSTS AND FUNDING

1984-2000

FIGURE 7



PUBLIC TRANSIT OPERATING COSTS AND FUNDING

YEAR 2000 OPERATIONS

FIGURE 8

Capital costs for Alternative F would increase by $150 million to place the Downtown segment in a subway, and by $250 million to extend the line to Pearl City.

FINANCIAL FEASIBILITY

Financial feasibility of the alternatives has been assessed by identifying potential funding available through existing Federal and State programs and revenue sources, and then determining the extent to which each alternative would need local funding. The analysis is expressed in 1983 dollars.

Highway Funding

Current funding sources for major highways on Oahu include the Federal Aid Interstate (FAI); Federal Aid Primary (FAP); Federal Aid Urban (FAU) programs, plus State revenues from the fuel gallonage tax, vehicle fees and temporary gasoline excise tax.

Based upon current Federal and State commitments and funding levels, highway funds would be available from the existing sources for committed projects, and for HOV lanes, widenings and interchange construction on the Interstate facilities. Costs for any new major highway projects may have to be primarily funded through new or increased local user fees and taxes.

Public Transit Funding

Capital Funds - Funds for purchase of vehicles and construction of facilities are available through several Federal programs, with each requiring local funding participation.

- Federal Section 9 formula block grants to Honolulu in Fiscal Year 1984 amount to $18.9 million, of which $15 million must be used for capital projects and the remainder for either capital or operating costs. Grants may be used to fund up to 80 percent of bus or rail project costs.

TABLE 4

LOCAL FUNDING NEEDS FOR YEAR 2000 ANNUAL COSTS
(Millions of 1983 Dollars)

COST ITEM	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL (29 Miles)	E LIGHT RAIL (29 Miles)	F RAPID TRANSIT (14 Miles)
HIGHWAY [(a)]							
Annual Amount for Local Share of Capital Costs	--	0.8	180.0	0.8	--	--	--
Operating Costs	--	0.4	1.8	0.4	--	--	--
Subtotal		1.2	181.8	1.2	--	--	--
PUBLIC TRANSIT							
Annual Amount for Local Share of Capital Costs	5.5	8.0	5.5	10.0	20.0	23.5	43.5
Operating Costs Less Fare Revenue	62.3	91.4	62.6	84.0	41.9	45.2	49.1
Subtotal	67.8	99.4	68.1	94.0	61.9	68.7	92.1
TOTAL LOCAL FUNDING	67.8	100.6	249.9	95.2	61.9	68.7	92.1

(a) Amounts do not include funding for existing and committed highways.

- Federal Section 3 grants are awarded by Congress on a discretionary basis for up to 75 percent of major transit project costs. Due to the large number of funding requests for new rail systems, the Federal Government is encouraging cities to request less than the 75 percent maximum.

- City General Fund monies are used to fund the local portion of project capital costs.

The alternatives capital funding summary presented in Figure 7 is based upon a continuation of Section 9 capital funds at the current level for bus acquisition and facilities, and to the extent not fully used by buses, for application to rail capital costs. The analysis is based upon a Section 3 contribution equal to 60 percent of the rail capital costs, which is reflective of the Federal participation levels requested by several other cities.

Operating Funds - Present funding sources for transit operating costs include: Federal Section 9 grant portion applicable to operating costs; special Federal Section 9 Commuter Rail Services formula grant ($6 million annually for a Honolulu rail system); fare revenues; and City General Fund and Highway Fund monies.

At present, Section 9 bus and rail operating grant programs are scheduled to end in Fiscal Year 1986. Therefore, only fare revenues and City funds are included for funding public transit operating costs (Figure 8). Estimated fare revenues reflect a continuation of 1983 rates ($0.50 adult fare).

Local Funding Needs

The Hali 2000 alternatives would each require increased local funding to implement and operate the highway and public transit projects. The comparison presented in Table 4 includes the local funds needed to support Year 2000 annual operating costs plus the annual debt service for bonds issued to fund the local share of project capital costs.

IMPACT EVALUATION SUMMARY

The island-wide analysis of long-range transportation alternatives is largely limited to the consideration of systemwide or corridor level measurement of impacts and effectiveness. Key measures are summarized in Table 5.

Choice of Travel Mode

Analysis of the alternatives was based upon the estimated weekday and morning peak hour travel for Year 2000. Travel volumes and conditions were forecast using the OMPO regional computer model.

Public transit use is projected to increase substantially for the Committed System and each of the six alternatives with the increases ranging between 32 and 45 percent above the 1980 patronage. The relatively narrow range between the lowest and highest patronage projects reflects the similarities in coverage and service levels for the alternatives.

Alternatives A and F are projected to attract the largest shift of automobile drivers to public transit, largely as a result of increased road user charges (A) and higher-speed transit service (F). Lowest transit use is forecast for Alternative B as a result of improved automobile travel and for Alternative E due to rail line location at the perimeter of the Downtown area.

Ridesharing (carpooling) would increase most for Alternative A as a result of the increase in driving costs and provision of HOV lanes. Alternatives B and F would result in lowest carpooling due to less roadway congestion (B) and the attraction of potential carpool participants to use public transit (F).

Automobile use would increase most with the increased highway capacities of Alternative B, and least with Alternatives A and F.

Travel Conditions

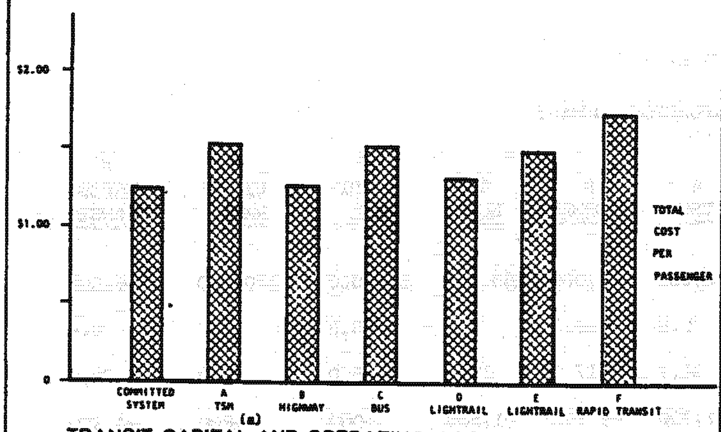
Portions of the major roadway system would continue to be heavily congested during the peak traffic periods with any of the alternatives. Systemwide measures indicate that the largest increases in travel delay and congestion would occur with Alternative D, due largely to the displacement of traffic lanes on several major streets to accommodate the at-grade light rail line. Locations and relative severity of highway congestion in the major corridors would differ among the alternatives:

TABLE 5

IMPACT EVALUATION SUMMARY

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
TRAVEL MODE-SYSTEMWIDE								
Weekday Public Transit Trips	205,000	274,000	298,000	270,000	283,000	274,000	270,000	295,000
Percent Resident Trips by Transit	8.2	8.8	9.8	8.7	9.1	8.8	8.7	9.6
Percent Work Trips by Transit	14.9	18.3	21.7	17.7	19.2	18.0	18.0	20.9
Weekday Person Trips in Carpools (a) (Residents)	540,500	681,500	+17,700	-3,700	-1,500	+900	+600	-4,300
Weekday Vehicle Trips (a)	1,536,900	1,917,500	-19,200	+6,500	-7,500	-400	+3,600	-14,100
PERCENT TRIPS BY TRANSIT IN MAJOR CORRIDORS								
Leeward @ Kalauao	6.9	9.5	11.4	8.7	9.9	9.3	9.1	10.6
Downtown @ Kapalama	9.1	10.8	13.0	10.5	11.2	10.8	10.5	12.1
Downtown @ Ward	8.7	10.8	12.6	10.6	11.1	10.6	10.3	11.9
MAJOR HIGHWAY CONDITIONS								
Weekday Vehicle Delay (Hours)	53,000	82,200	69,400	72,900	80,000	98,700	88,300	77,700
Percent Travel on Congested Roadways	10	14	11	13	14	17	13	13
CORRIDOR HIGHWAY CONDITIONS(b)								
Leeward @ Kalauao	1.07	1.28	.95	.96	1.25	1.28	1.30	1.25
Downtown @ Kapalama	1.07	1.16	1.05	.97	1.12	1.23	1.17	1.12
Downtown @ Ward	.78	.87	.78	.69	.87	.95	.88	.85
East Honolulu @ Kapakahi	1.23	1.16	1.02	1.16	1.16	1.18	1.16	1.14
Trans-Koolau	1.03	.96	.94	.96	.96	.97	.97	.92
PUBLIC TRANSIT COST EFFECTIVENESS								
Total Cost Per Passenger ($)	0.95	1.21	1.53	1.23	1.52	1.36	1.50	1.73
Operating Cost Per Passenger ($)	0.82	1.00	1.25	1.01	1.22	.76	.81	.83
ENVIRONMENTAL IMPACTS								
Weekday Emission (Tons)								
a. Carbon Monoxide (a)	—	242.4	-5.0	-10.5	-1.0	+0.2	+1.2	-3.9
b. Hydrocarbons (a)	—	22.2	- 0	- 0.4	+0.3	-0.4	-0.3	-0.6
c. Oxides of Sulfur (a)	—	1.3	- 0	- 0.1	- 0	+0.1	+0.1	+0.3
Visual—Miles of Elevated Facilities	—	—	0	5.5	0	0.6	5.7	10.0
Land Acquisition (Acres)	—	—	24	106	24	19	21	63
SOCIOECONOMIC/COMMUNITY								
Construction Employment	—	—	4,600	14,700	4,200	9,000	10,000	17,400

(a) Alternatives given as change from Committed System.
(b) Ratio of projected morning peak hour traffic volume to the design service volume (Level of Service D). Ratios above 1.00 indicate undesirable levels of congestion and delays (Level of Service E or F).

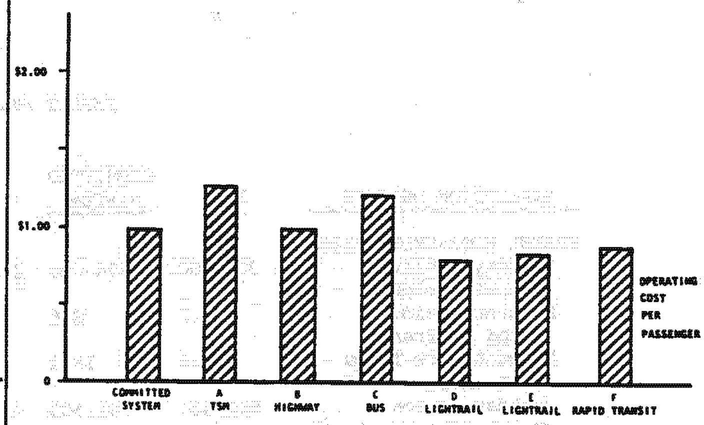


TRANSIT CAPITAL AND OPERATING COSTS PER PASSENGER

YEAR 2000

(a) Based on capital cost annualized at 7% discount rate

FIGURE 9



TRANSIT OPERATING COSTS PER PASSENGER

YEAR 2000

FIGURE 10

- Leeward/Central Oahu - Alternatives A (with H-1 HOV lanes and road user pricing penalties) and B (additional 4 to 6 highway lanes between Ewa and Downtown) would accommodate the corridor travel growth and improve traffic conditions.

  As indicated by the travel model forecasts, the expanded public transit services, regardless of transit mode, would not attract a sufficiently large increase in transit use to offset the substantial increase in travel from the Ewa and Central Oahu areas. To improve highway conditions on the Pearl City-Aiea and Iwilei-Downtown area roadways, increased public transit service should also be supplemented with roadway widenings, traffic operations modifications (HOV facilities or reversible lanes) and/or automobile disincentives.

- Windward Corridor - With the H-3 Freeway, the Trans-Koolau routes would be sufficient to serve the projected traffic volumes. Localized congestion may occur on roadways providing Windward access to the Trans-Koolau routes.

- East Honolulu - Free flow conditions in the two Kalanianaole Highway HOV lanes are projected to attract sufficient HOV use in the corridor to avoid worsening of traffic flow in the general traffic lanes beyond current congested conditions.

- Downtown - Alternatives A and B would maintain current conditions or improve traffic flow. Forecasts indicate that the other alternatives would result in a worsening of traffic conditions.

Transit Cost Effectiveness

The average total cost and operating cost per public transit passenger, as summarized in Table 5 and Figures 9 and 10, are based on the projected Year 2000 patronage and operating costs, and the annualized capital cost for each alternative. All costs are presented in 1983 dollars.

The lowest total capital plus operating cost per passenger is estimated for the 600-bus fleet, with the lower operating costs of the three rail alternatives are offset by their higher capital costs. During the study, a preliminary analysis was made of shorter rail lines within the most heavily travelled portion of the longer lines. The analyses indicate that the shorter light rail and rapid transit lines could approximate or exceed the cost-effectiveness for the 600-bus and the 800-bus systems, respectively. The range of rail line lengths and estimated total costs per passenger are:

Alternative D	5-19 miles	$1.11 - $1.31
Alternative E	5-19 miles	$1.19 - $1.44
Alternative F	8-11 miles	$1.48 - $1.59

These comparisons are made for forecast conditions in the Year 2000. As population and travel growth continue above the forecast levels, the cost-effectiveness of the rail alternatives would increase relative to the all-bus systems since the capital investment in facilities would be distributed among more passengers.

Environmental Factors

The assessment of the general impacts of the alternatives on the natural and socioeconomic environment indicated that there are few substantial differences between the alternatives. At a regional scale, the principal differences would include:

- The elevated roadways and transit guideways of Alternatives B, E and F would have significant visual impacts.
- Property acquisition requirements would be greatest for Alternatives B and F.
- Alternatives B and F would generate the largest number of construction jobs.
- Potential impacts on natural habitat areas would be most likely with Alternatives B, D and E in the Pearl Harbor and Ewa areas.

IN PROSPECT

The Hali 2000 Study information is for use in identifying those critical travel corridors which should be given priority in the development of transportation system improvements, and the range of alternatives appropriate for further investigation in each corridor. For the major travel corridors, the Hali 2000 Study forecasts indicate the following:

1. The largest travel growth and increased deterioration in travel conditions would occur in the Leeward/Central Oahu/Downtown corridor between Pearl City and the Kaimuki-Waikiki areas.
2. While the additional two HOV lanes planned for the East Honolulu corridor would accommodate the projected increase in person trips, the highway travel conditions in the general traffic lanes would continue

to be severely congested during the peak traffic periods. Some degree of congestion and delays would be needed in the general traffic lanes to encourage carpool and bus usage in the free-flowing HOV lanes.

3. Congestion in other corridors would be more localized and affect specific roadway segments or transit routes.

Formulation and analysis of transportation alternatives were focussed upon the Leeward/Central Oahu/Downtown Corridor. Principal findings include:

- Four to six additional highway lanes would mitigate corridor congestion. Without a new or increased source of Federal highway funds, the highway projects would require substantial increases in local funding.

- The Transportation System Management alternative would require use of automobile disincentives to reduce corridor travel to levels that could be accommodated by the improved transit service, HOV lanes and low-cost traffic operational improvements.

- Only limited differences in transit patronage were projected for the broad range of transit alternatives in this corridor. This reinforces the importance of other factors -- funding, cost effectiveness, service quality and impacts -- in considering the transit options.

- A principal difference between the all-bus and the combined bus-rail alternatives is the tradeoff between lower operating cost of the rail system and the lower capital cost of the bus system, and the implications of this difference upon funding and cost effectiveness.

- The at-grade LRT line would displace traffic lanes and worsen traffic conditions on several major streets. Grade separation of the LRT line through these areas would reduce or avoid those delays to traffic and improve transit operations, but would require increased construction costs.

- A fully grade-separated rapid transit line would provide improved service quality and attract the largest increase in patronage, but would require significantly increased capital funding.

- Each of the transit options would require additional roadway or TSM measures to mitigate traffic problems in the corridor.

The next step in the long-range planning process will be the selection and prioritization of those corridors which should receive further transportation improvements beyond the committed projects, and the range of alternatives which should be considered within each corridor. The information furnished in the Hali 2000 alternatives analysis is commensurate with that needed to guide the community and its policy-makers in these regional decisions.

Once these decisions have been made, further planning and engineering studies will be undertaken to provide in-depth analyses of the locations, specific alignments, costs, and impacts for the range of alternatives identified for each corridor. These future studies will provide the detailed analyses leading to final selection and definition of projects and alignments.

CHAPTER 1

INTRODUCTION

The development of major surface transportation facilities and programs on Oahu has been guided by the Oahu Long Range Transportation Plan. This plan evolved from the land use and travel forecasts and analyses prepared during the 1960s by the Oahu Transportation Study. The plan, which was initially adopted in 1976, has provided the basis for the State of Hawaii and City and County of Honolulu to develop and program projects to improve Oahu's transportation infrastructure.

The Oahu Long Range Transportation Plan was developed to serve travel needs in the study horizon year of 1985. Oahu population was expected to increase from the 617,000 residents in 1965, to an estimated 1,050,000 persons in 1985. To serve the travel needs of this population, the plan identified a number of freeway, arterial roadway and major transit projects for implementation. Many of these projects, such as the Interstate H-1 and H-2 Freeways, have been implemented and currently serve today's travel needs. Other elements of the Plan are presently included among the more than one billion dollars of highway projects now underway or targeted for construction in the next few years.

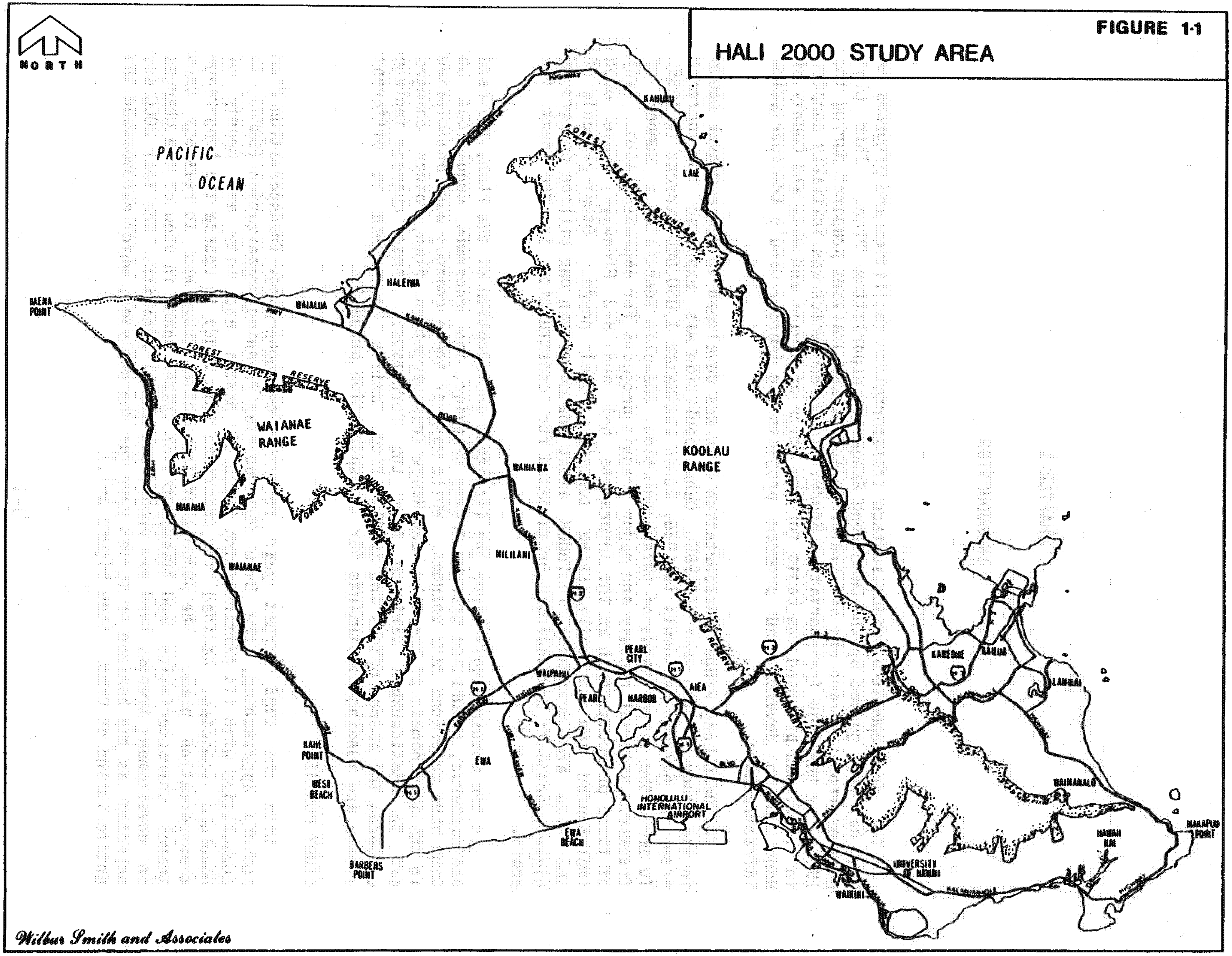
In the ensuing years since the inception and adoption of the Plan, the land use patterns, population growth, travel behavior, and economic conditions on Oahu have undergone many changes. While many of these changes were anticipated in the development of the Oahu Long Range Transportation Plan, other changes are in considerable variance from the forecasts. These changes include concerns for energy prices and availability, shifts in growth to different areas, and funding constraints for transportation projects.

STUDY PURPOSE

With the 1985 target year for the Oahu Long-Range Transportation Plan rapidly approaching, the Oahu Metropolitan Planning Organization (OMPO), in cooperation with its participating State of Hawaii and City and County of Honolulu agencies, decided to undertake this study to update the long-range transportation plan. The purpose of the update study was to reassess Oahu travel characteristics and transportation system needs in view of the changes in development trends, land use plans, and travel behavior. The Year 2000 was selected as the horizon or target year for the analyses, which encompassed the entire island of Oahu. (See Figure 1-1.)

FIGURE 1-1

HALI 2000 STUDY AREA



AR00050195

The Study is intended to provide the public officials and citizens of our community with an assessment of future travel needs, and an evaluation of broad system alternatives which have been developed to serve these needs in an effective and efficient manner. The study scope and approach have been designed to address several major issues inherent to the development of a transportation plan:

- The level of travel demands which would result from the location and scale of land use development, based upon the guidelines of the City and County of Honolulu General Plan and Area Development Plans.

- The location and magnitude of potential capacity deficiencies in the major travel corridors relative to the forecast travel demands. The identification of priority corridors for additional facilities and programs.

- The effectiveness of different types and/or scale of transportation facilities and programs in serving the travel needs.

- The level of capital and operating investment which may be necessary to address the needs.

- The differences between alternatives relative to funding availability through existing sources, and the probable level of need for additional local funding sources.

The study work program and evaluation measures were developed to address these issues.

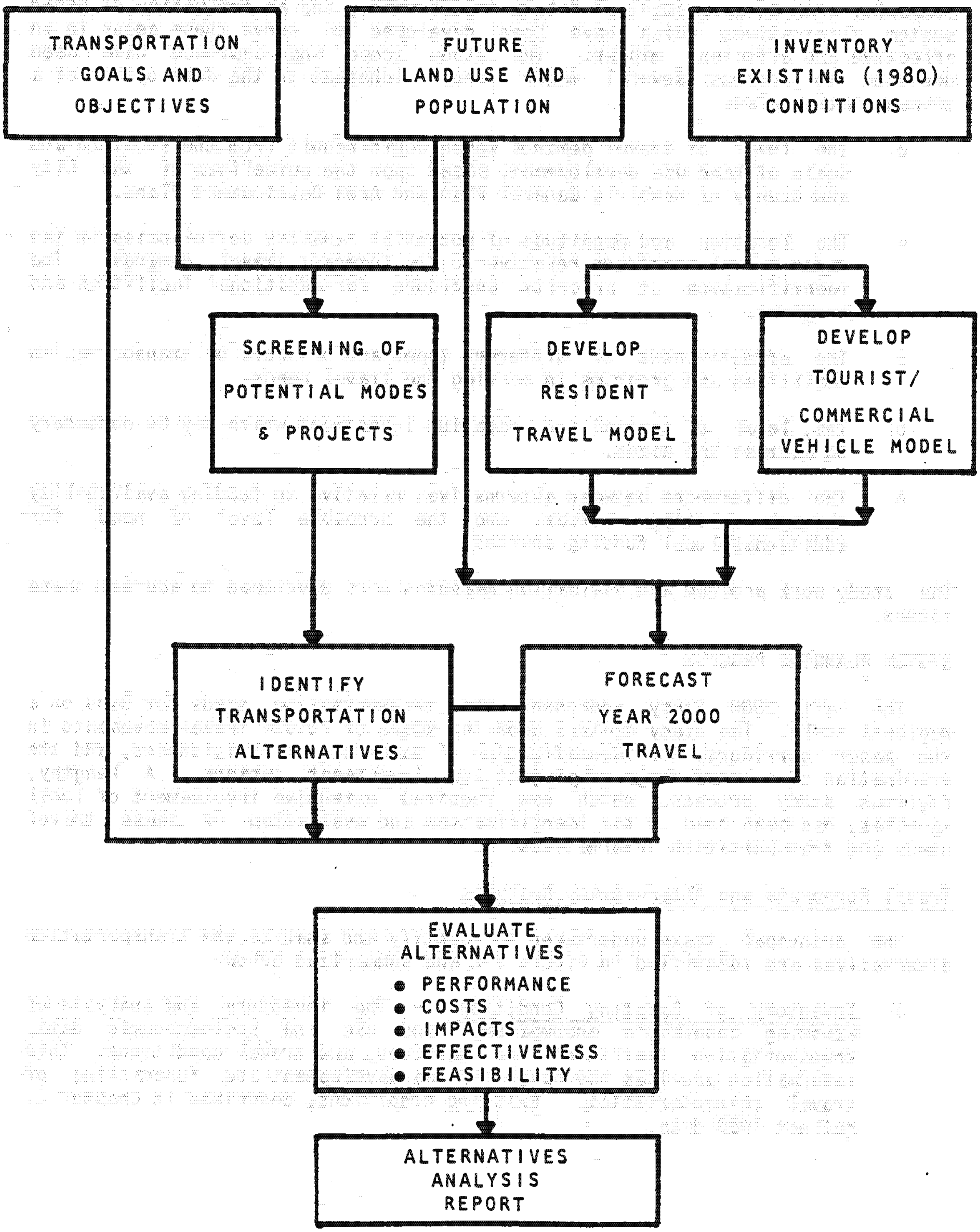
SYSTEM PLANNING PROCESS

The Hali 2000 Study addresses the transportation needs for Oahu on a regional scale. The study centers upon the scale of future travel movements in the major corridors, the identification of major system deficiencies, and the examination of a broad range of project and investment options. A lengthy, rigorous study process, which has required extensive involvement of local agencies, has been used in the identification and evaluation of these travel needs and transportation alternatives.

Travel Forecasts and Alternatives Analysis

The principal tasks undertaken to identify and analyze the transportation alternatives are identified in Figure 1-2 and summarized below.

1. Inventory of Existing Conditions - The inventory and analysis of existing conditions encompasses land use and socioeconomic data, transportation facilities and services, and travel conditions. This information provides the basis for the development and forecasting of travel characteristics. Existing conditions, described in Chapter 2, reflect 1980 data.



HALI 2000 WORK FLOW

FIGURE 1-2

2. Land Use Forecasts - Location, type and magnitude of development determines the volume and characteristics of future travel. The Year 2000 forecasts of land use, population and socioeconomic conditions, as summarized in Chapter 3, were based upon the plans and policies of the City and County of Honolulu and the State of Hawaii.

3. Goals and Objectives - The transportation-related goals and objectives for a community guide both the formulation and evaluation of the transportation alternatives. The Hali 2000 goals and objectives are discussed at the conclusion of this chapter.

4. Screening and Definition of Transportation Alternatives - An Alternatives Task Force, comprised of staff representatives of OMPO, City and State agencies, assessed the magnitude of travel growth and capacity needs that would likely occur in each area of Oahu. The Task Force, after consideration of a broad array of alternative facilities, modes and programs which address the needs in each travel corridor, identified a series of transportation system alternatives for detailed evaluation. The screening process and the alternatives are described in Chapter 4.

5. Development of Travel Model - A computerized regional travel model was developed for forecasting resident travel on Oahu. The model utilized the Federal Urban Transportation Planning System program package, with the model calibration based upon 1980 Oahu travel data. Tourist and commercial travel were forecast using special procedures developed for the analysis. (See Chapter 6.)

6. Travel Forecasts - The computer model and the tourist and commercial vehicle projections were used to estimate Year 2000 travel for each transportation alternative. Travel forecasts were made for average weekday conditions and morning peak hour.

7. Evaluation - The transportation alternatives were analyzed and evaluated relative to the study goals and objectives, using a comprehensive set of quantitative evaluation measures. Areas of evaluation included:

   - Travel performance including roadway level of service, transit usage, travel speeds, capacity sufficiency (Chapter 6).
   - Capital costs for implementation and annual operating and maintenance costs (Chapter 5).
   - Identification of significant differences in socioeconomic and environmental impacts (Chapter 7).
   - Availability of funding from existing programs and the increased need for local funding. (Chapter 8).
   - The comparative cost efficiency of each alternative (Chapter 9).

Level of Analysis

Due to the wide variation in travel needs in different corridors and the broad range of transportation alternatives, the definition of alternatives and analysis are specified in general terms commensurate with the needs of a regional planning study. Analysis of travel demands have emphasized the use of system-wide and corridor measures and evaluation parameters. Traffic movements and transit usage have been summarized and evaluated for key locations within each corridor without a detailed analysis of travel usage on each individual roadway or transit route.

The capital costs for highway and transit facilities have been estimated for specific alignments where possible. The identification of an alignment has been used for cost estimating purposes since locational considerations would greatly affect costs. Inclusion of these locational considerations thus should provide a more realistic estimate of major facility costs.

Assessment of potential socioeconomic and environmental impacts has emphasized the identification of those factors which may differ considerably between the identified transportation alternatives. The analysis seeks to identify those factors which differentiate the alternatives, rather than to provide a comprehensive, detailed analysis of the impacts of each alternative.

Study Organization

The Oahu Metropolitan Planning Organization (OMPO), which is responsible for coordinating transportation planning on Oahu, functioned as the lead agency on the Hali 2000 Study. In addition to OMPO, the Hali 2000 Study was sponsored by the State of Hawaii, the City and County of Honolulu, and the U.S. Department of Transportation. City and State transportation and planning agencies participated in the project through both direct staff commitment to the project tasks and involvement on advisory committees.

Study Efforts - Overall direction of the study effort was vested in the Executive Director of OMPO. The Executive Director executed the responsibility for the study within the role and missions established by the OMPO Policy Committee as assisted by the OMPO Technical Advisory Committee and the Citizens Advisory Committee.

The management of the study activities was performed by two co-managers whose services were provided by Hawaiian Electric Company and Hawaiian Telephone Company for this purpose. The co-managers guided the efforts assigned to the participating agencies and consultant firms:

- Technical Advisory Subcommittee - These agency staff persons have reviewed and approved the analysis methodologies, forecasts and alternatives for the Hali 2000 Study.

- Alternatives Task Force - These agency staff persons conducted the initial preliminary assessment of future deficiencies, and screened potential transportation projects to identify the transportation alternatives for detailed analysis.

- <u>Agency Technical Staffs</u> - OMPO, City, and State staff have conducted much of the travel forecasts through application of the regional travel models.

- <u>Consultant Firms</u> - The three consulting firms participating in the Hali 2000 Study and their responsibilities are:

  1. Schimpeler-Corradino Associates - Development and calibration of the regional transportation model.

  2. PRC Engineering - Inventory and forecasts of tourist and commercial travel.

  3. Wilbur Smith and Associates - Preparation of the alternatives analyses and project documentation.

<u>Citizen Participation</u> - Citizen participation in Hali 2000 was an integral part of the overall project. The Citizen's Advisory Committee (CAC) in its role of providing public input at the administration level of OMPO was instrumental in identifying concerns and directing the implementation of a public input process. In addition to the CAC, a number of Policy Advisory Groups (PAG) were formed during the project to provide input regarding various technical and social issues. The PAGs were made up of citizens representing a broad range of private sector concerns and concentrated their work in five major areas; policies, travel forecasting, alternative-analysis, and tourist and commercial vehicle studies.

Additional citizen input was solicited through two series of public information meetings which were sponsored by OMPO in March and August, 1983. The first series of island-wide meetings was held for the purpose of receiving public comments on the transportation issues. The second series of meetings identified and asked for comments regarding the transportation alternatives developed in the Hali 2000 project.

HALI 2000 TRANSPORTATION GOALS AND OBJECTIVES

The desirability of alternative transportation systems or a potential transportation investment must be assessed in terms of the degree to which each achieves local community goals. Thus, locally-defined goals and objectives were one of the primary guidelines used in both the development and evaluation of alternative transportation plans. In the evaluation process, these goals and objectives provided the basis for defining the evaluation measures and information needs. The Hali 2000 goals and objectives are presented in the following listing.

TABLE 1-1

HALI 2000 TRANSPORTATION GOALS AND OBJECTIVES for the OAHU LONG-RANGE TRANSPORTATION PLAN UPDATE

I. Transportation Service

System Goal:

Develop and maintain Oahu's island-wide transportation system to ensure safe, convenient, and economical movement of people and goods.

Objective

#1: Increase peak period person-carrying capacities on Oahu highways through measures to encourage higher vehicle occupancies.

#2: Provide peak period transit service to Oahu commuters which is convenient and cost-effective.

#3: Provide off-peak highway and transit service to communities on Oahu in a cost-effective manner.

#4: Encourage adequate facilities for the movement of goods on Oahu.

#5: Encourage the availability of adequate public and private services between Waikiki, the airport, and other tourist destinations.

#6: Promote intermodal efficiency of harbor terminal facilities and land transportation systems.

#7: Promote intermodal efficiency of airport terminal facilities and land transportation systems.

#8: Ensure that handicapped, elderly, and economically disadvantaged persons have reasonable access to transportation services.

#9: Ensure user and community safety in the physical design and operation of new and existing transportation facilities.

#10: Ensure that Oahu's transportation system is planned, designed and operated in a cost-effective manner.

II. Quality of Life

System Goal:

Develop and maintain Oahu's transport system in a manner which maintains environmental quality and community cohesiveness.

Objective

#11: Develop and maintain Oahu's transportation system to meet noise, air, and water quality standards set by Federal and State agencies.

#12: Preserve Oahu's cultural integrity and scenic beauty including sea and mountain vistas.

#13: Encourage tho public and private sectors to participate in the development and maintenance of "low-energy" transportation facilities including bikeways, walkways, and other energy efficient elements which can be safely integrated with other transport modes.

#14: Ensure that energy availability and cost are considered in the development and maintenance of Oahu's transportation system.

#15: Encourage energy conservation in transportation.

#16: Minimize disruption of existing neighborhoods due to transportation system construction.

#17: Ensure that transportation facility design and maintenance are compatible with the planned physical and social character of new and existing developments.

#18: Develop transportation contingency plans for energy shortages, natural and man-made disasters, and other potential transportation emergencies.

III. Community Responsibility

System Goal:

Develop and maintain Oahu's transportation system in a manner that is sensitive to community needs and desires.

Objective

#19: Maintain and improve the transportation system to reinforce Oahu's planned population distribution and land use development policies through coordinated efforts of the public and private sectors.

#20: Encourage innovation in planning, design, and maintenance of transportation services and facilities that supports community goals.

#21: Base transportation improvements for Oahu on a cooperative, comprehensive and continuing planning process with emphasis on community involvement.

#22: Encourage public-private partnerships to provide transportation services.

#23: Maintain and improve Oahu's transportation system in a manner consistent with Federal requirements and regulations.

IV. Demand Management

System Goal:

Develop a travel demand management system for Oahu which optimizes use of existing transportation resources.

Objective

#24: Encourage increases in system-wide ride-sharing on Oahu.

#25: Encourage increases in public transportation ridership.

#26: Encourage reductions in single occupancy vehicle travel during peak periods, particularly in the primary urban center.

CHAPTER 2

EXISTING LAND USE AND TRANSPORTATION CONDITIONS

The Hali 2000 Study utilized the year 1980 as its baseline year for projecting future demand for transportation services. This chapter summarizes the 1980 land use and transportation information which was utilized in identifying Oahu travel characteristics, in projecting future levels of demand, and in formulating specific transportation alternatives to meet that demand.

EXISTING LAND USE AND SOCIO-ECONOMIC CONDITIONS

As mandated by the 1973 Charter of the City and County of Honolulu, the island of Oahu has been divided into eight Development Plan Areas. A Development Plan has been adopted by City ordinance to regulate future land development and coordinate the construction of public facilities within each of the eight areas. The Development Plan Areas are identified in Figure 2-1.

In recognition of the role of the Development Plans (DPs) in guiding future land development on Oahu, the Hali 2000 project utilized them as the basic geographical areas for the analysis and presentation of existing land usage and socio-economic conditions.

Existing Land Use

Land use characteristics of the eight Development Plan Areas range from the intensely urbanized Primary Urban Center to the rural expanses of the North Shore and Koolauloa areas. An overview of the existing land use characteristics within each Development Plan Area is presented in the following sections. A more detailed description is included in the Technical Working Paper "Existing Land Use Conditions".

Primary Urban Center - Extending from Waialae-Kahala to Pearl City, this area contains the majority of the Oahu population and employment sites within its 63,631 acres (17 percent of Oahu's total land area). The urban land uses, military areas, and public facilities are located in the coastal area or valleys, while approximately 40 percent of the area is undeveloped or preservation lands on the slopes of the Koolau Range.

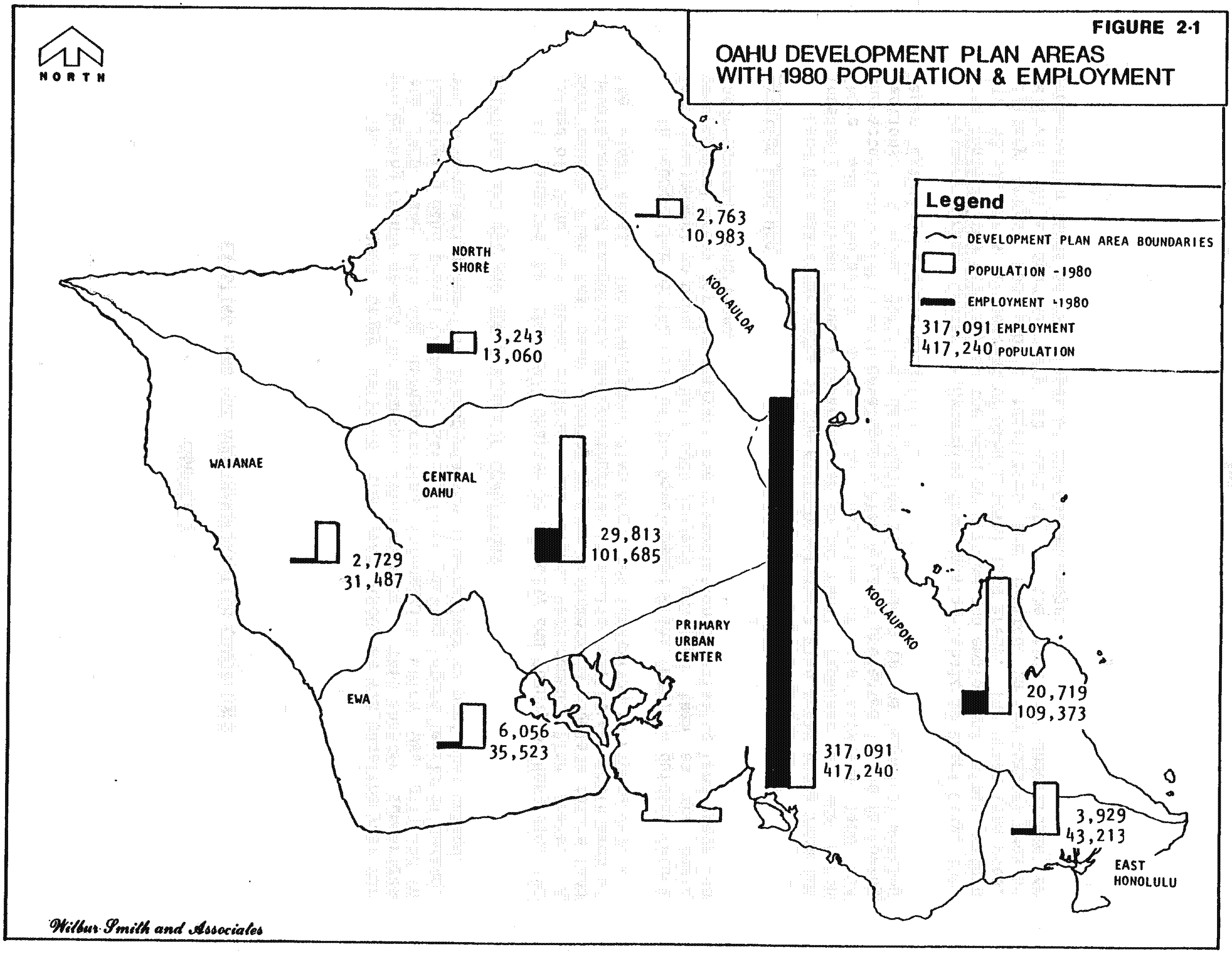


FIGURE 2-1
OAHU DEVELOPMENT PLAN AREAS WITH 1980 POPULATION & EMPLOYMENT

Within the Primary Urban Center, the Downtown area contains the State and City governmental centers as well as the major concentration of office and commercial uses on Oahu, while approximately 30,000 of Oahu's 34,000 resort/hotel accommodation units are located in the Ala Moana and Waikiki areas. Other major employment centers include the Honolulu International Airport, Port of Honolulu facilities, University of Hawaii, Kakaako and Mapunapuna areas as well as the Pearl Harbor Naval Base, Hickam Air Force Base and Fort Shafter military installations.

Ewa - The Ewa area is located in southwestern Oahu, situated between the western edge of Pearl Harbor and Kahe Point on the Waianae coast. Containing 32,593 acres, Ewa is the second smallest Development Plan Area. As established in the 1982 Revised General Plan, the West Beach-Makakilo portion of Ewa is intended for gradual development as the island's Secondary Urban Center.

This planned growth is in sharp contrast with the area's existing land use. Approximately 45 percent of the area is used for agricultural purposes and 21 percent is vacant, with the agricultural lands considered to be among the finest in the state. Development and population growth in this area is expected to center upon the on-going development of a deep-draft harbor at Barbers Point, the planned resort complex at West Beach, and continued growth in the communities of Ewa, Ewa Beach and Makakilo. The area also includes the Barbers Point Naval Air Station and Campbell Industrial Park.

Central Oahu - With an area of 68,050 acres, Central Oahu is the second largest Development Plan Area on the island. Situated on a broad fertile plain that stretches between the Koolau and Waianae mountain ranges, the area is principally divided among agriculture, military and preservation uses.

The area includes three major low-density suburban communities--Waipahu, Mililani and Wahiawa--which generate a significant volume of daily traffic to the employment centers in the Primary Urban Center. The area also includes Schofield Army Barracks and Wheeler Air Force Base.

East Honolulu - This is the smallest of the eight areas with just over 14,000 acres. It is considered residential in character, although the vacant, preservation or park uses on the steep slopes of the Koolau Mountain Range comprise 80 percent of its land area. The East Honolulu residential developments are concentrated along a single arterial highway -- Kalanianaole Highway -- and in Hawaii-Kai.

Koolaupoko - Koolaupoko, the southern portion of Windward Oahu, spans the area east of the Koolau Mountain Range from Makapuu Point to the northern end of Kaneohe Bay. Koolaupoko is comprised of two distinctive areas: the urbanized areas of Kaneohe, Kailua and Ahuimanu; and the rural area extending north from Kahaluu to Kualoa. The Kaneohe-Kailua urban center constitutes the second largest resident population on the island, with a 1980 population of 109,373 residents. The area includes several military installations and extensive commercial uses. Conversely, the northern section is comprised largely of preservation, agricultural and vacant areas with the resident population located along the coastal highway.

Koolauloa - Koolauloa, which encompasses the northern half of the Windward coast, is the most sparsely populated area on Oahu. The rural character is enhanced by the preservation, agricultural and vacant lands that comprise 92 percent of its 37,000 acres. The most significant urban uses are in the resort-visitor oriented developments in the Kuilima (Turtle Bay) and the Laie areas. The Laie area, which includes the Polynesian Cultural Center and Brigham Young University of Hawaii, is a major visitor destination area.

North Shore - The North Shore region is Oahu's largest Development Plan Area with 75,845 acres of land. The North Shore exhibits a rural character, approximately 95 percent of its area in agricultural and preservation uses, or vacant. The major residential and commercial uses are located in the communities of Haleiwa and Waialua.

Waianae - Located along the coastline between Kahe Point and Kaena Point, Waianae contains approximately 10 percent of the island's total land area. Waianae is largely rural in character with over 80 percent of its area in preservation, military reservation and agricultural uses, or vacant. The developed areas are primarily located in communities along the coastal highway -- Nanakuli, Maile, Waianae and Makaha.

Population and Household Characteristics

Oahu resident population(1) totaled 762,565 persons in 1980, with the majority of population located within the Primary Urban Center. The resident population and household characteristics are listed in Table 2-1 by Development Plan area.

Population - Some 417,240 persons,(2) or 54.7 percent of the resident Oahu population, resided within the Primary Urban Center in 1980. The Primary Urban Center, combined with the urbanized areas of the Koolaupoko area (14.3 percent) and Central Oahu area (13.4 percent), house 82 percent of Oahu residents. The most sparsely populated Development Plan Areas, Koolauloa and North Shore, each accommodate approximately one percent of the Oahu population.

Households - Oahu households numbered 230,214 in 1980, with an average household size of 3.16 persons.(3) Distribution of household size by Development Plan area for 1980 is presented in Table 2-1. The Primary Urban Center, with 60 percent of Oahu households, has the lowest household size. Single or two-member households, many of which are housed in the large proportion of multi-family dwellings in this area, make up 51 percent of all Primary Urban Center households.

---

(1)The term "resident" is used to describe year-round population of Oahu, which includes military personnel and dependents stationed on Oahu. Tourists and transient military personnel are excluded from the resident population statistics.

(2)City Department of General Planning, Land Use Forecast, May 19, 1983.

(3)City Department of General Planning, Land Supply Review, July 1983.

TABLE 2-1

OAHU RESIDENT POPULATION CHARACTERISTICS

Hali 2000 Study

DEVELOPMENT PLAN AREA	RESIDENT POPULATION		HOUSEHOLDS		AVERAGE HOUSEHOLD INCOME	AUTOMOBILES AVAILABLE TO HOUSEHOLD		
	Number	Percent of Total	Number	Average Size		None	One	Two or More
Primary Urban Center	417,240	54.7	138,297	3.02	$23,500	17,578	65,222	55,497
Ewa	35,585	4.7	8,967	3.97	19,600	641	3,682	4,644
Central Oahu	101,685	13.4	26,354	3.86	22,400	2,188	11,160	13,006
East Honolulu	43,213	5.7	12,898	3.35	45,700	708	4,707	7,483
Koolaupoko	109,373	14.3	29,148	3.75	29,000	1,852	11,266	16,030
Koolauloa	10,983	1.4	2,688	4.09	21,300	200	1,162	1,326
North Shore	13,061	1.7	3,898	3.35	21,300	362	1,821	1,715
Waianae	31,487	4.1	7,964	3.95	18,200	894	3,913	3,157
TOTAL	762,565	100.0	230,214	3.16	25,200	24,423	102,933	102,858

Income - Household income averaged approximately $25,200.(4) The average household income for each Development Plan area is presented in Table 2-1. Of particular interest is the relatively high average household income associated with the East Honolulu area. Removing East Honolulu from consideration, the average household income for Oahu would approximate $22,000.

Automobile Availability - As indicated in Table 2-1, approximately 24,400 Oahu households, or 10.6 percent of the total, did not have an automobile available to the household. The highest concentration of households without an automobile, both in terms of number and proportion (12.7 percent) of households, was the Primary Urban Center. With the exception of the Waianae area, 90 percent or more of the households in each of the other areas had an automobile available for use.

Highest automobile ownership occurs in the East Honolulu, Koolaupoko, and Ewa areas, where more than one-half of the households have two or more automobiles available.

Employment

In 1980, the civilian labor force totalled 338,900(5) persons. Actual civilian employment was 323,500, with 15,400 persons unemployed (4.5 percent).(6) The total civilian jobs were estimated at 355,200.(7)

For purposes of computer model forecasts, the Hali 2000 project classified jobs into three broad categories: retail, service and other. These categories are based upon job types as referenced in the 1972 Standard Industrial Classification. The distribution of retail, service and other jobs by Development Plan area are presented in Table 2-2, which includes self-employed persons.

Oahu's job market is predominantly service oriented, which contributes 222,367 jobs, or 58 percent of the total. Jobs in retail amount to 19 percent of the total, while the proportion of jobs in other categories (agriculture, manufacturing, construction, etc.) contribute 23 percent.

---

(4)U.S. Bureau of the Census, 1980 Census.

(5)City Department of General Planning, Land Supply Review, Table 277, July 1983.

(6)Ibid., Table 261.

(7)State Department of Planning and Economic Development, Data Book, 1981, Table 248.

TABLE 2-2

1980 OAHU EMPLOYMENT BY DEVELOPMENT PLAN AREA

Hali 2000 Study

DEVELOPMENT PLAN AREA	EMPLOYMENT				
	Retail	Service	Other	Combined	Percent of Total
Primary Urban Center	60,034	196,575	60,482	317,091	82.1
Ewa	726	1,533	3,797	6,056	1.6
Central Oahu	6,598	8,032	15,183	29,813	7.7
East Honolulu	834	2,913	182	3,929	1.0
Koolaupoko	4,333	8,315	8,071	20,719	5.4
Koolauloa	141	2,369	253	2,763	0.7
North Shore	346	593	2,304	3,243	0.8
Waianae	410	2,037	282	2,729	0.7
TOTAL	73,422	222,367	90,554	386,343	100.0

As indicated in Table 2-2 and Figure 2-1, Oahu employment is concentrated within the Primary Urban Center. Approximately 82 percent of the Oahu jobs are located within the Primary Urban Center, as compared to 54 percent of the population.

TRAVEL CHARACTERISTICS

In forecasting vehicular travel on Oahu, three principal components were analyzed separately in recognition of their differing characteristics. These are: personal travel by residents; intra-island travel by tourists; and commercial truck travel. Travel characteristics for these have been observed and analyzed as a part of a number of surveys conducted on the island over the past three years, including:

- o Information on travel by residents was obtained from a random sample of 1,400 households during November 1981. Weekday travel was recorded for all household members.(8)

---

(8) Schimpeler-Corradino Associates, Oahu Model Update Study, Volume 1, prepared for OMPO, December 1982.

- Tourist travel was investigated in surveys conducted in 1983.(9)
- Transit usage was studied in on-board bus surveys made in October 1983.(8)
- Data on commercial vehicles was obtained in November 1983.(10)

In addition, traffic data were obtained from the files of routine traffic counts made by State and City staff on major roadways. Further insights into local travel characteristics were derived from the 1980 Census and 1982 State of Hawaii Data Book.

Resident Travel

Transportation planners have found through previous research and surveys that land use is a major determinant of urban travel. The household is regarded as the basic generator of trip making, while other land uses are considered as attractors of trips. Trip making for each land use is associated with a limited number of trip purposes, each of which has individual characteristics, such as average trip length and travel mode. The term "trip" as used here, refers to one leg of a journey between an origin and a destination, made for a specific purpose by a person via a motorized vehicle. Motorized vehicles may include buses, vans, trucks, automobiles or motorcycles.

Households - Based on 1981 household travel surveys, the average Oahu household generates 9.4 person trips per average weekday. The average household resident makes 3.0 trips per day.

In order to isolate major differences in travel behavior, resident travel on Oahu was subdivided into six trip purposes, five of which are home-based and one is nonhome-based. Home-based trips refer to trips which either begin or end at home. Nonhome-based trips both start and end at locations other than home. The estimated distribution of 1980 person trips by purpose is given in Table 2-3, together with average trip lengths. The data shown was derived from the OMPO travel simulation models, which in turn were based on the 1981 survey data.

---

(8) Schimpeler-Corradino Associates, Oahu Model Update Study, Volume 1, prepared for OMPO, December 1982.

(9) PRC Voorhees, Tourist Travel Study in Honolulu (Draft), prepared for OMPO, November 1983.

(10) PRC Voorhees, Commercial Vehicle Study in Honolulu (Draft), prepared for OMPO, November 1983.

TABLE 2-3

1980 OAHU RESIDENT PERSON TRIPS BY PURPOSE

Hali 2000 Study

TRIP PURPOSE	WEEKDAY PERSON TRIPS	PERCENT OF TOTAL	AVERAGE TRAVEL DISTANCE (miles)
Home-Based Work	357,600	16.5	7.3
Shop	165,300	7.6	4.0
Soc-Rec	221,100	10.2	6.4
School	228,600	10.5	4.6
Other	413,600	19.0	6.1
Nonhome-Based	786,500	36.2	4.0
All	2,172,700	100.0	5.2

SOURCE: OMPO Trip Generation Model (July 22, 1983) and Distribution Model August 9, 1983) Output for 1980 travel.

As the data show, the mean trip lengths differ considerably by trip purpose, reflecting the trade-off between the distance which residents are willing to travel to satisfy their trip purpose objectives, and the availability of opportunities which satisfy these objectives. For example, at the extreme ends of the spectrum are work trips for which residents are willing to travel an average of 7.3 miles, versus shopping trips which averaged only 4.0 miles.

Mode Choice - Once an Oahu resident has selected a trip destination, his next decision involves whether to make the trip as an auto driver or passenger, or to take TheBus. Among factors likely to influence his choice of travel mode are availability of an automobile, cost, travel time, and relative convenience and suitability of each mode for various trip purposes. Estimates were made of the 1980 mode choices of Oahu residents by trip purpose, based on the 1981 household survey data. In order to develop estimates of vehicular traffic, the person trips were grouped into vehicle occupancy categories, based on information obtained in the surveys.

As shown in Table 2-4 for home-based work trips, approximately 304,200 residents make their daily trips by auto. Of these, about 213,600 drive alone, about 65,500 travel two-in-a-car, while some 25,100 make the journey in autos carrying three of more persons. The net result is approximately 253,800 vehicle trips, with an overall average occupancy of 1.20 persons per vehicle. In addition, almost 53,400 residents travel to and from work by transit, giving TheBus a 14.9 percent share of total person trips for this purpose.

The transit share is highest (18.8 percent) for school trips and relatively low (roughly 5 percent) for other home-based and nonhome-based categories. For all purposes combined, the transit share is shown to be 8.2 percent of total person tripmaking on a typical 1980 weekday.

TABLE 2-4

1980 AVERAGE WEEKDAY RESIDENT TRIPS BY PURPOSE AND MODE

Hali 2000 Study

TRIP PURPOSE	TRAVEL MODE [a]	PERSON TRIPS	VEHICLE TRIPS	AVERAGE PERSONS PER VEHICLE	PERCENT TRIPS BY TRANSIT
Home-Based Work	Auto 1	213,644			
	Auto 2	65,492			
	Auto 3+	25,100			
	Subtotal	304,236	254,000	1.20	
	Transit	53,400			14.9
Home-Based School	Auto 1	29,365			
	Auto 2	46,988			
	Auto 3+	92,455			
	Subtotal	168,808	76,000	2.22	
	Transit	39,100			18.8
Home-Based Other [b]	Auto 1	238,480			
	Auto 2	268,252			
	Auto 3+	252,621			
	Subtotal	759,353	447,000	1.70	
	Transit	40,570			5.1
Nonhome-Based	Auto 1	298,855			
	Auto 2	274,438			
	Auto 3+	170,349			
	Subtotal	743,642	539,000	1.38	
	Transit	42,823			5.4
Total	Auto 1	780,344			
	Auto 2	655,170			
	Auto 3+	540,525			
	Subtotal	1,976,039	1,316,000	1.50	
	Transit	175,952			8.2

SOURCE: OMPO Mode Choice Model Output.

[a] "Auto 1" denotes driver only; "Auto 2" denotes driver with one passenger; "Auto 3" denotes driver with 2 or more passengers.

[b] Includes home-based shopping social-recreation and other purposes.

Geographic Distribution - The geographic distribution of residents' travel, by transit and auto modes, is summarized in Table 2-5. Both person trips via transit and auto vehicle trips show very similar patterns of geographic distribution. For both modes, more than 70 percent of the trip ends are located in the Primary Urban Center. The second highest concentration is Koolaupoko, with approximately 10 percent of total trips in each mode, followed by Central Oahu, which accounts for about 8.5 percent. The remaining five Plan Areas each generate smaller amounts.

Tourist Travel

Several surveys were conducted during 1983 to develop a profile of current travel characteristics of Oahu tourists. These included trip generation surveys undertaken at several hotels and condominiums, supplemented by surveys at the Airport to intercept visitors staying with friends or relatives. Additional surveys were undertaken at a number of major tourist destinations.

Results of the surveys indicate that the typical Oahu tourist makes approximately four trips per day, two on foot and two by motorized vehicle. Of the vehicle trips, about 54 percent are made in rental cars; 28 percent by tour bus or van, and the remaining 18 percent by TheBus. Weekday tourist travel for 1980 is estimated to consist of approximately 32,700 auto trips plus 28,700 transit trips.

TABLE 2-5

1980 DAILY RESIDENT TRIPS BY DEVELOPMENT PLAN AREA

Hali 2000 Study

	AUTO VEHICLE TRIPS[(a)]		PERSON TRIPS BY TRANSIT	
DEVELOPMENT PLAN AREA	Number	Percent of Total	Number	Percent of Total
Primary Urban Center	929,100	70.6	124,400	70.7
Ewa	34,100	2.6	4,250	2.4
Central	111,450	8.5	14,900	8.5
East Honolulu	47,900	3.6	6,850	3.9
Waianae	34,850	2.6	4,450	2.5
North Shore	15,250	1.2	1,600	0.9
Koolauloa	13,150	1.0	1,650	0.9
Koolaupoko	130,200	9.9	17,900	10.2
Total	1,316,000	100.0	176,000	100.0

(a) Auto trips include vans and pickup trucks used for personal transportation.

Survey results also revealed that the significance of tourist trips as a factor in transportation planning is limited, because the magnitudes are relatively small (only about 3 percent of the vehicle trips and 15 percent of transit trips) and most take place during off-peak times. The surveys indicated that only about 3 percent of total daily tourist travel took place during the 7:00 - 8:00 AM travel period.

Commercial Vehicle Travel

Commercial vehicle trips are defined as truck travel made as part of a business activity. Counts of commercial vehicles were made at twenty-seven selected locations throughout Oahu as part of the OMPO surveys during the winter of 1983. Trucks include pickups, vans in commercial use, single-units and trailer combinations.

Survey results indicated that commercial vehicles typically make up 10-15 percent of the vehicle flow at most locations. Unusually high proportions of trucks occur at selected places where commercial/industrial activity is intense, such as the Campbell Industrial Park (33 percent trucks) and the Sand Island Access (23 percent trucks). An average daily total of 188,700 commercial vehicle trips was estimated for 1980.

Total Daily Travel

Each of the components of daily travel described above combines to make up the pattern of vehicular traffic flows and transit usage on Oahu. The resultant major travel corridors on Oahu are identified in Figure 2-2. For purposes of this regional study, the analysis and presentation of travel data within each corridor is made at a series of screenline locations where the roadway capacities, traffic volumes and transit usage are presented as totals for all major routes and transit lines serving corridor travel at each screenline. The dimensions of daily travel at these screenlines are given in Table 2-6. These data show total daily person trips, daily vehicles, peak directional flows, ratios of peak hour volumes to the design service volume and weekday transit usage.

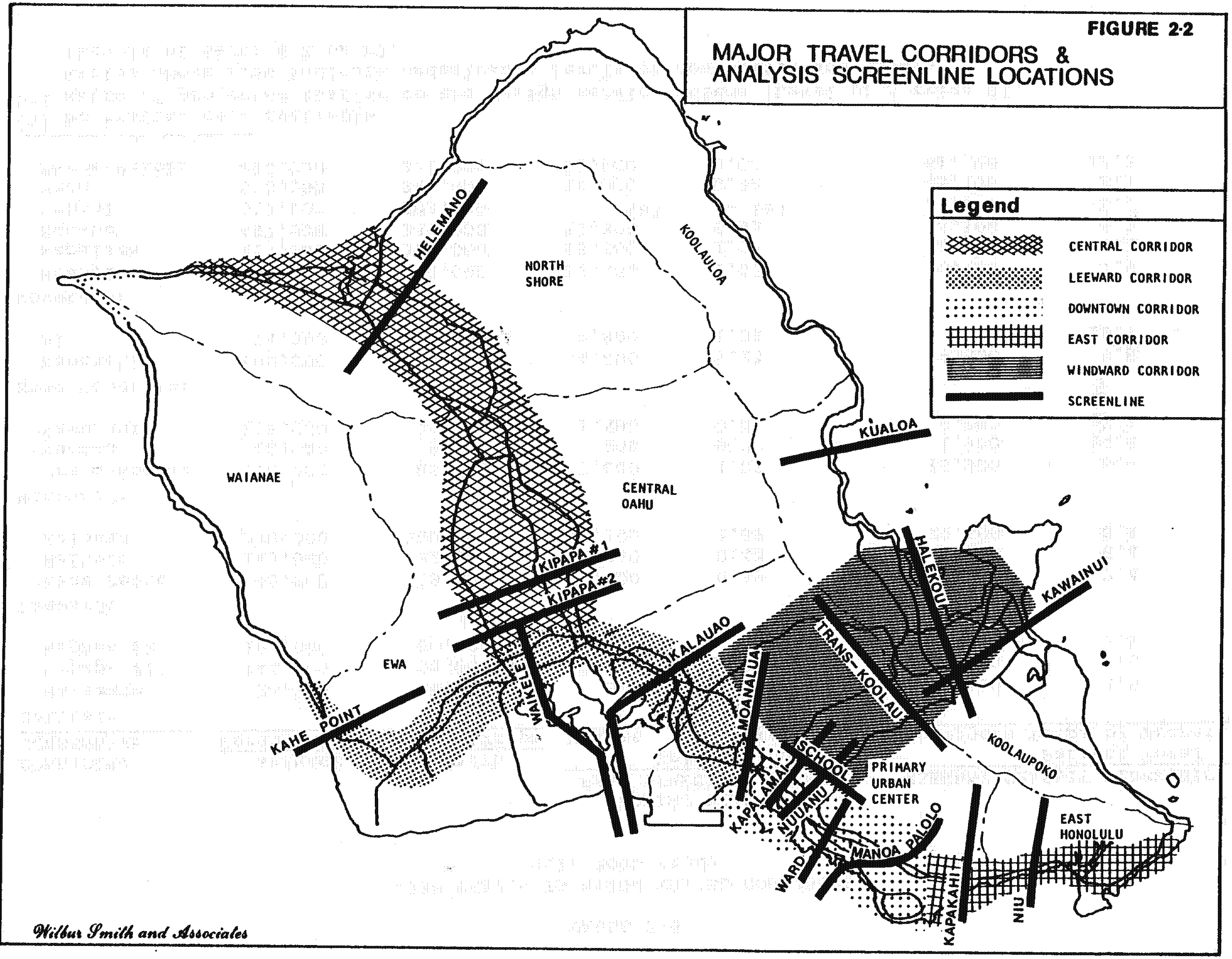
Review of the tabulated data reveals that the greatest daily travel occurs in the Downtown travel corridor, where average daily person trips are in the magnitude of 500,000, resulting in vehicle flows in the range of 320,000 to 350,000. Daily vehicle flows of about 200,000 occur in the Leeward Corridor at the Kalauao Screenline, but traffic in that corridor declines at points further westward. In the Windward Corridor, traffic increases as it moves toward the Trans-Koolau routes, reaching an estimated daily flow of 85,000 vehicles at the Trans-Koolau screenline.

In the Central Oahu corridor, traffic is greatest at the southern end, reaching about 80,000 vehicles per day at the lower Kipapa screenline. At the northern end, near Helemano, the daily volume is about 16,000.

The East Honolulu corridor has substantial traffic flows which increase from about 43,000 per day at Niu to 65,000 at the Kapakahi Stream crossing.

FIGURE 2-2

MAJOR TRAVEL CORRIDORS & ANALYSIS SCREENLINE LOCATIONS



AR00050214

TABLE 2-6

1980 TRAVEL IN MAJOR TRAVEL CORRIDORS
Hali 2000 Study

CORRIDOR/ SCREENLINE	AVERAGE DAILY TRAVEL		MORNING PEAK HOUR PEAK DIRECTION TRAFFIC		WEEKDAY TRANSIT RIDERSHIP	
	Person Trips	Vehicle Trips	Volume	Volume-Capacity Ratio(b)	Passengers	Percent Total Trips by Transit
Central:						
Helemano	28,000	16,000	800	0.51	2,100	7.5
Kipapa #1	144,000	58,000	3,800	0.58	8,400	5.8
Kipapa #2	162,000	80,000	- (a)	- (a)	9,400	5.8
Leeward:						
Kahe Point	46,000	19,000	1,400	0.69	3,400	7.4
Waikele	145,000	82,000	4,000	0.44	9,300	6.4
Kalauao	330,000	200,000	12,100	1.07	22,600	6.8
Windward:						
Trans-Koolau	178,000	85,000	7,000	1.03	15,900	8.9
Kualoa	13,000	8,000	200	0.27	1,900	14.6
Kawainui	115,000	45,000	1,400	0.44	8,200	7.1
East Honolulu:						
Kapakahi	100,000	65,000	4,800	1.23	9,800	9.8
Niu	74,000	43,000	2,800	1.08	7,900	10.7
Downtown:						
Moanalua	365,000	254,000	12,400	1.07	28,700	7.9
Kapalama	417,000	328,000	15,300	1.07	38,000	9.1
Nuuanu	497,000	342,000	17,300	0.92	34,100	6.9
School	317,000	203,000	- (a)	- (a)	27,300	8.6
Ward	520,000	348,000	14,000	0.78	45,100	8.7
Manoa-Palolo	496,000	321,000	12,900	0.60	61,200	12.3

(a) No traffic data available.
(b) Ratio of projected traffic to the design service volume (Level of Service D). Ratios above 1.00 indicate undesirable levels of congestion and delays (Levels of Service E or F).

Peak traffic volumes and roadway volume-capacity ratios are measures of special interest in transportation planning, since they indicate the ability of existing facilities to accommodate present traffic demand at acceptable travel conditions (Level of Service D).(11) The data reveals several screenline locations where present peak traffic exceeds the design service volume (Level of Service D) of the corridor roadways or is approaching it. Among the most serious conditions are those in East Honolulu at Kapakahi, in the Downtown corridor at Kapalama, in the Leeward corridor at Kalauao, and in the Windward corridor at the Trans-Koolau screenline.

Transit - Daily transit ridership and estimated share of total person trips is presented in Table 2-6 for the count locations in each travel corridor. As might be expected, the greatest volumes of transit ridership occur in the Downtown corridor, where daily passenger volumes range in the magnitude of 30,000 to 60,000 and the estimated transit share of total person travel ranges from about 7 to over 12 percent.

In the Leeward corridor, transit carries about 6.5 to 7.5 percent of total person trips. Transit ridership increases from 3,400 near Kahe Point to 22,600 at Kalauao. In the Windward corridor, transit serves 7.1 to 14.6 percent of total person travel. Maximum ridership is 15,900 at the Trans-Koolau screenline. In the East Honolulu corridor, patronage is 8,000 to 10,000 riders, a share of roughly 10 percent of total travel. In the Central corridor, public transit patronage increases toward the south, from 2,100 to 9,400 daily riders, but the transit share declines from 7.5 percent to 5.8 percent towards the south due to an increase in total travel volumes.

Access to transit service is good in all travel corridors. It is estimated that ninety-five percent of the population in urbanized areas of Oahu reside within a quarter-mile walking distance of the system.(12)

Information on TheBus system and a summary of operating statistics for Fiscal Year 1982 is given in Table 2-7. The system is shown to employ 1,121 people who operate 358 buses on 46 routes. Some 16,816,000 vehicle miles and 1,102,000 vehicle hours of service were furnished during the year. Among the performance statistics given, it is noted that total passenger revenue of $18,121,000 defrayed about 38 percent of total operating expenses $47,647,000, leaving an operating deficit of $29,526,000 in Fiscal Year 1982.

---

(11)See Level of Service descriptions in Appendices.

(12)Parsons Brinckerhoff Quade & Douglas, Bus Systems Planning Study, prepared for City and County of Honolulu, May 1980.

TABLE 2-7

TheBus TRANSIT OPERATING STATISTICS
FISCAL YEAR 1982

Hali 2000 Study

ITEM	AMOUNT
SYSTEM	
No. of Routes	46
Number of Buses	398
Number of Employees	1,121
Vehicle Hours in Service	1,102,000
Vehicle Miles in Service	16,816,000
PASSENGERS	
Total Passengers (Unlinked)	73,835,000
Initial Boarding Passengers (Linked)	65,238,000
Revenue Passengers	55,630,000
Annual Average Daily Passengers (Unlinked)	202,300
PERCENT OF TOTAL PASSENGERS	
Adults	53
Students & Children	22
Senior & Handicapped	13
Transfer	12
Total Passengers Per Vehicle Mile in Service	4.4
Total Passengers Per Vehicle Hour in Service	67.0
FARE REVENUE	
Average Fare/Revenue Passenger	$0.326
Average Fare/Total Passenger	$0.245
Total Passenger Revenue	$18,121,000
OPERATING EXPENSE	
Total Operating Expense	$47,647,000
Total Operating Expense/Vehicle Mile in Service	$ 2.83
Total Operating Expense/Vehicle Hour in Service	$43.24
Total Operating Expense/Rev. Passenger	$0.856
Total Operating Expense/Total Passenger	$0.645
OPERATING DEFICIT	
Total Operating Deficit	$29,526,000
Average Operating Deficit/Revenue Passenger	$0.531
Average Operating Deficit/Total Passenger	$0.400
OPERATING RATIO	
Passenger Revenue Coverage of Total Operating Expense	38.0%

According to a route profile study(13) conducted in 1980 for the City and County of Honolulu Department of Transportation Services, over eighty percent of TheBus routes experienced standing loads during the peak half hour. In addition, over half of all of the routes carried more than 74 passengers during the peak half hour; a majority of these were overloaded to the point where potential passengers had to be passed up at bus stops.

The operating fleet size has increased by approximately 50 buses since 1980. The City's Short Range Transit Plan (SRTP) calls for an increase in passenger capacity of 16 percent by the end of Fiscal Year 1985, which should, in the short run, reduce some of the overcrowding on the current system.

---

(13)Ibid.

CHAPTER 3

YEAR 2000 DEVELOPMENT POLICIES AND PROJECTIONS

Future travel demands and the resultant transportation system needs will reflect the location, type and magnitude of existing and future development on Oahu. In addition to the allocation of land uses, changing socioeconomic characteristics will also influence travel characteristics. These socioeconomic conditions which exert significant influence on travel growth include the number and size of households, household income, automobile ownership, and the employment characteristics of the various areas.

The land use development anticipated for Year 2000, based upon the City and County of Honolulu and State plans and policies, has been used to forecast the numbers and distribution of population and employment for the Year 2000. These forecasts, together with the forecast socioeconomic characteristics, have been used as input to the Hali 2000 transportation study to forecast travel demands for the Year 2000.

OAHU DEVELOPMENT PLANS AND POLICIES AFFECTING FORECASTS

Future land development on Oahu is regulated by a planning process comprised of three levels: the Oahu General Plan, eight area Development Plans, and the Comprehensive Zoning Code. The General Plan, adopted by resolution, establishes broad policies for the long range development of the City and County of Honolulu. These policies relate specifically to the distribution of social benefits, the desired use of land, the overall circulation pattern, and the most desirable population densities.

Pursuant to Section 5-409 of the City Charter, the Development Plans are "relatively detailed schemes for implementing and accomplishing the development objectives and policies of the general plan within the several parts of the City". In addition to setting standards and principles for land uses, urban design, and both public and private facilities, the Development Plans also provide the desirable sequence for development corresponding with "...the projected nature and rate of change in present conditions for the reasonable foreseeable future based upon a projection of current trends; and may forecast the probable social, economic and environmental consequences of such changes."(1) Adopted by ordinance, the Development Plans carry the weight of law as opposed to the General Plan which establishes policy guidelines.

---

(1)City Charter Section 5-409.

The third level of the planning process is the Comprehensive Zoning Code which contains the specific zoning regulations and permitting processes necessary to implement the provisions of land use contained in the Development Plans.

Because of their role in operationalizing the broad policies of the General Plan, the Development Plans represent the cornerstone of Oahu's land use planning process. Implicit to the Development Plans is an orientation to the Year 2000 in terms of land use allocation. Thus, the designation of land uses constitutes the assignment of general capacities based upon specific levels of density for each land use category. Although the assignment of capacity is independent of residential demand, capacity is estimated "on the assumption that it will meet the demand for residential development between now and the Year 2000."(2)

The Hali 2000 study's projections of future travel demand on Oahu utilize the Development Plan capacities as a major input variable. Consequently, the Development Plans provide the land use framework for future transportation planning as well as other public and private facilities and services.

The Development Plans are composed of three parts. The first part, Common Provisions, establishes the definitions, land use categories, standards, principles, controls, and processes for implementation and amendment for eight Development Plans. The second part, Special Provisions, vary in content with each of the Development Plans. Basically, the Special Provisions relate to specific design considerations such as height and density controls, and the identification of public views, open space, and special areas. Regarding the latter, the Special Provisions identify specific geographic areas within a particular Development Plan area and define principles and controls which are intended to regulate development in that area, including sequencing of development. The third part, Development Plan Maps, identifies and defines general land uses and planned public facilities utilizing a Land Use Map and Public Facilities Map for each of the eight Development Plan areas.

FORECAST SOCIOECONOMIC CONDITIONS

The forecasts of future land development and socioeconomic characteristics utilized in the Hali 2000 Long-Range Transportation Plan Update Study have been prepared by the Department of General Planning, City and County of Honolulu.

Population and Household Characteristics

The general methodology of the forecasting process is based upon a comparison of the supply of land planned for development as determined by adopted development plans, population and employment trends, and population

---

(2)Department of General Planning, Land Supply Review, July 1983, p.3.

guidelines in the General Plan. The analysis of land supply is documented in the Development Plan Land Use Analysis (DPLUA) published by the Department of General Planning in April 1980 and updated in the Land Supply Review of April 1982 and July 1983.

The Development Plan Land Use Analysis uses the II-F Series Population forecast by the State Department of Planning and Economic Development as its basis for population allocation. The Department of General Planning distributes the II-F Series' Year 2000 population projection for Oahu (917,400 residents) among the eight Development Plan areas. The Development Plan Land Use Analysis and the subsequent Land Supply Reviews establish the appropriate land use designation which can be translated into population capacities. These land use capacities and the present development policies of the City and County of Honolulu, as expressed in the Development Plans, provided the basis for the population inputs to the Hali 2000 travel forecasts.

Population - The population capacities, which result from the eight area Development Plans, have been used as a basic input to the Hali 2000 travel projections. Total population on Oahu for the Year 2000 is projected to increase by 20 percent over 1980, from 762,565 to 917,400 persons. Distribution of this population among the eight Development Plan Areas is presented in Table 3-1 and Figure 3-1. The Primary Urban Center would experience the largest numerical increase, 45,310 residents, or 11 percent above 1980.

With reference to relative growth, the development of a Secondary Urban Center in the Ewa area is expected to produce the largest percentage increase. The estimated 104 percent growth would increase the 1980 population of 35,523 by 36,960 residents. The other Development Plan Areas expected to grow at a rate greater than the average islandwide increase are the Waianae, Central Oahu and East Honolulu areas.

Households - The number of households on Oahu is projected to increase by 51,827 by the Year 2000; from 230,214 to 282,041. While the distribution of household sizes by Development Plan areas remains virtually unchanged when comparing 1980 to 2000, the distribution of the number of households among the Development Plan areas indicates a slightly greater increase for the Leeward area of Oahu.

Household Income - In the Year 2000, the City Department of General Planning projects the average household income to be about $42,590. The forecasts of year 2000 income levels by Development Plan area is presented in Table 3-1. Income was assumed to increase 1.7 percent per annum in 1981 dollars.

Automobile Availability - Increases in household income, in terms of real (constant) dollars, is expected to result in a corresponding increase in automobile ownership. The forecasts of automobile availability, as presented in Table 3-1, indicate that the number of households without an available automobile would decrease from 24,423 in 1980 to 19,789 in 2000. The proportion without an automobile available would decline from 10.6 percent in 1980 to 7 percent. The proportions of households without an automobile would amount to 8.9 percent in the Primary Urban Center and 4 to 5 percent in the other areas.

TABLE 3-1

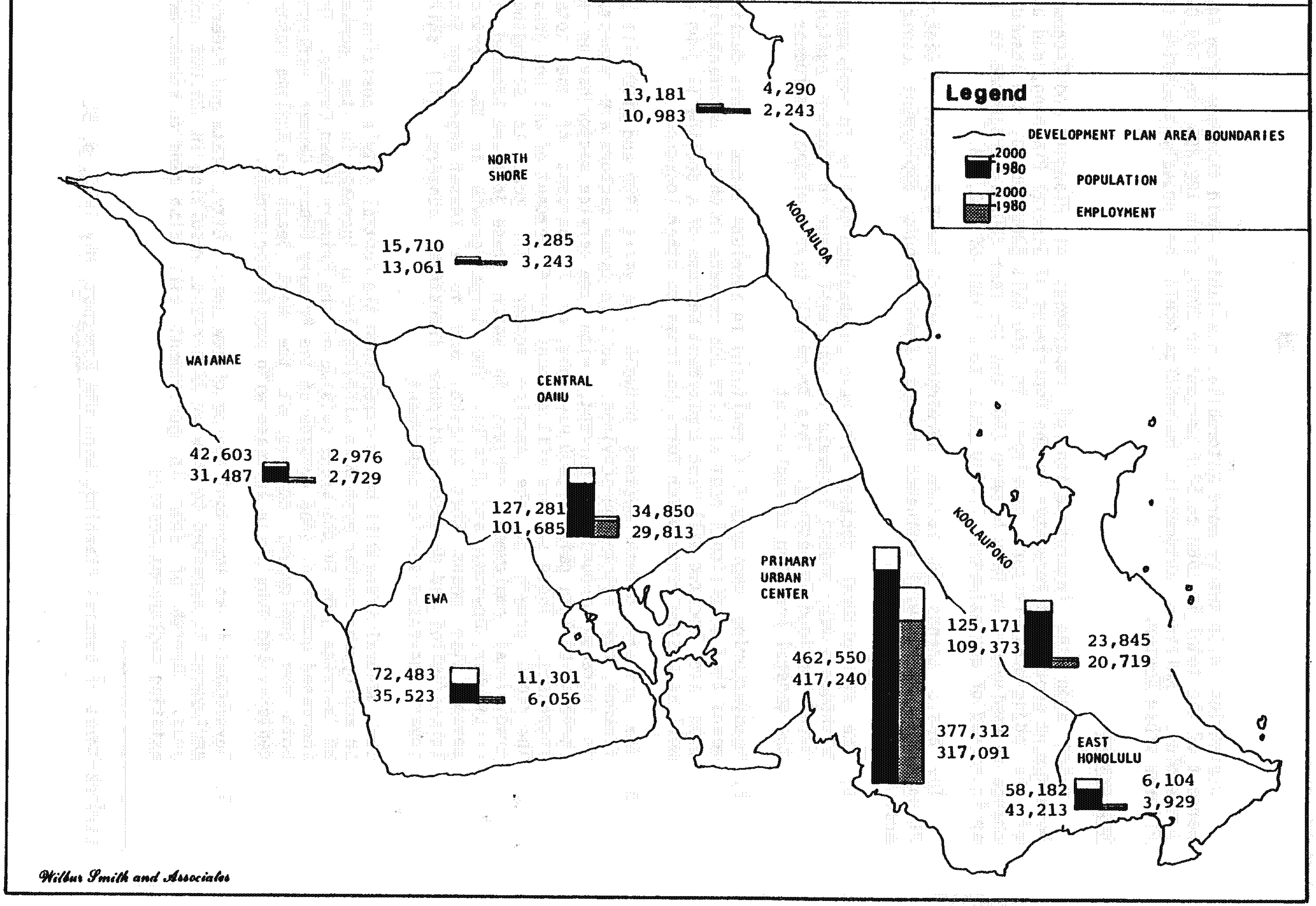
YEAR 2000 RESIDENT POPULATION CHARACTERISTICS

Hali 2000 Study

DEVELOPMENT PLAN AREA	POPULATION			HOUSEHOLDS			HOUSEHOLD INCOME	HOUSEHOLD AUTOMOBILE AVAILABILITY		
	1980	2000	Percent Increase	1980	2000	Percent Increase		None	One	Two Plus
Primary Urban Center	417,240	462,550	11	138,297	154,224	12	$39,840	13,749	67,368	73,097
Ewa	35,523	72,483	104	8,967	23,509	162	33,220	1,367	8,660	13,482
Central Oahu	101,685	127,281	25	26,354	33,788	28	37,970	1,992	12,805	18,990
East Honolulu	43,213	58,182	34	12,898	17,183	33	77,470	501	5,514	11,168
Koolaupoko	109,373	125,171	14	29,148	33,554	15	49,160	1,267	11,352	20,935
Koolauloa	10,983	13,181	20	2,688	3,345	24	36,100	161	1,292	1,892
North Shore	13,061	15,710	20	3,898	4,832	24	36,100	256	1,923	2,653
Waianae	31,487	42,603	35	7,964	11,606	46	30,850	496	4,299	6,812
TOTAL	762,565	917,400	20	230,214	282,041	23	42,590	19,789	113,213	149,029

FIGURE 3-1

CHANGE IN POPULATION AND EMPLOYMENT BY DEVELOPMENT PLAN AREA



Households with two or more automobiles available would increase from 44.7 percent of the total in 1980 to 52.8 percent in 2000, from 102,858 to 149,029 households. Multiple automobile households would be prevalent outside the Primary Urban Center.

Employment

Based upon the interpretation of Department of Planning and Economic Development employment forecasts by the Department of General Planning, and use of the adjustment factors developed in the Hali 2000 models, the absolute change in employment on Oahu between 1980 and the Year 2000 is projected to be an increased of approximately 77,600 jobs, to a total of 463,963.

The basic trends in future development which the Department of General Planning(3) believes will influence changes among Oahu's employment centers are:

1. The agricultural sector will have an absolute decline in employment, although a very modest increase in jobs will occur in "other agriculture" and food processing. This trend will have a minimal influence on the general location of employment.

2. Manufacturing employment is declining in absolute terms. This decline means that traditional central city job centers in which manufacturing jobs are located will lose employment because of a decline in jobs as well as rising rents which force business to other locations.

3. The primary growth sectors between the years 1980 and 2000 will be finance, real estate and services. Jobs in these sectors are expected to increase around 50 percent, with the service sector having the largest absolute gain (27,400 new jobs, or 31 percent of the total increase). These sectors will account for 45 percent of all new jobs. The rapid growth of the service sector will tend to strengthen traditional employment centers in which these jobs are located, in particular, Downtown and Waikiki. The large growth in the service sector also means that Kakaako, and to a lesser degree the Sand Island/Iwilei and Mapunapuna/Airport industrial centers, will shift toward increased service employment.

   The general trend will be to strengthen the central city's position as an employment center even when allowing for an increase in the number of service jobs in the areas outside of the Primary Urban Center. The increased number of jobs outside of the Primary Urban Center reflects both new employment centers at the West Beach and Kuilima resort centers, and jobs which increase with population growth.

4. Government is an important source of new jobs. City, State and Federal employment is expected to grow by 32 percent, resulting in 25,000 new jobs. Growth of jobs in government will also tend to strengthen existing employment centers.

---

(3)Department of General Planning, Land Use Forecast, May 1983, p. 5.

The distribution of employment among the eight Development Plan Areas is presented in Table 3-2, together with a comparison to the 1980 employment in each of the eight areas. The largest number of the new jobs is expected to occur in the Primary Urban Center, with an increase of 60,221 jobs out of the total Oahu increase of 77,620 jobs. The Ewa area is forecast to have the largest proportional increase in employment, although the 86.7 percent increase is from a comparatively low employment base. Large percentage increases are also anticipated for both the Koolauloa (Turtle Bay - Laie) and East Honolulu areas.

FUTURE TRAVEL DEMANDS

The estimates of travel demands for the Year 2000 were forecast based upon the Year 2000 land use plans, population projections and anticipated socioeconomic conditions. For residential travel, the travel forecasting process utilized the computerized regional travel demand model, as developed by the Oahu Metropolitan Planning Organization for the Hali 2000 Study. The discussion of residential travel in this chapter is limited to the general number and purpose of person trips projected for an average weekday in the Year 2000. The number of person trip origins and destinations forecast for each Development Plan Area is also presented. Choice of travel mode and travel volumes in Year 2000 are not discussed in Chapter 3 since these are dependent upon the future transportation system. Travel volumes by mode are presented in Chapter 6 for the Committed System and the transportation alternatives.

Tourist travel and commercial vehicle trips were projected separately from residential travel. Projection of the number and travel mode of tourist trips are based upon the number of tourists and types of accommodations anticipated for year 2000. Commercial vehicle travel is a function of the economic activity indicated by the projected levels of resident and visitor travel.

TABLE 3-2

YEAR 2000 EMPLOYMENT

Hali 2000 Study

DEVELOPMENT PLAN AREA	EMPLOYMENT 1980	EMPLOYMENT 2000	INCREASE 1980 - 2000 Number	INCREASE 1980 - 2000 Percent
Primary Urban Center	317,091	377,312	60,221	19.0
Ewa	6,056	11,301	5,245	86.7
Central Oahu	29,813	34,850	5,037	16.9
East Honolulu	3,929	6,104	2,175	55.4
Koolaupoko	20,719	23,845	3,126	15.1
Koolauloa	2,243	4,290	1,527	68.1
North Shore	3,243	3,285	42	1.3
Waianae	2,729	2,976	247	19.1
TOTAL	386,343	463,963	77,620	20.1

Resident Trips

Weekday person trips are projected to increase by more than 25 percent, from approximately 2,172,700 in 1980 to a total of 2,726,500 in 2000. These trip totals represent those person trips made by motor vehicles, regardless of the choice of travel mode. The number of person trips by trip purpose is presented in Table 3-3.

The increases in resident travel is expected to vary greatly for the eight Development Plan Areas, which reflects the distribution of population and economic growth within the areas. The estimated changes in the number of resident trips generated in each zone is listed in Table 3-4. The largest

TABLE 3-3

RESIDENT TRIPS BY PURPOSE
Hali 2000 Study

TRIP PURPOSE	1980 PERSON TRIPS	2000 PERSON TRIPS	PERCENT INCREASE
Home-Based Work	357,600	461,600	29.1
Home-Based Shopping	165,300	205,600	24.4
Home-Based Social/Recreation	221,100	284,900	28.9
Home-Based School	228,600	244,300	6.9
Home-Based Other	413,600	518,100	25.3
Non Home-Based	786,500	1,012,000	28.7
TOTAL	2,172,700	2,726,500	25.5

TABLE 3-4

RESIDENT TRIP GENERATION BY DEVELOPMENT PLAN AREA
Hali 2000 Study

PLANNING AREA	1980 DAILY PERSON TRIPS	2000 DAILY PERSON TRIPS	PERCENT INCREASE
Primary Urban Center	1,364,500	1,569,200	15.0
East Honolulu	107,300	145,800	35.9
Ewa	79,100	207,400	162.2
Central Oahu	227,700	305,800	34.3
Waianae	71,100	98,700	38.8
North Shore	23,000	38,900	69.1
Koolauloa	31,400	33,200	5.7
Koolaupoko	268,600	327,500	21.9
TOTAL	2,172,700	2,726,500	25.5

increase in trip generation is projected for the Ewa area, with almost a threefold increase in weekday trips. Conversely, the smallest increases are projected for the Koolauloa, Primary Urban Center and Koolaupoko areas. Resident trips for the other areas are projected to increase by between 34 and 69 percent. Relative changes for each of the eight areas are depicted in Figure 3-2.

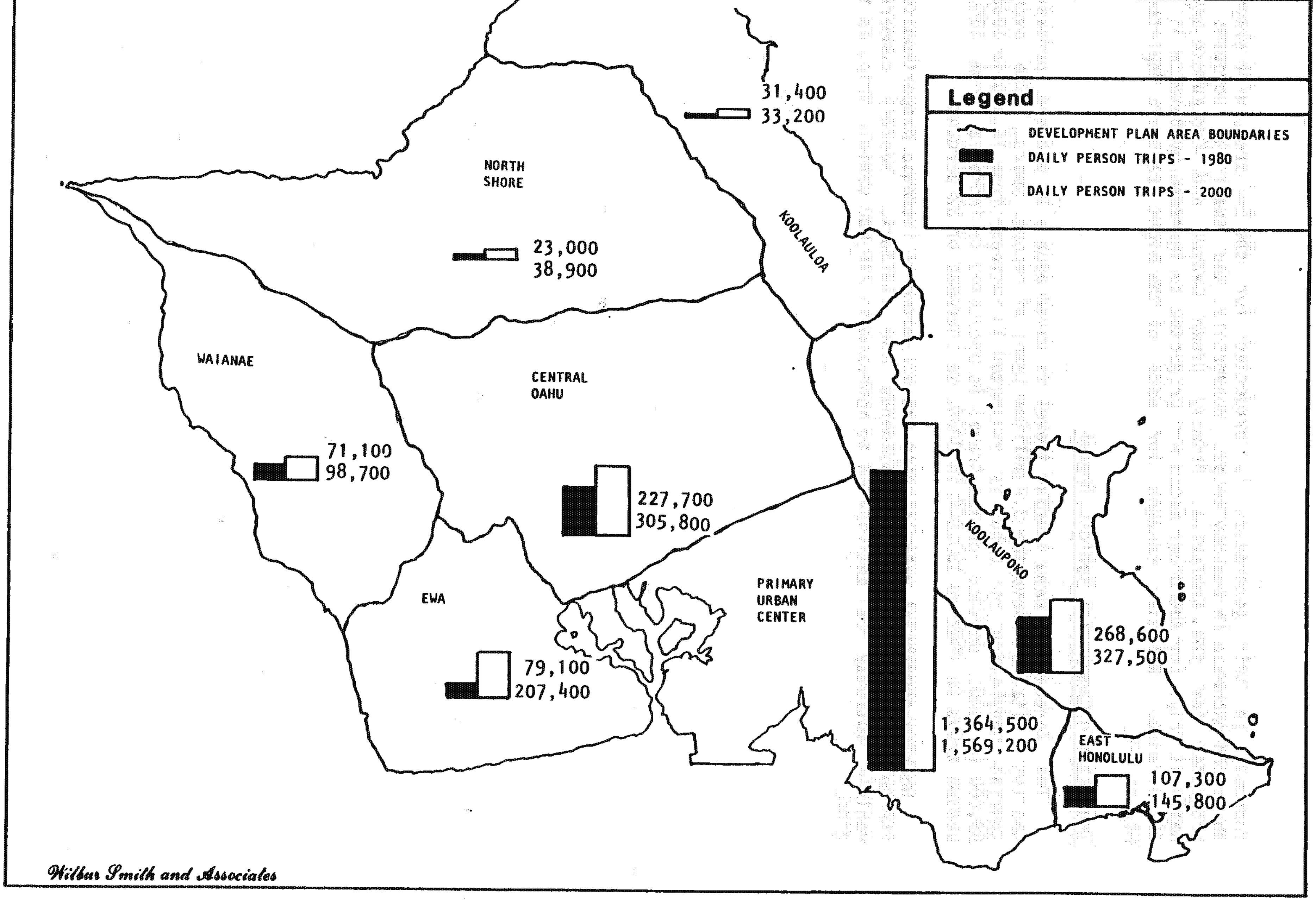
Tourist and Commercial Vehicle Travel

The forecast of Oahu tourist travel is based upon a 24 percent increase in tourist visitation above the 3.5 million level of recent years. The average tourist population on Oahu is estimated to increase from 78,500 in 1982 to 95,800 in 2000. Weekday tourist travel is projected to increase from 150,400 person trips in 1982 to 183,800 in 2000, an increase of 22 percent.

Weekday commercial vehicle trips are projected to increase proportionate to the total travel increase for residents and visitors. Weekday commercial vehicle activity is anticipated to approximate 235,000 vehicle trips in Year 2000.

FIGURE 3-2

YEAR 2000 OAHU TRIPS BY RESIDENTS



Wilbur Smith and Associates

CHAPTER 4

FORMULATION AND DESCRIPTION OF TRANSPORTATION ALTERNATIVES

The land use plans and development forecasts for the Year 2000 would produce widely differing increases in travel for the various areas of Oahu. As indicated in Chapter 3, the three development plan areas surrounding the Primary Urban Center -- Ewa, Central Oahu, and East Honolulu -- are expected to experience significant population growth, both in absolute terms and percentage of increase, thereby producing commensurate large increases in travel demands. The more rural areas are expected to experience lower growth, either in absolute or percentage terms, so as to produce travel demands more in line with existing or planned facilities.

The more intensely developed Primary Urban Center, while projected to experience a low percentage of population growth relative to its size, would experience the largest absolute increase in population and employment. The additional travel generated within the Primary Urban Center, together with the increased travel from the outlying areas into the Primary Urban Center, would exacerbate the transportation system deficiencies and congestion already present within this area.

A broad range of transportation measures and programs were identified and considered in order to address these varying levels of need in the different areas and travel corridors on Oahu. These encompassed the expansion of the existing transportation facilities, the introduction of new transportation modes and technologies, and the implementation of measures/programs to modify travel demands and characteristics.

The development of these alternatives is described in the following section. The remainder of the chapter describes each of six alternatives identified for detailed cost, travel and impact analyses.

DEVELOPMENT OF TRANSPORTATION ALTERNATIVES

The screening of candidate transportation measures, and the identification of six alternatives for detailed analysis, was performed by an Alternatives Task Force comprised of the participating agencies of Oahu Metropolitan Planning Organization (OMPO). The Task Force included staff from OMPO, the State's Department of Transportation (DOT) and Department of Planning and

Economic Development (DPED), and the City and County of Honolulu's Department of Transportation Services (DTS) and Department of General Planning (DGP).

It should be stressed that the analysis conducted by the Task Force was performed on a very preliminary level and incorporated many general assumptions to simplify their work. Principally, the Year 2000 travel demands were estimated using manual forecasting techniques and gross assumptions concerning land use and travel characteristics, rather than by use of the OMPO computerized regional travel demand models. This phase of the study was intended primarily to screen potential candidate modes, projects and programs and identify the most promising candidates for later, more detailed analysis.

The alternatives were developed by the Task Force to satisfy these preliminary estimates of travel needs for the Year 2000, subsequent to a review of the area development plans and the capacities of the existing and planned ("committed") transportation system. These "committed" projects assumed to be available for future use and the ensuing steps in the screening process are described in the following paragraphs.

Future Committed Projects (Committed System)

For the assessment of future deficiencies and needs, the available transportation system capacity was assumed to include both the present facilities and services, and those new or modified facilities and expanded services which have received agency commitments and which can be reasonably expected to be "in place" by the Year 2000. These committed projects/services are added to the existing transportation system to create a "Committed" system.

The comparison of the highway and transit capacities of the "Committed" system with the future travel demands was used as the basis for identifying future transportation deficiencies. Evaluation of the alternatives, as presented in later chapters, is also affected by the Committed System since it is used as the baseline condition from which many of the impacts of the alternatives are measured, such as capital costs, traffic congestion relief, and cost effectiveness.

The commited projects and programs included within the Committed System were identified by the City Department of Transportation Services and the State Department of Transportation. These projects/programs generally include those currently under construction or design, and those which will be initiated or implemented within the next five years. These include highway, high occupancy vehicle (HOV), and transit projects and programs.

Highways - The highway projects include several new roadways plus major widenings of present arterial routes. Those projects which would affect the capacity of the major traffic arteries are listed in Table 4-1, together with the approximate timing and costs. Locations of the projects are depicted in Figure 4-1.

The principal new highway project is the construction of Interstate Route H-3 from the Halawa area on the Leeward side of the Koolau Range across to the Kaneohe area on the Windward side. Construction of this major four-lane

TABLE 4-1

COMMITTED HIGHWAY PROJECTS

Hali 2000 Study

FACILITY	PROJECT LIMITS	PROJECT DESCRIPTION	YEAR COMPLETE	COST (Millions)
STATE PROJECTS:				
Interstate H-1	Keehi Interchange to Palama Interchange	Widen by one lane in each direction	1986	$ 7.5
	Waiawa Interchange to Halawa Interchange	Widen from four to five lanes in each direction	1990	3.1
	Palailai Interchange to Kunia Interchange	Widen from two to three lanes in each direction	1990	2.7
	Kapiolani Boulevard Interchange	New east bound on-ramp from Kapiolani Boulevard	1984	8.5
Interstate H-3	Halawa Interchange to Halekou Interchange	New four-lane freeway	1992	760.0
Moanalua Freeway	Puuloa Interchange to Kahauiki Interchange	Add one Ewa bound lane	1984	27.0
Moanalua Freeway Frontage Road	Kahauiki Interchange to Puuloa Interchange	Add one Ewa bound lane	1984	27.0
Kalanianaole Highway	Aina Haina to Aina Koa	Widen from six to eight lanes to provide two reversible HOV lanes	1994	42.0

TABLE 4-1
(Contd.)

COMMITTED HIGHWAY PROJECTS

Hali 2000 Study

FACILITY	PROJECT LIMITS	PROJECT DESCRIPTION	YEAR COMPLETE	COST (Millions)
STATE PROJECTS (Cont.)				
Kalanianaole Highway	Kuliouou to Aina Haina	Widen from four to six lanes to provide two reversible HOV lanes	1994	$ 55.0
Farrington Highway	Jade Street to Waianae Valley Road	Widen two-lane section to four lanes	1990	6.7
Kamehameha Highway	Haleiwa Bypass	New two-lane road	1988	14.5
Fort Weaver Road	H-1 to Mango Tree Road	New four-lane road	1982	18.0
	Mango Tree Road to Renton Road	Widen from two to four lanes	1984	4.6
	Renton Road to Ewa Beach	Widen from two to four lanes	--	--
Likelike Highway	H-3 to Kahekili Interchange	Widen from four lanes to six lanes		
Kahekili Highway	Likelike Highway to Keaahala Road	Widen from two lanes to six lanes	1994	19.0
	Keaahala Road to Kamehameha Highway	Widen from two lanes to four lanes	1993	11.5
Sand Island Access Road	Auiki Street to Sand Island Container Yard	Widen from two lanes to four lanes	1987	9.5

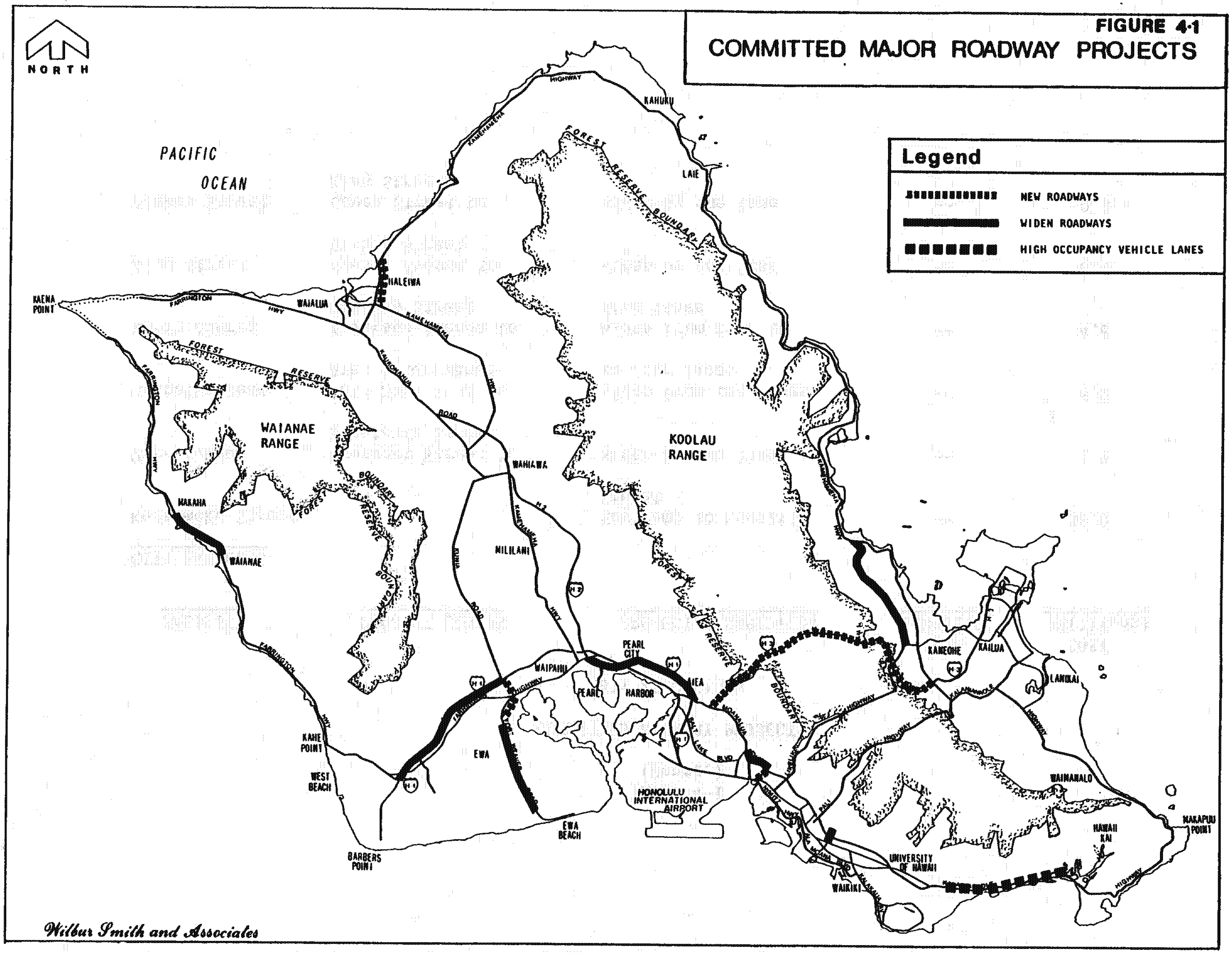
TABLE 4-1
(Contd.)

COMMITTED HIGHWAY PROJECTS

Hali 2000 Study

FACILITY	PROJECT LIMITS	PROJECT DESCRIPTION	YEAR COMPLETE	COST (Millions)
CITY PROJECTS				
Keeaumoku Street		New ramp to Lunalilo Street	--	$2.0
Ward Avenue	Prospect Street to Beretania Street	Widen by two lanes	--	1.2
Moanalua Road	Pali Momi Road to Aiea Interchange	Widen from two lanes to four lanes	--	6.9
Kuhio Avenue	Kalakaua Avenue to Olohana Street	Widen from four to five lanes	--	4.6
King Street	Nuuanu Avenue to Bishop Street	Widen by one lane	--	0.4
Alakea Street	Queen Street to King Street	Widen by one lane	--	0.3

FIGURE 4-1
COMMITTED MAJOR ROADWAY PROJECTS



project, which is currently being designed, is expected to require eight years, with completion in 1992. Other major projects include the widening of Fort Weaver Road in the Ewa area, construction of a Haleiwa bypass, and widening of the H-1 Freeway.

High Occupancy Vehicle (HOV) Lanes - The widening and modification of Kalanianaole Highway, from the terminus of the H-1 Freeway in Aina Koa to Hawaii Kai, is the major project involving HOV lanes. The Kalanianaole Highway project will include a reversible median lane operation, which would provide two new lanes operating in the peak traffic direction for buses and HOVs. The existing number of mixed traffic lanes would be retained.

Bus System Expansion - In December 1983, TheBus system had a fleet of 416 coaches, with 335 coaches in service during the peak period. Present City plans are to expand the fleet to 500 coaches by Fiscal Year 1987. A total of 28 articulated buses will be acquired in this expansion program.

The City and County of Honolulu envisions the expansion of the bus fleet to 600 coaches. The increased bus fleet will be used to provide additional routes and increased service frequencies to areas outside the Primary Urban Center, and increased service frequencies within the Primary Urban Center. With the 600-bus fleet, weekday bus miles of service are expected to increase to 70,000 miles, about 60 percent above the 1980 revenue miles of service.

Additional bus facilities are planned in order to maintain and garage the committed increase in bus fleet size. Currently, the City is developing a heavy maintenance facility for major bus overhaul and repair work. An additional bus operating facility will be developed, as well as the renovation of the existing Alapai bus operating and maintenance facility, or a new replacement facility, to accommodate the storage and daily preventative maintenance needs for a 600-bus fleet.

Year 2000 System Deficiencies (Preliminary)

The preliminary estimates of Year 2000 travel were compared to the estimated combined capacity of the existing plus committed highway and transit systems, as expressed in terms of person trips. The comparisons of estimated demand and capacity were made for the principal analysis screenlines located within each of the five major travel corridors. (See Figure 2-2, Chapter 2 for location of screenlines.)

The comparisons indicated that the available capacity, including those committed projects described in the previous section, would be insufficient to meet the peak hour travel requirements in portions of the Leeward, Windward and Downtown corridors. In the Leeward corridor, the principal deficiency would occur in the Pearl Harbor East Loch area, constituting an excess of 13,000 person trips in the morning peak hour (29,000 demand versus 16,000 capacity). A small deficiency of 1,000 person trips was indicated for the Waikele screenline.

In the Windward Corridor, the provision of the H-3 Freeway would provide sufficient additional capacity to accommodate increased travel at the

Trans-Koolau screenline. However, travel volumes closer to the Downtown area, as represented by the School Street screenline, would exceed planned capacity (13,000 demand versus 11,000 capacity).

The preliminary analysis indicated deficiencies for both the Ewa and Diamond Head approaches into the Downtown area. The morning peak hour demand Ewa of Downtown at the Nuuanu Stream screenline was estimated at 37,000 inbound person trips versus a capacity of 30,000. Diamond Head of Downtown, the Ward Avenue screenline was estimated to have a small deficiency, with a demand of 30,000 as compared to a capacity for 29,000 inbound person trips.

With the planned median reversible HOV/bus lanes on Kalanianaole Highway, there will be sufficient capacity in the East Honolulu Corridor to meet the estimated level of travel demand. However, this would require that the reversible median lanes attract a significant increase in bus use and carpool formation.

Assessment of Candidate Travel Modes

The Alternatives Task Force considered a broad range of alternative modes to address the deficiencies identified within the major Oahu travel corridors. Those major alternative modes, projects or programs considered for these corridors are summarized in Table 4-2.

The alternatives were assessed by the Task Force for each corridor relative to physical practicality, probable effectiveness, scale of the project relative to the deficiency, and conformance to the Hali 2000 goals and objectives. As a result of this screening process, the list of alternatives was reduced to those which appear most applicable for addressing each corridor's needs.

Selection of Alternatives for Study

Individual transportation projects and programs identified for each corridor were grouped into a set of six system alternatives based upon the compatibility of projects. Duplication of projects between alternatives was avoided where possible.

Included are alternatives which emphasize use of major highway construction, major increases in bus service major transit guideway investments and low capital cost programs to increase utilization of present facilities. Each of the transportation system alternatives affords sufficient potential capacity to satisfy the preliminary estimates of demand. The six alternatives are:

A. Transportation System Management (TSM)
B. Highway Emphasis
C. Major Bus Expansion Emphasis
D. At-Grade Light Rail System
E. Partially Grade-Separated Light Rail System
F. Fully-Separated Rapid Transit System.

Each alternative is described in the following sections of this chapter, while the evaluation of each alternative is discussed in Chapters 5 through 9.

TABLE 4-2

TRANSPORTATION MODES CONSIDERED FOR MAJOR TRAVEL CORRIDORS

Hali 2000 Study

TRANSPORTATION PROJECT/MODE/PROGRAM	CORRIDOR Leeward	Central	Downtown	Windward	East
New Roadway	X	X	X		
Widen Roadway	X	X	X	X	X
Contraflow Traffic Lanes	X	X	X	X	X
HOV Lanes	X	X	X	X	X
Bus Lanes	X		X	X	
Major Bus Expansion	X	X	X	X	X
Marine Bus (High-Speed Ferry)	X		X	X	X
Light Rail Transit	X	X	X	X	X
Rail Rapid Transit	X		X		X
Downtown People Mover			X		
Tramway				X	
Staggered Work Hours	X	X	X	X	X
Parking Management			X		
Congestion Charges	X	X	X	X	X

ALTERNATIVE A TRANSPORTATION SYSTEM MANAGEMENT (TSM) MEASURES

The TSM alternative includes a series of low-capital cost measures which are intended either to increase the person-carrying capacity of existing transportation facilities, or to modify travel characteristics to use facilities more efficiently. Measures to modify travel characteristics would encourage either a shift to a more efficient travel mode (e.g., from single-occupant automobile to bus or carpool use), or a change to travel in a less heavily-traveled time period.

This alternative would include additional application of programs/projects which have already been used on Oahu, such as HOV priority lanes, contraflow traffic lanes, and increased parking charges. Also included in the TSM Alternative are potentially controversial measures which have not been previously used on Oahu, such as "road congestion pricing" or auto-restricted zones.

High-Occupancy Vehicle (HOV) Facilities

Alternative A includes the implementation of an HOV lane either on or parallel to the H-1 Freeway from the Palailai interchange (Makakilo) to Keehi interchange. (See Figure 4-2 for location.) The HOV lane would serve buses and carpools traveling in the peak traffic direction, with the lane operating inbound (towards Downtown) in the morning peak period, and outbound during the afternoon. While a contraflow lane was assumed for cost estimation purposes, the specific locational features of this HOV lane and any necessary safety features were not examined as part of this study. The present with-flow HOV lane on H-1 would be converted to normal operation.

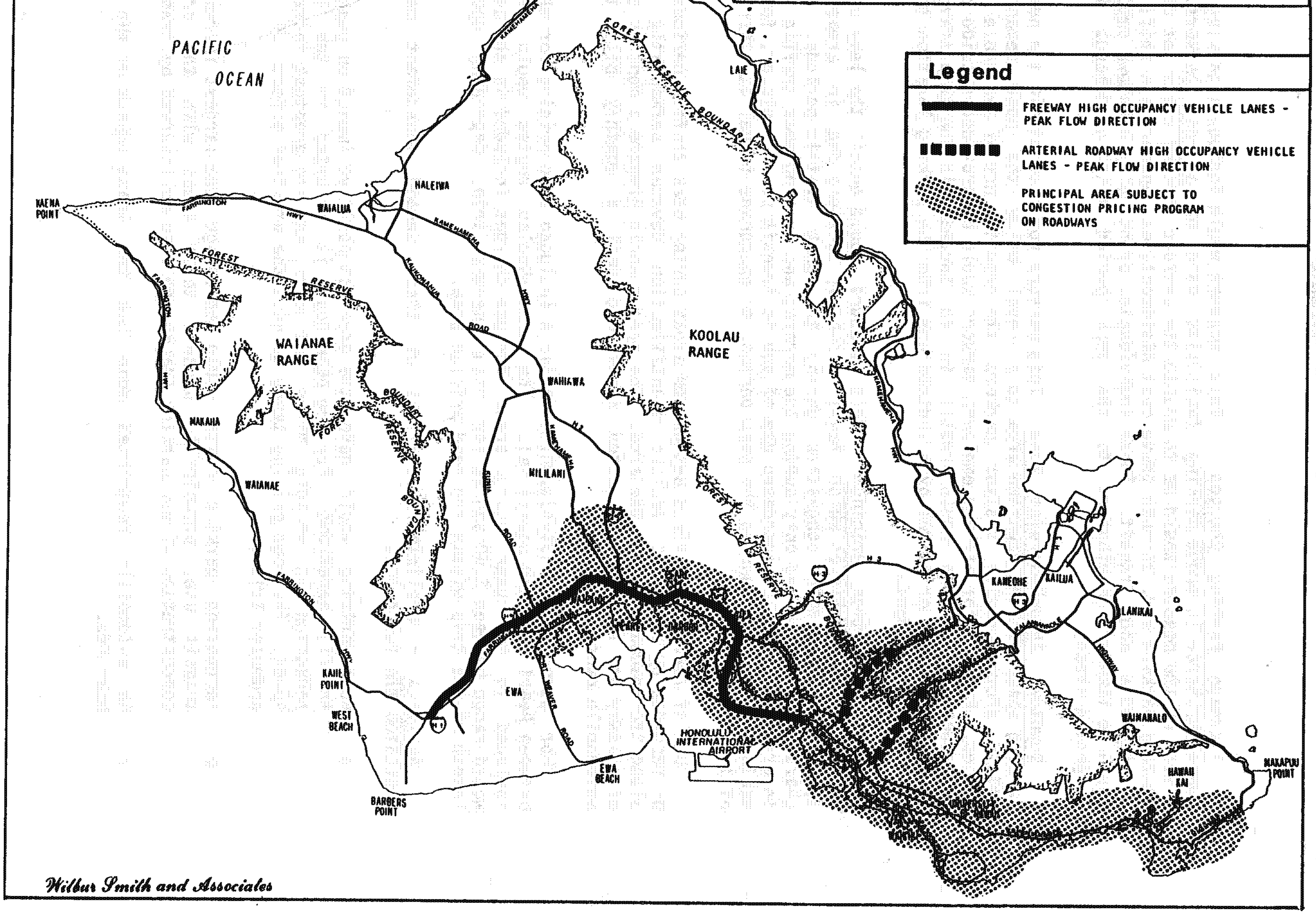
HOV lanes would also be provided on both the Pali and Likelike Highways for buses and carpools operating in the peak traffic direction during the morning and evening peak periods. The lanes would extend from the vicinity of the H-1 Freeway mauka through the Leeward residential areas of the Nuuanu and Kalihi Valleys. For costing purposes, implementation of the HOV lanes is assumed to be through reversing travel direction of existing off-peak direction lanes. However, the specific design of these HOV lanes and any operational safety features were not examined as part of this effort.

Travel Demand Management

A series of demand management measures were assessed for incorporation into Alternative A to encourage automobile drivers to shift to use of carpools or public transit. Each candidate measure was directed towards reducing the number of automobile trips during peak traffic periods, particularly those trips into the area of greatest congestion -- Downtown Honolulu and the adjacent areas between Waikiki and Pearl Harbor. The three measures studied include:

1) Doubling of all-day parking charges.
2) Implementation of a automobile-restraint zone in Downtown Honolulu.
3) Levying of direct road user charges on those highways which experience congestion during the peak travel (commute) periods of the day.

FIGURE 4-2
ALTERNATIVE A
TRANSPORTATION SYSTEM MANAGEMENT PRINCIPAL PROJECT LOCATIONS



Wilbur Smith and Associates

Increase Parking Charges - This measure would include a parking tax or space surcharge in those parking facilities used by all-day parkers. The effect of the measure would be to double the average parking costs for daily or monthly parkers and, through these cost disincentives, encourage a shift to use of carpools and transit. These individuals, principally Downtown employees, would be likely contributors to the peak period traffic demands in the congested areas.

Downtown Auto-Restraint Zone - This measure would constrain the number of parking spaces in the Downtown area to a level below the peak demand, and afford short-duration visitor parkers the priority use of available parking spaces. Parking for all-day employee parkers would be provided outside of the Downtown area, which would result in an increase in the trip travel time necessary to walk or travel by a shuttle bus from the parking location to their places of employment.

Road Congestion Pricing - This measure would entail the levy of a use charge on those vehicles which travel on roadway sections and in areas which typically experience congestion during the peak traffic periods. The use charge would be levied only during the morning and evening peak traffic periods in order to encourage increased use of public transit or carpools or, for those making choice trips during the peak period, to encourage travel at other times of the day.

Use of roadways in these designated areas during peak traffic periods would be recorded by automatic vehicle identification devices permanently placed along the roadways within the area. The system would prepare a monthly summary of roadway use in these congested areas and mail a monthly bill to the automobile owner.

For purposes of analysis, Alternative A included road pricing for the area between Pearl City and Hawaii Kai. The trans-Koolau routes would also be included in the user charge area. The use charges included in the analysis would range between $.50 and $2 for each one-way trip, depending upon the length of the trip within the road pricing area.

Analyses - Preliminary analyses of these demand management measures indicated the following:

- Road pricing would have the greatest positive impact on peak hour traffic operations. For the peak hour, it resulted in the largest reduction in vehicle miles and hours, and the greatest increase in speed. The road pricing tends to have the greatest effect on longer commuter trips.

- Increasing parking costs would encourage the largest increase in transit use, principally because those areas with the greatest concentration of pay parking spaces are also well-served by transit.

- An automobile restricted zone had the least impact of the three measures.

Based upon the above analyses, the road congestion pricing program was included within Alternative A as the principal mechanism to encourage a shift to more efficient travel modes.

Highway Improvements

No highway modification, other than the HOV-related facilities and the committed projects, is included in Alternative A.

Bus System

The fleet size for TheBus would be increased to approximately 880 coaches to serve the increased demand for public transportation which would result from the demand management program and HOV lanes. No change to private transportation company operations is included in Alternative A.

Changes to bus services for Alternative A would be similar to those described for the Alternative C Bus System Expansion Emphasis, with the additional buses used to increase frequency of service on both local and express routes. Weekday bus operations would increase by approximately 130 percent above 1980 bus miles of service. An additional bus maintenance and storage facility would be required above those identified for the committed system.

ALTERNATIVE B HIGHWAY DEVELOPMENT EMPHASIS

Alternative B addresses future travel needs principally through the provision of additional roadway capacity in the major travel corridors. These roadway projects include both new roadways and modifications to existing roadways, as well as the use of reversible and contra-flow operation of traffic lanes on several facilities. Public transportation would be provided by conventional local and express bus services.

Major Roadway Projects

The group of roadway projects included in Alternative B would center upon provision of increased roadway capacity to accommodate the traffic needs in the approaches to the Downtown Honolulu-to-Waikiki areas. The preliminary analyses indicated that the greatest needs, given the magnitude and distribution of population and employment growth, would be located in the Leeward/Central Oahu corridors between Pearl City and Downtown. Additional capacity would also be needed for roadways adjacent to the Downtown area in the Windward and East Honolulu corridors.

New roadways were included for the Leeward/Central Oahu travel corridors since there is limited opportunity to widen present roadways beyond the committed projects. Approximately four to six additional lanes would be required in the corridor.

The approach reflected in this alternative is to provide a highway tunnel across the Pearl Harbor entrance, with the construction of a parkway/expressway on either side of the harbor entrance to connect the Ewa Plains area to H-1 Interstate Freeway at the Pearl Harbor interchange. Adequate capacity is present between Pearl Harbor and the Middle Street area, where H-1 and the Moanalua Freeway converge. Additional capacity would be provided Diamond Head of the Middle Street area through the construction of an elevated roadway viaduct above the Nimitz Highway into Downtown Honolulu, with an extension along Ala Moana Boulevard. Roadway alternatives to these projects would involve either a widening of H-1/Moanalua Freeways in these areas, or the construction of a roadway viaduct above these facilities.

Ewa Parkway - Pearl Harbor Tunnel - The limited-access Ewa Parkway facility would begin in the West Beach - Barbers' Point area, possibly in the Kalaeloa Boulevard/H-1 Freeway area. The alignment would extend at-grade through the Ewa area and connect with the Ewa portal of the 1.1 mile long Pearl Harbor tunnel in the vicinity of Iroquois Point. (See Figure 4-3.) The Diamond Head portal of the tunnel would be in the vicinity of South Avenue, with an elevated roadway section between the tunnel portal and the H-1 Freeway at the Pearl Harbor Interchange.

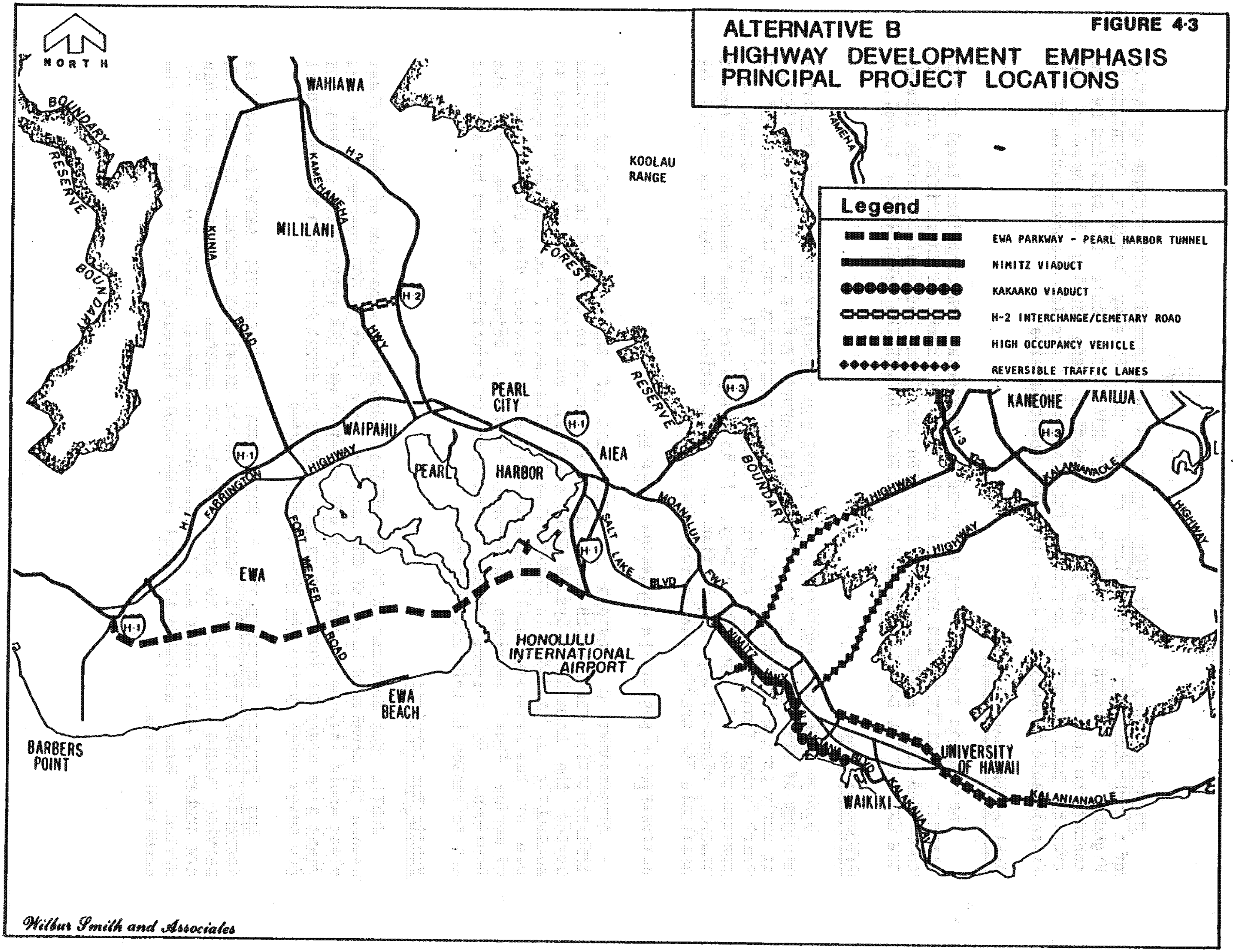
A six-lane roadway would be provided for the 1.2 miles between Fort Weaver Road and the Pearl Harbor Interchange, and four lanes Ewa of Fort Weaver Road. Interchanges would be constructed at Fort Weaver Road and at the H-1 Freeway (Pearl Harbor Interchange).

Nimitz Viaduct - The elevated facility would be located over Nimitz Highway between the H-1 Freeway viaduct at the Keehi Interchange and the Downtown area. The four-lane facility would be 2.6 miles in length. On- and off-ramps would be provided in the Downtown area.

Kakaako Viaduct - This 1.7-mile long facility would be an extension of the Nimitz Viaduct from Downtown Honolulu through the Kakaako area to the vicinity of Piikoi Street. The four-lane elevated facility would be located above Ala Moana Boulevard.

H-2 Freeway Interchange at Cemetery Road - At present there is no local access to the H-2 Freeway in the Central Oahu area between Mililani and Pearl City area. Therefore, Pearl City-bound traffic from this area must use the two-lane Kamehameha Highway. Construction of an interchange at the Cemetery Road crossing of the H-2 Freeway would permit Mililani area traffic to use the H-2 Freeway between Mililani and Pearl City, thus reducing traffic volumes on Kamehameha Highway.

Pali and Likelike Highways Contraflow Lanes - One additional traffic lane would be provided on these two routes to increase the peak direction traffic capacity during the morning and afternoon peak traffic periods. For the purposes of this analysis, it is assumed that the additional peak direction lane would be provided by reversing the direction of traffic flow in one existing off-peak direction lane during morning and afternoon peak travel periods. The reversed contraflow lanes would extend mauka from the H-1 Freeway area through the sections with traffic signal-controlled intersections. The reversed lanes would be available for general traffic use (not restricted to HOV or buses).


ALTERNATIVE B
FIGURE 4-3
HIGHWAY DEVELOPMENT EMPHASIS
PRINCIPAL PROJECT LOCATIONS
Legend
EWA PARKWAY - PEARL HARBOR TUNNEL
NIMITZ VIADUCT
KAKAAKO VIADUCT
H-2 INTERCHANGE/CEMETARY ROAD
HIGH OCCUPANCY VEHICLE
REVERSIBLE TRAFFIC LANES
NORTH
WAHIAWA
MILILANI
KOOLAU RANGE
FOREST RESERVE BOUNDARY
KUNIA ROAD
KAMEHAMEHA HWY
H-2
H-1
FARRINGTON HIGHWAY
WAIPAHU
PEARL CITY
AIEA
PEARL HARBOR
EWA
FORT WEAVER ROAD
EWA BEACH
BARBERS POINT
HONOLULU INTERNATIONAL AIRPORT
SALT LAKE BLVD
MOANALUA FWY
H-3
NIMITZ HWY
KANEOHE
KAILUA
HIGHWAY
KALANIANAOLE
UNIVERSITY OF HAWAII
WAIKIKI
KALAKAUA AV
Wilbur Smith and Associates

High-Occupancy Vehicle (HOV) Lanes - Alternative B would include operation of a high-occupancy vehicle lane on the H-1 Freeway between Kalanianaole Highway and Vineyard Boulevard. The HOV lane would be provided by the contraflow operation of one off-peak direction lane during the morning and evening peak traffic periods. This lane would provide a continuation of the Kalanianaole Highway HOV lanes into the Downtown area.

Public Transportation

The public transit fleet would be maintained at the committed level of 600 coaches. Facilities and services would be the same as described for the committed bus system with the exception that local and express routes serving the Ewa and Ewa Beach areas would be routed through the Pearl Harbor Tunnel.

Project Timing

Design and construction of the Nimitz and Kakaako Viaducts would require a minimum of five to six years. This would permit traffic use of the facilities as early as the 1990-92 period. The greater complexity and larger scale of the Pearl Harbor Tunnel would require a minimum of 10 years for design and construction of the Ewa Parkway. If no delays are experienced in the impact studies, right-of-way acquisition or construction, the facility could be available for traffic use in the late 1990s.

ALTERNATIVE C BUS SYSTEM EXPANSION EMPHASIS

Alternative C provides an assessment of the probable levels of public transportation usage which may be attained through an increase in bus services beyond the Committed System (600 coaches), but without the disincentives to automobile use included in Alternative A. Alternative C includes the expanded use of bus priority facilities and express bus services plus the introduction of marine "bus" services (high-speed ferries) between the Ewa area and Downtown. No changes in the future level of privately-operated bus services are reflected in this alternative.

Public Bus Services

Public bus services would be improved through an expansion of TheBus fleet beyond the committed level of 600 coaches, to a fleet of 800 coaches. The bus fleet would include approximately 672 standard and 128 articulated coaches. The fleet size would be increased to 600 coaches by about 1988, with an additional 200 buses added during the 1989 to 2000 period.

Bus Service Improvements - Both local and express services would be increased beyond the levels represented in the committed program. Express bus service would increase to approximately 120 coaches, or 50 percent more than the number of buses which would be assigned to express routes for the committed system. Buses assigned to local routes would increase by 25 percent over the committed system.

Several new express and local routes are included in Alternative C. Two new express routes would operate from the Ewa area to Downtown and the University of Hawaii areas. Additional local routes would include service between West Beach and the Pearl Harbor employment center, and between Wahiawa and the Downtown area. The remaining additional coaches would be used to increase service frequency on committed program routes.

Weekday bus services for Alternative C would increase by 110 percent from the 1980 base year level of 44,000 bus miles and 30 percent above the 70,000 weekday bus miles of service estimated for the committed 600-bus program.

Bus Priority Facilities - A traffic lane would be reserved on each of four roadways for exclusive use of buses traveling in the peak traffic direction. These reserved bus lanes would be located on the following facilities:

1) H-1 Freeway between the West Beach area and the Keehi Interchange.
2) H-1 Freeway between the end of the planned Kalanianaole Highway HOV lanes (at Aina Koa) and Downtown (Vineyard Boulevard).
3) Pali and Likelike Highways mauka from the H-1 Freeway area through the residential areas of Nuuanu and Kalihi Valleys.

Additional lanes reserved for bus use would be provided on each of the above roadways by reversing travel direction on one lane in the non-peak direction, and the use of the "reversed" lane as a peak direction bus lane.

Bus Support Facilities - Increase of TheBus fleet to 800 coaches would require one new operating division in addition to the facilities included in the committed program.

Marine Bus

Marine buses would provide service between the West Beach and Ewa Beach marinas and Downtown Honolulu during the peak commuter travel periods. During the mid-day and evening periods, the ferry craft could be utilized to serve tourist/recreation travel.

Marine bus services could be operated using six high-speed, high-capacity vessels, such as rigid sidewall hovercraft or jet-foils. Similar services are presently provided in San Francisco, Seattle and Hong Kong using different types of craft which typically travel at speeds averaging 15 to 30 miles per hour, and which accommodate 100 to 300 passengers.

Highway Facilities

No major highway modifications, other than the provision of reserved bus lanes, is included in Alternative C.

ALTERNATIVE D AT-GRADE LIGHT RAIL

This alternative is one of the three fixed-guideway transit alternatives (D, E and F) included within the Hali 2000 Study, which together establish the range of potential usage, costs, and general impacts of a rail transit system on Oahu. Each of the three rail alternatives represents a different degree of grade-separation, service quality, operating speeds, and costs, with Alternative D representing the lowest capital cost system for serving the heavily-traveled Leeward-Central Oahu-Downtown travel corridor.

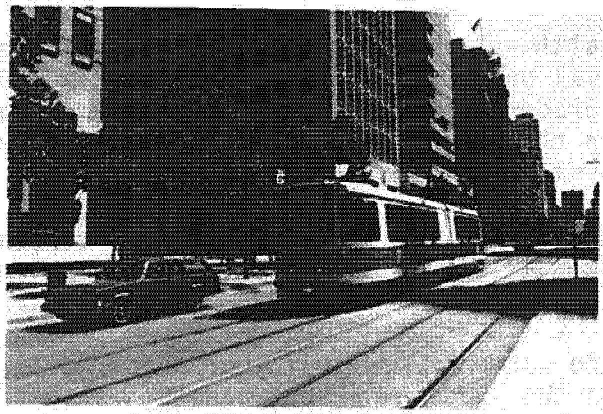
The rail system in Alternative D would be located at-grade to the fullest extent possible. To minimize right-of-way acquisition and costs, the system would be located within existing transportation facility rights-of-way. These rights-of-way include highways and streets, plus those segments of the former Oahu Railway and Land Company (OR&L) alignment in the Aiea, Waipahu and Ewa areas where development has not yet occurred on the right-of-way.

The light rail line would extend between West Beach and the University of Hawaii-Waikiki areas, a distance of approximately 27 miles. Other shorter line lengths were assessed which could represent the incremental phasing of construction for the 27-mile full length system. The computer travel model was applied to the full length system to forecast transit system patronage, which was then used to estimate rail and bus fleet size, operating levels and costs. Year 2000 patronage, fleet requirements, and cost estimates for the shorter line lengths were derived from manual analysis and adjustment of the patronage forecasts for the full length line.

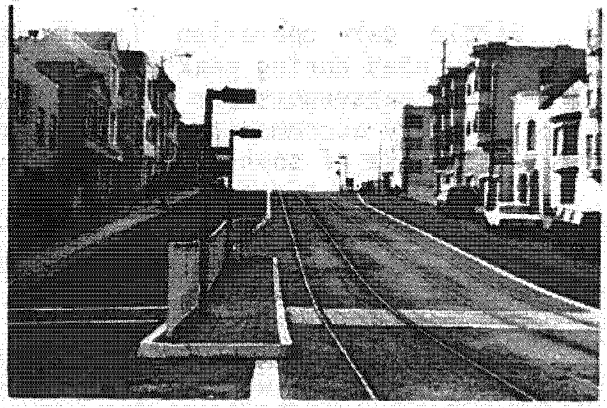
Light Rail Transit Modal Characteristics

The light rail transit mode is an urban electric railway with characteristics which permit its use in a wide range of operational environments. Operationally, the light rail system is more flexible than rail rapid transit ("heavy" rail) in that it can operate within streets in mixed flow with automobile traffic (defined in this report as "mixed traffic"), within streets on lanes reserved exclusively for light rail transit (defined in this report as "reserved street lanes"), outside of the street but on exclusive at-grade rights-of-way (defined in this report as "exclusive at-grade ROW"), or grade-separated on elevated or subway alignments (defined in this report as "grade-separated"). Light rail operations can also vary along the length of a line incorporating all four operational environments previously mentioned. Besides contending with automobile traffic in the same lane, light rail vehicles operating in mixed traffic are also affected by cross traffic at intersections. Cross traffic will also affect light rail vehicles operating on reserved street lanes and in exclusive at-grade rights-of-way, but will not affect light rail vehicles along grade-separated alignments. (Figure 4-4 illustrates different types of light rail operations.)

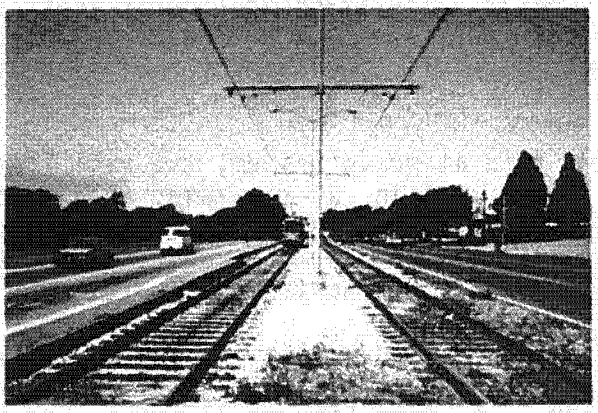
Spacing of light rail stops is generally similar to bus stop spacing (0.2 to 0.5 mile) where the system operates in mixed traffic or in reserved street lanes. On exclusive rights-of-way, the stops may be 0.5 to 2 miles apart. Passenger loading may be from simple street level stops or from weather-protected stations with passenger amenities. Speeds of light rail operation may range from 8 - 12 miles per hour where located in mixed vehicle traffic, to 35-50 miles per hour on exclusive rights-of-way with one to two miles between stops.



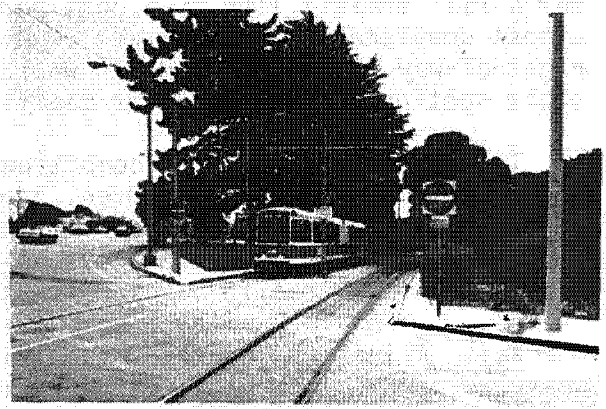
Light Rail Operations in Street
Mixed with Automobile Traffic



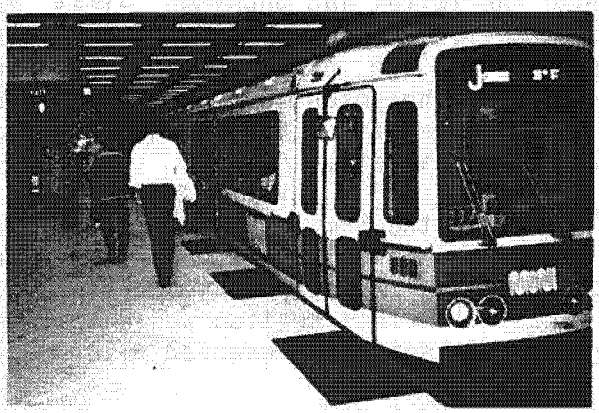
Light Rail Line in Reserved Street
Lanes with Passenger Stop



Light Rail Operations Within
Highway Median



Light Rail Line on Exclusive
At-Grade Right-of-Way



Light Rail Operations in Subway

TYPICAL OPERATIONS WITH LIGHT RAIL TRANSIT SYSTEMS

FIGURE 4-4

Single car operation is common, although two or three car trains are generally used during peak periods. Typical peak line volumes range from 2,000 to 3,000 passengers per hour, although grade-separated light rail systems can theoretically accommodate a peak volume on the order of 40,000 passengers per hour, with use of sophisticated control systems and short headways.

Electric power supply is from an overhead wire, which permits its operation in mixed traffic conditions. Typically, a very small degree of system automation is provided.

Thirteen cities in North America are currently operating or constructing light rail systems, with several others in the planning or engineering stages. Cities operating light rail systems include San Francisco, San Diego, New Orleans, Philadelphia and Boston.

Light Rail Alignment and Facilities

Alternative D is representative of the lowest level of capital investment for a rail transit line on a cost per mile basis. The at-grade line is located almost completely within street rights-of-way and the former OR&L railroad right-of-way. The alignment would be at-grade with the exception of several short sections where grades or traffic conflicts require vertical separation.

To enhance operating conditions for this at-grade system, the rail line would be located within reserved street lanes or in a separate, reserved right-of-way to minimize conflicts with automobile and bus traffic. Operation in mixed traffic flow would occur only on several short segments where physical constraints and traffic needs limit the opportunity for horizontal separation.

Rail Alignment - The light rail line is located within the most heavily traveled corridor on Oahu, which is also forecast to have the greatest need for additional transportation system capacity. A main line of 27 miles, and a 2-mile Waikiki branch line, were evaluated for the corridor. The general alignment is depicted in Figure 4-5. The shorter main line increments assessed in the corridor are approximately 5, 11 and 17 miles in length.

The shortest line increment considered in this analysis, the 5.4-mile segment extending from Middle Street through the Iwilei and Downtown areas to the University of Hawaii area, represents the minimum useful line length. As indicated in Table 4-3, the 5-mile increment would be primarily located in reserved lanes within street rights-of-way. The potential alignment would generally follow Dillingham Boulevard, a Hotel Street transit mall through the Central Business District, and King and Beretania Streets.

The 11-mile rail line increment would include the 5-mile line segment, and extend the line Ewa to the Aloha Stadium area. The potential alignment for the additional segment would use the rights-of-way of Kamehameha/Nimitz Highway, Puuloa Road and Salt Lake Boulevard (Figure 4-5). This section would include alignments within reserved roadway lanes and on separate reserved alignments adjacent to these roadways.

ALTERNATIVE D AT-GRADE LIGHT RAIL SYSTEM

FIGURE 4-5

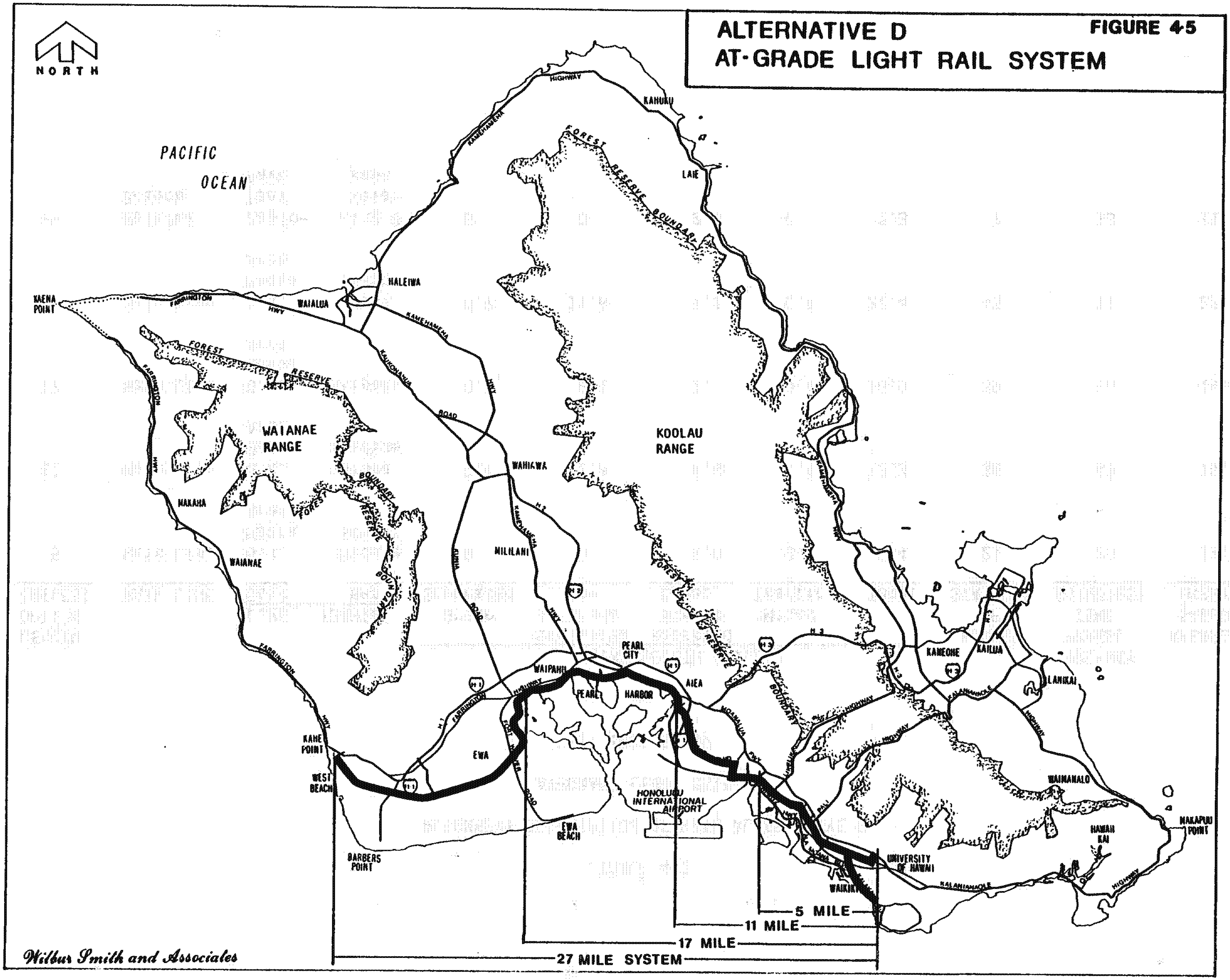


TABLE 4-3

ALIGNMENT DESCRIPTION OF RAIL ALTERNATIVE D

AT-GRADE LIGHT RAIL

Hali 2000 Study

LENGTH OPTION (MILES)	RAIL LINE	LINE TERMINI East	LINE TERMINI West	LINE LENGTH (MILES) Grade Separated	Exclusive At-Grade Row	Reserved Street Lanes	Mixed Traffic	Total	NUMBER OF STATIONS	ONE-WAY TRAVEL TIME (MINUTES)	AVERAGE SPEED (MPH)
5	Main Line	U.H. Manoa Area	Middle Street	0	0	5.0	0.4	5.4	21	26	12.5
11	Main Line	U.H. Manoa Area	Aloha Stadium	0.7	2.4	6.8	0.4	10.3	30	41	15.1
17	Main Line	U.H. Manoa Area	Waipahu	0.7	8.1	7.7	0.4	16.9	39	53	19.1
27	Main Line	U.H. Manoa Area	West Beach	0.7	17.6	7.7	0.4	26.4	45	71	22.3
--	Waikiki Branch	Kapio-lani Park	King @ Kala-kaua	0	0	2.3	0	2.3	7	13	11.0

The 17-mile line would extend in Ewa direction through the Aiea, Pearl City and Waipahu areas. The alignment could use reserved lanes within Kamehameha Highway between Aloha Stadium and McGrew Point. At McGrew Point, the line would enter and continue Ewa in the former OR&L right-of-way. The location of the OR&L alignment adjacent to the Pearl Harbor East, Middle and West Lochs, and through largely open areas across the Waipio and Pearl City Peninsulas would limit the number of traffic or pedestrian crossing points. This would increase the distance between stops and permit faster operating speeds.

The line extension to West Beach (27-mile line) would continue along the former OR&L railroad alignment from Waipahu through a largely agricultural area. The right-of-way would be fenced and would have a limited number of protected grade crossings, with the only grade separation at Fort Weaver Road. This line section would directly serve Ewa, Barbers Point Naval Air Station, and West Beach, and would serve Ewa Beach, Campbell Industrial Park, and the Waianae coast communities via feeder bus routes.

The 40-foot wide former OR&L right-of-way between Aiea and West Beach is presently owned by the Hawaii Department of Transportation (10.3 miles), U.S. Navy (3.9 miles) and Hawaiian Electric Company (0.8 miles). Most of this alignment is used as a utilities corridor and is occupied by underground fuel pipelines and above-ground electrical transmission lines which would require either relocation within the 40-foot right-of-way, or to parallel rights-of-way. The City of Honolulu currently has an easement on the Navy segment between Pearl City and the Halawa area for use as a bikeway.

The 2.3 mile Waikiki branch line could be combined with any of the main line segment lengths, or could be a main line component. The Waikiki line would be located in reserved street lanes.

Stations - For the 11-mile main line length and the Waikiki branch line, stations would be located every one-quarter to one-half mile. These stops would be simple street-level passenger loading platforms with a canopy and seating for passenger comfort. Stations along the former OR&L right-of-way would be located at intervals ranging between one-half and two miles. The stations would consist of a roof for weather protection and seating for waiting passengers. Number of stops/stations are indicated in Table 4-3.

Storage and Maintenance - For the 5 and 11 mile lines, storage and maintenance facilities could be efficiently provided at one facility. For the longer 17- and 27-mile lines, a second storage facility would be desirable to reduce the amount of out-of-service vehicle travel (deadhead) to and from the storage yard.

Rail Operating Plan

A rail operating plan was developed to serve estimated Year 2000 passenger levels for each line length increment. The operating plan identifies hours of operation, service frequency, train lengths, and operating speeds and is used to estimate vehicle requirements and operating costs for the rail service in the Year 2000. The rail operating plan includes a main line service, which would operate the length of the main line. Operating plans for the 17- and

27-mile length also include a turnback service, which would operate on the Waikiki branch line, with the service continuing in the Ewa direction on the main line to Aloha Stadium. The turnback line would provide increased capacity in the line sections carrying higher passenger volumes within and adjacent to the Downtown area.

Operating Speeds - Average operating speeds and end-to-end travel times are presented in Table 4-3 for each line length. Operating speeds would generally average 10 to 12 miles per hour for frequent-stop operations within existing streets. Average speeds would increase along the OR&L right-of-way segments to 25 to 30 miles per hour, with a top train speed of 40 to 45 miles per hour.

Service Periods and Frequencies - Rail passenger service would be provided for a 20-hour period each day, extending from 5 A.M. to 1 A.M., with peak period commuter service lasting for two hours during the morning and afternoon peak travel periods. The rail alternatives include a significant increase in service frequencies and extension of service hours during the evening periods as compared to the existing bus services, or those of the all-bus alternatives (A, B, C) which span a 17-hour service period. The service hours and train frequencies used in the cost analyses for weekdays on the 27-mile line are summarized in the following table:

SERVICE	APPROXIMATE TIME PERIOD	AVERAGE FREQUENCY (Minutes) MAIN LINE SERVICE	TURNBACK SERVICE	COMBINED
Peak	6 AM to 8 AM 3:30 PM to 5:30 PM	6	8	3.5
Midday (Base)	5 AM to 6 AM 8 AM to 3:30 PM 5:30 PM to 9 PM	15	10	6
Evening	9 PM to 1 AM	30	15	10

Weekend and holiday services would be provided using combinations of the midday and evening service frequencies.

Train Length and Capacity - The light rail cars are assumed to be standard 75-foot long articulated vehicles which can accommodate 154 seated and standing passengers (this reflects a seated load plus one standee per four square feet of open floor area in the vehicle). Average train length required during the commute peak periods would be three cars on the main line service and two cars on the turnback service. During other hours, single-car trains would be used. During the peak hour, the peak direction capacity would be 7,000 passengers along the section with combined mainline/turnback service, and 4,600 passengers on the main line Ewa of Aloha Stadium.

Vehicles - The estimated number of rail vehicles needed during the peak travel periods for each line length reflects the estimated capacity per car, the line length and average speeds, and the estimated number of passengers in the peak travel direction at the maximum load point on the line. The peak vehicle requirement was increased to provide 15 percent spares. The resultant vehicle fleet size in the Year 2000 for each line length is estimated as: 24 cars for 5 miles, 46 for 11 miles, 76 for 17 miles and 102 for the entire 27-mile line.

Public Bus System

Bus route system would be modified to reduce express and local bus services which parallel the rail line, and to modify local bus routes where appropriate to provide service to rail stops. The service eliminations and the shortened bus routes would reduce the required bus fleet size to less than the presently committed level of 600 coaches. The bus fleet size needed for the Year 2000 with each increment of rail line implementation, including spare vehicles, is estimated as follows:

5 mile - 530 buses	17 mile - 470 buses
11 mile - 510 buses	27 mile - 430 buses

The proportion of buses assigned to express routes would approximate 15 percent of the peak services.

Highways

Alternative D includes no additional highway facilities beyond those identified for the committed system.

The at-grade rail operation of Alternative D would eliminate one or two traffic lanes on those streets where the line would be located within the roadway. An estimated total of 11 lane-miles of roadway would be displaced on the heavily-traveled streets in the Iwilei, Downtown, Moiliili, and Waikiki areas.

Project Timing

Design, construction and testing of the shorter line lengths (5-11 miles) could be accomplished in approximately a five year period. Construction of a longer line would require a longer period and would likely have to be undertaken in several phases. Passenger service could begin on shorter segments as early as 1990-1991 with the construction of a full 27-mile line continuing into the mid to late 1990s. These completion times refer to the earliest time that the project is likely to be in operation given the time needed to conduct the necessary studies and engineering and for construction. The estimated completion time for this or any of the other rail alternatives (E and F) could be delayed by design, right-of-way acquisition or construction problems, or by delays in securing project funding.

ALTERNATIVE E PARTIALLY GRADE-SEPARATED LIGHT RAIL

For Alternative E, a light-rail transit line would be located to serve the same Leeward/Central Oahu/Downtown travel corridor as described for the Alternative D light rail line. The Alternative E light rail line, however, would be grade-separated through those areas where the greatest operational gain in system speed and performance could be obtained through vertical separation from vehicle and pedestrian conflicts. For the purposes of this evaluation, all grade-separated segments are considered as elevated lines.

Evaluation of a partially-grade separated light rail line includes a 27-mile main line which extends from the West Beach resort community planned for the Waianae coast of Oahu, through Downtown to the University of Hawaii area, and a Waikiki branch line. Requirements for shorter line lengths (5, 11 and 17 miles), which represent potential staged development of the 27-mile line, are assessed for the Year 2000.

A description and photographs of light rail vehicles and operations are included in the discussion of Alternative D.

Light Rail Alignment and Facilities

The Alternative E rail line would generally be located parallel to and makai of the Alternative D alignment between the University of Hawaii and Aloha Stadium. Ewa of Aloha Stadium, Alternative E would utilize the former OR&L railroad right-of-way. (See Figure 4-6.)

Grade-separated sections of Alternative E would total approximately 5.7 miles, as compared to 0.7 miles for Alternative D. The major portion of the grade-separated segments would be located in the Iwilei and Moiliili areas Ewa and Diamond Head of the Downtown area. Other grade separations are short segments located in Pearl Harbor-Aloha Stadium area at major cross-street intersections.

Rail Alignments - The light rail alignment of Alternative E shares some common segments with the Alternative D alignment. However, much of the Alternative E alignment is located makai of the Alternative D alignment. Alternative D is located primarily within residential areas, whereas Alternative E is located to provide access to major regional travel generators, such as the Ala Moana Shopping Center, Honolulu International Airport, and the Pearl Harbor Naval Shipyard/Hickam Air Force Base complex.

The length and terminus points of the incremental line lengths in Alternative E are similar to those for Alternative D. The shortest segment, 5.8 miles in length, would begin in the University of Hawaii area and extend at-grade to Kapiolani Boulevard. The line would be elevated at Kapiolani Boulevard and would continue to parallel Kapiolani Boulevard beyond the Ala Moana Shopping Center. The line would return to ground level and operate within street rights-of-way in the Kakaako and Downtown areas. From Downtown, the line would be elevated to and along Dillingham Boulevard as far as Middle Street. As indicated in Table 4-4, approximately 4.2 miles of this segment would be grade-separated.

The 11-mile line increment would continue Ewa from Middle Street at ground level within the Kamehameha Highway-Nimitz Highway/H-1 Viaduct right-of-way. The line would follow the Kamehameha Highway alignment Ewa of the Pearl Harbor Interchange, with the rail line located within reserved median lanes separated

ALTERNATIVE E
PARTIALLY GRADE-SEPARATED LIGHT RAIL SYSTEM

FIGURE 4·6

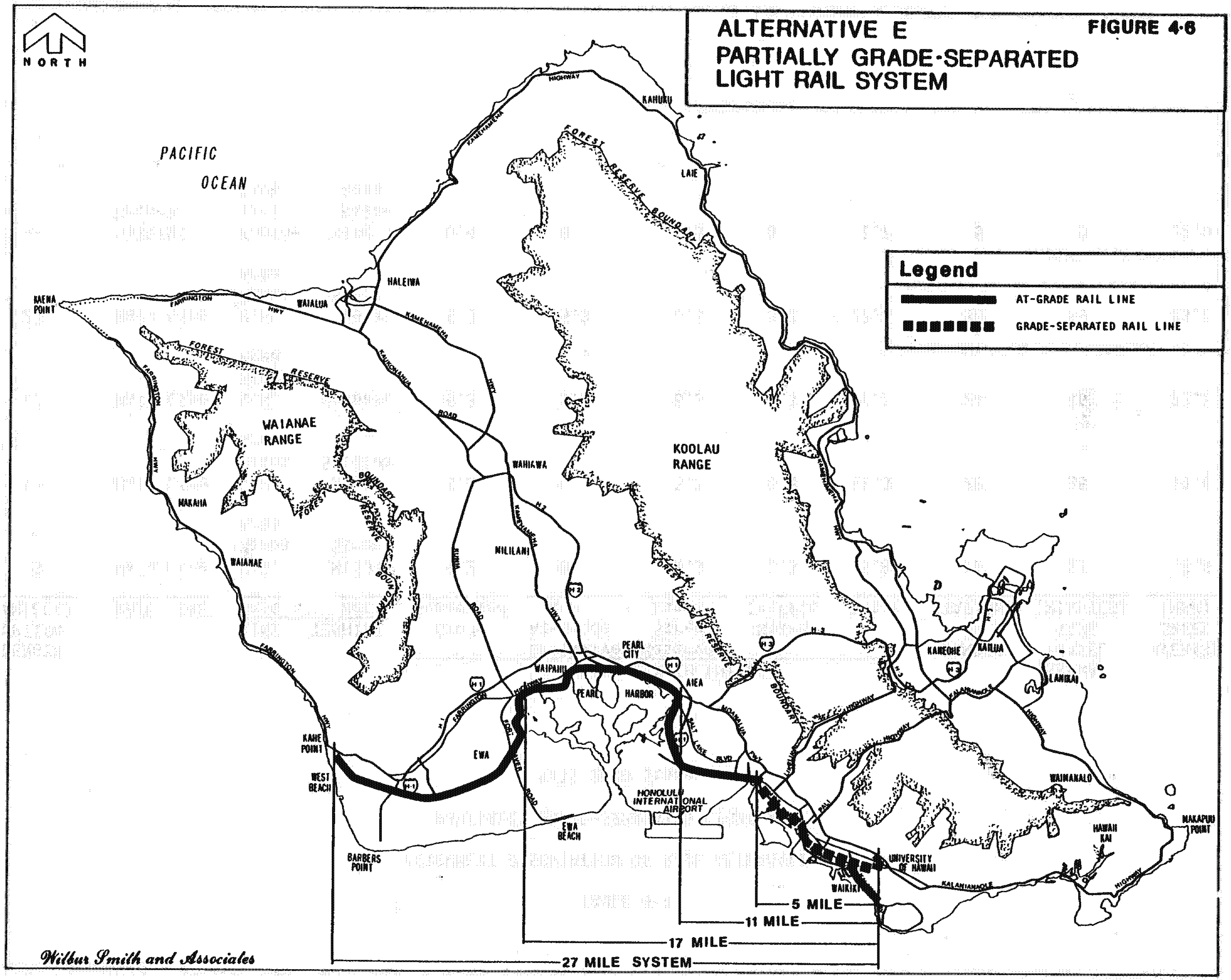


TABLE 4-4

ALIGNMENT DESCRIPTION OF RAIL ALTERNATIVE E

PARTIALLY GRADE-SEPARATED LIGHT RAIL

Hali 2000 Study

LENGTH OPTION (MILES)	RAIL LINE	LINE TERMINI East	LINE TERMINI West	LINE LENGTH (MILES) Grade Separated	Exclusive At-Grade Row	Reserved Street Lanes	Mixed Traffic	Total	NUMBER OF STATIONS	ONE-WAY TRAVEL TIME (MINUTES)	AVERAGE SPEED (MPH)
5	Main Line	U.H. Manoa Area	Middle Street	4.2	0	1.3	0.3	5.8	15	21	16.6
11	Main Line	U.H. Manoa Area	Aloha Stadium	5.3	0	5.7	0.3	11.3	20	35	19.4
17	Main Line	U.H. Manoa Area	Waipahu	5.3	5.8	6.3	0.3	17.7	24	46	23.1
27	Main Line	U.H. Manoa Area	West Beach	5.3	15.3	6.3	0.3	27.2	30	69	23.7
--	Waikiki Branch	Kapio-lani Park	King @ Kala-kaua	0.4	0	1.3	0	1.7	5	9	12.0

from adjacent traffic lanes by curb and fencing. Elevated line segments would be located at Pearl Harbor Interchange and at the Makalapa Gate intersection. The 11-mile line increment would end at Aloha Stadium.

The alignment of the 17- and 27-mile line segments Ewa of Aloha Stadium would be the same as those described for Alternative D.

The Waikiki branch line would connect to an elevated portion of the Alternative E alignment, and would therefore include a short 0.4 mile elevated segment to cross the Ala Wai Canal and return to ground level. The remainder of the 1.7 mile branch line would be located within reserved lanes along Kalakaua Avenue.

Stations - Alternative E would include fewer stops for passenger boarding/alighting than Alternative D (30 versus 45 stops for the main line), primarily as a result of the elevated segments and the alignment location. Eight stations along the elevated sections would require major construction including elevators and escalator facilities for passenger access, restrooms, and passenger waiting areas. Stops and stations along the at-grade segments would be similar in spacing and facilities to those described for Alternative D.

Maintenance Facilities - Storage and maintenance facilities would be the same as described for Alternative D.

Rail Operating Plan

A rail operating plan was developed for Alternative E similar to the one described for Alternative D. A main line service and a turnback service (Aloha Stadium to Waikiki) was included for the 17- and 27-mile lines.

Operating Speeds - The reduced number of stops for passenger boarding, together with the elimination of traffic conflicts and delays in the elevated sections, would result in an increase in average operating speeds over those for the at-grade system. Operating speeds would be 4 to 5 miles per hour faster for the 5- and 11-mile lengths, with a resultant reduction in trip travel times of up to 7 minutes, depending upon the length of the trip.

Service Periods and Frequency - Service periods and frequencies would be similar to those for Alternative D. The frequency of service during the peak travel periods would be 6 and 7 minutes for the main line and turnback service, respectively, with a combined average frequency of one train every 4-1/2 minutes on the line section served by both.

Train Lengths and Capacity - Single-car trains would be operated at times other than the peak travel periods. During the peak commute periods, alternating train lengths of two and three cars would be used on both the mainline and turnback line. Peak hour capacity in each direction would be 7,500 passengers along the line where both the mainline and turnback services operate, and 3,400 passengers for the mainline service alone.

Vehicles - A similar number of rail vehicles would be required for both Alternatives D and E. The number of vehicles required to provide services on each line length in Year 2000 is:

5-mile	23 cars	17-mile	73 cars
11-mile	40 cars	27-mile	104 cars

Each fleet size includes 15 percent reserve vehicles.

Public Bus Services

The public bus routes would be modified as described for Alternative D to eliminate bus duplication of the rail service, and to provide bus access to rail stops. The bus fleet size estimated for each line length, including 15 percent spares, is:

5 miles	- 530	17 miles	- 480
11 miles	- 510	27 miles	- 440

Highways

No additional highway facilities would be provided beyond those identified for the committed system.

Project Timing

Project timing would be approximately one year longer than that described for Alternative D due to the construction of the grade-separated segments.

ALTERNATIVE F FULLY GRADE-SEPARATED RAIL RAPID TRANSIT

The principal transportation project included within Alternative F is a fully grade-separated rail rapid transit line within the Leeward/Central Oahu/Downtown travel corridor. The full separation from traffic and pedestrian conflicts and reduced number of stops would provide a higher-speed system than is generally possible with a system which has at-grade traffic and pedestrian crossings.

The limits of the rapid transit line considered herein extends from Pearl City to Kahala, a distance of 18 miles. Line length increments of 8, 11 and 14 miles were also assessed within the corridor. Computer model patronage forecasts were made for the 14-mile line length (Aloha Stadium to Kahala), while Year 2000 patronage for other line lengths was estimated through manual adjustments to the model forecasts.

Rail Rapid Transit Model Characteristics

Rail rapid transit operates on an exclusive right-of-way with full access control. The roadbed is grade-separated from all vehicular or pedestrian conflicts, with frequent use of elevated or subway construction. Rail rapid transit encompasses both conventional "heavy" rail operations and the "intermediate capacity" transit systems.

Heavy rail systems generally employ multi-car train operation (4 to 10 cars per train) in larger 75 to 80-foot long vehicles with a capacity of 150-200 seated plus standing passengers. Intermediate capacity systems employ smaller 50-55 foot long vehicles with a capacity of 80-90 passengers (seated plus standees). (See Figure 4-7.)

Both systems provide passenger loading from floor-level platforms at relatively elaborate on-line stations. Stations tend to be widely spaced (1-3 miles) and automatic train controls commonly used to enable the system to realize faster operating speeds and more precise schedules than light rail systems.

A third (hot) rail system is the usual source for electrical power supply. Examples of heavy rail operation are San Francisco BART, Washington, D.C., Atlanta, and Chicago. Intermediate capacity systems are being developed in Toronto and Vancouver, Canada.

For the purposes of the Hali 2000 Study analyses, the heavy rail system is used to represent fully grade-separated rail rapid transit.

Rapid Transit Alignment and Facilities

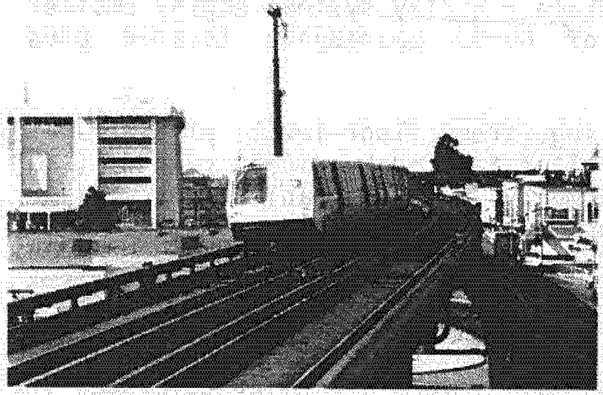
The fully grade-separated rail rapid transit alternative uses the horizontal alignment, station locations and facility locations identified for the Honolulu Area Rapid Transit (HART) system. Vertical alignment for Alternative F follows that of the HART system with the exception that both an elevated and a subway alignment were considered through the Downtown area where HART proposed a 1.6 mile subway alignment. The descriptions of the alignment are based on materials provided in earlier engineering analysis(1) and environmental studies.(2)

The basic alignment considered is a 14-mile line between Aloha Stadium and the Kahala area. Line lengths of 8, 11 and 18 miles were assessed to identify the general cost implications of different sized projects by the Year 2000. The 8-mile project includes the same segments as the proposed HART project: from Honolulu International Airport, through Downtown to the University of Hawaii-Manoa campus area. The 11- and 18-mile lengths generally serve the same area as the similar lengths of the light rail Alternatives D and E. The rail rapid transit line does not include a Waikiki branch line, but does include complementary feeder bus and other bus services to supplement the rail service.

---

(1) Honolulu Rapid Transit System, Preliminary Engineering and Evaluations Program, Phase II Final Report, prepared by Daniel, Mann, Johnson & Mendenhall for the City and County of Honolulu, 1976.

(2) Final Environmental Impact Statement, Honolulu Area Rail Rapid Transit Project, United States Urban Mass Transportation Administration, 1982.



Elevated Rapid Transit Line --
Heavy Rail

Elevated Rapid Transit Line --
Heavy Rail

Rapid Transit Station Interior

Elevated Rapid Transit Line --
Intermediate Capacity
Transit System

Subway Station with
Light Rail Transit

TYPICAL OPERATIONS WITH GRADE-SEPARATED RAPID TRANSIT

FIGURE 4-7

Rail Alignment - The rail rapid transit alternative would be completely separated from crossing conflicts, which would permit faster speeds/reduced travel times on the line and would provide a service more time-competitive with the automobile. The separation from crossing conflicts would be accomplished through either the elevation or depression of the rail line through an area, or the location within a freeway right-of-way.

The shortest line length of 8 miles would have its Ewa terminus on the mauka side of the Honolulu International Airport main terminal complex. (See Figure 4-8.) An elevated guideway would extend in the Diamond Head direction along Aolele Street to Keehi Lagoon Park, cross Nimitz Highway, and continue along Dillingham Boulevard. The HART system included a 1.6 mile subway section through the Downtown area, extending from Dillingham Boulevard/Kuaahi Street area, along Hotel Street, to the Kapiolani Boulevard/Cooke Street area. In order to assess the cost differences, both an elevated alignment and a subway were considered for this segment. The "base" condition, as indicated in Table 4-5, is the lower cost elevated alignment.

The 8-mile line would continue Diamond Head of Cooke Street on an elevated guideway parallel to Kapiolani Boulevard through the Kakaako and Ala Moana Shopping Center areas to University Avenue. The line would extend mauka along University Avenue to its terminus station in the University of Hawaii-Manoa campus area. The 8-mile line would include 11 stations for passenger access.

The 11-mile line would include the 8-mile segment plus an extension in the Ewa direction to Aloha Stadium, a distance of 2.7 miles. From the airport station, an elevated alignment would extend to the H-1 Freeway, and continue in the median of the H-1 Freeway for the remainder of the segment. Two stations would be included within the extension.

The 14-mile line would include the 11-mile segment and extend in the Koko Head direction from the University area to an eastern line terminus in the vicinity of Kahala Shopping Mall. The majority of this 2.6 mile section would be located within the H-1 Freeway right-of-way. Three stations would be included.

The 18-mile line would extend Ewa from the Aloha Stadium station and include the 11-mile line, plus a 4.2-mile segment from Aloha Stadium to Pearl City. The 4.2-mile extension segment would be located within the H-1 Freeway. The median rail line would either be elevated or H-1 Freeway modified to avoid any reduction of traffic capacity, since the roadways in this section are expected to experience major increases in traffic volumes. Two passenger stations would be included within this area.

Storage and Maintenance Facilities - The storage and maintenance facility for the rail system would be located adjacent to the mouth of Keehi Stream, as identified for the HART system. However, the 32.3 acre yard size proposed for HART has been reduced commensurate with the reduced length of vehicle storage tracks needed for smaller vehicle fleet sizes.

FIGURE 4·8

ALTERNATIVE F
FULLY GRADE-SEPARATED RAPID TRANSIT RAIL SYSTEM

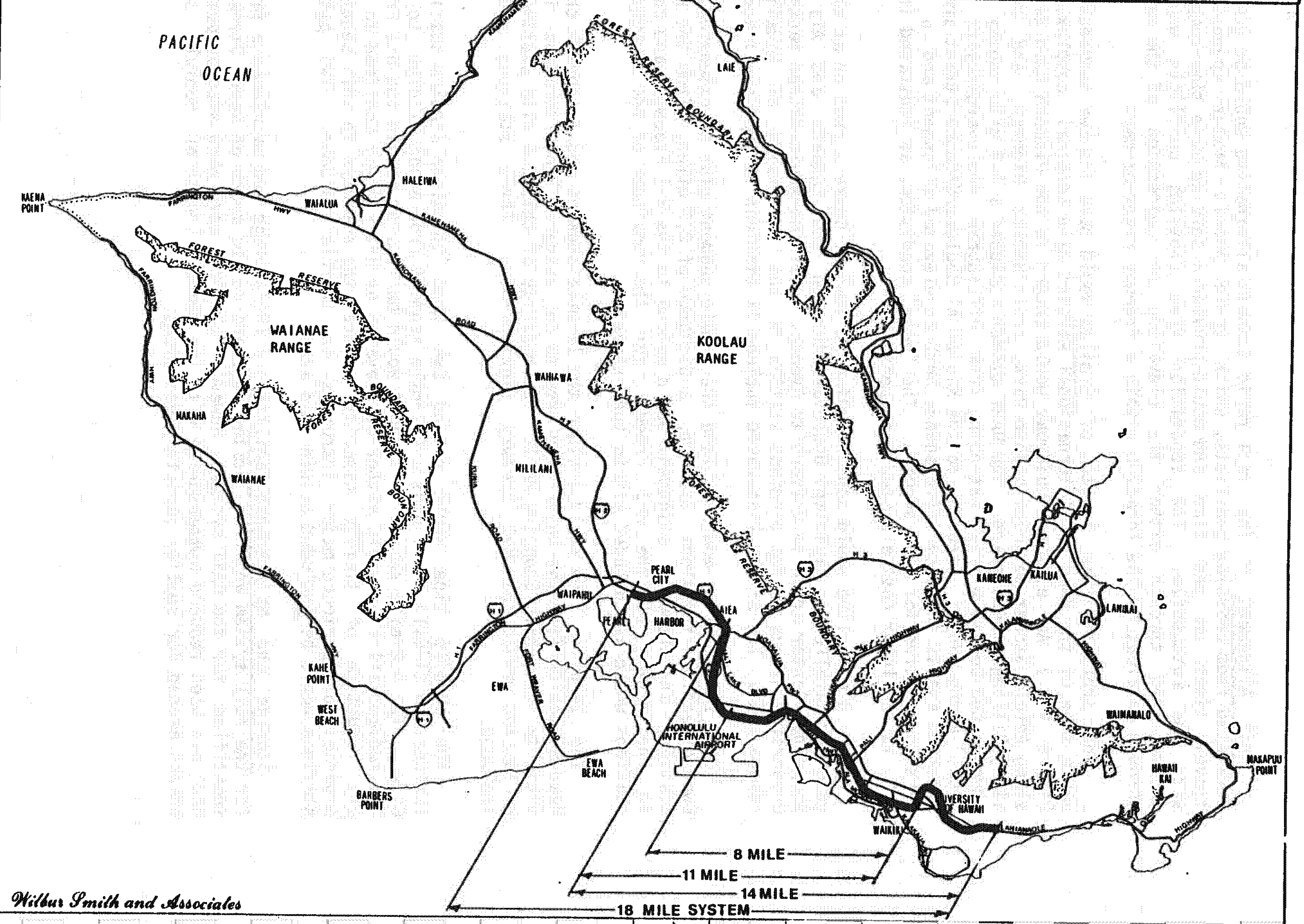


TABLE 4-5

ALIGNMENT DESCRIPTION OF RAIL ALTERNATIVE F

FULLY GRADE-SEPARATED RAPID TRANSIT

Hali 2000 Study

LENGTH OPTION (MILES)	RAIL LINE	LINE TERMINI East	LINE TERMINI West	LINE LENGTH (MILES) Grade Separated	LINE LENGTH (MILES) Exclusive At-Grade Row	LINE LENGTH (MILES) Reserved Street Lanes	LINE LENGTH (MILES) Mixed Traffic	LINE LENGTH (MILES) Total	NUMBER OF STATIONS	ONE-WAY TRAVEL TIME (MINUTES)	AVERAGE SPEED (MPH)
8	Main Line	U.H. Manoa Area	International Airport	8.5	0	0	0	8.5	11	16	31.9
11	Main Line	U.H. Manoa Area	Aloha Stadium	11.2	0	0	0	11.2	13	21	32.0
14	Main Line	Kahala Mall Area	Aloha Stadium	13.8	0	0	0	13.8	16	25	33.1
18	Main Line	Kahala Mall Area	Pearl City	18.0	0	0	0	18.0	18	31	34.8

Rail Operations

A rail operating plan was developed for each potential line length. The operating plan reflects the estimated service frequency and resultant peak hour passenger levels, and provides the hours of operation, operating speeds, train lengths and vehicle fleet size for the rail service. For the rapid transit operation, all trains were assumed to operate the full line length without any turnback operation.

Operating Speeds - The complete separation of the rapid transit line from crossing conflicts, plus the reduced number of station stops, would result in a significant increase in operating speeds as compared to light rail Alternatives D and E. As listed in Table 4-5, average speeds for the line lengths range between 32 and 35 miles per hour. Speeds would range upwards of 50 miles per hour between more widely spaced stations. The resultant rail travel times would be reduced for the segment lengths: to 21 minutes for an 11-mile line as compared to 41 and 35 minutes for Alternatives D and E, respectively, and to 31 minutes for the 18-mile line as compared to 53 and 46 minutes for the Alternatives D and E 17-mile lines.

Service Periods and Frequencies - Service would be provided for 20-hours per day, each day of the year. Length of time for the peak, midday and evening service levels would be the same as described for Alternative D.

Service frequency would be every 4 minutes during the morning and afternoon peak commute periods, which is similar to the frequency provided by Alternatives D and E. Midday (base) and evening services would average one train every 6 and 20 minutes, respectively.

Train Lengths and Line Capacity - During the peak hour, three-car trains would be necessary to service the estimated patronage levels for the 14-mile line. Two-car trains would be provided for the base and evening services.

The peak hour train length and capacity, when operating at three-minute frequency, would provide a capacity of approximately 11,400 passengers per hour at any point along the line. This capacity reflects a hour-long "design" load; "crush" loads would likely occur for short periods of the peak hour, thus exceeding the design load conditions on several trains.

Rail Vehicles - The number of rail vehicles needed for each line length was based upon the use of conventional "heavy rail" vehicles with a capacity of 189 passengers. This reflects a seated load plus one standee per four square feet of floor area for a 75-foot long vehicle with 74 seats.

The rail vehicle fleet was determined from the number of vehicles needed to serve the weekday peak demand, plus 15 percent reserve vehicles. The number of vehicles required for each line length are:

8-mile	29	14-mile	53
11-mile	41	18-mile	78

The required number of vehicles is considerably lower than the 105 estimated in the HART studies as a result of lower estimated peak passenger volumes.

Public Bus Services

The public bus routes would be reduced and/or modified to eliminate unnecessary redundancy between the rail service and the bus lines. Bus routes would be added or existing routes modified to provide passenger access to the rail stations.

Alternative F would require a larger bus fleet than that estimated for rail Alternatives D and E since the rapid transit line is projected to attract increased peak period use of the public transportation system. The increased use would primarily be centered on "feeder" services to rail stations. Public bus fleet requirements, including reserve vehicles, are estimated for the various rail line lengths as follows:

8 miles	-	550	14 miles	-	520
11 miles	-	540	18 miles	-	510

Because of the shorter length of the overall system, as compared to Alternatives D and E, express buses would comprise a higher proportion (20 percent) of the peak in-service buses.

Highways

No additional major highway facilities would be provided beyond those identified for the committed system.

Project Timing

Due to the greater complexity of design and construction, and increased right-of-way requirements, the design, construction and testing of the Alternative F rapid transit would require several years longer than that estimated for similar length lines in Alternatives D and E. Design, construction and testing for the 8-mile line would require a minimum of 8-10 years. The longer lines would likely be undertaken in two or more phases, and would require 12 to 15 years. Passenger service could begin as early as the mid 1990s on an 8-mile line, or the late 1990s on the longer lines. These completion times are subject to delays as discussed for Alternative D.

SUMMARY DESCRIPTION OF ALTERNATIVES

The major elements of the committed system of transportation projects and services, and the changes proposed in each Hali 2000 alternative, are summarized in Tables 4-6.

TABLE 4-6

SUMMARY OF TRANSPORTATION ALTERNATES

Hali 2000 Study

ALTERNATE	HIGHWAYS: MAJOR PROJECTS/ LENGTH (MILES)	TOTAL BUS FLEET SIZE[(a)]	RAIL PROJECTS: TYPE AND LENGTH	HIGH OCCUPANCY VEHICLE OR BUS LANES	TRANSPORTATION SYSTEM MANAGEMENT MEASURES
Committed System (E+C)	Various New and Widened Facilities, Including H-3	600	None	• Kalanianaole Hwy • H-1 (Existing) • Moanalua Road (Existing)	---
A (TSM Emphasis)	Committed Projects	880	None	• Kalanianaole Hwy • H-1 (Ewa to Dowtown) • Moanalua Road • Pali Hwy • Likelike Hwy	Road Congestion Pricing/Program
B (Highway Emphasis)	Committed Projects Plus: • Ewa Pkwy and Pearl Harbor Tunnel - 10.3 • Nimitz Viaduct - 2.6 • Kaka'ako Viaduct - 1.7	600	None	Committed Facilities plus H-1 Diamond Head of Downtown	Reversible Flow Traffic Lanes On: • Pali Hwy • Likelike Hwy
C (Bus Emphasis)	Committed Projects	800 plus Marine Ferry System	None	Bus Lanes On: • H-1 • Pali Hwy • Likelike Hwy	---

(a) Includes 15 percent reserve vehicles.

TABLE 4-6
(Cont.)

SUMMARY OF TRANSPORTATION ALTERNATES

Hali 2000 Study

ALTERNATE	HIGHWAYS: MAJOR PROJECTS/ LENGTH (MILES)	BUS FLEET SIZE	RAIL PROJECTS: TYPE AND LENGTH	HIGH OCCUPANCY VEHICLE OR BUS LANES	TRANSPORTATION SYSTEM MANAGEMENT MEASURES
D (Rail Emphasis)	Committed Projects	430	At-Grade Light Rail (Length 29 Miles)	Committed Facilities	None
E (Rail Emphasis)	Committed Projects	440	Partially-Separated Light Rail Line (Length 29 Miles)	Committed Facilities	None
F (Rail Emphasis)	Committed Projects	520	Fully Separated Rapid Transit Line (Length 14 Miles)	Committed Facilities	None

CHAPTER 5

CAPITAL AND OPERATING COSTS

The Hali 2000 Study alternatives include a broad array of transportation modes and projects which differ significantly in terms of costs. In particular, the alternatives represent a series of trade-offs between higher capital investments for implementation versus reduced annual public costs required to operate and maintain the system. Since these differences place greater emphasis on the cost-related comparison (financial feasibility and cost-effectiveness) of the alternatives, a more detailed cost analysis was undertaken for the Hali 2000 Study alternatives than is typical for a systemwide planning study.

Capital costs were estimated for the initial construction, right-of-way acquisition, and purchase of public transit vehicles needed to implement each alternative. Where appropriate, capital costs have also been estimated for replacement of facilities or vehicles whose useful life does not extend beyond the Year 2000 planning horizon of this study.

Annual operating costs were estimated only for the Year 2000, at which time all projects and programs included in the alternatives would have been implemented. Also, the computer travel model provided a detailed projection of Year 2000 travel, particularly for public transit use. The forecast passenger volumes were used to estimate necessary bus and rail system capacity and operating levels for the Year 2000, and thereby the estimated operating costs.

All costs, capital and operating, presented in this chapter are expressed in 1983 dollars, regardless of the year of planned expenditure. This eliminates inflation as a factor in comparing the cost-effectiveness of the investments. For information purposes, inflated values of capital and annual operating costs are presented in Chapter 8.

CAPITAL COSTS

The comparison of estimated capital costs provided in this section reflects a consistent cost analysis framework which:

- Accounts for the cumulative needs of the alternatives over the 1984-2000 period;

- Utilizes demand projections developed for the selected horizon year (2000) to size facilities and equipment;

- Recognizes the differing service lives of transit vehicles and other components of the alternative capital investments.

The capital cost estimates were based on a more detailed definition of horizontal and vertical facility alignment than typically used for a system planning level analysis of travel corridors, although not to the level of detail required for a specific alignment analysis. The primary purpose was to establish cost differentials among alternatives, rather than highly detailed cost estimates of a particular option or alternative.

The capital cost estimates for fixed facilities were primarily based on estimated quantities and unit prices for the individual elements of roadway and rail projects, rather than based on gross planning-level unit values. Unit costs for various construction items were developed based on recent construction contract bids for other similar projects. If the similar projects were located on the mainland, the unit prices were adjusted to reflect Hawaiian cost differentials for the constituent components of labor and materials, or for similar construction work.

The economic life of each major project element was estimated to assist in assessing the likelihood for replacement costs in addition to the initial implementation costs. The estimated economic life of the various project components is identified in Table 5-1. The only element whose economic life is less than the 17-year study period is that for transit buses, which may thus require replacements within the study time horizon.

TABLE 5-1

ESTIMATED ECONOMIC LIFE OF
TRANSPORTATION FACILITIES AND EQUIPMENT

Hali 2000 Study

SYSTEM ELEMENT		ECONOMIC LIFE EXPECTANCY (Years)
Rights-of-Way		50
Tunnels, Tubes		50
Highway Construction		25
Transit Ways		25
Maintenance Facilities		25
Parking Facilities		25
Stations, Terminals		25
Vehicles:	Bus	12
	Rail	25
	Water Craft	25

Roadway Project Costs

The principal roadway construction projects are included in Alternative B. These projects include the construction of several major highway projects: 1) the Ewa Parkway/Pearl Harbor Tunnel; 2) the Nimitz Viaduct; 3) the Kakaako Viaduct; and 4) an interchange for H-2 Freeway at Cemetery Road.

Estimation Methodology - With the exception of the Pearl Harbor tunnel section of the Ewa Parkway, unit cost items for roadway projects were compiled from recent bids submitted to the Hawaii Department of Transportation for similar roadway construction on Oahu. Unit cost items for earthwork, drainage, landscaping and pavement were identified per linear foot of roadway for differing widths and types of roadway construction, and for structures by the square foot of roadway surface. Unit costs were adjusted to reflect mid-1983 construction.

There is no local construction cost experience with an underwater tunnel of the size and complexity of the Pearl Harbor Tunnel. Therefore, costs were derived from the estimated costs for the construction of the 9,000-foot long Fort McHenry Tunnel under Baltimore Harbor, which is presently under construction (1980-1985).

Right-of-way requirements were based on standard cross sections for the roadways. Costs were included for acquisition of private properties, and for federal lands. No acquisition costs were included for construction above an existing State or City street right-of-way. Unit costs were developed for various land uses and areas based upon typical market values for similar types of properties in those parts of the Honolulu area. Relocation costs are included in the property costs.

Agency costs equivalent to 15 percent of the combined construction and right-of-way costs were included in the estimated project costs to reflect project planning, administration, and construction management expenses. A 25 percent factor was included in the costs as an allowance for contingencies.

Estimated Project Costs - Total estimated costs for the Alternative B roadway projects is $1,442,200,000, as expressed in 1983 dollars. An itemized listing of costs for each individual project is presented in Table 5-2.

The Ewa Parkway/Pearl Harbor Tunnel project represents $1,188.1 million of the estimated construction program costs. Construction of the tunnel accounts for 83 percent of the project costs. The tunnel is envisioned as a pair of concrete-encased steel tubes placed below the Pearl Harbor entrance channel in a dredged trench and covered over for protection. Tunnel costs include ventilation, environmental protection measures, and temporary navigational systems and controls.

The four-lane Nimitz Viaduct and the four-lane Kakaako Viaduct are estimated to cost $146.6 million and $98.5 million, respectively. The H-2 Freeway interchange at Cemetery Road south of Mililani is estimated to cost $9 million.

TABLE 5-2

CAPITAL COST ESTIMATES FOR MAJOR ROADWAY PROJECTS

(In Millions of 1983 Dollars)

Hali 2000 Study

COST ITEM	EWA PARKWAY-PEARL HARBOR TUNNEL	NIMITZ VIADUCT	KAKAAKO VIADUCT	CEMETERY RD./H-2 INTERCHANGE
Rights-of-Way	$ 94.3	$ 10.0	$ 6.5	$0.3
Demolition	21.0	1.0	1.0	---
Site Preparation	241.8	28.0	21.8	2.0
Structures	340.7	54.0	32.0	3.5
Pavement	23.3	---	---	---
Landscaping	3.1	1.0	0.8	0.3
Traffic Controls	5.2	3.0	1.4	0.2
Ramps	2.1	5.0	5.0	---
Miscellaneous	95.0	---	---	---
Subtotal	826.5	102.0	68.5	6.3
Agency Costs @ 15 Percent	124.0	15.3	10.3	0.9
Contingency Costs @ 25 Percent	237.6	29.3	19.7	1.8
TOTAL	$1,188.1	$146.6	$98.5	$9.0

Rail Facility Costs

Rail projects are included in Alternatives D, E and F. A light rail system is included in Alternatives D (at-grade) and E (partially grade-separated); a conventional "heavy" rail transit system is reflected in Alternative F project characteristics and costs.

Cost Estimation Methodology - The general description of the rail alignment characteristics provided by the Oahu Metropolitan Planning Organization and the City and County of Honolulu Transit Alternatives Development Committee was refined into a description of the horizontal and vertical alignment, based upon consultant review of field conditions. The alignment description and field review was then used to estimate unit quantities necessary for the rail line: trackwork, type and square footage of new or modified structures, type and length of utility and pipeline relocations, earthwork, right-of-way, etc.

Unit cost figures were developed from bid amounts of recently awarded local contracts for similar types of work such as concrete bridge structures, pavement widening, earthwork, and pipeline installation. Where available data were not current, prices were inflated to mid-1983 levels using construction cost indices published by Engineering News-Record and the Bank of Hawaii.

Since there has been no rail construction on Oahu in several decades, unit costs for many of the specialized items such as trackwork, electrification and control systems were developed from mainland projects, with the mainland prices factored to the Honolulu price base. The factor was established from the price ratio of known material and labor costs for similar or component items in Hawaii and the mainland location.

Construction costs have been adjusted to reflect allowances for a 20 percent contingency factor. An additional 25 percent has been added to reflect agency administration, preliminary engineering, tests and surveys, design, and construction management.

The rights-of-way for the rail alignments would include both public and privately owned land of widely differing values. Acquisition costs were estimated for both the private and public lands, other than alignments on existing City or State street rights-of-way. Federal properties, including the Navy-owned section of the former Oahu Railway and Land Company right-of-way, would likely be available only through a long-term (40-50 years) easement, which has been included within the right-of-way costs.

Right-of-way costs were estimated through the use of a series of unit cost values (per square foot) representative of market level values for the various land uses (agriculture, commercial, residential, industrial), level of development, and location within the urban area. The unit costs were adjusted to reflect relocation costs, agency costs and contingencies.

Alternative D Facility Costs - Construction and right-of-way costs for the 27-mile main line, the Waikiki branch line, and the shops and yards for the at-grade light rail system, are estimated at approximately $386 million. This system would extend from the University of Hawaii area to West Beach. Composition of the estimated costs is presented in Table 5-3.

A system extending as far in the Ewa direction as Waipahu (17-mile main line) is estimated to cost approximately $295 million, which includes the costs for a Waikiki branch line. The two shorter lines, 5-mile (to Middle Street) and 11-mile (to Aloha Stadium), are estimated to cost $94.4 million and $172.6 million, respectively. These two shorter lines do not include the costs for a Waikiki branch line, which would add $30.6 million to the project costs for each line length.

Average implementation cost per mile for each line, excluding rail vehicle costs, ranges between $13.4 million and $17.5 million. The average costs per mile decrease for the longer line lengths since the outer segments are less expensive to construct. The purchase costs for vehicles would add approximately $5 million per mile to the average cost for implementing the system.

TABLE 5-3

CAPITAL COST ESTIMATES FOR RAIL FACILITIES
(In Millions of 1983 Dollars)

Hali 2000 Study

COST ITEM	D - AT-GRADE LIGHT RAIL				E - PARTIALLY SEPARATED LIGHT RAIL				F - RAPID TRANSIT			
	5-Mile(a)	11-Mile	17-Mile(b)	27-Mile(b)	5-Mile(a)	11-Mile	17-Mile(b)	27-Mile(b)	8-Mile(a)	11-Mile	14-Mile	18-Mile
Tracks and Structures	21.4	43.5	70.3	92.2	65.5	96.3	123.4	145.3	207.0	244.6	309.0	410.2
Other Civil Work	1.4	6.7	9.4	10.7	0.7	5.2	7.6	8.8	2.0	4.8	4.8	4.8
Utility Relocation	3.6	7.8	15.7	16.7	0.2	3.2	10.8	11.8	0.7	0.7	0.7	0.7
Electrification	22.4	37.1	62.9	90.0	17.1	33.7	56.2	83.1	33.7	44.2	54.7	71.2
Signals/Controls	1.1	1.9	3.5	4.3	1.5	2.4	3.5	4.3	19.5	25.5	31.6	41.1
Stations/Parking	1.2	1.9	2.9	4.1	12.3	14.3	15.2	16.4	42.7	46.6	58.4	66.3
Maintenance Facilities	6.1	8.4	14.0	16.2	6.1	8.4	14.0	16.2	15.3	15.3	18.1	18.1
Subtotal	57.3	107.2	178.6	234.1	103.5	164.5	230.7	286.0	321.0	381.7	477.3	612.4
Contingencies @ 20%	11.5	21.4	35.7	46.8	20.7	32.7	46.1	57.2	64.2	76.3	95.5	122.5
Construction	68.8	128.6	214.3	280.9	124.2	196.2	276.8	343.2	385.2	458.0	572.8	734.9
Agency & Engineering Costs @ 25%	17.2	32.2	53.6	70.2	31.0	49.0	69.2	85.8	96.3	114.5	143.2	183.7
State Tax	3.4	6.4	10.7	14.0	6.2	9.8	13.8	17.2	19.3	22.9	28.6	36.7
Subtotal	89.4	167.2	278.6	365.1	161.4	255.0	359.8	446.2	500.8	595.4	744.6	955.3
Right-of-Way	5.0	5.4	16.2	21.5	24.3	24.3	35.8	41.0	124.6	127.7	138.7	142.1
TOTAL FACILITIES	94.4	172.6	294.8	386.6	184.7	279.3	395.6	487.2	625.4	723.1	883.3	1,097.4
Average Cost Per Mile(c)	17.5	16.7	15.3	13.4	31.8	24.7	20.4	16.8	73.6	64.6	64.0	61.0

(a) Length increment for Main Line (approximate).

(b) Includes costs for Waikiki branch line.

(c) Excludes cost for rail vehicles or for feeder bus system.

The resultant cost range of approximately $18 to $22 million per mile (with vehicles) for the different line lengths of the Honolulu at-grade system is consistent with those of other United States systems, given the cost differential of about 50 percent between Mainland and Hawaii construction prices. The average cost of the Portland system, now under construction, is estimated at $13 million per mile, with vehicles, when expressed in 1983 dollars. The Portland system is being constructed at-grade, primarily within an expressway-rail line corridor and on Downtown streets. The Los Angeles-to-Long Beach line is being designed to use a rail right-of-way for most of the 23-mile at-grade line, and will cost an estimated $15 to $17 million per mile. The 19.7-mile at-grade San Jose line is being designed within existing expressway and street rights-of-way, and is estimated to cost $15 million per mile.

The initial San Diego-Tijuana light rail line, with an average cost of $5 million per mile, was built as a single-track line in an existing rail right-of-way. The San Diego system used comparatively low design standards, and required few rail vehicles due to the low frequency of service (15 minutes) and low patronage.

Alternative E Facility Costs - Most of the grade-separated sections of Alternative E light rail system are included within the 5-mile length (4.2 mile of separation), with an additional 1.1 miles of separation included for the 11-mile length. The grade separation adds approximately $90 and $107 million in costs to the 5- and 11-mile lines, respectively, to bring the costs of those line lengths to approximately $184 and $279 million. (See Table 5-3.) The 17- and 27-mile lengths each include the additional $107 million, plus the added costs for larger shop and yard facilities, and for a Waikiki branch line. The Waikiki branch line is estimated to cost $29.3 million for Alternative E.

Alternative F Facility Costs - The rail rapid transit costs presented in Table 5-3 represent an elevated system, including the Downtown section which was proposed as a subway in the HART system. Construction and right-of-way costs for an elevated line range from about $625 million for an 8-mile line from the University area to Honolulu International Airport, to $1.1 billion for an 18-mile line between the Kahala area and Pearl City. A 1.6-mile subway section in the Downtown area, with three underground stations, would increase the cost of each of these lines by $150 million, thus resulting in a cost range of $775 million to $1.25 billion.

Average costs per mile range from $61 to $74 million with an elevated system, exclusive of rail vehicle purchase costs. Rail vehicle costs would add $5 million per mile to the average line costs, for a range of $66 to $79 million. If the additional $150 million were included for a subway section, the cost range, including vehicles, would increase to $85 to $100 million per mile for the various line lengths.

These costs are consistent with other systems recently constructed or under construction. When expressed in 1983 dollars, costs per mile average $106 million for the Atlanta system (1/4 subway); $120 million for Washington, D.C.; $59 million for Miami (no subway); and $132 million for Baltimore (all subway).

Bus Support Facility Costs

At present, a new heavy maintenance facility is being developed to support the existing Alapai and Halawa operating division facilities. These three facilities, including the renovation of the Alapai yard, would accommodate a bus fleet of 400 to 450 coaches. Only the full length (27-mile) light rail systems in Alternatives D and E are likely to constrain the bus fleet to a size within the capacity of these facilities through the Year 2000.

The committed bus system, the highway Alternative B, and the fleet requirements for the rapid transit (Alternative F) and the 5- to 17-mile light rail line lengths of Alternatives D and E, would require the development of an additional bus operating facility before the Year 2000 with a capacity of 200-250 coaches. Alternatives A and C would require bus fleets of 880 and 800 coaches, respectively, and thus necessitate the development of a second new operating facility.

The facility costs to support a fleet size of up to 450 coaches has been estimated as approximately $44 million (Table 5-4). Each additional operating facility would cost approximately $25 million. The costs were based on City of Honolulu estimates, as presented in the Transportation System Management Element for Oahu.(1)

Alternative C would also require new marine terminal facilities for the ferry services at Ewa Marina and West Beach. Existing facilities could be used in Downtown Honolulu. Construction of two dock facilities, plus provision of weather protection, passenger amenities, and ticket facilities at all three terminal locations are estimated to cost $6 million. This cost assumes only minor dredging or channel preparations would be required beyond that already existing or planned for these locations.

Bus and Rail Vehicle Costs

The cumulative costs of bus fleet additions and/or replacements, plus rail vehicle acquisition, constitute a large portion of the capital costs for any alternative. The fleet size for bus and rail systems were based upon the patronage forecast for these services, while the need for replacement vehicles reflected the estimated economic life for these vehicles and the ages of those vehicles now in service.

Of the various increments of rail line length, the travel model forecasts of patronage were available for, and used to estimate bus and rail fleet sizes on the 27-mile length of Alternatives D and E, and the 14-mile length of Alternative F. The Year 2000 model forecasts of patronage for these line lengths were used as a basis for manually-derived estimates of rail and bus system patronage on shorter/longer lines, and the resultant bus and rail fleet requirements.

---

(1) Transportation Systems Management Element for Oahu, Fiscal Year 1983, prepared by the Oahu Metropolitan Planning Organization, October 1982.

TABLE 5-4

BUS MAINTENANCE FACILITY NEEDS AND COSTS

Hali 2000 Study

APPROXIMATE BUS FLEET SIZE	ADDITIONAL FACILITY NEEDS	COSTS (Millions of 1983 Dollars)	NEEDED FOR ALTERNATIVES
400-450	New Heavy Maintenance Facility	$15.5	27-mile lines for D and E
	Renovate Alapai Facility	28.5	
		44.0	
450-700	New Operating Facility	25.0	Committed System B
		69.0	5- to 17-mile lines for D and E F
700-900	2nd New Operating Facility	25.0	A C
		$94.0	

Unit Costs - Unit prices for buses, rail cars and marine ferries depend upon the size of the order, equipment included (air conditioning, number and width of doors), and other factors. Therefore, an average value has been used for each vehicle type, which is representative of purchase prices in 1983.

Based upon recent City of Honolulu bus purchases, bus costs are estimated as $160,000 for standard coaches and $250,000 for articulated buses. These unit costs would include air conditioning, shipping and progress inspection costs.

For this cost analysis, the light rail vehicles were assumed to be double ended, six-axle articulated with air conditioning. Rapid transit cars were assumed to be equivalent to BART "C" cars. Purchase prices were estimated as $1,100,000 and $1,200,000 per light rail and rapid transit car, respectively. The costs per car were increased to $1,250,000 for light rail and $1,375,000 for rapid transit to reflect agency administration, testing and transportation charges.

Marine ferries are estimated to cost $6 million each. This cost represents a 200- to 300-passenger, rigid sidewall hovercraft or similar craft.

Bus Costs - The number of buses needed in service during the peak travel period was estimated on a line-by-line basis using the Year 2000 patronage forecast information. Articulated coaches were incorporated into each alternative to account for an average 16 percent of the required number of buses. Bus fleet size was determined by increasing the peak in-service requirement by 15 percent to account for spares.

With delivery of the 80 standard coaches in October, 1983, TheBus fleet consists of 416 coaches ranging in age from less than 1 year to 20 years. For the various alternatives, fleet expansion would require from 14 to 464 more coaches. Replacement needs, for both existing buses and the expansion buses, would range between 680 coaches (Alternative D) and 778 coaches (Alternative A). Total bus procurement needs for each alternative are summarized in Table 5-5 by coach size and as addition or replacement.

Rail Vehicle Costs - The number of peak in-service rail vehicles needed for each rail alternative was identified during the development of the rail operating plans (Chapter 4). The rail fleet size for the Year 2000 was then determined by increasing the peak in-service requirements by 15 percent to account for spares.

Since the economic life of the rail vehicles (25 years) extends beyond the study time horizon, rail vehicle procurement would equal the required fleet size to service estimated Year 2000 travel needs. The fleet sizes and costs are included in Table 5-5.

Marine Ferry Costs - An estimated six water craft would be required for the proposed ferry services in Alternative C. At a cost of $6 million each, acquisition costs would amount to $36 million.

Summary of Capital Costs

Capital costs for the public transit components of each alternative are summarized in Table 5-6, which includes the costs for each line length considered for rail Alternatives D, E and F.

OPERATING AND MAINTENANCE COSTS

Estimates of Year 2000 highway project-related maintenance costs and transit system operating and maintenance costs were prepared for each alternative, as expressed in 1983 dollars. For highways, the annual operating and maintenance cost was estimated only for those projects not included in the committed system. Transit system operating and maintenance costs were estimated for the entire fleet of public transit bus, rail and ferry vehicles included in each alternative.

Highway Projects

Recent State highway maintenance experience indicates an average annual cost of approximately $18,400 per lane-mile for landscaping, resurfacing, lighting and other related costs. The 84 lane-miles of new roadway included in Alternative B would require an annual maintenance effort of approximately $1.6 million. Special maintenance considerations for the Pearl Harbor tunnel could increase this amount, but by what degree is difficult to assess.

Alternatives A, B and C include high-occupancy vehicle (HOV) lanes and reversible traffic operations which would require field crews to place traffic

TABLE 5-5

SUMMARY OF BUS AND RAIL VEHICLE PURCHASES (1984 - 2000)

Hall 2000 Study

	ALTERNATIVE						
	Committed	A TSM	B Highway	C Bus	D Light Rail[a]	E Light Rail[a]	G Rapid Transit[a]
Standard Bus							
Addition	88	324	88	256	0	0	37
Replacement	670	710	670	670	596	596	650
Subtotal	758	1,034	758	926	596	596	687
Articulated Bus							
Addition	96	140	96	128	14	24	85
Replacement	68	68	68	68	84	94	48
Subtotal	164	208	164	196	98	118	133
Combined Bus							
Addition	184	464	184	384	14	24	122
Replacement	738	778	738	738	680	690	698
Total	922	1,242	922	1,122	694	714	820
Rail Vehicles							
Addition	---	---	---	---	102	104	53
Replacement	---	---	---	---	---	---	---
Total	---	---	---	---	102	104	53
Acquisition Costs (In Millions of 1983 Dollars)							
Bus	160.5	216.3	160.5	195.3	120.3	123.8	143.0
Rail	---	---	---	---	127.5	130.0	72.9
Total	160.5	216.3	160.5	195.3	247.8	253.8	215.9

[a] Vehicle purchases presented for 27-mile light rail and 14-mile rapid transit lines.

TABLE 5-6

TRANSIT CAPITAL COSTS Years 1984 - 2000
(In 1983 Dollars)

Hali 2000 Study

ALTERNATE	RAIL LINE LENGTH	BUS SYSTEM: Bus Purchases[a]	BUS SYSTEM: Vehicle Costs (Millions)	BUS SYSTEM: Facility Costs (Millions)	BUS SYSTEM: Total (Millions)	RAIL SYSTEM: Fixed Facilities (Millions)	RAIL SYSTEM: Vehicle Purchases	RAIL SYSTEM: Vehicle Costs (Millions)	RAIL SYSTEM: Total (Millions)	TOTAL BUS AND RAIL COSTS (Millions)
Committed	--	920	$160.5	$69.0	$229.5	--	--	--	--	$ 229.5
A - TSM	--	1,240	216.3	94.0	310.3	--	--	--	--	310.3
B - Highway	--	920	160.5	69.0	229.5	--	--	--	--	229.5
C - Bus	--	1,120	195.3	94.0	289.3	6.0[b]	6[b]	36.0	42.0	331.3
D - LRT	5	820	143.0	69.0	212.0	94.4	24	30.0	124.4	336.4
	11	790	137.8	69.0	206.8	172.6	46	57.5	230.1	436.9
	17	750	130.8	69.0	199.8	294.8	76	95.0	389.8	589.6
	27	690	120.3	44.0	164.3	386.6	102	127.5	514.1	678.4
E - LRT	5	820	143.0	69.0	212.0	184.7	23	28.8	213.5	425.5
	11	790	137.8	69.0	206.8	279.3	40	50.0	329.3	536.1
	17	760	132.5	69.0	201.5	395.6	73	91.3	486.9	688.4
	27	710	123.8	44.0	167.8	487.2	104	130.0	617.2	785.0
F - Rapid Transit	8	850	148.2	69.0	217.2	625.4	29	39.9	665.3	882.5
	11	830	144.7	69.0	213.7	723.1	41	56.4	779.5	993.2
	14	820	143.0	69.0	212.0	883.3	53	72.9	956.2	1,168.2
	18	790	137.8	69.0	206.8	1,097.4	78	107.3	1,204.7	1,411.9

[a] Bus purchases rounded to nearest 10 vehicles.

[b] Marine bus facilities and water craft.

cones to separate reversible lanes and HOV lanes from normal use lanes, increased enforcement efforts, and increased maintenance of the special signing and pavement markings. The cost of the field crew for cone placement and the additional maintenance needs would approximate $7,000 per mile of HOV or reversible lane. Additional enforcement and maintenance costs are estimated at $8,000 per mile, for a total cost of $15,000 per mile of HOV or reversible lanes. As indicated in Table 5-7, these costs would range from $0.2 million to $0.4 million each for Alternatives A, B and C.

Transit System

The operating and maintenance costs estimated for the bus and rail transit components of each alternative were based upon the level of services and the operating requirements identified in Chapter 4. These requirements were expressed in terms of vehicle miles of revenue service, bus or train hours in service, and the peak number of vehicles in service.

The operating cost experience of TheBus system over the past four years was used to develop unit cost values for the operation of standard size coaches. The unit cost values for operation of articulated buses and rail vehicles were based upon recent experience of other transit properties operating these vehicles, as modified to reflect Honolulu conditions concerning labor rates, electric rates and fuel charges. Consistent assumptions relative to wage rates, work rules and other common elements were made throughout the cost estimates.

TABLE 5-7

INCREASE IN ANNUAL HIGHWAY PROJECT OPERATING AND MAINTENANCE COSTS[a]

YEAR 2000 (In 1983 Dollars)

Hali 2000 Study

ALTERNATIVE	ROADWAY PROJECTS Lane Miles	ROADWAY PROJECTS Costs (Millions)	BUS/HOV LANES Lane Miles	BUS/HOV LANES Costs (Millions)	ALTERNATIVE INCREASE IN COSTS (Millions)
A TSM	--	--	23	$0.4	$0.4
B Highway	84	$1.6	11	0.2	1.8
C Bus	--	--	28	0.4	0.4
D Light Rail	--	--	--	--	0
E Light Rail	--	--	--	--	0
F Rapid Transit	--	--	--	--	0

(a) Increase above Committed System.

Bus Costs - TheBus costs for Fiscal Years 1980 through 1983 were used to develop a formula or model for estimating the annual cost, in 1983 dollars, for operation of standard coaches. A three-part formula was developed by aggregating TheBus cost items into three categories: 1) those associated with revenue hours of bus operation, such as driver wages and fringe benefit costs, training and supervisor costs; 2) those associated with the vehicle miles of service, such as fuel, tires, lubricants, insurance and maintenance costs; and 3) those costs attributed to peak vehicles in service since these cannot be attributed to bus miles or hours of operation, such as yard maintenance and other indirect costs.

The assigned costs and service parameters were calculated for the four-year period, and calibrated to yield the cost formula:

Annual Costs for Standard Coaches = (\$30 x revenue hours) + (\$0.95 x revenue miles) + (\$11,000 x peak vehicles requirement).

The formula was modified for articulated coaches based on mainland experience with fuel economy and maintenance costs since there has been no local operating experience with these vehicles. The formula used to estimate articulated bus costs is:

Annual Costs for Articulated Bus = (\$30 x revenue hours) + (\$1.24 x revenue miles) + (\$14,000 x peak vehicles requirement)

Annual bus operating and maintenance costs were estimated by application of the standard and articulated coach formulae to the projected Year 2000 revenue bus hours, revenue bus mile and peak vehicles in service. The bus operating statistics and the resultant annual costs are summarized in Table 5-8.

Light Rail and Rapid Transit Costs - Cost formulae were developed for these systems similar in concept to the bus formulae. Cost information was derived from other operating systems and adjusted for Honolulu conditions. Considerations in developing the rail cost formulae are:

1. Bus and rail operators would be paid the same wage scale. While operators would need special training for operating the rail vehicles, the modern control systems and the large degree of separation from traffic make the task of operating a rail vehicle easier than a bus.

2. Light rail or rapid transit trains would have only an operator aboard.

3. Cost per vehicle mile has been adjusted for electric prices on Oahu. An average electric rate of 11 cents per kilowatt hour is used, which is based on Hawaiian Electric Company Power Service Schedule P, in effect September, 1983. The estimated rate reflects purchase of electric power at each substation along the line, rather than at a central station.

4. Average electric consumption rates used for the rail systems are as follows:

TABLE 5-8

TRANSIT OPERATING AND MAINTENANCE COSTS
Year 2000 (in 1983 Dollars)
Hali 2000 Study

ALTERNATE	RAIL LINE LENGTH	ANNUAL RAIL OPERATIONS			ANNUAL BUS OPERATIONS			ANNUAL OPERATING COSTS (Millions)		
		Peak Vehicles In Service	Train Hours (Millions)	Vehicle Miles (Millions)	Peak Vehicles In Service	Vehicle Hours (Millions)	Vehicle Miles (Millions)	Rail	Bus	Combined
Existing (1980)	--	--	--	--	335	1.04	15.00	--	$ 53.3	$ 53.3
Committed	--	--	--	--	586	1.72	25.79	--	86.5	86.5
A - TSM	--	--	--	--	790	2.42	36.15	--	117.8	117.8
B - Highway	--	--	--	--	586	1.72	25.79	--	86.5	86.5
C - Bus	--	--	--	--	731	2.20	32.85	2.2[a]	106.8	109.0
D - LRT	5	20	0.06	0.86	448	1.38	19.33	4.2	65.9	70.1
	11	39	0.10	1.69	431	1.31	18.31	7.6	62.5	70.1
	17	64	0.12	2.51	400	1.21	16.96	10.8	57.9	68.7
	27	86	0.14	3.84	366	1.09	15.27	13.9	52.2	66.1
E - LRT	5	19	0.05	0.93	451	1.35	20.02	4.4	65.8	70.2
	11	34	0.08	1.93	434	1.30	19.26	7.7	63.3	71.0
	17	62	0.11	2.91	406	1.22	18.08	11.3	59.4	70.7
	27	88	0.13	3.91	372	1.12	16.60	14.7	54.4	69.1
F - Rapid Transit	8	25	0.04	2.47	467	1.35	19.72	7.7	65.6	73.3
	11	35	0.05	3.53	456	1.32	19.27	10.4	64.1	74.5
	14	45	0.06	4.15	446	1.29	18.85	12.5	62.7	75.2
	18	66	0.08	5.83	433	1.25	18.26	16.6	60.8	77.4

[a] Marine bus operations.

D - At-Grade Light Rail 7.0 kwh/car mile
E - Partially-Separated Light Rail 5.5 kwh/car mile
F - Rapid Transit 4.4 kwh/car mile

5. An additional cost element was added to reflect the operating cost for elevated or subway stations. These costs reflect manned operation during all service hours, plus utilities and maintenance costs.

The resultant cost formulae coefficients for the light rail and rapid transit systems are:

Parameters	At-Grade Light Rail	Partially Separated Light Rail	Rapid Transit
Revenue Train Hours	$30.00	$30.00	$30.00
Revenue Car Miles	2.40	2.24	1.80
Peak Vehicles in Service	16,200	16,200	16,200
Manned Stations	None	152,000	152,000

The lower costs per car mile for the rapid transit and partially-separated light rail systems reflect the lower energy consumption due to fewer stops and lower repair and insurance costs since the vehicles are separated from traffic along part or all of the line.

The resultant estimates of rail system operating costs are summarized in Table 5-8.

Ferry Costs - Ferry costs are estimated at $25 per mile, plus $150,000 per year to operate each of the three terminals. Based on an annual operation of 65,000 miles for service during the peak commute periods, the Year 2000 annual operating cost is estimated as $2.2 million for Alternative C.

COST SUMMARY

The alternative requiring the largest capital investment during the 1984 to 2000 period is Alternative B. The estimated highway project cost of $1.445 billion (1983 dollars) is the principal contributor to the $1.677 billion capital cost of Alternative B, as summarized in Table 5-9. The operations and maintenance costs of the increased highway mileage (Table 5-7), combined with the bus operating costs (Table 5-8), would result in comparatively little difference from the estimated operating costs of the committed system.

Alternative F, with $883.3 million estimated for the 14-mile rail rapid transit line, would require the second largest capital expenditures. The rapid transit system operating costs are projected to be higher than those for either of the light rail systems since it would attract significantly higher peak hour patronage, thus requiring increased peak period rail and feeder bus operations. The rapid transit operating costs would be below that for any of the bus-only alternatives.

TABLE 5-9

CAPITAL COST SUMMARY FOR 1984 TO 2000
(IN MILLIONS OF 1983 DOLLARS)
Hali 2000 Study

COST ITEM	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL(b)	E LIGHT RAIL(b)	F RAPID TRANSIT(c)
TRANSIT:							
Vehicles--Buses	$160.5	$216.3	$ 160.5	$195.3	$120.3	$123.8	$ 143.0
Rail	--	--	--	--	127.5	130.0	72.9
Marine	--	--	--	36.0	--	--	--
Subtotal	160.5	216.3	160.5	231.3	247.8	253.8	215.9
Bus Maintenance Facilities	69.0	94.0	69.0	94.0	44.0	44.0	69.0
Rail Guideway/ Facilities	--	--	--	--	386.6	487.2	883.3
Marine Facilities	--	--	--	6.0	--	--	--
Subtotal	69.0	94.0	69.0	100.0	430.6	531.2	952.3
TOTAL TRANSIT	229.5	310.3	229.5	331.3	678.4	785.0	1,168.2
ROADWAYS(a):							
Highway Facilities	--	--	1,442.2	--	--	--	--
HOV Facilities	--	12.3	3.6	15.3	--	--	--
Total Roadways	--	12.3	1,445.8	15.3	--	--	--
TOTAL PROGRAM	$229.5	$322.6	$1,675.3	$346.6	$678.4	$785.0	$1,168.2

(a) Excludes cost of committed projects.

(b) Costs for full-length 27-mile main line and Waikiki branch line.

(c) Costs for 14-mile line.

Alternative A (Transportation System Management) would require the lowest capital costs and the largest increase in annual expenditures for operations and maintenance. The principal contributor to annual costs is the estimated cost of $118 million for bus operations, which is needed to attract and serve the large increase in transit patronage for this alternative. Alternative C, which requires fewer buses, would require larger capital outlays as a result of the ferry system.

Both light rail alternatives are comparable in terms of operating costs, both for the rail and bus components of the systems (Table 5-8). Alternative E would accommodate slightly fewer passengers than Alternative D, but the forecasts indicate a higher passenger volume on the rail line section which accommodates the maximum passenger loads. (See Chapter 6.) This higher maximum passenger load on Alternative E increases the service needs and operating costs for the line.

For implementation, the grade-separated portions of Alternative E would increase rail capital costs to $487.2 million, as compared to $386.6 million for Alternative D.

CHAPTER 6

TRANSPORTATION SYSTEM PERFORMANCE

The magnitude and characteristics of Year 2000 travel were projected for the "Committed" transportation system and for each of the six alternatives to permit a comparative evaluation relative to the transportation service-related goals and objectives for Oahu. The travel projections were made through use of the Oahu Metropolitan Planning Organization (OMPO) computer travel models.

For purposes of these comparisons, the forecast travel and performance of the "Committed" transportation system is used as the "baseline" condition for the assessment and comparison of the transportation alternatives. Travel information for the existing system in 1980 is also provided to assist the reader in assessing the forecasts of future conditions.

FORECAST METHODOLOGY AND LIMITATIONS

Estimates of Year 2000 travel, travel mode usage, and many of the performance measures were developed for the Committed system and alternatives through use of the computerized regional travel model developed by OMPO for the Hali 2000 Study. The OMPO computer model was used to forecast travel made by Oahu's resident population while separate, special-purpose models were used to estimate commercial vehicle and tourist-related travel.

Methodology for Travel Projections

The OMPO travel model was used to estimate the number of weekday resident trips for each area, the trip destinations, the choice of travel mode, and the trip route. The development of the travel model is described in "The OMPO Travel Demand Models".(1) The model requires three sets of inputs in order to estimate future travel:

1. Forecasts of the magnitude and distribution of population growth and the socioeconomic factors describing future land use on Oahu for the Year 2000. These forecasts of population, households, employment, and

(1)The OMPO Travel Demand Models, prepared by the Oahu Metropolitan Planning Organization, December, 1983.

economic characteristics were developed from projections made by the City of Honolulu Department of General Planning. (See Chapters 2 and 3.)

2. Assumptions about the quality and perceived cost of highway travel in the Year 2000. The existing highway system, plus the committed projects identified in Chapter 4, will produce a comprehensive system of roadways which provide reasonably direct connections to the various communities and neighborhoods. The quality of travel will be dependent upon the impacts that changing volumes of traffic will have upon travel speeds. As traffic on a facility approaches or exceeds the design volume of the facility, traffic speeds are reduced and congestion and delays result, thus making alternative routes or a change in travel mode more attractive.

   Costs for highway travel reflect the perceived cost of operating the automobile plus out-of-pocket parking charges. Automobile operating costs were expressed on a per mile basis. Average parking costs were identified for those areas where all or a part of the drivers must pay for use of a parking space, and were weighted to reflect both the range of parking charges within an area, and the proportion of parkers which must pay for parking.

3. Assumptions about the future level of public transit service and the price of travel by transit (transit fares) in the Year 2000. The future level of transit service was one of the major variables being tested in the alternatives. The different alternatives represented different mixes of local and express buses, increased bus routes and frequencies, and a series of rail systems with different speed characteristics. Similar frequencies of service were used for the rail system alternatives. Bus fares were assumed to be the same in the Year 2000 (in constant dollars) as they are today. Free transfer between bus and rail was assumed as an input to the model, as is the continuation of the present free transfer between bus routes.

A separate model was used to forecast tourist and commercial trips.(2) The estimates of the number and travel mode of future tourist trips were based upon the projected number of average weekday tourists present on Oahu in the Year 2000, and the type of accommodations they would use while on Oahu. Commercial vehicle travel were estimated by use of a uniform ratio of commercial vehicle trips to resident and tourist vehicle trips.

The travel estimates and characteristics produced by the computer-based travel demand model process were modified in three instances:

1. The model estimates of morning peak hour traffic volumes reflect the 7-8 AM period, which is the peak traffic hour for the Downtown area. However, peak traffic volumes tend to occur at an earlier time in

---

(2) Tourist Travel Study in Honolulu, prepared for Oahu Metropolitan Planning Organization by PRC Voorhees, 1984.

the outlying areas, thus causing the model to underestimate the peak one-hour traffic volumes on roadways in these outlying areas. To compensate for this problem, the model estimates of morning peak hour traffic were adjusted for each screenline to reflect the percent of weekday traffic which occurs during the actual peak one-hour period at the screenline. In many areas, this revised peak hour traffic is still less than the actual peak demand since heavily congested conditions may preclude or deter some trips during this period.

2. Model forecasts were made for only the 27-mile main line length for Alternatives D and E and 14-mile line for Alternative F. Estimates of rail patronage for the incremental variations in the line lengths were derived through manual adjustment of the model results for the 27-mile light rail and 14-mile rapid transit system.

3. Water ferry service was not included in the model forecast for Alternative C. Patronage estimates were developed based upon the experience of the Marin County to San Francisco ferry services. Forty percent of the patronage was drawn from automobiles and 60 percent from buses.

Limitations of the Study Methodology

The travel forecasting and analysis methodologies were developed for the purpose of assessing general conditions in the major travel corridors and to identify major differences in travel impacts between the transportation alternatives. Although there is a high degree of uncertainty in forecasting travel conditions for a period 17 years into the future, the forecast procedures and analysis methodology are appropriate for comparing the major travel impacts of the alternatives.

However, the procedures used for the regional study are limited to the extent to which they can be used to identify localized impacts. Particular constraints include:

1. The computer travel model is appropriate for estimation of total corridor travel and traffic conditions, but does not provide sufficient sensitivity to localized roadway conditions to ensure the reasonable distribution of traffic to each facility within a travel corridor.

2. The traffic analyses were based on the morning peak hour travel forecasts. Limitation of the analysis to morning conditions is sufficient for a general assessment of corridor travel conditions, although in some instances afternoon peak hour conditions may be of more critical concern due to higher volumes or difference in corridor travel patterns. More detailed analysis of afternoon peak hour conditions would be needed to further define and analyze those projects identified for further study in each corridor.

3. Design of HOV Lanes - This study focuses on the potential usage and effectiveness of HOV lanes within the travel corridors. The study does not encompass project planning and design and therefore cannot assess the particular operational and safety factors regarding lane location, lane entry and exit, or enforcement. The cost analyses were based upon use of reversible or contraflow lanes for HOV travel which would not require roadway widening.

In summary, the information is intended for use in assessing the impacts of alternatives on corridor travel conditions and assisting in the selection of projects for further, more detailed study. The ensuing corridor and project-specific studies will provide a more detailed analysis of localized impacts.

SYSTEMWIDE TRAVEL MODE USAGE

The Committed System and each of the alternatives would provide either increases in bus services and/or the introduction of a rail system to encourage increased transit ridership, while HOV lanes are included to encourage ridesharing. These differences between the alternatives, however, affect only the computer model forecasts of resident travel since tourist choice of travel mode was made through a procedure largely independent of the alternatives.

Resident Travel by Mode

Travel by Oahu residents in the Year 2000 is estimated to increase to approximately 2.70 million person trips on an average weekday, a 26 percent increase above the 2.15 million average weekday person trips made by residents in 1980.

Committed System - With the completion of the bus expansion program and the highway projects included in the Committed System, model forecasts indicate that public transit would attract 238,200 weekday trips by residents in Year 2000, a 35 percent increase above the 176,000 weekday resident trips by transit in 1980.

As indicated in Table 6-1, the expansion of the public transit services is projected to increase resident use of transit to 8.8 percent of weekday trips, as compared to 8.2 percent in 1980. However, the model forecasts indicate that the increased services would have a far greater effect on work trips, with transit use increasing from 14.9 percent to 18.3 percent of work trips.

Automobile usage with the committed system would increase by 24.6 percent, or slightly less than the increase in person trips.

Alternatives - Model forecasts indicate that Alternatives A and F would have the greatest effect on resident choice of travel mode. The increased public transit services and cost penalties of peak period automobile travel would increase transit use with Alternative A (TSM) by 24,000 trips above the Committed System, to 9.8 percent of resident trips. Impact on transit use for work trips would be greater, 21.7 percent for A versus 18.3 percent for the Committed System, since work trips are made predominately during the periods in which the congestion road pricing would be in effect.

TABLE 6-1

WEEKDAY RESIDENT TRIPS BY TRAVEL MODE[a]

Hali 2000 Study

		YEAR 2000						
TRAVEL PARAMETER	1980	Committed System	A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
By Automobile, with Occupancy of:								
1 Person	780,300	965,200	926,800	972,400	959,400	964,400	967,800	955,100
2 Persons	655,200	816,700	813,600	817,300	813,900	817,000	817,900	810,900
3 or More	540,500	681,500	699,200	677,800	680,000	682,400	682,100	677,200
Subtotal	1,976,000	2,463,400	2,439,600	2,467,500	2,453,300	2,463,800	2,467,800	2,443,200
By Public Transit:[b]	176,000	238,200	262,000	234,100	248,300	238,000	233,800	258,500
Change from Committed System	---	---	+ 23,800	- 4,100	+ 10,100	- 200	- 4,400	+ 20,300
TOTAL PERSON TRIPS BY RESIDENTS	2,152,000	2,701,600	---	---	---	---	---	---
Percent of Resident Trips by Transit	8.2	8.8	9.8	8.7	9.1	8.8	8.7	9.6
Percent Work Trips by Transit	14.9	18.3	21.7	17.7	19.2	18.0	18.0	20.9
TOTAL VEHICLE TRIPS	1,315,500	1,634,800	1,615,600	1,641,300	1,627,300	1,634,400	1,638,400	1,620,700
Change as Compared to Committed System	---	---	- 19,200	+ 6,500	- 7,500	- 400	+ 3,600	- 14,100

(a) Resident person trips only, excludes commercial vehicle and tourist trips.

(b) Linked transit trips which eliminates double counting for transfer between modes.

Alternative A also increases the projected number of automobile ridesharing trips, those made in an automobile occupied by 3 or more persons, by about 18,000 person trips. The increased transit and ridesharing use would result in 19,000 fewer vehicle trips.

The forecast effects of Alternative F on travel mode choice closely approximate those of Alternative A. The introduction of the rail rapid transit line would increase weekday transit use by 20,000 trips, with a corresponding increase in the proportion of work trips by transit. Vehicle trips would be reduced 14,000 below the number projected for the Committed System.

Alternatives B, C, D and E are projected to have only nominal effects on choice of travel mode.

Activity Center Travel Modes - Resident choice of travel mode to the major activity areas, as forecast by the travel model, parallel the systemwide results for the alternatives. Key travel characteristics are presented in Table 6-2 for several of the major activity areas.

In general, Alternative A results in the largest increases in use of transit and automobile ridesharing for resident travel to each of these activity areas, and the lowest estimated number of vehicle trips. Changes in transit use and ridesharing tend to be more pronounced for the activity areas, as compared to the systemwide averages, since the activity areas are major employment centers where work trips constitute a major portion of the trips.

Tourist and Commercial Trips

Weekday tourist travel was projected to increase from 150,400 person trips in 1980, to 183,800 in 2000, an increase of 23 percent. As previously indicated, the number of tourist trips and choice of travel mode -- automobile, private transit or public transit -- were forecast through a process independent of the Hali 2000 alternatives. The forecast weekday tourist travel would be accommodated in 47,200 private vehicle trips (rental cars, tour buses and vans), while 36,200 trips would be made on public transit. The only difference between the Hali 2000 alternatives is whether the tourist trips using public transit would be made on a bus route or rail line.

Weekday commercial vehicle travel for the Committed System and each of the six alternatives approximate 235,000 vehicle trips.

HIGHWAY USAGE AND SERVICE LEVELS

Alternative impacts on traffic volumes and highway conditions reflect both the modifications to the highway system and the extent to which the number of vehicle trips are reduced (increased) by transit and transportation management measures.

Highway System Conditions

Total weekday vehicle trips -- resident, tourist and commercial -- are estimated to increase by 25 percent, from 1,536,900 in 1980 to 1,917,500 for

TABLE 6-2

TRAVEL MODE TO MAJOR ACTIVITY AREAS FOR YEAR 2000 RESIDENT TRIPS

Hali 2000 Study

ACTIVITY AREA	ANALYSIS PARAMETER	1980 TRAVEL	Committed System	YEAR 2000 ALTERNATIVES A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
Downtown	Person Trips	179,000	225,000						
	Auto Trips	101,500	123,500	116,300	124,500	122,900	124,100	124,500	122,700
	% Rideshare	21.3	21.2	22.4	21.0	20.9	21.2	21.2	21.0
	% By Transit[a]	13.9	15.9	18.9	15.5	16.4	15.6	15.2	16.4
Kakaako	Person Trips	136,900	162,100						
	Auto Trips	85,500	101,100	97,200	101,400	100,400	101,600	100,600	99,100
	% Rideshare	22.2	21.3	22.7	21.2	21.3	21.5	21.2	21.2
	% By Transit[a]	7.8	8.3	9.9	8.1	8.7	7.7	8.6	9.7
Waikiki	Person Trips	133,800	176,100						
	Auto Trips	78,900	101,400	98,300	102,000	100,600	101,600	101,500	99,000
	% Rideshare	21.6	21.4	22.0	21.3	21.3	21.6	21.4	21.0
	% By Transit[a]	11.1	12.9	14.7	12.5	13.5	12.5	12.8	14.8
Airport	Person Trips	30,900	43,300						
	Auto Trips	20,600	27,700	27,000	28,200	27,700	28,600	28,700	26,900
	% Rideshare	18.8	20.3	21.4	19.7	20.3	20.5	20.7	20.1
	% By Transit[a]	6.5	8.0	9.1	7.5	8.3	6.0	5.4	10.5
Pearl Harbor	Person Trips	39,000	44,700						
	Auto Trips	26,000	29,500	28,800	29,900	29,300	30,100	29,000	29,800
	% Rideshare	17.6	16.5	17.0	16.2	16.4	16.6	16.2	16.6
	% By Transit[a]	8.4	10.6	11.8	9.8	11.1	9.0	12.1	9.5

[a] Trips made by public transit only; excludes trips made by private bus carriers.

the Committed System in 2000. As indicated in Table 6-3, the transportation alternatives are projected to have only nominal effects upon the total number of vehicle trips. The largest change in total travel is projected for Alternative A (TSM), which is expected to reduce daily trips by 1.1 percent and peak hour trips by 4.3 percent, as compared to the Committed System.

The alternatives, however, differ more significantly in their impact on traffic congestion and vehicle delays. One measure is the vehicle miles of travel which would occur on roadway sections where the traffic volumes exceed the facility's design (desirable) volume.(3) In Table 6-3, the travel mileage is presented for those roadways where the volume exceeds the design volume by 1 to 25 percent, which indicates slow speeds and short delays, and where the volume exceeds design volume by more than 25 percent, which would imply "stop and go" freeway conditions or extensive delays on arterial streets. A second measure, vehicle delay time, indicates the cumulative number of vehicle hours of travel occurring on those roadway sections where hourly volumes exceed the design volume, and thus experience the resultant slower speeds and increased stopping and standing.

The model forecasts indicate that the projects and programs included in the Committed System and the six alternatives would not be sufficient to fully offset the increased highway travel in Year 2000 and would thus result in a worsening of congestion and delays within certain areas, as compared to 1980 conditions. The forecasts also indicate significant differences in highway conditions among the alternatives. Key factors include the following:

- Compared to 1980, the Committed System would experience almost a doubling of vehicle miles of travel on roadways where the hourly volumes exceed the design volume.

- Alternative A (TSM) would result in the lowest levels of Year 2000 highway congestion and delay.

- Alternative B would result in the lowest increases in both vehicle miles and hours of travel as a result of the more direct connection between Ewa and the areas east of Pearl Harbor.

- Alternative D results in the highest estimates of traffic delays and travel on congested roadways. This is due largely to lower roadway capacities for those streets where traffic lanes would be displaced by the construction of the at-grade light rail line.

Corridor Traffic Impacts

Traffic volumes and impacts within each corridor reflect a combination of factors: 1) the magnitude of population and employment growth within the

(3)The design volume used herein is for Level of Service "D" conditions. See Appendix C for definition.

TABLE 6-3

ROADWAY SYSTEM OPERATING CHARACTERISTICS

Hali 2000 Study

PARAMETER	1980	YEAR 2000 ALTERNATIVES						
		Committed System	A TSM	B Highway	C Bus	D LRT	E LRT	F Rapid Transit
Weekday Vehicle Trips	1,536,900	1,917,500	1,895,500	1,924,800	1,910,400	1,916,900	1,921,500	1,901,300
Change as Compared to Committed System	--	--	-1.1%	+0.4%	-0.4%	--	+0.2%	-0.8%
Weekday Vehicle Miles	8,741,100	11,867,500	11,600,500	11,332,600	11,800,500	11,896,400	11,940,700	11,687,500
Change as Compared to Committed System	--	--	-2.3%	-4.5%	-0.6%	-0.2%	-0.6%	-1.5%
Weekday Vehicle Hours	328,900	442,100	421,300	418,900	438,100	460,400	449,900	432,500
Change as Compared to Committed System	--	--	-4.7%	-5.2%	-0.9%	+4.1%	+1.8%	-2.2%
Weekday Vehicle Travel Delay Time (Hours)	53,000	82,200	69,400	72,900	80,000	98,700	88,300	77,700
Change as Compared to Committed System	--	--	-15.6%	-11.3%	-2.7%	+20.1%	+7.4%	-5.4%
Weekday Vehicle Miles of Travel at Volume - Capacity Ratios of								
1.00 - 1.25	635,000	1,323,000	959,300	1,131,200	1,245,900	1,475,000	1,216,000	1,240,200
1.25 and worse	217,900	298,500	277,600	307,000	349,800	604,200	383,400	305,600
Proportion of Vehicle Miles of Travel at Volume-Capacity Ratios of 1.00 or worse	10%	14%	11%	13%	14%	17%	13%	13%

corridor; 2) the shift from automobile use to public transit as a result of alternative transit measures/projects; and 3) the increase or decrease in roadway capacity with each alternative.

For purposes of this system planning study, traffic volumes and roadway conditions were analyzed at the screenline locations within each corridor (Figure 2-2).

The total inbound traffic volumes forecast for all major roadways crossing each screenline during the morning peak hour period are presented in Table 6-4. Traffic conditions at each screenline are indicated by the ratio of the summed traffic volumes to the combined design volume for all existing and proposed roadways across each screenline. The design volume represents Level of Service D. A ratio in excess of 1.00 indicates that the corridor traffic would be expected to experience undesirable congestion and delays on roadways at that location (Levels of Service E or F). See Appendix C for description of traffic conditions at each Level of Service.

Roadway capacities for each screenline and estimated daily traffic volumes are presented in the Appendices.

High-occupancy vehicle (HOV) volumes are included in the Table 6-4 traffic volumes. For those alternatives and screenline locations where HOV lanes are proposed, the HOV volumes which would use the HOV facility were subtracted from the peak hour volume before calculation of the volume-capacity ratio.

<u>Central Corridor</u> - The population growth and development anticipated in the Central and North Shore areas would increase Year 2000 travel across the screenlines in the Central corridor by approximately 70 percent above 1980 conditions. The magnitude of the increase is generally consistent across each of the screenlines -- Helemano, and Kipapa #1 and #2 -- and for each of the alternatives. Only Alternative A has a significant effect on the estimated traffic volumes, with a 10 percent reduction of traffic across each screenline.

The increased traffic would result in a significant deterioration of future operating conditions across each screenline. At Kipapa #2, traffic volumes would exceed the maximum desirable service volume by 15 to 25 percent, thus indicating the likelihood of greatly lower speeds and increased delays as compared to present conditions. Volumes on roadways crossing Helemano and Kipapa #1 screenlines would approach design capacity levels.

<u>Leeward Corridor</u> - The Waianae and Ewa areas are expected to experience a major increase in population and economic growth relative to the existing conditions. The travel forecasts for the Committed System indicate traffic increases of 57, 90 and 37 percent above 1980 traffic volumes for Kahe Point, Waikele and Kalauao screenlines, respectively.

At present, the corridor experiences traffic problems on the roadways between the Aiea area and the Waipahu-Pearl City junction of the H-1 and H-2 Freeways. Congestion in this area is reflected by the Kalauao screenline volume-capacity ratio of 1.07 for the 1980 conditions.

TABLE 6-4

MORNING PEAK HOUR TRAFFIC CONDITIONS AT ANALYSIS SCREENLINES

Hali 2000 Study

SCREENLINE LOCATION		1980	YEAR 2000 ALTERNATIVES: Committed System	A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
CENTRAL CORRIDOR:									
Helemano	Volume	800	1,400	1,200	1,400	1,400	1,200	1,200	1,200
	V/C Ratio[a]	0.51	0.93	0.80	0.93	0.93	0.80	0.80	0.80
Kipapa #1	Volume	3,800	6,400	5,800	6,400	6,200	6,200	6,300	6,200
	V/C Ratio[a]	0.58	0.97	0.88	0.97	0.94	0.94	0.95	0.94
Kipapa #2	Volume	---	8,200	7,400	8,200	8,000	8,200	8,200	8,100
	V/C Ratio[a]	---	1.24	1.12	1.24	1.21	1.24	1.24	1.23
LEEWARD CORRIDOR:									
Kahe Point	Volume	1,400	2,200	2,000	2,300	2,200	2,400	2,400	2,200
	V/C Ratio[a]	0.69	1.10	1.00	1.15	1.10	1.20	1.20	1.10
Waikele	Volume	4,000	7,600	7,000[b]	8,100	7,300	7,700	8,000	7,300
	V/C Ratio[a]	0.44	0.84	0.65	0.57	0.81	0.85	0.88	0.81
Kalauao	Volume	12,100	16,600	14,900[b]	17,400	16,200	16,700	16,900	16,200
	V/C Ratio[a]	1.07	1.28	0.95	0.96	1.25	1.28	1.30	1.25
EAST HONOLULU CORRIDOR:									
Kapakahi	Volume	4,800	5,500[b]	5,100[b]	5,500[b]	5,500[b]	5,600[b]	5,500[b]	5,400[b]
	V/C Ratio[a]	1.23	1.16	1.02	1.16	1.16	1.18	1.16	1.14
Niu	Volume	2,800	4,000[b]	3,500[b]	4,000[b]	4,000[b]	3,900[b]	3,900[b]	3,800[b]
	V/C Ratio[a]	1.08	1.28	1.04	1.27	1.27	1.24	1.24	1.20

(a) Ratio of morning peak hour, peak direction traffic volume to the design service volume at Level of Service D. Ratios above 1.00 represent Levels of Service E or F, which indicate undesirable levels of congestion.

(b) Traffic volumes include HOV volumes. Where HOV lanes are proposed, the volume capacity ratio reflects only the nonHOV traffic volumes and capacities.

TABLE 6-4
(Contd.)

MORNING PEAK HOUR TRAFFIC CONDITIONS AT ANALYSIS SCREENLINES

Hali 2000 Study

SCREENLINE LOCATION		1980	Committed System	YEAR 2000 ALTERNATIVES: A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
DOWNTOWN CORRIDOR:									
Moanalua	Volume	12,400	15,100	13,600[b]	15,400	14,500	15,200	15,300	14,600
	V/C Ratio[a]	1.07	0.83	0.69	0.85	0.80	0.84	0.85	0.81
Kapalama	Volume	15,300	16,600	15,000	17,100	16,000	16,700	16,800	16,000
	V/C Ratio[a]	1.07	1.16	1.05	0.97	1.12	1.23	1.17	1.12
Nuuanu	Volume	17,300	19,300	17,000	19,800	18,700	19,300	19,600	18,700
	V/C Ratio[a]	0.92	0.98	0.87	0.86	0.95	0.98	1.00	0.95
School St.	Volume	---	11,900	10,500[b]	11,800	11,400	10,800	12,000	11,500
	V/C Ratio[a]	---	0.90	0.70	0.80	0.86	0.82	0.91	0.87
Ward	Volume	14,000	15,500	14,000	15,100[b]	15,500	15,600	15,700	15,100
	V/C Ratio[a]	0.78	0.87	0.78	0.69	0.87	0.95	0.88	0.85
Manoa-Palolo	Volume	12,900	17,100	15,300	16,400[b]	17,000	17,200	15,900	13,200
	V/C Ratio[a]	0.60	0.80	0.72	0.71	0.80	0.81	0.85	0.78
WINDWARD CORRIDOR:									
Trans-Koolau	Volume	7,000	9,800	9,600	9,800	9,800	9,900	9,900	9,400
	V/C Ratio[a]	1.03	0.96	0.94	0.96	0.96	0.97	0.97	0.92
Kualoa	Volume	200	500	400	500	500	500	500	500
	V/C Ratio[a]	0.27	0.67	0.53	0.67	0.67	0.67	0.67	0.67
Kawainui	Volume	1,400	3,500	3,100	3,300	3,500	3,500	3,500	3,400
	V/C Ratio[a]	0.44	1.09	0.97	1.03	1.09	1.09	1.09	1.06

(a) Ratio of morning peak hour, peak direction traffic volume to the design service volume at Level of Service D. Ratios above 1.00 represent Levels of Service E or F, which indicate undesirable levels of congestion.

(b) Traffic volumes include HOV volumes. Where HOV lanes are proposed, the volume capacity ratio reflects only the nonHOV traffic volumes and capacities

The Committed System includes roadway widening projects and expansion of the bus services to reduce the present traffic problems and to serve the major growth envisioned for this area. The scale of these committed improvements, however, is insufficient to accommodate the forecast travel demands and would result in a worsening of congestion in the vicinity of the Kalauao screenline, as indicated by the volume-capacity ratio of 1.28. Also, traffic volumes at Kahe Point are projected to exceed the design service volume of Farrington Highway, thus indicating a deterioration in traffic conditions between the H-1 Freeway terminus and Nanakuli.

The transportation systems management projects and programs included within Alternative A would encourage a shift to use of transit and ridesharing sufficient to reduce morning peak hour traffic by approximately 10 percent at each Leeward screenline. Additionally the H-1 Freeway HOV lanes could potentially attract use by as many as 2,500 buses and carpools (with two HOV lanes), thus removing these vehicles from the normal flow lanes. The combined effect of these two measures would reduce peak hour traffic to the design service volume in the general traffic lanes.

Alternative B, with the increased directness of travel and added capacity provided by the Ewa Parkway/Pearl Harbor Tunnel, would make automobile travel more attractive in the corridor and would result in increased vehicle travel across each Leeward screenline. The additional Ewa Parkway capacity would be sufficient to accommodate projected Alternative B traffic volumes at Kalauao. However, the Parkway does not extend far enough to alleviate the increased traffic congestion at Kahe Point.

The model forecasts indicate that the bus service increases of Alternative C and the construction of a light rail line (Alternatives D and E) through the corridor to West Beach would not reduce peak hour traffic volumes, nor improve the highway conditions in the corridor beyond those forecast for the Committed System.

Alternative F (rail rapid transit), which would extend in the Ewa direction to Pearl City, would result in a nominal decrease in highway traffic volumes, but with no significant effect on corridor highway conditions.

Windward Corridor - The socioeconomic forecasts indicate that the increase in population will continue to exceed the increased employment opportunities in the Koolaupoko and Koolauloa areas. This difference in Windward population and employment growth is reflected in the projected 40 percent increase in morning peak hour commuter traffic across the Trans-Koolau screenline into the Primary Urban Center employment centers.

Present traffic volumes across the Trans-Koolau screenline approximate the design capacity of the Pali and Likelike Highways. The Committed System, with the additional capacity provided by H-3 Freeway, would be able to accommodate the projected Year 2000 traffic increases with highway conditions similar to or improved upon the 1980 conditions.

The growth projected for the Laie area would increase traffic crossings of the Kualoa screenline by a much greater proportion than the average traffic growth projected for Windward Oahu. The roadway capacity at Kualoa would be sufficient to accommodate the projected increase in morning inbound peak hour traffic, although congestion could occur on weekends or weekday afternoon periods which experience more tourist travel. At the Kawainui screenline, a projected 150 percent in traffic increase would result in reduced travel speeds and increased congestion on major roadways in the area.

East Honolulu Corridor - The East Honolulu corridor is served by a single major arterial -- the Kalanianaole Highway. In 1980, Kalanianaole Highway had an inbound peak hour volume of 4,800 vehicles at the Kapakahi screenline, which approximates the roadway capacity (Level of Service E) for this facility. Peak hour volume in 1980 at the Niu screenline was slightly below the design volume. Traffic volumes are forecast to increase by 22 and 43 percent at the Kapakahi and Niu screenlines, respectively.

The Committed System includes the widening of Kalanianaole Highway with provision for two reversible-flow median lanes which would operate in the peak travel direction during the morning and evening peak traffic periods. Current plans are to reserve the reversible lanes for HOV traffic and maintain the current number of three inbound lanes for general traffic use at Kapakahi and two lanes at Niu. Increased travel speeds and reduced trip times for vehicles using the reversible median lanes are intended to encourage increased bus ridership and carpooling.

The travel model projections for the Committed System indicate that the reserved HOV lanes would attract sufficient bus and carpool usage to offset the increased Year 2000 travel volumes at the Kapakahi screenline. Traffic using the general traffic lanes would experience congestion and delays similar to 1980 conditions. The traffic forecast and analysis at the Niu screenline indicate that the traffic conditions would be expected to worsen to the levels currently experienced in the Aina Haina section of Kalanianaole Highway. Projected HOV volumes would permit free-flow travel conditions in the two reserved HOV lanes.

Downtown Corridor - Although the Primary Urban Center is projected to experience the largest number of new residents and employees, the percentage increases are low when compared to those forecast for other areas of Oahu. This, plus more extensive use of transit for peak hour trips in the Primary Urban Center, results in low increases in vehicle travel across the screenlines. Traffic increases for the Committed System, as compared to 1980 inbound peak hour volumes, range between 8 and 12 percent for the screenlines closest to the Downtown area, and 22 and 33 percent, respectively, for the Moanalua and Manoa-Palolo screenlines.

On the Ewa side of Downtown, the roadways across the Moanalua screenline presently experience morning peak hour volumes in excess of the design capacity. However, the widening projects now underway along the Moanalua Freeway and its frontage roads would provide a sufficient increase in capacity to accommodate estimated Year 2000 traffic in the section between Aiea and Middle Street.

The Ewa side screenlines closer to Downtown both presently experience peak hour congestion and delays, particularly on the H-1 Freeway facility. The Nuuanu screenline ratio of total crossings to total capacity understates traffic problems in this area since several of the arterial streets are underutilized, while others are more congested than indicated by the "average" condition for the screenline roadways.

Alternatives A and B would each significantly affect roadway conditions at the Kapalama and Nuuanu screenlines. Alternative B would provide an increased roadway capacity of 3,400 vehicles per hour per direction (Nimitz Viaduct) across the two screenlines, which would be sufficient to meet the forecast Year 2000 peak traffic needs. These two screenlines would be located within the area affected by the congestion road pricing scenario of Alternative A. The model projections indicate Alternative A would reduce screenline traffic by 10 to 14 percent and provide traffic conditions similar to those experienced in 1980.

The public transit service expansions in Alternatives C, D and E would have little effect upon traffic volumes across the Kapalama and Nuuanu screenlines, while Alternative F is projected to reduce traffic by 5 percent. As indicated by the volume-capacity ratios, Alternative D would result in a slight deterioration in traffic conditions where the at-grade light rail line would displace traffic lanes and reduce roadway capacity.

School Street screenline indicates sufficient capacity to accommodate the projected Year 2000 traffic demands, although conditions on individual facilities (e.g., Pali and Likelike Highways) could be substantially worse than indicated by the average volume-capacity ratio. Alternatives A and B would have the most favorable impact upon traffic conditions since each includes reversible lanes on Pali and Likelike Highways. This would provide an additional lane in the peak traffic direction. In Alternative A, the additional lane in the peak flow direction would be used for HOVs, and in Alternative B, for general traffic.

An improvement in traffic operations is also projected for Alternative D as a result of reduced traffic volumes. This results from the proximity of the areas above the School Street screenline to the at-grade light rail line, and a resultant increase in transit use.

The Ward Avenue screenline would experience an 11 percent increase in traffic with the Committed System. The volume-capacity ratios of 0.78 (1980) and 0.87 (2000) greatly understate the congestion and delays in this corridor since the major facilities across the screenline (H-1 Freeway, Beretania, Ala Moana) experience volumes in excess of their design service volumes, while the minor arterials are underutilized. The effect of the alternatives on Ward Avenue screenline conditions parallel those discussed for the Kapalama and Nuuanu screenlines.

Highway Travel Times

The effect of the transportation alternatives on highway travel conditions is also reflected in changes in automobile travel times between locations within the different corridors. As traffic volumes approach and exceed the desirable capacity of roadways within a corridor, motorists experience decreases in travel speeds and increased delays which affect the time required for the trip.

Trip travel times by automobile were estimated for 1980 morning peak hour conditions, and with each alternative for the Year 2000 conditions. Estimates for both 1980 and 2000 trip times were derived from the computer model synthesis of morning peak hour travel. The highway travel times were determined for trips to major employment centers in the Primary Urban Center -- Downtown, Waikiki, and the Honolulu International Airport -- from various communities throughout Oahu. The resultant estimates of trip times are presented in Table 6-5.

The model synthesis of travel times is appropriate for comparing travel times between alternatives within the same corridor. Its usefulness is limited in comparing trip times between different corridors, or comparing automobile and transit travel times (Table 6-8) due to the computer model procedures in selection of travel routes and use of travel time - travel cost trade-offs and penalties, as well as the choice of local and express transit service.

The impact of the alternatives on trips in the Leeward corridor is reflected in the trip times from Waianae and Ewa Beach. Alternative B, with the more direct route and increased capacity between the Leeward areas and the Primary Urban Center, would result in a reduction in travel times ranging between 7 and 25 minutes, as compared to the Committed System. Alternative D would increase travel times, primarily as a result of the traffic lanes for the light rail line.

Traffic volumes are projected to increase, with commensurate increases in congestion and delays, on the Diamond Head bound roadways from Downtown to the University of Hawaii and Waikiki areas. The increasing congestion in the Diamond Head bound direction is reflected in the significantly greater increases in Year 2000 trip times from Leeward locations to Waikiki than the increases to Downtown and the Airport.

Travel times from Kailua reflect the effect of the future conditions in the Windward corridor. Trip times are faster to the Airport and to Downtown for the 2000 Committed System than for 1980 as a result of the faster speeds on the H-3 Freeway, and the attraction of traffic to use H-3 in lieu of the Likelike and Pali Highways. Changes in trip times between alternatives are nominal.

In the East Honolulu corridor, trip times in general traffic lanes from Hawaii Kai are expected to show little change from 1980 or between the alternatives. The shorter trip times using the Kalanianaole Highway HOV lanes are not reflected in Table 6-5.

Nominal changes are indicated for trip times within the Primary Urban Center (Makiki and Airport trip origins) with the exception of Diamond Head direction travel between the Downtown area and Waikiki. Within the Primary Urban Center, Alternative D increases trip time by several minutes while Alternative F reduces trip time by several minutes.

TABLE 6-5

HIGHWAY TRAVEL TIMES TO SELECTED ACTIVITY CENTERS

MORNING PEAK HOUR CONDITIONS

Hali 2000 Study

		TRAVEL TIME (IN MINUTES)							
FROM	TO	1980	Existing + Committed	A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
Waianae	Downtown	60	69	75	54	68	76	68	68
	Airport	51	53	57	44	53	55	53	52
	Waikiki	67	79	85	72	89	96	82	79
Ewa Beach	Downtown	43	55	53	29	55	61	54	54
	Airport	34	37	35	18	38	40	38	37
	Waikiki	50	65	63	40	67	78	68	65
Mililani	Downtown	34	44	42	38	43	50	44	43
	Airport	25	26	24	23	26	29	27	26
	Waikiki	41	55	52	49	56	62	57	54
Kailua	Downtown	35	34	37	38	34	35	34	32
	Airport	45	39	38	39	39	40	39	38
	Waikiki	42	45	43	43	48	49	47	42
Hawaii Kai	Downtown	37	39	37	40	39	40	39	37
	Airport	46	49	48	46	48	50	38	46
	Waikiki	32	37	36	36	37	37	37	35
Makiki	Downtown	10	11	11	10	11	13	11	11
	Airport	21	21	21	19	21	22	21	20
	Waikiki	4	6	6	5	6	6	6	5
Airport	Downtown	14	17	16	15	16	20	16	17
	Waikiki	21	28	28	27	29	32	30	28

Highway User Costs

The alternatives would affect the cumulative cost of private vehicle operation on Oahu. Motorists may experience either a reduction or an increase in the annual mileage driven, with a comparable change in vehicle-related costs, as a result of:

1. New roadway projects which reduce trip distance between areas;

2. Decrease or increase in congestion which affects the vehicle miles driven to bypass the problem area; and

3. Shift of automobile drivers to use of transit or ridesharing.

These changes in vehicle travel would affect the annual expenses of operating private vehicles, and the costs to the community from motor vehicle accidents. These costs include only private vehicles since changes in public transit costs have been addressed in Chapter 5. A value has not been included for changes in travel time since much of the change represents a shift between travel modes.

The analyses have been expressed as differences between each alternative and the Committed System.

Vehicle Operating Costs - Changes in the annual expenses for motor vehicle operation have been based upon the computer model travel forecasts and the Federal Highway Administration's unit vehicle operating costs.(4) The 18.5 cents per mile unit operating cost reflects the 1983 variable cost of compact automobile operation such as gas, oil, maintenance, tires and depreciation, but excludes insurance and parking costs. Commercial vehicle costs have not been estimated separately due to the relatively small proportion of travel during the peak traffic periods and the limited effects of the alternatives upon commercial vehicle travel.

The effect of the alternatives upon Year 2000 annual operating costs, as expressed in 1983 dollars, is summarized in Table 6-6. The most significant reduction, $35 million, would occur with Alternative B as a result of the more direct highway connection between the Ewa area and the Primary Urban Center. Alternative A would result in an estimated $17.6 million reduction in vehicle operating costs; however, this does not reflect the approximately $30 million which would be paid by motorists for the road congestion user charges.

Accident Costs - Motorists may also benefit from transportation system improvements through reduced accident losses. Motorists' accident losses would vary as a function of the total vehicle miles driven on the various roadway facility types (freeway, expressway, arterial). The methodology and the estimated number and severity of highway accidents are described in the "Travel Safety" section of this chapter.

---

(4)Federal Highway Administration, Cost of Owning and Operating Automobiles and Vans, 1982.

TABLE 6-6

ECONOMIC EFFECTS OF ALTERNATIVES ON HIGHWAY USERS

Hali 2000 Study

ALTERNATIVE	YEAR 2000 ANNUAL OPERATING COSTS IN MILLIONS OF 1983 DOLLARS		
	Vehicle Operation	Accidents	Combined
Committed System[a]	$780.0	$79.0	$859.0
Change as Compared to Committed System:			
A TSM	- 17.6[b]	- 1.4	- 19.0[b]
B Highway	- 35.2	- 2.0	- 37.2
C Bus	- 4.4	- 0.4	- 4.8
D Light Rail	+ 1.8	+ 0.2	+ 2.0
E Light Rail	+ 4.8	- 0.2	+ 4.6
F Rapid Transit	- 11.8	- 0.9	- 12.7

[a] Includes vehicle travel on major roadway system; excludes public transit costs.

[b] Excludes approximately $30 million in congestion pricing road user charges.

A dollar value was estimated for these accidents based upon 1982 National Safety Council statistics, as adjusted to reflect Honolulu prices in 1983. The average costs per accident used in this analysis are:

Fatal accidents	$205,000
Injury accidents	8,200
Property damage only	1,100

The resultant estimates of Year 2000 accident losses to private vehicles are summarized in Table 6-6.

Combined Results - As compared to the Committed System, Alternatives B, A and F would result in the largest "savings" in Oahu vehicle operating costs in the Year 2000. The decreased annual costs would be largest for Alternative B, with the reduction of $37.2 million. Higher fuel or other taxes, and the Alternative A congestion pricing charges, which may be required to implement these alternatives are not included in the highway user cost analysis.

HIGH OCCUPANCY VEHICLE TRAVEL AND FACILITY USE

High occupancy vehicle (HOV) usage was projected for the major travel corridors by the computer travel model based upon how each alternative affects the trip time and costs for each travel mode (single-occupant automobile, carpool, public transit). The resultant forecasts indicate the effectiveness of the alternatives in encouraging shared rides. This HOV assessment includes only automobiles and other private vehicles with three or more passengers; public transit use is addressed in a separate section.

Alternatives Effect on Ride-Sharing

The island-wide travel summary, as presented in Table 6-1, indicates the person trips made in automobiles with three or more occupants would constitute the same proportion of travel in the Year 2000 with the Committed System (25.2 percent) as in 1980 (25.1 percent). On a weekday basis, Alternative A is projected to increase HOVs by the largest amount -- 2.6 percent -- while alternatives would have no significant effect.

However, the measures which encourage ride-sharing are focussed on travel during the peak traffic hours. Analysis of morning peak hour travel indicates much more pronounced differences between the alternatives in carpool formation and use, as indicated in Table 6-7 for those corridors and screenlines affected by these ride-sharing measures.

Projected screenline traffic information for Alternative A indicates that during peak hours, HOV volumes would increase by 8 to 22 percent for the various screenlines, as compared to the Committed System. Increases are greatest on the East Honolulu and Windward approaches to Downtown.

Alternative B would result in decreased HOV use in the Leeward corridor where general highway conditions would be improved with the proposed roadway projects. Decreases in HOV volumes are also projected for Alternative F in the Leeward and East Honolulu corridors where the rapid transit line would attract riders from carpools.

HOV Facility Usage

To attract usage, reserved HOV lanes must provide higher travel speeds and shorter trip times than that provided in the general traffic lanes. Therefore, the number of vehicles using HOV lanes should permit relatively free flow traffic conditions in the reserved HOV lane. Similarly, the HOV lanes are most successful in attracting bus and carpool usage where congested traffic conditions are and will continue to be present in the parallel general traffic lanes. Maximum effectiveness is attained when the HOV lane attracts and accommodates greater usage than the lane would have served as a general traffic lane.

Kalanianaole Highway - As described in "Corridor Traffic Conditions", the general traffic lanes on Kalanianaole Highway would continue to experience severe congestion and delays during peak traffic periods while the provision of two reserved median HOV lanes would permit free flow conditions for the estimated 680 to 980 vehicles using these lanes. Therefore, HOV users would likely be provided a significant trip time advantage over general traffic.

TABLE 6-7

NUMBER OF HIGH OCCUPANCY VEHICLES IN MAJOR TRAVEL CORRIDORS

YEAR 2000 MORNING PEAK HOUR

Hali 2000 Study

LOCATION	VEHICLES WITH THREE OR MORE OCCUPANTS[a] Committed System	A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
Central Corridor							
Kipapa #2	1,320	1,460	1,310	1,310	1,340	1,330	1,310
Leeward Corridor							
Waikele	1,530	1,660	1,460	1,520	1,530	1,530	1,500
Kalauao	2,940	3,320	2,880	2,940	2,960	2,940	2,880
Downtown Corridor							
Moanalua	2,800	3,140	2,750	2,800	2,830	2,810	2,760
Ward	1,250	1,520	1,320	1,250	1,250	1,250	1,240
East Honolulu Corridor							
Kapakahi	980	1,130	980	980	970	980	950
Niu	680	780	680	680	670	670	660
Windward Corridor							
School	1,850	2,250	1,830	1,860	1,860	1,870	1,830

[a] Number of HOVs in peak travel direction across screenline. Includes both those HOVs using the reserved lanes and those using general traffic lanes.

Based upon the forecast carpool and public transit volumes, approximately 4,000 to 4,500 persons would use the two HOV lanes at Kapakahi during the morning peak hour. If all traffic were permitted to use the two median lanes (five inbound general traffic lanes), the two lanes would be used by approximately 3,000 to 3,500 persons.

H-1 Freeway Downtown - In Alternative B, implementation of an HOV lane is proposed for the H-1 Freeway to continue the Kalanianaole Highway HOV lane to Vineyard Boulevard by reversing the travel direction of an off-peak direction lane for peak direction use by HOVs. The projected traffic volumes indicate free flow conditions for the HOV lane at Ward Avenue screenline. This section however, experiences almost equal traffic volumes in both directions during peak periods, both on the Freeway and on surface streets. The reduction of "off-peak" direction travel lane would thus severely impact Diamond Head-bound traffic conditions. Also, more persons may be served by continued use of the lane for general traffic than by use as an HOV lane.

H-1 Freeway Leeward - The extension of the H-1 Freeway HOV lane from Halawa to Makakilo, as proposed in Alternative A, would serve HOV traffic through the capacity-deficient Pearl City-Aiea section represented by the Kalauao screenline. The projected peak hour volume of HOVs would require two reserved HOV lanes to maintain free flow conditions. If only one HOV lane is provided, use of the lane might have to be restricted to buses and registered carpools to avoid the "overloading" of the HOV lane. Reserved use of the lane for HOVs could serve approximately 6,000 to 7,000 person trips during the morning peak hour versus 1,500 to 2,000 persons if continued as a general traffic lane.

The termination of the HOV lanes at Middle street reduces the potential attraction to carpool formation since the roadways in the area between Middle Street and Downtown would be among the most congested in the corridor. To gain full benefit from the Leeward H-1 Freeway HOV lanes, the lanes should continue Diamond Head to the Nuuanu Stream area.

Pali and Likelike Highways - In Alternative A, one off-peak direction lane would be reversed for use by HOV traffic travelling in the peak direction in each of these facilities. Analysis of projected traffic volumes at the School Street screenline indicate that the number of HOV vehicles would likely "overload" the reserved lane and result in congested conditions which offer no advantage over use of the normal flow lanes.

The volume-capacity analysis indicates that a reversible lane operation would be effective in improving traffic conditions on both facilities. The reversible lanes could be initially used as reserved HOV lanes, however, the projected magnitude and composition of Year 2000 traffic indicates that the reversible lanes may eventually be converted to peak direction use for general traffic.

PUBLIC TRANSIT SERVICE AND USAGE

The Committed System and each of the alternatives envision a significant increase in public transit services. The Committed System includes a 50 percent expansion in the public transit fleet size and a 60 percent increase in bus miles of service. Each of the six alternatives provides service increases approximating or greater than the increases included in the Committed System. The alternatives differ primarily in the methods used to provide the transit service increases, with the different methods offering potential differences in service levels, travel speeds, or system capacities.

Levels of Service

The quality of public transit services is reflected in a number of measures: coverage of area, directness of travel, schedule reliability, operating speeds and frequency of service. These factors combine to produce the trip time required for travel by public transit, and to determine the attractiveness of public transit for travel within different areas of Oahu.

Area Coverage and Directness - TheBus currently provides services to most residential areas and employment centers within the Primary Urban Center, and to each of the communities outside of the Primary Urban Center. Each of the alternatives would provide additional routes within these communities and to future major developments.

The alternatives would have significant effect upon the directness of travel on the transit system, as represented by the future need to transfer between lines (or modes) in order to complete a transit trip. The rail alternatives provide a single rail line as a travel spine through the heaviest travel corridor, and use feeder bus routes for access between the line and those neighborhoods not directly served by the line. All-bus alternatives provide a larger number of local and express lines offering an opportunity for travel along the same corridor without transfer.

The model projections indicate that each of the rail alternatives (D, E and F) would require 70 to 75 percent of all public transit passengers to transfer, while the all-bus systems (Committed, A, B and C) would necessitate transfers by 45 percent of riders.

Reliability and Operating Speeds - The alternatives would primarily affect schedule reliability and speeds through separation of transit vehicles from automobile traffic. Transit speeds are improved by operation in exclusive rights-of-way and grade-separated facilities which minimize potential schedule disruptions and delays as a result of traffic accidents, traffic congestion and traffic signals.

Alternatives which would provide such separations from automobile traffic include:

C - 28 miles of reserved bus lanes

D - 17 miles of rail line on exclusive right-of-way

E - 5 miles on grade-separated guideway and
15 miles of rail line on exclusive right-of-way

F - 18 miles grade-separated guideway.

Frequency of Service - No significant difference in service frequency is proposed among the alternatives. Service frequency on the rail lines would be similar to those for the principal local bus routes and more frequent than express bus services.

However, the peak period frequency of the rapid transit service (Alternative F) requires operations of only two- to three-car trains. A reduction of train frequency to 6 to 10 minutes would benefit the rapid transit alternative by permitting the increased efficiency available with longer train lengths (four to seven car trains).

Travel Times - The overall effects of these alternatives on quality of service is reflected in trip travel times. For comparison purposes, trip times from various locales across Oahu to three activity centers -- Downtown, Honolulu International Airport, and Waikiki -- are presented in Table 6-8. These travel times are for morning peak hour conditions in 1980 and 2000, as estimated by the regional travel model. In rail alternatives, travel times via the rail line are reflected in the trip times. Express bus times are used where both local and express routes provide service between the two locations. The transit travel times cannot be meaningful compared to automobile travel times in Table 6-5 due to the differences in the methodology used by the computer to estimate transit and automobile trips.

For communities along the Waianae Coast and the Ewa area, the increased number of bus routes (directness) and service frequency of the Committed System would significantly reduce trip times to the Primary Urban Center as compared to present service. Among the alternatives, faster travel times would result from the more direct bus routes permitted by the Pearl Harbor Tunnel (Alternative B). Alternative F would significantly reduce trip times below other alternatives except for trips to the Downtown area. Alternatives A and C are estimated to provide faster travel to Downtown as a result of increased direct express bus services to Downtown and use of the H-1 Freeway HOV/bus lanes included in these alternatives.

The Alternative F rapid transit line would provide the faster travel times for trips from Central Oahu (Mililani) and the Waipahu--Aiea area to each of the three destinations. Light rail Alternative E provides favorable trip times from communities along its route, but trip times from other communities in the corridor are dependent upon the operational characteristics of the feeder bus service. Alternative D trip times become comparatively longer as the trips extend in the Diamond Head direction due to the slower line speeds along the sections located at-grade within street rights-of-way.

For the Windward area, trip times would be reduced with increased bus services included in the Committed System and the alternatives. Rail Alternatives E and F are estimated to provide faster travel to the Airport and Waikiki through transfers to the rail system in Downtown.

Transit Patronage

The computer travel model was used to estimate transit patronage for each alternative transportation system, based upon the forecast population and

TABLE 6-8

TRANSIT TRAVEL TIMES TO SELECTED ACTIVITY CENTERS

MORNING PEAK HOUR CONDITIONS

Hali 2000 Study

FROM	TO	TRAVEL TIME (IN MINUTES)[a] 1980	Existing + Committed	A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
Waianae	Downtown	72	69	57	47	57	84	72	52
	Airport	62	62	62	57	62	69	63	45
	Waikiki	96	80	80	72	80	103	89	66
Ewa Beach	Downtown	57	41	40	29	40	52	44	48
	Airport	44	44	44	23	44	36	35	41
	Waikiki	81	64	57	50	57	70	61	62
Mililani	Downtown	39	44	34	38	34	37	34	28
	Airport	29	29	29	29	29	29	25	20
	Waikiki	55	55	55	55	55	55	51	41
Kailua	Downtown	31	34	37	38	34	35	34	32
	Airport	47	39	39	39	39	40	33	30
	Waikiki	54	40	40	40	40	40	39	37
Hawaii Kai	Downtown	31	31	31	31	31	30	30	26
	Airport	46	46	46	46	46	42	38	33
	Waikiki	40	40	40	40	40	40	39	24
Makiki	Downtown	28	28	28	28	28	19	19	12
	Airport	45	48	48	48	48	39	35	20
	Waikiki	11	11	11	11	11	8	8	8
Airport	Downtown	16	16	16	16	16	19	14	12
	Waikiki	44	44	44	44	44	38	31	21

[a] The travel times are based on use of rail service in the rail alternatives, and use of local or express bus service in bus-only alternatives. Travel times include walk time to and from transit stop, wait time, travel time and transfer times and are highly sensitive to assumptions concerning future bus routes and frequencies.

socioeconomic conditions presented in Chapter 3, and the service characteristics identified for each system. It is important to note that no land use changes were made to reflect whether a rail line or all-bus system is included within an alternative. Development of a rail facility would likely exert pressures upon the distribution and density of development different from those of an all-bus system.

For the rail alternatives, the computer travel model was used to forecast patronage only for the 27-mile line length of light rail Alternatives D and E, and the 14-mile length of rapid transit Alternative F. Patronage was estimated for the other line lengths by manual adjustment of the model results for these basic line lengths. For these alternatives, the total transit patronage was assumed to remain constant regardless of line length, with rail and bus use varying between the line lengths for each alternative. Passenger volumes along the line segment deleted in a shortened line were analyzed and the passengers reassigned to either a feeder bus route to the relocated line terminus, or to their destination via bus. These manually-derived patronage estimates and resultant bus operating cost estimates for the incremental line lengths do not provide the same consistency and degree of accuracy as those provided for the computer-modelled line lengths. However, the manually-derived patronage and bus cost information should reasonably represent the general magnitude of change between the line lengths.

System Patronage - The regional travel model forecasts a 34 percent increase in weekday patronage for the Committed System, as compared to 1980 transit use. As indicated in Table 6-9, the 600-bus fleet of the Committed System would attract usage by 274,000 passengers on an average weekday, as compared to 205,000 in 1980. Some 12.6 percent, or 34,500 passengers, would use the system in the morning peak hour.

Estimated Year 2000 weekday public transit patronage for the six alternatives falls within a fairly narrow range, from 270,000 to 298,000 passengers. The limited differences between the alternative reflects their general comparability in the service level.

The increased weekday patronage of Alternative A (298,000 passengers) reflects the automobile "disincentives" included among the proposed TSM measures, more so than the improved bus services offered by the fleet expansion to 880 coaches. The peak period roadway congestion pricing program would discourage automobile use for work trips and encourage use of public transit.

In comparison to Alternative A, the improved frequency and directness of service provided by the 800-bus system of Alternative C, which includes bus priority lanes but no automobile disincentives, is forecast to attract significantly fewer weekday and peak hour passengers. The computer travel demand model forecast indicates the additional 200 bus increase would yield only 4 to 5 percent more patronage than the Committed System. This implies that continued expansion of the bus fleet significantly beyond 600 coaches, without complementary measures to encourage bus use and discourage automobile use, would benefit the area primarily through increased rider comfort (less crowding, fewer standees) with little offsetting increase in ridership.

TABLE 6-9

TRANSIT PATRONAGE SUMMARY FOR YEAR 2000

Hali 2000 Study

ALTERNATIVE	RAIL LINE LENGTH (Miles)	TOTAL SYSTEM PASSENGERS Weekday	TOTAL SYSTEM PASSENGERS AM Peak Hour	PERCENT WEEKDAY RESIDENT TRIPS BY TRANSIT	RAIL PASSENGER TRIPS Weekday	RAIL PASSENGER TRIPS AM Peak Hour	DAILY RAIL PASSENGERS PER LINE MILE	MORNING PEAK HOUR MAXIMUM LOAD POINT VOLUME[a]
Existing (1980)	--	205,000	26,100	8.2	--	--	--	--
Committed	--	274,000	34,500	8.8	--	--	--	--
A - TSM	--	298,000	40,800	9.8	--	--	--	--
B - Highway	--	270,000	33,800	8.7	--	--	--	--
C - Bus	--	283,000	35,600	9.1	--	--	--	--
D	5	--	--	8.8	80,000	10,400	14,800	3,400
At-Grade	11	--	--	8.8	92,300	12,000	9,000	4,000
Light Rail	17	--	--	8.8	137,700	17,900	7,200	5,900
	27	274,000	34,300	8.8	151,500	19,700	5,300	6,500
E	5	--	--	8.7	72,300	9,400	12,500	3,700
Partially	11	--	--	8.7	83,100	10,800	7,400	4,300
Separated	17	--	--	8.7	125,400	16,300	6,500	6,400
Light Rail	27	270,000	33,900	8.7	136,200	17,700	4,700	7,000
F	8	--	--	9.6	125,000	17,500	14,700	8,400
Fully	11	--	--	9.6	152,900	21,400	13,600	8,800
Separated	14	295,000	38,300	9.6	169,300	23,700	12,300	9,600
Rapid	18	--	--	9.6	199,300	27,900	11,000	11,300
Transit								

[a] Inbound passengers using rail line at point of maximum loads during morning peak one hour period.

Model forecasts indicate that the rapid transit line (Alternative F), through its faster operating speeds, would attract the largest increase in transit use of any transit alternative (without automobile disincentives). In comparison, the two light rail systems (Alternatives D and E), with their comparatively slower travel speeds, would attract patronage volumes similar to the 600-bus Committed System. Higher patronage is forecast for Alternative D (at-grade) than E (partially grade-separated), however, this may result more from the line location than the grade separation.

Comparison to Other Rail Systems - The daily rail passengers and the rail passengers per mile forecast for Honolulu in the Year 2000 are compared in Table 6-10 to the statistics for several existing systems and the forecasts for several systems now under construction. Forecast rail patronage for the systems under construction are generally for 1995 or 2000.

The forecast rapid transit patronage for Honolulu is similar, on a passengers per mile basis, to estimated patronage for the Miami and Baltimore systems now under construction, and the existing Boston, Washington, D.C. and Atlanta systems. The projected passengers for the 27-mile light rail lines (5,300 for D and 4,700 for E) would rank among the more heavily used light rail systems in North America. The system would experience line volumes per mile similar to those of San Francisco Municipal Railway (MUNI) or Edmonton.

These projected levels of rail system usage in Honolulu are reinforced by the comparison with the present levels of combined bus and rail transit use in the cities with rail systems currently operating or under construction. Ridership on the Honolulu TheBus system is currently equivalent to 97 passenger trips per year per resident.(5) The current level of Honolulu transit use approximates that for Boston, Washington, D.C. and Chicago and exceeds that of many of the other cities, such as Cleveland, Atlanta and Baltimore, by 50 percent or more. The level of current transit use in Honolulu is commensurate with that of most other cities with rail systems.

Corridor Transit Use - The effect of the Committed System and the alternatives upon transit use would vary significantly between the major travel corridors. Presented in Table 6-11 are the total number of public transit passenger trips crossing each screenline in either direction, and the passenger trips as a percentage of the total person trips crossing the screenline.

The most significant increases are forecast for the Leeward and Central Oahu corridor approaches to Downtown. The travel model projections indicate that the Committed System would result in significant increases in both the number and percent of person trips using public transit, with the proportion of trips by transit increasing by one-third to one-half between 1980 and 2000.

Among the alternatives, A and F were estimated to induce the greatest increases in transit use in the Leeward and Central Oahu corridors, while the

(5) Trips include those made each year by both residents and visitors, but divided by the resident population.

TABLE 6-10

TRANSIT USAGE FOR URBAN AREAS WITH RAIL SYSTEMS

Hali 2000 Study

SYSTEM	ANNUAL TRANSIT PASSENGER TRIPS PER CAPITA[a]	RAIL LINE MILES	DAILY RAIL PASSENGERS	
			Total	Per Line-Mile
Rail Rapid Transit:				
Toronto	--	26.6	789,000	29,700
Montreal	--	18.5	434,000	23,500
New York City	222	230.6	3,596,000	15,600
Baltimore[b]	55	13.7	150,000	11,000
Miami[b]	41	21.0	230,000	11,000
Washington, D.C.	98	33.7	354,000	10,500
Atlanta	53	12.5	126,000	10,100
Boston	92	32.9	325,000	9,900
Honolulu[c]	97	14.0	169,000	9,600
Chicago	101	89.4	516,000	5,800
San Francisco (Bay Area)	46	71.5	190,000	2,800
Light Rail Transit:				
Buffalo[b]	30	6.4	65,000	10,000
San Francisco (City)	401	22.0	140,000	6,400
Honolulu[c]	97	28.7	151,000	5,300
Edmonton	--	4.5	21,000	4,700
Portland[b]	40	14.9	42,000	2,800
Newark	57	4.3	7,000	1,600
Cleveland	62	13.2	17,000	1,300
San Diego	18	15.9	13,000	800

(a) Total combined rail and bus passenger trips per capita for current operations.

(b) Estimates for systems under construction.

(c) Honolulu passenger estimates for Year 2000 operations for Alternative F for rapid transit and Alternative D for light rail transit.

TABLE 6-11

WEEKDAY TRANSIT PASSENGER TRIPS IN MAJOR TRAVEL CORRIDORS

Hali 2000 Study

			YEAR 2000 ALTERNATIVES						
LOCATION		1980	Committed System	A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
Leeward/Central Oahu/Downtown:									
Kahe Point	Number	3,400	8,400	10,000	8,000	9,000	7,600	7,700	9,600
	Percent[a]	7.4	10.8	12.8	10.3	11.5	9.7	9.9	12.3
Waikele	Number	9,300	24,700	29,300	21,600	26,000	24,200	24,900	28,000
	Percent	6.4	9.3	11.0	8.1	9.7	9.1	9.3	10.5
Kipapa #2	Number	9,400	16,500	19,000	16,000	17,200	15,400	15,300	17,800
	Percent	5.8	7.5	8.6	7.3	7.8	7.0	7.0	8.1
Kalauao	Number	22,600	43,700	52,500	39,900	45,500	42,600	41,900	48,600
	Percent	6.9	9.5	11.4	8.7	9.9	9.3	9.1	10.6
Kapalama	Number	38,000	59,700	71,700	58,000	61,900	59,500	58,200	66,900
	Percent	9.1	10.8	13.0	10.5	11.2	10.8	10.5	12.1
Windward:									
Trans Koolau	Number	15,900	19,400	25,900	19,200	20,700	18,100	18,100	21,400
	Percent	8.9	9.1	12.2	9.0	9.7	8.5	8.5	10.1
School	Number	27,300	32,900	41,600	32,700	34,700	31,900	30,600	35,400
	Percent	8.6	9.2	11.6	9.1	9.7	8.9	8.5	9.9
East Honolulu/Downtown:									
Niu	Number	7,900	11,900	13,600	12,000	12,200	12,700	12,600	13,700
	Percent	10.7	10.3	11.7	10.3	10.5	11.0	10.9	11.8
Kapakahi	Number	9,800	14,600	16,700	14,600	14,800	15,200	15,000	16,600
	Percent	9.8	9.9	11.3	9.9	10.0	10.3	10.1	11.2
Ward	Number	45,100	72,200	84,700	71,100	74,500	70,900	69,400	79,800
	Percent	8.7	10.8	12.6	10.6	11.1	10.6	10.3	11.9

[a] Percent of total person trips across screenline made by public transit.

increased automobile accessibility between the Ewa area and the Primary Urban Center would reduce transit use for Alternative B. The model forecasts lower transit use for Alternatives D and E across the outlying screenlines where the rail lines are competing against express bus services of the all-bus alternatives. However, the lower proportions in the outlying areas are largely offset at the innermost screenlines where the light rail alternatives compete with the local bus lines of the all-bus alternatives.

TRAVEL SAFETY

On a system-wide basis, the number of transportation related accidents is a function of the amount of travel, and the characteristics of the facilities on which the travel occurs. The Hali 2000 alternatives would result in different numbers of transportation accidents, injuries, and fatalities as a function of each alternative's effect upon the vehicle miles of travel, and upon the distribution of the travel among the various modes and facility types.

Estimates were based upon the accident rates obtained for Hawaii experience, or for similar modes on the Mainland. The estimated numbers of year 2000 highway accidents are below present levels since model estimates of vehicle miles of travel do not fully reflect travel on local streets.

Accident Rates

Accident rates for highway travel were developed from recent State Department of Transportation data for Oahu highways. Rates were developed for accidents, injuries and fatalities for travel on freeways, expressways and arterial streets, as summarized in Table 6-12.

Analyses of bus and rail system accidents were based upon a set of average rates complied for a number of transit systems. These national statistics were used to provide consistency between estimates for bus and rail systems.

Year 2000 Accidents

A total of 10,660 accidents are estimated for combined travel on the major roadways and by the 600-bus public transit fleet for the Committed System. As indicated in Table 6-13, a total of 8,160 injuries and 67 fatalities would be expected to result from these accidents.

Lower numbers of highway accidents and injuries, as compared to the Committed System, are projected for those alternatives which result in lower estimates of highway travel or a relative shift of travel from arterials to expressways and freeways. As a result of the more direct Ewa Parkway route, Alternative B would result in the largest reduction in vehicle miles of travel and projected number of highway accidents. Alternatives A and F would each reduce automobile trips and accidents through attraction to alternative modes.

Transit accidents would be expected to increase as a shift from automobile to transit requires increases in transit services. The exception is Alternative F, which is projected to have a decrease in accidents and injuries

TABLE 6-12

AVERAGE ACCIDENT RATES

Hali 2000 Study

TRAVEL CATEGORY	RATES PER MILLION VEHICLE MILES		
	Accidents	Injuries	Fatalities
Highway Traffic[a]			
• Arterials	2.73	2.04	0.023
• Expressways	2.28	1.73	0.017
• Freeways	1.80	1.40	0.010
Buses	65[b]	52.0[c]	0.08[c]
Rail[c]			
• Light Rail	281	134.0	1.68
• Fully Separated Rapid Transit	0.17	3.65	0.016

Sources: [a] Hawaii Department of Transportation

[b] MTL Inc. for TheBus, Fiscal Years 1977-1982.

[c] Characteristics of Urban Transportation Systems, prepared for U.S. Department of Transportation by COMSIS, 1981.

TABLE 6-13

ANNUAL ACCIDENTS ON MAJOR TRANSPORTATION FACILITIES

YEAR 2000

Hali 2000 Study

MODE	TYPE	Existing + Committed	CHANGE FROM COMMITTED SYSTEM A TSM	B Highway	C Bus	D Light Rail	E Light Rail	F Rapid Transit
Traffic	Reported Accidents[a]	8,890	-230	-340	- 60	+ 60	0	-150
	Injuries	6,820	-180	-260	- 40	+ 20	- 70	-120
	Fatalities	65	- 2	- 2	0	0	- 1	- 1
Bus & Rail	Accidents	1,680	+670	0	+460	+390	+170	-490
	Injuries	1,340	+550	0	+370	- 40	-110	-390
	Fatalities	2	1	0	+ 1	+ 4	+ 3	0
Combined	Accidents	10,660	+460	-340	+400	+450	+170	-640
	Injuries	8,160	+370	-260	+330	- 20	-180	-510
	Fatalities	67	- 1	- 2	+ 1	+ 4	+ 2	- 1

[a] Highway accident statistics reflect only reported accidents on major highway systems.

due to the substantially lower accident rates for fully grade-separated rapid transit systems.

Combined highway and transit accidents, injuries and fatalities are projected at levels below the Committed System for both alternatives B and F. Because of the unique accident characteristics of the light rail systems, Alternatives D and E would result in increased accidents and fatalities but decreased numbers of injuries. Although bus services experience lower accident rates than light rail services, the increased service miles which result from the lower vehicle capacities result in increases in both accidents and injuries.

CENTRAL BUSINESS DISTRICT IMPACTS

In addition to the impacts of the transportation alternatives on the regional accessibility of the Honolulu Central Business District (CBD), which is addressed in previous sections, the alternatives would also have significantly different effects on automobile parking needs and transit circulation and passenger loading needs. (The Honolulu CBD is that area bounded by River Street, Vineyard Boulevard, Richards Street and the waterfront.)

Transit Circulation Impacts in CBD

The Honolulu CBD attracts some 25,000 passenger trips by public transit each weekday and serves as a major focus for bus routes. At present, between 220 and 250 public transit buses travel through the CBD during each hour of the morning and evening peak traffic periods. The majority of the buses traverse the CBD on Hotel and King Streets for Ewa and Diamond head direction travel, respectively. Current bus volumes, which range between 80 and 100 buses per hour on each of these two streets, have reached the maximum levels which can be accommodated by the curb lengths and sidewalk passenger waiting areas available for use as bus stops along these streets.

The Committed System and Alternative B would each increase bus travel to the CBD by 50 percent while Alternatives A and C would double the number of buses on CBD streets. These increased bus volumes would have to be accommodated on streets other than Hotel and King Streets, such as Beretania, Bishop and Alakea Streets. However, each of these streets would pose severe problems for bus use as a result of heavy traffic turning volumes and narrow sidewalk areas. Also, the increased numbers of buses stopping to board/discharge passengers along these streets would adversely affect traffic circulation within the CBD.

Given the problems on these streets, and the narrow widths of other CBD streets, the increased bus volumes with all-bus transit systems may have to be accommodated through development of an off-street bus terminal(s) to provide adequate waiting and boarding areas for bus passengers. Cost for such a facility, which would likely be in the tens of millions of dollars, was not included in capital cost estimates for these alternatives.

The rail alternatives would maintain or reduce bus volumes on CBD streets since the rail line would replace/reduce bus services on most of the heavily used lines passing through the CBD (1, 2, 3, 8, 9 and 20). (Increased bus operations would occur on these alternatives as feeder service to the rail system or on bus lines between areas not served by the rail systems.) Depending upon its horizontal and vertical alignment through the CBD, a rail system could require rerouting of the remaining buses from Hotel Street.

CBD Area Parking Impacts

The alternatives would have significant parking impacts within the Honolulu CBD and adjacent areas, given its large number of spaces within a relatively confined area. These differences are important in that the future parking needs could affect the size, composition, and aesthetic values of future development, and would affect development cost. Cost for construction of a parking garage currently approximate $12,000 per space.

In 1982, the CBD and the adjacent Civic Center and Chinatown areas, had approximately 22,500 public and private parking spaces.(6) Based upon the Travel forecasts for Year 2000, the parking requirements in this area would increase to approximately 27,500 spaces with implementation of the committed projects.

Each transportation alternative would affect automobile usage for travel to the CBD area, and the number of parking spaces needed to accommodate this use. Based upon the model forecasts, the alternatives would result in the following changes from the 27,500 spaces estimated for the Committed System:

A	-3,700 spaces	D	+400 spaces
B	+500 spaces	E	+900 spaces
C	-700 spaces	F	-800 spaces

Alternative A would have the most significant impact in reducing parking needs while both Alternatives C and F would also reduce the needed increase in parking. Light rail Alternative E would result in the largest increase in parking needs since it is projected to have the highest automobile use and lowest transit use to Downtown. The low transit use may be attributed to the location of the light rail line along Nimitz Highway and Queen Street through Downtown, which is at the periphery of the area.

SUMMARY OF TRAVEL PERFORMANCE

The analysis of the alternatives was based on the travel needs associated with the land use plans and population forecasts for the Year 2000. These travel needs were estimated through use of the computerized regional travel model which projected the choice of travel mode, traffic volumes, and transit usage with each of the alternatives. The general findings with regard to Year 2000 travel on the Committed System and the alternatives include:

---

(6)Hali 2000 Study, Terminal Facilities Inventory, May 1983.

Committed System

1. Year 2000 travel would increase by approximately 25 percent over 1980.

2. The increase of TheBus fleet to 600 coaches would attract 34 percent increase in public transit ridership. Public transit usage would increase from 8.2 percent of weekday trips to 8.8 percent.

3. Automobile travel would increase 24 percent. Even with implementation of the committed projects, the projected traffic would result in increased congestion in the Leeward, Central Oahu, Downtown and East Honolulu corridors.

4. The Trans-Koolau roadways would be sufficient to meet the projected Year 2000 traffic, although the peak hour traffic conditions would be approaching Level of Service E. Localized congestion may occur on other major roadways on the Windward side.

5. For the Committed System, as well as all of the alternatives, the mixed traffic lanes on Kalanianaole Highway would continue to experience severe congestion in the peak travel direction. The reversible median HOV/bus lanes would be operating at the desired free-flow condition.

Alternative A TSM

1. Alternative A would have the most significant effect upon Oahu travel as a result of its aggressive automobile disincentives. It is projected to increase transit use by 10 percent and ride-sharing by 3 percent, as compared to the Committed System.

2. The aggressive travel management measures such as the "road congestion pricing" concept used in this alternative, coupled with an expanded bus (or rail) public transit system, could largely mitigate corridor traffic problems.

3. The number of rideshare vehicles in the Leeward Corridor warrants the provision of one, and potentially two, High Occupancy Vehicle (HOV) lanes on the H-1 Freeway. Further analysis is needed to determine the operational feasibility of the contraflow HOV lane(s). To optimize its effectiveness and usage, the HOV lane should extend to the Downtown area.

4. HOV lanes on Pali and Likelike Highways would not provide an incentive to carpooling and transit use in the Year 2000 since the projected number of HOVs would result in similar travel conditions in both the HOV lanes and the nonHOV lanes.

Alternative B Highway Emphasis

1. The Ewa Parkway/Pearl Harbor Tunnel would mitigate traffic congestion and greatly reduce travel time in the Leeward/Central Oahu corridors into Downtown.

2. Provision of peak-direction reversible lanes for general traffic use on the Pali and Likelike Highways would provide more efficient use of the roadways and sufficient capacity to serve forecast traffic volumes.

3. Implementation of a "peak" direction contraflow HOV lane on H-1 Freeway between Kalanianaole Highway and Downtown would result in severe congestion in the off-peak direction.

Alternative C Bus Emphasis

1. The improved frequency and directness of service provided by 800 bus system would attract approximately 4 percent additional weekday riders above that projected for the 600-bus system.

2. Reserved bus lanes on the Leeward H-1 Freeway and the Pali Highway would provide significant time advantage to public transit. Estimated bus and passenger volumes would merit provision of a contraflow bus lane on the H-1 Freeway and Pali Highway.

3. Model forecasts indicate that the Alternative C bus services, as well as the three rail transit alternatives (D, E and F), would not attract sufficient increases in transit patronage to significantly reduce the severe congestion in the Leeward/Central Oahu/Downtown Corridor. Each of these alternatives would also require complementary measures such as contraflow HOV lanes, reversible lanes on one or more Iwilei area streets, and/or highway widenings.

Alternative D At-Grade Light Rail

1. The light rail system is projected to attract transit usage similar to that projected for the 600-bus Committed System. Patronage could be increased by:

   a. Rerouting Waikiki branch line to serve Ala Moana Center.

   b. Minimize transfer requirements by operating Waikiki branch line service through Downtown area to Aiea area.

2. As discussed in Item C.3, Alternative D would not reduce congestion in the Leeward corridor without additional measures.

3. The at-grade rail line may displace arterial street traffic lanes and result in increased traffic congestion in the Iwilei, Downtown, Moiliili and Waikiki areas.

Alternative E Partially Grade-Separated Light Rail

1. Forecast patronage for Alternative E is nominally below that for Alternative D. The patronage difference, however, is a function of the differences in alignment as well as grade-separation.

2. Alternative E attracts the lowest use of transit for travel to the Downtown. This may be largely attributed to the line's location at the makai edge of the Downtown (Queen Street), which increases overall walking distances between the transit stops and many of the major developments.

3. As discussed in Item C.3, Alternative E would not reduce congestion in the Leeward corridor without additional measures.

4. Alternative E would result in less congestion than Alternative D since it is elevated in the Iwilei, Kapiolani and Moiliili areas.

Alternative F Rapid Transit

1. The higher operating speeds would attract an increase of approximately 20,000 passengers per day, with a decrease of 14,000 vehicle trips.

2. The rapid transit line would increase transit use by 5 to 15 percent within the Leeward, Central Oahu and Downtown travel corridors.

3. The rapid transit line would result in a nominal improvement in severe traffic congestion in the Leeward corridor, but would require additional measures to fully mitigate the traffic deficiencies.

CHAPTER 7

ENVIRONMENTAL IMPACTS

The development of transportation projects will result in both positive and negative social, economic and environmental impacts, with the impacts varying for the different geographic areas, impact categories, and population groups. The extent to which these impacts can be evaluated is limited for an islandwide transportation system planning study. Whereas the Hali 2000 Study defines the transportation alternatives and projects only in general locational and descriptive terms, many impact categories are very localized in character and require a well-defined alignment and project description to permit an assessment.

Therefore, the impact categories and measures addressed in the Hali 2000 Study are generally limited to those which relate to regionwide effects, such as energy consumption and daily pollutant emissions. Where possible, a coarse assessment has been made of locational impacts.

IMPACTS ON THE NATURAL ENVIRONMENT

The environmental analyses included use of the Year 2000 travel forecasts to estimate the comparative regionwide pollutant emissions and energy consumption with each alternative. The project components of each alternative were reviewed to identify where adverse effects may occur to air quality, noise levels, water quality, or the ecosystem.

Air Quality Impacts

Air quality impacts of the Hali 2000 alternatives were assessed in terms of the total transportation-related pollutants which would be emitted on the average weekday during the Year 2000. The pollutants include both vehicle exhaust emissions and the portion of power plant emissions attributable to electrical power generation for the rail systems. The estimates were based on the weekday vehicle miles of travel and future average emission factors(1) for each mode of transportation. Table 7-1 indicates the weight of pollutants produced in the Year 2000 for each alternative.

---

(1)U.S. Department of Transportation Systems Center, Characteristics of Urban Transportation, October, 1981.

TABLE 7-1

YEAR 2000 TRANSPORTATION-RELATED EMISSIONS
(TONS PER DAY)

Hali 2000 Study

ALTERNATIVE	CARBON MONOXIDE	HYDRO-CARBONS	OXIDES OF NITROGEN	OXIDES OF SULFUR	PARTIC-ULATES	TOTAL
Committed System	242.4	22.2	28.7	1.3	3.9	298.5
A - TSM	237.4	22.2	28.5	1.3	3.8	293.2
B - Highway	231.9	21.8	27.9	1.2	3.7	286.5
C - Bus	241.4	22.5	28.9	1.3	3.9	298.0
D - LRT At-Grade	242.6	21.8	28.5	1.4	3.9	298.2
E - LRT	243.6	21.9	28.6	1.4	3.9	299.4
F - Heavy Rail	238.5	21.6	28.3	1.6	3.9	293.9

The pollutant which is produced in the greatest quantity, and which is also the most critical to the Honolulu area, is carbon monoxide. Since this pollutant is produced primarily by automobiles, it varies with the number of automobile miles travelled. With the more direct Pearl Harbor tunnel connection, Alternative B would result in the lowest number of automobile miles and generation of carbon monoxide, with approximately four percent less than the Committed System. Alternatives A and F would also result in lower carbon monoxide generation than the Committed System.

Bus travel produces the highest rate of hydrocarbon emissions, while oxides of sulfur are produced in the greatest quantities by the rail modes (power plant emissions). The all-bus systems (the Committed System and Alternatives A and C) would produce comparatively higher levels of hydrocarbons, while the rail systems in Alternatives D, E and F would generate lower hydrocarbon emissions, but increased oxides of sulfur.

Energy Usage

Energy requirements were estimated for both the annual energy consumption to operate the automobiles, buses, and rail vehicles, and the total energy used to construct the transportation facilities and rolling stock included in each alternative. Energy use is expressed in British Thermal Units (BTU), with one gallon of oil equivalent to approximately 138,000 BTUs.

Estimates of annual operating energy consumption were based on the computer model travel forecasts for the Year 2000 and future energy consumption rates anticipated for each mode in U.S. Department of Transportation projections.(2) Energy used in distribution of liquid fuels and energy loss in the conversion to and transmission of electrical energy are reflected in the analyses.

(2)U.S. Department of Transportation, Transportation System Center, Corridor Refinement Studies, June 1981.

Construction energy requirements were estimated using a factor of 24,260 BTUs per 1983 dollar(3) expended for the construction of highway and transit projects, and bus and rail vehicles. Automobile construction energy requirements were not included in the comparison due to the difficulty relating the number of private vehicles to a particular alternative.

Operating Energy - Travel on the major highway network and the public transit system is estimated to require the consumption of approximately 20 million BTUs in the Year 2000 for each of the alternatives, as presented in Table 7-2. As compared to the Committed System, Alternatives A, B and F are projected to provide a one to three percent reduction in the operating energy requirement while Alternatives C, D and E would result in a nominal increase.

Construction Energy Use and Payback Period - Construction energy use, as indicated in Table 7-2, is largest for those alternatives which include construction of a major highway or rail facility. Note that the energy use includes the amount used for vehicle and materials construction at locations outside of Hawaii as well as the construction activity on Oahu.

A measure of the overall energy efficiency of an alternative is the "energy payback period", which compares the annual savings in operating energy to the total amount of construction energy used to obtain these savings. Table 7-2 indicates the estimated number of years required to "pay off" the initial energy investment of each alternative, using the Committed System as the base condition.

Alternative A would require the shortest estimated time period, 10.6 years, to pay off its low level of energy investment. Alternative C, D and E estimates show no operating energy savings and thus would not offset the energy used in implementation based on model forecasts of Year 2000 transit patronage. However, the rail alternatives would be able to accommodate additional passengers with minimal increases in construction energy and thus would improve relative to bus and highway alternatives as travel increases beyond the forecast Year 2000 levels.

Noise Impacts

Transportation noise impacts were evaluated for the major projects and programs included within each alternative. This assessment was made by comparing noise levels typically generated by each type of project/facility to noise level standards considered appropriate for the communities and areas in which the projects would likely be located. The transit noise impact analyses were based on peak single event (intermittent) noise levels, while the highway noise impact analysis is based on the average noise level generated over a one hour period.

Sensitive receptors were identified along each of the general alignments for the major new highway and rail projects. These are summarized in Table 7-3 These receptors do not include those already in close proximity to a major transportation facility noise source.

---

(3) Ibid.

TABLE 7-2

TRANSPORTATION SYSTEM OPERATING AND CONSTRUCTION ENERGY USE

Hali 2000 Study

ALTERNATIVE	TOTAL CONSTRUCTION ENERGY[b] (Millions of BTUs)		ANNUAL OPERATING ENERGY[a] (Millions of BTUs)		TOTAL NUMBER OF YEARS TO PAY OFF CONSTRUCTION ENERGY
	Gross Amount	Compared to Committed	Gross Amount	Compared to Committed	
Committed System	6,836,468	+0	20,474,913	+0	--
A - TSM	9,213,948	+ 2,377,480	20,249,670	-225,243	10.6 years
B - Highway	29,713,648	+22,877,180	19,800,063	-674,850	33.9 years
C - Bus	8,549,224	+ 1,712,756	20,514,658	+ 39,745	No Energy Savings
D - LRT At-Grade	18,197,426	+11,360,958	20,597,568	+122,655	No Energy Savings
E - LRT Grade-Separated	20,519,108	+13,682,640	20,641,067	+166,154	No Energy Savings
F - Rapid Transit	35,143,036	+28,306,568	20,305,999	-168,914	167.6 years

(a) Year 2000 fuel and electrical power used for ground transportation purposes.
(b) Energy required to construct facilities and transit vehicles needed to implement each alternative.

TABLE 7-3

POTENTIAL SENSITIVE NOISE RECEPTORS

NEAR MAJOR PROJECTS

Hali 2000 Study

ALTERNATIVE	LENGTH OF FACILITY ABUTTING RESIDENTIAL AREA	SCHOOLS	OTHER
B Highway	2.5 Miles of Multi-Family	Barbers Point Elem. Hickam Elem.	--
D Light Rail	1.5 Miles of Single Family 1.8 Miles of Multi-Family	Barbers Point Elem Lehua Elem. Makalapa Elem. Radford High Aliamanu Elem.	Blaisdell Park McGrew Park
E Light Rail	1.5 Miles of Single Family 2.6 Miles of Multi-Family	Barbers Point Elem. Lehua Elem.	Blaisdell Park McGrew Park
F Rapid Transit Park	--	--	Keehi Lagoon

Rail Facility Impacts - Typical single event peak noise levels for rail operations are outlined in Table 7-4 for different ranges of operating speed, and for both ground level and elevated alignments. To assist in identifying the potential for rail noise-related problems, these peak noise levels were compared to the community noise standards (Table 7-5) for the various land uses along the potential alignments.

Sensitive single and multi-family residence areas and schools would be primarily located along the former Oahu Railway and Land Company (OR&L) right-of-way in Barbers Point, Waipahu, and Pearl City, and in Aliamanu. It is unlikely that the average residential school noise level standard of 75 dBA would be exceeded in these areas since the operating speed of light rail trains (Alternatives D and E) would be expected to be 40-45 miles per hour or less. If speeds were to exceed this range, noise problems could be mitigated with a sound barrier. The 65 dBA level for a "Quiet" recreation area such as Blaisdell Park could be met by providing a sound wall and limiting rail operating speeds in the area to 40 miles per hour.

East of Pearl Harbor, the at-grade sections of Alternatives D and E would not exceed standards for Average or High Density Residential, Commercial or Industrial areas since speeds would not exceed 40-45 miles per hour. On the

TABLE 7-4

TYPICAL RAIL NOISE LEVELS
(in dBA 50 Feet From Track Centerline)

Hali 2000 Study

	AT-GRADE		ELEVATED	
SPEED (mph)	Without Sound Barrier	With Sound Barrier	Without Sound Barrier	With Sound Barrier
10	57	48	64	55
20	66	57	73	64
30	71	62	78	69
40	74	65	81	72
50	78	69	85	76
60	80	71	87	78

Source: Alan M. Voorhees and Associates "Guidelines for Assessing the Environmental Impact of Public Mass Transportation Projects" prepared for USDOT, April, 1979, pages IV 181-2.

TABLE 7-5

COMMUNITY NOISE LEVEL DESIGN GUIDELINES

Hali 2000 Study

	SINGLE EVENT MAXIMUM NOISE LEVEL DESIGN GOAL		
AREA DESCRIPTION	Single Family Dwellings	Multi-Family Dwellings	Commercial Buildings
Low Density Residential	70 dBA	75 dBA	80 dBA
Average Residential	75	75	80
High Density Residential	75	80	85
Commercial	80	80	85
Industrial/Highway	80	85	85
Amphitheaters	60		
"Quiet" Outdoor Recreation Areas	65		
Concert Halls, Auditoriums	70		
Churches, Schools, Hospitals Libraries	75		

Source: American Public Transit Association elevated section of Alternatives E and F, operating speeds of 40-50 miles per hour would require the provision of sound barriers to mitigate rail noise.

Bus Noise Impacts - The all-bus alternatives would principally result in increased incidence of high noise levels at locations which already experience bus noise impacts, with only a limited number of new routes likely to introduce bus operations into new neighborhood areas. Impacts would be most severe on slopes and at locations where buses must accelerate and decelerate. Maximum bus noise levels are estimated at 80 dBA at 50 feet. Impacts of bus noise on residential streets would be more noticeable than on arterial streets, where other noises could "mask" bus impacts.

Highway Noise Impacts - Due to the constant nature of highway noise, evaluation was based on average noise levels attained during a one-hour period, referred to as the noise equivalent level or Leq. The Federal Highway Administration (FHWA) guideline for maximum Leq levels at residences, schools, churches, parks and playgrounds is 67 Leq.

Anticipated traffic volumes on the proposed Ewa Parkway (Alternative B) are estimated to generate noise levels in the range of 70-75 Leq. Locations where highway generated noise levels might exceed the FHWA guideline include the residential areas and schools at Barbers Point Naval Air Station and Hickam Air Force Base.

Hydrology

The assessment of hydrological impacts centered on the western half of the Alternative D and E rail lines where the lines would follow the former Oahu Railway and Land Company (OR&L) alignment along Pearl Harbor. The OR&L alignment passes through three 100-year flood plains: at Waiawa, McGrew Point and Keehi Lagoon. The rail lines would have to be constructed to a height above 100-year flood level.

Use of the OR&L alignment may require either the relocation of some utility lines or placement of fill along portions of Pearl Harbor in order to accommodate the light rail line where the full forty-foot wide right-of-way is not available. Fill in this area could cause increased sedimentation and erosion in Pearl Harbor.

Ecosystems

Ecosystem impacts are most likely to be brought about by construction of transportation facilities on undeveloped land, such as the western portion of the light rail line (Alternatives D and E) and the Ewa Parkway (Alternative B). These facilities could potentially impact wetlands and other habitat areas.

For Alternatives D and E, the OR&L alignment is close to two National Wildlife Refuges on Pearl Harbor: the Waiawa Unit on the Middle Loch of Pearl Harbor and the Honouliuli Unit on the West Loch of Pearl Harbor. These refuges are habitats for several rare species of water birds, including the Hawaiian Stilt, the Hawaiian Hoot, the Hawaiian Duck and the Hawaiian Gallinule. Rare or endangered plant species which are known to be present in the Ewa or West

Beach areas include Hawaiian Cotton and Coastal Sandelwood. However, it is unlikely that these plants are present within OR&L right-of-way due to its usage as a transportation and utilities corridor.

An endangered plant species which may be present along the Ewa Parkway alignment is euphorbia. Species currently under review for inclusion on the list of endangered species which may be located in the general vicinity of the highway alignment corridor include achyratenhes, myoporum and sicyos.

IMPACTS ON THE BUILT ENVIRONMENT

Impact categories for the built environment include displacement, park land, archaeological and historical, employment, and visual/aesthetic considerations. Each of these subject areas is addressed below in relation to the Hali 2000 transportation alternatives.

Displacement and Neighborhood Impacts

Impacts of each of the alternatives on existing land uses were estimated based on generalized alignments and current land uses in the study corridor. In general, Alternative B (Highway) requires the greatest amount of land area, but Alternative F (Rapid Transit) displaces the largest amount of urban uses. Table 7-6 provides the estimated number of acres of each land use displaced by the alternatives.

Displacement - Alternative B would displace approximately 70 acres of agricultural land and approximately 35 acres of military land, all Ewa of the proposed Pearl Harbor tunnel. Diamond Head of the tunnel, the highway would be almost completely in an aerial alignment above streets and highways, with only small displacement impacts on industrial and commercial properties at viaduct ramp locations.

The rapid transit alternative (Alternative F) could displace up to 5 acres of residential area, primarily at station locations. Approximately 15 acres of commercial property is likely to be displaced, primarily in the central Honolulu area between the Civic Center and the University of Hawaii. The majority of the 35 acres of industrial land would be required for a rail yard.

The light rail alternatives (Alternatives D and E), which are anticipated to mostly use roadway rights-of-way, and the former OR&L right-of-way, would also use small amounts of residential property, agricultural land, and commercial property. Additional land may be required along sections of the former OR&L right-of-way where utility relocation may be necessary in order to accommodate the light rail lines. Industrial land would be used for maintenance and storage facilities.

Bus facility requirements for Alternatives A and C amount to approximately 24 acres of industrial land for storage and maintenance facilities.

Disruption - Neighborhood disruption would be greater for the rail and highway alternatives than for the all-bus alternatives. The raised rail alignments in Alternatives E and F could create psychological barriers between

TABLE 7-6

LAND ACQUISITION REQUIREMENTS FOR ALTERNATIVES BY LAND USE TYPE

(In Acres)

Hali 2000 Study

ALTERNATIVES	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	AGRICULTURAL	PARKS AND PUBLIC FACILITIES	MILITARY	TOTAL
Existing Plus Committed	0	0	12	0	0	0	12
A - TSM	0	0	24	0	0	0	24
B - Highway	0	0.5	0.5	70	0	35	106
C - Bus	0	0	24	0	0	0	24
D - Light Rail	1	0.6	13	4	0.1	0	18.7
E - Light Rail	0	2.5	13	4	1.8	0	21.3
F - Rapid Transit	5	15	35	0	8	0	63

neighborhoods, in addition to requiring the displacement of some residential land and generating traffic and parking demand near stations.

Parkland Impacts

Parkland impacts are most likely to result from rail alternatives which may require the use of parklands for stations, street widenings and aerial support columns, or which may separate parks from adjacent areas. Table 7-7 indicates the parks which could possibly be impacted by numerous possible alignments for each of the rail alternatives.

The former OR&L alignment, which may be utilized by the two light rail alternatives, passes through one existing and one proposed park, and is adjacent to several others. The proposed park is located near the western terminus of the light rail corridor, just south of the Kahe Point Beach Park. The OR&L alignment passes through the existing Blaisdell Park makai of Kamehameha Highway in Waiau. If this right-of-way is utilized by the light rail line, the light rail line would separate the park from the waterfront. Utilization of this section of right-of-way may constitute a taking of park land and may require compliance with Section 4(f) procedures. Other parklands located near the OR&L alignment include the proposed Ewa Mill Park, McGrew Point Park, and Aliamanu Park.

Diamond Head of Pearl Harbor, light rail alignments are generally within existing streets and thus have less potential for parkland impacts. However, use of existing streets for light rail could require street widenings which would result in takings of park property. For example, use of North King or North Beretania Streets for light rail could result in street widenings which would impact Aala Triangle Park. Thomas Square Park could be impacted by widenings of South King or South Beretania Streets, or by the selection of a Young Street alignment. A Kapiolani Boulevard light rail alignment may impact Ala Wai Park. The need for a turnaround for the Kalakaua Avenue light rail line in the vicinity of Kapiolani Regional Park may require a taking of some park land. (Kalakaua Avenue itself is park property Diamond Head of Kapahulu Avenue.) Takings of park lands for an elevated light rail or rapid transit facility would be limited to the possible need to locate guideway support columns or stations within existing parks, such as Keehi Lagoon Park and Ala Wai Park.

Highway improvements which would for the most part impact military lands and existing roadways, and bus service increases would not likely require any taking of parklands. Possible noise and visual impacts of each alternative on parks are discussed in the noise and visual impact sections.

Archaeological and Historical Impacts

Archaeological impacts of the Hali 2000 alternatives would most likely occur with the light rail alternatives (Alternatives D and E) and the highway alternative (Alternative B), where facilities would be constructed on undeveloped land, including the former OR&L right-of-way. Historical impacts are most likely to occur along the developed portion of the corridors, particularly in downtown Honolulu. Section 106 of the National Historic

TABLE 7-7

PARKS POTENTIALLY IMPACTED BY ALTERNATIVES

Hali 2000 Study

PARK	ALTERNATIVE A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
Kahe Point Beach Park				X	X	
West Beach Park (Proposed)				X	X	
Ewa Mall Park (Proposed)		X		X	X	
Blaisdell Park				X	X	
McGrew Point Park				X	X	
Pearl Ridge Park						X
Navy Marina				X	X	
Keehi Lagoon Beach Park						X
Aala International Park				X	X	X
Thomas Square				X		
Moilili Field				X		
Stadium Park				X		
Ala Moana Park		X				
Ala Wai Park					X	X
Ala Wai Park Strip					X	X
Kapiolani Park				X	X	

Preservation Act requires that impact documentation of proposed projects on historical and cultural resources be submitted to the Advisory Council on Historic Preservation for review and comment prior to any Federal agency approval.

Known archaeological and historical resources located near the former OR&L right-of-way include the West Beach archaeological sites near the light rail alternative's terminus, the Barbers Point Archaeological District makai of the alignment, and several Hawaiian fishing ponds in the Waipahu area. A 12-mile portion of the former OR&L right-of-way between Nanakuli and Honouliuli has been preserved for narrow gauge (36 inch) rail operations by the Hawaiian Railway Society, and the facility has been listed on the National Register of Historical Places. Light rail operations within the 40-foot wide OR&L corridor may not be compatible with the operation of the narrow gauge railway.

A rapid transit system through downtown Honolulu may impact historical buildings located within three downtown historical districts which are on the National Register: the Chinatown Historic District, the Hawaii Capitol Historic

District, and the Merchant Street Historic District. A grade-separated rail line may require the demolition of certain buildings within these areas in order to provide stations below or above narrow downtown streets.

If constructed at-grade, light rail impacts on historical sites downtown would likely be less significant than those of a rapid transit line. An at-grade light rail alignment on Hotel Street could impact the Hotel Street Sidewalk Elements, which include distinctive granite paved sidewalks and lava curbing. These elements have been determined to be eligible for inclusion on the National Register. A grade-separated light rail line through downtown would require guideway support columns which may impact historical structures. Any street widenings which may result from light rail construction downtown may impact historically significant buildings.

The Pearl Harbor tunnel section of the highway alternative may impact historical buildings within the Pearl Harbor area, which is on the National Register. Alternatives A and C are not likely to impact any archaeological or historical sites.

Employment Impacts

Table 7-8 indicates the estimated number of construction jobs created by the transportation alternatives. Construction jobs created were estimated based on the construction costs for each alternative, using a factor of ten construction and two service jobs for each one million dollars of construction costs. Construction costs include vehicle construction, which is the primary cost associated with Alternatives A and C.

The rail and highway alternatives, (Alternatives B, D, E and F) would create the greater number of construction jobs, while the bus alternatives (Alternatives A and C) would generate the fewest. It is assumed that while most of the facility construction jobs would be created on Oahu, most new work related to vehicle construction would occur elsewhere.

Visual and Aesthetic Impacts

The rapid transit alternative (Alternative F) is likely to have the greatest visual impact of any of the transit alternatives, since approximately 10 miles of its alignment would be on elevated structure above existing City streets. Elevated structures of this type are sometimes felt to create a "barrier" effect between sections of town. Additionally, the structure can block views of existing buildings and view corridors. Visual impacts could be mitigated downtown by constructing the rail line underground. This would increase construction costs by approximately $150 million above that for an elevated alignment.

Approximately 5.7 miles of the grade-separated light rail line (Alternative E) would be elevated, as would short sections of the Alternative D light rail line (approximately 0.6 miles). In addition to these elevated sections, the light rail lines would require electric wires and poles above the rights-of-way to provide power to the cars. These wires would be approximately 19 feet above the tracks and would impose a continuous visual impact along the length of the alignment.

TABLE 7-8

EMPLOYMENT GENERATED BY CONSTRUCTION OF TRANSPORTATION PROJECTS

Hali 2000 Study

ALTERNATIVE	ESTIMATED NUMBER OF CONSTRUCTION AND SERVICE JOBS
Committed Projects	3,400
A - TSM	4,600
B - Highway	14,700
C - Bus	4,200
D - LRT At-Grade	9,000
E - LRT Grade-Separated	10,000
F - Rapid Transit	17,400

The Nimitz Viaduct and Kakaako Viaduct, key components of Alternative B, would create a visual barrier between downtown Honolulu and the waterfront. The elevations of these structures are likely to range to 30 feet above grade, which could restrict existing views of the water and historical buildings, such as the Aloha Tower, from many of the Downtown streets. The elevated roadway on the Diamond Head side of the Pearl Harbor tunnel would also present a visual intrusion through the military area it would traverse. The total length of elevated structure represented by these roadways is approximately 5.5 miles.

Alternatives A and C are unlikely to produce any significant visual or aesthetic impacts.

Employment Accessibility

Accessibility of residential areas to Waikiki-Downtown-Pearl Harbor employment centers under each alternative was evaluated based on Year 2000 travel time estimates (Chapter 6). In general, many Year 2000 transit travel times would approach the increased travel time for highway mode, both as a result of increased highway congestion and the provision of separate transit facilities. The most significant travel time improvements to employment areas would occur for the transit mode under the rapid transit alternative from the Central Oahu and East Honolulu corridors, and for both the highway and transit modes for the highway Alternative B from the Ewa area.

Impacts of the TSM alternatives (Alternative A) include a moderate reduction in highway travel times in nearly all travel corridors due to the general reduction in traffic, but improvement in transit travel times would be limited to the Leeward Corridor. Alternative B, the highway alternative, would result in shortened highway travel times in most corridors, particularly those from Ewa into the Primary Urban Center. Transit times would also improve from Ewa, but would remain equal to the Committed System travel times from other residential areas.

Alternative C would have only a minor impact on the highway and transit travel times except for reduced transit times from Leeward areas. Alternative D would result in equal or longer highway and transit travel times in most corridors.

Alternative E (grade-separated light rail) would have little impact on highway travel times, but would afford an improvement in transit times to employment centers from most areas. Alternative F (rapid transit) would afford a moderate improvement in most travel times for the highway mode, and would provide the shortest transit travel times from Central Oahu of any of the alternatives.

CHAPTER 8

FINANCIAL FEASIBILITY

Currently, transportation capital and operating costs are primarily funded through government programs, whose funds are generated from fees or general tax revenues, and to a minor extent, by direct revenues from users, such as bus fares. These current programs and funding sources were reviewed to assess their applicability and potential availability for funding of the Hali 2000 transportation alternatives, and to determine the extent to which each alternative would need additional funds from new or increased local sources.

The City and County of Honolulu and State of Hawaii have considered a number of additional sources of local funds in recent years, both for transportation projects and for other governmental programs. These potential sources have been evaluated for their revenue generating potential as compared to the local funds needed for each alternative. Each potential source was also assessed relative to its reliability, appropriateness for transportation purposes, and compatibility with institutional considerations.

ANALYSIS APPROACH AND ASSUMPTIONS

To simplify the comparison of the alternatives, the funding analysis is based on annual expenses incurred in the study horizon Year 2000. The analysis is expressed in 1983 dollars to provide more meaningful cost and funding comparisons without the exaggerated effects of inflation. This approach avoids the potential complexities such as the year of project implementation and incremental increases in operating costs. It also implies a commonality in inflation rates between the capital cost components, operating costs, and revenue sources. Growth in real terms, such as patronage, has been incorporated into the analysis where the information is available.

Project capital costs inflated to year of implementation, and operating costs inflated to Year 2000 are presented for information purposes. Where inflated values are presented, a seven percent rate of inflation has been used, which reflects the current recommendations of the U.S. Department of Transportation, Urban Mass Transportation Administration.

Capital funding for major projects would occur in differing amounts and times for each of the projects. For the purposes of this analysis, it is assumed that the portion of each project cost not funded through presently available sources would be financed through the issuance of local (City and/or State) revenue bonds. The capital cost requirement reflected in the financial analysis thus represents the annual cost of the interest and debt retirement for the Year 2000.

The annual cost (debt service) required to support the bonds will be determined by prevailing interest rates and bonding period. An interest rate of nine percent and a 20-year obligation is used for this analysis. Based upon these assumptions, approximately one dollar in annual tax revenue would be required to service each eight dollars of principal generated by the bond sale.

CAPITAL FUNDING NEEDS

The analyses of capital funding needs focussed upon those projects and costs which differ among the alternatives. Therefore, the costs and funding for the committed highway projects are not presented in this chapter, since these projects are common to all of the alternatives. However, the impact of the committed projects on availability of funds from present funding programs is reflected in the analyses. For the transit component of the alternatives, all vehicle, guideway and facility costs are included for both bus and rail projects.

Project Costs

The capital costs estimated for the major highway projects and for the incremental lengths of the three rail transit alternatives are presented in Table 8-1. All projects include engineering, right-of-way, and construction costs, while the rail projects also include the costs for rail vehicles. Future bus facility costs are shown for those facilities required in one or more alternatives. For information purposes, the escalated capital cost in the year of construction is also presented in Table 8-1 for each project.

Highway Funding Sources and Availability

Current funding sources for major highways on Oahu include Federal Aid Programs, State gasoline tax and motor vehicle fees, and the current State Excise Tax on motor fuels.

Federal Aid Programs - The State currently receives highway funds through several Federal programs. These programs and their funding availability are summarized below.

Federal Aid Interstate. With the completion of H-1 and H-3 Freeways, no additional Interstate funding will be available except for major reconstruction and resurfacing of the presently authorized mileage.

Federal Aid Primary. Hawaii currently receives $8 to $10 million per year in formula-grant Primary funds for expenditure on the designated system of major highways. Increases in Hawaii's population and highway mileage are not expected to increase the Primary funding beyond the minimum 1/2 percent grant to each state. The cost of

TABLE 8-1

ESCALATED CAPITAL COSTS OF MAJOR PROJECTS[a]
Hali 2000 Study

ALTERNATIVE/PROJECT	1983 Base (Cost) (Millions)	Mid-Year of Construction	Escalation Factor	Escalated Cost (Millions)
B - Pearl Harbor				
Tunnel	$1,188	1993	1.97	$2,340
Nimitz Viaduct	147	1989	1.50	221
Kakaako Viaduct	98	1990	1.61	158
Cemetery Road Interchange	9	1989	1.50	14
D - Light Rail				
5 Mile System	125	1988	1.40	175
11 Mile System	230	1988	1.40	322
17 Mile System	390	1990	1.61	628
27 Mile System	515	1992	1.84	948
E - Light Rail				
5 Mile System	214	1989	1.50	321
11 Mile System	330	1989	1.50	495
17 Mile System	487	1991	1.72	838
27 Mile System	617	1993	1.97	1,215
F - Rapid Transit				
8 Mile System	665	1991	1.72	1,144
11 Mile System	780	1993	1.97	1,537
14 Mile System	956	1993	1.97	1,883
18 Mile System	1,205	1995	2.25	2,711
Bus Facilities				
Renovate Alapai Yard	28	1987	1.40	39
1st New Bus Yard	25	1987	1.31	33
2nd New Bus Yard	25	1993	1.97	50

(a) Excludes costs of buses.

constructing the committed highway projects and reconstruction of the current major highway system is expected to fully utilize all available Primary aid funds through the 1980s and into the 1990s.

Federal Aid Urban. Through the State, which is the primary recipient of highway funds, the City and County of Honolulu currently receives $3 to $4 million per year from the Federal Aid Urban program. These funds are available for a broad range of projects and are expected to be fully utilized for committed projects.

State Programs - Hawaii currently has a number of funding sources for the State highway program, in addition to the Federal program. These current revenue sources include:

1. Fuel Gallonage Tax. The 8.5 cents a gallon State motor fuel tax is expected to yield $28.4 million in Fiscal Year 1984.

2. Vehicle Weight and Registration Fees. Current fees of $1 per vehicle for registration plus 4.5 cents per pound for automobiles should produce about $8.8 million in Fiscal Year 1984.

3. General Fund/Excise Tax. As a temporary measure (expires in 1984), the Legislature has allocated the proceeds from the 4 percent excise tax on motor fuels to the State Highway Account. This amounts to approximately $18.1 million in Fiscal Year 1984.

The above sources are expected to be fully used for construction of committed projects and for maintenance during the study period.

Transit Funding Sources and Availability

The only major funding programs existing for transit projects are the Federal Urban Mass Transportation Administration (UMTA) Section 3 and 9 programs. Local source of transit capital funds is generally through City revenue bonds.

Section 3 Program - The UMTA Section 3 program funds are distributed as discretionary capital grants for major public transit projects. Section 3 monies may currently constitute up to 75 percent of the total project costs.

The availability of Section 3 program funds is contingent upon the amounts available to Congress in the annual appropriations acts. At present, there is intense competition between cities for use of these funds for new rail systems, with current requests approximating $5.7 billion over the next five years for 11 new systems.

The probability of receiving Section 3 funds for a major Honolulu rail project would be enhanced by a request for less than the maximum 75 percent Section 3 contribution to project costs. In recent proposals to UMTA for the funding of new rail systems, Santa Clara County, Houston and Los Angeles requested that Section 3 contribute funds amounting to between 50 and 65 percent of the program capital costs. For purposes of this analyses, it is assumed that Section 3 funds would be available to fund 60 percent of project capital costs for a Honolulu rail system.

Section 9 Program - Section 9 block grants are allocated to local jurisdictions by a formula which includes population, density, and transit service parameters. The 1984 Fiscal Year apportionment for Honolulu is $18.9 million, of which $15 million must be used for capital projects and the remainder can be applied to capital or operating costs. Continuation of the current funding level for capital projects would provide approximately $250 million (1983 dollars) between 1984 and 2000. These Section 9 funds would be available for bus acquisition and facility costs and, to the extent not fully used for buses, for application to the implementation of a rail system. These funds may be used to fund up to 80 percent of capital projects.

Local Sources - Funding for the local share of transit capital projects has come from the City and County of Honolulu General Funds. There is no dedicated local funding source for transit purposes.

Local Needs for Major Projects

No funding from present Federal or State sources is expected to be available for the highway projects included in the alternatives, with the possible exception of Federal Interstate funds for the interchanges and HOV lanes on the H-1 and H-2 Freeways. The principal programs and sources for Oahu highways are expected to be fully utilized for construction of committed projects, or for maintenance of the existing highway system.

Funding for any major new highway projects will thus have to be generated from local sources, through either new or increased taxes or user fees. Assuming the projects are financed through issuance of bonds, the annual cost for bond interest and retirement would approximate $180 million for the highway projects in Alternative B. (See Table 8-2.)

The funding analysis for the transit projects assumes the receipt of Federal Section 3 funds equal to 60 percent of the rail project costs plus the Federal Section 9 funds. Based on those assumptions, the local funding share of transit costs, as summarized in Table 8-2, would equal 20 percent for Alternatives A, B and C, and 24, 24 and 29 percent for Alternatives D, E and F, respectively. Annual debt service for local share of transit costs would approximate $5.5 to $10 million for the all-bus alternatives and $20 to $43 million for the combined bus-rail transit systems, as expressed in 1983 dollars.

OPERATING FUNDING NEEDS

The transportation alternatives would principally affect the operating and maintenance costs for a public transit system. Changes in highway system operating and maintenance costs and funding requirements would occur only for the major new facilities or the introduction of HOV lanes or reversible lane operations.

TABLE 8-2

LOCAL FUNDING NEEDS FOR CAPITAL PROJECTS

In Millions of 1983 Dollars

Hali 2000 Study

ITEM	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
CAPITAL COSTS 1984-2000							
Highway[(a)]	---	12.3	1,445.8	15.3	---	---	---
Buses & Bus Facilities	229.5	310.3	229.5	331.3	164.3	167.8	212.0
Rail System	---	---	---	---	514.1	617.2	956.2
Total	229.5	322.6	1,675.3	346.6	678.4	785.0	1,168.2
POTENTIAL FEDERAL FUNDS							
Interstate Highway[(a)]	---	6.0	10.8	9.0	---	---	---
Section 9 - Buses[(b)]	183.6	248.2	183.6	250.0	131.4	134.2	169.6
Rail[(b)]	---	---	---	---	118.6	115.8	80.4
Section 3 - Rail[(c)]	---	---	---	---	267.0	347.2	573.6
Total	183.6	254.2	194.4	259.0	517.0	597.2	823.6
LOCAL FUNDING NEEDS							
Highways[(a)]	---	6.3	1,435.0	6.3	---	---	---
Bus	45.9	62.1	45.9	81.3	32.9	33.6	42.4
Rail	---	---	---	---	128.5	154.2	302.2
Total	45.9	68.4	1,480.9	87.6	161.4	187.8	344.6
ANNUAL COSTS							
For Local Share[(d)]							
Highways[(a)]	---	0.8	180.0	0.8	---	---	---
Transit	5.5	8.0	5.5	10.0	20.0	23.5	43.0

(a) Highway costs and funding do not include amounts for Committed System.

(b) Based upon $250 million available through continued funding at current levels for transit capital investments.

(c) Amounts reflect funding of 60 percent of project cost from Section 3 (maximum is 75 percent).

(d) Amounts reflect debt service for 20-year bonds at 9 percent interest issued for local share of project costs.

Transit Funding Needs for Operations

The annual operating costs estimated for the Year 2000 range between $66 and $117 million (in 1983 dollars) for the transportation alternatives, versus $57.5 million for annual operating costs in Fiscal Year 1984.

Available Funding Sources - In recent years, funds for operating costs for TheBus system have come principally from fare revenues, City General Fund and Federal Section 9 (formerly 5) funds. The general proportion from each source has been:

Fares	30-35 percent
City General Fund	50-70 percent
Federal Operating Support	0- 5 percent

The proportion from fares has declined in recent years since there has not been a fare increase for several years to offset the increased operating costs. Increases in fares, either on a uniform or selective basis, represent a potential source for increased local revenues to support transit operations.

Federal operating support through the Section 9 formula grant program (formerly Section 5) has declined in recent years. Although the Administration has sought to end Federal operating support of public transit, Congress has continued to fund this program at lower levels through Fiscal Year 1986. Honolulu expends the majority of the funds for bus acquisition and facility costs, with approximately $3.8 million of the current year's allocation used for operating support.

For communities which operate a fixed guideway transit system, the Section 9 program also includes a special "Commuter Rail Services Fund".These funds are distributed to local jurisdictions based on a formula which reflects the local system's contribution to the nationwide total of rail system revenue miles of service and rail passenger miles. Given the potential size of rail operations, Honolulu would likely receive only the minimum allocation for a jurisdiction, which is 3/4 percent of the special fund. The minimum annual allocation, based upon Fiscal Year 1984 funding, would be $6 million.

The balance of TheBus operating costs are funded from nondedicated City and County of Honolulu sources. For Fiscal Year 1984, the budgeted local funds total $38.1 million, with $12.2 million from the highway excise tax and $25.9 million from the City General Fund.

Analysis of Funding Needs - The transit system operating costs estimated for the Year 2000, in 1983 dollars, are presented in Table 8-3. The analysis of the need for local funding support in the Year 2000 is made in terms of 1983 dollars, and is based upon the following assumptions:

1. The transit fare structure would remain unchanged in terms of constant (1983) dollars. This implies that fares would increase on average the same amount as the inflation rate. (At the seven percent inflation rate, the base fare in Year 2000 would be about $1.35.)

TABLE 8-3

FUNDING FOR TRANSIT OPERATING COSTS
YEAR 2000 OPERATIONS (In Millions)
Hali 2000 Study

	1983 DOLLARS					2000 DOLLARS		
		POTENTIAL INCOME		LOCAL FUNDING NEEDS			LOCAL[c] FUNDING[c]	
ALTERNATIVE	OPERATING COST	Fares[a]	Federal[b] Section 9	With Federal	Without Federal	OPERATING[c] COSTS	With Federal	Without Federal
Existing[d]	$ 57.5	15.6	3.8	38.1	41.9	---	---	---
Committed System	86.5	24.2	4.3	58.0	62.3	273	183	197
A	117.8	26.4	5.9	85.5	91.4	372	270	288
B	86.5	23.9	4.3	58.3	62.6	273	184	198
C	109.0	25.0	5.4	78.6	84.0	344	248	265
D	66.1	24.2	9.3	32.6	41.9	209	103	132
E	69.1	23.9	9.5	35.7	45.2	218	113	143
F	75.2	26.1	9.9	39.2	49.1	237	124	155

(a) Based on present fares with average revenue of $.28 per linked passenger.

(b) Federal Section 9 funds for operations based on 5 percent of operating costs plus $6 million for rail operations.

(c) Reflects a 7 percent per annum inflation rate for costs and revenues.

(d) Fiscal Year 1984 estimate.

2. Federal Section 9 funds for bus and rail operating costs may be terminated in 1986, therefore the analysis presents local needs both with and without Section 9 monies. For the analysis, the Section 9 funds are estimated as five percent of the annual transit operating costs plus $6 million from the "Commuter Rail Services Fund" for the rail alternatives.

The estimated revenues from these sources are summarized in Table 8-3. When subtracted from the annual operating costs, the remaining amount indicates the estimated costs which must be funded from local sources.

The resultant estimates of the local funding needs indicate that the light rail alternatives would maintain the local subsidy requirement for transit operations at a level similar to the current contribution (in constant dollars). The rapid transit alternative would increase local costs by 10 to 25 percent, while the bus alternatives would result in increases of 50 percent or more.

Highway Funding Needs for Operations and Maintenance

The annual cost for highway operation and maintenance is estimated to increase for several alternatives: by $0.4 million, $3.2 million, and $0.4 million for Alternatives A, B and C, respectively.

Current funding sources would be fully used for the maintenance of the existing and committed highway system. Therefore, the increased maintenance costs would have to be funded by increases in present taxes and user fees, or introduction of new funding sources.

POTENTIAL LOCAL FUNDING SOURCES

The comparisons of the capital and operating costs to the available funding sources indicate that additional funds would be required for each of the alternatives. A number of sources have been identified which could be collected within the City and County of Honolulu by the State, the County, or either the State or County.

These potential sources have been assessed relative to revenue potential, equitability, transportation-relatedness, and economic responsiveness. The potential sources and much of the analysis are based upon an earlier study by Ernst and Whinney.(1)

Potential Funding Sources

Increased rates for several broad-based taxes, and increased or new user fees from a variety of mechanisms appear to be potential sources for the local share of project implementation and operating costs.

---

(1)Ernst and Whinney, Proposed Financial Program for the Honolulu Bus/Rail Transportation System, February, 1980.

Parking Surtax - A parking surtax would apply to pay parking in the Downtown area (or in other areas with pay parking). Such taxes are in use in other cities with revenues applied either for General Fund or parking-specific purposes. A parking surtax would apply to approximately 11,300 paid parking spaces in the Downtown area,(2) with average daily parking charges of $2-$3 per day.

Special Assessment Districts - Benefit assessment districts have been used to pay for a variety of public works projects, including highways and transit systems. Special assessment districts are included in the funding plan for the Los Angeles Metrorail Project (Wilshire line). The tax is applied to real property and can be said to partly recapture some of the additional value created by the public improvement. When applied to transit projects, as in Los Angeles, the assessment district is usually defined as the area within a specified distance from rail stations. Some benefit assessment districts, called tax increment financing, involve freezing the assessment in a particular area and then diverting all future tax revenue to pay for the public facility improvement. This technique is only a very crude measure of the additional land value created by the public improvement and diverts future tax growth away from the other purposes.

Because of the number of variables involved in assessment districts, it is difficult to estimate the tax base and resultant revenues without a detailed analysis of the locale. For the purposes of this general analysis, revenue potential has been based on the district including an average of one square mile per mile of line within urban areas, with 50 percent of the land use values taxable.

Gasoline Taxes - Liquid fuel taxes have traditionally been used to pay for the construction and operating costs of highways. In Hawaii, the gasoline tax has been collected for both State and local governments, and has been specially earmarked for highway purposes at the State level.

In Fiscal Year 1982, approximately 238 million gallons of gasoline and diesel fuel were sold on Oahu for highway use. Thus, each additional penny tax per gallon would raise approximately $2.4 million per year in additional revenue. This tax could also be created as a fuel excise tax (percent of sale price), which would make it more responsive to future changes in fuel prices.

Development Fees - Development fees have been used for many years to pay for certain public facilities required by new developments. The fees are typically a one-time charge, and can be based on either the value or on the square footage of the development. The projects funded by such fees are generally restricted to the immediate area of the development, such as traffic signals, schools, or parks. Attempts to broaden a development fee into a fee for more general assistance for capital projects is being attempted for the

(2) Alan M. Voorhees Associates, Honolulu Parking Management Study, May 1983. Includes metered parking spaces, for which the surtax would be levied by adding 5-10 cents per hour to the rate.

first time in San Francisco, but has encountered strong political opposition, and is currently being litigated.

For the purposes of this analysis, the development fee is assumed to apply only to nonresidential construction, which the Hawaii Data Book 1982 indicates amounted to $233 million in 1981.

Lottery - A number of states have begun to use state lotteries to supplement tax revenues. In Arizona, a portion of the state lottery proceeds is dedicated for use by public transit systems in the major urban areas. No formal study has been done to assess how much money could be generated by a state lottery although a preliminary review by the State Department of Taxation indicated that the gross statewide revenue from a lottery would be $2 - $3 million per year.

Hotel Tax - A number of states have implemented special hotel taxes. For example, in California, hotel charges are exempt from general sales tax but local jurisdictions are permitted to levy taxes on hotel accommodations.

With an estimated 35,000 hotel units on Oahu in 1983, an average occupancy rate of 68.2%, and a daily rate of $43.05 (1981), the total hotel revenues would be $375 million per year. Thus, a one percent room tax could generate $3.7 million or more per year.

Direct Road Pricing - Road pricing refers to any one of several mechanisms for directly relating what the road user pays to the cost of providing and maintaining the road. The proposed road pricing scheme would consist of road user charges levied for travel within congested areas of Oahu during the peak traffic periods of the day. The approach is further discussed in Chapter 4.

General Property Tax - In Fiscal Year 1982, 51 percent of the total revenue in the City and County of Honolulu came from real property taxes. The assessed value of taxable property in 1982 was approximately $15,095,000,000. Real property taxes have traditionally been used to pay for most local government facilities, though recent political sensitivity to increased property taxes has reduced its role to mainly supporting the general operating costs of local governments rather than for use in paying for major public improvements. Since the assessed value base is large, a relatively small increment in the existing tax rate of $15.23 per $1,000 of assessed value can generate rather substantial revenues.

State Excise Tax - The state currently collects a tax on the gross income, gross receipts, or gross proceeds of all business activities at a rate of 0.5 percent on wholesaling and intermediary goods; 0.15 percent on insurance solicitors; and 4 percent on retail sales of goods, services, and other end-use activities. About $577,265,000 was collected statewide in Fiscal Year 1983, with some 88 percent of the statewide amount attributable to Oahu. With a tax applied only to the retail sales tax base of $6,875 million, each 1/2 percent increment in the retail portion of the sales tax could generate approximately $30.3 million per year. A major advantage of this tax is that it would be shared directly by residents and tourists.

One successful formula for a voter-approved sales tax increase involved using the proceeds from a half-cent sales tax increase to keep fares low and support rail transit development in Los Angeles County. This was an attractive combination, because it involved the immediate and visible benefits of a fare reduction (from a high base fare) plus the longer-term benefit of proposed rail developments.

Income or Payroll Tax - The State of Hawaii currently collects a tax on the net incomes of individuals; tax rates vary from zero to 11 percent, with capital gains fixed at 4.4 percent. In Fiscal Year 1982 this tax raised $347 million, or almost 25 percent of all State tax collections.

A payroll tax differs from an income tax in that a payroll tax normally applies only to the employer's gross payroll, so that the tax is invisible to the employee. This has the advantage of making the tax more politically viable and easier to collect (for the taxing agency), but it means that governmental entities are not taxed, since one level of government cannot tax another. Dedicated payroll taxes have been used in some areas (e.g. Portland, Oregon) to pay for transit services.

Summary Evaluation of Local Funding Sources

Key considerations concerning the use of these funding sources for a transportation project or program include: 1) revenue generating productivity; 2) responsiveness to changing economic conditions; and 3) the relative equity or "fairness". Table 8-4 summarizes the assessment of these factors for each of the sources. A further issue is consideration of the implementability of each mechanism.

Revenue Potential - As indicated in the earlier sections of this chapter, the local user fee or taxing sources must be capable of generating several tens of millions of dollars of annual revenue in order to fund the capital and/or operating costs of the alternatives. In Table 8-4, the revenue potential of each source has been expressed in terms of the incremental rate needed on Oahu to generate $1 million in current (1983) dollars.

The most productive revenue sources would be the levy of any of the broad-based taxes -- excise or retail tax, motor fuel tax (or increased gasoline excise tax), income tax, and property tax. These taxes affect all or most sections of the economy and are levied against an extremely large tax base. Sufficient revenues to fund the transportation projects could be generated by small incremental increases in these taxes.

Based on previous analyses by the State of Hawaii, the use of a lottery would likely be the most limited revenue generator. Implementation of a surcharge on pay parking in the Downtown area would also be likely to generate only small amounts of funds, relative to the needs of the alternatives.

A further, hypothetical demonstration of the revenue generation potential is presented in Tables 8-5 and 8-6. These tables indicate the current tax rate that would be needed to fund the entire estimated amount of additional local funding required for the capital costs (Table 8-5) and annual operating costs (Table 8-6).

TABLE 8-4

SUMMARY OF POTENTIAL LOCAL FUNDING SOURCES

Hali 2000 Study

TAX/USER FEE SOURCE	1983 RATE TO YIELD $1 MILLION ANNUAL REVENUE: Approx. Rate	1983 RATE TO YIELD $1 MILLION ANNUAL REVENUE: Unit Base	ECONOMIC RESPONSIVENESS: Real Growth[a] to 2000	ECONOMIC RESPONSIVENESS: Inflation Sensitive	EQUITY: Vertical	EQUITY: Horizontal	TRANSPORT RELATED	TAXING AUTHORITY
Fuel Tax Increase	$ .004	Per Gallon	0-10%	No	Regressive	Broad	Yes	State/County
Property Tax Increase	$ .07	Per $1000 Assessed Valuation	70-80%	Yes	Proportional	Broad	No	County
Income Tax Surcharge	0.3%	Annual Income Tax Receipts	70-80%	Yes	Progressive	Broad	No	State
Retail Sales Tax	0.02%	Retail Sales	70-80%	Yes	Regressive	Broad	No	State
Hotel Room Tax	.25%	Room Rate	20-30%	Yes	Proportional	Narrow	No	State
Downtown Parking Surcharge	12%	Parking Fee Revenues	15%	Yes	---	Narrow	Yes	County
Development Fee[b]	0.4%	Value of Construction	---	Yes	Progressive	Narrow	No	County
Lottery	$2 - $3 Million	-----	---	---	Regressive	Narrow	No	State
Road Congestion Pricing	$ .005	Charge per Auto Mile in Congested Areas	20-30%	No	Regressive	Narrow	Yes	State
Benefit Assessment District[b]	$.25-.50	Per $1000 Assessed Value	---	Yes	Proportional	Narrow	Yes	County
Transit Fare Increase	$.02-.03	Per Passenger	30-40%	No	Regressive	Narrow	Yes	County

[a] Increase in the taxable base between 1983 and Year 2000, without inflation.

[b] Non-residential properties only.

TABLE 8-5

EXAMPLES OF TAX AND/OR USER FEE RATES NEEDED TO SUPPORT LOCAL SHARE OF CAPITAL COSTS[(a)]
Hali 2000 Study

ITEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
LOCAL SHARE OF ANNUAL ACQUISITION/ DEBT SERVICE COSTS (in Millions):						
Highways[(b)]	$0.8	$180.0	$0.8	-	-	-
Transit[(c)]	5.0	3.5	9.0	20.0	23.5	43.0
Total	5.8	183.5	9.8	-	-	-
INCREASES IN TAX RATES OR USER FEES TO FUND LOCAL COSTS:[(b)(c)(d)]						
Fuel Tax ($ per Gallon)	.025	.73	.04	.08	.095	.16
Property Tax ($ per $1000 Assessed Value)	.42	12.85	.70	1.30	1.50	2.80
Income Tax Surcharge (%)	2	55	3	6	7	13
Retail Sales Tax (%)	0.2	3.5	0.3	0.5	0.6	0.9
Hotel Tax (%)	1.5	45	3	5	6	11
Benefit Assessment District ($ per $1000 Assessed Value)	NA	NA	NA	6	7	13
Road Congestion Pricing (per Mile in congested areas)	$.03	.90	.05	.10	.12	.20
Transit Fare Increase[(e)]	$.15	.10	.30	.60	.70	1.20
OTHER POTENTIAL SOURCES:						
Lottery	$2 - 3 million total annually					
Parking Surcharge	1 - 4 million total annually					

(a) Based on use of a single source.
(b) Annual debt service for highways, exclusive of Committed projects.
(c) Annual debt service for transit facility construction, and for local share of vehicle acquisition for transit fleet.
(d) Rates reflect 1983 tax base.
(e) For transit-related costs only.

TABLE 8-6

EXAMPLES OF TAX AND/OR USER FEE RATES NEEDED TO SUPPORT LOCAL SHARE OF TRANSIT OPERATING COSTS
(Based on Use of a Single Source)
Hali 2000 Study

ITEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
PORTION OF TRANSIT OPERATING COSTS FROM LOCAL SOURCES, AFTER OFFSET OF REVENUES FROM PRESENT FARE & FEDERAL FUNDS (in Millions of 1983 Dollars)	$85.5	$58.3	$78.6	$32.6	$35.7	$39.2
INCREASES IN TAX RATES OR USER FEES:(a)						
Fuel Tax (per Gallon)	$.35	.25	.32	.13	.14	.16
Property Tax (per $1000 of Assessed Value)	$6.00	4.20	5.50	2.30	2.50	2.75
Income Tax Surcharge (%)	25	18	25	10	11	12
Retail Sales Tax (%)	1.7	1.2	1.6	0.7	0.8	0.8
Hotel Tax (%)	21	15	20	8	9	10
Benefit Assessment District (per $1000 of Assessed Value)	NA	NA	NA	$10.50	12.00	12.75
Road Congestion Pricing (per Mile Driven in Congested Areas)	$.40	.30	.35	.15	.18	.19
Transit Fare Increase	$2.50	1.80	2.40	1.00	1.10	1.15

OTHER POTENTIAL SOURCES:

Lottery	$2 - 3 Million Annually
Parking Surcharge	$1 - 4 Million Annually

(a) Rates reflect 1983 tax rate base.

Economic Responsiveness - The responsiveness to changing economic conditions has been expressed in Table 8-4 in terms of: 1) the anticipated growth of the tax base in real terms (constant dollars) over the 1984-2000 period; and 2) whether or not the tax base is likely to experience "inflated growth" in line with or in excess of general inflation. Estimates of the "real" tax base growth rates have been based on the projections included within this study (e.g. Gross Oahu income subject to tax would increase as a factor of the forecast population and the estimated future "constant dollar" increases in household incomes, as presented in Chapter 3; motor fuel gallonage as estimated in Chapter 7; parking spaces as discussed in Chapter 6).

Based upon these analyses, funding sources with the most favorable "real growth" in the tax base include the property, income, and sales-related taxes. The "real growth" in the tax base would permit the use of lower tax rates at the time of future funding needs, or would provide funds for additional projects/programs.

The funding mechanisms which are expected to keep pace with inflation (i.e. the tax base should experience equal or higher inflation) include taxes on real property, incomes, retail sales and hotel room rates. Development fees based on the value of new construction would experience inflationary growth in the unit costs but could experience large variations in annual activity. Fuel taxes, lottery revenues, and road congestion pricing fees would require action by government to raise prices/rates since each does not reflect an inherent inflationary growth. (The present cents per gallon fuel tax does not reflect inflation, whereas a percentage of sales price tax would.) These assessments are based in part on the Ernst and Whinney study of inflationary growth of revenue sources in the 1973 to 1978 period.(3)

Equity - The equitability of a tax is a function of its comparative impact on different income groups (vertical equity) and the degree to which it affects all areas and segments of the community (horizontal equity).

Vertical equity has been categorized in Table 8-4 as having one of three effects:

- Regressive - A tax or fee which takes a larger percentage of the income available to lower income households than the percentage taken from a higher income household.
- Proportional - Requires approximately equal percentage of the incomes for both low and high income households.
- Progressive - Takes a larger percentage of the income of higher income households as compared to lower income households.

From a social policy viewpoint, a tax would desirably be proportional or progressive, such as indicated for property and income taxes, and hotel room

(3)op.cit., Ernst and Whinney.

tax. Conversely, from a transportation policy point of view, several of the regressive taxes may be more effective in encouraging the desired behavior. Such regressive sources would include the fuel tax and road congestion pricing where the increased cost of travel would more likely have the desired effect -- encourage a shift from automobile to transit use, or to travel outside the peak traffic periods -- upon lower income than the higher income households.

Horizontal equity is subject to a similar trade-off. Whereas it may be desirable from a social policy viewpoint to distribute the cost of improvements as broadly as possible, the transportation objectives may be better served by use of such narrow measures as the parking surcharge and road congestion pricing.

Ease of Implementation - The relative ease or difficulty of implementation encompasses a broad number of issues and considerations. These issues include public acceptance, jurisdictional issues, and institutional requirements and costs for start-up and administration.

It is doubtful that any new or increased tax or user fee would be highly acceptable to the public. A tax fee based on voluntary participation, such as a lottery, may be among the more widely acceptable mechanisms. Another consideration is whether the tax/fee is transportation-related and therefore provides a means of charging the beneficiaries (travellers) for the general improvement to travel conditions. The most prominent example would be the use of a "benefit assessment district", particularly where the highway or transit project encourages increased economic benefits (sales, property values) within an area. Beyond this, the most publicly acceptable taxes are likely to be those which require a very small incremental rate increase or exhibit very low visibility.

Since the City and County of Honolulu would likely be most directly concerned with the implementation and funding of the alternative projects, those funding sources which it is already empowered to use would afford greatest jurisdiction ease of implementation. These sources include property taxes, parking surcharge, development fee and benefit assessment district.

Implementation and administration requirements and costs would be lowest for adding incremental increases to existing taxes or fees, since the levy and collection of an increased rate would require little in the way of new facilities or staff. Implementation and administrative requirements would be greatest for the lottery and road congesting pricing.

SUMMARY

The financial feasibility analysis of the Hali 2000 transportation alternatives has encompassed a review of existing programs to determine the potential for funding from these sources, and the identification and assessment of potential local revenue sources to meet additional funding needs for the alternative projects. The funding analysis for the highway element considers only the construction and maintenance costs for those projects included within the alternatives; it does not analyze funding for the existing and committed roadway system. For the public transit component, the funding analysis addresses the costs of maintaining the existing services as well as the varying levels of rail and bus expansion included in the alternatives.

Funding Availability from Existing Programs

Present Federal, State and City programs and the current tax/fee rates afford limited sources for potential funding of the alternatives.

- o Federal and State highway funds are expected to be fully used for funding of the committed projects and the reconstruction and maintenance of the existing facilities, and would thus likely require funding from new or increased local sources.

- o The Federal Section 3 discretionary grant program, which provides funding for up to 75 percent of transit project capital costs, could be used for a guideway system. However, since present applications far exceed the funds available the Federal Urban Mass Transportation Administration is encouraging local governments to request less than the maximum 75 percent Federal participation, and is considering the percent local contribution in prioritizing projects for receipt of the limited Section 3 funds. Receipt of Section 3 funds for a Honolulu guideway system would likely be contingent upon a request for less than the 75 percent funding.

- o Federal Section 9 funds will continue to be available for use on bus and rail capital projects. However, the future use of Federal Section 9 formula grants for use in funding transit operating costs is uncertain. The present Administration has plans to eliminate use of Federal funds for operating costs, although Congress has funded the program at a low level through Fiscal Year 1986. (In 1983, $3.8 million in Section 9 funds was applied to TheBus operating costs, and approximately $15 million to capital items.)

- o Section 9 also includes a "Commuter Rail Services Fund" which, if continued at the current funding level beyond the 1986 termination date for the program, would provide $6 million annually for operation of a Honolulu rail system.

In summary, costs to implement and maintain those highway projects included in the alternatives would likely be funded by additional or increased local funding sources. Transit capital and operating costs would likely receive significant Federal funding support, but would also require increased local funds.

Local Funding Needs

The estimated capital and operating costs for each alternative were compared to the anticipated funding from the existing programs to estimate the local funding requirements. Analysis assumptions include:

- o All increased highway costs would be funded by new or increased State and/or City revenue sources.

- Federal Section 3 program would provide 60 percent of rail capital costs.

- Federal Section 9 funds for capital projects would continue at present rate.

- No Federal transit operating assistance would be received after 1986.

- The local share of capital costs would be financed through issuance of 20-year bonds.

The resultant comparison of local funding needs for each alternative is summarized in Table 8-7 for the Year 2000 level of operations as expressed in 1983 dollars.

The estimated Year 2000 annual local funding needs are lowest for the Committed System (600-bus fleet) and the light rail Alternatives D and E. The largest requirement for local funds would be Alternative B since the highway projects, without additional Federal funds, would require funding primarily by local (State/City) sources.

Potential Sources of Local Funds

Potential sources of new or increased local revenues to fund the alternatives are summarized in Table 8-4. An assessment of the revenue potential and implementation issues are included in the summary.

A review of the amount and nature of the funding needs for the alternatives leads to several conclusions:

1. The large amounts of local funding required for most of the alternatives encourage the use of more than one revenue source.

2. The magnitude of the funding needs will likely require that at least one broad-based tax be used as a funding source.

3. Given the need for bonding in most alternatives, a dedicated tax source for transportation purposes is desirable.

4. Beneficiaries of the transportation improvements should be included in any funding program. This would include increased transit fares (above inflation) and use of special assessment districts.

TABLE 8-7

SUMMARY OF LOCAL FUNDING NEEDS FOR ALTERNATIVES
YEAR 2000 ANNUAL COSTS IN 1983 DOLLARS
Hali 2000 Study

COST ITEM	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D[a] LIGHT RAIL	E[a] LIGHT RAIL	F[a] RAPID TRANSIT
HIGHWAYS[b]							
Annual Debt Service for Local Share of Capital Costs	---	0.8	180.0	0.8	---	---	---
Operating Costs[c]	---	0.4	1.8	0.4	---	---	---
Subtotal Highways	---	1.2	181.8	1.2	---	---	---
PUBLIC TRANSIT							
Operating Costs	86.5	117.8	86.5	109.0	66.1	69.1	75.2
Less Fares	(24.2)	(26.4)	(23.9)	(25.0)	(24.2)	(23.9)	(26.1)
Subsidy Needs	62.3	91.4	62.6	84.0	41.9	45.2	49.1
Annual Debt Service for Local Share of Capital Costs	5.5	8.0	5.5	10.0	20.0	23.5	43.0
Subtotal Transit	67.8	99.4	68.1	94.0	61.9	68.7	92.1
TOTAL TO BE FUNDED BY LOCAL SOURCES	67.8	100.6	249.9	95.2	61.9	68.7	92.1

(a) Rail alternatives D, E and F represent 27, 27 and 14 mile systems, respectively.

(b) Analysis does not include funding needs for committed highway projects.

(c) Analysis does not include funding needs for maintaining existing and commited highway facilities.

CHAPTER 9

EVALUATION OF ALTERNATIVES

The information describing the service characteristics, capital and operating costs, travel impacts, and the environmental and socioeconomic impacts has been used to provide a summary evaluation for the alternatives:

1) The estimated costs and the results of the travel forecasts have been evaluated to assess the comparative cost effectiveness of the alternatives.

2) Principal aspects of the alternatives which may affect the potential for community and/or institutional acceptance have been identified for consideration.

3) A series of measures of effectiveness have been identified for comparative evaluation of the Hali 2000 alternatives relative to the transportation goals and objectives. (See Chapter 1 for listing of goals and objectives.)

COST EFFECTIVENESS

Cost effectiveness indicators measure the efficiency of the alternatives by relating the resources required by the alternative (capital and operating costs) to measures of the resultant travel performance (transit passengers, travel time savings). These cost effectiveness indicators provide a comparison of the relative cost efficiency between various travel modes or projects for serving area travel needs.

Such comparative measures are useful in assessing the justification for a transportation project, although this mechanism does not provide a direct indication of "net" benefits or rate of return for a transportation investment. For transportation cost effectiveness measures, the basis for project justification is arrived at through a comparison of the alternatives to a "do nothing" condition, which for the purposes of this study is the Committed System. Thus, the cost effectiveness measures afford both a measure of the comparative efficiency of the alternatives, and whether the alternatives can deliver services or benefits at a lower unit cost than the "do nothing" condition.

Analysis Methodology

In order to make valid comparisons of alternative projects, all costs were expressed in present (1983) dollars, and appropriate adjustments made for the various lives of the sub-systems associated with each alternative. The two principal reasons for making these adjustments are:

- Costs are incurred at various times over the evaluation period (1984-2000), but a dollar spent today is not the same as a dollar spent in 1990 or 2000. This is because money (like all economic resources) is valued more now than in the future, even after taking into account the effects of inflation.

- Various elements or sub-systems in a project or alternative -- land, structures, rolling stock, and so forth, have different useful lives which must be normalized to permit a meaningful comparison of the total economic cost of projects.

The techniques for cost discounting analyses are fairly standard and references can be found in a number of documents justifying the methodology in greater detail.(1) A brief description of the methodology and assumptions used for the cost discounting procedure is provided in the following paragraphs.

There are four significant parameters which must be determined for the analysis. They are:

1. The overall time frame for project evaluation;
2. The discount rate;
3. The useful lives of sub-systems (vehicles, structures, etc.); and
4. Salvage value of sub-systems.

Evaluation Time-Frame - The time-frame chosen for the evaluation is 17 years, from 1984 to 2000. The alternatives encompass only projects which should be implemented prior to the Year 2000. While elements of each alternative have lives longer than 17 years, this is accounted for through the use of annualized costs (capital recovery factors) in order not to bias the evaluation in favor of projects with short useful lives.

Discount Rate - Since costs occur at different times during the evaluation time period, a discount rate is needed to convert all dollars to a common year for comparison. The year 1983 is used since accurate cost information is available, and the costs are more meaningful when expressed in current dollars.

---

(1)Harry S. Cohen, et. al., "Evaluating Urban Transportation System Alternatives", prepared for the U.S. Department of Transportation, 1978, pp. IV-35 ff. and, Richard de Neufville and Joseph H. Stafford, Systems Analysis for Engineers and Managers, 1971, pp. 160 ff.

A discount rate represents the value of capital in constant dollar terms -- the rate of return which would be realized without any inflation. If inflation occurs, the discount rate of return is over and above the inflation rate. Thus, if inflation is expected to be 7 percent through most of the 1980s, a 5 percent discount rate implies an equivalent return of 12.4 percent; a 10 percent discount rate implies an equivalent rate of return of 17.7 percent (pre-tax). High discount rates tend to favor projects with low front-end costs and immediate pay-outs, while low discount rates favor high capital cost projects with low operating costs.

The choice of discount rate could significantly affect the results of the cost effectiveness analysis. For this reason, a range of discount rates is used in order to test the sensitivity of the analyses results to the value of the discount rate. The U.S. Office of Management and Budget guidelines require that a 10 percent rate of return be included within economic analyses.(2) In addition to this rate, a discount rate of 5 percent was used to reflect the low-end of the range of discount factors which might be considered reasonable, and a 7 percent rate as a compromise mid-range rate.

Inflation is excluded from the cost effectiveness analysis since the evaluation is in terms of constant dollars (1983). Inflation would affect the financial feasibility of the alternatives (Chapter 8), but would not affect cost effectiveness unless there were to be greatly different rates of inflation between the component costs of the alternatives.

Useful Lives - In order to make valid comparisons between alternatives and projects, the economic life of each project element must be considered. The length of service will depend upon the amount of use, level of maintenance, and technical obsolescence of the sub-system. The values used for service lives of the project elements are presented in Chapter 5, Table 5-1, and conform to values suggested by the U.S. Department of Transportation.(3)

Capital costs (in 1983 terms) for each project element were converted to annual costs using the capital recovery factors which reflect the useful life of the project element and the appropriate discount rate.

Salvage Value - All projects were assumed to have no salvage value at the end of their useful life since the amounts are generally small in terms of constant dollars and insignificant as compared to the initial costs.

---

(2)Circular A-94, revised March 27, 1972, states: "The discount rates to be used for evaluations of programs and projects subject to the guidance of this Circular are ... 10 percent; and, where relevant, any other rate proscribed by or pursuant to law, Executive Order, or other relevant Circulars".

(3)Jacobs, Michael, "Technical Guidance for Transit Project Planning: Overview", Urban Mass Transportation Administration, U.S. Department of Transportation, 1982.

Transit Cost Effectiveness

The travel model forecasts, discussed in Chapter 6, result in little difference in the patronage estimates for the public transportation component of each alternative, with weekday patronage estimates ranging between 270,000 and 298,000 passengers. Conversely, the alternatives differ significantly in costs between those requiring higher capital investments (rail) and those requiring higher annual operating costs (buses).

Given these differences, cost effectiveness becomes a key comparator in indicating the relative efficiency with which the combined capital and operating costs would be utilized in each alternative. This has been accomplished through the annualization of transit capital costs, and the combination of these annualized capital costs with the Year 2000 annual operating cost to determine the total annualized cost for serving the projected Year 2000 transit travel. The annualized costs based on the 7 percent discount rate are presented in Table 9-1, while the annualized costs using the low-high range of 5 and 10 percent values for capital return are presented in Table 9-2.

Annual public transit patronage in 2000 was estimated by multiplying the projected weekday patronage by a factor of 316, the factor used for the present bus system. Resultant annual patronage estimated for the alternatives is as follows:

Existing	64.8 Million	C	89.4 Million
Committed System	86.6	D	86.6
A	94.2	E	85.3
B	85.3	F	93.2

Cost Per Passenger - The annualized capital and operating cost per passenger is estimated to increase to $1.21 for the Committed 600-bus fleet from the estimated cost of $0.95 for the existing system, based on the 7 percent discount rate (Table 9-1). The cost per passenger is also projected to increase for the two alternatives envisioning additional expansions of the bus fleet beyond the 600-coach Committed System: to $1.53 and $1.52 for Alternatives A and C, respectively. These increasing costs reflect the model's forecast of lower productivity -- fewer additional passengers attracted by each incremental increase in service -- with continued expansion of the bus fleet. This reflects actual transit experience since "captive" riders use the bus service with even low service levels, while "choice" riders require increasingly more attractive directness and frequency of service to attract additional usage.

Alternative B also results in an increased cost per passenger above the Committed System. Although the Ewa Parkway/Pearl Harbor Tunnel decreases transit costs for serving the Leeward area, the improvement in automobile accessibility between the Leeward and Primary Urban Center areas is projected to result in a more than offsetting shift of "choice" transit riders to automobile usage, thus reducing transit ridership by a greater amount than costs.

With a 7 percent discount rate, the system cost per passenger for the 27-mile light rail lines of Alternatives D ($1.36) and E ($1.50) compare

TABLE 9-1

COST EFFECTIVENESS MEASURES
BASED ON CAPITAL COSTS ANNUALIZED AT 7 PERCENT

Hali 2000 Study

ALTERNATIVE	RAIL LINE LENGTH	YEAR 2000 ANNUAL COST (Millions): Capital Costs Annualized at 7%: Bus	Rail	Combined	Bus & Rail Operating Costs	Total	TOTAL ANNUAL COST PER PASSENGER	OPERATING COST PER PASSENGER	REVENUE COVERAGE OF OPERATING COSTS (Percent)	ANNUAL RAIL CAPITAL COST PER RAIL PASSENGER
Existing	--	$ 8.5	--	$ 8.5	$ 53.3	$ 53.3	$0.95	$0.82	34	--
Committed	--	18.1		18.1	86.5	104.6	1.21	1.00	28	--
A - TSM	--	26.1	--	26.1	117.8	143.9	1.53	1.25	22	--
B - Highway	--	18.1	--	18.1	86.5	104.6	1.23	1.01	28	--
C - Bus	--	27.9	--	27.9	109.0	136.9	1.52	1.22	23	--
D	5[(a)]	16.6	$ 9.4	26.0	70.1	96.1	1.11	.81	35	$ .37
At-Grade	11	16.1	17.4	33.5	70.1	103.6	1.20	.81	35	.60
Light Rail	17	15.3	29.3	44.6	68.7	113.3	1.31	.79	35	.74
	27	12.6	38.8	51.4	66.1	117.5	1.36	.76	37	.81
E	5[(a)]	16.6	15.8	32.4	70.2	102.6	1.19	.82	34	.69
Partially	11	16.1	24.4	40.5	71.0	111.5	1.30	.83	34	.93
Separated	17	15.5	36.3	51.8	70.7	122.5	1.44	.83	34	.93
Light Rail	27	12.8	46.2	59.0	69.1	128.1	1.50	.81	35	1.07
F	8[(a)]	17.0	48.2	65.2	73.3	138.5	1.48[(b)]	.79	35	1.22
Fully	11	16.8	56.7	73.5	74.5	148.0	1.59[(b)]	.80	35	1.17
Separated	14	16.6	69.6	86.2	75.2	161.4	1.73[(b)]	.81	35	1.30
Rapid	18	16.2	87.9	104.1	77.4	181.5	1.95[(b)]	.83	34	1.39
Transit										

[(a)] Passengers and costs were based on computer model results for the 27-mile light rail and 14-mile rapid transit line lengths. Estimates for other line lengths are manually derived and afford assessment only of the direction and general magnitude of change.

[(b)] Downtown tunnel would increase annualized cost by $10.8 million and cost per passenger by $0.12.

TABLE 9-2

COST EFFECTIVENESS MEASURES
BASED ON CAPITAL COSTS ANNUALIZED WITH DISCOUNT RATES OF 5 AND 10 PERCENT

Hali 2000 Study

ALTERNATIVE	RAIL LINE LENGTH	BUS & RAIL OPERATING COSTS	YEAR 2000 ANNUAL COSTS @ 5%			YEAR 2000 ANNUAL COSTS @ 10%		
			Annualized Capital Costs	Capital & Operating Costs	Cost Per Passenger	Annualized Capital Costs	Capital & Operating Costs	Cost Per Passenger
Existing	--	$ 53.3	--	--	--			
Committed	--	86.5	$15.6	$102.1	$1.18	$22.3	$108.8	$1.26
A - TSM	--	117.8	22.5	140.3	1.49	32.0	149.8	1.68
B - Highway	--	86.5	15.6	102.1	1.20	22.3	108.8	1.28
C - Bus	--	109.0	23.8	132.8	1.49	34.6	143.6	1.61
D At-Grade Light Rail	5	70.1	21.5	91.6	1.06	33.4	103.5	1.19
	11	70.1	27.4	97.5	1.12	43.8	113.9	1.31
	17	68.7	35.8	104.5	1.20	59.2	127.9	1.48
	27	66.1	41.4	107.2	1.24	68.5	134.6	1.55
E Partially Separated Light Rail	5	70.2	26.3	96.5	1.13	42.4	112.6	1.32
	11	71.0	33.0	104.0	1.22	54.2	125.2	1.47
	17	70.7	41.3	112.0	1.31	69.2	139.9	1.64
	27	69.1	46.9	116.0	1.36	79.2	148.3	1.74
F Fully Separated Rapid Transit	8	73.3	51.2	124.5	1.33	88.4	161.7	1.73
	11	74.5	57.3	131.8	1.41	99.9	174.4	1.87
	14	75.2	67.3	142.5	1.53	117.6	192.8	2.07
	18	77.4	81.1	158.4	1.70	142.5	219.9	2.35

favorably with the continued expansion of the bus fleet beyond the Committed System. Based upon the manually derived estimates for patronage and bus operations of the incremental line lengths, the relative cost effectiveness for shorter line lengths would approximate that for the Committed bus fleet. (Note: Reliability of the manually derived operating patronage and cost estimates for the 5-, 11- and 17-mile line lengths are significantly less than the computer model-based estimates for the 27-mile system. However, the manual estimates indicate the relative direction and magnitude of changes in cost per passenger for the incremental line lengths.)

The differences in the cost per passenger between the two light rail systems cannot be used as a meaningful indicator of the cost effectiveness of at-grade operation versus a partially-grade separated system. This is due to significant differences in the two horizontal alignments and in the areas each system serves, the effects of which cannot be distinguished from those which may be a result of grade-separation. The combined results for the two alternatives are indicative of the cost-effectiveness which could be anticipated for the range of potential light rail operations.

The increased patronage projected for rapid transit Alternative F is largely offset by the capital investment required for the system. The estimated system cost per passenger for the shorter rapid transit lines are similar to those for the bus expansion and longer light rail lines, while the incremental increases in line length result in less favorable comparisons. (Patronage and operating cost estimates are based on computer forecasts for the 14-mile line, while the other line lengths were estimated by manual adjustment of the 14-mile forecast.) The cost per passenger provided in Table 9-1 reflects the costs for an elevated system. The provision of the Downtown subway section would increase these annualized capital costs by $10.8 million and the cost per passenger by $0.12.

As presented in Table 9-2, use of a 5 percent discount rate for the analyses produces lower annualized costs for capital investment than the 7 percent rate, while a 10 percent rate increases the annualized capital costs. With a 5 percent discount rate, the light rail alternatives would afford significantly lower costs per passenger than the bus expansion alternatives, and the rapid transit line would compare more favorably with the bus or light rail systems. At a 10 percent discount rate, the increased capital investment of the longer partially grade separated light rail and rapid transit lines would yield less favorable costs per passenger as compared to bus fleet expansion.

Operating Costs Per Passenger - Operating costs per passenger are of significance since these costs must be borne largely by local revenue sources. While continuation of present Federal public transportation funding programs may fund up to 75 or 80 percent of capital investments, the Federal contribution to funding of operating costs will likely be terminated or remain at a nominal rate (5 to 10 percent).

Annual operating costs (in 1983 dollars) to serve the Year 2000 transit patronage are projected between $1.00 and $1.20 per passenger for the all-bus systems (Committed, A, B and C). Based on the current fare structure, fares would return approximately 23 to 28 percent of the operating costs.

Operating costs for the combined bus-rail systems (Alternatives D, E and F) range between $0.76 and $0.83 per passenger. Estimated revenue coverage of operating costs is between 34 and 37 percent. The revenue estimate is based on free transfer between bus and rail services.

COMMUNITY AND INSTITUTIONAL ACCEPTANCE

In addition to the potential environmental and socioeconomic impacts discussed in Chapter 7, there are several factors which may affect community and institutional acceptance of the alternatives. These factors generally encompass the conformity of these alternatives with existing plans, the ease of staging or expansion, and vulnerability to delays.

Compatibility with Emergency Plans

At present, a local emergency plan exists for the potential event of a petroleum shortage(4). The City and County of Honolulu is currently preparing to develop an emergency evacuation plan which will address both natural events (tsunamis, hurricanes) and civil defense needs.

Petroleum Shortage - Each of the alternatives will continue reliance on petroleum fuel through the Year 2000 since the electrical power for the Hawaiian Electric Company will continue to be generated almost entirely from petroleum products through the Year 2000.

For the transit mode, currently both electrically-powered rail and diesel-powered buses have similar energy requirements for vehicle operation. The greater efficiency of the electric motor, as compared to the diesel engine, is offset by power plant energy conversion and transmission losses. Current trends, however, are towards an increased efficiency in energy use by electric rail systems versus stable to decreased energy efficiency for diesel-powered buses.

Both rail and bus vehicles can each provide capacity, in terms of place-miles(5) at approximately one-third the energy consumption per passenger seat of a standard-sized car and one-half that for a compact-size car. The comparative energy efficiency of these modes in an emergency thus favors increased supply of transit services to the extent that the capacity can be used effectively.

Evacuation - Although an evacuation plan is not available for review and assessment, several aspects of the alternatives would affect potential evacuations:

---

(4)Hawaii Department of Planning and Economic Development, "Managing a Gasoline Shortage in Hawaii", October 1981.

(5)Seated plus standee passenger load.

1. Expansion of public transportation capacity would likely be useful for an evacuation given the number of residents and tourists without an automobile. This is particularly true of the Waikiki area, where the low elevation is susceptible to tsunamis and flooding.

2. Buses would be expected to be of greater use in an evacuation than a fixed guideway system due to the routing flexibility of buses. A transit guideway system would be subject to blockage by debris or flooding, and to loss of electrical power.

Compatibility with Area Development Plans

As discussed in Chapter 3, the City and County of Honolulu General Plan and the eight Area Development Plans envision the largest population increases will be located in the Primary Urban Center and Ewa (45,560 and 36,977 additional residents, respectively). The General Plan and Ewa Development Plan call for provision of a secondary urban center in Ewa to relieve development pressure in the rural and other urban fringe areas. Large percentage increases in population are projected for Waianae and East Honolulu.

The capital-intensive alternatives (B, D, E and F) would each support increased development of the Primary Urban Center and Ewa areas by the location of a major transportation route through these areas, and would enhance access to the Waianae area. The alternatives provide no major facilities for East Honolulu beyond the committed projects on Kalanianaole Highway.

The State Transportation Plan and the Area Development Plans have as a policy the encouragement of energy conservation by the development of transportation systems which support concentrated development within existing urban areas. The rapid transit alternative would be most consistent with this policy since it would provide a high-capacity system within existing developed areas. The limited number of station access points would further encourage development of higher-density activity nodes at these locations. The light rail alternatives D and E would also support this policy. The highway alternative B would be least consistent with the policy.

The Ewa Development Plan discourages the use of overhead utility wires and poles in order to preserve views. The two light rail alternatives would require use of overhead power lines, although these poles and lines would be located along an alignment which presently has utility poles and lines.

Within the Primary Urban Center, the elevated structures included in Alternatives B, E and F would affect views in a number of locations along the alignments.

Staging and Expansion

Each of the bus systems and the rail lines could be developed incrementally over the 1984-2000 period. Staging the expansion of the all-bus alternatives would be the most flexible since no major construction projects are required other than additional bus maintenance facilities. The approximate 5-, 11-, 17- and 27-mile light rail line lengths, and the 8-, 11-, 14- and 18-mile rail rapid transit line lengths represent potential staged development of these alternatives.

Highway construction for Alternative B would be most limited in terms of incremental development. The tunnel, and the approach roadways on either side of the Pearl Harbor channel, would have to be constructed to provide a useful project. Project cost efficiencies would encourage the initial construction of the full width tunnel. The Nimitz and Kakaako Viaducts could be developed separately from the Pearl Harbor Tunnel.

All three of the rail alternatives could be extended or expanded to meet increased travel needs beyond the system terminus or in other corridors. The guideway facility for each of the rail alternatives could accommodate increases in transit patronage above the Year 2000 forecasts by the acquisition and use of additional rail cars to increase train length or service frequency.

Fiscal Impact

The Committed System and each of the six alternatives would have significant fiscal impacts on the community and the local governments. The funding of the capital costs and increased operating costs of the public transit programs and highway projects will require additional funding sources or increased tax rates for present sources. These fiscal needs will likely evolve into several community and institutional issues:

- o Role of State and City in funding of projects/programs. The role and extent to which each would participate in implementation and funding would vary among the alternatives.
- o Public acceptance of new or increased taxes.
- o Dedication of a particular tax or tax increment for general transportation purposes or to fund a particular project or program (such as local subsidy for bus operations or rail construction). This would probably be required as a condition for use of Federal funds on a rail project.

A positive impact would be the fiscal benefit to the area which would result from a project with major Federal funding support (Alternatives D, E and F).

Vulnerability to Delays

Implementation of each of the alternatives would be subject to delays due to community and institutional concerns. Potential foci of concerns for the alternatives include:

Alternative	Potential Source of Delay
A	o Public and institutional resistance to strong disincentives to peak period automobile use.

Alternative	Potential Source of Delay
B	o U.S. Navy and Air Force concerns with highway penetration of military installations.
	o Local funding of construction costs.
	o Environmental concerns.
	o Right-of-way acquisition.
C	o Local funding of increased bus operating costs.
D and E	o Funding of local share of construction and operating costs.
	o Utility considerations along former OR&L right-of-way.
	o For E, community concerns for impacts of elevated sections.
F	o Funding of local share of construction and operating costs.
	o Community concern for impacts of elevated sections.
	o Right-of-way acquisition.

CONFORMANCE WITH GOALS AND OBJECTIVES

At the initiation of the alternatives analysis phase of the Hali 2000 Study, a series of "Measures of Effectiveness" were identified for use in comparing the alternatives degree of attainment for the transportation goals and objectives. The measures encompass all of the objectives, with many of the objectives addressed by two or more of the measures. The comparative measures are summarized for the alternatives in Table 9-3.

TABLE 9-3

SUMMARY OF EVALUATION MEASURES
HALI 2000 ALTERNATIVES

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
EXPANDED FACILITIES/ SERVICES								
1. Added Highway Lane Miles	-	-	-	84	0	0	0	0
2. Added HOV Lanes (Miles)(a)	-	-	23	5	0	0	0	0
3. Transit System (Total)								
a. Weekday Vehicle Miles of Service	44,000	70,000	100,000	69,000	92,000	58,000	60,000	73,000
b. Facilities on Separate Right-of-Way (Bus & Rail)	-	-	0	0	0	18.3	21.0	13.8
c. Reserved Transit Lanes Within Roadways	-	-	0	0	28	10.4	7.6	0
TRAVEL MODE CHOICE								
1. Weekday Resident Person Trips by								
a. Public Transit(b)	176,000	238,200	+23,800	-4,100	+10,100	-200	-4,400	+20,300
b. Carpools(b) (3+ Occupants)	540,500	681,500	+17,700	-3,700	-1,500	+900	+600	-4,300
c. Single Occupant Autos(b)	780,300	965,200	-38,400	+7,200	-5,800	-800	+2,600	-10,100
2. Work Trips by Public Transit (%)	14.9	18.3	21.7	17.7	19.2	18.0	18.0	20.9

(a) HOV - High Occupancy Vehicles with 3 or more occupants.
(b) Values for alternatives are changes from Committed System.

TABLE 9-3

SUMMARY OF EVALUATION MEASURES
HALI 2000 ALTERNATIVES

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
TRAVEL MODE CHOICE (con't)								
3. Percent Peak Hour Resident Trips by Public Transit to								
a. Downtown	13.9	15.9	18.9	15.5	16.4	15.6	15.2	16.4
b. Waikiki	11.1	12.9	14.7	12.5	13.5	12.5	12.8	14.8
c. Airport	6.5	8.0	9.1	7.5	8.3	6.0	5.4	10.5
4. Percent Person Trips by Public Transit at Corridor/Screenline								
a. Leeward @ Kalauao	6.9	9.5	11.4	8.7	9.9	9.3	9.1	10.6
b. Downtown @ Kapalama	9.1	10.8	13.0	10.5	11.2	10.8	10.5	12.1
c. Downtown @ Ward	8.7	10.8	12.6	10.6	11.1	10.6	10.3	11.9
d. Downtown @ School	8.6	9.2	11.6	9.1	9.7	8.9	8.5	9.9
TRAVEL SYSTEM PERFORMANCE								
1. Weekday Vehicle Travel								
a. Vehicle Delay (Hours)(c)	53,000	82,200	69,400	72,900	80,000	98,700	88,300	77,700
b. Percent Travel on Congested Roadways(c)	10	14	11	13	14	17	13	13
2. Travel Safety (All Modes)								
a. Annual Accidents(c)	-	10,660	+460	-340	+400	+450	+170	-640
b. Annual Injuries(c)	-	8,160	+370	-260	+330	-20	-180	-510
3. Ratio of Peak Hour Traffic to Design Capacity								
a. Leeward @ Kalauao	1.07	1.28	0.95	0.96	1.25	1.28	1.30	1.25
b. Downtown @ Kapalama	1.07	1.16	1.05	0.97	1.12	1.23	1.17	1.12
c. Downtown @ Ward	0.78	0.87	0.78	0.69	0.87	0.95	0.88	0.85
d. Downtown @ School	-	0.90	0.70	0.80	0.86	0.82	0.91	0.87
e. East Honolulu @ Kapakahi	1.23	1.16	1.02	1.16	1.16	1.18	1.16	1.14

(c) For major roadway system; excludes local streets.

TABLE 9-3

SUMMARY OF EVALUATION MEASURES
HALI 2000 ALTERNATIVES

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
TRAVEL SYSTEM PERFORMANCE (con't)								
4. Downtown Parking Spaces or Change from Committed	22,500	27,500	-3,700	+500	-700	+400	+900	-800
COST OF ALTERNATIVES(e)								
1. Capital Costs 1984-2000	-	229.5	322.6	1,675.3	346.6	678.4	785.0	1,168.2
a. Highway(d)	-	-	12.3	1,445.8	15.3	0	0	0
b. Public Transit	-	229.5	310.3	229.5	331.3	678.4	785.0	1,168.2
2. Year 2000 Operating Costs	-	86.5	118.2	88.3	109.4	66.1	69.1	75.2
a. Highway(d)		0	0.4	1.8	0.4	0	0	0
b. Public Transit		86.5	117.8	86.5	109.0	66.1	69.1	75.2
3. Equivalent Uniform Annual Costs (@ 7% Discount Rate)	-	104.6	143.9	104.6	136.9	117.5	128.1	161.4
FINANCIAL ANALYSIS(e)								
1. Capital Funding								
a. Federal Highway(d)		0	6.0	10.8	9.0	0	0	0
b. Federal Transit		183.6	248.2	183.6	250.0	517.0	597.2	823.6
c. State & City		45.9	68.4	1,480.9	87.6	161.4	187.8	344.6
2. Operations Funding (Year 2000)								
a. Federal Highway(d)		0	0	0	0	0	0	0
b. Transit Fares		24.2	26.4	23.9	25.0	24.2	23.9	26.1
c. State & City		62.3	91.4	62.6	84.0	41.9	45.2	49.1
3. Year 2000 Annual Funding Required from State & City Sources(d)		67.8	100.6	249.9	95.2	61.9	68.7	92.1

(d) Does not include Committed highway projects.
(e) In millions of 1983 dollars.

TABLE 9-3

SUMMARY OF EVALUATION MEASURES
HALI 2000 ALTERNATIVES

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
PUBLIC TRANSIT COST EFFECTIVENESS(f)								
1. Annualized Capital and Operating Costs per Passenger	0.95	1.21	1.53	1.23	1.52	1.36	1.50	1.73
2. Operating Costs per Passenger	0.82	1.00	1.25	1.01	1.22	.76	.81	.83
ENVIRONMENTAL IMPACTS								
1. Year 2000 Daily Emissions (Tons)								
a. Carbon Monoxide(b)	-	242.4	-5.0	-10.5	-1.0	+0.2	+1.2	-3.9
b. Hydrocarbons(b)	-	22.2	0	-0.4	+0.3	-0.4	-0.3	-0.6
c. Oxides of Sulfur(b)	-	1.3	0	-0.1	0	+0.1	+0.1	+0.3
2. Energy Consumption (Billions of BTUS)								
a. Year 2000 Operations(b)		20,475	-225	-675	+40	+122	+166	-169
b. Construction (1984-2000)		6,836	9,214	29,714	8,549	18,197	20,519	35,143
3. Visual — Miles of Elevated Facilities		-	0	5.5	0	0.6	5.7	10.0
4. Ecosystem - Potential Wildlife Impacts		-	None	Pearl Harbor Crossing & Ewa	None	Waiawa & Honouliuli Refuge Units	Waiawa & Honouliuli Refuge Units	None
5. Ecosystem - Potential for Impact to Endangered Plant Species			None	Ewa	None	Former OR&L Alignment	Former OR&L Alignment	None

(f) Year 2000 passengers and operations, with costs in 1983 dollars. Annualized capital costs reflect discount rate of 7%.

TABLE 9-3

SUMMARY OF EVALUATION MEASURES
HALI 2000 ALTERNATIVES

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
SOCIOECONOMIC IMPACTS								
1. Land Acquisition (Acres)								
a. Residential(g)		–	0	0.5	0	1	0	5
b. Commercial-Industrial(g)		–	24	0.5	24	13.6	15.5	50
c. Agriculture & Public(g)		–	0	70	0	4.1	5.8	8
d. Military(g)		–	0	35	0	0	0	0
e. Total		–	24	106	24	18.7	21.3	63
2. Potential for Parkland(4f) Impacts		–	Minimal	1 Park Encroachment	Minimal	Potential Encroachments	Potential Encroachments	Major Encroachments
3. Potential for Historic/Cultural Facility Impacts		–	Minimal		Minimal			
4. Significant Reduction in Travel Time to Major Employment Center from Areas		–	• Minor Reduction All Areas	• Ewa, • Central Oahu	Transit from Leeward	None	None	Transit from Leeward
5. Project Construction Employment		–	4,600	14,700	4,200	9,000	10,000	17,400
COMMUNITY/INSTITUTIONAL FACTORS								
1. Potential for Adverse Impact on Military Installations		–	Road Pricing	Displacement, Disruption	None	Minimal	Minimal	Minimal
2. Ease of Staging Improvements		–	Excellent	Poor	Excellent	Good	Good	Fair

(g) Includes both developed and undeveloped land.

TABLE 9-3

SUMMARY OF EVALUATION MEASURES
HALI 2000 ALTERNATIVES

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
COMMUNITY/INSTITUTIONAL FACTORS (con't)								
3. Ease of Expansion for Projects, Programs & Services		-	Fair	Poor	Good	Excellent	Excellent	Excellent
4. Reinforcement of Area Development Plans		-	Minimal	Encourage Growth in Leeward & Central Oahu	Minimal	Encourage Development in Primary & Secondary Urban Centers Encourage Densification of Urbanized Areas		
5. Compatibility with Emergency Plans								
a. Energy Shortage			Good	Fair	Good	Excellent	Excellent	Excellent
b. Natural Disaster			Good	Fair	Good	Poor	Poor	Poor

APPENDICES

APPENDIX A

LIST OF TECHNICAL WORKING PAPERS
Hali 2000 Alternatives Analysis
Hali 2000 Study

1. Measures of Effectiveness for Evaluating System Level Alternatives, July 1983

2. Unit Costs for Transit Capital Projects, October 1983

3. Transit Guideway Alignment and Costs for Alternatives D, E and F, November 1983

4. Unit and Total Operating and Maintenance Costs for Transit Alternatives, January 1984

5. Highway Project Costs, January 1984

6. Highway User Cost Analysis, January 1984

7. Funding Requirements and Availability, January 1984

8. Energy Impacts, January 1984

9. Air Quality Impacts, January 1984

10. Noise Impacts, January 1984

APPENDIX B

GLOSSARY

Annualized Capital Cost	A one-time capital cost converted into an annual value which incorporates both the depreciation on the capital item and the foregone interest on the money invested in the project.
Annualization Factor	A number used to convert average weekday ridership to an annual value. Typical ranges are 280-300 for commuter oriented systems, and 300-325 for urban transit systems.
Boarding Trips	Number of trips boarding (entering) transit vehicles, regardless of whether the trip involved a transfer from another transit vehicle. Equivalent to unlinked trips. A fare may or may not be collected for each boarding trip, depending on whether a transfer is used.
CBD	Central Business District.
Deadheading	Unproductive movement of a vehicle in order to bring it into, or take it out of, revenue service.
Discount Rate	The rate used to annualize a capital cost (see Annualized Capital Cost).
Fixed Route Transit	Transit service providing service along a route and at times fixed by a schedule.
Guideway Transit System	Transit system which is restricted to a specific routing because of (1) horizontal steering or roadbed requirements (e.g. a railroad track), and/or (2) a fixed system of power distribution which restricts vehicles to specific routes (e.g. overhead electrical power distribution system).
Headway	The time between two consecutive transit vehicles. For example, six trains per hour is the same as a 10 minute headway.
Heavy Rail	Rail transit mode characterized by exclusive grade-separated operation (aerial or subway in many cases) and higher average operating speeds. Usually heavy rail involves a higher degree of automation and central control than does light rail.

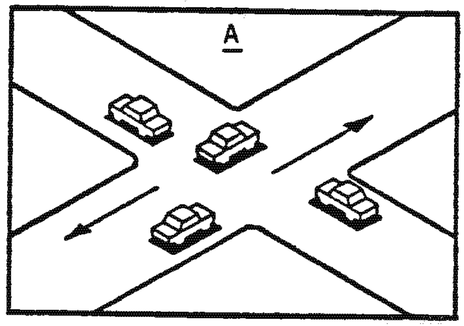
Light Rail	Transit mode characterized by its ability to operate in both at-grade and grade-separated environment, and usually operating in single cars, or in trains of no more than four vehicles.
Line-Mile	Unduplicated miles of rail line, regardless of the number of tracks.
HOV	High Occupancy Vehicle. Typically includes carpools with three or more people, vanpools, and buses.
Load, Crush	The maximum physical capacity of a rail vehicle under overloaded conditions; about 2.5 square feet of gross floor area per passenger.
Load, Design	About four square feet of gross floor area of a rail car per "place." Used as a "tolerable" level of crowding under peak conditions. Used as a basis for calculating normal design capacity. See also Crush Load.
Load, Desirable Maximum	About 5.5 square feet of gross floor area per "place" or passenger.
LRV	Light Rail Vehicle.
Linked Trips	Total passenger (fare-paying trips). Linked trips exclude transfers; consequently, the number of linked trips must always be less than (or equal to) the number of unlinked (boarding) trips.
Overhead	The wires, switches, and related equipment used to supply electrically propelled vehicles with power.
Place-miles	The number of places (seated and standing) in a car, times the number of car-miles operated.
Revenue Service	The time during which a transit vehicle is in service and available to passengers for transportation. This term also applies to revenue car-miles and to revenue car-hours. The time during which a vehicle is not available is deadheading time.
Trolley Bus	Rubber-tired, electrically propelled bus.
Turnback	A facility for reversing the direction of rail vehicles.
Unlinked Trips	See boarding trips.

APPENDIX C

INTERSECTION LEVEL OF SERVICE CONCEPT
Hali 2000 Study

<u>LEVEL OF SERVICE A</u> *Volume/Capacity Ratio= 0 - 0.69*

- Free flow conditions
- No vehicle waits longer than one signal indication

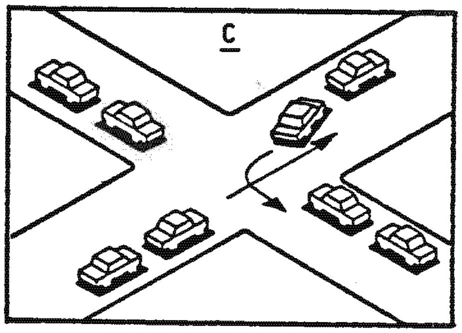


<u>LEVEL OF SERVICE B</u> *Volume/Capacity Ratio= 0.70 - 0.79*

- Stable traffic flow
- Motorists rarely wait through more than one signal indication

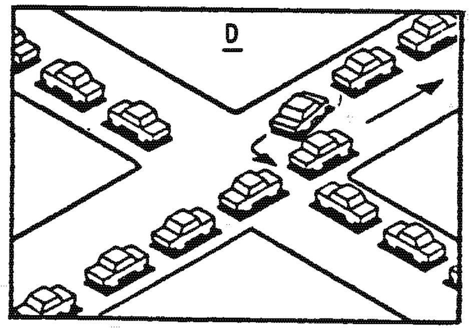
<u>LEVEL OF SERVICE C</u> *Volume/Capacity Ratio= 0.80 - 0.89*

- Stable and acceptable flow but speed and maneuverability somewhat restricted due to higher volumes
- Motorists intermittently wait through more than one signal indication
- Occasional backups behind left turning vehicles



<u>LEVEL OF SERVICE D</u> *Volume/Capacity Ratio= 0.90 - 1.00*

- Extensive delays at times
- Some motorists, especially left turners, may wait through one or more signal indications, but enough cycles with lower demand occur to prevent excessive backups
- Maneuverability restricted

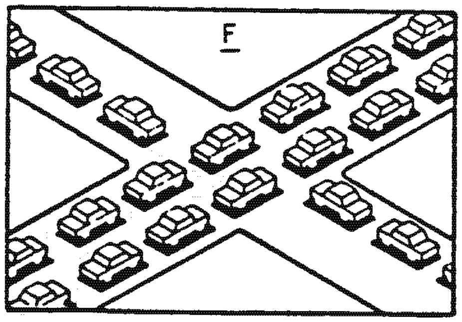


<u>LEVEL OF SERVICE E</u> *Volume/Capacity Ratio= 1.00 -1.15*

- Very long queues may create lengthy delays, especially for left turning vehicles
- Volume at or near capacity
- Unstable flow

<u>LEVEL OF SERVICE F</u> *Volume/Capacity Ratio=1.16 or greater*

- Backups from locations downstream restrict movement at intersection approaches
- Forced flow conditions
- Stoppage for long periods due to congestion
- Volumes drop to zero in extreme cases



APPENDIX D

YEAR 2000 HIGHWAY DESIGN VOLUMES(a) FOR MORNING PEAK HOUR, PEAK DIRECTION

CORRIDOR/SCREENLINE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
CENTRAL CORRIDOR								
Helemano	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Kipapa #1	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600
Kipapa #2	6,600	6,600	6,600	6,600	6,600	6,600	6,600	6,600
LEEWARD CORRIDOR								
Kahe Point	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Waikele	9,050	9,050	9,050(b)	14,150	9,050(b)	9,050	9,050	9,050
Kalauao	11,300	13,000	13,000(b)	18,100	13,000(b)	13,000	13,000	13,000
DOWNTOWN CORRIDOR								
Moanalua	11,600	18,100	18,100(b)	18,100	18,100(b)	18,100	18,100	18,100
Kapalama	14,300	14,300	14,300	17,700	14,300	13,550	14,300	14,300
Nuuanu	18,850	19,600	19,600	23,000	19,600	19,600	19,600	19,600
School Street	–	13,250	13,250(b)	14,950	13,250(b)	13,250	13,250	13,250
Ward	17,850	17,850	17,850	21,250(b)	17,850(b)	16,350	17,850	17,850
Manoa-Palolo	21,350	21,350	21,350	21,350(b)	21,350	21,350	21,350	21,350
EAST HONOLULU CORRIDOR								
Kapakahi	3,900(b)	3,900(b)	3,900(b)	3,900(b)	3,900(b)	3,900(b)	3,900(b)	3,900(b)
Niu	2,600	2,600(b)	2,600(b)	2,600(b)	2,600(b)	2,600(b)	2,600(b)	2,600(b)
WINDWARD CORRIDOR								
Trans-Koolau	6,800	10,200	10,200	10,200	10,200	10,200	10,200	10,200
Kualoa	750	750	750	750	750	750	750	750
Kawainui	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200

(a) Design volume represents Level of Service D. (See Appendix C.)
(b) Design volume does not reflect peak direction HOV or bus lanes proposed for this location.

APPENDIX E

YEAR 2000 WEEKDAY TRAFFIC VOLUMES
ACROSS ANALYSIS SCREENLINES

SCREENLINE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D AT-GRADE LRT	E LIGHT RAIL	F RAPID TRANSIT
CENTRAL/LEEWARD CORRIDOR								
Helemano	18,000	26,000	26,000	26,000	26,000	25,000	26,000	25,000
Kipapa #1	58,000	96,000	94,000	96,000	96,000	96,000	97,000	95,000
Kipapa #2	80,000	123,000	121,000	123,000	123,000	123,000	124,000	122,000
Kahe Point	19,000	36,000	34,000	37,000	36,000	37,000	37,000	35,000
Waikele	82,000	143,000	138,000	152,000	142,000	143,000	143,000	140,000
Kalauao	200,000	254,000	245,000	268,000	253,000	255,000	256,000	250,000
DOWNTOWN CORRIDOR								
Moanalua	254,000	265,000	257,000	271,000	265,000	264,000	267,000	261,000
Kapalama	265,000	323,000	308,000	327,000	316,000	323,000	322,000	316,000
Nuuanu	342,000	388,000	379,000	394,000	391,000	389,000	388,000	383,000
School	203,000	213,000	206,000	213,000	211,000	218,000	215,000	211,000
Ward	348,000	414,000	402,000	407,000	410,000	409,000	415,000	406,000
Manoa-Palolo	321,000	380,000	369,000	380,000	379,000	382,000	379,000	377,000
EAST HONOLULU CORRIDOR								
Kapakahi	65,000	81,000	79,000	81,000	81,000	80,000	81,000	80,000
Niu	43,000	64,000	62,000	64,000	64,000	63,000	63,000	62,000
WINDWARD CORRIDOR								
Trans-Koolau	85,000	120,000	119,000	120,000	119,000	121,000	121,000	118,000
Kualoa	8,000	12,000	120,000	12,000	12,000	12,000	12,000	12,000
Kawainui	45,000	80,000	77,000	77,000	79,000	81,000	79,000	78,000

AR00050389