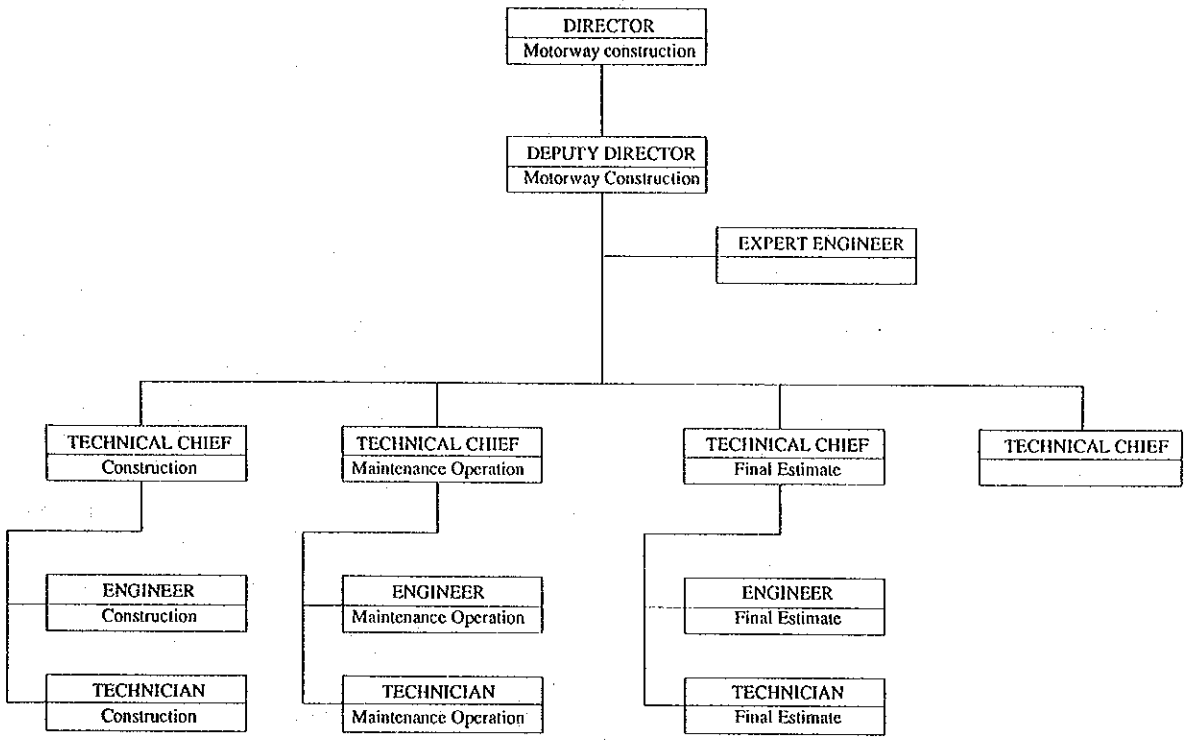


Figure 3.1.4 Organization Chart of Motorway Construction Division

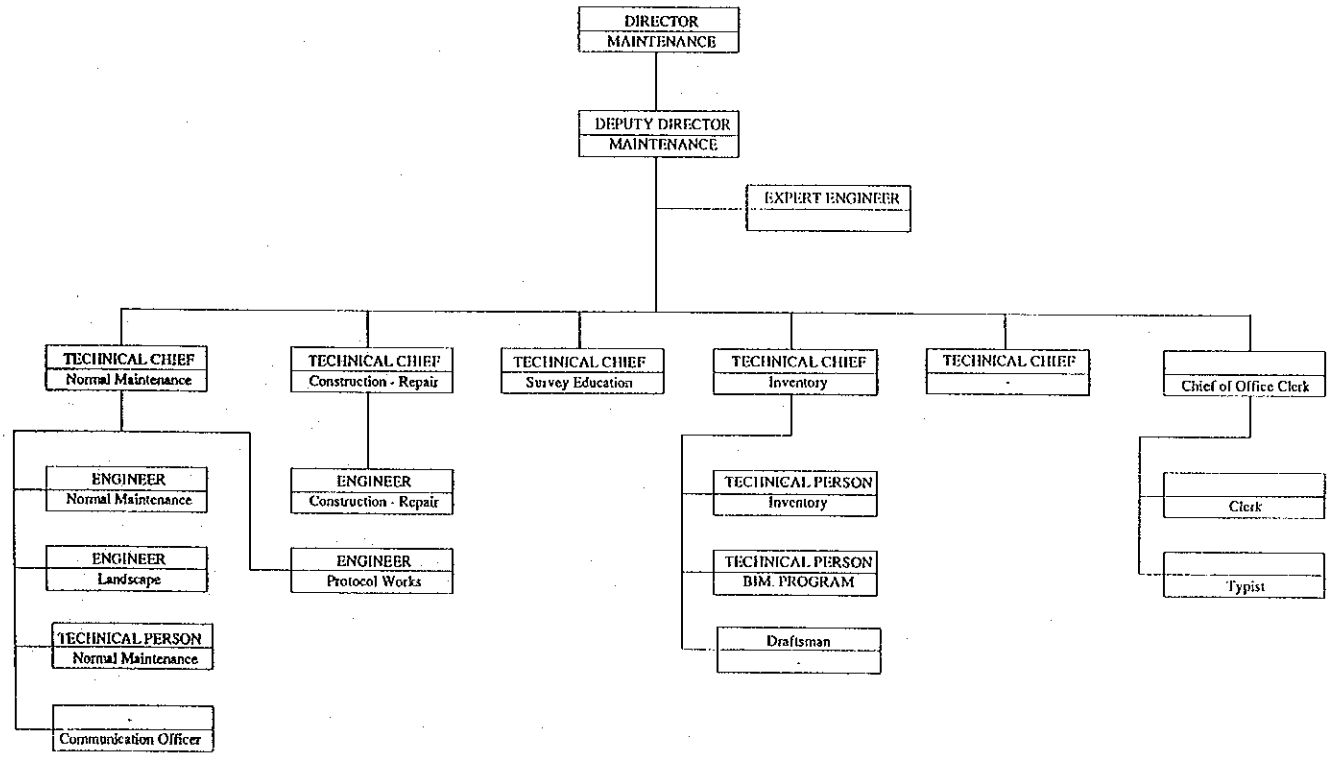


Figure 3.1.5 Organization Chart of Maintenance Division

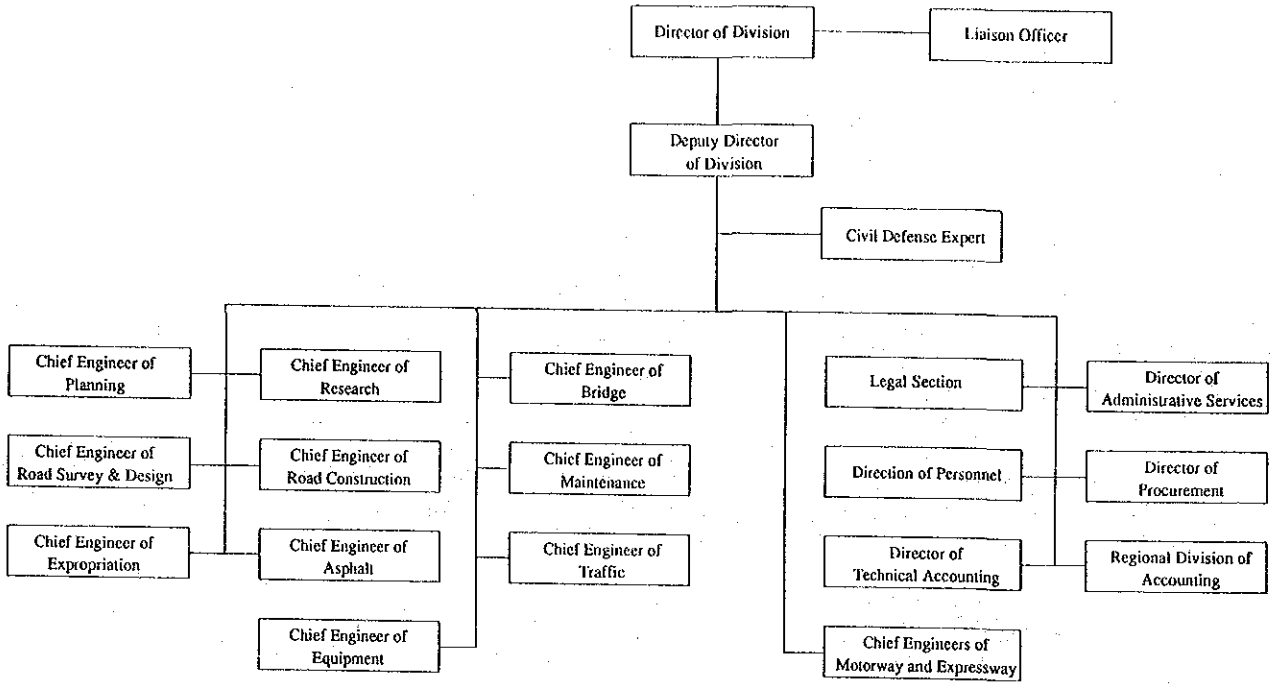


Figure 3.1.6 Typical Organization Chart of Regional Division

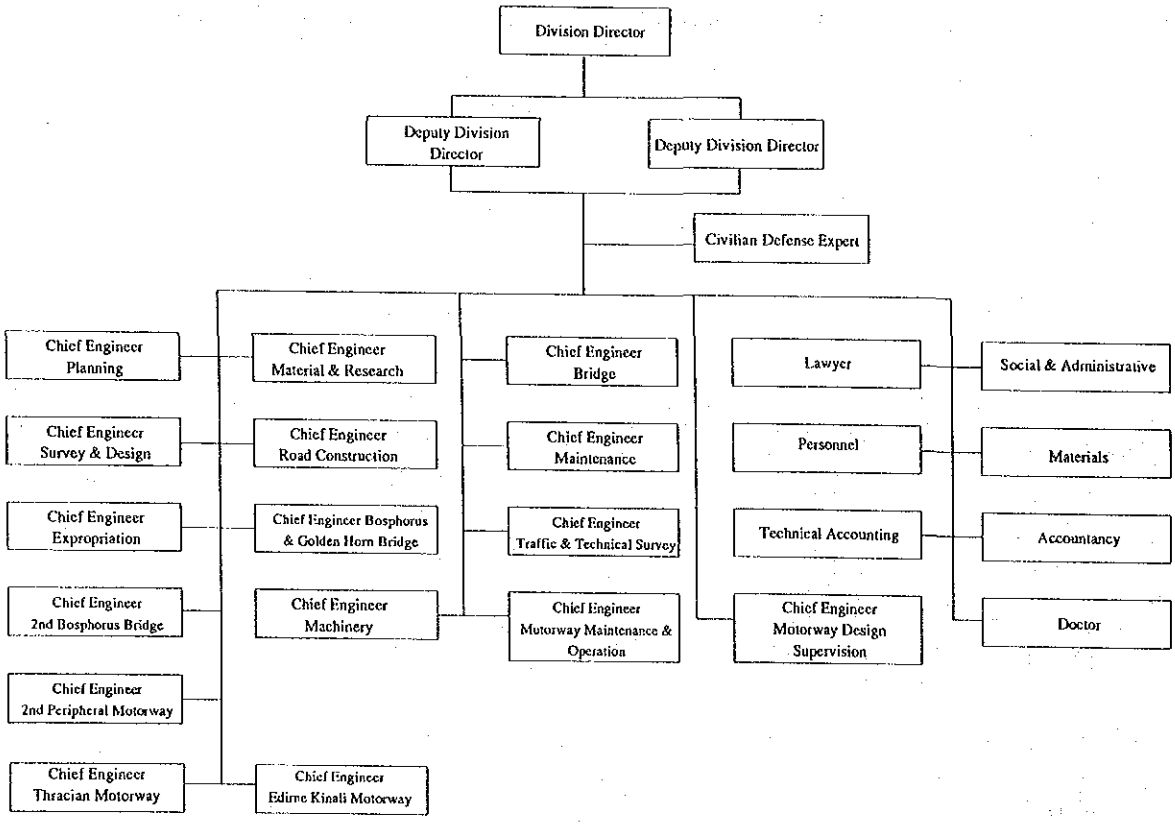


Figure 3.1.7 Organization Chart of Regional Division 17

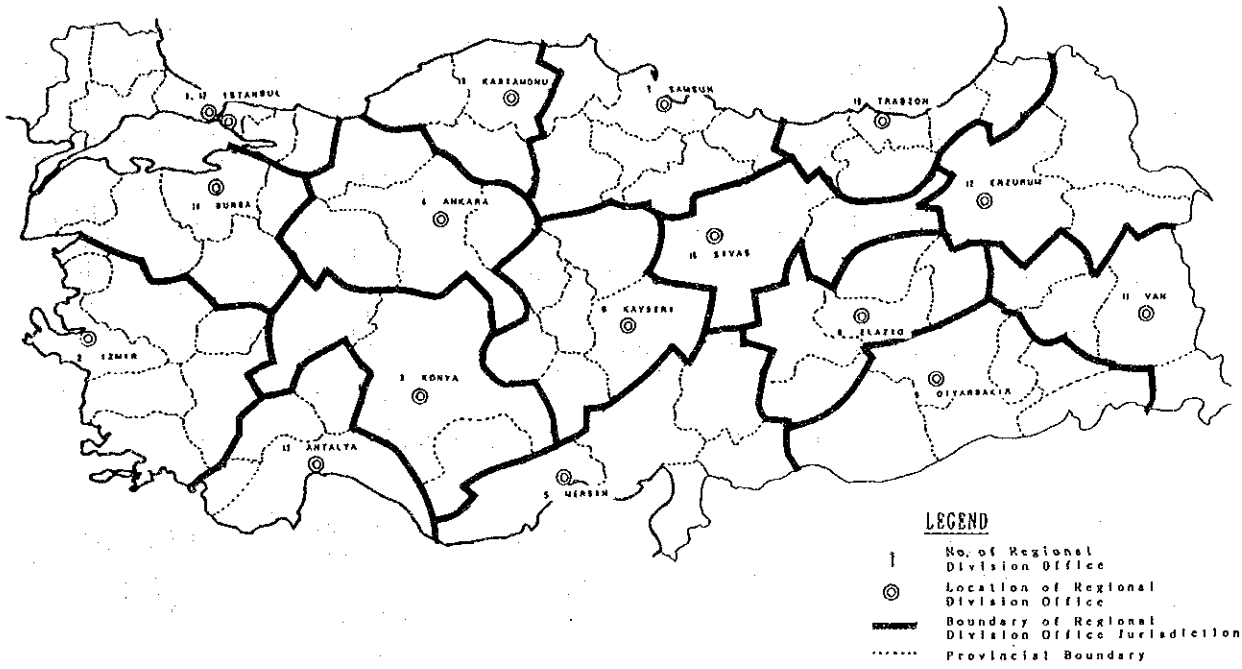


Figure 3.1.8 Location of Regional Division Offices and Their Boundaries

3.2. Present Road Maintenance and Operations

3.2.1. Maintenance and Operations of Highways and Roads

KGM maintained and operated 30,843 km of state highways, 26,956 km of provincial roads at the end of 1991.

In 1950 the maintenance and operations functions were provided by 62 district offices (regional subdivisions). Because of the increasing length of roads, the number of district offices increased from 87 in 1960 to 112 as of 1992 for state highways and provincial roads.

The 112 district maintenance offices under the supervision of 16 regional division offices are responsible for maintenance and operations for 57,799 km. Each office is responsible for an average of approximately 516 km.

Maintenance crews take care of road maintenance within the boundaries of district offices. Maintenance crews keep roads open to traffic at all times by asphalt paving operations, ditch cleaning, grading of side slopes, maintenance of obstructed pipes and culverts, grading of stabilized roads, landscaping roadside rest areas, and providing slope protection, etc. To furnish these services, 5,531 pieces of equipment and 11,203 personnel are presently used.

Crews are based along the roads in 374 "Maintenance Houses" which are the responsibility of 112 district-chiefs. These "Maintenance Houses" are also used as refuges during snow removal. During bad weather conditions people in stalled vehicles can also use the "Maintenance Houses" for refuge.

3.2.2. Maintenance and Operations of Motorway

KGM started to maintain and operate the motorway sections in December 1973. The needs of the motorway maintenance and operations has been fully recognized since the time.

The motorway sections open to public traffic are shown in Table 3.2.1.

Table 3.2.1 Motorways in Operation

Section Name	Length (km)	Regional Division	Opening year
1. Kapikule - Edirne	20	17	Nov. '87
2. Istanbul 1st Bosphorus Bridge & peripheral road	24	17	Oct. '73
3. Selimpasa-Mahmutbey	44	17	Dec. '91
4. Istanbul 2nd Bosphorus Bridge & peripheral Road	37	17	Dec. '91
5. Mahmutbey-Cobancesme	8	17	Dec. '91
6. Mahmutbey-Vatan	11	17	Dec. '91
7. Hasdel-Okmeydani	5	17	Dec. '91
8. Camlica/Istanbul-Anadolu	6	17	Dec. '91
Sub-total of Regional Division 17	155		
9. Anadolu-Sakarya	130	1	Dec. '91
10. Sekerpinar-Cayirova	7	1	Dec. '91
Sub-total of Regional Division 1	137		
11. Pozanti	14	5	Dec. '84
12. Tarsus-Yilankale	70	5	Sept. '91
Sub-total of Regional Divisions	84		
Total	376		

The Regional Divisions 17 and 1 have personnel activities and motorway sections for the maintenance and operations as follows;

1) Regional Division 17

The Regional Division 17 has 1,026 personnel (1992), of which 494 are governmental officers and 532 personnel are workers (full-time employees). The breakdown of the personnel is shown in Table 3.2.2.

Table 3.2.2 Personnel of Regional Division 17

Position	Number*
1. Division Director	1
2. Deputy Division Directors	2
3. Chief Engineers	17
4. Engineers	78
5. Architects	4
6. Senior Technicians	22
7. Technicians	49
8. Geomorphologists	2
9. Mathematician	1
10. Doctors	3
11. Lawyers	3
12. Nurses	2
13. Toll Collectors	281
14. Administrative Officers	28
Sub-total no. of officers	493
15. Permanent Workers	458
16. Temporary Workers	74
Sub-total no. of workers	532
Total no. of personnel	1,025

Note: The number includes the personnel for sections of motorway construction

The Regional Division 17 maintains and operates 155 km of motorways together with the following maintenance offices as shown in Table 3.2.3.

Table 3.2.3 Existing Maintenance Offices of Regional Division 17

	Maintenance Office	Motorway Length(km)	Number of Personnel
1.	Main Maintenance Center (located at 17th Div. complex, maintenance and traffic section)	72	235
2.	Mahmutbey	63	129
3.	Bosphorus & Golden Horn Bridges	-	221
4.	Edirne	20	29
	Total	155	614 persons

The above maintenance offices are in charge of the following work:

- Patrolling:
- Collecting rubbish:
- Repairing asphalt:
- Snow/ice removal:
- Periodic control of drainage system:
- Dirt/dust removal by sweeper:
- Cleaning of guardrails:
- Washing of tunnel walls:
- Maintenance of telephones:
- Maintenance of roadside plants and flowers: and
- Grass cutting.

The traffic and technical survey section is responsible for the maintenance of traffic signs, traffic control and traffic patrolling. The machinery section maintains equipment and wireless (radio) communication devices.

Because of limitations with KGM providing adequate numbers of employees, the following maintenance activities are provided by private companies on a contract basis:

- Removal of damaged cars
- Road cleaning and miscellaneous works
- Repair of guardrails and wire fences
- Vegetation control landscaping & watering
- Lighting maintenance
- Grass cutting

2) Regional Division 1

One main maintenance center and three (3) maintenance centers maintain and operate the 137 km motorways of the Regional Division 1.

The main maintenance center manages and supervises the 3 maintenance offices. This organization is shown in Figure 3.2.1, having a total of 443 personnel (1992).

Main Maintenance Center	Tutunciftlik
1. Head	1
2. Machinery Chief	1
3. Maintenance Engineer	1
4. Traffic Engineer	1
5. Electric Engineer	1
6. Electronic Engineer	1
7. Facility Architect	1
Total	7

Maintenance Office	Kurtkoy	Tutunciftlik	Sapanca
1. Maintenance Operation Chief	1	1	1
2. Maintenance Engr.	1	-	-
3. Operation Engr.	1	1	-
4. Electronic Technician	1	-	-
5. Traffic	-	1	2
6. Traffic Technician M/S	7	2	5
7. Toll Gate Cleark	90	96	65
8. Office Cleark	-	2	-
9. S/S Personnel	24	112	15
Total	125	215	89

Note: Figures indicate number of personnel.

Figure 3.2.1 Organization of Main Maintenance Center and Maintenance Offices

3) Regional Division 5

One maintenance center maintained and operated the Pozanti section of 14 km motorway as of July 1992. Regarding Tarsus - Yilankale section of 70 km motorway, KGM conducted traffic patrolling only as of July 1992, since a contractor undertook maintenance works of which the maintenance period was included in the construction works of the motorway on a contract basis.

3.2.3. Existing Workshops and Equipment

The Department of Equipment and Supply furnishes general usage cars, patrol cars for maintenance & operations and traffic management, as well as construction and maintenance equipment for roads and communication equipment with district maintenance offices and maintenance centers. The workshops and equipment of Regional divisions 17 and 1 are described as typical ones as follows:

1) Regional Division 17 (Istanbul region)

The Regional Division 17 has 129 units of equipment for maintenance & operations and traffic management & operations for the motorway as of 1992. These equipment (excluding communication equipment) are distributed to each maintenance office as indicated in Table 3.2.4.

Table 3.2.4 Numbers of Equipment in Regional Division 17

Maintenance Office	Number of Units
1. Main Maintenance Center (Located at Division 17 office)	
• Maintenance section	52
• Traffic section	51
2. Bosphorus and Golden Horn	19
3. Selimpasa	7
Total	129 units

2) Regional Division 1 (Istanbul region)

The Regional Division 1 manages a 137 km segment of motorway in addition to state highways and provincial roads. For the maintenance and operations and traffic management and operations of 137 km motorway there is a main maintenance center at Tutunciftlik along with three (3) maintenance offices (one maintenance office is located at the main maintenance center/Tutunciftlik).

The main maintenance center at Tutunciftlik has 101 units of equipment (1992) which are distributed to each maintenance office as shown in Table 3.2.5.

Table 3.2.5 *Number of Equipment in the Regional Division 1*

Name of Maintenance Office	Equipment
1. Kurtkoy	27
2. Tutunciftlik	57
3. Sapanca	17
Totals	101 units

3.2.4 Issues on Motorway Maintenance and Operations

Current issues relating to maintenance and operations being conducted on the motorways are as follows:

1) Newly opened motorways such as the Istanbul 2nd Bosphorus Bridge and peripheral road and Tarsus/Yilankale section should be fully maintained and operated as soon as possible. KGM is presently only undertaking traffic patrolling and minimal maintenance due to the warranty period of the recent construction.

2) The number and procurement of equipment for the maintenance and operations of all motorway sections should be what is appropriate considering the privatization of maintenance of road surface, guardrails, lighting, drainage and vegetation, grass cutting, removal of damaged cars caused by accidents and engine problems, asphalt overlays, bridge repairs, etc.

3) Maintenance manuals should be prepared and furnished to the personnel concerned for inspection pavement repairs, road cleaning, bridge repairs, snow/ice removal and others.

3.3. Present Traffic Management and Operations

3.3.1. Policies of Traffic Management

The basic philosophy for motorway traffic management by KGM is as follows:

"A fully developed technical control system on the motorway system will provide for the safety and security of users and maintain the productive use of the motorway. The high level of safety provided on the motorway will attract more users and increase the national productivity."

3.3.2. Existing Traffic Management

Existing functions provided by motorway traffic management are as follows:

- toll collection
- daily traffic patrol
- emergency telephone system
- data collection
- traffic information service
- treatment of traffic accidents

1) Toll Collection

At present the "closed" toll collection system was adopted in principle on the motorway. The "Open" type of toll collection system was adopted at specified motorway sections such as the 1st and 2nd Bosphorus Bridges in Istanbul, and the Pozanti section on Pozanti-Tarsus Motorway (about 14 km in operation). The peripheral motorways in Istanbul (in operation), Ankara (under construction) and Izmir (under construction) are basically toll free.

2) Daily Traffic Patrol

At present, daily traffic patrol is performed by traffic patrol units in the 1st, 5th and 17th Divisions. The maintenance patrol cars are on stand by at maintenance office until maintenance engineer requests a dispatch. Their duties are as follows:

- to observe the changes in meteorological and motorway conditions, and to take appropriate traffic safety measures or ensure that appropriate traffic measures have been taken.
- supervision and inspection of all work carried out within the right-of-way boundaries of the motorway (deposit of rubbish and rubble, etc.), to initiate legal procedures against people violating laws and regulations, and to eliminate and remove elements affecting motorway safety.
- to initiate legal procedures against people who damage motorway facilities.
- to locate and ensure removal of temporary buildings encroaching within the right-of-way of the motorway (miniature transportable restaurants, temporary housing, or any temporary work facilities, etc.).

- operations group personnel conduct their control and inspection activities on a 24 hour-a-day basis, to remove obstacles affecting traffic flow and ensure that the motorway remains open.
- the communication center (radio center) is in operation 24 hours-a-day to ensure coordination and communications within the motorway network.
- ensure the appropriate maintenance, repair and replacement of traffic signs and markings.
- the 17th Division, in particular, carries out control and inspections 24 hours-a-day (including the maintenance and repair of CCTV) to assure a state of optimum preparedness for fires and other emergencies on the Bosphorus Bridges.

3) Emergency Telephone System

An emergency telephone system is currently in operation on specific segments of the Kinali - Sakarya Motorway. The existing emergency telephone system is provided by a radio communications system. Emergency telephone operations centers (radio centers) currently are established at the main maintenance center at Tutunciftlik in Izmit (1st Division) and the 17th Division administration building. The operations centers control motorway sections of about 50 km and 68 km, respectively. The spacing of emergency telephones (with solar batteries) on the motorway is basically 2.0 km. On the 2nd Peripheral Road of Istanbul the spacing is 1.5 km.

4) Data Collection

At present, the information data collection system on the motorway is provided by the toll collection offices, the traffic patrol teams, traffic police patrol units and the emergency telephone systems. Traffic volumes, toll revenues collected by vehicle classifications, traffic accidents, and other traffic information is provided from these data inputs.

5) Traffic Information Service

Traffic information is supplied through variable message signs on the motorway and by the state radio broadcast. The state radio broadcasts information regarding traffic regulations and traffic restrictions on the motorways and ordinary roads. This information is provided to the state radio system by KGM on a daily basis.

6) Treatment of Traffic Accidents

Traffic control and enforcement of regulations for traffic accidents occurring on the motorway are done cooperatively by KGM traffic personnel and the traffic police. Their duties on the motorway include the inspection of traffic, intervention during traffic accidents and the carrying out of legal procedures. The regulations which define their duties are Traffic Law No. 2918 and the Law for Highways with Access Control No. 1593. After a traffic accident has occurred, the traffic police make out traffic accident reports which consist of the time and place of accident, factors causing the accident, road conditions, accident type, the condition of vehicles and people involved in the accident, a written accident summary, an accident diagram, etc.

First-aid assistance during traffic accidents is carried out by first-aid stations or centers in accordance with the Traffic Law, in which "First-aid on the motorway, emergency aid, transportation of injured people and having the necessary measures for medical treatment" is defined as duties of the Ministry of Health.

3.3.3. Existing Traffic Operations

1) Variable Message Signs - Sign Types/Locations/Messages

(1) Directional-Prismatic

Division 17-The 17th Division currently uses prismatic variable message signs as a device to help divert traffic from the First Bosphorus Bridge (southernmost bridge) to the Second Bosphorus Bridge (northernmost bridge, and the bridged crossing of the Motorway across the Bosphorus). These signs are installed at critical locations as shown in Figure 3.3.1, and are shown in series of three. The primary sign is a gantry (or signbridge) installation and is installed so that the signs are overhead and clearly visible to drivers. In addition to the gantry mounted variable message signs, the identical messages are shown at 1000m and 400m in advance of the gantry sign on free-standing signs (side-mounted signs). An example of the sign messages is shown in Figure 3.3.2. These signs are currently activated manually at a control box at the gantry sign locations. The gantry signs are connected to the free-standing signs, so that the identical message is repeated. The 17th Division has plans to control the messages remotely at the communications control center by the end of 1992.

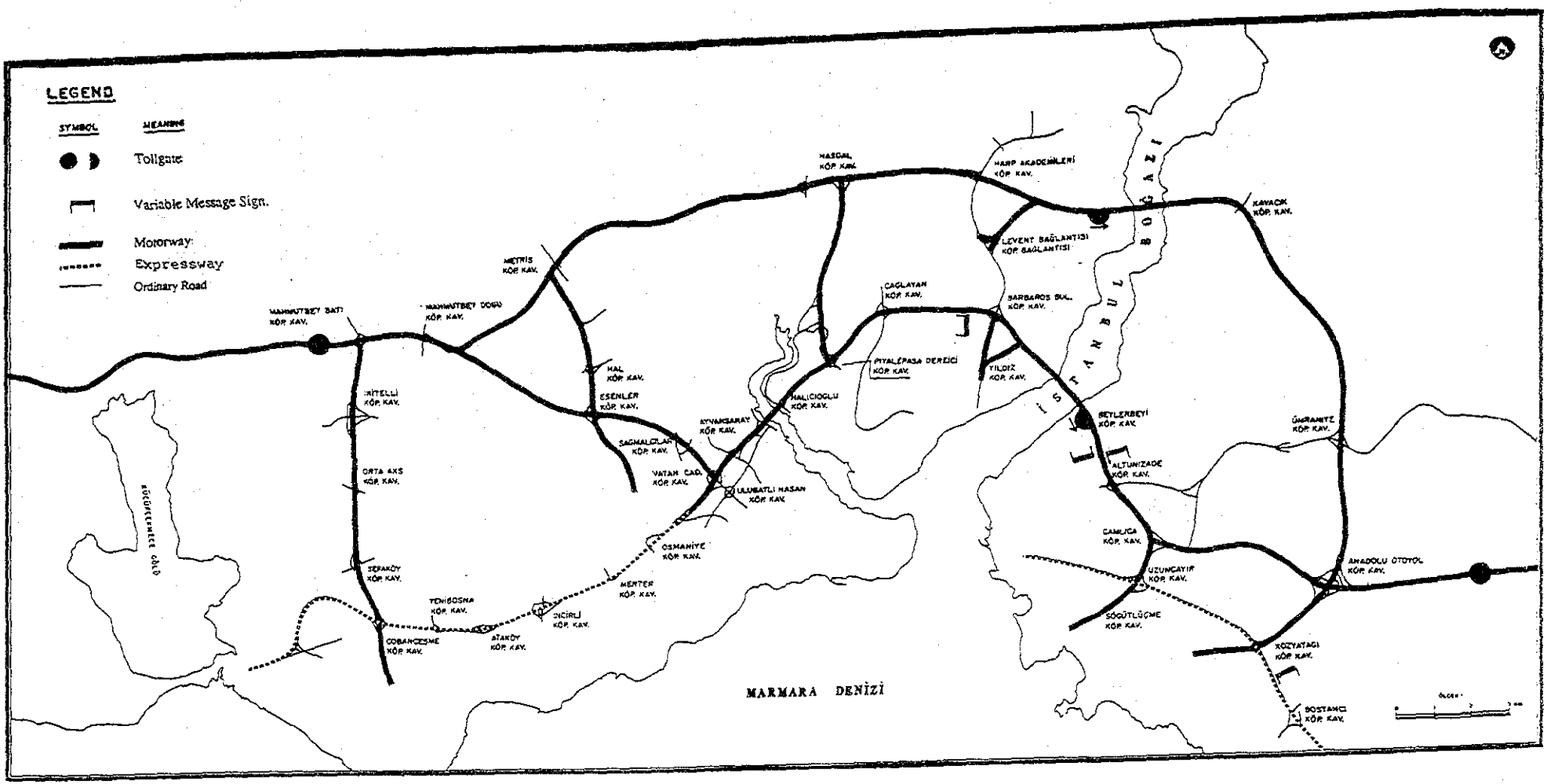
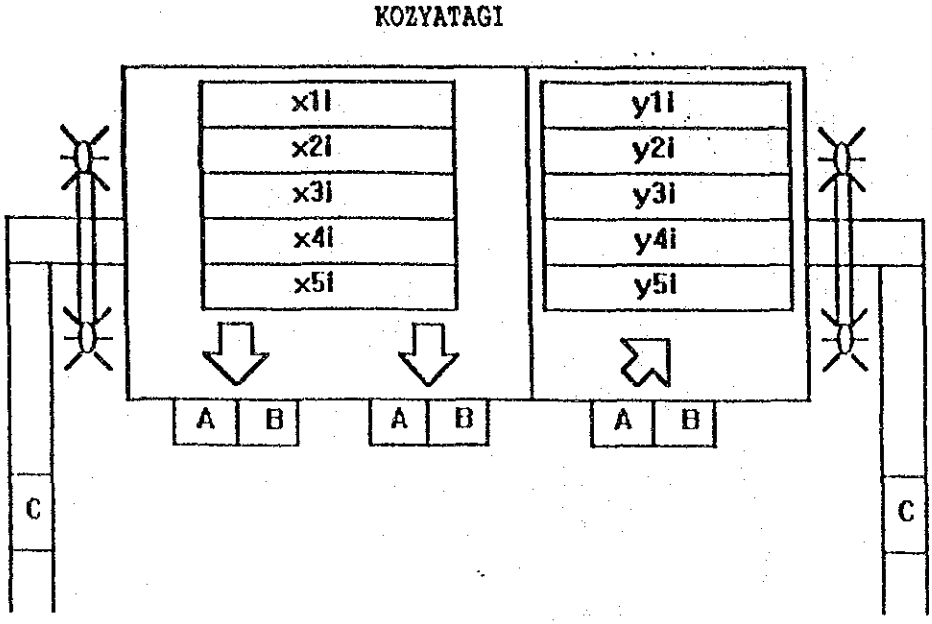


Figure 3.3.1 Existing Tollgate/Variable Message Sign Locations in Istanbul



PRISM	SURFACE i=1	SURFACE i=2	SURFACE i=3
x1	Bosphorus Bridge	Bosphorus Bridge	Bosphorus Bridge
x2	Heavy Traffic	Closed to Traffic	Topkapi
x3	Accident Ahead	Roadwork Ahead	Edirne
x4	Kadikoy	Kadikoy	Kadikoy
x5	Haydarpasa	Haydarpasa	Haydarpasa
y1	Fatih S.M. Bridge	Fatih S.M. Bridge	Fatih S.M. Bridge
y2	Topkapi	Heavy Traffic	Closed to Traffic
y3	Edirne	Kaza Var	Roadwork Ahead
y4	Umraniye	Edirne	Umraniye
y5	(Not Used)	(Not Used)	(Not Used)

FIBER-OPTIC SIGNS A,B AND C

SIGN	MEANING	SIGN	MEANING	SIGN	MEANING
A-1	Fog	B-1	Lane Closed	C-1	50km/hr
A-2	Rain	B-2	Move Right	C-2	60km/hr
A-3	Accident	B-3	Move Left	C-3	70km/hr
A-4	Heavy Trafffic			C-4	80km/hr
A-5	Roadwork			C-5	90km/hr

Figure 3.3.2 Examples of Variable Message Signs in Division 17

(2) Warning+Regulatory-Fiberoptic

Division 17-The 17th Division currently uses fiberoptic variable message signs to help warn motorists of hazardous conditions and of conditions whereby it would be safer to travel at a speed slower than the normal posted speed. In such cases, Division 17 can change the warning message to the desired one, and can change the speed limit to that which is considered safe for the current conditions. The locations for these signs are shown on Figure 3.3.1. The control for these signs is the same as for those of the prismatic signs, mentioned above. Division 17 has plans to also be able to control these signs remotely, as with the prismatic signs, by the end of 1992.

2) Identification of Problems of the Existing System

(1) Incident Detection

a. Limited by Traffic Patrol Detection-2 Hours

The current system of using the traffic patrol as the primary method of detecting incidents on the motorway gives KGM at least one method of incident detection that can be used universally on the motorways, but not without some limitations. Because it takes approximately two hours to make a normal circuit for the traffic patrol, it could conceivably take the two hour maximum to detect a problem on the motorway. The average time is substantially less than this, as the traffic patrol can normally see problems in both directions of the motorway simultaneously. The worst condition exists at the extremes of the traffic patrol route. In a highly congested area incident detection needs to occur within a matter of minutes, and the response needs to be immediate to have any significant effect. A two hour delay in the detection of an incident could mean that an entire rush hour period could come and go without a detecting the incident by the traffic patrol. Another limitation of the traffic patrol is that it may become tied up with a small but time consuming incident on the motorway, and is unable to perform its function of incident detection on the remaining portion of its route.

b. Effects on Successful Traffic Diversion

To provide effective traffic diversion, especially during rush hour traffic periods, it is essential to detect a traffic incident within a few minutes and take immediate action to remove or minimize the impact of the traffic incident. This means contacting the response teams and providing appropriate information to motorists, either warning them or rerouting them to less congested facilities. This type of immediate incident detection and response will become even more important as traffic becomes more highly congested.

c. Effects of the Time to Implement Variable Message Signs

In order to create a successful traffic diversion from one facility to another, it is necessary after first detecting and confirming a traffic incident, to immediately provide the motoring public with accurate information and a logical diversion route (to help minimize the impact to their individual trip, and to the effectiveness of the transportation network). The existing system in Division 17 requires that someone drive out to the signs, and activate them in the field. This is not efficient, and Division 17 has plans to bring the control of the variable message signs to a central facility.

d. Time to Notify Public / Radio+TV

Another extremely effective tool to reduce the impacts of traffic incidents, is to establish a system to provide immediate communications of the incident to public radio and TV, so that they might notify the public as soon as possible. This method can cause people to postpone travel or to divert to other routes before getting trapped unnecessarily in areas with traffic congestion.

(2) Improper Use of Emergency Telephones

The current problems of improper use of the emergency telephones by the public can be expected to continue in the future, unless some specific actions are taken. Firstly, a better public education system could be initiated, so that the public better understands the purpose and uses of the emergency telephone system. Secondly, it may be important to reduce unauthorized public access to the telephones by making it more difficult for the non-motoring public to use the motorway.

(3) Motorway Safety/Traffic Safety

a. Pedestrians

One of the most obvious methods of reducing pedestrian accidents on the motorway is to successfully limit the access to the motorway by pedestrians. Pedestrians are not compatible with high-speed traffic. Currently, pedestrians can be seen almost anywhere on the motorway, as access is not adequately limited by continuous, well-maintained fencing and enforcement of "No Pedestrians on the Motorway".

b. High Probabilities of Traffic Congestion by Deficiency of Busstops

c. Parked Vehicles

Parked vehicles are an "accident waiting to happen" on the motorway, as a slight change in travel path or inattention by drivers could result in an

accident. The shoulders on the motorway are designed for emergency use only for vehicles with problems that need a place to pull safely out of moving traffic.

d. Oversized Vehicles
Oversized vehicles operate at much slower speeds than normal traffic and constitute an accident hazard to traffic moving at higher speeds.

e. Speeding Vehicles
Vehicles traveling at unusually high speeds are a potential accident problem, specially when coupled with the slow-moving, oversized vehicles mentioned above. Motorways are designed for high-speed traffic, but a large variation in traffic speeds is detrimental to overall motorway safety. It may be desirable to establish minimum and maximum acceptable speeds to reduce the impacts of vehicles operating at greatly variable speeds. Having all vehicles operating at near the same speed would provide for the safest condition on the motorway, and the problems associated with overtaking and passing would be minimized.

f. Maintenance of Guardrails, Markings, Reflectors
To provide the safest possible environment for motorists, it is important that traffic safety devices that provide guidance and help prohibit head-on accidents be maintained in optimum condition. Guardrail that is damaged has very little safety value to motorists. Likewise, traffic markings or reflectors that cannot be seen offer very little guidance to drivers. It is important to provide a driving environment that offers motorists every possible advantage to minimize the probability of traffic accidents on the motorways.

g. Accident Data Collection and Analysis
In order to adequately access the safety issues on the motorway, it is helpful to have an accurate and up to date database describing all of the accidents on the motorway. In the database, information can be obtained regarding the time and place of the accident, type of accident, severity of the accident, weather conditions, etc.

h. Effect of Adverse Weather / Traffic Conditions
Another important aspect of traffic safety to be investigated is the effect of adverse weather on traffic accidents. Abnormal amounts of rainfall, icing, snow, high winds, or other unusual conditions may require special treatments to reduce accident potential.

i. Frequent Breakdowns of Vehicles

Frequent breakdowns of vehicles on the motorway were observed in the Istanbul area. It is helpful to detect and remove these vehicles as soon as possible, as vehicles stopped along the motorway restrict travel, reduce capacity, and increase potential for accidents with other drivers on the motorway.

(4) Coordination

A communication network that allows for the immediate flow of information regarding travel restrictions and problems on motorways within each Division, between Divisions, and outside Divisions can help provide maximum service to the motorway users is of great value.

3.4. Present Toll Collection System

3.4.1. Toll Collection System

The current toll collection system is typically a "closed" system. In the entry lanes, the drivers are issued printed and magnetically recorded paper tickets. These tickets are processed at the exit lanes and tolls are collected in cash.

The magnetic-paper tickets obtained at the automatic ticket issuing machines (ATIM) indicate the location, number, date and time (hour) of entry, and other relevant information. This is done both by printed and magnetic means. These tickets are retained by the drivers and presented to the operators on duty at the exit lanes. Operators classify the vehicles via the operator's console, and then have the tickets read by the automatic magnetic readers. The vehicle classification and corresponding toll appear on indicators for both the operators and the drivers. Payment is made in cash. When the vehicles depart from the toll gates, the vehicle type is checked by a vehicle detector system which provides automatic vehicle classification.

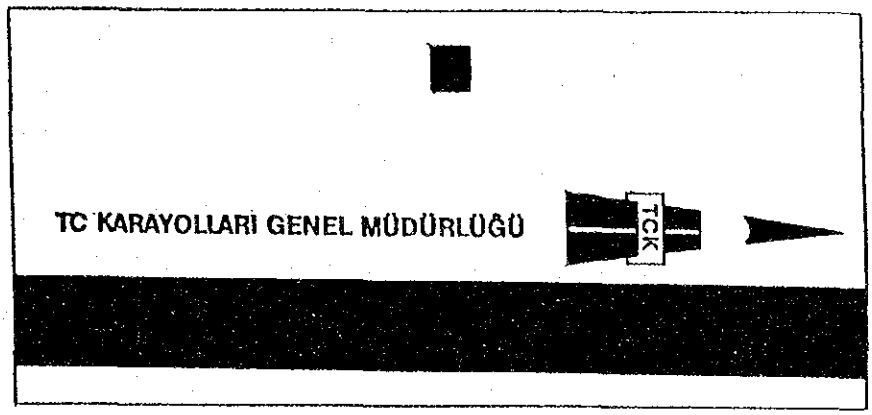
The dimension on the magnetic-paper tickets is about 54x120 mm as shown in Fig. 3.4.1.

The following vehicle classifications are used:

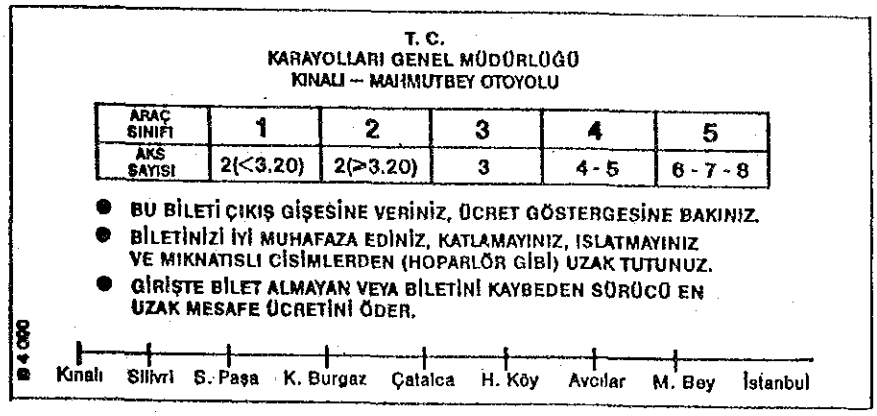
Class 1 : 2 axles, having an axle separation smaller than 3.2m
Class 2 : 2 axles, having an axle separation greater than 3.2m
Class 3 : 3 axles
Class 4 : 4 and 5 axles
Class 5 : 6,7 and 8 axles

1) *Entry Lane*

In the entry lanes, a desk is inside the tollbooths, and an automatic ticket issuing machine (ATIM) is installed on the side wall of the booth to be accessible to drivers. The ATIM has two ticket issuing push buttons, the lower one for small vehicles and the upper one for large vehicles.



(Front)



(Back)

Figure 3.4.1 Magnetic-paper Ticket

Drivers push the ATIM button, remove the ticket issued, and continue driving. During this operation, the transit light turns from red to green. As soon as the vehicle leaves the entry lane, the transit light turns back to red.

Each entry lane has a capacity of 500 vehicles per hour (7.2 sec/vehicle). In the case where 10 % of the traffic consists of large and/or long trucks, the capacity is reduced to 400 per hour (9.2 sec/vehicle).

2) Exit Lane

Exit lanes are of the manual type and are not automatic. At the exit lane a lane operator's desk is provided in the booth, inside which is a suitably installed magnetic ticket reader, a box for used tickets, a lane microcomputer, a receipt issuing machine and similar equipment as well as the connectors for cables coming from the toll collection office computer and the lane equipment. During normal times, the exit capacity is 250 vehicles per hour (14.4 sec/vehicle). When 10% of the traffic consists of large and/or long trucks, the exit capacity is reduced to 180 vehicles per hour (20 sec/vehicle).

3) Toll Office Computer System

The toll office computer system is designed to process and organize data in the toll collection facilities and to output this data in automatically generated or specially requested reports.

4) Existing Facilities for the Toll Collection System

The existing facilities for the toll collection system are as follows:

(1) Entry lane equipment

- Automatic ticket issuing machine (ATIM)
- Traffic volume counter
- Transit lights (red/green)
- Alarm signal lamp
- Lane open-closed lights (red/green)
- Manual barrier

(2) Exit lanes equipment

- Operator consol
- Lane processor

- Magnetic encoder-reader device
- Receipt printer
- Lane side indicator
- Alarm lamp
- "Gong" sound device to signal the transit of a vehicle
- Detector system for automatic vehicle classification (AVC)
- Vehicle classification indicator (on the canopy)
- Lane open-close lights (red/green, on the canopy)
- Manual barrier
- Intercom to communicate with the toll collection control room

(3) Toll office computer equipment

- Microcomputer with disk drives, CRT terminal (with keyboard), and interface circuits
- Printers
- Cables between the toll office computer and the lane processors

3.4.2. Issues Concerning the Toll Collection System

The potential capabilities of the existing toll collection system which utilizes a magnetic card system are not being fully utilized. To reach the potential of the existing system, it will be necessary to provide for an administrative organization and communication cable network that will connect to each office. When that happens, the existing toll collection system will have the following capabilities:

1) Expeditious and efficient toll and traffic data collection will occur when the communications system is modified as follows: toll gate-(to and from)-toll collection office-(to and from)-maintenance office-(to and from)-main maintenance center.

2) Operational simplicity, improved reliability and reduced maintenance can be achieved, and maintenance expense can be reduced by computerizing and interconnecting the entire system.

3) Efficient toll collection operations will be possible.

4) Efficient site inspections can be performed.

5) Most illegal activities can be eliminated.

3.5 Present Financial and Budgeting System

3.5.1. Financial Sources for Roads and Motorways

Financial sources for roads and motorways consist of the general budget, support from foreign governments (including loans), oil consumption funds (ATF), the public fund (KOF), and a portion of the revenue from toll roads.

The financial source from the general budget is a portion of the taxes collected, and is approved by the national assembly.

Support funds from foreign governments or international organizations are provided through KOI (Organization which controls KOF).

A part of the oil consumption fund, which consumers pay when they purchase gasoline, becomes a fund resource through ATF.

KOF is a fund which is created by the benefits obtained from financial investments.

Ten percent of the revenue from toll roads automatically becomes KGM's fund resource for maintenance and management of the motorway.

Funds for development and improvement of special roads such as tourism roads, power supply roads, and agricultural roads are obtained by each concerned organization, and construction is entrusted to KGM.

As for fund resources for motorways, both land purchases and construction costs are provided by KOF. Most of the construction funds for motorways are foreign funds raised by contractors of the motorways.

3.5.2 Budgeting

KGM's budget is divided into a general budget and a highway construction budget. The general budget is divided into a budget for KGM's road management, and a budget raised and entrusted by concerned organizations for the maintenance and improvement of roads for tourism, power supply, and agriculture.

The general road budget is divided into investment, business, and expropriation budgets. The investment budget is further divided into budgets for KGM managed roads and entrusted roads.

The investment budget for KGM managed roads consists of costs for the maintenance, management, and improvement of existing roads, and the construction of new roads and related costs such as land acquisition and compensation costs.

The budget entrusted by organizations is used to maintain and manage each entrusted road. This budget includes the cost for road improvements, and new road construction and related costs such as land acquisition and compensation costs, business expenses and administration costs.

Part of planning and research costs for motorways, maintenance and management costs, construction costs for access roads to motorways and other related costs are considered as KGM expenses.

3.6 *Present State of Architectural Facility Construction Work*

The construction of the architectural facilities required for the management and maintenance of motorways and for traffic control has made little progress so far. The motorway construction project currently in progress includes the construction of maintenance office, toll collection stations, interchanges and parking areas but excludes the construction of service areas and rest areas.

Within the jurisdiction of the Division 17 covering the area around Istanbul, the construction of maintenance offices has almost been completed at Selimpasa and Kavacik but neither office has yet begun operation. In comparison, the maintenance office at Tutunciftlic in Division 1 has already commenced operation. An additional maintenance office is under construction at Kurtkoy.

Within the jurisdiction of Divisions 17 and 1, toll collection stations consisting of toll booths and a combined monitoring station and office building have been introduced and tolls are collected.

Within the jurisdiction of Division 2 (covering the area around Izmir), a 26 km section of the total 84 km between Izmir and Cesme was completed in July, 1992, but the toll booths at the toll collection station are temporary and lack any other buildings. The construction of other facilities including a maintenance office has not yet started.

The construction of the maintenance office for the section between Adana and Mersin in Division 5 has not yet started. With regard to toll collection stations, the construction of permanent toll booths, a combined monitoring station and office building and a police station is taking place simultaneously. The construction of service areas and rest areas which will generate income is not included in the motorway construction project. Their construction and management will take place under a separate contract under conditions determined by the BOT method.

Traffic Survey and Analysis

4. Traffic Survey and Analysis

4.1 Outline of Traffic Survey

4.1.1 Objective of Traffic Survey

Purpose of the traffic survey is to ascertain the present traffic conditions on the first and second peripheral road because of studying traffic control and information dissemination in the Istanbul central area. The results have an effect on the implementation of a traffic management and operation system for the motorway network in the Istanbul area.

4.1.2 Location of Survey Area

The survey area is located in the Istanbul metropolitan area. It covers both the Anatolia-side and European-side of the Istanbul metropolitan area. The survey area is shown in Figure 4.1.1.

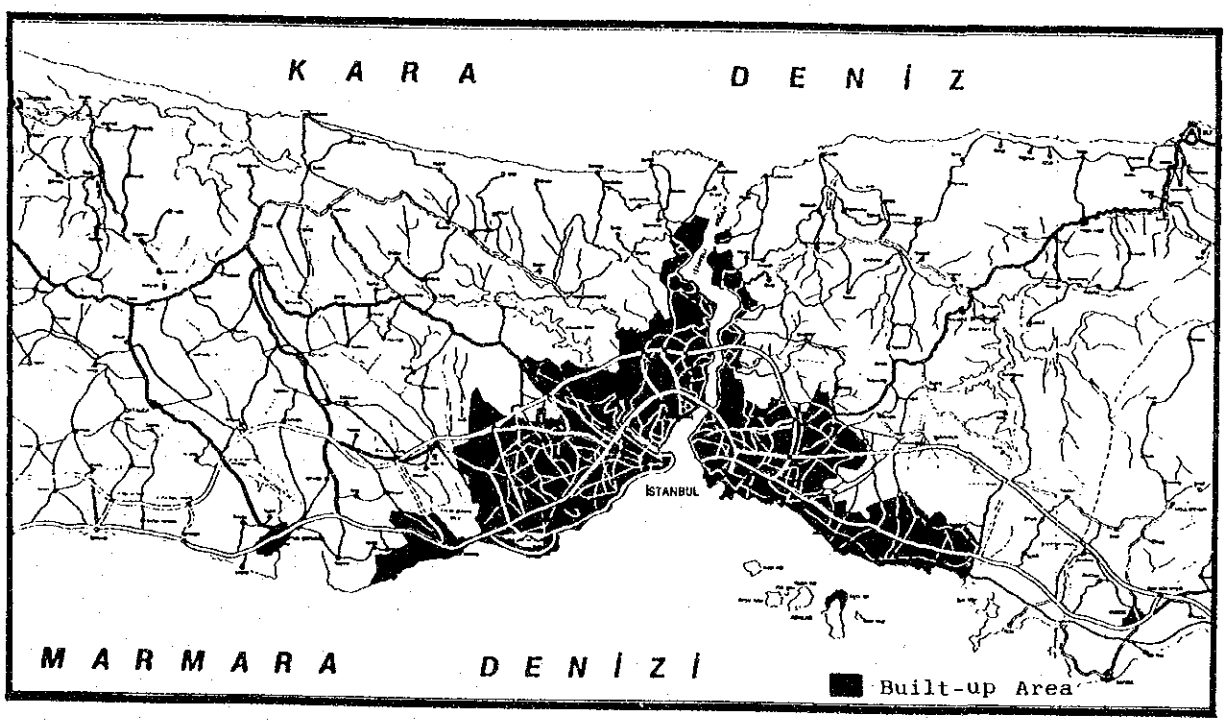


Figure 4.1.1 Survey Area

4.1.3 Types of Survey Conducted

The traffic survey consists of three (3) traffic surveys as follows:

- Traffic Count Surveys at selected interchanges on the 1st and 2nd Peripheral Road.
- Origin and Destination Surveys at 1st and 2nd Bosphorus Bridges.
- Travel Speed Surveys on 1st Peripheral Road, 2nd Peripheral Road, and several major roads in the Istanbul area.

4.2 Previous Traffic Studies

4.2.1 Tollgate Traffic Counts

1) Average Daily Traffic Volumes (ADT)

(1) Bosphorus Bridges

The data were obtained from KGM's 17th Division toll collection records. Toll is collected in one direction only (eastbound). There are no tollbooths for westbound on either Bosphorus bridge.

The Average daily traffic volumes(ADT) for the Bosphorus bridges from April, 1991, to April, 1992, is shown in Figure 4.2.1.

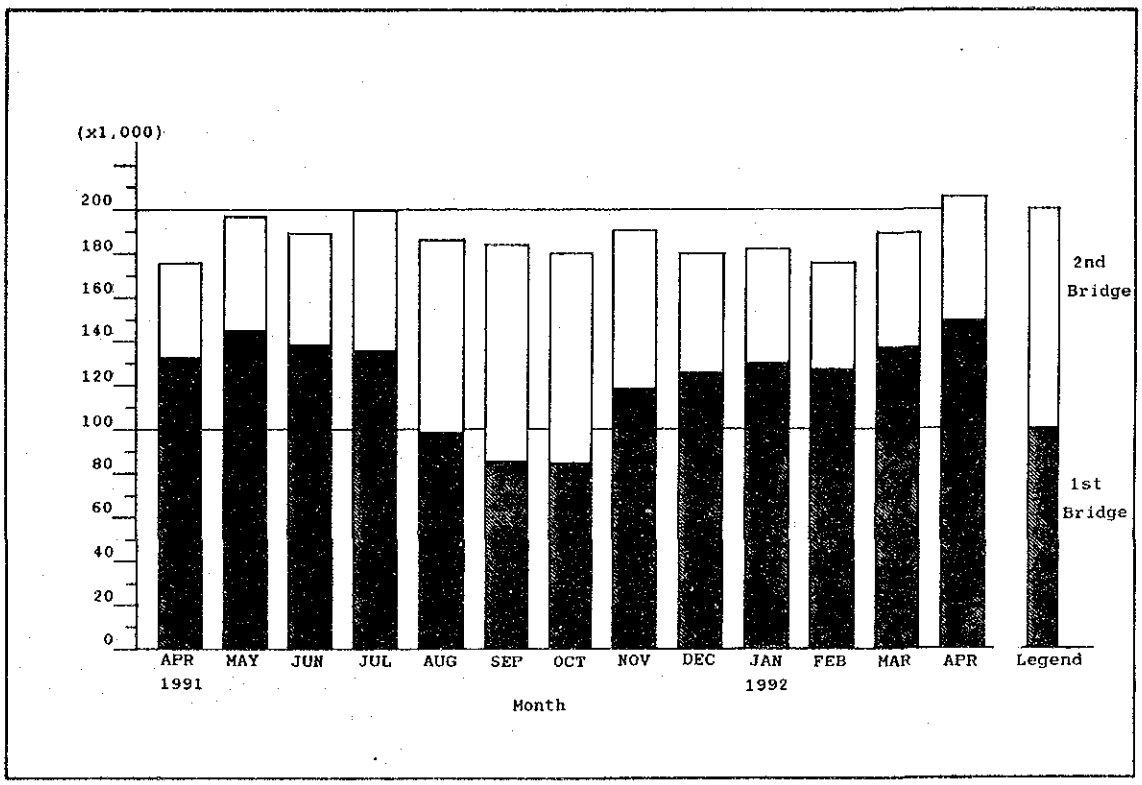
The average daily traffic volumes for the 1st and 2nd Bosphorus bridges were, respectively, 148,124 veh./day and 57,504 veh./day in April, 1992. Traffic volumes increased 11 % at the 1st Bosphorus bridge and 30 % at the 2nd Bosphorus bridge from April,1991, to April,1992. The total daily traffic volumes crossing the Bosphorus Strait was 205,628 vehicles. The percentage of traffic crossing the Bosphorus at the 1st and 2nd Bosphorus bridges was 72.0 % and 28.0 %, respectively. Because of road maintenance and traffic restrictions on the 1st Bosphorus bridge (from July to November,1991), the traffic increase on the 2nd Bosphorus bridge was about twice what was expected.

The number of lanes on the 1st and 2nd Bosphorus bridges are six (6) lanes and eight (8) lanes, respectively. The number of lanes for westbound and for eastbound traffic on the 1st Bosphorus bridge (during the morning and evening

rush hours) is changed by special traffic control (using traffic cones and traffic control police), as follows:

Number of Lanes on the 1st Bosphorus Bridge:

Direction	Morning	Evening	Off-Peak
Eastbound	2 lanes	4 lanes	3 lanes
Westbound	4 lanes	2 lanes	3 lanes



Source: Regional Division Office 17

Figure 4.2.1 Bosphorus Bridges Monthly ADT

(2) Motorway

Traffic volume data on the motorway at the Anadolu toll barrier were obtained from KGM's 1st Division toll collection records. Toll is collected at the exit booth. The average daily traffic volumes (ADT) on the motorway from January, 1991, to December, 1991, are shown in the following table. The annual average daily traffic volume was 22,369 veh./day in 1991.

Table 4.1.1 Average Daily Traffic Volumes by Month

Month		ADT	Ratio = Monthly ADT/Yearly ADT
1991	JAN	14,639	0.65
	FEB	12,790	0.57
	MAR	18,662	0.83
	APR	24,914	1.11
	MAY	22,491	1.01
	JUN	27,647	1.24
	JUL	27,603	1.23
	AUG	25,711	1.15
	SEP	27,878	1.25
	OCT	23,930	1.07
	NOV	22,700	1.01
	DEC	18,976	0.85
Average		22,328	1.00

Source: Regional Division Office 1

2) Vehicle Classifications

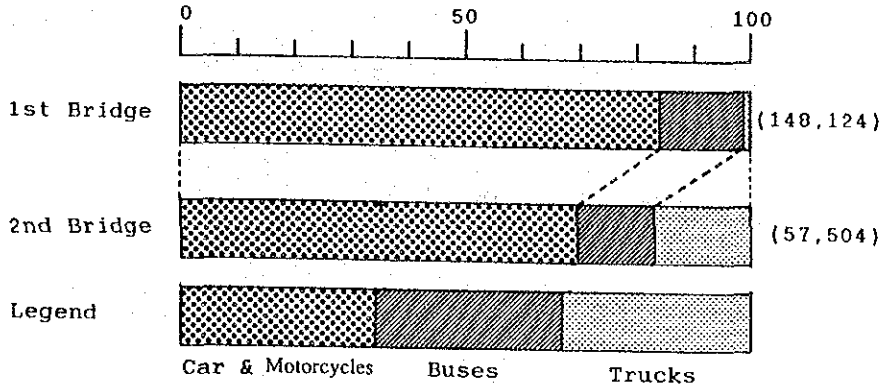
(1) Bosphorus Bridges

Toll is collected for eight (8) vehicle classifications at the Bosphorus bridge tollbooths. Figure 4.2.2 shows the classifications during April,1992.

The percentage of cars, buses and trucks on the 1st Bosphorus bridge was 83.9 %, 15.1 % and 1.0 %, respectively. The percentage of cars, buses and trucks on the 2nd Bosphorus bridge was 69.6 %, 13.3 % and 17.1 %, respectively. The majority of trucks (87 %) used the 2nd Bosphorus bridge due to traffic regulations on the 1st Bosphorus bridge.

(2) Motorway

Toll is collected according to five (5) vehicle classifications at toll barrier on the motorway. The percentages of traffic by vehicle classification for 1991 AADT, were as follows:



Source: Regional Division Office 17

Figure 4.2.2 Vehicle Classifications on the Bosphorus Bridges (April, 1992)

Table 4.1.2 Vehicle Type Composition

Vehicle Type	Percentage
2 Axles(AS<3.2m)	66.7 %
2 Axles(AS>3.2m)	16.2 %
3 Axles	13.7 %
4 & 5 Axles	3.4 %
More than 5 Axles	0.0 %

Note AS: Axle Spacing

Source: Regional Division Office 1

3) Hourly Traffic Variations

Hourly traffic variations at tollbooths on both Bosphorus bridges(eastbound direction, only) and Mahmutbey (both directions) for May 28,1992, are shown in Figure 4.2.3 and Figure 4.2.4.

(1) Bosphorus Bridges

As shown in Figure 4.2.3, traffic volumes for the eastbound direction on both Bosphorus bridges display a distinctive evening peak hour pattern. This is a typical hourly pattern for commuter dominated traffic. The peak hours and peak hour ratios (peak hour traffic/24 hour traffic) are as follows:

Location	Peak Hours	Peak Hour Ratios
1st Bosphorus	7 pm - 8 pm	9.0 %
2nd Bosphorus	6 pm - 7 pm	16.1 %

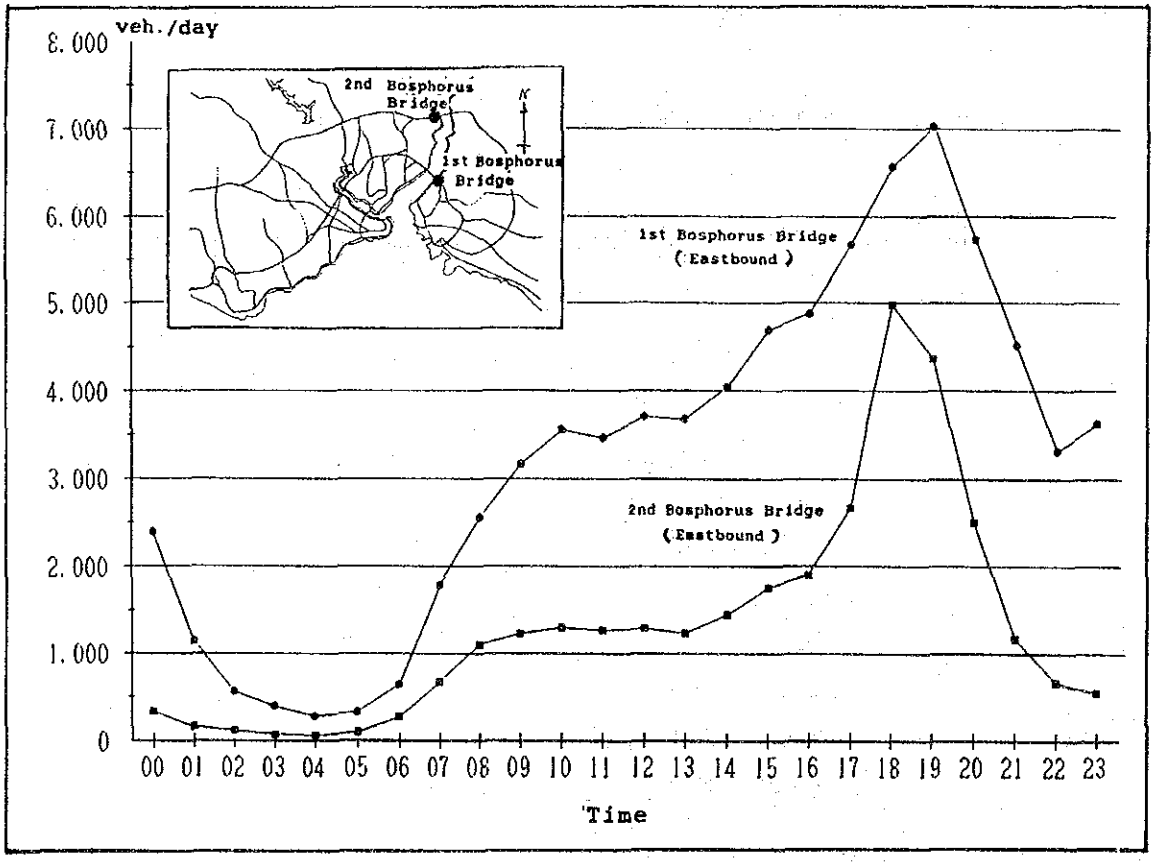


Figure 4.2.3 Hourly Traffic Variations at the 1st and 2nd Bosphorus Bridge

(2) Motorway

As shown on Figure 4.2.4, it shows a typical hourly variation pattern for commuter traffic nearby a metropolitan area. Namely, the eastbound peak hour from the suburban area to the central area is 8 am - 9 am, and the westbound peak hour is 6 pm - 7 pm. The peak hours and peak hours ratio are as follows:

	Peak Hour	Peak Hour Ratio
Eastbound	8 am - 9 pm	10.0 %
Westbound	6 pm - 7 pm	9.0 %

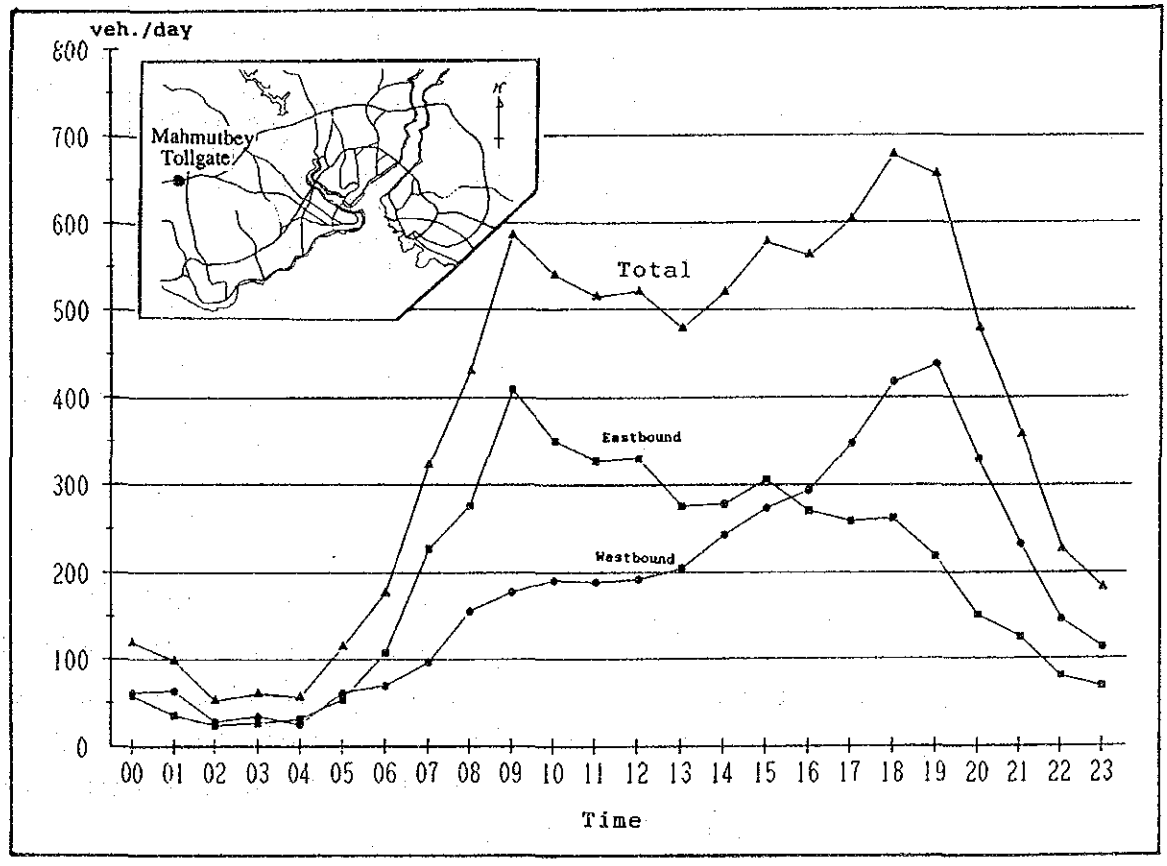


Figure 4.2.4 Hourly Traffic Variations at the Mahmutbey Tollbooth

4.2.2 Traffic Volumes on Highways

1) Survey Locations

KGM conducted traffic count surveys on state highways and provincial roads all over the country. Figure 4.2.5 show the survey locations near Istanbul.

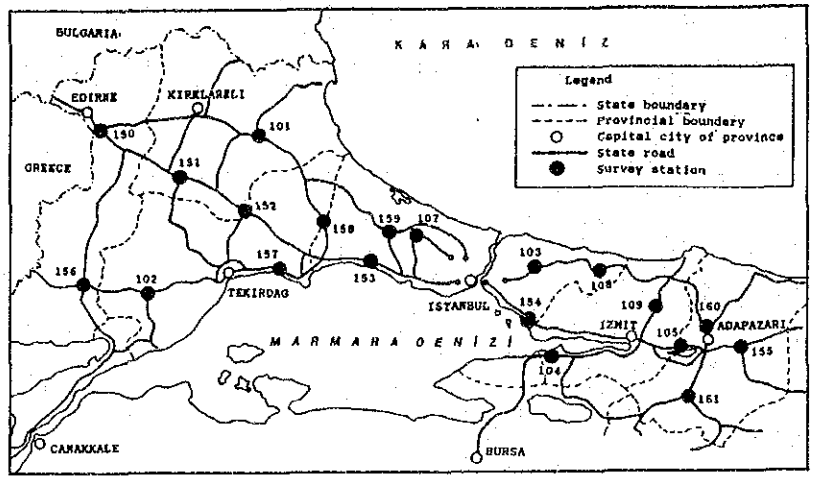


Figure 4.2.5 Survey Locations

2) Traffic Volumes

The traffic volumes illustrated in this section were obtained from KGM's 1st Division. Traffic volumes by traffic count station are shown in Table 4.2.1. As shown on Table 4.2.1, traffic volumes at the traffic count stations (Locations No. 105, 150, 151, 152, 153, 154 and 155) located on the E-5 (D-100 in Turkey) were larger than other count stations. Traffic volumes at traffic count station No.154 were the largest, with an AADT of 33,797 veh./day.

Table 4.2.1 AADT and Seasonal Traffic Volumes in 1991

(Unit : Veh./Day)

Location	Direction	Spring	Summer	Autmun	Winter	AADT
91-101	Vize	830	941	572	0	704
91-102	Tekirdag	2,376	3,266	3,748	0	2,817
91-103	Istanbul	1,636	3,530	2,031	0	2,160
91-104	Karamursel	7,594	10,236	8,715	0	7,963
91-105	Izmit	16,067	17,472	14,425	0	14,389
91-107	Arnavutkoy	324	501	348	0	352
91-108	Sile	220	730	411	0	408
91-109	Izmit	523	1,695	525	0	823
91-150	Havas	4,905	10,174	5,843	0	6,277
91-151	Luleburgaz	5,786	13,625	6,339	0	7,733
91-152	Corlu	8,098	9,725	9,237	0	8,118
91-153	Istanbul	13,432	27,303	14,627	0	16,609
91-154	Istanbul	31,936	48,180	32,542	0	33,797
91-155	Adapazari	12,618	17,722	13,738	0	13,223
91-156	Malkara	2,630	5,132	3,831	0	3,478
91-157	Kinali	3,940	8,553	4,633	0	5,138
91-158	Kinali	2,230	2,477	2,423	0	2,139
91-159	Istanbul	1,585	1,783	1,533	0	1,470
91-160	Adapazari	5,641	6,570	5,586	0	5,339
91-161	Adapazari	6,372	7,486	7,181	0	6,312

Source: Regional Division Office 1

3) Vehicle Classifications

Table 4.2.2 shows vehicle classifications by percent of the total at each traffic count station in 1991. The percentage of passenger cars was more than 50 % at most of the traffic count stations.

Table 4.2.2 Vehicle Classifications in 1991

(%) (Unit : Veh./Day)

Location	Direction	Car	Bus	Trucks	Total	AADT
91-101	Vize	46.9	3.2	49.9	100.0	704
91-102	Tekirdag	61.4	9.0	29.6	100.0	2,817
91-103	Istanbul	53.3	2.9	43.8	100.0	2,160
91-104	Karamursel	50.1	5.8	44.1	100.0	7,963
91-105	Izmit	24.2	14.0	61.8	100.0	14,389
91-107	Arnavutkoy	62.2	1.7	36.1	100.0	352
91-108	Sile	77.0	5.1	17.9	100.0	408
91-109	Izmit	71.1	6.5	22.4	100.0	823
91-150	Havas	68.5	10.1	21.4	100.0	6,277
91-151	Luleburgaz	63.0	8.1	28.9	100.0	7,733
91-152	Corlu	54.5	12.1	33.4	100.0	8,118
91-153	Istanbul	58.4	8.4	33.2	100.0	16,609
91-154	Istanbul	57.2	12.0	30.8	100.0	3,797
91-155	Adapazari	46.0	12.3	41.7	100.0	13,223
91-156	Malkara	65.4	6.4	28.2	100.0	3,478
91-157	Kinali	66.6	7.0	26.4	100.0	5,138
91-158	Kinali	54.1	4.1	41.8	100.0	2,139
91-159	Istanbul	63.5	3.2	33.3	100.0	1,470
91-160	Adapazari	57.7	8.3	34.0	100.0	5,339
91-161	Adapazari	38.0	8.4	53.6	100.0	6,312

Source: Regional Division Office 1

Note Cars: Passenger car/Jeep/Minibus/Pickup
Bus: Bus
Trucks: Truck/Lorry/Trailer

4) Traffic Volumes in Division 1 on the Motorway and E-5 (D-100)

This section shows a comparison of the traffic using the motorway compared to E-5 (D-100), between Gebze and Izmit. The percent of the total traffic using the motorway between Gebze and Izmit is shown in Table 4.2.3, and was approximately 53% from 1987 to 1990.

Table 4.2.3 Annual Average Daily Traffic Volume (Gebze - Izmit)

(Unit: veh./day, %)

Year	E-5 (D-100)	Motorway	Total	Motorway/Total
1987	10,780	12,352	23,132	53.4
1988	11,898	14,299	26,197	54.6
1989	13,126	14,097	27,223	51.8
1990	13,126	14,999	28,125	53.3

Source: Regional Division Office 1

4.3 Traffic Count Surveys

4.3.1 Method Used

1) Survey Items

The survey items were traffic volumes by direction, vehicle type and hour. The vehicle classifications followed those used by KGM at tollgates on the Bosphorus Bridges. The vehicle counts were organized according to eight (8) different classifications as follows: Motorcycles, Passenger cars/Taxis, Minibuses/Vans, Small buses, Large buses, IETT (Municipality Buses)/MAVI (Private Owner Buses), Trucks, Lorries/Trailers.

2) Method

The Video Camera Method was mainly used for the traffic count survey. The survey was conducted either from 6:00 AM to 8:00 PM (14 hours) or from 6:00 AM to 6:00 AM (24 hours). After field collection of the data by cameras, traffic count data were transferred to computers by a Magnetic Bar Code System.

3) Work Schedule

The traffic count survey was conducted on May 28, 1992. The Study Team inspected the field surveys and data processing in the office.

4.3.2 Location of Traffic Count Stations

Traffic count surveys were done at nine (9) interchanges as follows:

1. Kozyatagi Interchange
2. Anadolu Otoyolu Interchange
3. Barbaros Bulvari Interchange
4. Levent Interchange
5. Harp Akademileri Interchange
6. Hasdal Interchange
7. Metris Interchange
8. Mahmutbey-West Interchange
9. Cobancesme Interchange

The locations of the traffic count stations and length of traffic counts are shown in Figure 4.3.1.

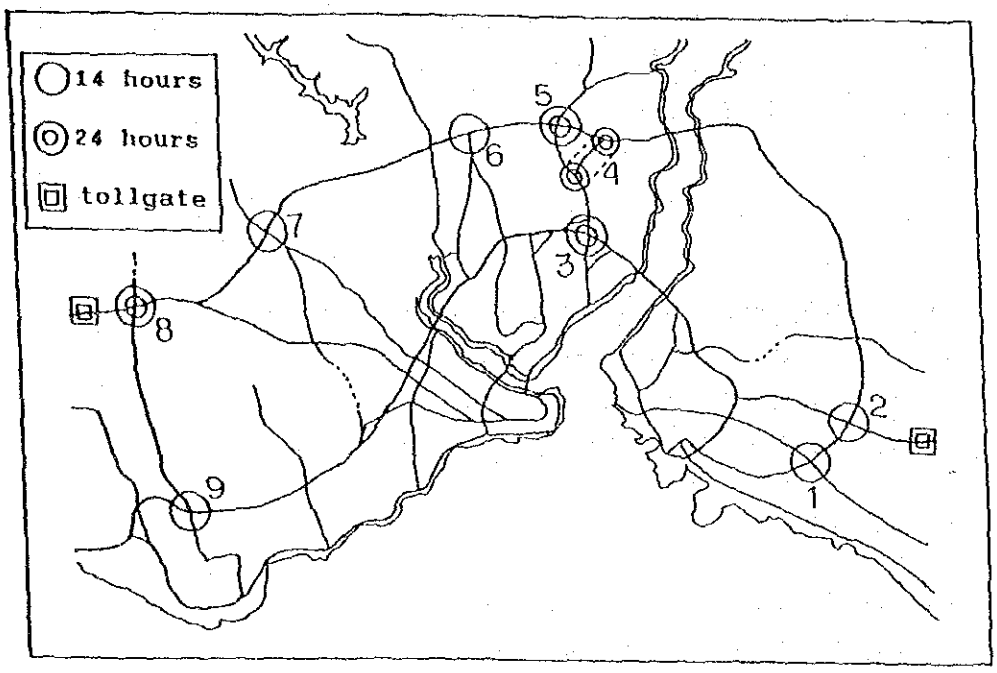
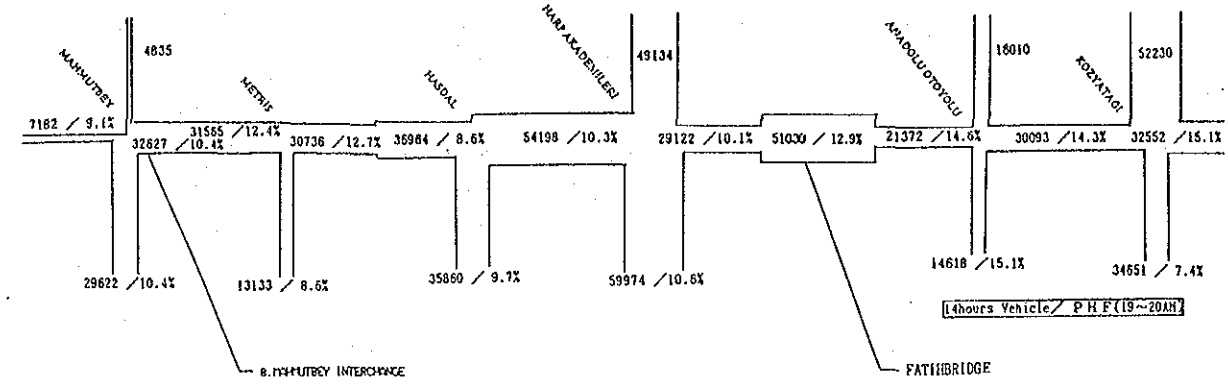


Figure 4.3.1 Location of the Traffic Count Stations

4.3.3 Results of the Traffic Count Survey

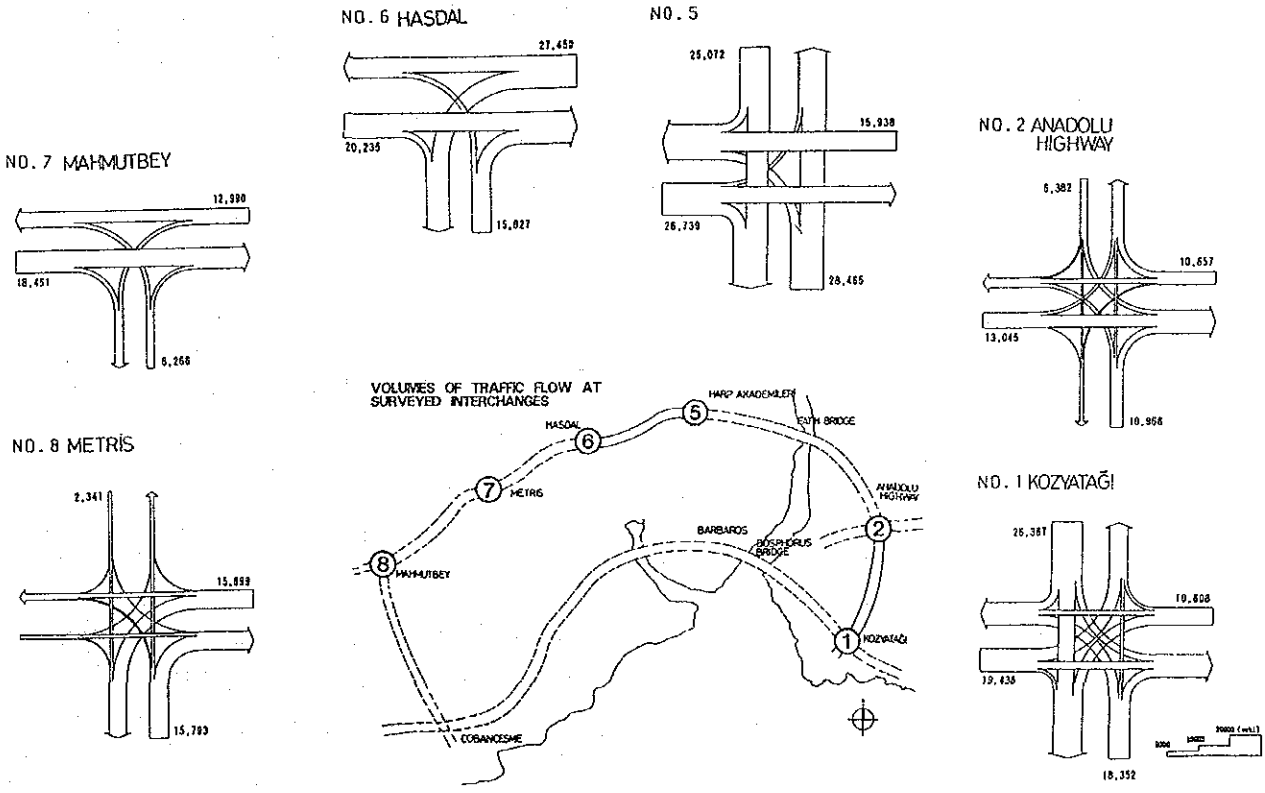
1) Traffic flow

Figure 4.3.2 shows the traffic flow (14 hours) on the 2nd peripheral road.



Source: JICA Study Team

Figure 4.3.2 Traffic Flow



Source: JICA Study Team

Figure 4.3.3 Traffic Volumes at Interchanges(14 hours)

According to the traffic flow diagram of the 2nd peripheral roads including the 2nd Bosphorus Bridge based on a 14-hour traffic volume study, the section between Harp Akademileri ~ Hasdal shows the highest traffic volume of 54,198 vehicles. Most of the traffic is considered to be bound for the city center such as at Levent and Barbaros, and actually the traffic in this direction (south of the 2nd peripheral road) is high at 59,974 vehicles.

Traffic at the 2nd Bosphorus Bridge is high at 51,030 vehicles, however, the traffic at both ends (of the bridge) is lower (20,000 to 30,000 vehicles).

2) Peak Ratio

(1) 1st Peripheral Road

a. 1st Bosphorus Bridge

According to the 14-hour traffic volume study, the hourly peak ratio at the Bosphorus Bridge is the highest between 19:00 ~ 20:00 at 12.7 % for eastbound traffic, between 9:00 ~ 10:00 at 11.5 % for westbound traffic, and between 8:00 ~ 9:00 at 8.9 % for the total. This illustrates that the Bosphorus Bridge is a heavy commuter facility for work trips from east to west, and for returning home trips from west to east.

b. Barbaros ~ Okmeydani

The hourly peak ratio between Barbaros ~ Okmeydani is the highest between 19:00 ~ 20:00 at 10.5 % for eastbound traffic, and between 9:00 ~ 10:00 at 10.8 % for the total. In this section , westbound work trips are dominant as in above.

c. Topkapi ~ Cobancesme

The hourly peak ratio between Tapkapi ~ Cobancesme is the highest between 18:00 ~ 19:00 at 10.0 % for eastbound traffic and between 8:00 ~ 9:00 at 8.7 % for westbound traffic. At other times the traffic is balanced for both directions.

(2) 2nd Peripheral Road

a. 2nd Bosphorus Bridge

The hourly peak ratio at the 2nd Bosphorus Bridge is the highest between 18:00 ~ 19:00 at 19.6 % for eastbound traffic, and between 8:00 ~ 9:00 at 19.8 % for the total. The peak ratio value is the highest of all the sections, and it shows a significant trend for westbound work trips.

b. Harp Akademileri ~ Hasdal

The peak ratio between Harp Akademileri ~ Hasdal is the highest between 18:00 ~ 19:00 at 11.2 % for eastbound traffic, and between 7:00 ~ 8:00 at 15.6 % for westbound traffic. Also at this section the westbound work trips trend is observed.

c. Metris ~ Mahmutbey

The peak ratio between Metris ~ Mahmutbey is the highest between 18:00 ~ 19:00 at 10.2 % for eastbound traffic, and between 19:00 ~ 20:00 at 11.3 % for westbound traffic. Unlike the other sections, this section shows the highest peak ratio around the same hour for both east and westbound traffic.

3) Ratio of Daily Traffic to Daytime Traffic

A 24-hour traffic volume study has been conducted at the following six points : 1st Bosphorus Bridge, 2nd Bosphorus Bridge, Barbaros, Topkapi, Harp Akademibri and Mahmutbey near downtown Istanbul.

The eastbound traffic at two of these locations, from Barbaros to the 1st Bosphorus Bridge, and from Hasdal to Harp Akademileri has a high ratio of 1.6 for total daily traffic to daytime traffic.

Table 4.3.1 Ratio of Daily Traffic to Daytime Traffic

Interchange	Hour / No.	Daytime *1 12h Total	Nighttime *2 12h Total	24h Total	Ratio
Barbaros	31	113,728	29,928	143,656	1.263
	32	80,320	40,081	120,401	1.499
	33	83,637	17,711	101,348	1.212
	34	100,202	25,198	125,400	1.251
Levent	41	52,148	13,103	65,251	1.251
	42	15,847	6,406	22,253	1.404
	43	54,497	14,025	68,522	1.257
Harp Akademileri	51	42,828	14,611	57,439	1.341
	52	24,929	8,981	33,910	1.360
	53	51,903	21,975	73,878	1.423
	54	46,998	17,170	64,168	1.365
Mahmutbey	81	4,417	1,710	6,127	1.387
	82	28,442	11,564	40,006	1.407
	83	25,880	9,030	34,910	1.349
	84	6,357	2,633	8,990	1.414
1st Bosphorus Bridge	Eastbound	47,750	29,949	77,699	1.627
	Westbound	57,623	22,979	80,602	1.399
	Total	105,373	52,928	158,301	1.502
2nd Bosphorus Bridge	Eastbound	20,773	10,348	31,121	1.498
	Westbound	23,136	7,954	31,090	1.344
	Total	43,909	18,302	62,211	1.417

Note: *1 Daytime : 07:00 ~ 19:00
*2 Nighttime : 19:00 ~ 07:00

Source: JICA Study Team

4) Truck Ratio

The 1st Bosphorus Bridge shows a high truck ratio of 6 ~ 9 % in the morning for eastbound traffic, and of 15 ~ 19 % between 3:00 ~ 6:00 for westbound traffic. During the daytime, the average truck ratio is about 4 ~ 5 %.

The 2nd Bosphorus Bridge shows a higher truck ratio than that of the 1st Bosphorus Bridge. The ratio is low during commuting hours from 8:00 to 10:00 at 6.7 % ~ 9.7 %.

During 2:00 to 6:00 the truck ratio is over 50 %, and is under 50 %, otherwise.

4.4 Origin and Destination Surveys

4.4.1 Purpose and Method Used

1) Purpose

This survey was conducted to obtain the O/D data and other important travel related information from vehicles crossing both Bosphorus bridges. The results of this survey will be reflected to the implementation of the traffic management and operations system in the survey area.

This survey consists of two separate survey tasks. One task is the roadside interview survey and the other task is the traffic count survey. The results from the traffic count survey were used for calculation of expansion ratios for the roadside interview data collected from drivers.

2) Survey Questions

(1) *Roadside Interview Survey*

The survey questions for the roadside interview survey were as follows:

1. Survey Time
2. Vehicle Type
3. Origin Zone
4. Destination Zone
5. Trip Purpose
6. Routine Trip (YES or NO)
7. Interchange Name (ENTER)
8. Interchange Name (EXIT)
9. Load Level of Trucks (overloaded or not)

(2) Traffic Count Survey

The survey data to be collected for the traffic count survey were traffic volumes by direction, by vehicle type and by hour. The vehicle classifications followed the KGM vehicle classification system used at the tollgates for the Bosphorus Bridges. Vehicle types were classified into eight (8) separate types as follows:

1. Motorcycles
2. Passenger cars/Taxis
3. Minibuses/Vans
4. Small buses
5. Large buses
6. IETT/MAVI
7. Trucks
8. Lorries/Trailers

3) Method

(1) Roadside Interview Survey

The roadside interview method was used for the origin and destination survey.

The surveyors interviewed selected drivers using the questionnaire on a 24-hour basis on the approach lanes of the tollgates for both Bosphorus bridges. The sampling percentage obtained was more than ten (10) percent of the total traffic volume. The origin and destination data were on a zone-zone basis.

The data collected from drivers were coded at the main office and input into a computer.

(2) Traffic Count Survey

Two (2) methods for the traffic count survey were adopted. The video camera method was used to count westbound traffic and the manual count method was used to count eastbound traffic. The traffic count survey was conducted from 6:00 AM to 6:00 AM (24 hours).

After completing the field survey, data was entered into the computer both by the Magnetic Bar Code System and by direct input.

4) Establishment of O-D Zones

After careful consideration, eight (8) zones were identified for the origin and destination survey. Three (3) of the zones were on the Anatolia side and five (5) of the zones were on the European side. A map illustrating the eight zones is shown in Figure 4.4.1.

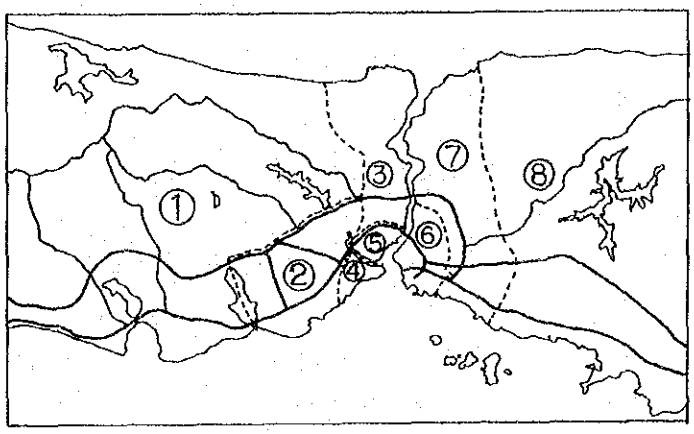


Figure 4.4.1 O-D Zones

5) Progress of Work

The origin and destination survey was conducted on May 28, 1992. The Study Team reviewed the survey in the field and data processing in the office.

4.4.2 Location of Origin and Destination Survey

The survey was done for both Bosphorus bridges. The roadside interview survey was conducted at the eastbound tollgates. The tollgate of the 1st Bosphorus bridge is located in the Anatolia side and the tollgate of the 2nd Bosphorus Bridge is located in the European side of the Bosphorus Strait.

4.4.3 Results of the Origin and Destination Survey

Figure 4.4.2 illustrates the interchange numbers (or zones) needed to interpret Tables 4.4.1, 4.4.2, and 4.4.3. Tables 4.4.1 and 4.4.2 show the origin - destination results for traffic using the 1st Bosphorus Bridge and 2nd Bosphorus Bridge (these values are calculated by expanding the results of the OD survey at both bridges to the actual traffic volume). The number of vehicle trips using the 1st Bosphorus Bridge was 155,105 vehicles/day. Among the OD pairs, those that could be rerouted to the 2nd Bosphorus Bridge are framed in Table 4.4.1. If these trips were reassigned to the 2nd Bosphorus Bridge, the traffic at the 1st Bosphorus Bridge could be reduced to 140,194 trip/day (from 155,105 veh./day).

Table 4.4.3 shows the total OD table for both the 1st Bosphorus Bridge and 2nd Bosphorus Bridge, together. The OD pairs, which would normally be assigned to the 1st Bosphorus Bridge because the alternative route is inconvenient, are framed in Table 4.4.3. If

all other trips were eliminated from the 1st Bosphorus Bridge, the traffic would be reduced from 217,372 veh./day to 99,560 veh./day. The south-eastern regions of Istanbul, Uskudar and Kadikoy are major generation and attraction points for the traffic crossing the bridges, having 49.5 % of the total (107,876 out of 217,372 veh./day).

The long distance trips originating and terminating in rural areas away from Istanbul and crossing both bridges are 7,200 veh./day, or 3.2 % of the total crossing trips of 217,372 veh./day. One of the results of this study is that only the existing 7,200 vehicles/day that originate and terminate away from the Istanbul area could be expected to be diverted from the 1st Bosphonus Bridge to the 2nd Bosphorus Bridge, by implementing the system of traffic management and controls that have been recommended.

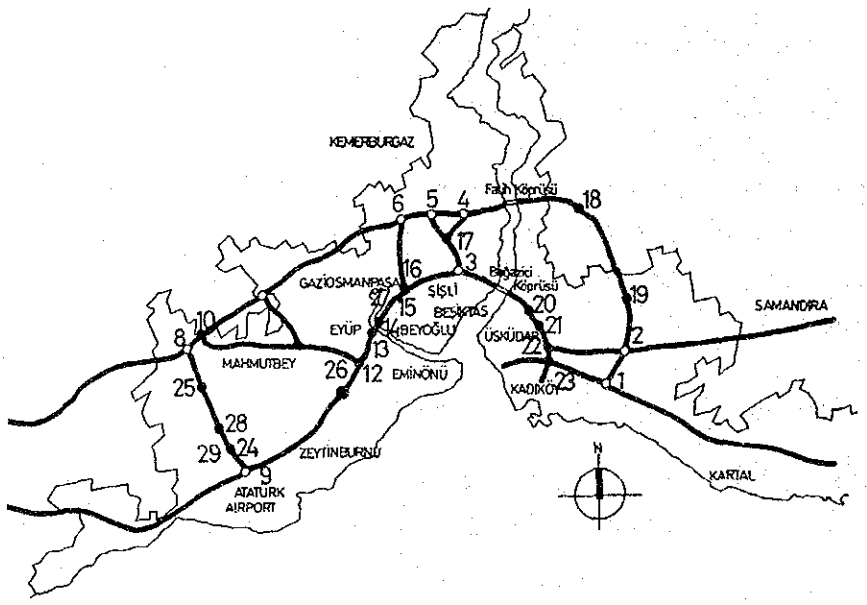


Figure 4.4.2 Origin Destination Survey Interchange Number

Table 4.4.1 O-D Table at the 1st Bosphorus Bridge

Zone	1	2	18	19	20	21	22	23	
3	7,536	6,795	515	2,180	8,657	15,878	5,378	9,630	
4	3,894	3,543	97	870	3,833	7,890	3,575	4,122	
5	161	64	0	0	0	0	0	0	
6	0	32	0	0	64	0	0	0	
7	0	64	0	0	0	97	64	129	
8	129	286	0	0	193	290	193	258	
9	322	386	0	0	837	805	322	386	
10	129	64	0	0	0	129	0	97	
11	32	129	0	193	225	322	32	258	
12	515	870	0	129	419	1,643	451	515	
13	805	419	0	0	451	548	322	258	
14	709	837	32	354	837	1,063	386	161	
15	1,997	1,224	0	515	902	2,641	483	483	
16	1,353	1,224	64	902	1,481	4,283	1,836	1,063	
17	1,288	419	0	258	612	1,288	644	1,256	
24	64	0	0	0	64	129	0	0	
25	64	129	0	0	0	290	258	0	
26	3,478	4,219	225	676	1,932	4,992	1,868	1,900	
27	902	97	0	64	354	998	934	451	
28	258	129	0	0	129	129	64	129	
29	322	64	0	129	129	129	0	97	
TOTAL	24,058	20,966	934	6,280	21,320	43,543	16,812	21,192	155,105
	20,000	17,327	0	0	21,320	43,543	16,812	21,192	140,194

Source: JICA Study Team

Table 4.4.2 O-D Table at the 2nd Bosphorus Bridge (Fatih Bridge)

Zone	1	2	18	19	20	21	22	23	
3	291	145	262	116	0	0	58	0	
4	10,436	2,297	2,238	5,233	145	378	610	116	
5	291	58	0	116	0	0	0	0	
6	436	87	87	174	29	0	29	0	
7	378	145	116	436	0	0	0	29	
8	3,343	1,076	669	1,250	58	262	203	0	
9	1,163	494	174	233	0	58	116	116	
10	87	87	58	58	0	58	116	0	
11	436	203	174	174	87	0	0	29	
12	203	58	0	116	0	58	0	0	
13	145	29	29	87	0	0	0	0	
14	116	262	145	436	29	29	0	58	
15	5,669	2,006	872	3,140	29	233	233	87	
16	465	145	174	262	0	87	0	0	
17	988	116	262	610	0	29	58	0	
24	87	0	0	0	0	0	0	0	
25	523	203	87	320	0	29	29	0	
26	930	959	407	523	58	58	203	174	
27	291	29	0	58	0	87	0	0	
28	930	291	87	320	0	174	29	58	
29	1,337	407	116	291	29	174	174	0	
	28,547	9,099	5,959	13,953	465	1,715	1,860	669	62,267

Source: JICA Study Team

Table 4.4.3 O-D Table for the Total Bridge Crossing

Zone	1	2	18	19	20	21	22	23	
3	7,827	6,941	777	2,306	8,857	16,478	5,437	8,690	
4	14,430	5,839	2,335	6,102	3,978	8,248	4,185	4,289	
5	452	123	0	116	0	0	0	0	
6	436	119	87	174	93	0	29	0	
7	378	210	116	436	0	97	64	158	
8	3,472	1,333	669	1,250	251	551	397	258	
9	1,485	881	174	233	837	863	438	503	
10	216	152	58	58	0	187	116	97	
11	468	332	174	368	313	322	32	287	
12	719	928	0	245	419	1,791	451	515	
13	951	448	29	87	451	548	322	258	
14	825	1,099	178	790	866	1,402	386	219	
15	7,665	3,230	872	3,655	851	2,875	716	570	
16	1,818	1,369	239	1,163	1,481	4,371	1,436	1,003	
17	2,277	535	262	868	612	1,337	702	1,266	
24	152	0	0	0	64	129	0	0	
25	588	332	87	320	0	319	287	0	
26	4,408	5,178	632	1,200	1,991	5,050	2,071	2,075	
27	1,192	126	0	123	364	1,086	934	451	
28	1,188	420	87	320	129	303	93	187	
29	1,659	471	116	420	158	303	174	97	
TOTAL	52,604	30,065	6,893	20,234	21,786	45,258	18,672	21,860	217,372
					20,033	42,183	17,069	20,275	99,560

Source: JICA Study Team

4.5 Travel Speed Surveys

4.5.1 Purpose and Method Used

1) Purpose

The travel speed survey was conducted to identify existing traffic conditions on the 1st peripheral road, the 2nd peripheral road and several other main roads in the Istanbul area.

2) Survey Item

The information collected in the field was travel time by roadway segment on the selected survey routes.

3) Method

The survey team consisted of one driver and one observer. The driver traveled at normal speeds and generally moved at the same speed as surrounding traffic. The driver drove in a manner so as not to frequently overtake or be overtaken by other traffic. The observer identified the assigned check points and traffic conditions, as well as recording the time and other required information on the survey form.

The survey was conducted during the morning peak hours, off-peak hours and evening peak hours.

All survey data were first checked and then input into a computer.

4) *Progress of Work*

The travel speed survey was conducted from May 25 to May 28, 1992.

May 25	:	1st Peripheral Road (Starting from Anatolian side)
May 26	:	1st Peripheral Road (Starting from European side)
May 27	:	2nd Peripheral Road (Starting from Anatolian side)
May 28	:	North-South Arterial Roads (Starting from the north end)

4.5.2 Route Map of Travel Speed Survey

This travel speed survey was conducted on three(3) selected routes. The survey routes and check points are shown in Figure 4.5.1.

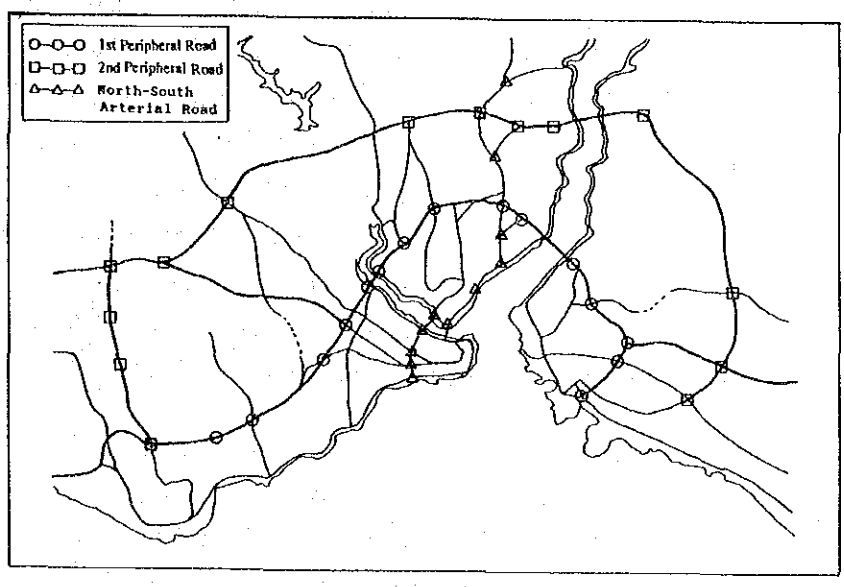


Figure 4.5.1 Travel Speed Survey Route

4.5.3 Results of the Travel Speed Survey

1) Summaries by Route

The summaries by route are shown in Table 4.5.1. During the survey period the Galata Bridge was closed to traffic due to a fire. Vehicles that would normally use the Galata Bridge moved to the Ataturk Bridge and the Golden Horn Bridge. As a result, heavy traffic congestion occurred over the Golden Horn on those two(2) survey routes. A description of the three survey routes is as follows:

- On the 1st peripheral road the speed limit is 90 km/hour. The average travel speed was 32 to 62 km/hour for westbound traffic and 33 to 62 km/hour for eastbound traffic. The maximum speeds were 72 to 92 km/hour for westbound traffic and 68 to 91 km/hour for eastbound traffic. The minimum speeds were 6 to 36 km/hour for westbound traffic and 7 to 24 km/hour for eastbound traffic. The average travel speeds during the morning and evening rush hours decreased by 35 % and 45 %, respectively (compared to the uncongested off-peak speeds).

- On the 2nd peripheral road the speed limit is unlimited on the motorway section. The average travel speeds were 70 to 89 km/hour for westbound traffic and 60 to 78 km/hour for eastbound traffic. The maximum speeds were 92 to 109 Km/hour for westbound traffic and 81 to 108 km/hour for eastbound traffic. The minimum speeds were 45 to 65 km/hour for westbound traffic and 17 to 37 Km/hour for eastbound traffic. The average travel speeds during the morning and evening rush hours decreased by 20 % and 25 %, respectively (compared to the uncongested off-peak speeds). Due to the construction work and the traffic control used at the Ikitelli interchange, the minimum travel speeds for eastbound traffic were lower than for westbound. The average travel speeds in the motorway section on the 2nd Ring Road were 76 to 94 km/hour for westbound traffic and 71 to 88 km/hour for eastbound traffic.

- The North-South Arterial Road, which mostly, passes through the area in Istanbul with the highest economic activity. The average travel speed was 18 to 25 km/hour for southbound traffic and 17 to 29 km/hour for northbound traffic. The maximum speeds were 35 to 45 km/hour for southbound traffic and 33 to 53 km/hour for northbound traffic. The minimum speeds were 10 to 18 km/hour for southbound traffic and 4 to 14 km/hour for northbound traffic.

Table 4.5.1 Summaries of the Travel Speed Survey

(1) 1st Peripheral Road

Start Time	From Anatolia to Europe			From Europe to Anatolia		
	Average (km/h)	max. (km/h)	min. (km/h)	Average (km/h)	max. (km/h)	min. (km/h)
7:30	41.1	73.5	11.8	41.7	87.8	18.3
8:30	39.6	72.7	13.7	39.2	91.1	19.4
10:00	51.5	88.9	15.1	51.8	80.9	23.7
11:00	49.7	92.3	17.3	59.0	86.7	13.2
13:30	60.5	81.8	36.0			
14:15				61.9	88.9	18.5
15:00	60.9	88.6	26.5	39.7	79.1	6.6
16:00	61.5	79.9	28.4	45.0	90.0	9.2
17:30	37.4	84.0	6.2	32.8	72.0	8.9
18:30	32.4	72.0	13.2	36.2	67.5	12.2

(2) 2nd Peripheral Road

Start Time	From Anatolia to Europe			From Europe to Anatolia		
	Average (km/h)	max. (km/h)	min. (km/h)	Average (km/h)	max. (km/h)	min. (km/h)
8:00	70.1	92.0	44.7			
9:00				76.2	101.4	31.8
10:30	85.4	106.3	59.5			
11:30				77.6	107.5	36.6
15:30	88.5	106.6	65.1			
16:30				78.2	105.7	35.3
17:30	86.1	109.4	64.5			
18:30				59.7	80.7	16.9

(3) North-South Arterial Road

Start Time	From North to South			From South to North		
	Average (km/h)	max. (km/h)	min. (km/h)	Average (km/h)	max. (km/h)	min. (km/h)
8:00	19.1	37.5	12.3			
9:00				20.4	41.4	5.6
10:30	22.6	45.0	10.2			
11:30				28.7	53.3	14.3
15:30	25.2	36.9	18.3			
16:30				17.2	33.4	3.9
17:30	18.3	34.7	9.6			
18:30				17.5	40.0	6.9

Source: JICA Study Team

Basic Plan of the Motorway OMM System

5. BASIC PLAN OF THE MOTORWAY OMM SYSTEM

5.1. Introduction

This chapter is intended to report the study conducted to provide a basic plan of Motorway Maintenance, Operations and Traffic Management System (Motorway OMM System) taking into account that the motorway network in Turkey is developed to approximately 3,000 km in length. The objective of this basic plan is to provide a basis for formulating the long-term implementation program.

The Motorway OMM system has three goals, which have been identified as ensuring "traffic safety", "smooth traffic flow" and "users' comfort" by an efficient and economical system operation.

The definitions and functions of the Motorway OMM System in this study are shown in Figure 5.1.1. The motorway OMM system is defined in terms of two basic functions, "Traffic Management and Operations" and "Motorway Maintenance and Operations". The various components constituting these functions are identified, the tasks performed under these components are discussed and the administrative organization allowing efficient operation of the motorway OMM system in the stage of 3,000 km motorway network will be discussed in this chapter.

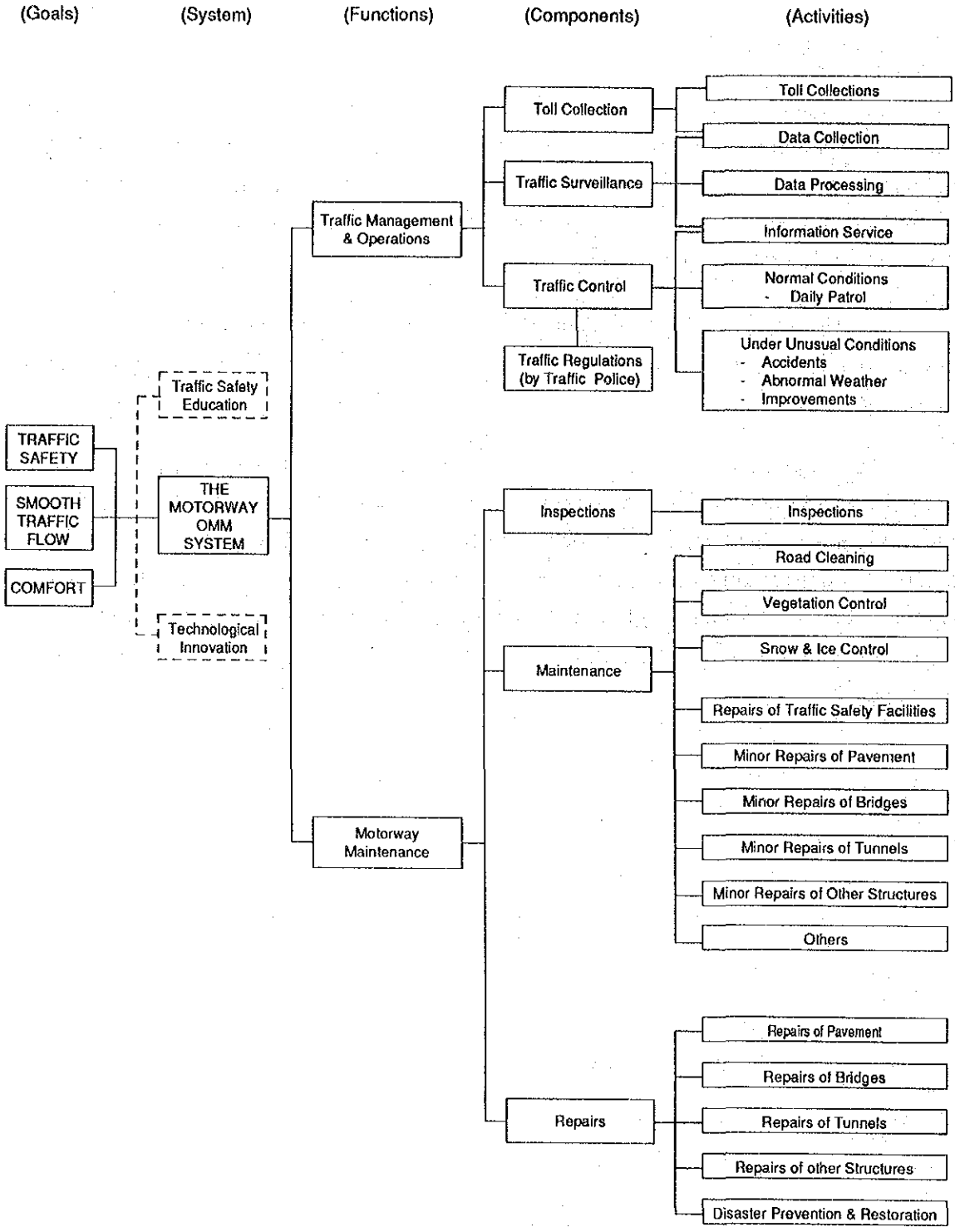


Figure 5.1.1 Definition and Functions of the Motorway OMM System

5.2. Basic Concept

5.2.1. Traffic Management and Operations Function

The functional roles of traffic management and operations are indicated as follows:

- Maintaining safe and smooth traffic flow on the Motorway.
- Preventing unusual conditions such as traffic accidents and traffic congestion which impact traffic flow.
- Recovering from traffic accidents and traffic congestion to normal traffic flow as quickly as possible.

The traffic management and operations function has four components as shown in Figure 5.1.1. They are as follows:

- Toll collection
- Traffic surveillance
- Traffic control
- Traffic regulation

The toll collection component is basic, i.e. the collection of tolls from vehicles using the motorway at tollgates (in the case of a closed system) or at toll barriers (in the case of an open system). The toll collection process provides fundamental data such as traffic volumes and vehicle classifications.

Traffic surveillance is the process of obtaining information regarding traffic performance on the motorways and determining existing traffic conditions by using special equipment and other means such as patrol cars, cooperative motorists, etc. Some of this information will provide quantitative data while others will provide information regarding traffic incidents or level of service. Traffic information is analyzed by traffic engineers and conveyed to the traffic patrol or traffic police for traffic control purposes.

Traffic control includes not only general traffic control on motorways under normal conditions (as carried out by the traffic patrol or traffic police patrol units everyday), but also emergency measures taken for the purpose of controlling traffic under unusual conditions. These unusual conditions may include traffic accidents, unusual weather (heavy rain or snow, strong wind, dense fog, etc.) or conditions generated by motorway construction. Traffic control also performs a very important task, of providing information services. Traffic conditions or weather information gathered at traffic control rooms in the main maintenance centers are conveyed to other offices, patrol units via radio, dedicated or public telephone, variable message signs, etc. and to other broadcasting services.

Traffic regulations legitimize traffic control measures, such as maximum/minimum speed limit control or temporary closure of a lane or a section of the motorway during an emergency.

5.2.2 Basic Concept for Establishing Traffic Management and Operations

The purpose of providing traffic management and operations facilities on the motorway is to maintain traffic safety and convenience for the motorway users through the activities of KGM and other agencies concerned. This is done through the installation and operation of appropriate facilities on the motorway. The computer system is operated by the judgment of staff such as information processing, decision making and execution/enforcement. These facilities include both hardware and software aspects of traffic management. Facilities for the motorway can be divided into two groups. The first group consists of permanent facilities such as lighting, signs, emergency telephones, etc. The second group is related to traffic surveillance and control equipment to deal with the changing conditions of the road, traffic and the weather.

Establishing traffic management and operations levels are dictated by organizational activity and the utilization of special facilities to improve the movement of traffic. It is obviously most important to eliminate existing problems and issues. As an example, it is not possible to warn motorists of potential new hazards without the necessary facilities, such as variable message signs.

Establishing traffic management and operations levels also must take into account social and economic needs as the results of traffic congestion, traffic accidents, or road closures can have a dramatic impact on the vitality of a city or region. In these cases, the introduction of facilities to alleviate these problems can be of the utmost importance. Traffic accidents and the potential for loss of human life must weigh heavily on decisions for the provision of traffic management and operations facilities, almost irrespective of the cost.

As a matter of practicality, however, the implementation of traffic management and operations systems is a costly venture, and it would be best to stage and prioritize the implementation of a system, so that KGM can get the largest benefit for the money spent. For example, it would be beneficial to have variable message signs installed at close intervals on all segments of the motorway, so that motorists might be notified of any change of driving conditions. However, for the majority of motorway segments away from the population centers, the traffic volumes would be so small and the occurrence of traffic incidents so seldom that it would not be a worthwhile expense (capital and operational).

Because of this fact, several different service levels have been established for the provision of traffic management and operations on motorways. This multiple service level method allows the logical implementation of traffic control devices where they are needed, and provides the best use of KGM's budget. Service levels are established so that they can change as traffic conditions change, and facilities can be upgraded to provide for the new situation. This allows the staged implementation of traffic management and operations facilities as they are needed. This method of staging serves to reduce the financial burden on KGM by providing only those facilities that are needed.

5.2.3 Motorway Maintenance and Operations Function

1) Classification of Motorway Maintenance and Activities

To attain traffic safety, smooth traffic flow and riding comfort, the major requirement other than traffic management and operations on motorways is to provide motorway maintenance and operations. The purpose of motorway maintenance and operations is to maintain the road structures and facilities as originally constructed or improved, so that traffic safety, smooth traffic flow and riding comfort will be achieved. There are many kinds of interpretations and definitions of road maintenance and operations depending on the particular study, financing agency and/or country.

In this study, motorway maintenance has three components, inspections, maintenance and repairs. The components of inspections, maintenance and repairs are defined as shown in Figure 5.1.1.

The inspection component consists of inspection activities. The maintenance component consists of road cleaning, vegetation control, snow & ice control, repairs of traffic safety and management facilities and minor repairs of pavement, bridges, tunnels and other structures.

The repair component consists of pavement repairs, bridge repairs, tunnel repairs, other structures repairs and disaster prevention & restoration.

2) Definition of Motorway Maintenance and Operations

Motorway maintenance and operations is defined as systematic activities to preserve and repair a system of motorways with its elements to its designed or accepted configuration. System elements include the travelway surface, shoulders, roadside areas, drainage facilities, bridges, tunnels, traffic safety facilities, traffic managements facilities, inspection facilities, etc. Included in these activities are such services as

inspections, maintenance of road structures, safety facilities, snow and ice control, and maintenance of roadside rest areas.

Motorway maintenance activities are developed to offset the effects of weather, vegetation growth, deterioration, traffic wear, damage and vandalism.

The maintenance and repairs of buildings, stockpiles and equipment essential to perfoming the above are also a part of motorway maintenance.

- Maintenance and Repairs;

  Maintenance is defined as preservation and minor repairs of road structures & road facilities as well as snow and ice control. Those activities are daily or routine work designed to preserve and repair the motorway system.

  Repair is defined as the repairs and restoration of road structures and facilities identified by periodic and special inspections.

  For instance, the following explanation of the maintenance and repairs of the pavement will clarify the above definitions. The serviceability of pavement will decrease in general due to traffic and aging as an elapse of the time as shown in Figure 5.2.1. Therefore, maintenance for pavement is required for preserving motorway pavement by minor repairs within acceptable range of the pavement. Repairs for pavement is required for repairing pavement as close as possible to the original condition (perfect level).

  Maintenance for pavement as minor repairs is composed of repairs of potholes, patching, surface treatments, and repairs of rutting and cracking. Repairs include asphalt overlays and the replacement of pavement. The Figure 5.2.1 illustrates definitions of maintenance and repairs for pavement, using perfect level and unacceptable level referring to Present Serviceability Index (PSI) as per AASHTO Guide for Design of Pavement Structure, 1986. The maintenance and repairs will be done within an acceptable range not including improvement nor reconstruction work.

- Improvement and Reconstruction;

  Improvement is defined as improving the motorway width, alignments, radious and gradient for improving traffic speed, safety and capacity. Reconstruction is defined as renewal of deteriorated road structures and/or as renewal of the motorway alignment, radius and gradient for improving safety.

The improvement and reconstruction are out of scope of the motorway maintenance for this study.

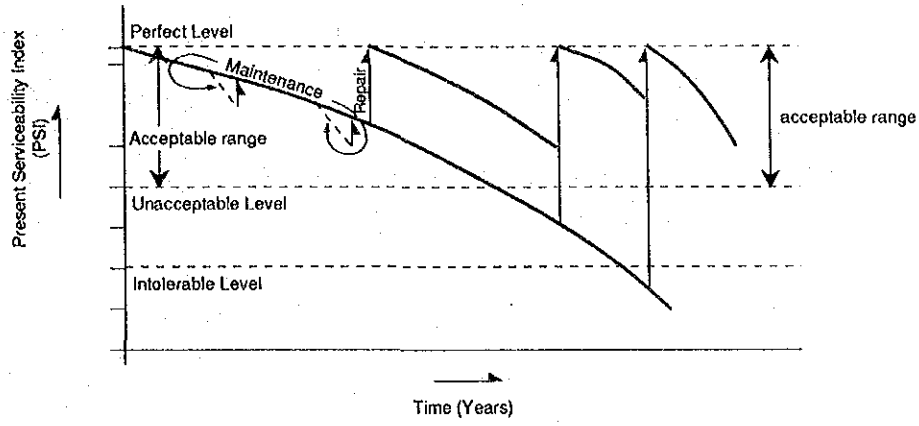


Figure 5.2.1 Definition of Pavement Maintenance and Repairs

5.2.4 Basic Consideration on Establishing Motorway Maintenance and Operations

The road is an important infrastructure for social and economic activity. The need for road construction in Turkey has been increasing due to the recent acceleration in vehicle ownership. In this background, 3,000 km network of motorways are considered for this basic plan. As of December 1992, there is 900 km of motorway open to traffic and the length will soon be developed to 1,500 km.

Under this circumstance, it is a focused subject for KGM how to maintain and operate the motorway in an efficient and economic manner, considering the future increase in motorway length. If the budget were not provided appropriately for motorway maintenance and operations, eventually extra investment would be needed at several times larger than the original construction cost due to expensive repairs and reconstruction. KGM are responsible for establishing an organization and providing necessary personnel, facilities, equipment, material and budget. A consideration whether the work should be done directly by force account or on contract basis is necessary to determine the number of KGM personnel required by the quality and quantity of the motorway maintenance works. It is also important to establish a training system for KGM personnel, and a system to keep as-built drawings, design documents construction record of the relevant motorway structures for the use for motorway maintenance and operations.

5.3 Organization

5.3.1 General

The future concept of 10,000 km of motorways may require an independent motorway authority. Until that time, KGM must determine how best to manage the 3,000 km motorway system for a long-term plan. It is recommended that KGM look to strengthen the existing organization, and do so in a manner similar to that used by motorway organizations of other developed countries. By strengthening its existing organization, KGM can proceed in a more practical direction following the basic government policy of not creating new agencies at all if possible. In addition to these considerations, KGM must create a workable organization that is capable of managing the 1,500 km of motorways that are scheduled to open to traffic in 1995.

This section provides discussion on an organization which will permit the efficient maintenance and management as the long-term plan.

5.3.2 KGM Headquarters

The KGM headquarters is responsible for the overall planning and programming, i.e. planning of future highway and motorway networks, future implementation programmes, etc. The headquarters is also responsible for carrying out studies, research, development and formulation of standards on highway and motorway facilities designs, traffic engineering, traffic operations, traffic safety and maintenance. In addition, it is entrusted to draw up policy, future highway and motorway development plans, work contracts, financial plan for new constructions or improvement works and oversee all works contracted to private companies.

The headquarters is to be solely responsible for inter-agency cooperation and liaison at the national level with related departments in each ministry.

The major department concerned with the traffic management and operations, and motorway maintenance and operations for the present are the Dept. of Motorway, Dept. of Maintenance, Dept. of Equipment & Supply and the Dept. of Construction.

Involved in the regional KGM divisions of traffic management and operations, and motorway maintenance and operations, are the regional division office, main maintenance center, maintenance office and toll collections office.

There are certain motorway responsibilities that must be carried out at the KGM headquarters office and at the regional division offices to assure that the motorways are functioning at acceptable levels. To provide the organization required to manage the short-term

needs of the motorways, it has been recommended that two new offices be created and added to the existing organizational structure. The two new offices are the Division of Motorway Maintenance and Traffic Management and Control, and the Division of Toll Management and Motorway Revenues.

The Division of Motorway Maintenance and Traffic Management and Control is needed to undertake the planning, programming and execution of maintenance operations and traffic management and control. The Division of Toll Management and Motorway Revenues is required for toll collection control, management, budgeting, auditing, and research and analysis.

It has been necessary to consider how to best transit from the existing KGM organization to the new needs of the motorways relating to maintenance and operations which would be required in the very near future. There are several offices related to motorway maintenance and traffic management, motorway facilities and toll management at KGM headquarters. The new Division of Motorway Maintenance and Traffic Management and Control has been recommended to be established within the framework of the present Maintenance Department. The Division of Toll Management and Motorway Revenues could be considered to be placed under the responsibility of the Motorway Department, in cooperation with the Planning Department.

In addition to creating two new motorway divisions, and determining which department should accommodate these new divisions, comes the task of providing adequate additional staff to carry out the necessary operational and maintenance tasks when the motorways are completed and open to traffic. KGM has a policy of privatization when it comes to providing government services to the public. For example, Division 17 currently uses private contractors to conduct road cleaning, vegetation control and equipment repairs. KGM headquarters currently has plans to introduce a BOT (Build, Operate, and Transfer) system for construction and operation of the service areas to be provided for motorway users. As it may be possible not to increase KGM staff, it may be necessary to rely very heavily on the concept of privatization when it comes to adding motorway maintenance and operations staff.

5.3.3 Regional Offices

Considering the present regional organization mentioned above, the main maintenance center, maintenance office and toll collection office are recommended to be established under regional division offices 1, 2, 4, 5, 6, 13, 14, and 17 as follows:

1) Main Maintenance Center (MMC) and Regional Division Office

The purpose of the main maintenance center is to carry out the planning and supervising of maintenance operations, traffic management and operations, and toll collection on the motorways under the direction of headquarters. The main maintenance center is to be fully responsible for the daily operations, control and management of its lower level offices. The regional division office is responsible for general affairs for MMC, MO and TCO.

2) Maintenance Office (MO)

The maintenance office is mainly responsible for carrying out daily field activities as planned by the main maintenance center, such as patrolling, traffic management, maintenance and repair of the motorway.

3) Toll Collections Office (TCO)

The toll collections office is mainly responsible for carrying out toll collections and checking the collected tolls.

The conceptual organization structure for the motorway OMM system is shown in Figure 5.3.1.

5.3.4 Responsibilities and Functions by Office

The main tasks involved in the motorway OMM system can be divided into the following items:

- Planning and programming
- Traffic engineering and safety
- Traffic management and operations
- Maintenance and operations
- Toll collections
- Coordination with related agencies and public relations
- Administration

The proposed main tasks of the motorway OMM system by the level of offices are shown in Table 5.3.1.

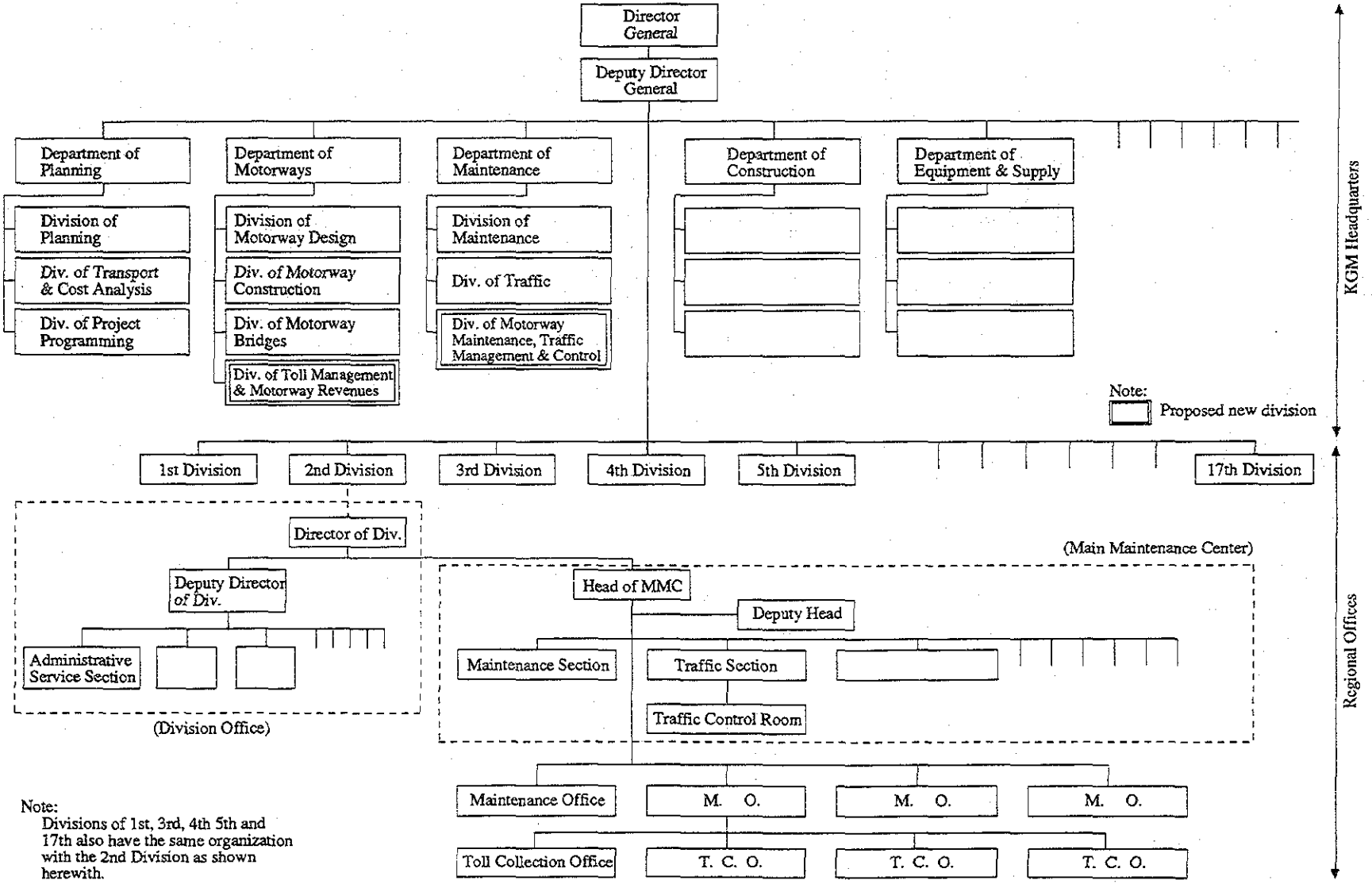


Figure 5.3.1 Conceptual Organization Chart for OMM System

1) KGM Headquarters

The KGM headquarters is mainly responsible for basic planning, setting and development of standards for the motorway OMM system, together with budgeting, auditing, and other responsibilities. It is also responsible for conducting traffic engineering studies for enhancing the efficiency and quality of the motorway OMM system.

2) Main Maintenance Center

The main maintenance center is mainly responsible for managing traffic operations and activities of maintenance and toll collections in its jurisdiction based on the standards and guidelines set-up by the KGM headquarters. It is also responsible for the planning and scheduling of maintenance.

The main maintenance center also manages the traffic control room to facilitate traffic operations.

And the administration such as the general affairs for main maintenance center and maintenance office is carried out by regional division office.

3) Maintenance Office

The maintenance office deals with the day-to-day operation and maintenance of the motorway. This office maintains a fleet of patrol cars for carrying out routine patrol on the motorway, traffic management tasks, emergency assistance, inspection and maintenance works, traffic control, etc.

Table 5.3.1 Main Tasks of Motorway OMM System and its Responsible Office

Main Tasks	Activities	Responsible Office				
		Headquarters	Regional Division Office	Main Maintenance Center	Maintenance Office	Toll Collection Office
1. Planning and Programming	a. Planning	○				
	b. Implementation programming	○				
	c. Estimation of toll revenue	○				
	d. Redemption study	○				
2. Traffic Engineering and Safety	a. Setting of standards and management level	○				
	b. Road and traffic engineering development and research	○				
	c. Traffic forecasts	○				
	d. Implementation of traffic survey	○		○		
	e. Statistical data processing			○	○	
3. Traffic Management and Operations	a. Basic planning	○		○		
	b. Traffic operations			○	○	
4. Maintenance and Operations	a. Setting of standards	○				
	b. Supervision and consultation works			○		
	c. Maintenance and operations				○	
5. Toll Collections	a. Basic planning	○				
	b. Data processing			○		
	c. Toll collections					○
6. Coordination and Public Relations	a. Coordination with relevant agencies	○		○		
	b. Response activity	○		○		
7. Administration	a. Personnel management, salary, welfare, etc.	○	○			

Table 5.3.2 shows the detailed responsibilities and functions for the OMM system by the level of offices.

Table 5.3.2 Responsibilities and Functions for OMM System

Items \ Office	Headquarters	Division Office	Main Maintenance Center	Maintenance Office
1 Planning and Programming	a. Planning b. Implementation programming c. Estimation of toll revenue d. Redemption study			
2. Traffic Engineering and Safety	a. Setting of standards and management level b. Research, development, training on road and traffic engineering, traffic safety c. Traffic forecasts d. Planning of traffic survey		a. Implementation of traffic survey b. Collection, processing, analysis, compilation and management of traffic data	a. Data collection
3. Traffic Management and Operations	a. Basic planning for traffic operations b. Preparation of operations manual c. Consultation and training in traffic management and operations (MMC, MO)		a. Planning of traffic operations procedure for the routes under its jurisdiction. b. Management and implementation of traffic operation activities (TCR) c. Close communication with patrol cars under normal conditions	a. Traffic patrolling b. Routine traffic management c. Close communication with patrol cars under normal conditions d. Carrying out traffic control measures during incidents e. Preparing and keeping records of road and traffic conditions f. Patrolling for pre-caution and emergency stage when instructed by MMC g. Monitoring emergency telephones and terminal equipment h. Others
4. Maintenance and Operations	a. Setting of standards b. Preparation of manual c. Consultation and training in maintenance activities (MMC, MO)		a. Planning of maintenance schedule and procedure b. Supervision and management of maintenance works (MO) c. Management and compilation of road inventories	a. Maintenance patrolling b. Inspections c. Management and supervision of contracting works d. Close communication with patrol cars e. Report to MMC regarding maintenance and repairs f. Daily check of vehicles and equipment g. Rescue measures during disaster or accidents h. Handling of breakdown and accident vehicles i. Handling of hazardous spills during accidents j. Carrying out traffic control measures during maintenance and repairs k. Preparing and updating road inventories l. Inspections for level of warning when instructed by MMC m. Others
5. Toll Collections	a. Basic planning for toll collections		a. Data processing for toll collections	a. Toll collections
6. Coordination and Public Relations	a. Liaison with public bodies and departments b. Pubic relations at national level		a. Inter-agency cooperation and report for the managed routes b. Public relations at local level	
7. Administration	a. Setting of basic policy and standards for the wage structure, personnel management, welfare, etc.	a. General affairs for MMC, MO		

5.4 Service Level of Traffic Management and Operation

5.4.1 Discussion of Service Level

The function of Traffic Management and Operation is to help provide traffic safety, smooth traffic flow and users comfort on the Motorway by use of specialized devices. Traffic Management and Operations includes both software and hardware aspects.

The various facilities on motorways can be divided into two groups. The first consists of permanent facilities such as traffic guidance and protection devices. The second group consists of specialized devices concerned with traffic surveillance and control which are modified along with the changes in the road, traffic and weather conditions. Figure 5.4.1 shows the components for Traffic Management and Operations.

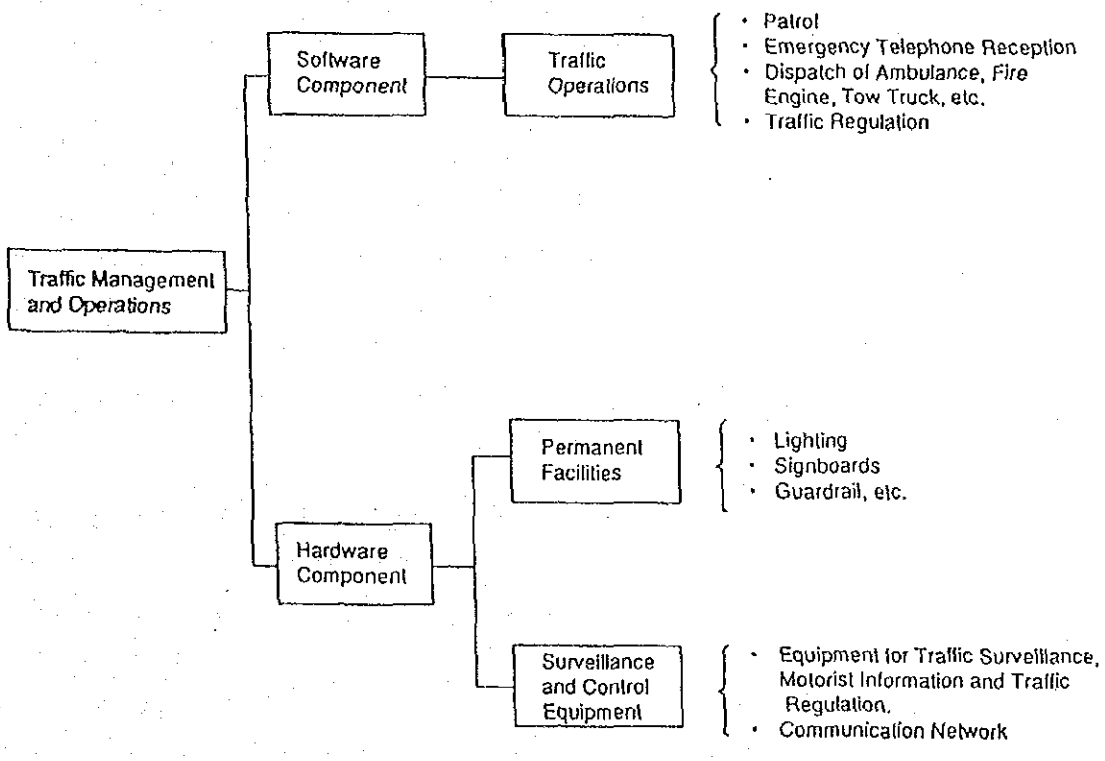


Figure 5.4.1 Components of Traffic Management and Operations

When "Service Level" of traffic management and operations is discussed, it is necessary to consider two factors. The first factor is organizational structure and the second is utilization of facilities in relation to existing conditions, future traffic demands, social demands and economic aspects.

Solving existing problems and issues related to traffic management and operations is of primary importance. For instance, if a section of motorway has no direct communication system, the responses to traffic incidents are greatly delayed. Because of this, the installation of an emergency telephone system and the strengthening of the use of traffic patrol units must be considered. If traffic accidents and the resultant loss to society are a matter of primary concern, then effective facilities must be installed on the motorways to reduce traffic accidents, irrespective of the costs.

The adoption of a comprehensive traffic management and operations system will involve major costs. Therefore, the discussion of the economic aspects of the system is necessary. For example, the more variable message signs which are installed on the motorways, the faster traffic information will be offered to the motorway users, but providing many variable message signs requires a large capital investment and high operation costs.

In order to avoid large capital investments and high operations costs, recommended service levels for a traffic management and operations system on the motorways must be reviewed based on traffic volumes and other countries' experience. Each of these levels is applied to a particular section of the motorway in response to its special characteristics such as traffic volumes, natural and physical conditions, and locations where long tunnels or bridges exist. Also, for any particular section of motorway, the service level can be upgraded gradually as conditions change. The upgrading of service levels by section according to their changing needs can help to reduce the immediate financial impacts on the KGM.

Service levels are important in how they can help determine the type of traffic management and operations system required to help remedy particular situations. Experience by other countries have dictated that to ensure that the motorways remain as open and unobstructed to traffic movement as possible, it is essential that KGM in Turkey and other countries who share the "TEM" install the necessary OMM facilities and be properly trained to operate them. Service levels are normally predicated on the occurrence of predictable traffic congestion on the motorway where traffic volumes exceed specific thresholds. The thresholds typically used for motorway traffic congestion and the need for specific types of traffic management and traffic control measures are as follows:

Service Level 1:	>10,000 pcu/day/lane	-	Traffic congestion is expected
Service Level 2:	6,000 -10,000 pcu/day/lane	-	Traffic congestion is possible
Service Level 3:	< 6,000 pcu/day/lane	-	Traffic congestion is unlikely

Note : Critical value by service level based on TEM

As might be expected, the equipment, facilities, and manpower required for Service Level 1 are the greatest, and the least for Service Level 3. It is important to assign the appropriate service levels to the appropriate segments of motorways, and not to overprotect or underprotect these motorway segments. To underprotect a given segment of motorway would create unnecessary traffic congestion and accident problems for the motorway users. To overprotect a given segment of the motorway would mean unnecessary expenditures by KGM. It is important to assign the appropriate service levels and provide the facilities that match those service levels. Starting with Service Level 3 (basic services for a traffic management and operations system) and working upwards to Service Level 1 (maximum service level provided in the most congested corridors) a brief description of the objectives of providing each service level is as follows.

Service Level 3 provides basic services and has the following objectives:

- Providing road users with a means of communications for reporting incidents or to request information
- Establishing a sophisticated communications network among the related agencies

Service Level 3 facilities includes the introduction of emergency telephones and weather detection equipment.

Service Level 2 provides an interim level of service where there are moderate levels of traffic congestion and has these additional objectives:

- Upgrading of the traffic flow monitoring function
- Upgrading of the information dissemination function to road users
- Providing road users with road condition and traffic problem information

Service level 2 facilities additionally include the introduction of traffic detectors, variable message signs and a CCTV system.

Service Level 1 provides the highest level of service where there are significant levels of traffic congestion and has the additional following objective:

- Strengthening the function of traffic surveillance, incident detection and information dissemination

Service Level 1 provides all of the facilities and services of Levels 3 and 2, but with spacing at even smaller intervals to deal with the greater levels of traffic congestion and higher probabilities of traffic accidents. In particular, at the sections having very heavy traffic volumes as Istanbul area, facilities installation for traffic management and operations should be necessary to be considered especially.

5.4.2 Establishing Service Level

According to the above-mentioned discussion, three service levels for a traffic management and operations system have been identified to match the different requirements along the motorway. The proposed Service Levels 1 - 3 are shown in Table 5.4.1.

Service Level 3

Service Level 3 is applied to sections having traffic volumes less than 6,000 pcu/day/lane. In these sections, free flow of traffic is normal and the probability of secondary incidents is almost nil. Most of the sections of the motorway in operation (except Istanbul) currently have traffic volumes corresponding to Service Level 3.

Service Level 3 has the requirements for provision of a basic traffic management and operation system.

Facilities required to provide Service Level 3 are as follows:

1) Permanent Facilities
   Traffic Guide Devices, Traffic Safety Devices, Data Processing Facilities, Communications Cable, Roadway Lighting, Power Sources.

2) Communications Facilities
   Emergency Telephones, Exclusive Telephones, Wireless System.

3) Measurement Facilities
   Vehicle Height Checkers, Axle Scales.

4) Traffic Information Gathering Facilities
   Traffic Detectors, Meteorological Information Facilities.

5) Motorist Information Facilities
   Variable Message Signs, Radio Broadcasts

Table 5.4.1 Service Level for Traffic Management and Operation System

Service Level	Characteristics of Applied Sections	Objectives	Purpose of Facilities Installation	Facilities/Equipment
Level 3	• Traffic volume lower than 6,000 pcu/day/lane.	1) Providing road users with a means of communications for reporting incidents or to request informations. 2) Establishing a sophisticated communications network among the related agencies.	1) Information gathering and dissemination on representative sections having high traffic incidents or severe weather conditions. 2) Gathering traffic conditions statistical data.	1) Permanent Facilities Traffic Guide Devices, Traffic Safety Devices, Data Processing Facilities, Communications Cable, Roadway Lighting, Power Sources. 2) Communication Facilities Emergency Telephones, Exclusive Telephones, Wireless System 3) Measurement Facilities Vehicle Height Checkers, Axle Weight Scales 4) Traffic Information Gathering Facilities Traffic Detectors, Meteorological Information Facilities 5) Motorist Information Facilities Variable Message Signs, Radio Broadcasts
Level 2	• High traffic volumes and occasional traffic congestion. • Traffic volumes 6,000 - 10,000 pcu/day/lane.	In addition to 1) and 2) above: 3) Upgrading of the traffic flow monitoring function. 4) Upgrading of the information dissemination function to road users. 5) Providing road users with road conditions and traffic problem informations.	In addition to 1) and 2) above: 3) Traffic flow monitoring by CCTV at representative points and the information gathering/dissemination.	In addition to the facilities/equipment above: * CCTV system
Level 1	• High traffic volumes causing significant traffic congestion. • Traffic volumes greater than 10,000 pcu/day/lane.	In addition to 1) through 5) above: 6) Strengthening the function of traffic surveillance, incident detection and information dissemination.	In addition to 1) through 3) above: 4) Facilities installation with spacing at even smaller intervals to deal with the greater levels of traffic congestion and high probabilities of traffic incidents, and prompt information dissemination.	Facilities/equipment are the same as Service Level 2.

Service Level 2

Level 2 will be applied for sections with high traffic volumes and occasional traffic congestion.

Traffic volumes in these sections is typically 6,000 - 10,000 pcu/day/lane. As daily traffic volumes increase above 6,000 pcu/day/lane, traffic flow can be significantly affected by delays in the handling of traffic incidents.

Facilities required to provide Service Level 2 are as follows:

In addition to the facilities at Service Level 3 above:

- CCTV system as traffic information gathering facilities

Service Level 1

This level will be adopted for sections with high traffic volumes causing significant traffic congestion. In these sections, probabilities of secondary incidents are high even if minor incidents occur. Quick and prompt countermeasures are required to minimize incidents as they cause severe congestion and adverse safety effects. Because of increasing traffic volumes and demands for higher levels of traffic safety and comfort in these sections, highly developed traffic surveillance and information facilities should be installed.

Traffic volume in these sections is typically greater than 10,000 pcu/day/lane.

Facilities required to provide Service Level 1 are the same as Service Level 2, but their installation spacings are decreased.

In the case of sections within metropolitan areas like Istanbul, an areawide traffic control system would be introduced. This is a computerized central control system to provide for the efficient utilization of the road network including the motorway in the entire urban area.

Additional Safety Facilities as Required

Special safety facilities are required for long tunnels with the length greater than 500 m. Safety facilities are provided according to the tunnel class which depends on tunnel length and traffic volumes.

Since roadways in tunnels are typically not as wide as elsewhere and space is limited, the probability of secondary incidents or fires is high once a traffic accident occurs in the tunnel. Also, traffic capacity can be significantly lowered when visibility is reduced by smoke.

Tunnel safety facilities have specific functions, such as notifying motorists of fire or traffic incidents, and the facilities are designed to reduce the probability of traffic accidents.

Additional safety facilities are required for motorway sections having severe weather conditions. These sections require extreme countermeasures to ensure traffic safety during severe weather. In particular, special countermeasures might be used on motorways during winter when many traffic restrictions and traffic accidents occur.

These additional facilities require significant amounts of weather and traffic information, facilities to provide motorists with information, and facilities for snow and ice control.

Service Level	Permanent Facilities					Toll Collection Facilities	Traffic Surveillance											
							Data Collection Facilities								Data Processing Facilities		Motorist Information Facilities	
							Communication Facilities			Measurement Facilities		Traffic Information Gathering Facilities						
	· Traffic Guide Devices	· Traffic Safety Devices	· Communications Cable	· Roadway Lighting	· Power Sources	· Toll Collection Facilities	· Emergency Telephones	· Exclusive Telephones	· Wireless System	· Vehicle Height Checker	· Axle Weight Scale	· Traffic Detectors	· CCTV System	· Meteorological Information Facilities	· CPU	· Operator's Console	· Variable Message Signs	· Radio Broadcasts
1	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2	○	○	○	○	○	○	○	○	○	○	○	✕	✕	○	○	○	✕	○
3	○	○	○	○	○	○	○	○	○	○	○	✕	—	○	—	—	✕	○

Notes : ○ Facilities on a large scale

✕ Facilities on a medium/small scale

Figure 5.4.2 Facilities/Equipment Corresponding to Service Level

5.5. Basic Plan for Traffic Management and Operation

In accordance with the previous discussion of service levels, the basic plan for traffic management and operations on the future 3,000 km motorway network in Turkey is described in the following paragraphs.

Segmentation of the future motorway network is described in Section 5.5.1, and is a result of the determination of the appropriate service levels defined for each segment of the motorway as defined by future traffic volumes, historic weather conditions or proven landslide locations, the identification of motorway sections with long tunnels, etc.

The application of service levels in relation to specific motorway segments is described in Section 5.5.2, and the basic plan for traffic management and operations is described in the sections that follow.

5.5.1. Segmentation of the Future Motorway Network

The conditions considered for defining the segments of the future motorway network according to specific service levels and additional safety facilities required for special conditions are as follows:

- future traffic volumes
- historic weather conditions along the Motorway
- locations of motorway with long tunnels (longer than 500m)
- locations of motorway subject to closure because of natural disasters

Future traffic volumes on the motorway network are shown in Figure 5.5.1 and Figure 5.5.2. The only section of motorway having predicted traffic volumes greater than 60,000pcu/day by the year 2000 is the section of the Kinali-Sakarya Motorway from the Catalca I.C. to the Izmit Dogu I.C. In particular, the section of the Kinali-Sakarya Motorway from the Avcilar I.C. to the Hereke I.C. will carry traffic volumes totalling(all lanes) greater than 100,000pcu/day. By the year 2010, sections of the motorway with traffic volumes greater than 60,000pcu/day are the Cerkezkoy I.C.-Hendek I.C., the Izmir I.C.-Zeytinler I.C. (Izmir-Cesme Motorway), the Izmir I.C.-Aydin I.C. and the section of motorway between the Mersin I.C.-Tarsus I.C.

Weather conditions along the motorway are shown in Figures 5.5.3 to 5.5.5. The weather conditions shown help define the appropriate measures which must be taken to counteract anticipated problems on the motorway, as follows:

- Fog-Near Edirne in the Edirne-Kinali section

- Fog and Snow/Ice-In the Sakarya-Bolu-Ankara section
- Snow/Ice-In the Ankara-Pozanti section
- Rain and Snow/Ice-Near Pozanti
- Rain-Near Manisa and the Balikesir provincial boundary in the Izmir-Bursa section, the Izmir-Salihli section, the Toprakkale-Gaziantep section, the Toprakkale-Iskendrun section and in the Antalya-Alanya section

The locations of motorway with tunnels longer than 500m are shown in Figure 5.5.6. There are nine (9) long tunnels on the motorway in operation or currently under construction.

It can be seen in Figure 5.5.7 that the occurrence of landslides are common in the Bolu province along the motorway, and flooding is possible near Pozanti. It can also be seen in Figure 5.5.7 that road closures caused by excessive snowfall are common to many locations in Turkey.

Based on the information mentioned above, the future motorway network should be divided into 27 clearly defined segments. These proposed segments are shown in Figure 5.5.8 and Table 5.5.1.

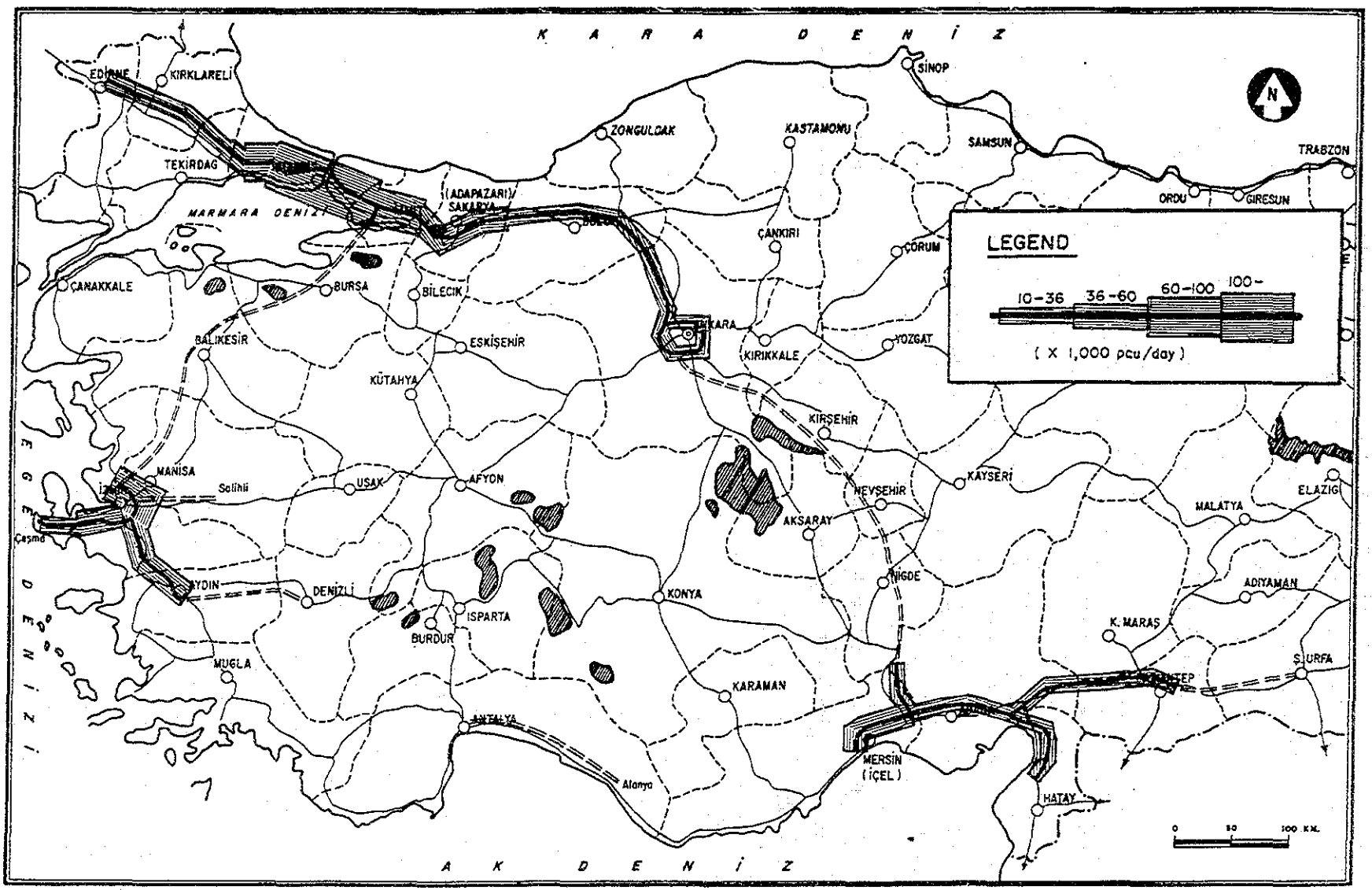


Figure 5.5.1 Future Traffic Volumes on Motorway (in 2000)

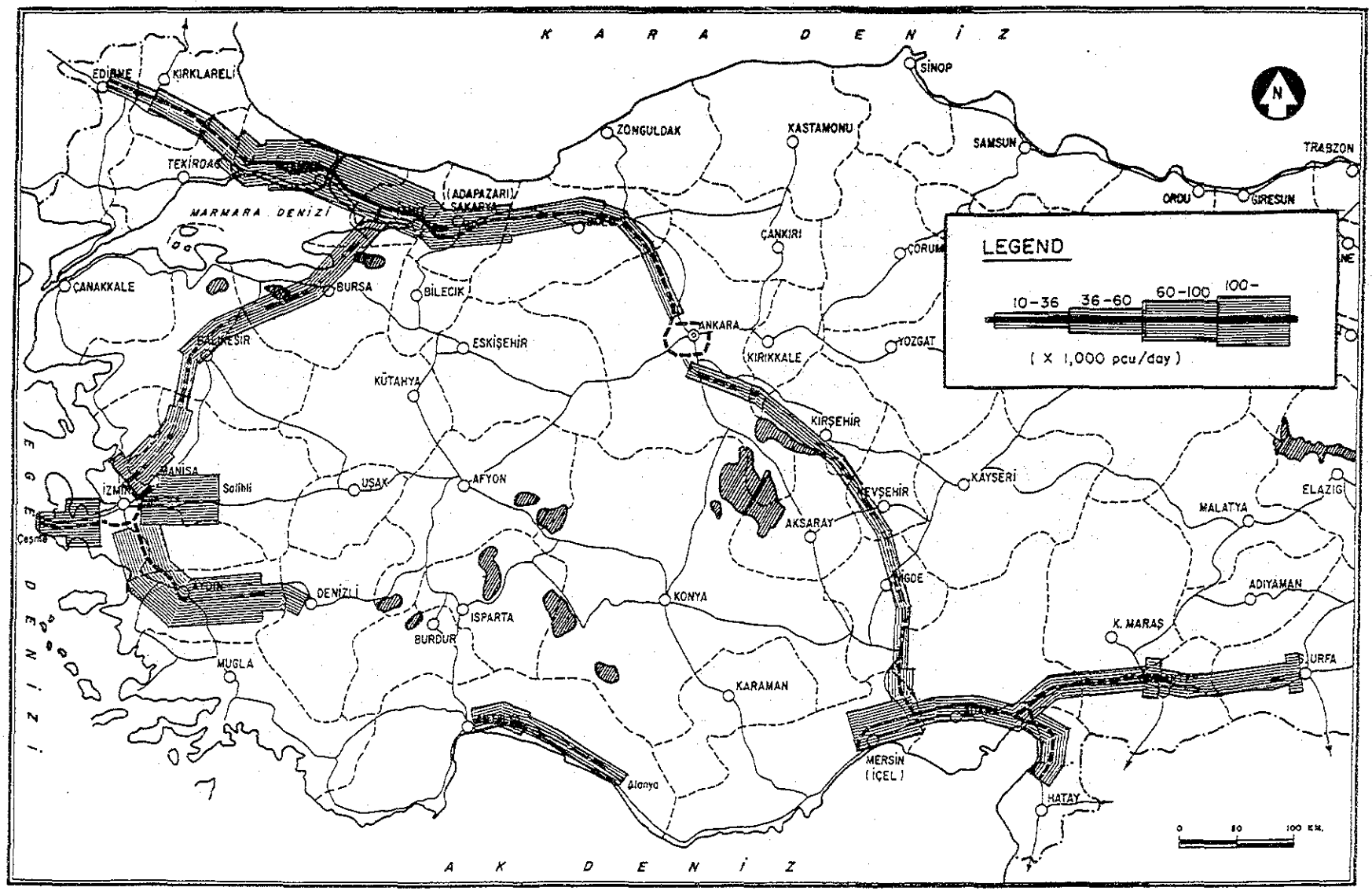


Figure 5.5.2 Future Traffic Volumes on Motorway (in 2010)

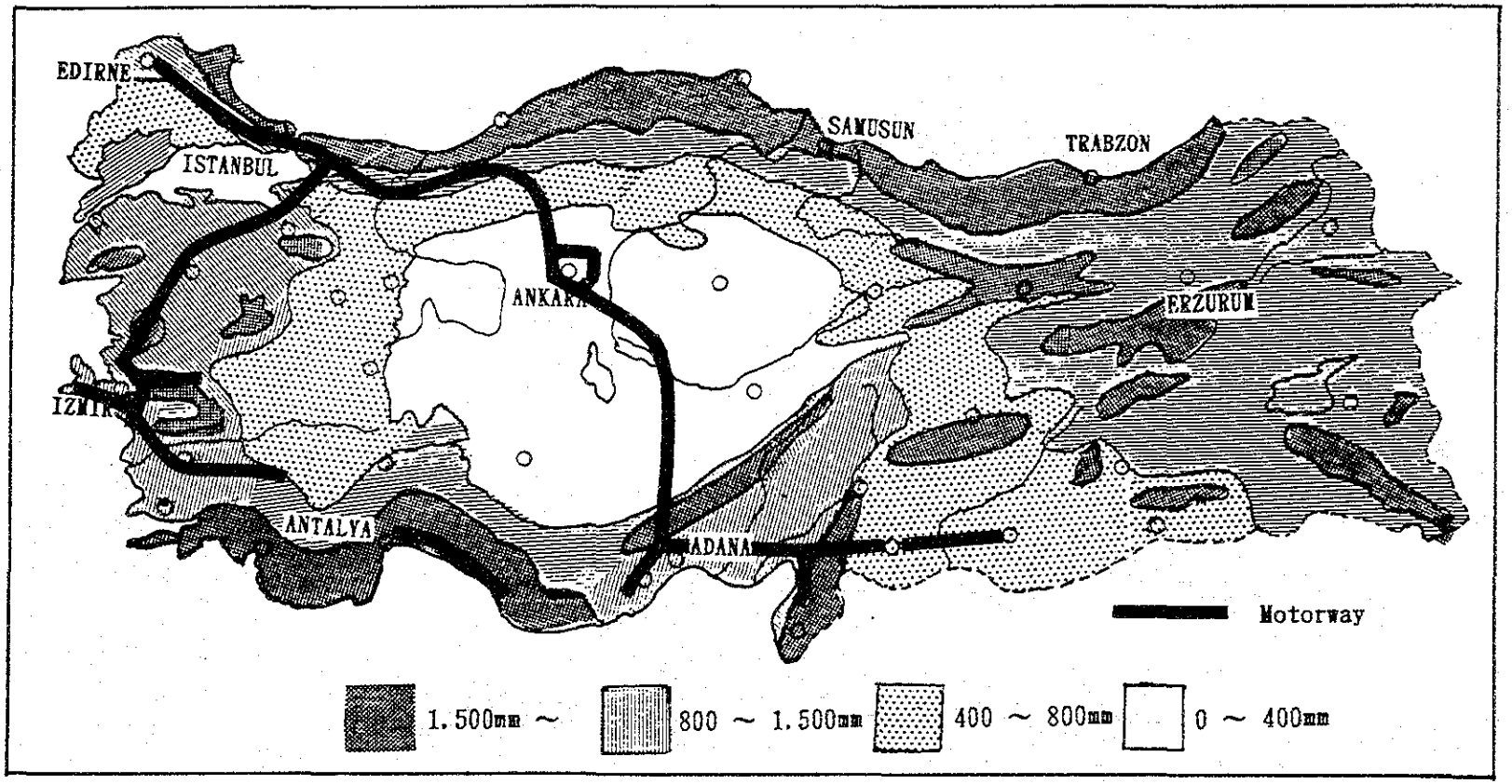


Figure 5.5.3 Annual Average Rainfall Amounts along the Motorways

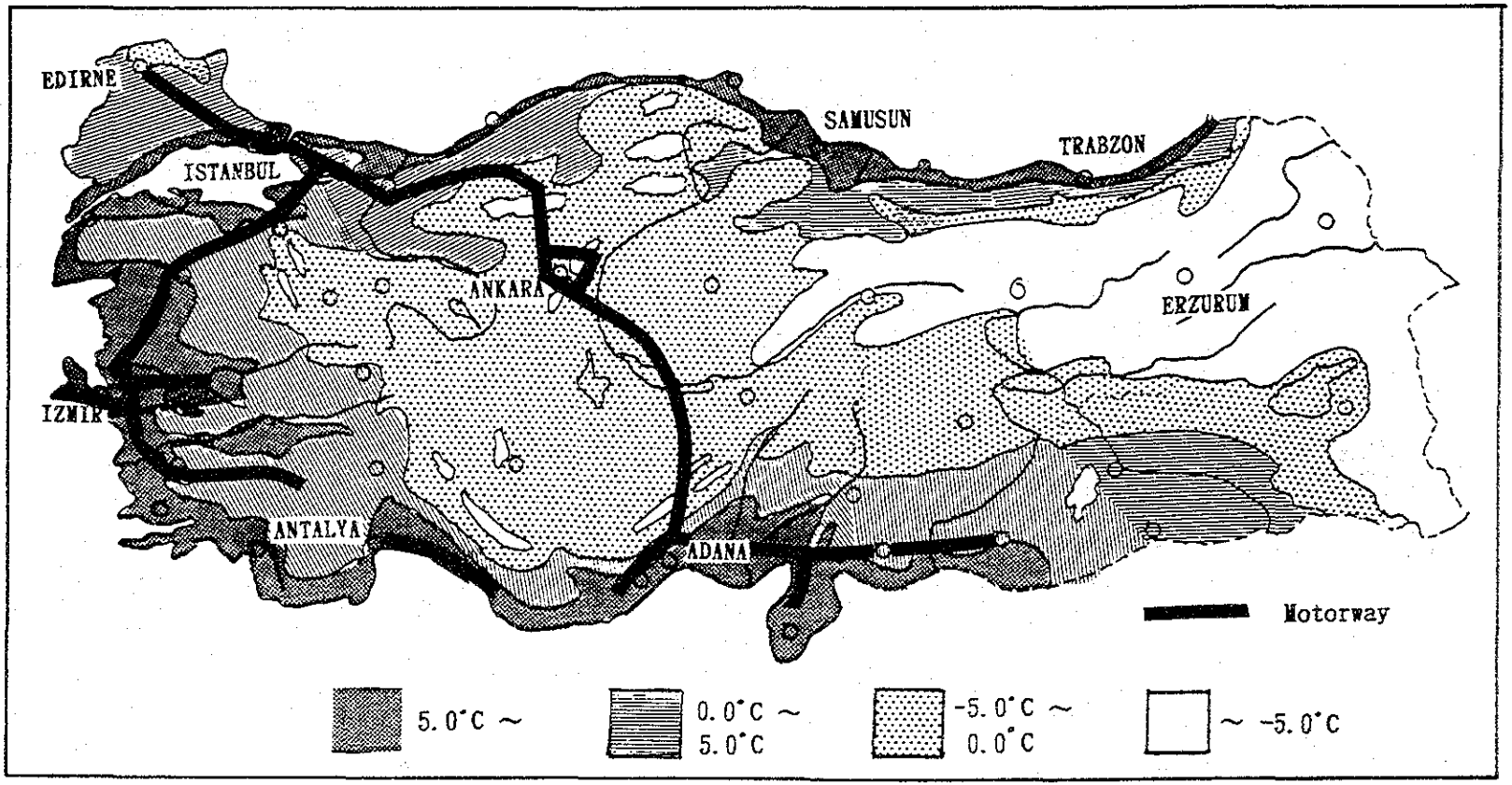


Figure 5.5.4 Average Temperature (January) along the Motorways

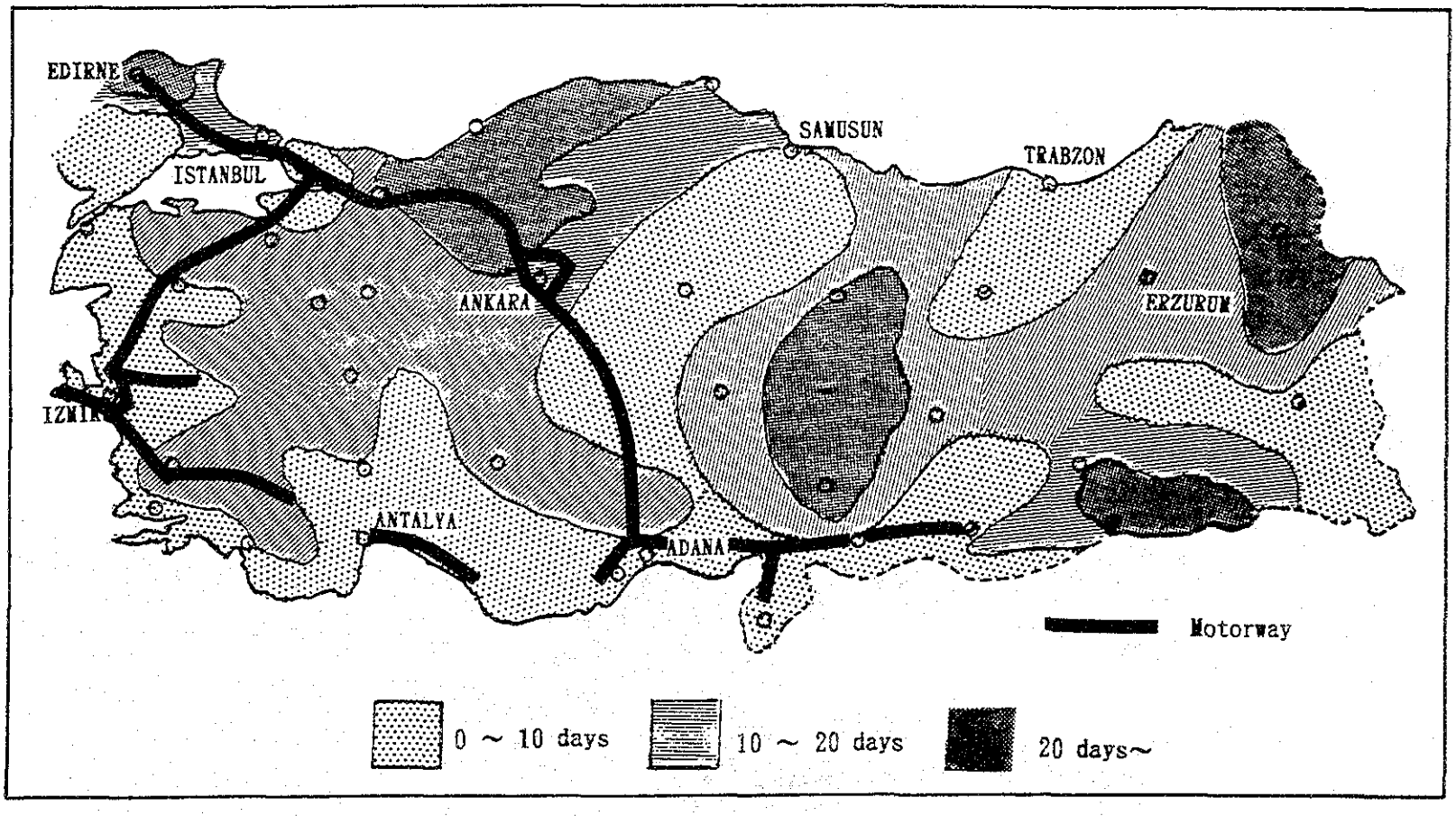


Figure 5.5.5 Annual Numbers of Foggy Days along the Motorways

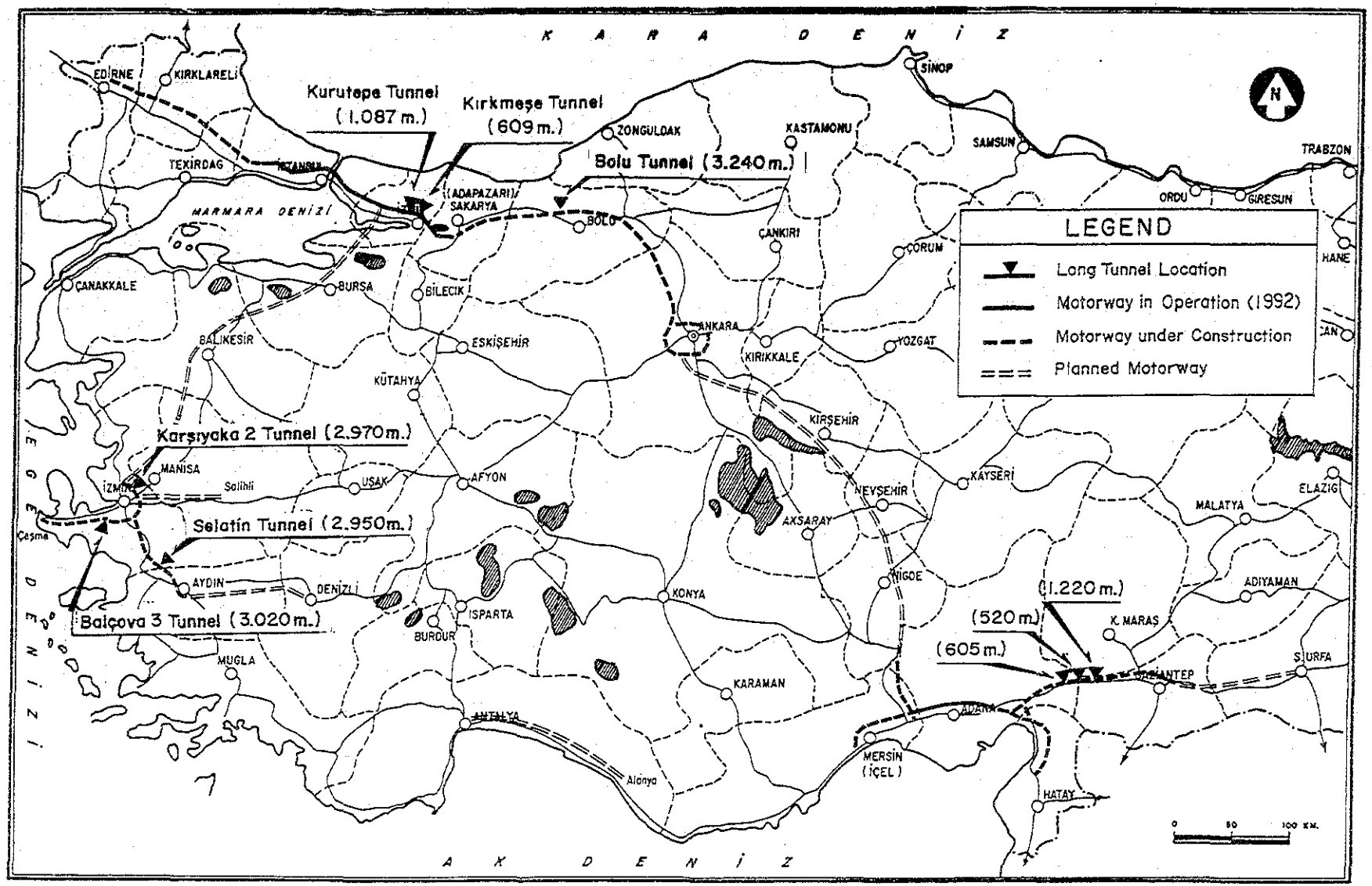
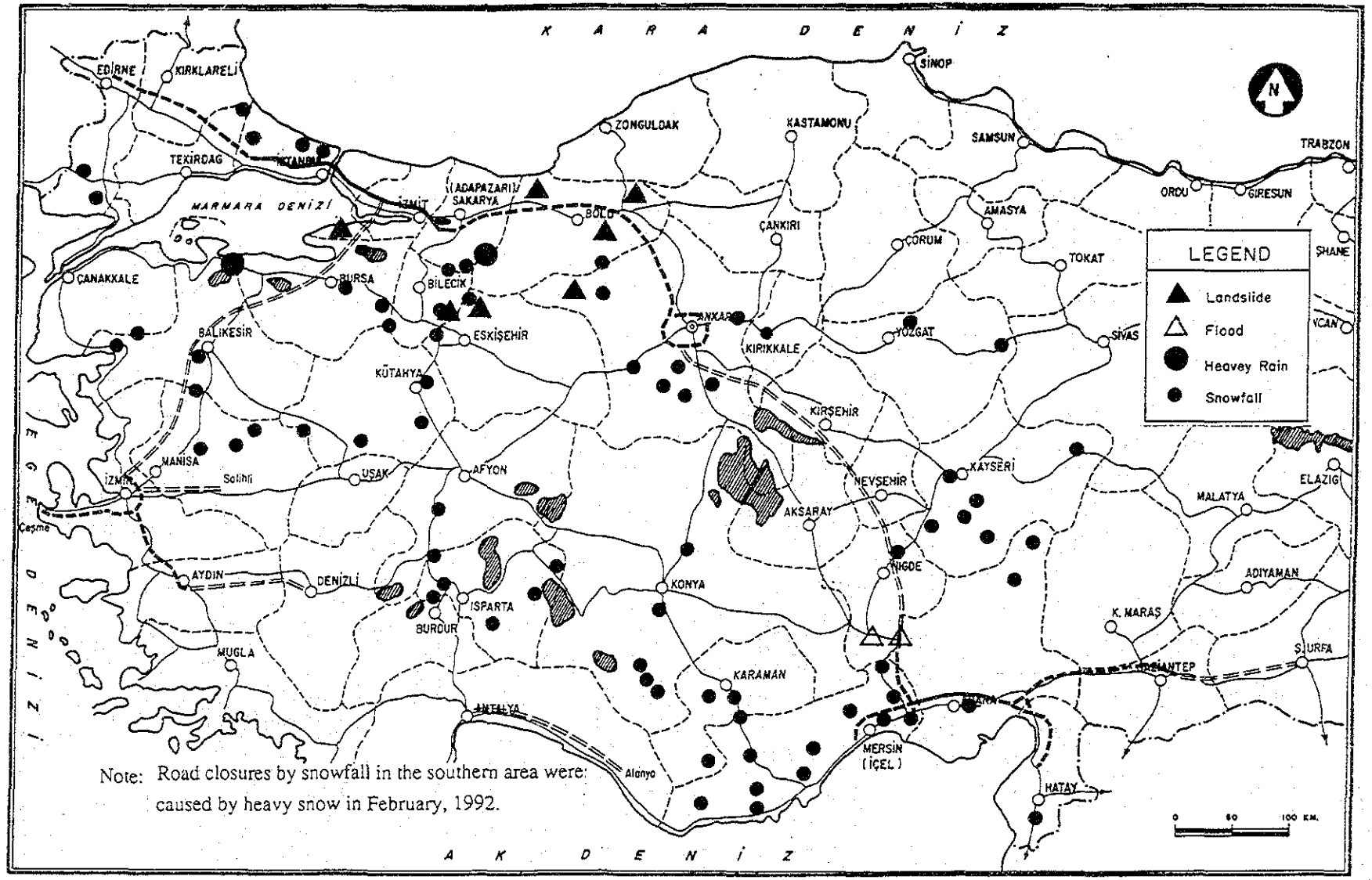


Figure 5.5.6 Long Tunnel Locations (excluding Planned Motorways)



Note: Road closures by snowfall in the southern area were caused by heavy snow in February, 1992.

Figure 5.5.7 Locations of Road Closure Caused by Natural Disasters (January, 1989-March, 1992)

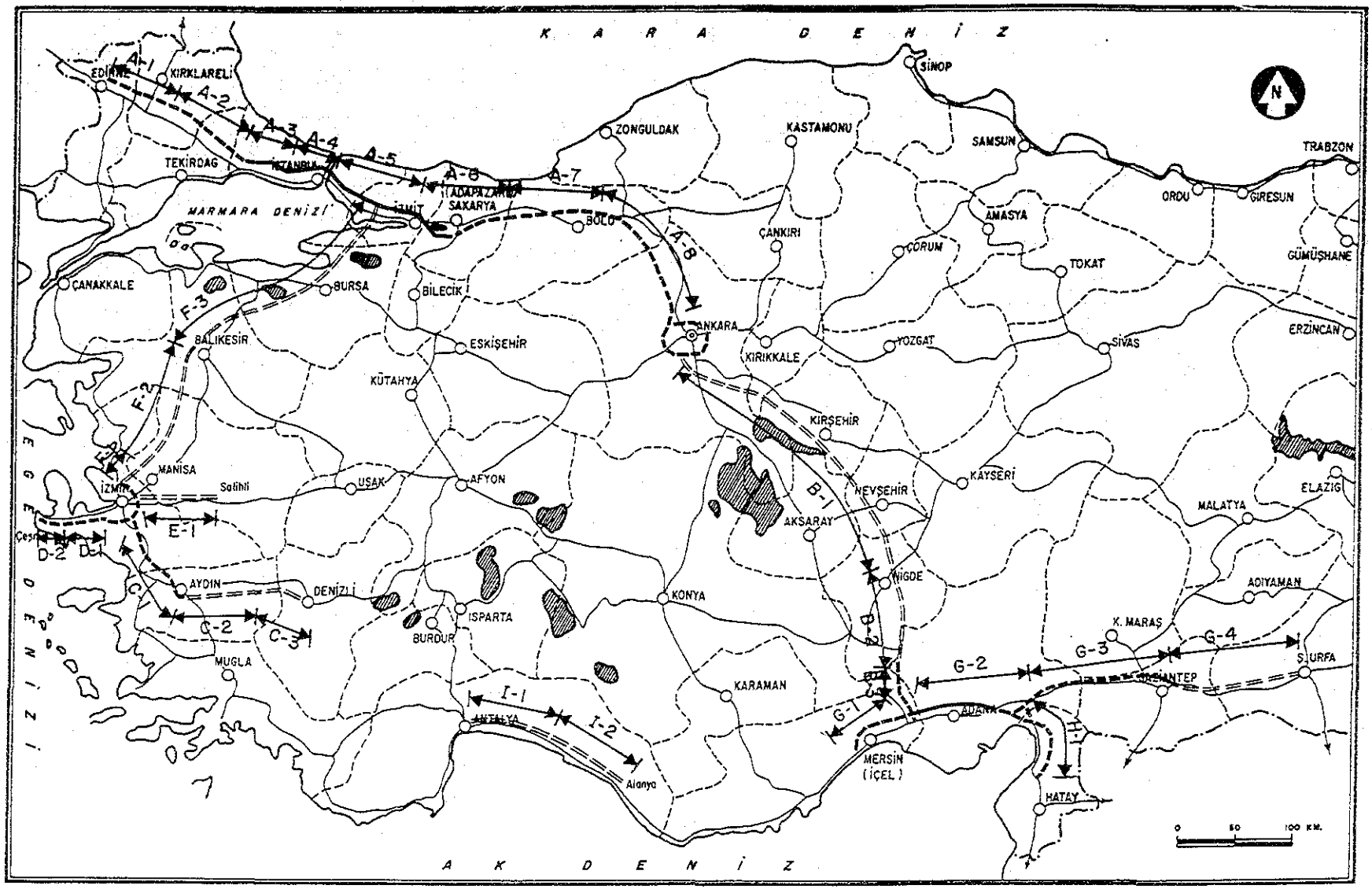


Figure 5.5.8 Segmentations of the Motorway Networks

Table 5.5.1 Segmentations and Applications of Service Level on Motorway Networks

Section No.	Section	Distance (Km)	Traffic Volume (x 1,000 pcu/day)		Weather Condition	Long Tunnel	Record of Natural Disaster	Service Level	
			2000	2010				Short Term (1,500 km)	Long Term (3,000 km)
A-1	Edirne - Babaeski	73.0	-36	-36	Fog	-	-	3	3
A-2	Babaeski - Cerkezkoy	90.0	-36	36-60	-	-	-	3	2
A-3	Cerkezkoy - Catalca	54.0	36-60	60-	-	-	-	2	1
A-4	Catalca - Istanbul	69.5	60-	60-	-	-	-	1	1
A-5	Istanbul - Kandira	87.5	60-	60-	-	*	-	1	1
A-6	Kandira - Hendek	67.8	36-60	60-	Fog	-	-	2	1
A-7	Hendek - Caydurt	100.9	-36	36-60	Fog, Snow/Ice	*	Landslide	3	2
A-8	Caydurt - Ankara	262.2	-36	-36	Fog, Snow/Ice	-	-	3	3
B-1	Ankara - Nigde	-	-	-36	Snow/Ice	-	Snowfall	-	3
B-2	Nigde - Pozanti	-	-	-36	Rain, Snow/Ice	-	Flood, Snowfall	-	3
B-3	Pozanti - Tarsus	59.6	-36	36-60	Rain, Snow/Ice	-	Flood, Snowfall	3	2
C-1	Izmir - Aydin	126.0	36-60	60-	-	*	-	2	1
C-2	Aydin - Buharkent	-	-	60-	-	-	-	-	1
C-3	Buharkent - Denizli	-	-	36-60	-	-	-	-	1
D-1	Izmir - Zeytinler	43.6	36-60	60-	-	-	-	2	1
D-2	Zeytinler - Cesme	27.9	-36	36-60	-	-	-	2	1
E-1	Izmir - Salihli	-	-	60-	Rain	-	-	-	1
F-1	Izmir - Manisa	-	-	60-	-	-	-	-	1
F-2	Manisa - Balikesir	-	-	36-60	Rain	-	Snowfall	-	2
F-3	Balikesir - Gebze	-	-	36-60	-	-	Landslide	-	2
G-1	Mersin - Tarsus	58.6	36-60	60-	-	-	Snowfall	2	1
G-2	Tarsus - Toprakkale	110.5	-36	36-60	-	-	Snowfall	3	2
G-3	Toprakkale - Gaziantep	144.8	-36	36-60	Rain	*	-	3	2
G-4	Gaziantep - S. Ulfa	-		36-60	-	-	-	-	2
H-1	Toprakkale - Iskendern	90.4	-36	36-60	Rain	-	-	3	2
I-1	Antalya - Manavgat	-	-	36-60	Rain	-	-	-	2
I-2	Manavgat - Alanya	-	-	-36	Rain	-	-	-	3

Notes : 1. Service level of the short-term program includes 1,500 km of motorways, and traffic volumes in the year 2000.
2. Service level of the long-term plan includes 3,000 km of motorways, and traffic volumes in the year 2010.
3. Distance (-) shows that section distance is not yet determined.

5.5.2. Application of Service Levels

Following the previous discussions relating to segmentation of the future motorway network, specific recommended service levels corresponding to each segment can be determined. The results of these recommended service levels are shown in Figures 5.5.9 and 5.5.10, and in Table 5.5.1. They also illustrate how these recommended service levels can be used to help determine a staging plan for providing OMM facilities on the motorways.

Sections A-7 and G-3, which have a combination of severe weather conditions and long tunnels require a special application of traffic operations procedures. Section A-7, in particular, will require special traffic patrol procedures because of historic records of landslides. In those sections where Service Level 1 is applied, measures to help mitigate the traffic congestion expected with traffic incidents are necessary.

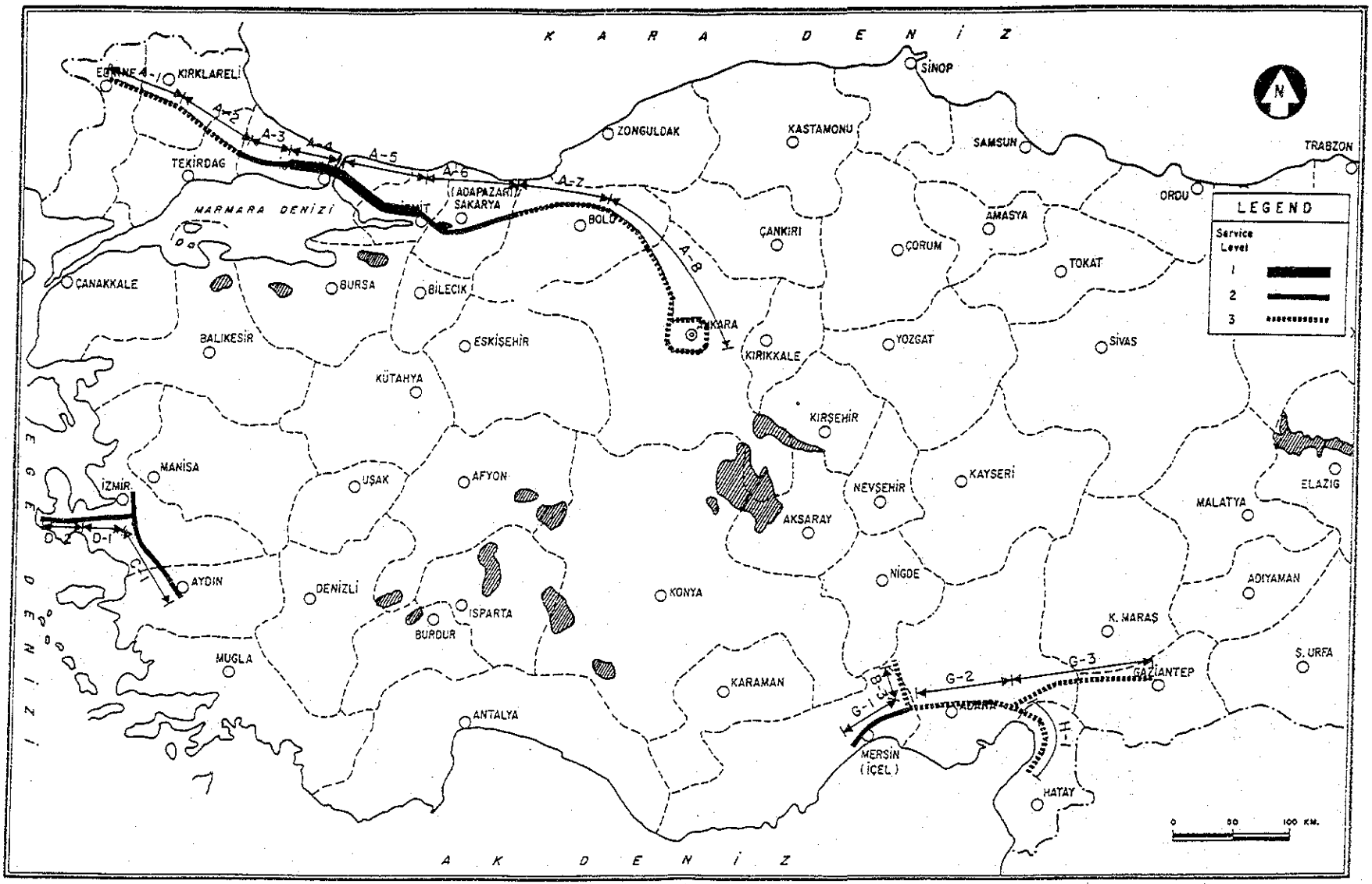


Figure 5.5.9 Application of Service Level (Short-term)