Appendix B-1

Traffic Analysis Update

UPDATE TO TRAFFIC ANALYSIS

KAONOULU INDUSTRIAL PARK

Kihei, Maui, Hawaii

Prepared for:

Kaonoulu Ranch

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Kaonoulu Industrial Park
Kihei, Maui, Hawaii

April, 1998

Kaonoulu Ranch has proposed an 88-acre industrial park in Kihei, east of Piilani Highway across from the Kaonoulu Estates project (Exhibit 1). A report[1] summarizing a traffic impact analysis was prepared in March 1994 as part of the State Land Use petition; the report identified the potential impact of the industrial park and recommended appropriate roadway improvements to provide adequate traffic capacity to serve the industrial park. While the proposed project has not changed, additional traffic data and new analytical procedures are now available. This update reevaluates the traffic impact of the project using the new information as part of the application for a change in zoning.

The proposed project would construct infrastructure and subdivide the land for industrial use. While details of the project have not yet been finalized, vehicular access is proposed from Piilani Highway across from the Kaonoulu Estates project, changing the existing T-intersection of Piilani Highway and Kaonoulu Street to a cross-intersection. The access road would bisect the site, and an extension of this access road farther east could become the proposed roadway between Kihei and Upcountry Maui. Two secondary roadways providing access to the individual lots would cross the Kaonoulu Street extension, forming two additional intersections east of Piilani Highway.

Because the project is expected to provide industrial space in support of resort, residential, and other development in the South Maui area, regional traffic impacts would be positive in that travel into and out of the South Maui area would be lessened. Since occupancy of the proposed project would occur over a period of several years, the traffic impact would not be immediate, but would increase over a number of years. The analysis, however, has assumed full occupancy of the project by the year 2010.

For an industrial park, the greatest traffic impact would occur during weekday peak commuting periods. Because specific uses within the park have not yet been determined, per-acre trip rates from the informational report *Trip Generation*[2] were used to estimate the traffic generated by the project.

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1 Julian Ng, Inc., *Traffic Impact Analysis Report, Kaonoulu Industrial Park*, March 1994.

2 Institute of Transportation Engineers, *Trip Generation, 6th Edition*, 1997.

In the morning peak hour, when traffic entering the project is the greatest, the expected high volume of left turns off the southbound Piilani Highway would be made against a heavy northbound traffic flow on the highway; in the afternoon peak period, left turns out of the site would be made across and into the peak highway traffic. Conditions during these weekday peak hours were analyzed to determine the most critical conditions expected at the intersection of Piilani Highway and Kaonoulu Street; impacts at other times of the weekday, and on weekends, would be less since project traffic will be considerably lower at these times.

The results of the current analyses are also compared with the findings for year 2010 from the 1994 report, for the existing highway network and for a roadway system which includes a Kihei-Upcountry road with its west terminus at Kaonoulu Street.

Analyses were done using methods described in the *Highway Capacity Manual*[3] from the Transportation Research Board. At unsignalized intersections, average delays and a Level of Service (LOS) were identified for each controlled movement. Levels of service were determined for signalized intersections using the Planning Method. Levels of service are described in an attached appendix.

Existing Conditions

The proposed project would have access from Piilani Highway, via a new roadway that will add a fourth leg to the existing T-intersection with Kaonoulu Street. Piilani Highway is a major arterial, two lanes wide, serving through traffic at a posted speed limit of 45 miles per hour. The typical section of the highway includes 12-foot lanes and 10-foot wide paved shoulders, which also serve as bikelanes. At Kaonoulu Street and other major intersections, right turn deceleration and left turn deceleration/storage lanes are provided.

Four intersections along Piilani Highway in the vicinity of the proposed project, at Mokulele Highway, Uwapo Road, Ohukai Street, and Lipoa Street are presently signalized. Other side streets, including Kaonoulu Street, are stop-controlled at their intersections with Piilani Highway. Kaonoulu Street and Kulanihakoi Street to the south, which serve residential subdivisions, form the stop-controlled stem approaches at "T"-intersections with Piilani Highway.

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3 Transportation Research Board Special Report 209, *Highway Capacity Manual, Third Edition*, 1994.

Counts taken by the State Highways Division[4, 5] show increasing traffic volumes on Piilani Highway. At a station north of Lipoa Street, located approximately 1½ miles south of Kaonoulu Street, this increase has been approximately 5% per year. The State Highways Division[6] has estimated that the Average Daily Traffic (ADT) on Piilani Highway in the vicinity of the project was 23,040 vehicles per day (vpd) in 1995. Table 1 shows the recent traffic counts and estimates on Piilani Highway near the project site.

Table 1

EXISTING TRAFFIC

	24-hour count		AM Peak Hour		PM Peak Hour	
direction of travel:	South	North	South	North	South	North
Piilani Highway, North of Lipoa Street						
May, 1997	13,173	12,559	1,052	1,020	984	1,081
August, 1995	12,740	11,214	849	846	1,029	913
June, 1993	11,677	10,397	848	703	830	1,083
May, 1991	10,574	10,025	968	1,005	702	793
Piilani Highway, Ohukai Street to Lipoa Street						
estimated 1995	11,520	11,520	950	778	828	1,015
estimated 1993	10,380	10,380	856	701	793	971
estimated 1991	10,320	10,320	907	744	742	1,116

Future Conditions Without The Proposed Project

The State Department of Transportation and the County of Maui Departments of Public Works and Planning in 1988 initiated a long-range highway planning study, which included projections of traffic demands for years 2000 and 2010. The future traffic demand at the Waiakoa Gulch screenline shown in the final report[7] for this study were used in the 1994 project traffic report to estimate future traffic on Piilani Highway.

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4 State Highways Division, *Traffic Survey Data (Individual Stations) - Island Of Maui, 1997.* Station 13-E.

5 State Highways Division, *Traffic Survey Data (Individual Stations) - Island Of Maui, 1995.* Station 13-E.

6 State Highways Division, *Traffic Summary - Island of Maui 1995.*

7 State of Hawaii (Department of Transportation) and County of Maui (Department of Public Works, Department of Planning), *Maui Long-Range Highway Planning Study Island-Wide Plan*, May 1991.

An update of the islandwide study was completed in 1997; its final report[8] included forecasts for segments of Piilani Highway for year 2020. A companion report[9] for the Kihei area showed forecasts for year 2005. These forecasts were used to develop a new estimate of year 2010 traffic on Piilani Highway, south of Kaonoulu Street, as shown in Table 2. The new estimates are 70% (AM Peak Hour) and 80% (PM Peak Hour) of the estimates contained in the 1994 traffic report for this project. Table 2 shows the growth expected in Piilani Highway traffic.

Table 2

FUTURE TRAFFIC
Piilani Highway

	AM Peak Hour		PM Peak Hour	
direction of travel:	South	North	South	North
1994 Traffic Report for this project				
Year 2000, South of Kaonoulu Street	1,101	1,191	1,296	1,176
Year 2010, South of Kaonoulu Street	1,729	1,881	2,040	1,835
Kihei Traffic Study				
Year 2005, South of Mokulele Highway	980	1,925	2,155	1,425
Year 2005, South of Kaonoulu Street	1,270	1,330	1,660	1,385
Year 2005, South of Lipoa Street	1,100	1,270	1,280	1,290
Maui Long-Range Plan				
Year 2020, South of Mokulele Highway	1,136	1,614	1,668	1,833
Year 2020, South of Lipoa Street	841	1,139	1,342	1,482
Current Estimate for				
Year 2010, South of Kaonoulu Street	1,250	1,270	1,590	1,485

The revised projections for year 2020 traffic without the industrial park are lower than the earlier projections. No additional information is available to change any of the earlier estimates for traffic due to the residential development to the west (Kaonoulu Estates) and to the Kihei-Upcountry road. Exhibit 2 compares the without-project traffic assignments from the 1994 report with the current projections.

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8 Kaku Associates. *Final Report, Maui Long Range Land Transportation Plan*, February, 1997.

9 Kaku Associates. *Kihei Traffic Master Plan*, March, 1996.

Proposed Project

The proposed project is an industrial park intended to satisfy the existing needs of South Maui and the expected growth of the area. The 88-acre site presently does not generate any traffic and does not affect flows on Piilani Highway. Equations for best-fit lines provided in *Trip Generation* were used to estimate the traffic generated by development of the site as an industrial park. Table 3 shows the trip generation estimates.

Table 3
TRIP GENERATION

	Average weekday		AM Peak Hour		PM Peak Hour	
	Enter	Exit	Enter	Exit	Enter	Exit
previous *	2,410	2,410	610	134	152	574
current **	2,410	2,410	623	128	152	572

* based on *Trip Generation, 5th Edition* (1991), used in 1994 report
** based on *Trip Generation, 6th Edition* (1997)

Table 3 shows minimal change in the estimates of traffic generated by the project by using the most current factors. The project traffic based on the current factors was distributed using the factors shown in Table 4, which were developed from a review of the traffic projections at the intersection of Piilani Highway and Kaonoulu Street. For the case with the Kihei-Upcountry road at Kaonoulu, 10% of the project traffic was assumed to originate or be destined to Upcountry.

Table 4
TRIP DISTRIBUTION

	West		North		South	
	Enter	Exit	Enter	Exit	Enter	Exit
AM Peak Hour	2%	10%	45%	46%	53%	44%
PM Peak Hour	4%	8%	57%	55%	39%	37%

Since the project is expected to meet the needs of South Maui, trips attracted to the site from the south would be from the traffic which would otherwise have to travel north to other parts of the island. In preparing traffic assignments for future conditions with the project, non-project traffic to or from the north were therefore decreased by the same amount of any project-related movements so that approach and departure volumes on the south leg of the intersection are maintained. Exhibit 3 shows the with-project traffic assignments.

Traffic Analyses - Piilani Highway

Service volumes, the maximum volume a highway can accommodate at a given level of service, for the existing two-lane Piilani Highway were calculated using procedures from the *Highway Capacity Manual.*

In the AM Peak Hour, the maximum two-way volume is 1,490 vehicles per hour (vph) for LOS D and capacity (LOS E) is 2,610 vph. Because of different traffic characteristics, PM Peak Hour service volumes are slightly lower: 1,460 vph for LOS D and 2,550 vph for LOS E. Peak hour conditions on Piilani Highway south of the site would be LOS E in the AM Peak Hour and LOS F in the PM Peak Hour. North of the site, AM Peak Hour conditions would be LOS E, and volumes in the PM Peak Hour exceed the capacities of the two-lane highway (LOS F). Table 5 summarizes the level of service findings for the existing highway without and with the proposed project; ratios of the volume to capacity (the service volume for LOS E) are also shown.

Table 5
HIGHWAY LEVELS OF SERVICE
Two-Lane Piilani Highway

	Existing Highway Network				With Kihei-Upcountry road			
LOS, v/c ratio:	without project		with the project		without project		with the project	
NORTH OF KAONOULU STREET								
AM Peak Hour	E	0.99	F	1.03	E	0.99	E	0.98
PM Peak Hour	F	1.30	F	1.34	F	1.30	F	1.35
SOUTH OF KAONOULU STREET								
AM Peak Hour	E	0.97	E	0.97	E	0.97	E	0.97
PM Peak Hour	F	1.21	F	1.21	F	1.21	F	1.21

Table 5 indicates that the existing two-lane highway would not have adequate capacity to serve future traffic volumes on Piilani Highway. The proposed project will have a minor effect on traffic conditions on Piilani Highway north of Kaonoulu Street. These results are similar to the findings of the 1994 traffic report and are consistent with the recommendations of the long-range transportation plan and the Kihei Subarea Study.

The analysis also shows that the widening of Piilani Highway to four lanes, as described in the long-range plan, will be needed. When widened, service volumes for a four-lane Piilani Highway will be increased, as shown below (from the 1994 report):

	AM Peak Hour	PM Peak Hour
LOS B	1,570	1,350
LOS C	2,120	1,820
LOS D	2,670	2,290
LOS E (capacity)	3,500	3,010

Acceptable levels of service (LOS D or better) were found with a four-lane highway for the year 2010 peak hour traffic. The ratios of volume to capacity (i.e., service volume at LOS E) and levels of service are shown in Table 6.

Table 6
HIGHWAY LEVELS OF SERVICE
Four-Lane Piilani Highway

LOS, v/C ratio:	North of Kaonoulu Street				South of Kaonoulu Street	
	without project		with the project			
direction (--bound):	south	north	south	north	south	north
Existing Highway Network						
AM Peak Hour	0.48 B	0.54 B	0.57 B	0.44 B	0.47 B	0.48 B
PM Peak Hour	0.77 C	0.67 C	0.71 C	0.78 C	0.69 C	0.65 C
With Kihei-Upcountry road						
AM Peak Hour	0.48 B	0.54 B	0.45 B	0.51 B	0.47 B	0.48 B
PM Peak Hour	0.77 C	0.67 C	0.70 C	0.80 D	0.70 C	0.65 C

Traffic conditions at the intersection of Piilani Highway and Kaonoulu Street were also considered. As an unsignalized intersection in which Kaonoulu Street traffic must stop before entering or crossing Piilani Highway, unacceptable Level of Service F conditions would describe left turns from Kaonoulu Street to Piilani Highway even without the addition of traffic from the proposed project (Table 7). Traffic signals would be warranted by the peak hour volumes with or without the proposed industrial parks.

Table 7
UNSIGNALIZED INTERSECTION LEVELS OF SERVICE
Kaonoulu Street and Piilani Highway

LOS, Left turns	Existing Highway Network				With Kihei-Upcountry road			
WB, EB	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
without project	-	F	-	F	F	F	F	F
with project	F	F	F	F	F	F	F	F

If signalized, the intersection of Piilani Highway and Kaonoulu Street would operate at acceptable conditions if separate lanes are provided for each movement, as illustrated in Exhibit 5. The planning analyses of the signalized intersection indicates that the changes in traffic movements due to the project would increase average delays, as shown in Table 8.

Table 8
SIGNALIZED INTERSECTION CONDITIONS
Piilani Highway and Kaonoulu Street

average delay	Existing Highway Network				With Kihei-Upcountry road			
(seconds), LOS	without project		with the project		without project		with the project	
AM Peak Hour:								
southbound	19.2	C	20.1	C	21.6	C	31.7	D
eastbound	22.8	C	28.7	D	35.5	D	39.9	D
westbound	-	-	27.4	D	34.0	D	38.2	D
northbound	19.7	C	22.9	C	30.3	D	37.1	D
overall	19.8	C	22.3	D	30.3	D	35.8	D
PM Peak Hour:								
southbound	21.8	C	25.1	D	23.9	C	29.0	D
eastbound	24.7	C	35.4	D	33.3	D	33.1	D
westbound	-	-	38.2	D	26.6	D	30.0	D
northbound	8.9	B	34.7	D	22.8	C	25.4	D
overall	16.3	C	31.2	D	24.2	C	28.4	D

In general, the findings of the analyses are similar to those from the 1994 traffic study; i. e., peak hour conditions with the traffic from the proposed project will be acceptable. However, because the new forecasts for non-project traffic are lower, the additional lanes (a second westbound left turn lane and a second southbound left turn lane) that had been identified in the 1994 traffic report as possible mitigation measures would not be necessary.

Traffic Analyses - Kaonoulu Street Extension

The proposed site plan shows access to the site provided by north-south secondary streets which intersect the east-west extension of Kaonoulu Street at two cross intersections. Each of these intersections was analyzed as an unsignalized intersection, with stop sign control of the northbound and southbound approaches; each approach was considered to consist of a single lane shared by traffic wishing to cross Kaonoulu Street and turns toward

Upcountry, with an additional lane for turns toward Piilani Highway. A separate lane for left turns from the Kaonoulu Street Extension was assumed in each direction.

The unsignalized intersection analyses show that there would be adequate capacities for each movement. Level of service findings from the analyses are shown in Table 9.

Table 9
INTERSECTION CONDITIONS
Unsignalized Intersections, Kaonoulu Street extension

(average delay in seconds, LOS)	Existing Highway Network		With Kihei-Upcountry road	
intersection:	makai	mauka	makai	mauka
AM Peak Hour:				
southbound approach	4.1 A	3.1 A	15.1 C	9.3 B
westbound left turn lane	4.0 A	- -	5.1 B	3.6 A
eastbound left turn lane	2.5 A	2.4 A	6.2 B	6.7 B
northbound approach	10.0 B	6.5 B	41.9 E	35.1 E
PM Peak Hour:				
southbound approach	3.7 A	3.0 A	7.0 B	4.5 A
westbound left turn lane	2.5 A	- -	3.3 A	3.1 A
eastbound left turn lane	3.4 A	2.2 A	5.5 B	3.4 A
northbound approach	11.0 C	6.4 B	47.4 E	27.8 D

Generally, delays are acceptable, with conditions on each approach described by Level of Service D or better. However, the very long delays that are expected for left turns from the northbound project roadways to the Kihei-Upcountry road toward Piilani Highway are described as Level of Service E. At both intersections, however, the peak hour volumes do not meet the minimum volumes required[10] for signalization and mitigation of the very long delays are not recommended at this time. One of the intersections (the mauka intersection based on the proposed layout) should be constructed with conduits to expedite future signalization, when warrants be met.

[10] U.S. Department of Transportation, Federal Highway Administration, *Manual on Uniform Traffic Control Devices for Streets and Highways*, 1989, as amended.

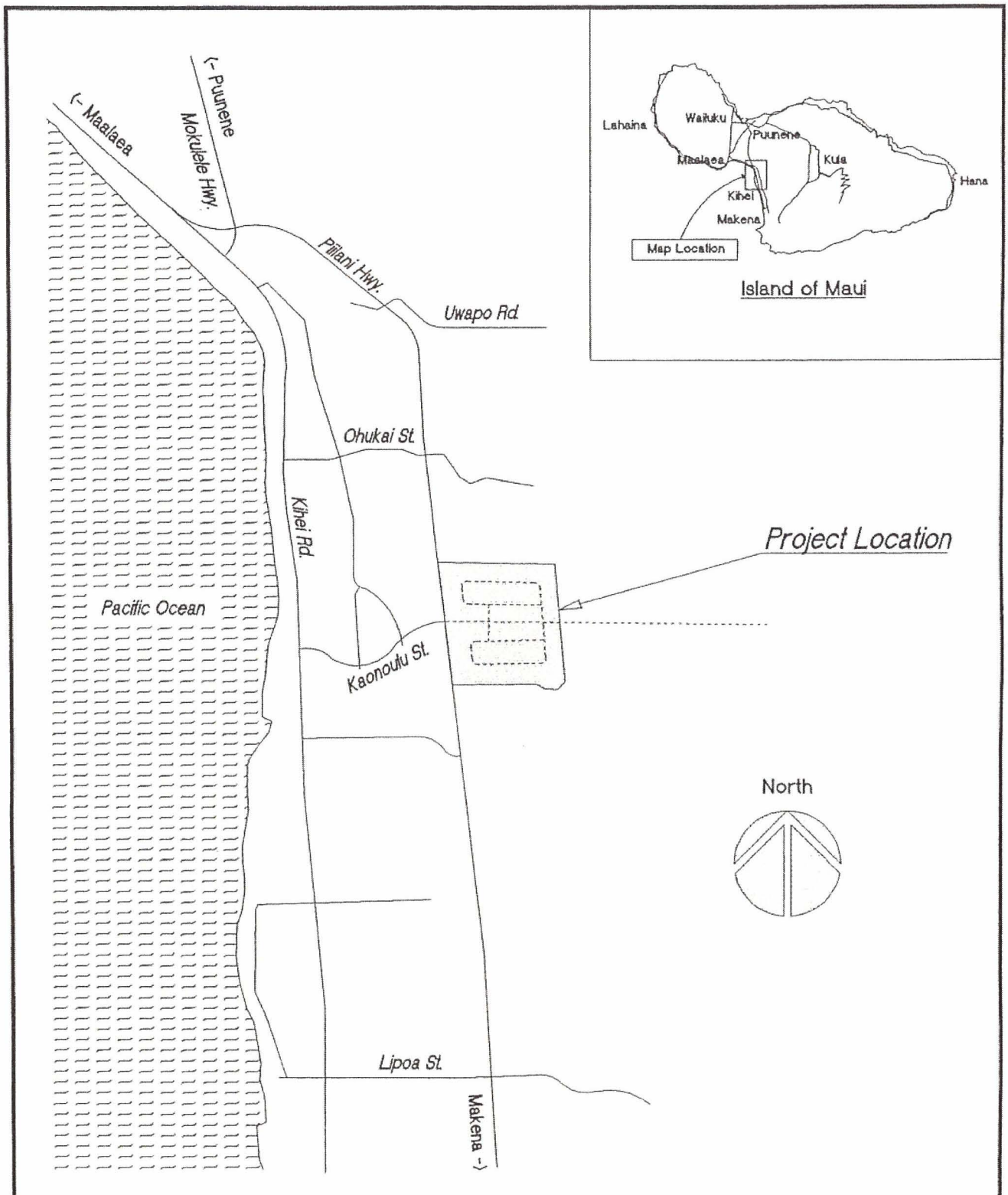
Conclusions and Recommendations

The expected growth of traffic on Piilani Highway indicates the highway would need widening to four lanes without the proposed project. In addition, the Piilani Highway and Kaonoulu Street intersection would need signalization even without the proposed industrial park. Separate lanes for left turns and right turns from the highway would be provided with any improvement of the highway.

The proposed industrial park project would change the existing T-intersection to a cross intersection and alter traffic demand in the vicinity of Kaonoulu Street. A new southbound left turn lane and other appropriate intersection improvements will be constructed as part of the project. Traffic from the proposed project would increase delays at the intersection but no mitigative measures will needed. Regional traffic impacts are minimal and in some cases are positive (reduction in volume).

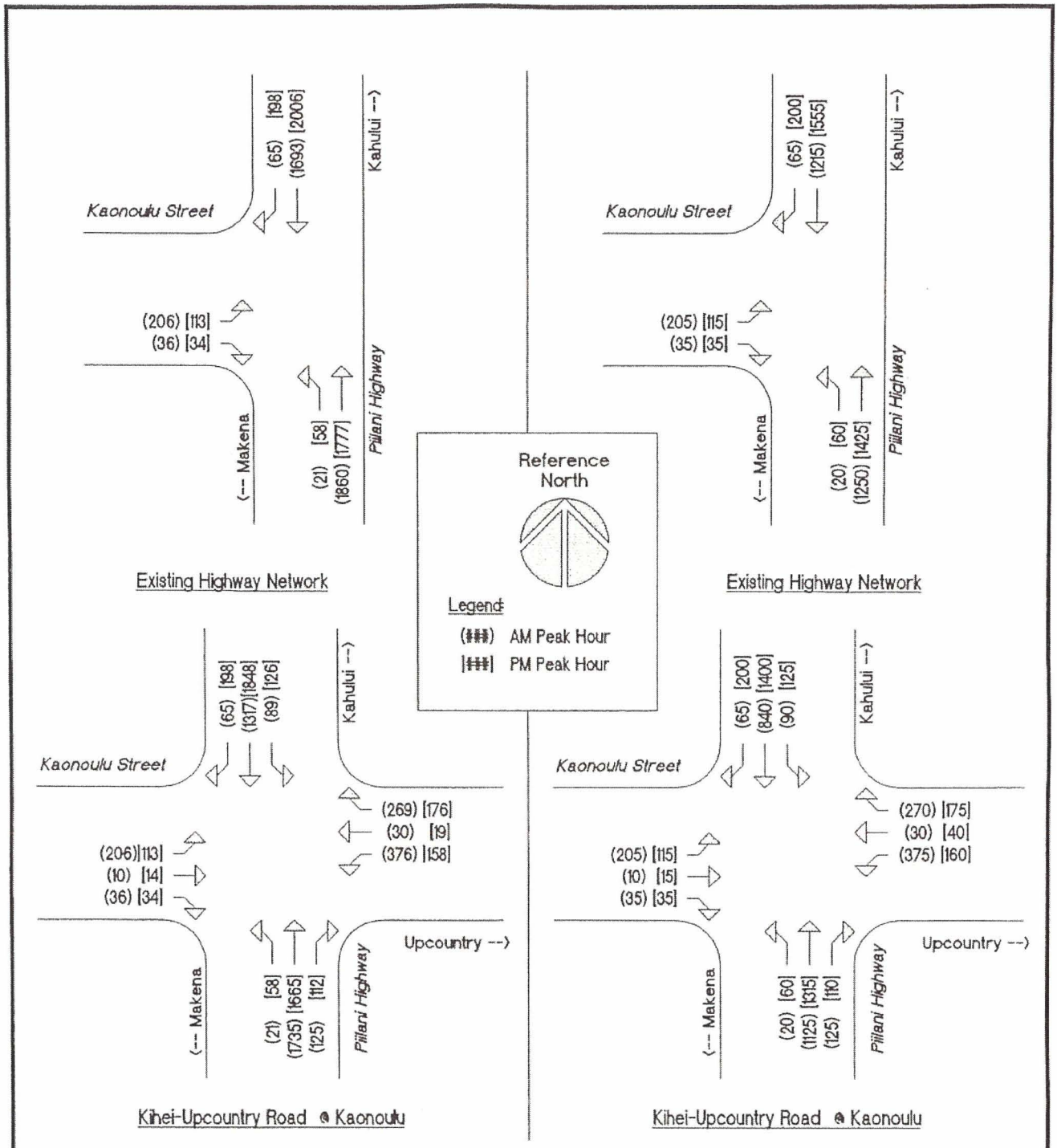
For the projected traffic with the proposed project fully occupied in year 2010, the Piilani Highway and Kaonoulu Street intersection would have adequate capacity, whether or not a road between Kihei and Upcountry Maui is constructed.

Exhibit 5 shows the recommended laneage for the Kaonoulu Street extension.



Update to Traffic Analysis Kaonoulu Industrial Park	PROJECT LOCATION AND SITE PLAN	Exhibit 1
prepared for: Kaonoulu Ranch prepared by: Julian Ng, Inc.	Not to Scale April, 1998	

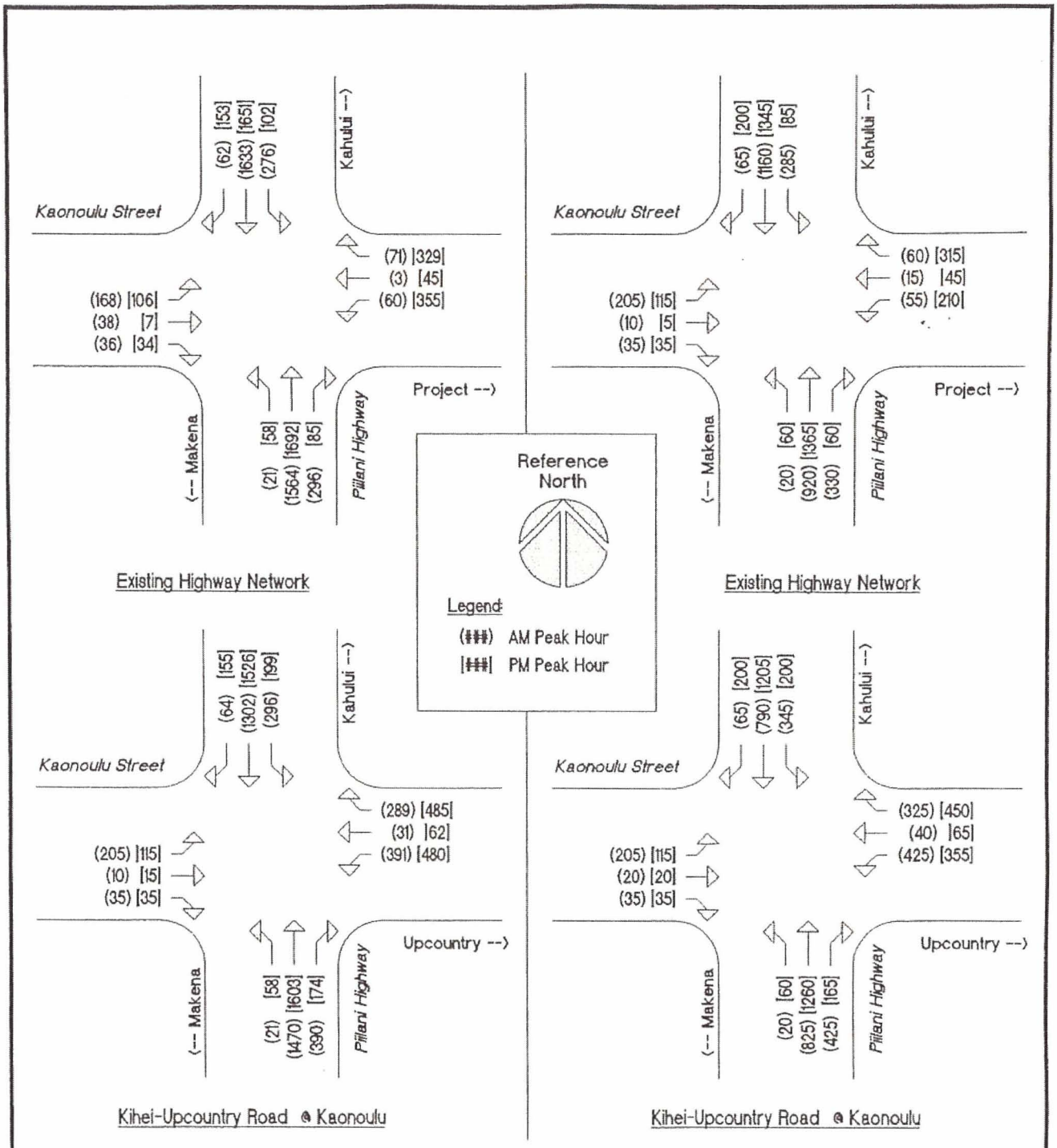
UPDATE1.SKU 04/10/98 10:21



Traffic Assignment from 1994 Report

Updated Traffic Assignment (2010)

Update to Traffic Analysis Kaonoulu Industrial Park	TRAFFIC ASSIGNMENTS WITHOUT PROJECT	Exhibit 2
prepared for: Kaonoulu Ranch — Not to Scale prepared by: Julian Ng, Inc. — April, 1998		



Traffic Assignment from 1994 Report

Updated Traffic Assignment (2010)

Update to Traffic Analysis Kaonoulu Industrial Park	TRAFFIC ASSIGNMENTS WITH PROJECT	Exhibit 3
prepared for: Kaonoulu Ranch — Not to Scale prepared by: Julian Ng, Inc. — April, 1998		

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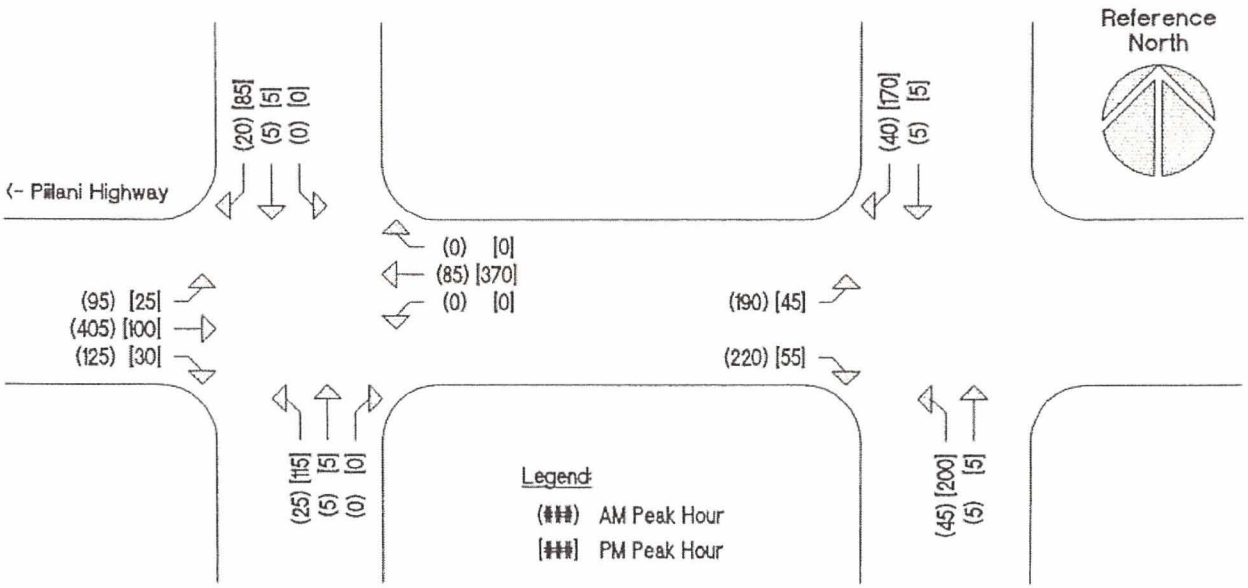
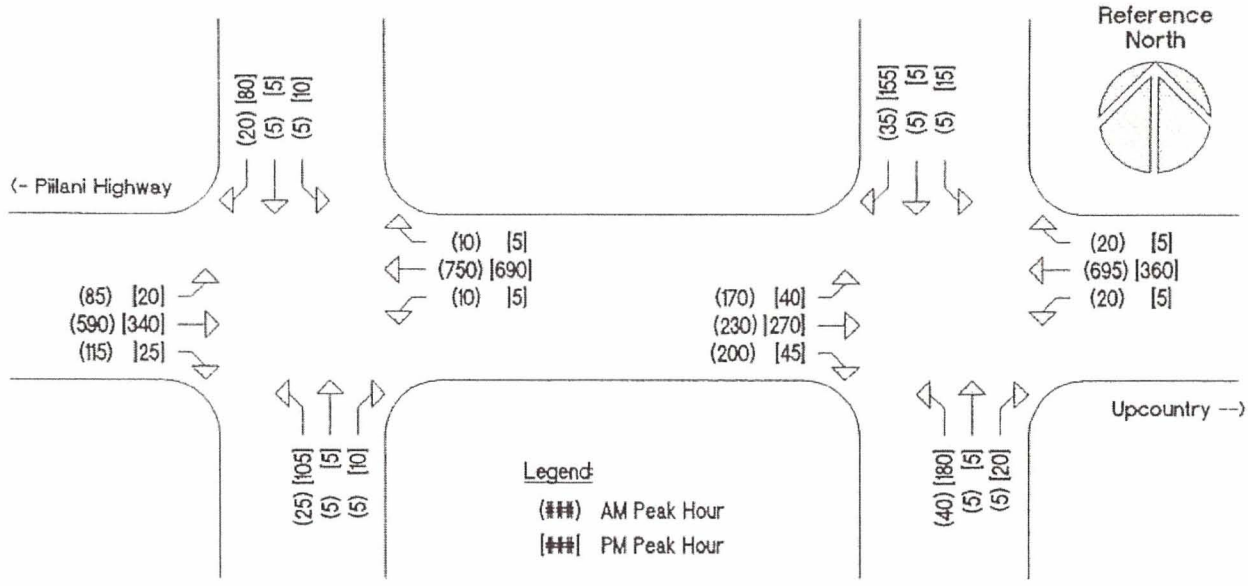


Existing Highway Network (2010)



Kihei-Upcountry Road @ Kaonoulu (2010)

Update to Traffic Analysis Kaonoulu Industrial Park	TRAFFIC ASSIGNMENTS PROJECT ROADWAYS	Exhibit 4
prepared for: Kaonoulu Ranch prepared by: Julian Ng, Inc.	Not to Scale April, 1998	

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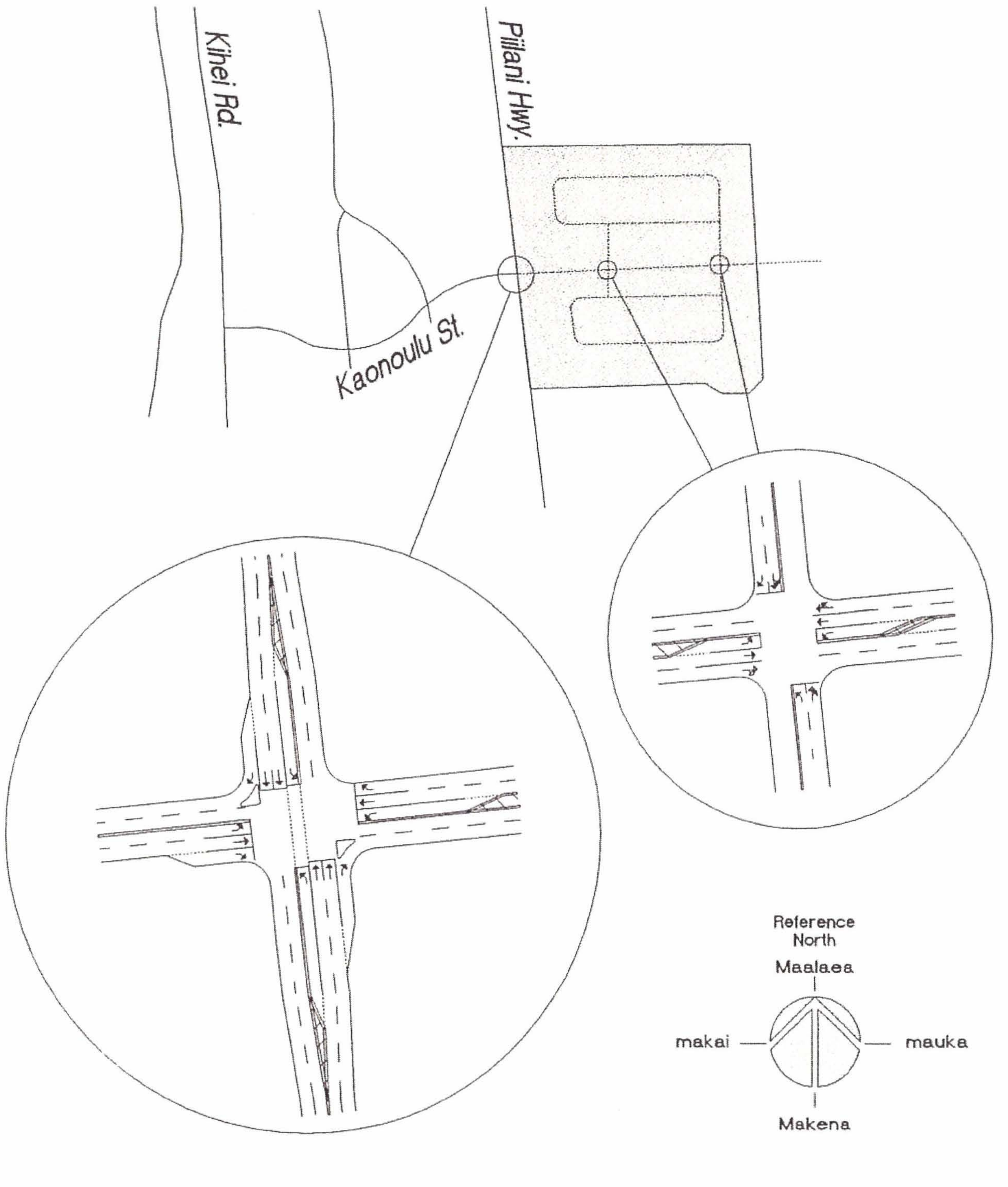

Update to Traffic Analysis
Kaonoulu Industrial Park

prepared for: Kaonoulu Ranch — Not to Scale
prepared by: Julian Ng, Inc. — April, 1998

RECOMMENDED MINIMUM LANEAGE

Exhibit
5

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APPENDIX - LEVELS OF SERVICE

A qualitative measure used by traffic engineers to describe traffic operational conditions is the **level of service** (LOS). Six levels have been defined, from **LOS A** (best operating condition) to **LOS F** (worst). The *Highway Capacity Manual* describes analysis procedures for different types of facilities. For uninterrupted flow facilities such as freeways, other divided highways, and two-lane rural highways, factors such as speed and travel time, freedom to maneuver, comfort and safety, and continuity of flow are used to determine levels of service.

On multi-lane highways, levels of service are related to maneuverability within the traffic stream travelling in the same direction; directional volume and traffic density are used to determine capacities and levels of service. On two-lane highways, levels of service are affected by a driver's ability to pass slow-moving vehicles; opposing volume is also a factor. Descriptions of the levels of service for two-lane rural highways are:

LOS A represents free flow. Travel at desired speeds is unimpeded, as passing of any slow-moving vehicles is infrequent and can be done easily. Platoons of vehicles would be three or less.

LOS B describes stable flow. Passing to maintain desired speed becomes significant and platooning of vehicles increases.

LOS C also describes stable flow. Platooning and restrictions to passing become noticeable and while flow remains stable, some congestion may occur because of slow-moving vehicles or turning movements.

LOS D is characterized by opposing traffic flows operating separately. Passing is extremely difficult as opportunities are very limited.

LOS E describes unstable operation at or near capacity levels. There are no usable gaps in the traffic stream and any disruption to flow causes congestion. Flow is unstable as slow-moving vehicles and other interruptions cause intense platooning and congestion; passing is virtually impossible.

LOS F represents a forced or breakdown flow caused by traffic demand volume exceeding capacity; actual volume served will drop as speed decreases and congestion increases. LOS F is used to identify bottlenecks, or points of congestion, and operations within the queue behind these bottlenecks.

Levels of service are also identified for signalized intersections and for the controlled movements at unsignalized intersections. These levels of service are based on average delays, which in turn are based on volumes and capacities. For signalized intersections, an operational analysis is used to determine these delays for each lane group of each approach. For unsignalized intersections, the procedures from the *Highway Capacity Manual - Third Edition* were used to calculate delays. Criteria for levels of service are:

LOS	General Description of Estimated Delay	Average Delay at Signalized Intersection	Average Delay at Unsignalized Intersection
A	Little or no delay	($\leq$5 seconds)	($\leq$5 seconds)
B	Short traffic delays	($>$5 and $\leq$15 seconds)	($>$5 and $\leq$10 seconds)
C	Average traffic delays	($>$15 and $\leq$25 seconds)	($>$10 and $\leq$20 seconds)
D	Long traffic delays	($>$25 and $\leq$40 seconds)	($>$20 and $\leq$30 seconds)
E	Very long traffic delays	($>$40 and $\leq$60 seconds)	($>$30 and $\leq$45 seconds)
F	Very long traffic delays	($>$60 seconds)	($>$45 seconds)

References: Transportation Research Board, National Research Council, *Highway Capacity Manual*, Special Report 209, Washington, D.C., 1985

Transportation Research Board, National Research Council, *Highway Capacity Manual - Third Edition, Updated 1994*, Special Report 209, Washington, D.C., 1994