



COMPREHENSIVE  
TRANSPORTATION PLAN  
IN THE MUNICIPALITY OF  
MANAGUA  
IN THE REPUBLIC OF  
NICARAGUA

Final Report  
Main Text

JICA LIBRARY  
  
J1148344 [3]

March 1999

ALMEC CORPORATION  
YACHIYO ENGINEERING CO. LTD.

SSF

99-015(1/2)

**EXCHANGE RATES USED (C\$ / US\$)**

1990	1.00
1991	5.00
1992	5.00
1993	6.12
1994	6.72
1995	7.53
1996	8.44
1997	9.45
1998	10.50

COMPREHENSIVE  
TRANSPORTATION PLAN  
IN THE MUNICIPALITY OF  
MANAGUA  
IN THE REPUBLIC OF  
NICARAGUA

Final Report  
Main Text

March 1999

ALMEC CORPORATION  
YACHIYO ENGINEERING CO. LTD.



1148344 (3)

# FINAL REPORT

## Table of Contents

<b>1. Introduction</b>	
1.1 Study Framework .....	1-1
1.2 Study Organization .....	1-1
<b>2. Analysis On Urban Transportation Problems</b>	
2.1 Natural Conditions .....	2-1
2.1.1 Topography and Geology .....	2-1
2.1.2 Climate .....	2-2
2.1.3 Volcanoes and Earthquake .....	2-3
2.2 Socio-Economic Characteristics .....	2-7
2.2.1 Basic Indicators .....	2-7
2.2.2 Population .....	2-7
2.2.3 Economy .....	2-11
2.2.4 Land Use .....	2-15
2.2.5 Vehicles Ownership .....	2-17
2.2.6 Governmental Expenditure .....	2-24
2.3 Transportation Demand .....	2-25
2.3.1 Number of Trips .....	2-25
2.3.2 Trip Purpose and Transportation Mode .....	2-26
2.3.3 Generation and Attraction .....	2-30
2.3.4 Trip Distribution .....	2-33
2.3.5 Travel Time .....	2-33
2.4 Roads and Road Traffic .....	2-37
2.4.1 Road Network Configuration .....	2-37
2.4.2 Road Characteristics .....	2-39
2.4.3 Traffic Volume .....	2-44
2.4.4 Traffic Characteristics .....	2-44
2.4.5 Travel Speed .....	2-49
2.5 Public Transportation System .....	2-51
2.5.1 Bus Routes .....	2-51
2.5.2 Bus Operational Characteristics .....	2-51
2.5.3 Number of Bus Passengers .....	2-54
2.5.4 Utilization of Bus Units .....	2-54
2.5.5 Bus Terminal .....	2-57
2.5.6 Taxi .....	2-57
2.5.7 Regulations on Public Transportation .....	2-59

2.6	Traffic Management.....	2-61
2.6.1	Intersection Management.....	2-61
2.6.2	Parking.....	2-64
2.6.3	Road Traffic Management.....	2-65
2.7	Traffic Safety.....	2-70
2.7.1	Historical Trend of Traffic Accidents.....	2-70
2.7.2	Type and Cause of Traffic Accidents.....	2-71
2.8	Environmental Aspects.....	2-73
2.8.1	Air Pollution.....	2-73
2.8.2	Noise Level.....	2-81
<b>3.</b>	<b>Urban Transportation Policies</b>	
3.1	Review of Existing Plans.....	3-1
3.1.1	Master Plan of Central Area of Managua.....	3-1
3.1.2	General Plan of Urban Development of Managua (PGDU).....	3-3
3.1.3	Regulatory Plan of Managua.....	3-3
3.1.4	Road Projects.....	3-4
3.2	Urban / Transportation Policies.....	3-7
3.2.1	Overview of Managua's Urban Transportation.....	3-7
3.2.2	Concept of Network Structure.....	3-9
3.2.3	Urban Transportation Strategies.....	3-17
<b>4.</b>	<b>Future Socio-Economic Framework</b>	
4.1	Future Socio-Economic Prospect of Nicaragua.....	4-1
4.1.1	Population.....	4-1
4.1.2	Gross Domestic Product by Sector.....	4-2
4.1.3	Labor Force and Employment.....	4-3
4.2	Future Socio-Economic Framework of Managua.....	4-5
4.2.1	Population and Vivienda.....	4-5
4.2.2	Gross Regional Domestic Product by Sector.....	4-6
4.2.3	Labor Force and Employment.....	4-8
4.2.4	School Enrolment.....	4-9
4.2.5	Income Level and Car Ownership.....	4-11

<b>5. Traffic Demand Forecast Model and Its Application to Alternative Development Scenarios</b>	<b>Master Plan</b>
5.1 Model Development.....	5-1
5.1.1 Basic Approach.....	5-1
5.1.2 Trip Production Model .....	5-4
5.1.3 Trip Generation / Attraction Model .....	5-5
5.1.4 Trip Distribution .....	5-14
5.1.5 Modal Choice Model .....	5-14
5.1.6 Traffic Assignment Model.....	5-18
5.2 Alternative Development Scenarios.....	5-19
5.2.1 Considerations for Formulating Alternative Scenarios.....	5-19
5.2.2 Alternative Scenarios.....	5-21
5.3 Future Socio-Economic Features by Development Scenarios .....	5-29
5.3.1 Population Distribution.....	5-29
5.3.2 Employment Distribution .....	5-31
5.3.3 Zones Attracting Students.....	5-33
5.3.4 Income Level and Car Ownership .....	5-35
5.4 Model Application to Alternative Development Scenarios.....	5-38
5.4.1 Trip Production .....	5-38
5.4.2 Trip Generation and Attraction.....	5-38
5.4.3 Trip Distribution .....	5-38
5.4.4 Modal Choice.....	5-43
5.4.5 Traffic Assignment .....	5-43
5.5 Most Realistic Urban Development Scenario .....	5-45
5.5.1 Comparison of Traffic Situation .....	5-45
5.5.2 Selection of Most Realistic Development Scenario.....	5-45
<b>6. Fund Sources and Possible Investment Amount</b>	
6.1 Possible Investment Amount by Existing Sources.....	6-1
6.1.1 Past Trends.....	6-1
6.1.2 Estimate of Possible Future Investment on Transportation Sector of Managua .....	6-3
6.2 Possible New Fund Sources .....	6-6
6.2.1 Existing Taxes and Duties with Increased Rates .....	6-6
6.2.2 New Fund Sources .....	6-12

## 7. Master Plan

7.1 Land Use Plan.....	7-1
7.1.1 Development Concept .....	7-1
7.1.2 Land Use Plan .....	7-1
7.2 Road Network Development .....	7-8
7.2.1 General .....	7-8
7.2.2 Evaluation of Existing Road Network .....	7-9
7.2.3 Desirable Future Road Network and Hierarchy.....	7-12
7.3 Public Transportation .....	7-26
7.3.1 General .....	7-26
7.3.2 Development of Public Transportation Corridor .....	7-27
7.3.3 Diversification and Upgrading of Public Transportation Services.....	7-38
7.3.4 Improvement of Public Transportation Terminals.....	7-48
7.4 Enhanced Traffic Management .....	7-52
7.4.1 General .....	7-52
7.4.2 Intersection Improvement.....	7-53
7.4.3 Development of Space for Pedestrians and Bicycles.....	7-58
7.4.4 Transportation Demand Management (TDM).....	7-60
7.4.5 Determination of Truck Routes.....	7-67

## 8. Project Evaluation

8.1 Project Packages.....	8-1
8.1.1 Road Development Projects .....	8-1
8.1.2 Public Transportation Projects .....	8-1
8.1.3 Traffic Management Projects .....	8-6
8.2 Economic Evaluation .....	8-7
8.2.1 Approach and Assumptions.....	8-7
8.2.2 Evaluation of Entire Master Plan .....	8-14
8.2.3 Road Project Package .....	8-17
8.2.4 Travesia Toll Road Project.....	8-19
8.2.5 Public Transportation Corridor Project.....	8-21
8.3 Financial Evaluation.....	8-23
8.3.1 Travesia Project (Toll Road) .....	8-23
8.3.2 Public Transportation Corridor.....	8-25
8.3.3 Public Transportation Terminal.....	8-28



8.4 Initial Environmental Examination (IEE).....	8-30
8.4.1 Study Flow and Environmental Items of IEE Study.....	8-30
8.4.2 Summary of Environmental Issues and Examinations .....	8-31
8.4.3 Results of Initial Environmental Examination.....	8-42
8.4.4 Overall Evaluation .....	8-44
8.4.5 EIA system in Nicaragua.....	8-46
<b>9. Implementation Program</b>	
9.1 Investment Program.....	9-1
9.2 Fund Source.....	9-8
<b>10. Conclusion and Recommendations</b>	
10.1 Conclusion .....	10-1
10.2 Recommendations .....	10-2

## List of Tables

Table 2.1.1	Meteorological Data of Managua	2-3
Table 2.1.2	Volcanoes in the Pacific Lowlands	2-4
Table 2.1.3	Seismic Faults in Managua City	2-4
Table 2.2.1	Basic Indicators of Nicaragua, 1995	2-7
Table 2.2.2	Annual Growth Rate of Population and Population Density by Department	2-8
Table 2.2.3	Population by Age Group and Sex in Managua Municipality, 1995	2-9
Table 2.2.4	Population by Economic Activity and Sex in Managua Municipality, 1995	2-9
Table 2.2.5	Population by Occupation and Sex in Managua Municipality, 1995	2-10
Table 2.2.6	Gross Domestic Product by Sector (Current Price: C\$ million)	2-11
Table 2.2.7	Growth of GDP by Industrial Sector (Constant Price of 1980)	2-11
Table 2.2.8	Balance of Payment (Million US\$)	2-13
Table 2.2.9	Exchange Rate	2-13
Table 2.2.10	Consumer Price Index	2-13
Table 2.2.11	Consumer Price of Petroleum Goods	2-14
Table 2.2.12	Population by Industrial Sector, 1995	2-14
Table 2.2.13	Average Nominal and Real Monthly Salary	2-15
Table 2.2.14	Land Use Distribution of Managua Municipality	2-15
Table 2.2.15	Location of the Major Industry in Managua Municipality	2-17
Table 2.2.16	Past Trends of Registered Vehicles	2-18
Table 2.2.17	Number of Registered Vehicles by Department, 1994	2-20
Table 2.2.18	Comparison of Car Ownership of Nicaragua with Other Countries, 1996	2-21
Table 2.2.19	Car Ownership and No. of Owned Cars by District, 1998	2-21
Table 2.2.20	Car Ownership by Average Income Level, 1998	2-22
Table 2.2.21	Revenue of Central Government	2-24
Table 2.2.22	Expenditure of Central Government	2-24
Table 2.3.1	Number of Trips Traveled in the Study Area, 1998	2-25
Table 2.3.2	Number of Person Trips by Direction and Type of Vehicle, 1998	2-26
Table 2.3.3	Number of Person Trips by Trip Purpose, 1998	2-26
Table 2.3.4	Number of Person Trips by Transportation Mode, 1998	2-28
Table 2.3.5	Average Trip Time by Mode, 1998	2-33
Table 2.3.6	Number of Trips Generated by Hour, 1998	2-36
Table 2.3.7	Number of Trips Attracted by Hour, 1998	2-36
Table 2.4.1	Functional Classification of Urban Road System	2-38
Table 2.4.2	Length of Roads by Road Classification in Managua, 1998	2-39
Table 2.4.3	Vehicle Composition (24 hours/both directions), 1998	2-44
Table 2.4.4	Traffic Volume by Vehicle Type and by Hour (Pista Juan Pablo II)	2-47

Table 2.4.5	Ratio of Daytime/Nighttime Traffic (12/24 hours), 1998	2-48
Table 2.4.6	Ratio of Peak-hour Traffic, 1998	2-49
Table 2.5.1	Existing Bus Routes, 1998	2-52
Table 2.5.2	Occupancy and Load Factor of Buses, 1998	2-54
Table 2.5.3	No. of Bus Passengers by Route, 1998	2-55
Table 2.5.4	Utilization of Bus Units by Company/Cooperative, 1998	2-56
Table 2.5.5	Number of Bus Terminals by Function and Location, 1998	2-57
Table 2.5.6	Characteristics of Taxi Operation and Taxi Drivers at Selected Location, 1998	2-59
Table 2.7.1	Number of Traffic Accidents by Department (1993 to 1997)	2-71
Table 2.7.2	Number of Accidents by District in Managua Department in 1997	2-71
Table 2.7.3	Type of Traffic Accidents, 1997	2-72
Table 2.7.4	Causes of Accidents, 1997	2-72
Table 2.8.1	NO <sub>2</sub> Concentration in Managua, 1998	2-73
Table 2.8.2	NO <sub>x</sub> Concentration in Managua, 1998	2-75
Table 2.8.3	SO <sub>2</sub> Concentration in Managua, 1998	2-76
Table 2.8.4	SPM in Managua, 1998	2-77
Table 2.8.5	Summary of Air Pollution Survey Results (1) Proyecto Aire Puro by ProEco, 1996	2-80
Table 2.8.6	Summary of Air Pollution Survey Results (2) Proyecto Aire Puro by ProEco, 1996	2-80
Table 2.8.7	Noise Level (A8), 1998	2-81
Table 2.8.8	Noise Level (B6), 1998	2-81
Table 2.8.9	Noise Level (C2)-a, 1998	2-82
Table 2.8.10	Noise Level (C2)-b, 1998	2-83
Table 2.8.11	Noise Level (D5), 1998	2-83
Table 2.8.12	Road Traffic Noise Regulations in Different Countries, Emission Values for Residential Areas in dB (A)	2-85
Table 3.1.1	Demographic Parameters and Area of Construction by Scenario	3-1
Table 3.1.2	Road Projects of Managua (Not defined in the field)	3-4
Table 3.1.3	Road Projects of Managua (Defined in the field)	3-6
Table 3.2.1	Existing Roads by Classification, 1997	3-13
Table 4.1.1	Future Population of Nicaragua	4-1
Table 4.1.2	Short-Term Projections of GDP by BCN, 1998-2003	4-2
Table 4.1.3	Future Projections of GDP, 1998-2018	4-2
Table 4.1.4	Labour Force and Employment, 1995	4-3
Table 4.1.5	Estimated Productivity by Sector (at 1980 prices), 1995	4-3
Table 4.1.6	Future Projection of Labor Force	4-3

Table 4.1.7	Future Projection of Employment Situation, 1998-2018	4-4
Table 4.2.1	Managua's Share of Population to Nicaragua, 1971 and 1995	4-5
Table 4.2.2	Future Projection of Population, 1998-2018	4-5
Table 4.2.3	Number of Persons per Vivienda by Type	4-5
Table 4.2.4	Future Projection of Number of Viviendas, Managua 1998-2018	4-6
Table 4.2.5	Estimation of GRDP of Managua in 1998	4-6
Table 4.2.6	Comparison between GRDP and GDP, 1998	4-7
Table 4.2.7	Future Projection of GRDP of Managua by Sector, 1998-2018	4-7
Table 4.2.8	Employed Persons by Sector and Place of Work, Managua, 1998	4-8
Table 4.2.9	Future Projection of Labour Force Supply, Managua, 1998-2018	4-8
Table 4.2.10	Future Projection of Labour Force Demand by Sector, Managua, 1998-2018	4-9
Table 4.2.11	Future Projection of Demand/Supply Balance of Labour Force, Managua, 1998-2018	4-9
Table 4.2.12	School Attendance in 6-29 Year Group, Nicaragua, 1963, 1971 and 1995	4-9
Table 4.2.13	Rate of Initial Enrolment by Educational Stage, Nicaragua, 1992-1997	4-10
Table 4.2.14	School Enrolment of Managua by Census and P.T. Survey	4-10
Table 4.2.15	Future Projection of Number of Students	4-10
Table 5.1.1	Trip Production Rate by Sex, 1998	5-4
Table 5.1.2	Trip Production Rate by Age Group, 1998	5-4
Table 5.1.3	Trip Production Rate by Car Ownership, 1998	5-4
Table 5.1.4	Trip Production Rate by Economic Activity, 1998	5-4
Table 5.1.5	Trip Generation/Attraction Model Parameters	5-6
Table 5.1.6	Intra-zonal Trip Model Parameters	5-11
Table 5.1.7	Trip Distribution Model Parameters	5-14
Table 5.1.8	Parameters of Modal Choice Model (I)	5-15
Table 5.1.9	Parameters of Modal Choice Model (II)	5-16
Table 5.2.1	Distribution of Population, 1998	5-19
Table 5.2.2	Result of Sample Survey on Land and Floor Area for Selected Establishments, 1998	5-20
Table 5.2.3	Land Use Comparison of Alternative Scenarios, 2018	5-28
Table 5.3.1	Distribution of Population by Scenario, 2018	5-29
Table 5.3.2	Distribution of Employment by Scenario, 2018	5-31
Table 5.3.3	Distribution of Students at School Place by Scenario, 2018	5-33
Table 5.3.4	Income Level and Car Ownership by Scenario, 2018	5-35
Table 5.4.1	Estimated Trip Production, 2018	5-38
Table 5.4.2	Average Trip Length and Trip Distance by Land Use Alternative, 2018	5-41
Table 5.4.3	Modal Choice by Development Alternative, 2018	5-43
Table 5.5.1	Comparison of Traffic Situation of Development Scenarios	5-45

Table 6.1.1	Actual Investment Amount by Sector, Public Investment Program of Nicaragua. . . . .	6-1
Table 6.1.2	Composition of Fund Sources in Actual Investment Amount, Public Investment Program of Nicaragua. . . . .	6-1
Table 6.1.3	Investment Amount by MTI, Public Investment Program of Nicaragua. . . . .	6-2
Table 6.1.4	Planned Investment Amount by MTI (Tentative), Public Investment Program of Nicaragua, June 1998. . . . .	6-2
Table 6.1.5	Public Investment by Municipality of Managua . . . . .	6-3
Table 6.1.6	Estimated Public Investment on Transportation Infrastructure In the Municipality of Managua. . . . .	6-3
Table 6.1.7	Possible Investment Amount in Transportation Sector of Managua at 1998 Prices. . . . .	6-4
Table 6.1.8	Budget Envelope for the Transportation Sector of Managua at 1998 Prices . . . . .	6-5
Table 6.2.1	Annual Income of Municipality of Managua, 1990-1997 . . . . .	6-7
Table 6.2.2	Comparison of Car Price, June 1998 (Toyota Corolla, 98) . . . . .	6-7
Table 6.2.3	Comparison of Gasoline Price, June 1998 . . . . .	6-8
Table 6.2.4	Road User Tax, 1997 . . . . .	6-10
Table 6.2.5	Annual Income of Nicaragua's Central Government, 1990-1997 . . . . .	6-10
Table 6.2.6	Petroleum Consumption Tax, 1998 . . . . .	6-11
Table 7.1.1	Land Use and Population, 1998, 2003, 2008 and 2018 . . . . .	7-3
Table 7.2.1	Results of Traffic Assignment for Do-Nothing Situation (excluding walk trips) . . . . .	7-9
Table 7.2.2	New Roads Proposed in This Study in Comparison with Existing Plan of ALMA . . . . .	7-14
Table 7.2.3	Phasing of New Road Construction . . . . .	7-14
Table 7.2.4	Phasing of Widening of Existing Road Sections . . . . .	7-20
Table 7.2.5	Results of Traffic Assignment for Proposed Road Network . . . . .	7-20
Table 7.2.6	Cost Estimate for Road Development . . . . .	7-22
Table 7.2.7	Annual Road Maintenance Cost . . . . .	7-22
Table 7.2.8	Estimate of Time Value at 1998 Prices . . . . .	7-23
Table 7.2.9	Patronage Traffic and Revenue of Travesia by Toll Rate . . . . .	7-23
Table 7.2.10	Comparison of Network Performance, Without and With Tolls (C\$10/PCU) . . . . .	7-24
Table 7.3.1	Major Busways and Guided Bus Systems in the World . . . . .	7-27
Table 7.3.2	Comparison of Network Performance, Without and With Proposed Public Transportation Corridor . . . . .	7-36
Table 7.3.3	Facility Development Requirement for Public Transportation Corridor . . . . .	7-36
Table 7.3.4	Estimated Project Cost for Public Transportation Corridor . . . . .	7-38
Table 7.3.5	Bus Average Load Factor by Vehicle Size . . . . .	7-40
Table 7.3.6	Proposed Public Transportation System . . . . .	7-47
Table 7.4.1	Desirable Type of Intersection . . . . .	7-53
Table 7.4.2	Comparison of Signalization and Roundabouts . . . . .	7-53
Table 7.4.3	No. of Projects by Planning Period . . . . .	7-58

Table 7.4.4	No. of Intersections by Type of Control	7-58
Table 7.4.5	Estimated Cost for Intersection Improvement and Development	7-59
Table 7.4.6	TDM Techniques	7-62
Table 7.4.7	Increase of Damage on Pavement of Roads due to Overloading	7-67
Table 8.1.1	Road Development Project Summary	8-4
Table 8.1.2	Road Project Package	8-5
Table 8.1.3	Public Transportation Project Package	8-6
Table 8.1.4	Traffic Management Project Packages	8-6
Table 8.2.1	Characteristics of Representative Vehicle	8-9
Table 8.2.2	Vehicle Operating Cost by Type of Vehicle	8-9
Table 8.2.3	Travel Time Value per Vehicle	8-11
Table 8.2.4	Financial and Economic Cost Project Package	8-13
Table 8.2.5	Annual Economic Benefit of Entire Master Plan	8-15
Table 8.2.6	Benefit/Cost Flow of Proposed Masterplan	8-16
Table 8.2.7	Sensitivity of IRR to Cost and Benefit Change	8-16
Table 8.2.8	Annual Economic Benefit of Entire Road Project Package	8-17
Table 8.2.9	Benefit/Cost Flow of Proposed Masterplan	8-18
Table 8.2.10	Economic Evaluation of Road Project Package	8-19
Table 8.2.11	Economic Cost and Benefit of Travesia Toll Road Project	8-20
Table 8.2.12	Economic Evaluation of Travesia Toll Road Project	8-20
Table 8.2.13	Economic Cost and Benefit of Public Transport Corridor Project	8-21
Table 8.2.14	Economic Evaluation of Public Transport Corridor Project	8-21
Table 8.2.15	Economic Evaluation for Public Transportation Corridor and Road Widening of Carretera Norte	8-22
Table 8.3.1	Traffic Volume and Revenue of Travesía Project by Toll Rate	8-23
Table 8.3.2	Cost and Revenue of Travesía Toll Road Project	8-24
Table 8.3.3	Financial Evaluation of Travesía Toll Road Project	8-24
Table 8.3.4	Sensitivity of Financial IRR of Travesía Toll Road Project to Cost and Revenue Change	5-25
Table 8.3.5	Results of Traffic Assignment	8-25
Table 8.3.6	No. of Bus Units on Public Transportation Corridor	8-26
Table 8.3.7	Estimated Revenue from the Proposed Public Transportation Corridors	8-26
Table 8.3.8	Financial Analysis of Public Transportation Corridor Project	8-27
Table 8.3.9	Sensitivity of Financial IRR of Public Transportation Corridor Project to Charging Rate	8-27
Table 8.3.10	Evaluation of Public Transportation Terminal Project	8-28
Table 8.3.11	Sensitivity of Financial IRR of Public Transportation Terminal Project	8-29
Table 8.4.1	Environmental Items	8-30

Table 8.4.2	Ground Water Level of Wells in Managua .....	8-38
Table 8.4.3	Protected Crater Lake Areas .....	8-39
Table 8.4.4	Examination Category.....	8-42
Table 8.4.5	Summary of IEE Results.....	8-43
Table 8.4.6	Project Category for EIA process of MTI.....	8-48
Table 9.1.1	Investment Program of Road Development Projects .....	9-2
Table 9.1.2	Summary Investment Program by Road Project Package and Planning Period .....	9-5
Table 9.1.3	Summary Investment Program by Public Transportation Project Package and Planning Period .....	9-6
Table 9.1.4	Summary Investment Program by Traffic Management Project Package and Planning Period .....	9-6
Table 9.1.5	Summary9-8 Investment Program of Master Plan by Planning Period .....	9-7
Table 9.2.1	Investment R9-9requirements of Master Plan .....	9-8
Table 9.2.2	Possible Fund Sources for Managua's Transportation .....	9-9

## List of Figures

Figure 1.1.1	Overall Study Framework	1-2
Figure 1.2.1	Study Organization	1-4
Figure 2.1.1	Location of Epicenters of Past Earthquakes	2-5
Figure 2.1.2	Physical Constraint Factors	2-6
Figure 2.2.1	Increase of National Population	2-7
Figure 2.2.2	Population Density	2-10
Figure 2.2.3	Per Capita Gross Domestic Product in Latin-American Countries, 1995	2-12
Figure 2.2.4	Existing Land Use	2-166
Figure 2.2.5	Trends of Registered Vehicles	2-19
Figure 2.2.6	Car Ownership and Monthly Income, 1998	2-22
Figure 2.2.7	Average Income and Car Ownership	2-23
Figure 2.3.1	Number of Person Trips in the Study Area, 1998	2-25
Figure 2.3.2	Trip Purpose Composition (Including “walk” trips), 1998	2-27
Figure 2.3.3	Trip Purpose Composition (Excluding “walk” trips), 1998	2-27
Figure 2.3.4	Modal Share of Person Trips	2-29
Figure 2.3.5	Generation of Person Trip by Traffic Zone	2-31
Figure 2.3.6	Attraction of Person Trip by Traffic Zone	2-32
Figure 2.3.7	Desire Lines of Trips by Purpose, 1998	2-34
Figure 2.4.1	Existing Functional Road Network Configuration	2-40
Figure 2.4.2	Number of Lanes on the Inventory Network	2-41
Figure 2.4.3	Right-Of Way on the Inventory Network	2-41
Figure 2.4.4	Type of Pavement on the Inventory Network	2-42
Figure 2.4.5	Pavement Condition	2-43
Figure 2.4.6	Sidewalk by Surface Type	2-43
Figure 2.4.7	Traffic Volume (all Vehicles, 24 hours)	2-45
Figure 2.4.8	Traffic Volume (Buses, 24 hours)	2-45
Figure 2.4.9	Traffic Volume (Trucks, 24 hours)	2-46
Figure 2.4.10	Volume/Capacity Ratio	2-46
Figure 2.4.11	Hourly Variation of Traffic (Pista Juan Pablo II)	2-48
Figure 2.4.12	Result of Travel Speed Survey (Morning Peak Hours)	2-50
Figure 2.5.1	Bus Service Coverage	2-53
Figure 2.5.2	Location of Bus Terminal by Function	2-58
Figure 2.5.3	Location of Bus Terminals by Type of Locations	2-58
Figure 2.6.1	Location of Major Intersections by Type of Control	2-63
Figure 2.6.2	Common Signal Phase Plans in Managua	2-64



Figure 2.6.3	Existing Type of Signal Equipment .....	2-62
Figure 2.6.4	Existing Situation of On-Street Parking .....	2-66
Figure 2.6.5	Distribution of Off-Road Parkings Commonly Used .....	2-67
Figure 2.6.6	Existing Traffic Sign and Marking .....	2-68
Figure 2.6.7	Condition of Existing Road Signs .....	2-69
Figure 2.6.8	Condition of Existing Road Markings .....	2-69
Figure 2.7.1	Number of Accidents in Nicaragua (1982 to 1997) .....	2-70
Figure 2.8.1	NO <sub>2</sub> Concentration .....	2-74
Figure 2.8.2	Trend of NO <sub>2</sub> Concentration from Sunday to Tuesday .....	2-74
Figure 2.8.3	NO <sub>x</sub> Concentration .....	2-76
Figure 2.8.4	SO <sub>2</sub> Concentration in Managua, 1998 .....	2-77
Figure 2.8.5	SPM Concentration in Managua, 1998 .....	2-78
Figure 2.8.6	Maximum and Minimum of Noise Level at Location A8, 1998 .....	2-81
Figure 2.8.7	Maximum and Minimum of Noise Level at Location B6, 1998 .....	2-82
Figure 2.8.8	Maximum and Minimum of Noise Level at Location C2- a, 1998 .....	2-82
Figure 2.8.9	Maximum and Minimum of Noise Level at Location C2-b, 1998 .....	2-83
Figure 2.8.10	Maximum and Minimum of Noise Level at Location D5 .....	2-84
Figure 3.1.1	Study Area of the Master Plan .....	3-1
Figure 3.1.2	Aerial Photo of the Study Area .....	3-2
Figure 3.1.3	Urban Road Network Development Plan in Managua (1983) .....	3-5
Figure 3.2.1	Growth Trend .....	3-10
Figure 3.2.2	Population Distribution in Study Area .....	3-11
Figure 3.2.3	Development Potentials in the City .....	3-11
Figure 3.2.4	Probable Areas for High Activities Concentrations .....	3-12
Figure 3.2.5	Activity Centers and Corridors .....	3-12
Figure 3.2.6	Inter-city Transport Corridors .....	3-13
Figure 3.2.7	Conceptual Understanding of Roads Network Configuration in Compliance with Urban Development Pattern .....	3-14
Figure 3.2.8	Alternative Concepts of Transportation Structure Plan .....	3-15
Figure 3.2.9	Conceptual Urban Transportation Network Structure .....	3-16
Figure 3.2.10	Approach to Promoting Public Transportation-Based City .....	3-18
Figure 4.2.1	Relationship between Monthly Vivienda Income and Percentage of Car Owning Viviendas .....	4-11
Figure 5.1.1	Outline of Future Traffic Forecasting .....	5-2
Figure 5.1.2	Models for Estimation of OD Matrices .....	5-3

Figure 5.1.3	Generation of Non-car Owner by Zone, 1998	5-7
Figure 5.1.4	Attraction of Non-car Owner by Zone, 1998	5-8
Figure 5.1.5	Generation of Car Owner by Zone, 1998	5-9
Figure 5.1.6	Attraction of Car Owner by Zone	5-10
Figure 5.1.7	Intra-zonal Trips of Non-car Owner by Zone, 1998	5-12
Figure 5.1.8	Intra-zonal Trips of Car Owner by Zone, 1998	5-13
Figure 5.1.9	Structure of Modal Choice Model	5-14
Figure 5.1.10	Actual Walk Trip Shares 1998 and Modal Split Curve	5-15
Figure 5.1.11	Modal Split Curve for Private/Public Selection	5-17
Figure 5.1.12	Delay Function	5-18
Figure 5.2.1	Definition of Existing Urban Area	5-19
Figure 5.2.2	Urban Area (Scenario I)	5-23
Figure 5.2.3	Urban Area (Scenario II)	5-25
Figure 5.2.4	Urban Area (Scenario III)	5-27
Figure 5.3.1	Distribution of Population by Scenario, 2018	5-30
Figure 5.3.2	Distribution of Employment by Scenario, 2018	5-32
Figure 5.3.3	Distribution of School Enrolment by Scenario, 2018	5-34
Figure 5.3.4	Distribution of Average Income by Scenario, 2018	5-36
Figure 5.3.5	Car Owning Ratio by Scenario, 2018	5-37
Figure 5.4.1	Trip Generation by Development Scenario, 2018	5-39
Figure 5.4.2	Trip Attraction by Development Scenario, 2018	5-40
Figure 5.4.3	Trip Distribution by Development Scenario, 2018	5-42
Figure 5.4.4	Assigned Traffic Volume by Development Scenario, 2018 (on 1998 Network)	5-44
Figure 5.5.1	Concept of Combined Development Scenarios of I and III	5-46
Figure 7.1.1	Managua's Development Strategies	7-2
Figure 7.1.2	Planned Land Use, 2003	7-4
Figure 7.1.3	Planned Land Use, 2008	7-5
Figure 7.1.4	Planned Land Use, 2018	7-6
Figure 7.2.1	Forecasted Traffic Flow on Existing Road Network	7-10
Figure 7.2.2	Typical Road Cross Section Plan by Road Classification	7-13
Figure 7.2.3	Road Network Master Plan for Managua, 2018	7-15
Figure 7.2.4	Master Plan Road Network by No. of Lanes	7-16
Figure 7.2.5	New Road Construction Projects	7-17
Figure 7.2.6	Widening Projects	7-18
Figure 7.2.7	Phasing of Road Development	7-19
Figure 7.2.8	Traffic Flow Forecasted on Master Plan Road Network	7-21
Figure 7.2.9	Traffic Flow Forecasted on Master Plan Road Network (with Toll Road)	7-25
Figure 7.2.10	Forecast Traffic Flow on Travesia with and without Toll, 2018 (CS10/Trip)	7-24

Figure 7.3.1	Public Transportation Corridor Development, Phase I (Short-Term) .....	7-28
Figure 7.3.2	Public Transportation Corridor Development, Phase II (Medium-Term) .....	7-29
Figure 7.3.3	Public Transportation Corridor Development, Phase III (Long-Term) .....	7-30
Figure 7.3.4	Proposed Public Transportation Corridors .....	7-32
Figure 7.3.5	Typical Cross Section of Public Transportation Corridor .....	7-34
Figure 7.3.6	Layout of Intersection Pista Juan Pablo II and Pista Sabana Grande .....	7-35
Figure 7.3.7	Forecasted Traffic Flow on Proposed Public Transportation Corridor .....	7-37
Figure 7.3.8	Exclusive Busway in Lima, Peru .....	7-39
Figure 7.3.9	Future Public Transportation Demand .....	7-42
Figure 7.3.10	Service Area of Ecoder Bus .....	7-45
Figure 7.3.11	Proposed Location of Public Bus Terminal .....	7-51
Figure 7.4.1	Master Plan of Intersection Improvement and Development .....	7-56
Figure 7.4.2	Phasing of Intersection Improvement and Development .....	7-57
Figure 7.4.3	Proposed Bicycle Road and Pedestrian path .....	7-61
Figure 7.4.4	Vicious Circle of Traffic Congestion .....	7-60
Figure 7.4.5	Concept of Public Transportation Priority Area .....	7-63
Figure 7.4.6	Proposed TDM projects .....	7-65
Figure 7.4.7	Proposed Truck Routes .....	7-69
Figure 8.1.1	Road Widening Projects .....	8-2
Figure 8.1.2	Network Road Construction Projects .....	8-3
Figure 8.2.1	Work-Flow of Plan / Project Evaluation .....	8-7
Figure 8.2.2	VOC and TTC by Operation Speed .....	8-10
Figure 8.2.3	Trend of Total Travel Cost and Economic Benefit .....	8-14
Figure 8.2.4	IRR and NPV of Road Project Package .....	8-19
Figure 8.4.1	New Road Construction Project vs Spontaneous and Progressive Settlements .....	8-32
Figure 8.4.2	EIA flow from Permit Request to Environmental Control by MARENA .....	8-46
Figure 8.4.3	EIA Flow of MTI Construction Project .....	8-47
Figure 9.1.1	Summary Investment Program of Road Development Projects .....	9-1
Figure 9.1.2	Summary Investment Program of All Projects in Master Plan .....	9-7

## ACRONYMS AND ABBREVIATIONS

ALMA	Alcaldía de Managua (Managua Municipality Office)
BCN	Banco Central de Nicaragua (Central Bank of Nicaragua)
B/CR	Benefit Cost Ratio
BPR	Bureau of Public Roads, USA
C\$	Córdoba
CBD	Central Business District
CC	Correlation Coefficient
CELADE	Centro Latino-Americano de Demografía (Latino-American Center of Demography)
COMMEMA	Corporación Municipal de Mercados de Managua (Corporation of Municipality Markets of Managua)
EAP	Economically Active Population
EIA	Environmental Impact Assessment
EIP	Economically Inactive Population
ENACAL	Empresa Nacional de Acueductos y Alcantarillados
FAR	Floor/Area Ratio
GDP	Gross Domestic Product
GIS	Geographical Information System
GRDP	Gross Regional Domestic Product
IBRD	International Bank for Reconstruction and Development (same as WB)
IDB	Inter-American Development Bank
IEC	Impuesto Específico al Consumo (Specific Consumption Tax)
IEE	Initial Environmental Examination
IGV	Impuesto General del Valor (General Value-Added Tax)
INEC	Instituto Nacional de Estadísticas y Censos (National Institute of Statistics and Census)
INETER	Instituto Nicaragüense de Estudios Territoriales (Land Study Institute of Nicaragua)
IRR	Internal Rate of Return
JICA	Japan International Cooperative Agency
MARENA	Ministerio de Ambiente y Recursos Naturales (Ministry of Environment and Natural Resources)
MCC	Multiple Correlation Coefficient
MCT	Ministerio de Construcción y Transporte (Ministry of Construction and Transport – Current MTI)
MTI	Ministerio de Transporte e Infraestructura (Ministry of Transport and Infrastructure)
MED	Ministerio de Educación (Ministry of Education)
MFIN/MIFIN	Ministerio de Finanzas (Ministry of Finance)

NPV	Net Present Value
OD	Origin-Destination
OJT	On-the-Job Training
PCU	Passenger Car Unit
PM <sub>10</sub>	Particulate Matter with diameter less than 10 µm
ROW	Right-of-Way
SPM	Suspended Particulate Matter
STRADA	System for Transport Demand Analysis (JICA Software)
SWR	Shadow Wage Rates
TDM	Transportation Demand Management
TRRL	Transport and Road Research Laboratory, UK
TTC	Travel Time Cost
VOC	Vehicle Operating Cost
UTB	Uso Territorial Básico (Basic Land Use)
WB	World Bank (same as IBRD)

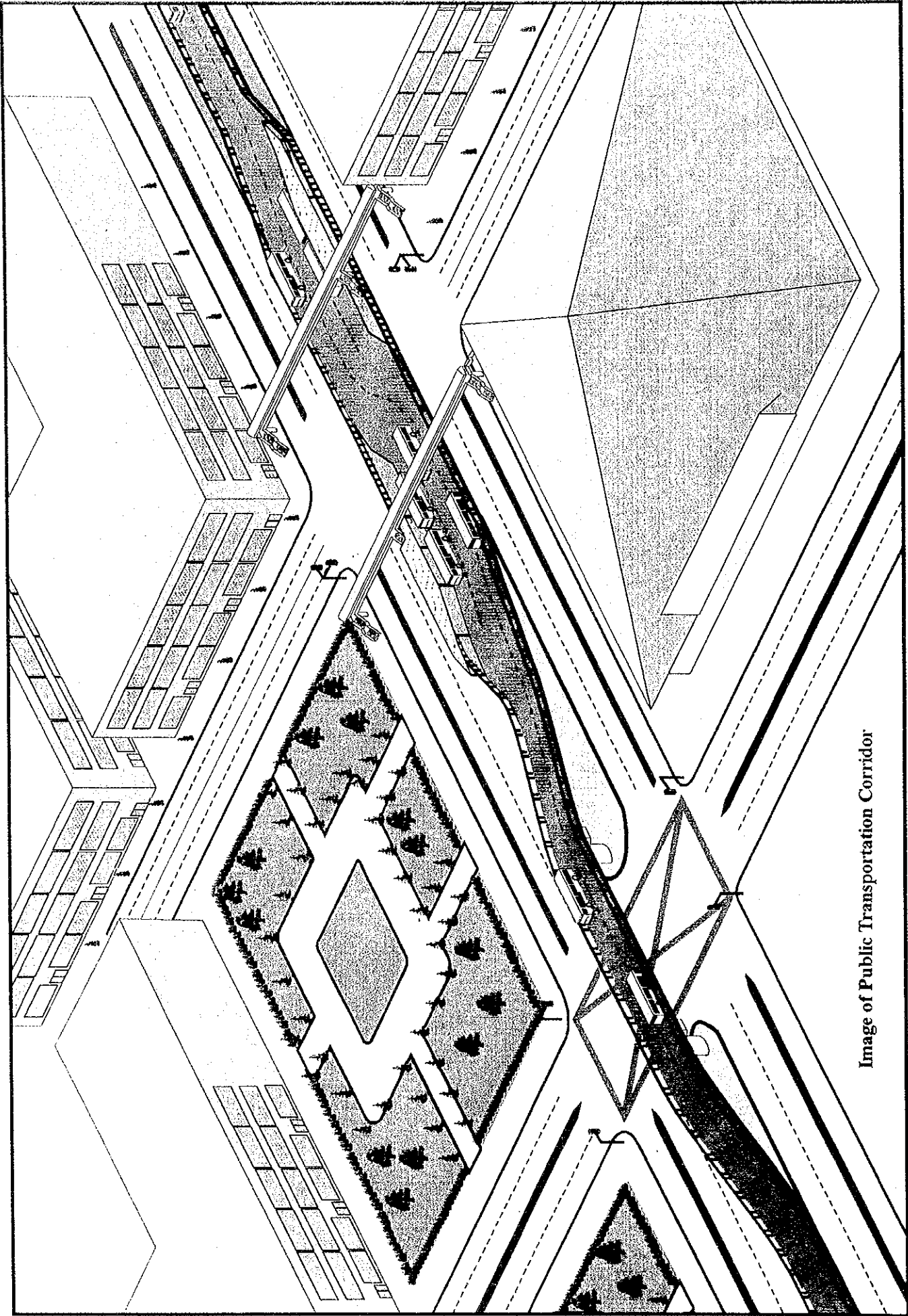
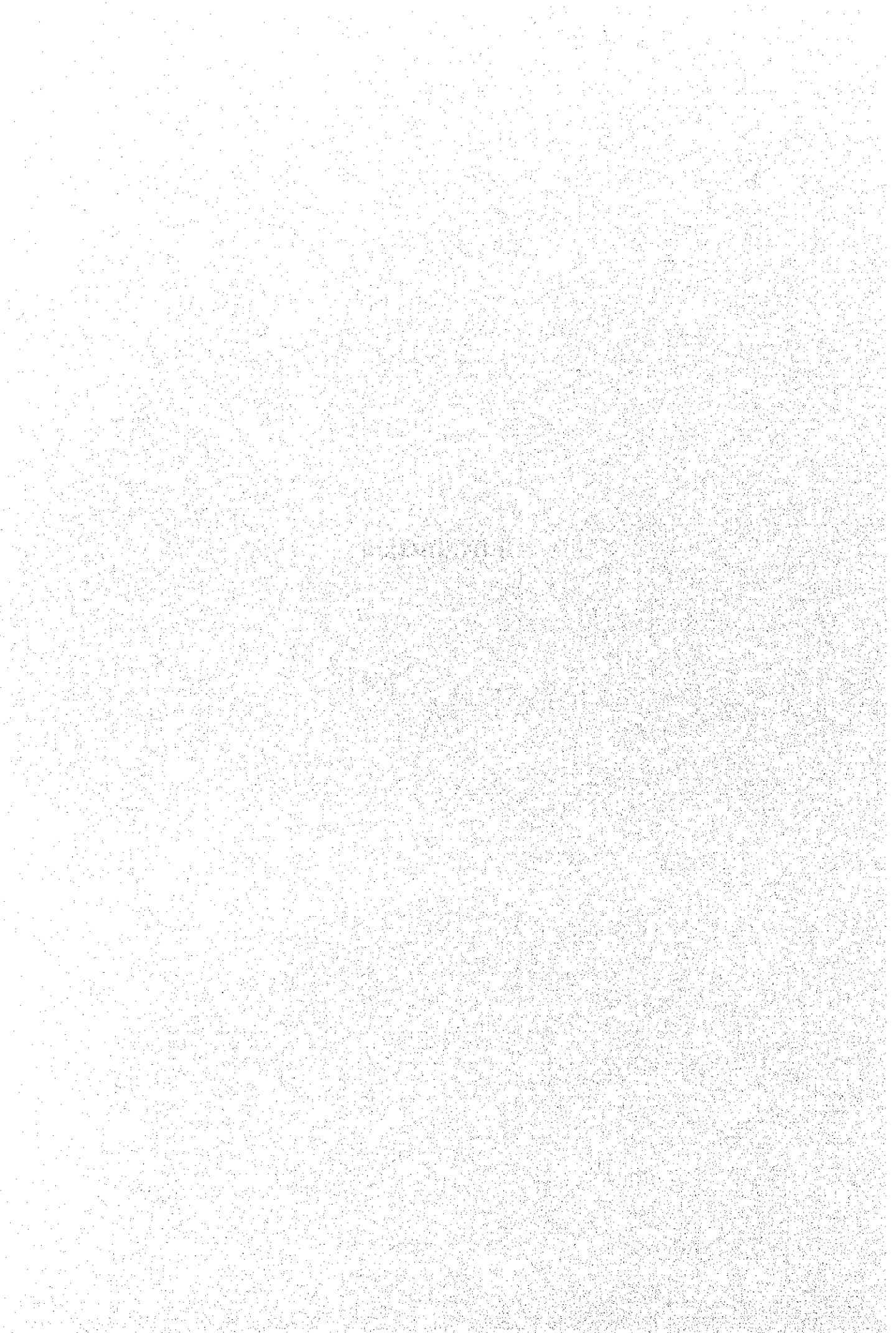


Image of Public Transportation Corridor

## **1. Introduction**





## **1. INTRODUCTION**

### **1.1 STUDY FRAMEWORK**

The overall study framework is outlined in Figure 1.1.1. The Study has the following stages as a whole:

Stage I (January – March, 1998)

- Data collection through surveys
- Progress Report was submitted

Stage II (May – July, 1998)

- Basic concept and directions of Master Plan
- Interim Report was submitted

Stage III (August – December, 1998)

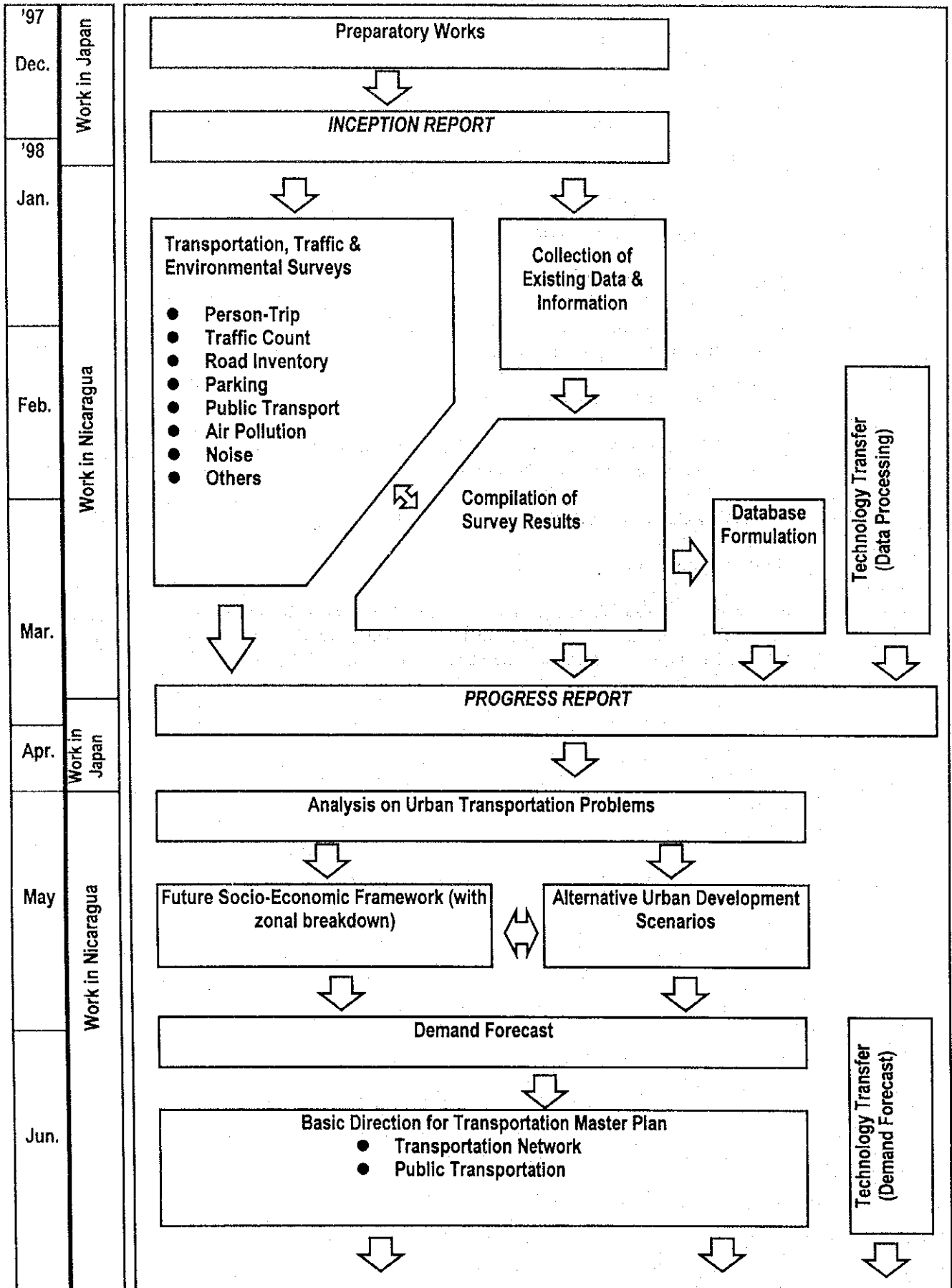
- Refinement of Master Plan and Recommendations
- Draft Final Report is submitted

### **1.2 STUDY ORGANIZATION**

#### **1) Study Organization**

The study organization is composed of the JICA Advisory Committee and the JICA Study Team on the Japanese side and the Consultative Committee, the Coordination Committee and the Counterpart Team as shown in Figure 1.2.1

Figure 1.1.1 Overall Study Framework



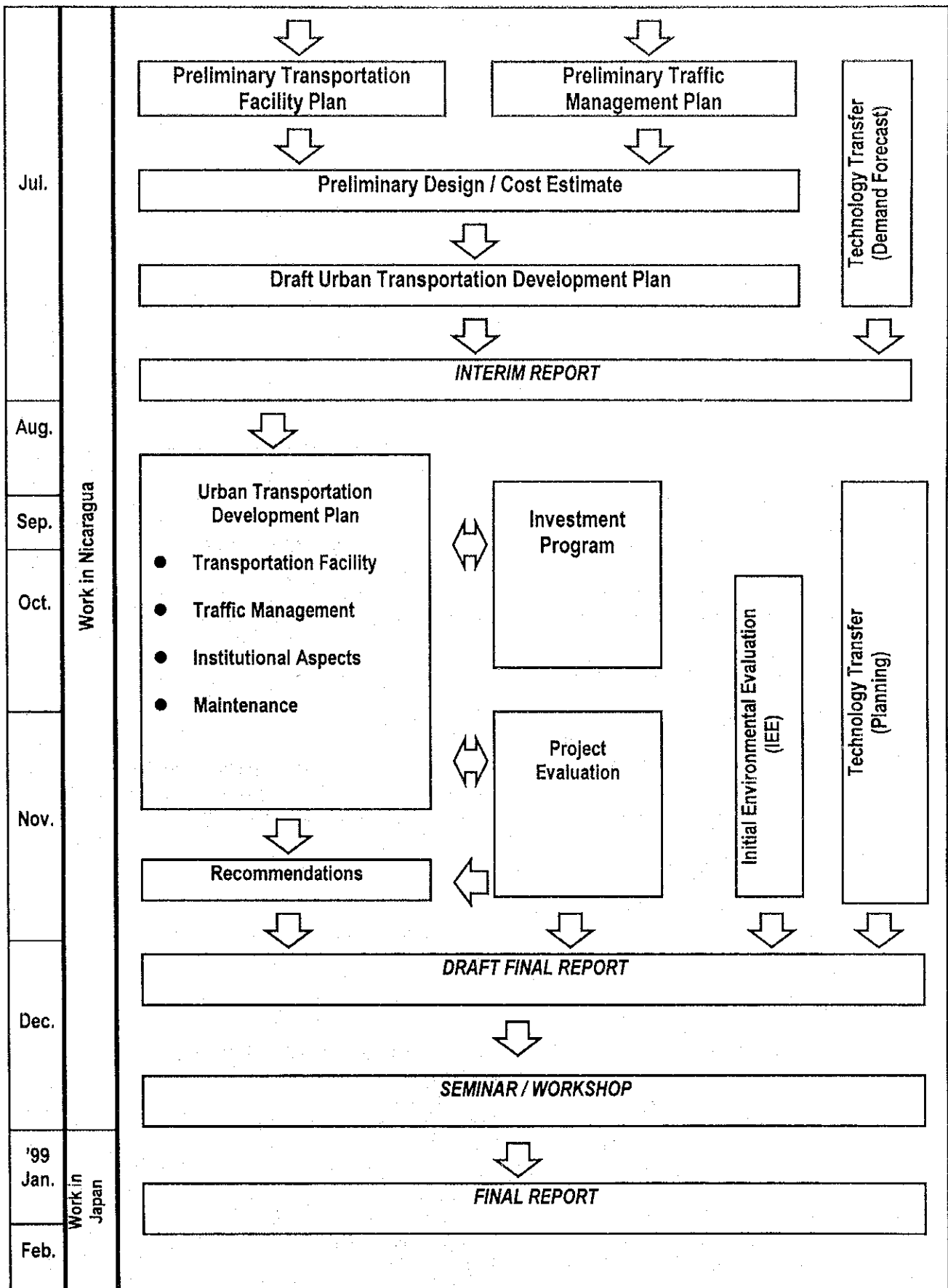
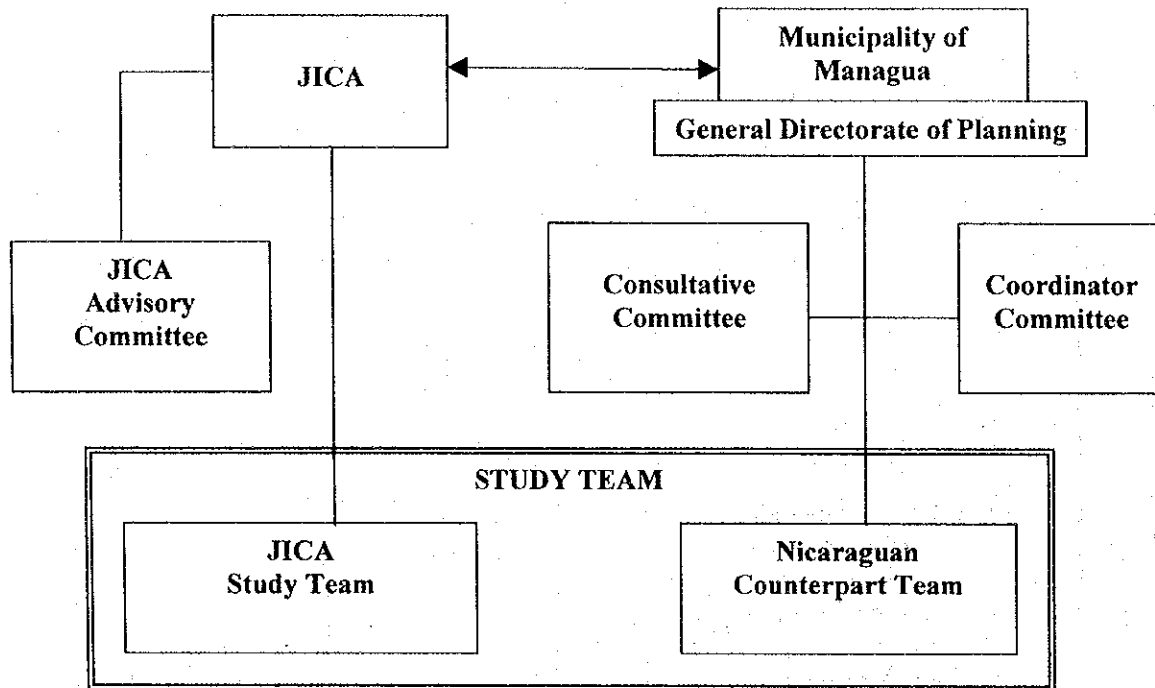


Figure 1.2.1  
Study Organization



1) **JICA Secretariat, Advisory Committee and Study Team**

JICA Secretariat

- 1) Mr. Takao KAIBARA : Director, First Social Development Study Div.
- 2) Ms. Eri HONDA : Deputy Director, First Social Development Study Div.
- 3) Mr. Mutsumi NARAWA : First Social Development Study Div.

JICA Advisory Committee Members

- 1) Dr. Kazuaki MIYAMOTO : Chairman
- 2) Mr. Naohiko HANABUSA : Urban Transportation Planning
- 3) Mr. Hitoshi KAWATA : Public Transportation Planning

JICA Study Team Members

- 1) Mr. Takashi SHOYAMA : Team Leader, Transportation Planning
- 2) Dr. Akira ISHIDO : Road Planning
- 3) Mr. Iwane MIZUNO : City Planning
- 4) Mr. Masayuki ISHIYA : Public Transportation Planning
- 5) Mr. Michimasa TAKAGI : Traffic Management
- 6) Mr. Kagemasa NAKAKOJI : Transportation Survey
- 7) Dr. Tetsuji MASUJIMA : Demand Forecast
- 8) Mr. Tetsuo WAKUI : Economic/Financial Evaluation
- 9) Mr. Kenji IGARASHI : Environmental Evaluation
- 10) Dr. Shizuo IWATA : Transportation Policy
- 11) Mr. Fumihiko HANDA : Data Processing
- 12) Ms. Yasuko YAMADA : Coordinator

### 3) Consultative Committee, Coordination Committee and Counterpart Team

#### Consultative Committee Members

Eng. René Quesada Prado	:	General Director of Planning and Coordinator of the Committee, ALMA.
Eng. Víctor Valdivia Hidalgo	:	Project Manager and Secretary of the Committee, ALMA.
Cap. -Eng. Gilberto Solís	:	National Police.
Dr. Sergio López	:	Ministry of Finances.
Dr Adolfo Evertsz	:	Secretariat of External Cooperation.
Eng. Rafael Urbina	:	Ministry of Transport and Infrastructure
Lic. Milton Medina	:	MARENA.

#### Coordinator Committee Members

Eng. René Quesada Prado	:	General Director of Planning and Coordinator of the Committee, ALMA.
Eng. Víctor Valdivia Hidalgo	:	Project Manager and Secretary of the Committee, ALMA.
Eng. Jorge González Mosquera	:	General Director of Urban Development, ALMA.
Eng. Víctor Guerrero	:	General Director of Municipal Development, ALMA.
Eng. Mario Palacios	:	Representative from MTI.

#### Counterpart Members

Eng. Víctor Valdivia H.	:	Project Manager	ALMA
Eng. David Gaitán F.	:	Traffic and Transport	ALMA
Arch. Ligia Solorzano	:	City Planning	ALMA
Lic. Luisa M. Castellón	:	Environment	ALMA
Arch. Cony Mendoza	:	Urban Planning	ALMA
Arch. Gerald Pentzke	:	Urban Planning	ALMA
Lic. Humberto Araúz	:	Pre-Investment	M.T.I.
Eng. Yasser Mahmud G.	:	Public Transport	M.T.I.
Mr. Jardiel Quesada S.	:	Data Processing	ALMA
Mr. Rafael Bautista S.	:	Administrator Assistant	ALMA
Miss Karla Ramírez P.	:	Secretary	ALMA
Mr. Carlos Adán Genet	:	Driver	ALMA
Mrs. Celia Zavala	:	Janitor	ALMA

## **2. Analysis On Urban Transportation Problems**

## 2. ANALYSIS ON URBAN TRANSPORT PROBLEMS

### 2.1 Natural Conditions

#### 2.1.1. Topography and Geology

##### Nicaragua

Nicaragua became an independent state in 1821. It is located in the center of the Central American Isthmus, linking the continental masses of North and South America. The national territory extends between Honduras (North), Costa Rica (South), the Atlantic Ocean (East) and the Pacific Ocean (West) with a territorial extension of 129,702 km.<sup>2</sup>, of which 120,462 km.<sup>2</sup> correspond to land and 9,240 km.<sup>2</sup> to lakes and interior waters.

The two lakes of Nicaragua are: Lake Nicaragua (*Lago de Nicaragua or Cocibolca*), which is the largest lake (approximately 8,200 km<sup>2</sup>) along the border with Costa Rica, and the Lake of Managua (*Lago de Managua or Xolotlán*), the second largest lake (approximately 1,035 km<sup>2</sup>) in the Central America region.

The mean altitude of Nicaragua is 339.0 meters above sea level. More than half of the territory has altitudes below 200 m. located on the Atlantic and Pacific coast plains. About 20% of the territory have altitudes of 200 to 500 m. 14% have altitudes of 500 to 1,500 m. and are located in the center of the country in "Sierras de Managua", and only 3% have altitudes over 1,500 m.

The land territory of Nicaragua can be divided into following four (4) regions:

- Pacific Ocean Coast Tropical and Dry Lowlands Regions
- Atlantic Ocean Coast Tropical and Humid Lowlands Region
- Pacific Ocean Side Subtropical Dry Highlands Region
- Atlantic Ocean Side Subtropical Humid Highlands Regions

##### Managua

Managua was declared capital of the country in 1852.

The Department of Managua is located in the Pacific Ocean Coast Tropical and Dry Lowlands Region, with a territorial extension of 3,672 km.<sup>2</sup>, and a population of about 1.1 million people according to the 1995 census. It has a mean altitude of 86 m.

The topography of the Department present two well-defined zones: the *Zona Montañosa*, or "Sierras de Managua" (altitudes from 400 to 700 m.) and the *Zona de las Llanuras* or plains.

Inside its territory there is the Xolotlán Lake or Lake of Managua (approximately 1,035 km<sup>2</sup>), the crater lagoons of Nejapa (0.19 km.<sup>2</sup>), Xiloa (10 km<sup>2</sup>), Apoyeque (8.0 km<sup>2</sup>), Tiscapa (0.13 km<sup>2</sup>), Acahualinca (0.06 km<sup>2</sup>) and Asososca (0.69 km<sup>2</sup>). The latter provides most of the drinking water of the city. There are also the hills of Chiltepe and Motastepe.

The Municipality spreads along the southern shore of the Lake with a territory of 540 km<sup>2</sup> and is located Meridians: 86° 40' and 86° 16'. Longitudinal West, Parallel: 12° 7' and 110° 43' North latitude. Altitude: 82.97 m.

The urban area of Managua is 250 km<sup>2</sup>. Its configuration extends with gently slope from South to North, its altitude being approximately 42m, at South shore of the Lake, to approximately 220m above the sea level nearby the Sierras (mountains).

The urban area of Managua is 250 km<sup>2</sup>. Its configuration extends with gently slope from South to North, its altitude being approximately 42m, at South shore of the Lake, to approximately 220m above the sea level nearby the Sierras (mountains).

### 2.1.2. Climate

Periodic meteorological monitoring at the Managua International Airport has been carried out by INETER (*Instituto Nicaragüense de Estudios Territoriales*), which is an affiliate institute of Ministry of Transportation and Infrastructure (MTI). Table 2.1.1 shows the meteorological monthly data for last three years (1995-1997). The meteorological condition in the Study Area can be summarized as follows:

#### A. Evaporation

Annual mean evaporation of these three years ranges from 166 mm to 171 mm. The data shows that most of monthly evaporation (mm) in dry season of Managua (December to April) is higher than the precipitation (mm) of the same month. These weather conditions may lead to water shortage in the Study Area during the dry season.

#### B. Wind

- **Wind Direction:**  
Prevailing wind direction all year round in the Study Area is from the East.
- **Wind Velocity**  
Wind velocity is relatively low all year round with a range from 1.0 m/sec. to 1.5 m/sec. as the yearly mean velocity. Data shows that the monthly velocity from December to May is relatively higher than the rest of the year.

#### C. Temperature

- **Maximum Temperature:**  
Maximum temperature has been observed in May of each year such as 37.0 of 1995, 37.0 of 1996 and 37.5 of 1997.
- **Minimum Temperature:**  
Minimum temperature has been observed during January and February of each year, such as 18.0 in January of 1995, 15.2 in February of 1996, and 17.0 in January of 1997.
- **Average Temperature:**  
Annual average temperature during these three years ranges from 26.8 to 27.4.

#### D. Humidity

Annual mean relative humidity of these three years ranges from 71% to 75%. Based on the data, the period from December to April has lower humidity than the rest of the year.

#### E. Precipitation

Annual total precipitation of these three years ranges from 862.5 mm to 1,613.9mm. Total precipitation of 1997 is almost a half of 1996. This difference may be one of the influences of so called *El Niño* phenomena.



**Table 2.1.1**  
**Meteorological Data of Managua**

INSTITUTO NICARAGUENSE DE ESTUDIOS TERRITORIALES INETER													
STATION: A.C.SANDINO (AIRPORT)							COORDINATE: LATITUDE : 12°08'N LONGITUDE : 86°10'W ELEVATION : 56m						
CLIMATOLOGICAL DATA													
YEAR: 1995													
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
EVAPORATION (mm)	168	206	242	222	201	145	154	146	135	130	123	133	167
WIND DIRECTION (course)	NE	E	E	E	E	E	E	E	E	W	E	E	E
WIND SPEED (m/sec)	1.4	1.6	1.6	1.1	1.0	0.8	1.1	0.5	0.6	0.8	1.0	1.0	1.0
MAX. TEMP. ABS. (°C)	34.5	35.4	36.3	36.5	37.0	35.2	34.8	34.5	34.1	32.9	34.5	33.4	37.0
MIN. TEMP. ABS. (°C)	18.0	19.2	20.0	21.4	21.8	22.0	22.0	22.2	21.4	20.3	20.3	19.8	18.0
AVER. TEMP (°C)	26.3	27.0	28.3	29.0	29.0	26.5	27.1	28.0	26.5	26.5	26.4	26.2	27.2
RELATIVE HUMIDITY (%)	67	62	63	66	69	80	80	89	85	85	81	78	75
PRECIPITATION (mm)	0.0	0.0	16.0	112.9	20.6	212.3	112.3	326.1	297.4	202.6	44.2	13.0	1,357.4
YEAR: 1996													
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
EVAPORATION (mm)	158	192	236	264	168	145	141	148	142	131	111	152	166
WIND DIRECTION (course)	E	E	E	E	E	E	E	E	E	E	E	E	E
WIND SPEED (m/sec)	1.5	1.8	1.5	1.6	0.9	0.7	0.8	0.7	0.6	0.4	0.8	1.5	1.07
MAX. TEMP. ABS. (°C)	33.4	34.5	37.2	37.5	37.0	35.3	34.6	33.7	33.6	33.4	33.5	33.0	37.5
MIN. TEMP. ABS. (°C)	16.6	15.2	16.6	21.0	22.2	22.2	21.2	21.3	21.8	21.3	18.2	19.3	15.2
AVER. TEMP (°C)	25.6	26.8	27.5	29.4	27.7	27.2	26.7	26.4	26.6	26.4	25.9	25.8	26.8
RELATIVE HUMIDITY (%)	73	67	63	63	76	79	80	81	83	84	80	71	75
PRECIPITATION (mm)	21.3	0.0	5.3	0.0	240.8	221.6	282.3	121.9	275.9	315.6	127.1	2.1	1,613.9
YEAR: 1997													
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
EVAPORATION (mm)	154	172	228	226	256	131	164	160	153	138	118	157	171
WIND DIRECTION (course)	E	E	E	E	E	E	E	E	E	E	E	E	E
WIND SPEED (m/sec)	1.2	2.0	2.0	1.6	2.2	0.7	1.2	1.1	3.0	0.7	0.9	1.4	1.5
MAX. TEMP. ABS. (°C)	33.5	34.7	35.7	36.5	37.5	35.5	35.3	36.2	36.5	33.8	33.3	34.0	37.5
MIN. TEMP. ABS. (°C)	17.0	19.1	19.0	19.8	22.0	21.9	21.5	21.6	22.0	21.6	21.0	18.3	17.0
AVER. TEMP (°C)	25.6	26.8	27.6	28.7	29.9	26.7	27.7	27.6	27.7	27.0	26.8	26.5	27.4
RELATIVE HUMIDITY (%)	71	66	61	62	58	81	74	76	78	81	79	66	71
PRECIPITATION (mm)	5.8	0.5	0.4	1.3	14.1	291.7	59.4	82.3	99.3	246.2	63.3	0.0	864.3

Source: INETER

### 2.1.3 Volcanoes and Earthquake

The Pacific Lowlands Area is characterized by 18 volcanoes shown in Table 2.1.2. These volcanoes make a volcano chain, which runs in a straight line from Northwest to Southeast in the center of the Lowland Area.

**Table 2.1.2**  
**Volcanoes in the Pacific Lowlands**

	Volcano	Elevation (m)	Condition
1	Consignina	859	Active
2	Chonco	-	-
3	San Cristóbal	1,745	Active
4	Casita	1,592	Active
5	Telica	1,060	Active
6	Santa Clara	-	-
7	Rola	836	-
8	Cerro Negro	631	Active
9	Las Pitas	-	-
10	El Hoyo	1,050	Active
11	Momotombo	1,280	Active
12	Momotombito	-	-
13	Chiltepe	512	-
14	Masaya ( <i>Volcán Santiago</i> )	400	Active
15	Mombacho	1,345	Active
16	Zapatera	-	-
17	Concepción	1,610	Active
18	Maderas	1,394	-

Sources: "NICARAGUA Y EL MUNDO- ATLAS BASICO ILUSTRADO" First edition 1993,  
Authorized Distributor: Universidad Centroamericana U.C.A Managua  
- "Nicaragua Sales Guide", 11/1996, Ministry of Tourism

The volcanic ashes fertilize soil of agricultural fields in the area, and the geothermal energy has been found in the underground of several volcanoes and it is used for electricity generation such as the power plant at Volcano Momotombo.

Managua City was hit and destroyed by two major earthquakes in March 1931 and December 1972. Earthquake is a very critical issue in this region and has negative impact on social and natural environment, and of the City development. Most of the earthquakes in Nicaragua have been observed around the Pacific Lowlands Area. Figure 2.1.1 shows the location of epicenters of the past earthquakes.

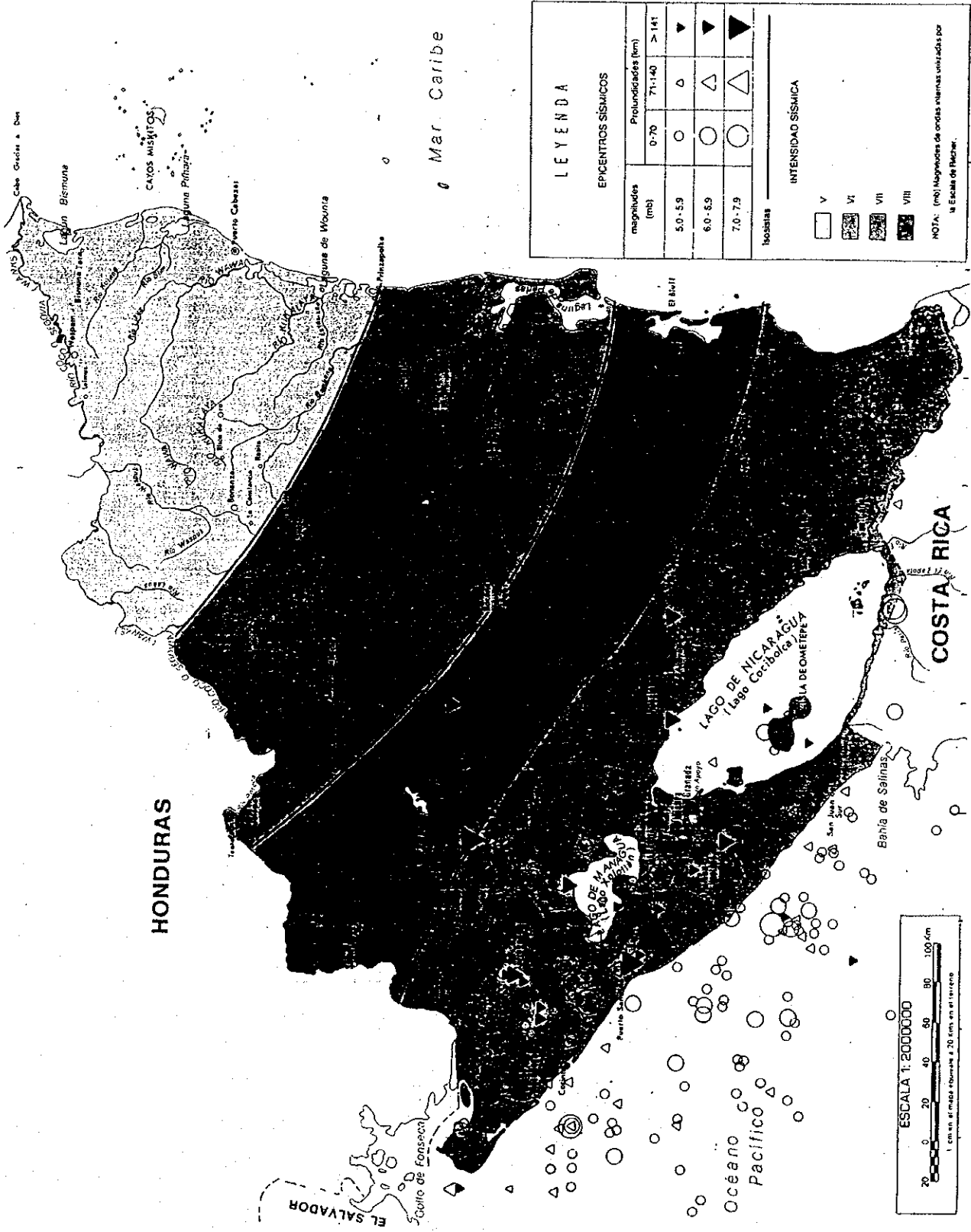
In Managua, a number of active and inferred faults are found as summarized in Table 2.1.3 (also see Figure 2.1.2).

**Table 2.1.3**  
**Seismic Faults in Managua City**

Seismic Faults	Size (km)
North of Batahola	2.0
Stadium fault	2.2
Fault of the banks	2.0
Tiscapa fault	8.1
Chico Pelon fault	5.8
West of International airport	3.4
East of International Airport	0.6
East of Ruben Dario road	3.0
West of Colegio Centro America	2.0
Metrocentro fault	1.1
East of Colonia Centro America	3.7
West of San Judas neighborhood	3.7

Source: ALMA

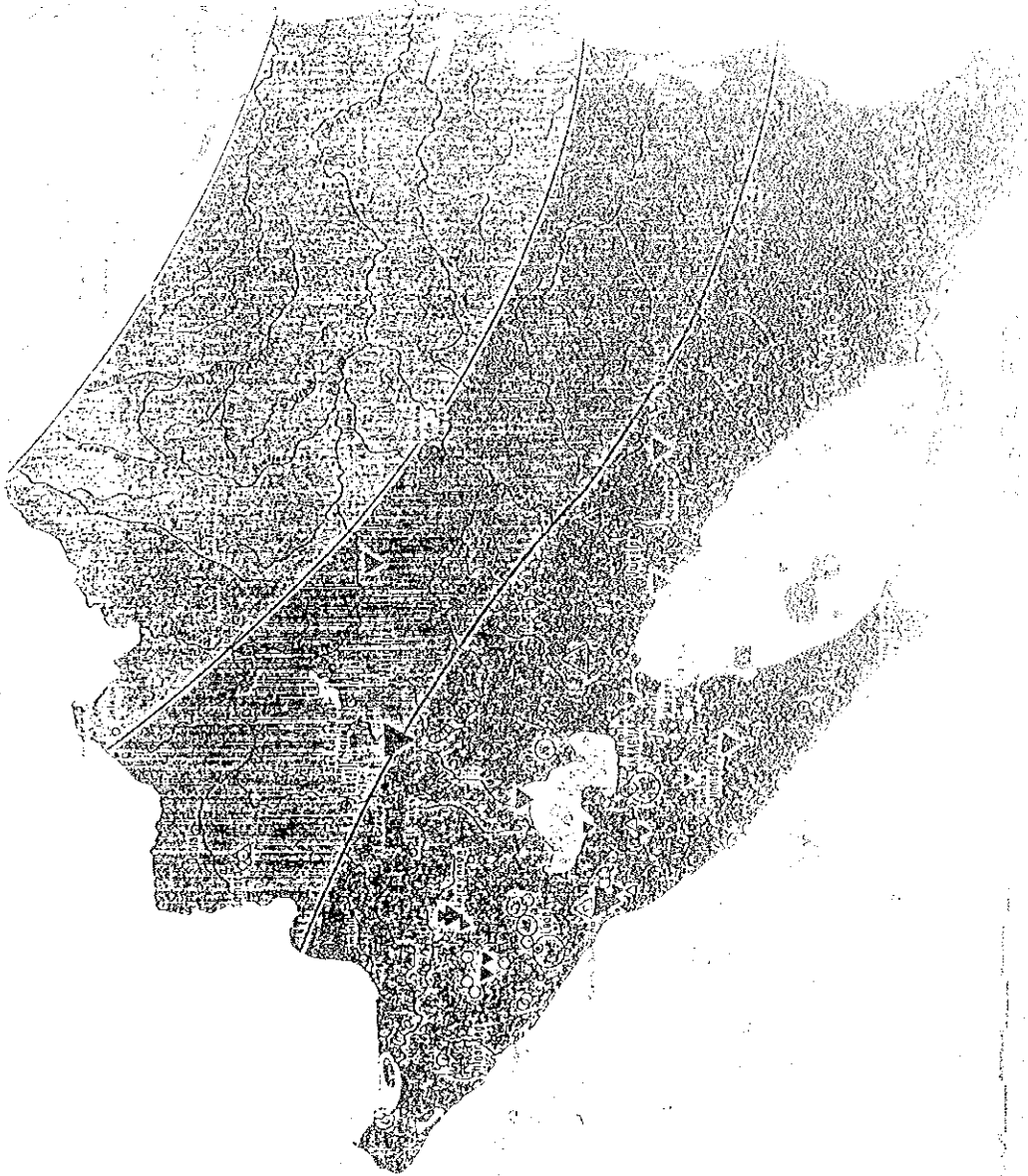
Figure 2.1.2 presents the physical constraint factors of Managua, including the location of faults. Judging from this map, the conditions of Managua for development are not ideal. Particularly in relation to earthquake, some preventive measures should be considered in land use and city planning in the future.



Source: Atlas Escolar de Nicaragua, INETER, 1992.

Figure 2.1.1 Location of Epicenters of Past Earthquakes

HONDURAS



EL SALVADOR

Figure 2.1.1.2 Physical Constraint Factors



Source: ALMA

## 2.2 Socio-Economic Characteristics

### 2.2.1 Basic Indicators

Demographic information and other basic social indicators of the Republic of Nicaragua are listed in the following table:

**Table 2.2.1**  
**Basic Indicators of Nicaragua, 1995**

Indicators	Number	Unit
Land Area	120,462	Km2
Number of Houses	821	Thousand houses
Population	4,357	Thousand persons
Average Annual Growth Rate (%)	3.6	%
Density	36.4	Persons/km2
Economically Active Population (EAP)	1,448	Thousand persons
% of Urban Population to the Total	54.4	%
% of Rural Population to the Total	45.6	%
Industrial Composition of Population		
% of Primary Sector to the Total	42.9	%
% of Secondary Sector to the Total	13.8	%
% of Tertiary Sector to the Total	43.3	%
Unemployment Rate*	16.9	%

Source: INEC

Note: \* Estimated by the number of employed and unemployed population

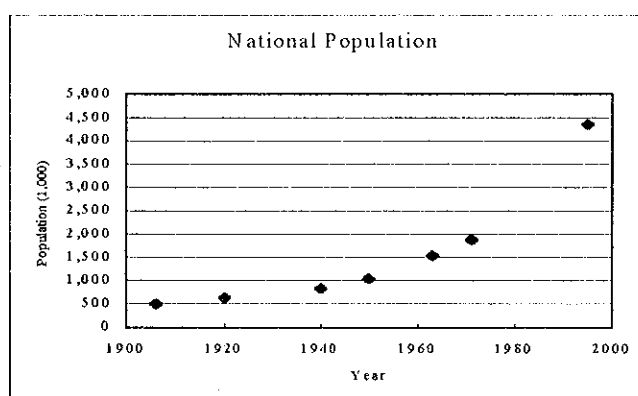
### 2.2.2 Population

#### National Population

The national population estimated at 4,357 thousand at the Census conducted in 1995. The growth of the national population is shown in Figure 2.2.1.

Population density of Masaya Department is the highest in the country followed by Managua Department.

**Figure 2.2.1**  
**Increase of National Population**



**Table 2.2.2**  
**Annual Growth Rate of Population and Population Density by Department**

Region/ Department	Population in CENSUS				Annual Growth Rate (%)			Area (km <sup>2</sup> )	Population Density
	1950	1963	1971	1995	63/50	71/63	95/71		
<b>National Total</b>	<b>1,049,611</b>	<b>1,535,588</b>	<b>1,877,952</b>	<b>4,357,099</b>	<b>3.0</b>	<b>2.5</b>	<b>3.6</b>	<b>119,838</b>	<b>36.4</b>
<b>Pacific Total</b>	<b>585,593</b>	<b>869,973</b>	<b>1,116,473</b>	<b>2,467,742</b>	<b>3.1</b>	<b>3.2</b>	<b>3.4</b>	<b>18,638</b>	<b>132.4</b>
Chinandega	81,836	128,624	155,286	350,212	3.5	2.4	3.4	4,822	72.6
Leon	123,614	150,051	166,820	336,894	1.5	1.3	3.0	5,457	61.7
Managua	161,513	318,826	485,850	1,093,760	5.4	5.4	3.4	3,465	315.7
Masaya	72,446	76,580	92,152	241,354	0.4	2.3	4.1	611	395.0
Granada	48,732	65,643	71,102	155,683	2.3	1.0	3.3	1,040	149.7
Carazo	52,138	65,888	71,134	149,407	1.8	1.0	3.1	1,081	138.2
Rivas	45,314	64,361	74,129	140,432	2.7	1.8	2.7	2,162	65.0
<b>Central-North Total</b>	<b>387,202</b>	<b>560,976</b>	<b>595,139</b>	<b>1,354,246</b>	<b>2.9</b>	<b>0.7</b>	<b>3.5</b>	<b>33,985</b>	<b>39.8</b>
Boaco	50,039	71,615	69,187	136,949	2.8	-0.4	2.9	4,177	32.8
Chontales	50,529	75,575	68,802	144,635	3.1	-1.2	3.1	6,481	22.3
Jinotega	48,325	76,935	90,640	257,933	3.6	2.1	4.5	9,492	27.2
Mategalpa	135,401	171,465	168,139	383,776	1.8	-0.2	3.5	6,804	56.4
Esteli	43,742	69,257	79,164	174,894	3.6	1.7	3.4	2,230	78.4
Madriz	33,178	50,229	53,423	107,567	3.2	0.8	3.0	1,708	63.0
Nueva Segovia	25,988	45,900	65,784	148,492	4.5	4.6	3.5	3,093	48.0
<b>Atlantic Total</b>	<b>76,816</b>	<b>104,639</b>	<b>166,340</b>	<b>535,111</b>	<b>2.4</b>	<b>6.0</b>	<b>5.0</b>	<b>67,215</b>	<b>8.0</b>
Rio San Juan	9,089	15,676	20,832	70,143	4.3	3.6	5.2	7,541	9.3
Zelaya	67,727	88,963	145,508	464,968	2.1	6.3	5.0	59,674	7.8
RAAN	-	-	-	192,716	-	-	-	32,127	-
RAAS	-	-	-	272,252	-	-	-	27,547	-

Source: INEC

### Population of Managua

According to the result of the Census carried out in 1995, population of the Municipality of Managua is 903 thousand which consists of a male population of 429 thousand (47.5%) and a female population of 474 thousand (52.5%) as shown in Table 2.2.2. The ratio of the population of five (5) years old or more, which is the target age group of the person-trip survey, is estimated at 86.7% based on Table 2.2.3.

**Table 2.2.3**  
**Population by Age Group and Sex in Managua Municipality, 1995**

Age Group	Total		Male		Female	
	Population	(%)	Population	(%)	Population	(%)
0	25,017	2.8	12,738	3.0	12,279	2.6
1 - 4	95,148	10.5	48,704	11.4	46,444	9.8
5 - 9	115,333	12.8	58,386	13.6	56,947	12.0
10 - 14	121,231	13.4	60,482	14.1	60,749	12.8
15 - 19	100,086	11.1	47,245	11.0	52,841	11.1
20 - 24	87,983	9.7	39,432	9.2	48,551	10.2
25 - 29	76,263	8.4	34,152	8.0	42,111	8.9
30 - 34	66,319	7.3	30,316	7.1	36,003	7.6
35 - 39	56,766	6.3	25,768	6.0	30,998	6.5
40 - 44	42,008	4.7	19,771	4.6	22,237	4.7
45 - 49	29,893	3.3	13,967	3.3	15,926	3.4
50 - 54	21,771	2.4	9,978	2.3	11,793	2.5
55 - 59	18,163	2.0	8,051	1.9	10,112	2.1
60 - 64	15,444	1.7	6,806	1.6	8,638	1.8
65 - 69	11,591	1.3	4,944	1.2	6,647	1.4
70 - 74	8,106	0.9	3,420	0.8	4,686	1.0
75 - 79	5,360	0.6	2,280	0.5	3,080	0.6
80 - 84	3,596	0.4	1,334	0.3	2,262	0.5
85 -	3,022	0.3	1,043	0.2	1,979	0.4
<b>Total</b>	<b>903,100</b>	<b>100.0</b>	<b>428,817</b>	<b>100.0</b>	<b>474,283</b>	<b>100.0</b>

Source: INEC

Population by Economic Activity

The total number of economically active population (EAP) in Managua Municipality is 328 thousand (36.4% to the total population), while that of economically inactive population is 339 thousand (37.5%). The unemployment rate is calculated at 18.6% based on Table 2.2.4. In addition, there is a large percentage of underemployment that is classified as employment (43.5% of EAP as of 1994 according to ALMA).

Population by occupation and sex in Managua Municipality is described in Table 2.2.5.

**Table 2.2.4**  
**Population by Economic Activity and Sex in Managua Municipality, 1995**

Economic Activity	Total		Male		Female	
	Population	(%)	Population	(%)	Population	(%)
<b>Total</b>	<b>667,602</b>	<b>100.0</b>	<b>308,989</b>	<b>100.0</b>	<b>358,613</b>	<b>100.0</b>
<b>Total EAP</b>	<b>328,496</b>	<b>49.2</b>	<b>195,687</b>	<b>63.3</b>	<b>132,809</b>	<b>37.0</b>
Employed	267,376	40.1	152,676	49.4	114,700	32.0
Unemployed	61,120	9.2	43,011	13.9	18,109	5.0
<b>Total EIP</b>	<b>339,106</b>	<b>50.8</b>	<b>113,302</b>	<b>36.7</b>	<b>225,804</b>	<b>63.0</b>
Retired	11,254	1.7	7,481	2.4	3,773	1.1
Housewife	115,286	17.3	526	0.2	114,760	32.0
Student	187,159	28.0	90,859	29.4	96,300	26.9
Disabled	6,974	1.0	3,918	1.3	3,056	0.9
Others	18,433	2.8	10,518	3.4	7,915	2.2

Source: INEC



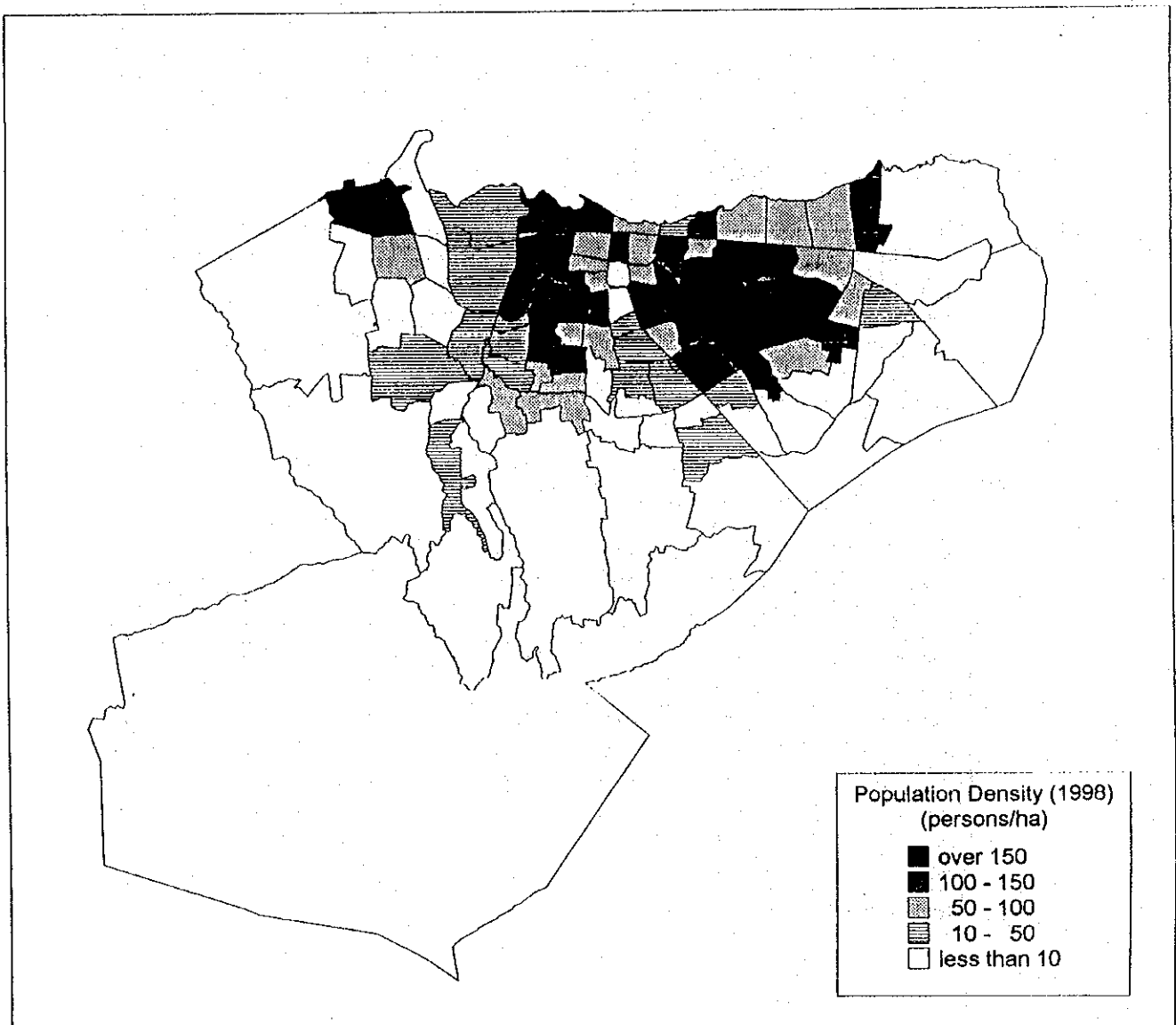
**Table 2.2.5**  
**Population by Occupation and Sex in Managua Municipality, 1995**

Occupation	Total		Male		Female	
	Population	(%)	Population	(%)	Population	(%)
Managers and Executives	5,225	2.0	3,456	2.3	1,769	1.5
Scientific Professionals	18,389	6.9	10,834	7.1	7,555	6.6
Professionals and Technicians	27,024	10.1	14,346	9.4	12,678	11.1
Office Employees	15,830	5.9	5,776	3.8	10,054	8.8
Service Workers and Salesmen	48,631	18.2	23,708	15.5	24,923	21.7
Personal Service Workers	17,442	6.5	5,939	3.9	11,503	10.0
Farmers and Fishermen	5,603	2.1	5,373	3.5	230	0.2
Operatives and Artisans	40,227	15.0	34,744	22.8	5,483	4.8
Machine Operators	20,179	7.5	17,898	11.7	2,281	2.0
Unskilled Laborers	54,738	20.5	24,348	15.9	30,390	26.5
Others	14,088	5.3	6,254	4.1	7,834	6.8
<b>Total</b>	<b>267,376</b>	<b>100.0</b>	<b>152,676</b>	<b>100.0</b>	<b>114,700</b>	<b>100.0</b>

Source: INEC

Distribution of population density in Managua Municipality is shown in Figure 2.2.2. Zones with high population density are distributed mainly in the district of II, IV, more than 100 persons per ha.

**Figure 2.2.2**      **Population Density**



## 2.2.3 Economy

### Gross Domestic Product

The gross domestic product (GDP) of the Republic of Nicaragua is described in Table 2.2.6. The economic situation of this country has slightly recovered since Chamorro came into power in 1990. After 1994 the economy shows a strong growth, led mainly by the increase of the primary sector's GDP.

**Table 2.2.6**  
**Gross Domestic Product by Sector (Current Price: C\$ million)**

Industrial Sector	1991		1992		1993		1994		1995		1996	
	Amount	(%)	Amount	(%)	Amount	(%)	Amount	(%)	Amount	(%)	Amount	(%)
<b>Gross Domestic Product</b>	<b>7,429.1</b>	<b>100.0</b>	<b>9,225.4</b>	<b>100.0</b>	<b>11,067.3</b>	<b>100.0</b>	<b>12,445.4</b>	<b>100.0</b>	<b>14,455.5</b>	<b>100.0</b>	<b>17,126.0</b>	<b>100.0</b>
<b>Primary Sector</b>	<b>2,220.4</b>	<b>29.9</b>	<b>2,805.1</b>	<b>30.4</b>	<b>3,372.1</b>	<b>30.5</b>	<b>4,074.5</b>	<b>32.7</b>	<b>4,813.6</b>	<b>33.3</b>	<b>5,981.2</b>	<b>34.9</b>
Agriculture	1,622.3	21.8	1,995.8	21.6	2,253.6	20.4	2,820.4	22.7	3,391.4	23.5	4,395.7	25.7
Livestock	556.6	7.5	748.5	8.1	1,011.0	9.1	1,084.7	8.7	1,154.8	8.0	1,278.6	7.5
Fishing	28.9	0.4	45.1	0.5	88.4	0.8	148.5	1.2	243.5	1.7	279.3	1.6
Forestry	12.6	0.2	15.7	0.2	19.1	0.2	20.9	0.2	23.9	0.2	27.6	0.2
<b>Secondary Sector</b>	<b>1,507.8</b>	<b>20.3</b>	<b>1,804.5</b>	<b>19.6</b>	<b>2,224.2</b>	<b>20.1</b>	<b>2,487.0</b>	<b>20.0</b>	<b>2,923.3</b>	<b>20.2</b>	<b>3,423.8</b>	<b>20.0</b>
Industrial manufacture	1,293.9	17.4	1,531.9	16.6	1,884.9	17.0	2,051.9	16.5	2,350.0	16.3	2,677.2	15.6
Construction	174.3	2.3	215.2	2.3	268.4	2.4	366.4	2.9	473.8	3.3	614.0	3.6
Mining	39.6	0.5	57.4	0.6	70.9	0.6	68.7	0.6	99.5	0.7	132.6	0.8
<b>Tertiary Sector</b>	<b>3,700.9</b>	<b>49.8</b>	<b>4,615.8</b>	<b>50.0</b>	<b>5,471.0</b>	<b>49.4</b>	<b>5,883.9</b>	<b>47.3</b>	<b>6,718.6</b>	<b>46.5</b>	<b>7,721.0</b>	<b>45.1</b>
Commercial	1,879.2	25.3	2,191.3	23.8	2,757.8	24.9	3,019.3	24.3	3,524.2	24.4	4,184.0	24.4
Government	616.1	8.3	910.9	9.9	915.3	8.3	898.4	7.2	910.6	6.3	927.6	5.4
Transport and Communication	288.3	3.9	361.6	3.9	422.6	3.8	453.4	3.6	529.7	3.7	612.0	3.6
Bank and Insurance	207.6	2.8	256.7	2.8	304.7	2.8	333.0	2.7	381.4	2.6	428.1	2.5
Energy and Water	83.3	1.1	106.2	1.2	129.6	1.2	144.4	1.2	170.0	1.2	186.4	1.1
Real estate	205.0	2.8	255.0	2.8	308.5	2.8	334.2	2.7	383.9	2.7	430.6	2.5
Other Services	421.4	5.7	534.1	5.8	632.5	5.7	701.2	5.6	818.8	5.7	952.3	5.6

Source: Department of National Account, Management of Economic Study

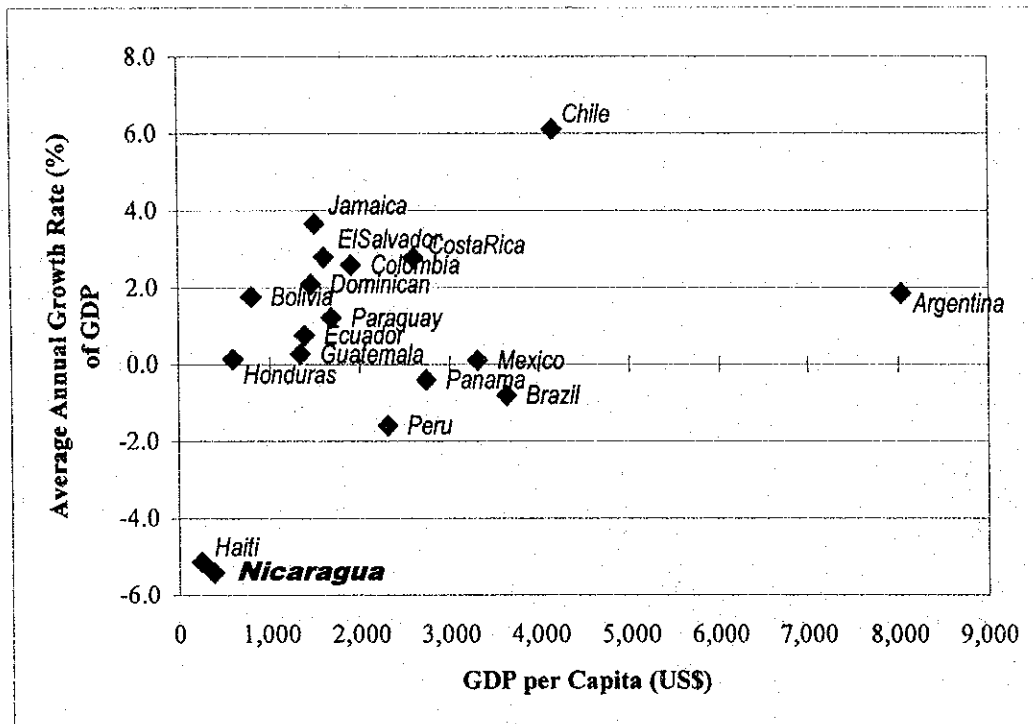
**Table 2.2.7**  
**Growth of GDP by Industrial Sector (Constant Price of 1980)**

Industrial Sector	1991	1992	1993	1994	1995	1996
<b>GDP Total</b>	<b>-0.2</b>	<b>0.4</b>	<b>-0.4</b>	<b>3.3</b>	<b>4.5</b>	<b>5.5</b>
<b>Primary Sector</b>	<b>-3.9</b>	<b>3.1</b>	<b>1.8</b>	<b>10.8</b>	<b>5.5</b>	<b>9.8</b>
Agriculture	-5.0	-0.5	-6.2	16.1	8.2	15.4
Livestock	-3.5	8.7	12.2	-0.5	-4.2	-0.2
Fishing	45.4	26.4	62.7	55.8	47.5	7.9
Forestry	1.0	1.2	1.0	1.5	2.6	2.8
<b>Secondary Sector</b>	<b>4.5</b>	<b>-3.3</b>	<b>0.3</b>	<b>2.7</b>	<b>5.4</b>	<b>4.7</b>
Industrial manufacture	6.4	-5.1	0.0	1.0	3.0	2.0
Construction	-8.1	8.3	1.5	17.8	16.3	15.4
Mining	-1.4	17.1	2.7	-10.1	30.3	27.2
<b>Tertiary Sector</b>	<b>-0.7</b>	<b>1.2</b>	<b>-1.8</b>	<b>-0.1</b>	<b>3.3</b>	<b>3.4</b>
Commercial	4.9	1.4	-2.3	1.6	5.0	5.7
Government	-12.5	0.1	-1.8	-5.5	-1.8	-3.9
Transport and Communication	4.9	1.4	-3.9	-0.5	5.1	5.5
Bank and Insurance	-1.9	0.0	-1.4	1.4	3.0	3.6
Energy and Water	0.3	3.1	1.4	3.4	5.8	5.9
Real estate	0.8	0.6	0.5	0.5	3.3	3.5
Other Services	4.3	2.5	-1.6	2.9	5.0	5.2

Source: Department of National Account, Management of Economic Study

Figure 2.2.3 compares the Per Capita Gross Domestic Product in Latin-American countries. In the figure, the horizontal axis indicates Gross Domestic Product per Capita in 1995 and the vertical axis indicates the average annual growth rate of Gross Domestic Product from 1985 to 1995. The source of both figures is the statistics published by the World Bank. According to the figure, Gross Domestic Product per Capita of Nicaragua was US\$380 and it was the second lowest. Furthermore, the annual growth rate was the lowest in Latin-American countries at minus 5.4% p.a.

**Figure 2.2.3**  
**Per Capita Gross Domestic Product in Latin-American Countries, 1995**



Source: WB

#### Balance of Payments and Exchange Rate

The historical changes in balance of payment is shown in Table 2.2.8. The value of Cordoba has been stable with a moderate devaluation tendency in the exchange market in 1990's as shown in Table 2.2.9.

**Table 2.2.8**  
**Balance of Payment (Million US\$)**

Items	1991	1992	1993	1994	1995	1996	1997
<b>Current Operation</b>	-7.8	-716.2	-482.9	-532.8	960.2	3,772.4	-419.8
Commercial	-396.3	-547.8	-402.6	-433.5	-338.6	-381.8	-555.0
Services	-470.9	-557.0	-501.6	-536.2	-458.9	-410.8	-293.2
Transfer	859.4	388.6	421.3	436.9	1,757.7	4,565.0	428.4
<b>Capital Operation</b>	-765.2	-369.8	-391.4	-621.8	-1,660.1	-4,255.7	314.9
Private	-5.9	68.0	177.0	165.7	108.8	161.5	462.7
Official	-759.3	-437.8	-568.4	-787.5	-1,768.9	-4,417.2	-147.8
<b>Balance of Payment</b>	-773.0	-1,086.0	-874.3	-1,154.6	-699.9	-483.3	-104.9
<b>Finance</b>	773.0	1,086.0	874.3	1,154.6	699.9	483.2	105.0
Net International Reserve	-15.8	4.9	100.1	-68.7	9.0	-79.3	-67.2
Exceptional	788.8	1,081.1	774.2	1,223.3	690.9	562.5	172.2

Source: BCN

**Table 2.2.9**  
**Exchange Rate**

Items	(Córdoba/Dollar)						
	1991	1992	1993	1994	1995	1996	1997
<b>Financial Market</b>							
Buying	4.85	5.29	6.20	6.87	7.61	8.44	9.40
Selling	4.94	5.40	6.28	6.95	7.69	8.50	9.44

Source: BCN

### Inflation

The consumer price index is shown for the past five (5) years in Table 2.2.10. According to the table, aggregate inflation has been remaining constant at around 10% p.a. for this period.

**Table 2.2.10**  
**Consumer Price Index**

Year	Index	Annual Inflation Rate (%)
1993	92.1417	-
1994	100.0000	8.5
1995	110.9355	10.9
1996	123.8262	11.6
1997	135.5758	9.5

Source: BCN

Note: As of June 1997

**Table 2.2.11**  
**Consumer Price of Petroleum Goods**

Items	(C\$/gallon)						
	1991	1992	1993	1994	1995	1996	1997
Liquid Gas *	18.80	20.00	22.55	23.81	29.43	46.98	50.91
Regular Gasoline	9.04	9.55	12.92	16.19	16.33	19.51	21.45
Turbo	5.94	6.47	7.74	8.75	10.61	13.70	14.97
Diesel	5.67	5.88	7.02	7.75	8.40	10.38	12.13
Oil	1.67	1.75	2.13	2.46	3.30	4.48	4.74
Asphalt	5.64	5.71	7.09	7.76	9.47	11.33	12.48

Source: BCN

Note: \* by 25 pound cylinder

### Employment and Salaries

The agricultural and fishery sector has the highest portion (40.5%) in employment, followed by the social services sector. The ratio of female workers in tertiary sector is more than 70%, while that of male workers is less than 30%.

Salary has not caught up with the increase of inflation as shown in Table 2.2.13. The average of real monthly salary has been constant about 1,200 Cordoba from the year 1992 to 1997.

**Table 2.2.12**  
**Population by Industrial Sector, 1995**

Industrial Sector	Total		Male		Female	
	Population	(%)	Population	(%)	Population	(%)
<b>Primary Sector</b>	<b>486,924</b>	<b>40.5</b>	<b>459,152</b>	<b>53.5</b>	<b>27,772</b>	<b>8.1</b>
Agriculture and fishing	486,924	40.5	459,152	53.5	27,772	8.1
<b>Secondary Sector</b>	<b>157,328</b>	<b>13.1</b>	<b>124,022</b>	<b>14.4</b>	<b>33,306</b>	<b>9.7</b>
Mining	4,119	0.3	3,881	0.5	238	0.1
Industrial manufacture	107,932	9.0	75,650	8.8	32,282	9.4
Construction	45,277	3.8	44,491	5.2	786	0.2
<b>Tertiary Sector</b>	<b>492,034</b>	<b>40.9</b>	<b>244,057</b>	<b>28.4</b>	<b>247,977</b>	<b>72.0</b>
Electricity and Water	6,022	0.5	4,909	0.6	1,113	0.3
Commercial and Restaurants	205,840	17.1	110,003	12.8	95,837	27.8
Transport and Communication	40,122	3.3	37,173	4.3	2,949	0.9
Financial	7,143	0.6	4,157	0.5	2,986	0.9
Social Service	232,907	19.4	87,815	10.2	145,092	42.1
Others	66,778	5.6	31,256	3.6	35,522	10.3
<b>Total</b>	<b>1,203,064</b>	<b>100.0</b>	<b>858,487</b>	<b>100.0</b>	<b>344,577</b>	<b>100.0</b>

Source: INEC

**Table 2.2.13**  
**Average Nominal and Real Monthly Salary**

(C\$)							
Items	1991	1992	1993	1994	1995	1996	1997
<b>Nominal Average</b>							
Central Government	467.57	675.21	735.89	788.04	849.10	874.34	961.36
Insured INSS	671.57	1,050.61	1,171.07	1,289.33	1,405.21	1,508.59	1,678.91
National Level	642.04	944.90	1,056.53	1,198.20	1,357.51	1,482.27	1,608.20
Deflator IPC	62.17	76.89	92.58	99.78	110.93	123.83	134.17
<b>Real Average (Cordoba in 1994)</b>							
Central Government	752.08	878.15	794.87	789.78	765.44	706.08	716.52
Insured INSS	1,080.22	1,366.38	1,264.93	1,292.17	1,266.75	1,218.28	1,251.33
National Level	1,032.72	1,228.90	1,141.21	1,200.84	1,223.75	1,197.02	1,198.63
<i>Change in Salary*</i>	<i>100</i>	<i>119</i>	<i>111</i>	<i>116</i>	<i>118</i>	<i>116</i>	<i>116</i>

Source: Ministry of Finance (MIFIN), Institute of Social Insurance in Nicaragua (INSS), Ministry of Labor (MITLAB)

Note: \* 1991 = 100

## 2.2.4 Land Use

### Land distribution

The present land use distribution of Managua Municipality is shown in Table 2.2.14. Housing area shares 50% of the Municipality. The uninhabited lots occupy 18% of the total area.

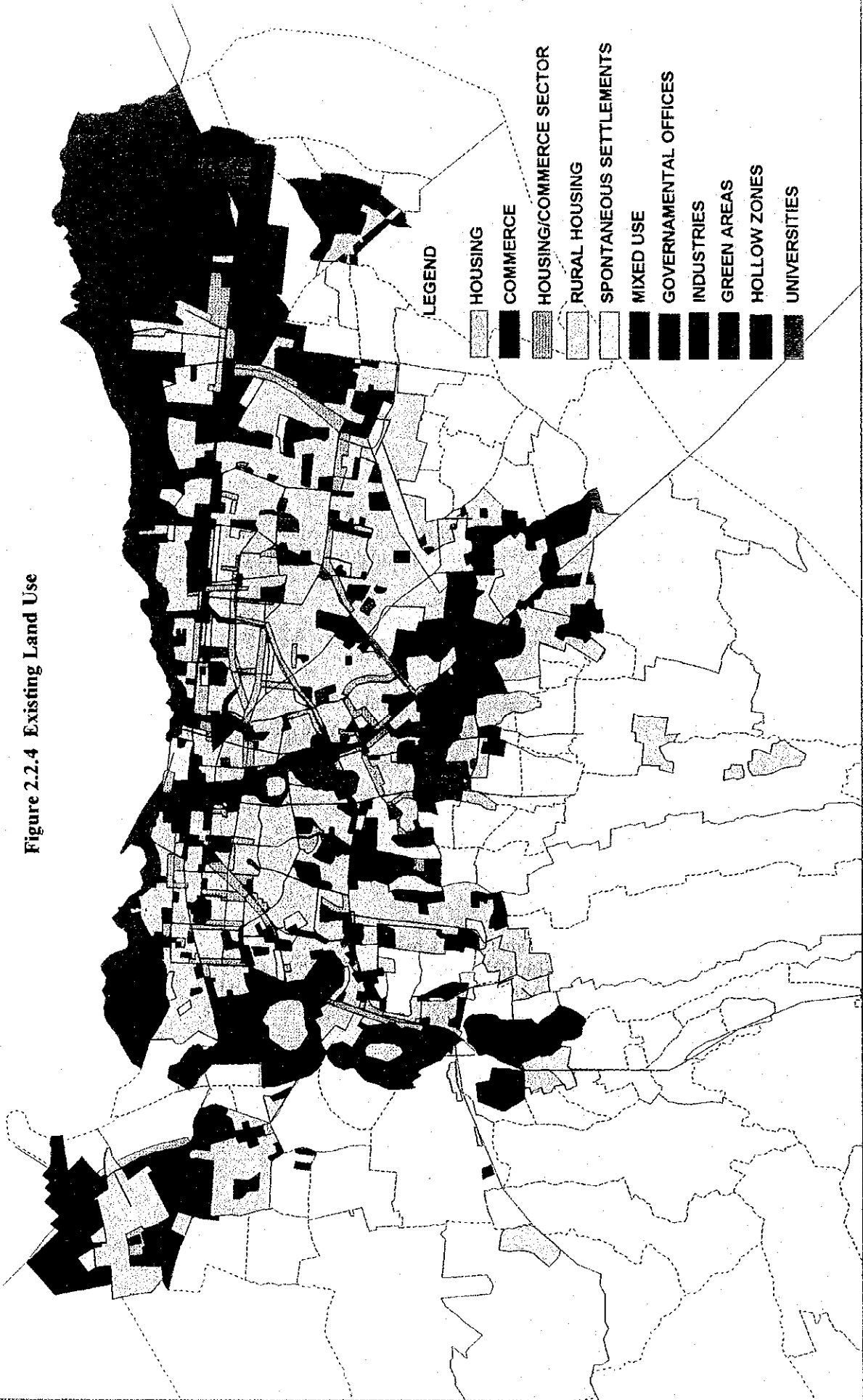
Land use map is shown in Figure 2.2.4.

**Table 2.2.14**  
**Land Use Distribution of Managua Municipality**

Sectors	%
Housing	50%
Uninhabited lots	18%
Industry	5%
Green area	1%
Services	6%
Commerce	3%
Main network road	8%
Pluvial drainage network	2%
Agriculture	7%

Source: ALMA

Figure 2.2.4 Existing Land Use



## Major Industry

The location of the major industries in Managua Municipality is shown in Table 2.2.15.

**Table 2.2.15**  
**Location of the Major Industry in Managua Municipality**

<b>Industry</b>	<b>Location</b>
Textile Industry	Aside the Pan-American North Highway
Food Industry	<i>Acahualinca</i> neighborhood
Chemical-Textile Industry	Aside the Pan-American South Highway
Chemical-Petroleum Industry	<i>Cuesta el Plomo</i> , Northwest of the City
Metal-Mechanical Industry	New Highway to Leon
Chemical-Pharmaceutical Industry	Aside the Highway to <i>Masaya</i>

Source: ALMA

Most of the industrial activities and the industrial employment of the country are concentrated in the Managua Municipality. Most of the large industries, more than 145, are located along Pista Pedro Joaquin Chamorro and Carretera Norte Via Panamericana. Small industry is scattered all over the City.

## 2.2.5 Vehicle Ownership

### 1) Past Trends of Number of Registered Vehicles in Nicaragua

Table 2.2.16 and Figure 2.2.5 show the past trends in the number of registered vehicles. During the period 1977 to 1990, the number had been gradually increasing. However, it suddenly jumped up by about 60% in 1991. This is due to the democratization in 1990, which admitted expatriate Nicaraguan people to come back to their country with their vehicles free from taxation. After 1991, its growth rate seems to have been accelerated to 2 - 4% p.a.

By vehicle type, passenger vehicles (car and jeep) and trucks share about 40% each. The share of motorcycle and bus is about 14% and 4%, respectively.

### 2) Number of Registered Vehicles in Managua

The statistics of number of registered vehicles is not available for the Municipality of Managua. Table 2.2.17 shows the regional breakdown (by "Departamento") of registered vehicles for 1994, which was available with MTI.

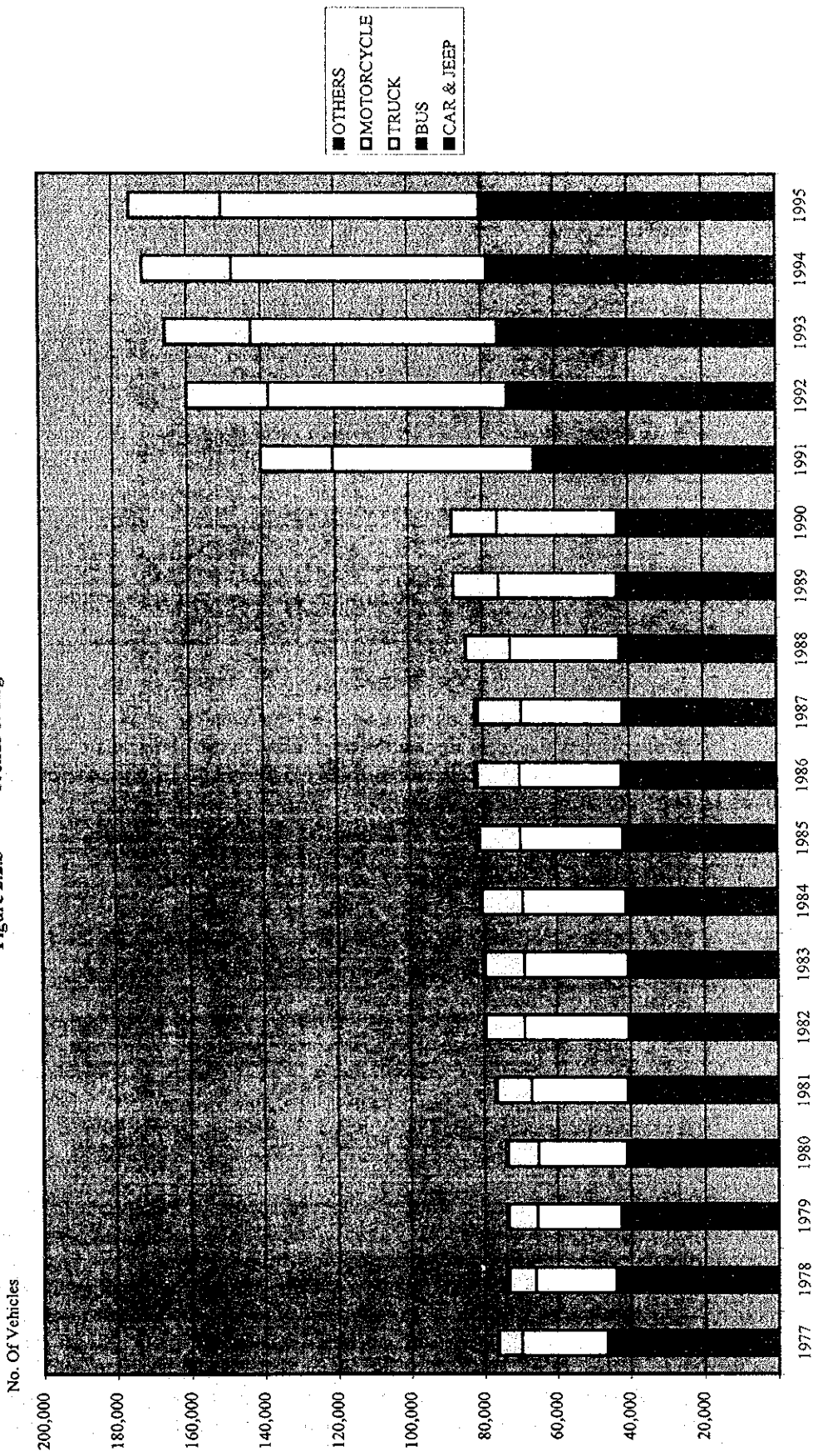


Table 2.2.16 Past Trends of Registered Vehicles

YEAR	CAR & JEEP	BUS	TRUCK	MOTORCYCLE	OTHERS	TOTAL
1977	42,937	3,341	23,579	6,414	458	76,729
	56%	4%	31%	8%	1%	100%
1978	40,979	3,020	21,966	7,356	542	73,863
	55%	4%	30%	10%	1%	100%
1979	39,259	3,255	23,027	7,840	569	73,950
	53%	4%	31%	11%	1%	100%
1980	37,540	3,489	24,089	8,324	588	74,030
	50%	5%	33%	11%	1%	100%
1981	35,467	5,288	26,228	9,541	483	77,007
	46%	7%	34%	12%	1%	100%
1982	33,394	7,087	28,370	10,758	377	79,986
	42%	9%	35%	13%	1%	100%
1983	34,356	6,372	28,235	10,887	451	80,301
	43%	8%	35%	14%	1%	100%
1984	35,478	5,735	28,183	11,140	555	81,091
	44%	7%	35%	14%	1%	100%
1985	36,638	5,159	28,023	11,255	622	81,697
	45%	6%	34%	14%	1%	100%
1986	37,593	4,443	27,908	11,606	722	82,272
	46%	5%	34%	14%	1%	100%
1987	37,979	3,728	27,687	11,903	788	82,085
	46%	5%	34%	14%	1%	100%
1988	39,267	3,045	29,984	12,158		84,454
	46%	4%	35%	14%		100%
1989	39,771	3,139	32,486	12,306		87,702
	45%	4%	37%	14%		100%
1990	39,823	3,139	32,868	12,308		88,138
	45%	4%	37%	14%		100%
1991	61,385	4,368	54,736	19,501		139,990
	44%	3%	39%	14%		100%
1992	67,158	5,943	64,684	22,221		160,006
	42%	4%	40%	14%		100%
1993	69,508	6,151	66,947	22,998		165,604
	42%	4%	40%	14%		100%
1994	72,046	6,376	69,392	23,838		171,652
	42%	4%	40%	14%		100%
1995	73,557	6,719	70,284	24,525		175,085
	42%	4%	40%	14%		100%

Source: Policia Nacional

Figure 2.2.5 Trends of Registered Vehicles



Source: Policia Nacional

**Table 2.2.17**  
**Number of Registered Vehicles by Department, 1994**

DEPARTMENT	NO. OF REGISTERED VEHICLES	%
Managua	85,594	49.9
Estelí	5,569	3.2
Matagalpa	7,276	4.2
León	12,116	7.1
Chontales	5,575	3.2
Rama-Nueva Guinea	719	0.4
Rio San Juan	368	0.2
Granada	9,926	5.8
Rivas	5,187	3.0
Madriz	2,956	1.7
Nueva Segovia	4,317	2.5
Jinotega	3,561	2.1
Chinandega	10,947	6.4
Boaco	2,751	1.6
Carazo	5,976	3.5
Masaya	7,346	4.2
RAAN	886	0.5
RAAS	582	0.3
<b>TOTAL</b>	<b>171,652</b>	<b>100.0</b>

Source: Policía Nacional

The Department of Managua, which includes the Municipality of Managua, shares a half of the national total. Considering that the population of the Department of Managua is 25%, the number of vehicles per person is three (3) times higher in the Department of Managua than in the rest of the country.

### 3) Level of Car Ownership of Nicaragua

Table 2.2.18 compares the level of car ownership of Nicaragua with other selected countries.

In Central America, Mexico, Costa Rica and Panama constitute a high car ownership group, while El Salvador, Guatemala and Honduras belong to a low car ownership group. Nicaragua's position falls in between these two (2) groups, though nearer to the low car ownership group. However, the car ownership level of the countries like Mexico and Costa Rica is still considerably lower than the developed countries such as U.S.A. and Germany.

In consideration of this situation, the car ownership level of Nicaragua is likely to increase very rapidly, if economy is to grow as planned. Moreover, Nicaragua's population is growing and will grow at a relatively high rate (e.g. 3 - 4 % p.a.). The effect of multiplication of these two (2) factors will result in a tremendous increase in number of cars running on roads of Nicaragua. For instance, if population doubles and car ownership increases to a level of 100 cars per 1000 persons in the next 20 years, the number of cars will be nearly 12 times of the present level. Even if the growth is slower than this hypothetical calculation, traffic congestion will be serious soon, and the needs for developing transport infrastructure will be of national interest.

**Table 2.2.18**  
**Comparison of Car Ownership of Nicaragua with Other Countries, 1996**

COUNTRY	No. OF CARS OWNED	POPULATION (000)	No. OF CARS PER 1000 PERSONS
Nicaragua	72,413*	4,357*	16.6
Costa Rica	259,000*	3,400	76.2
El Salvador	35,300*	5,829	6.1
Guatemala	103,500*	10,930	9.5
Honduras	69,000*	6,140	11.2
Mexico	8,330,000*	96,580	86.2
Panama	144,000*	2,670	53.9
Brazil	12,500,000*	157,870	79.2
U.S.A.	137,295,000	266,560	515.1
Germany	41,045,217	81,910	501.1
U.K.	25,547,607	58,140	439.4
Japan	46,868,362	125,760	372.7

Source: World Automotive Market Report  
Note: \* As of 1995

#### 4) Car Ownership in the Municipality of Managua

Table 2.2.19 shows the car ownership and number of owned cars by District as revealed by the Person-Trip Survey of this Study.

**Table 2.2.19**  
**Car Ownership and No. of Owned Cars by District, 1998**

District	Total	No. of Viviendas			No. of Cars Owned
		No-car Owning	Car Owning	Ratio (%)	
1	11,775	10,108	1,667	14.2	1,787
2	22,430	17,448	4,982	22.2	6,193
3	35,714	28,144	7,570	21.2	11,224
4	32,449	26,379	6,070	18.7	8,138
5	43,253	33,245	10,008	23.1	14,322
6	44,252	36,605	7,647	17.3	9,212
7	2,167	1,826	341	15.7	589
<b>Total</b>	<b>192,040</b>	<b>153,755</b>	<b>38,285</b>	<b>19.9</b>	<b>51,465</b>

Source: Person-Trip Survey, 1998

The average car ownership for the entire Municipality is about 20% in terms of number of viviendas. The rate is high in District 5, 2 and 3.

Car ownership has a strong relationship with the income level. Table 2.2.20 and Figure 2.2.6 clearly indicate that car ownership increases as income grows. For the viviendas with an income of C\$4,000/month or more, it seems to be natural to own a car.

Figure 2.2.7 shows distributions of average monthly income and car ownership of vivienda by traffic zone. It is clear that the car ownership is determined by the income level.

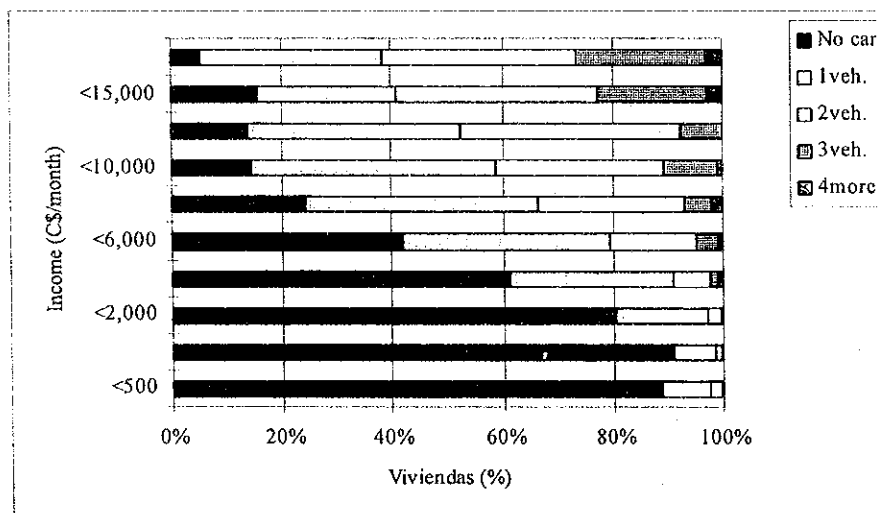
Zones that include higher-class residential areas such as Bolonia, Villa Fontana, Las Colinas and los Altos de Santo Domingo, with an average monthly income of more than C\$5,000/month are shown as with a car ownership of more than 50%. While rural zones and some zones in the urban area with an average monthly income of lower than C\$2,000/month show a car ownership of lower than 20%.

**Table 2.2.20**  
**Car Ownership by Average Income Level, 1998**

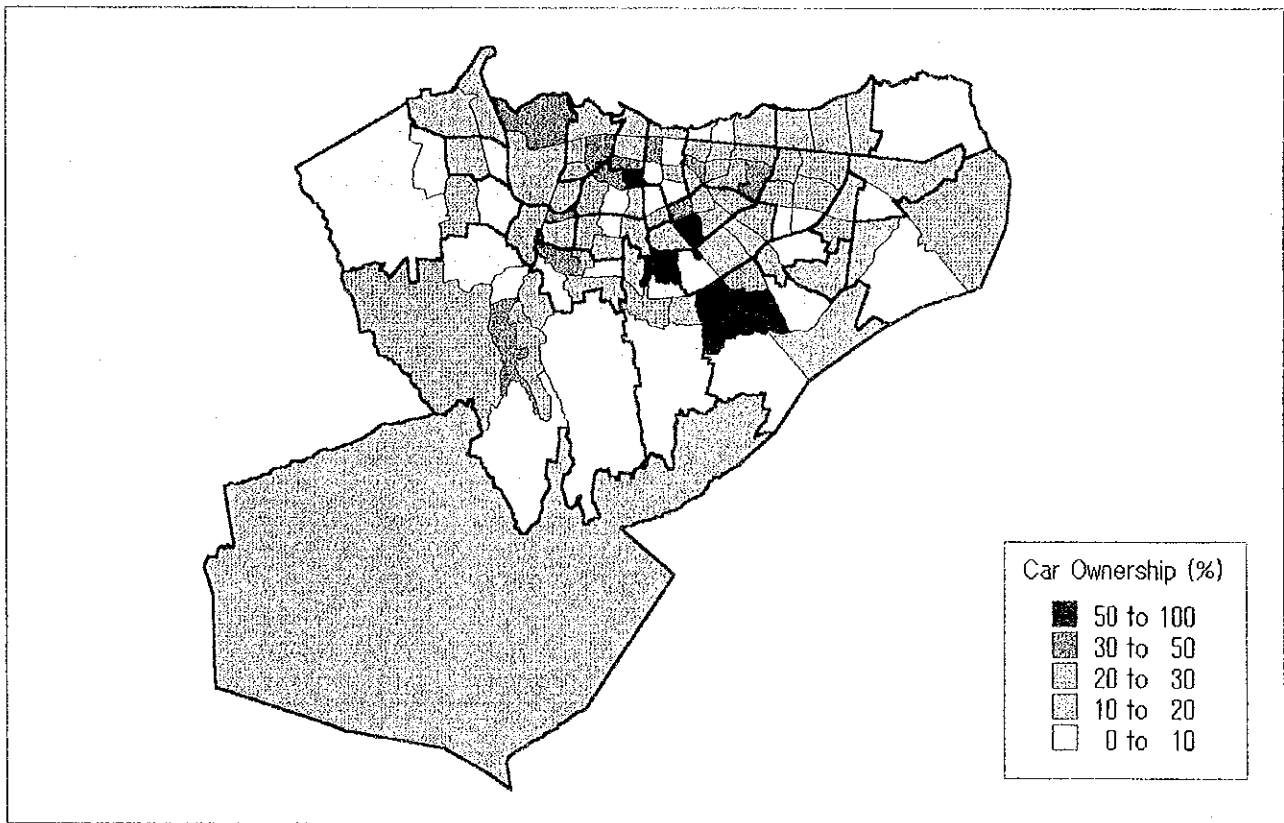
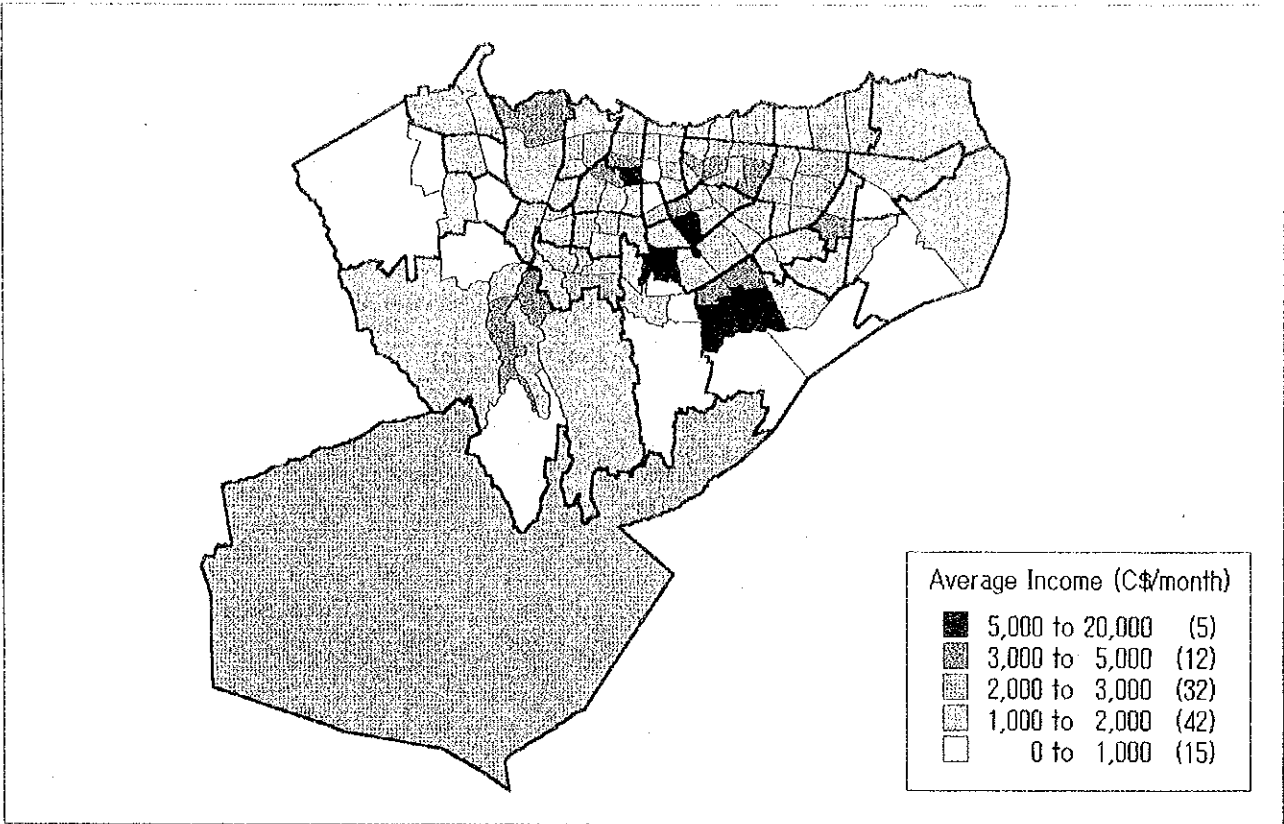
Monthly Income (C\$/vivienda)	Non car Owing Viviendas	Car Owing Viviendas					Total	Car Owing Ratio
		1 veh.	2 veh.	3 veh.	4 veh. and more			
0 - 500	22,463	2,172	525	43	70	2,810	11.1	
501 - 1,000	46,052	3,991	536	35	86	4,648	9.2	
1,001 - 2,000	39,069	8,234	1,141	100	133	9,608	19.7	
2,001 - 4,000	13,708	6,664	1,443	352	213	8,672	38.7	
4,001 - 6,000	2,429	2,165	900	243	43	3,351	58.0	
6,001 - 8,000	451	790	497	90	39	1,416	75.8	
8,001 - 10,000	212	663	451	146	16	1,276	85.8	
10,001 - 12,000	114	322	331	63	0	716	86.3	
12,001 - 15,000	119	198	283	154	22	657	84.7	
15,001 - 20,000	41	253	266	180	22	721	94.6	
20,001 and more	200	266	152	67	69	554	73.5	
<b>Total</b>	<b>124,858</b>	<b>25,718</b>	<b>6,525</b>	<b>1,473</b>	<b>713</b>	<b>34,429</b>	<b>21.6</b>	

Source: Person-Trip Survey 1998  
Note: Based on effective answers.

**Figure 2.2.6**  
**Car Ownership and Monthly Income, 1998**



Source: Person-Trip Survey 1998



**Figure 2.2.7**  
Average Income and Car Ownership

## 2.2.6 Governmental Expenditure

The revenue of the Central Government of Nicaragua is shown in Table 2.2.21. The increase rate of the total revenue from the year 1991 to 1997 is about 20% p.a. The revenue derived from the import tax shares 22% to the total revenue, followed by other consumption tax at 20% in 1997.

**Table 2.2.21**  
**Revenue of Central Government**

Items	(C\$ million)						
	1991	1992	1993	1994	1995	1996	1997
<b>Total Revenue</b>	<b>1,446.6</b>	<b>1,893.0</b>	<b>2,221.8</b>	<b>2,529.6</b>	<b>3,136.3</b>	<b>3,654.2</b>	<b>4,151.1</b>
<b>Tax</b>	<b>1,359.9</b>	<b>1,796.1</b>	<b>2,073.6</b>	<b>2,383.3</b>	<b>2,932.9</b>	<b>3,452.3</b>	<b>3,912.1</b>
Income Tax	205.1	306.5	266.7	263.0	400.5	511.3	611.9
I.G.V *	159.0	211.6	320.5	354.2	409.4	519.4	616.7
Oil Consumption Tax	208.9	297.4	409.6	513.7	574.3	667.6	740.3
Other Consumption Tax	359.0	504.6	461.8	557.6	646.3	707.6	816.5
Others	161.2	111.8	171.4	178.6	223.3	267.5	196.9
Import Tax	266.7	364.2	443.6	516.2	679.1	778.9	929.8
<b>Non-Tax</b>	<b>72.0</b>	<b>84.3</b>	<b>89.6</b>	<b>115.0</b>	<b>135.3</b>	<b>159.8</b>	<b>217.2</b>
<b>Capital Revenue</b>	<b>14.7</b>	<b>12.6</b>	<b>58.6</b>	<b>31.3</b>	<b>68.1</b>	<b>42.1</b>	<b>21.8</b>

Source: MIFIN

Note: \* General Sales Tax (Impuesto General de Ventas)

Capital expenditure by the Central Government shares 32% of the total expenditure as shown in Table 2.2.22. The direct investment to the works and construction sector was 661 million Cordoba in 1997 which shares 13.3% of the total expenditure.

**Table 2.2.22**  
**Expenditure of Central Government**

Items	(C\$ million)						
	1991	1992	1993	1994	1995	1996	1997
<b>Total Expenditure</b>	<b>2,003.0</b>	<b>2,595.9</b>	<b>3,033.6</b>	<b>3,768.0</b>	<b>4,396.0</b>	<b>5,057.3</b>	<b>4,956.5</b>
<b>Current Expenditure</b>	<b>1,742.6</b>	<b>2,042.0</b>	<b>2,281.7</b>	<b>2,649.3</b>	<b>2,728.4</b>	<b>3,280.5</b>	<b>3,365.7</b>
Payment	434.4	673.7	818.8	834.2	863.7	844.6	842.7
Goods and Services	733.7	635.1	604.2	585.9	487.3	954.3	667.8
Internal Interests	0.6	0.5	0.0	42.0	26.9	48.8	70.4
External	84.2	263.3	425.5	600.9	544.0	447.3	761.6
Transfer	489.7	469.4	433.2	586.3	806.5	985.5	1,023.2
<b>Capital Expenditure</b>	<b>260.4</b>	<b>553.9</b>	<b>751.9</b>	<b>1,118.7</b>	<b>1,667.6</b>	<b>1,776.8</b>	<b>1,590.8</b>
Direct Investment	223.5	330.8	301.5	657.5	933.9	1,061.8	757.9
Works and Construction	130.8	261.8	249.1	553.5	627.7	880.8	661.0
Machine and Equipment	25.1	48.7	26.1	24.1	138.2	178.5	91.3
Finance	67.6	20.3	26.3	79.9	168.0	2.5	5.6
Transfer	36.9	223.1	450.4	461.2	733.7	715.0	832.9

Source: MIFIN

## 2.3 Transportation Demand

### 2.3.1 Number of Trips

The total number of trips generated in a weekday in the Study Area (Municipality of Managua, hereafter referred to as Managua) is about 2,500 thousand, of which 94.5% are made by residents in Managua and the remaining 5.5% by non-residents. The modal shares are 25.6% by walk, 34.1% by car (passenger car and taxi), 36.5% by bus, 1.1% by truck and 2.7% by others (motorcycle, bicycle, etc.).

**Table 2.3.1**  
**Number of Trips Traveled in the Study Area, 1998**

Mode	Number of Trips Traveled by				Total (000)	Rate (%)
	Residents		Non-Residents			
	(000)	Rate (%)	(000)	Rate (%)		
Walk	638	27.1	0	0.0	638	26.0
Car	811	34.5	37	36.1	849	34.5
Truck	17	0.7	11	10.2	27	1.1
Bus	822	34.9	53	51.6	875	35.6
Others	65	2.8	2	2.1	67	2.7
<b>Total</b>	<b>2,353</b>	<b>100.0</b>	<b>103</b>	<b>100.0</b>	<b>2,457</b>	<b>100.0</b>
Rate (%)	94.5		4.2			

2,300 thousand trips or 92% are those that move inside Managua, while 200 thousand trips or 8% move crossing the boundary of Managua. Though the share is low, these intercity trips have a considerable influence on the traffic situation of Managua because all of them are motorized without any walk trips.

**Figure 2.3.1**  
**Number of Person Trips in the Study Area, 1998**

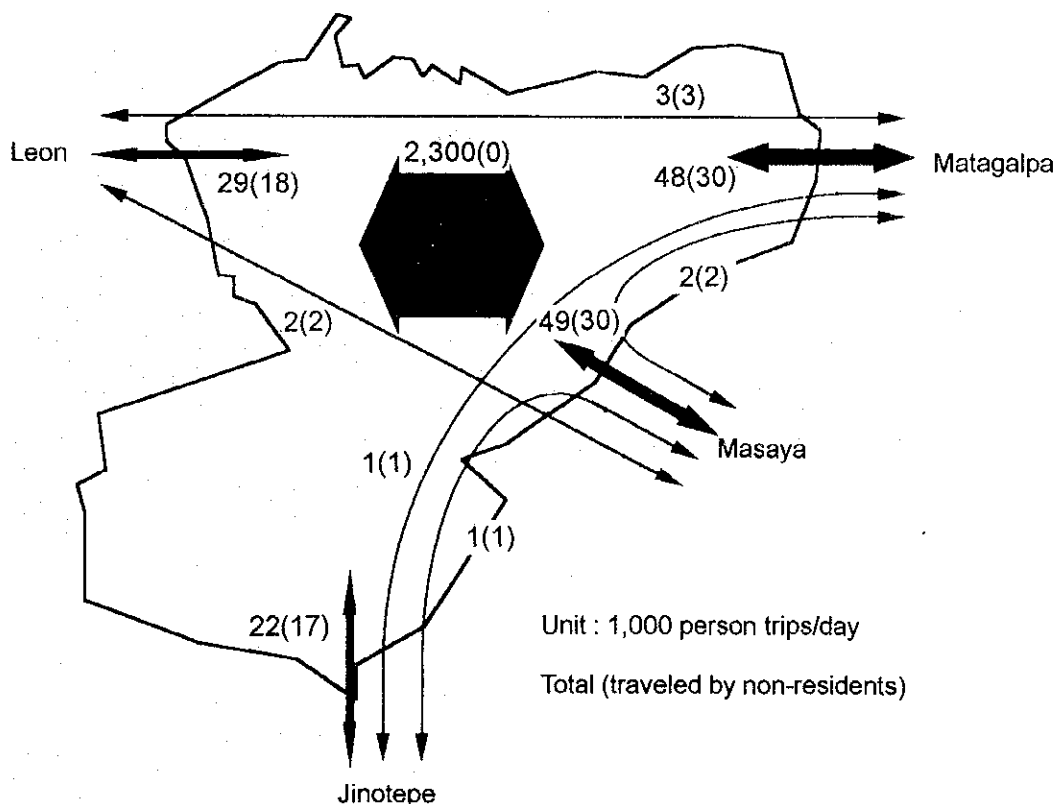




Table 2.3.2 classifies the intercity traffic by direction and by vehicle type. 78 thousand trips are of the direction of Matagalpa, 57 thousand of Masaya, 26 thousand to Jinotepe and 35 thousand to Leon. As a whole, Managua residents use cars while non-residents are mostly bus passengers. For the direction of Masaya, however, half of non-resident passengers use cars.

**Table 2.3.2**  
**Number of Person Trips by Direction and Type of Vehicle, 1998**

Mode	Bound to / from							
	Matagalpa		Masaya		Jinotepe		Leon	
	Residents (000)	Non- Residents (000)	Residents (000)	Non- Residents (000)	Residents (000)	Non- Residents (000)	Residents (000)	Non- Residents (000)
Car	10.6	11.8	9.9	18.9	2.5	4/5	7.7	4.2
(%)	60.1	19.6	55.1	48.4	53.6	21.3	70.7	17.8
Truck	0.2	4.9	0.6	3.8	0.0	1.5	0.3	2.0
(%)	0.9	8.1	3.5	9.7	0.0	7.0	2.4	8.5
Bus	6.2	42.4	7.1	15.4	2.2	15.1	2.6	17.5
(%)	35.3	70.6	39.1	39.5	46.4	71.1	23.9	73.7
Others	0.7	1.0	0.4	0.9	0.0	0.1	0.3	0.0
(%)	3.7	1.7	2.3	2.4	0.0	0.6	3.1	0.1
Total	17.7	60.1	18.1	39.1	4.7	21.2	10.9	23.7
(%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

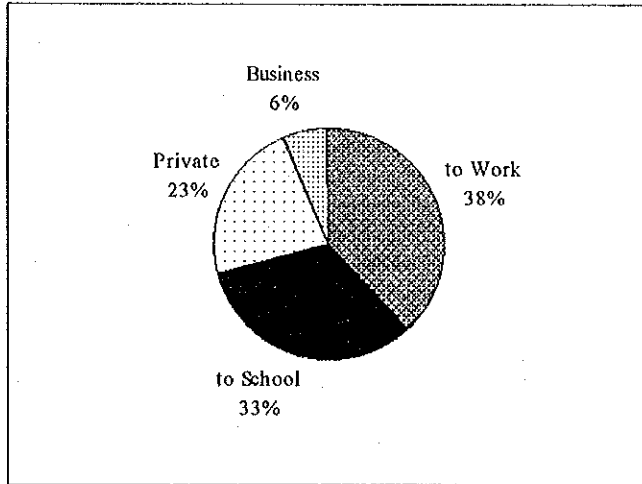
### 2.3.2 Trip Purpose and Transportation Mode

The trip purpose composition of Managua's residents is presented in Table 2.3.3. Excluding "To home" trips, "To work" shares 38%, "To school" 33%, "Personal activity" 23% and "Business activity" 6%. If walk trips are excluded, the share of "To school" trips decreases considerably.

**Table 2.3.3**  
**Number of Person Trips by Trip Purpose, 1998**

Trip Purpose	Including Walk Trips			Excluding Walk Trips		
	(000)	Rate (%)	Rate (%)	(000)	Rate (%)	Rate (%)
To Home	1,125	47.8		809	47.2	
To work	467	19.8	38.0	414	24.1	45.7
To School	399	17.0	32.5	197	11.5	21.7
Personal Activity	284	12.1	23.1	224	13.1	24.8
Business Activity	78	3.3	6.4	71	4.1	7.8
<b>Total</b>	<b>2,353</b>	<b>100.0</b>		<b>1,715</b>	<b>100.0</b>	

**Figure 2.3.2**  
**Trip Purpose Composition (Including "walk" trips)**



**Figure 2.3.3**  
**Trip Purpose Composition (Excluding "walk" trips)**

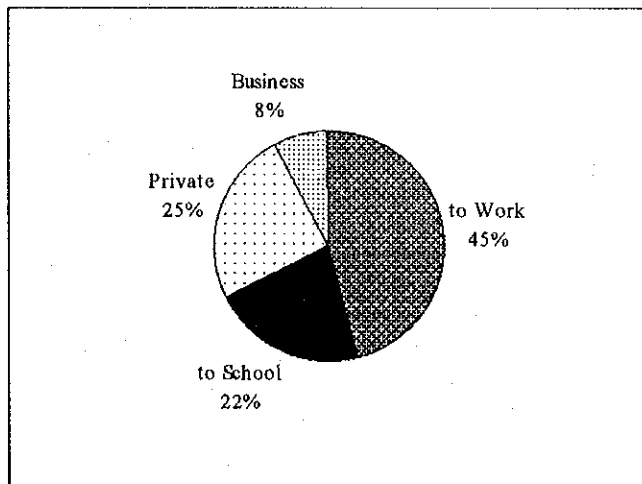


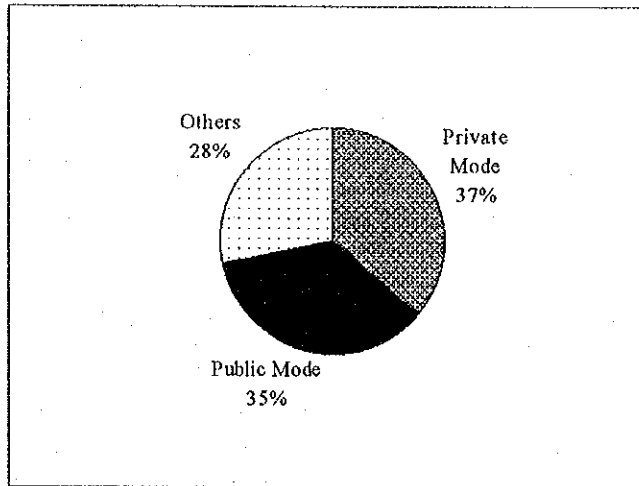
Table 2.3.4 shows the modal choice behavior of Managua's residents. Private mode shares 36.5% and public mode 35.1%. The remaining 28.4% are by non-motorized modes such as walk and bicycle. It should be noted that taxi is classified as private mode. If taxi is regarded as public mode, the share of private and public mode becomes 30.9% and 40.7%, respectively. Of the private mode, car shares nearly 80%, and bus is actually the only choice of the public mode. Namely, the modal choice in Managua is simple, i.e. car or bus.

**Table 2.3.4**  
**Number of Person Trips by Transportation Mode, 1998**

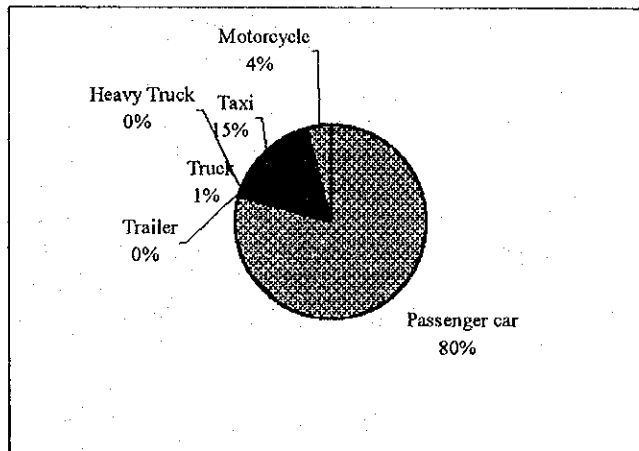
Mode	No. of Trips (000)	% to Mode	% to Total
<b>Total</b>	<b>2,353.3</b>		<b>100.0</b>
<b>Private Mode</b>	<b>858.7</b>	<b>100.0</b>	<b>36.5</b>
Passenger car	679.6	79.1	28.9
Truck	10.6	1.2	0.5
Heavy Truck	1.3	0.1	0.1
Trailer	0.1	0.0	0.0
Taxi	131.8	15.4	5.6
Motorcycle	35.3	4.1	1.5
<b>Public Mode</b>	<b>826.6</b>	<b>100.0</b>	<b>35.1</b>
Passenger truck	4.5	0.5	0.2
Micro-bus	16.1	1.9	0.7
Bus	806.0	97.5	34.3
<b>Others</b>	<b>667.9</b>	<b>100.0</b>	<b>28.4</b>
Walking	638.3	95.6	27.1
Bicycle	25.7	3.8	1.1
Others	3.9	0.6	0.2

Note: 1) Taxi is classified as private.  
2) "Passenger truck" and "Microbus" are institutionally city buses.

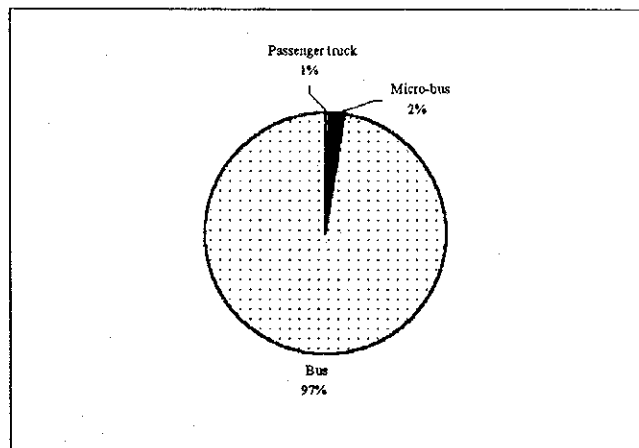
Figure 2.3.4  
Modal Share of Person Trips



TOTAL



PRIVATE



PUBLIC

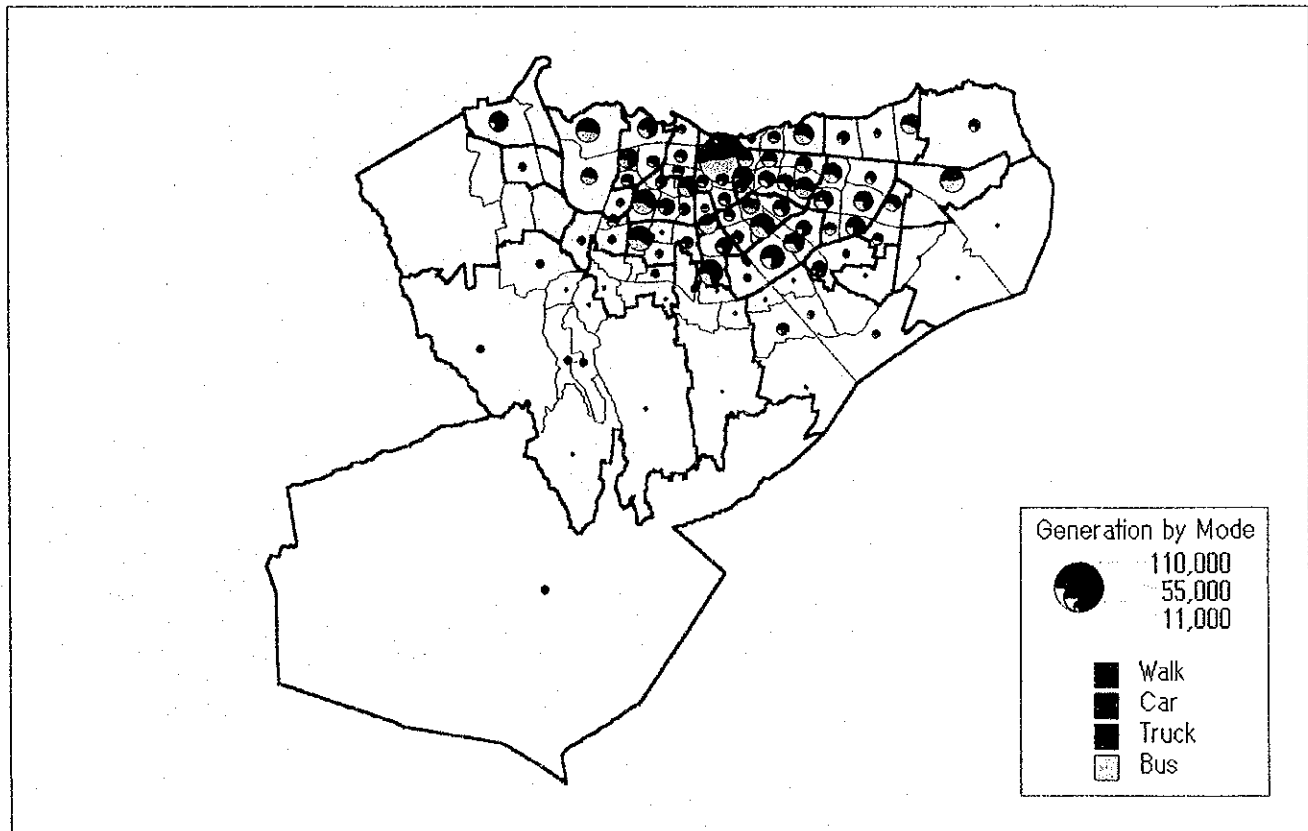
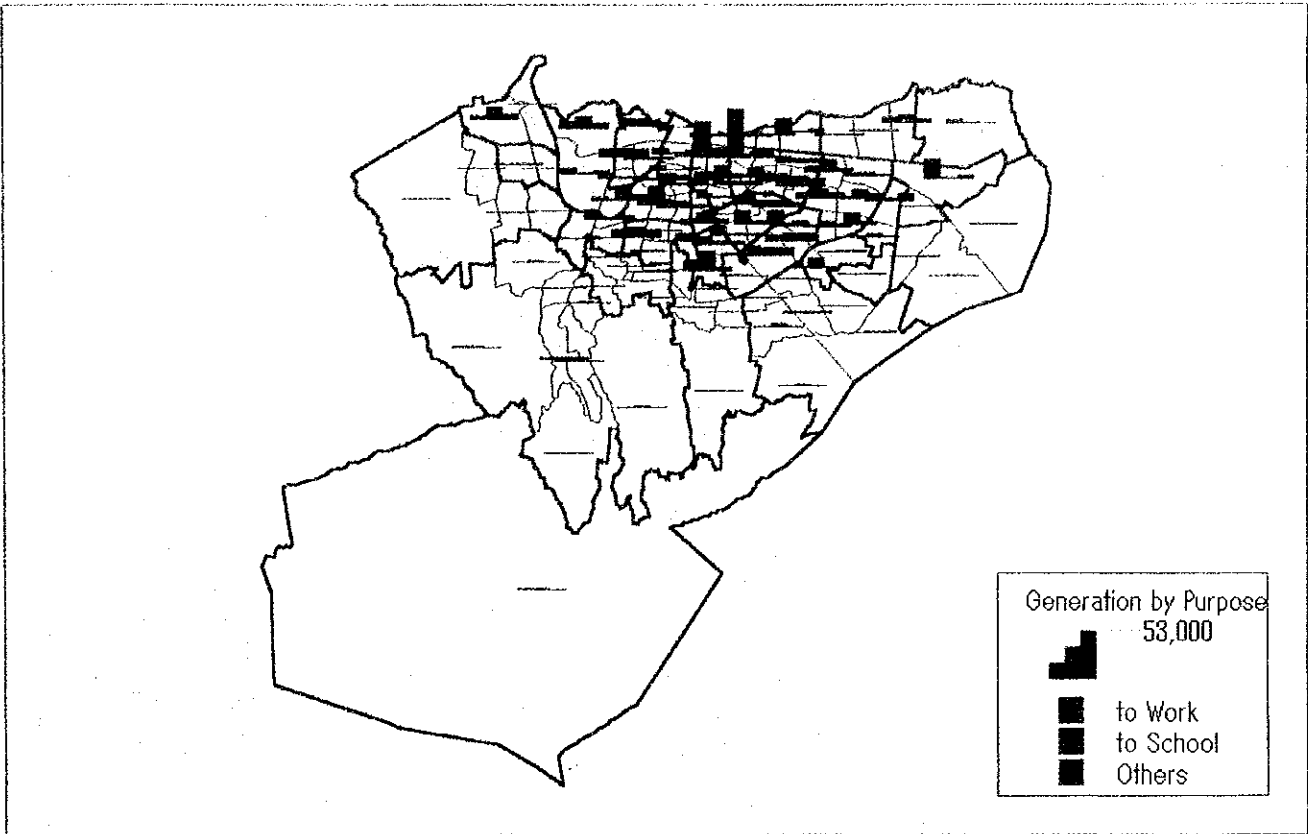
### 2.3.3. Generation and Attraction

Figure 2.3.5 presents the trip generation by zone and by trip purpose.

- Trip generation is large in the south-eastern part of the urbanized area surrounded by Carretera Norte, Pista Juan Pablo II, Carretera a Masaya and Pista del Mayoreo. Ciudad Sandino and some other densely populated zones also have a large generation.
- Zones that have large trip generation are Villa Progreso, Ciudad Sandino, Villa Revolución, 14 de Septiembre, Georgino Andrade, Linda Vista, Mercado Boer, etc.
- Trip purpose composition is similar in most zones; where “To work” trips are generated in large numbers, “To school” and other trips are also numerous.
- However, mode selection differs remarkably by zone. The share of car as well as the number of car trips is high in Linda Vista, 10 de Junio, Mercado Boer, Villa Fontana, Santo Domingo, San José Oriental, etc. On the other hand, bus trips are dominant in Villa Progreso, Ciudad Jardín, Villa J.B. Escobar, 14 de Septiembre, Villa Revolución, Georgino Andrade, Sócrates Sandino, etc.

Figure 2.3.6 shows the distribution of destination (trip attraction) for the same trips shown in the previous figure excluding “To home” trips.

- More than 100 thousand trips are attracted to Zone 51 (Mercado Oriental). “To work” trips accounts for 40 thousand and “Others (personal and business)” 53 thousand.
- “To school” trips are almost proportional to zonal population reflecting children’s walk trips to their schools. Its number is large in Villa Fontana, Ciudad Sandino, Villa Progreso, Villa Venezuela, UCA, Riguero, Villa Revolución, Sócrates Sandino, etc.
- Mode selection also differs by zone though not so noticeable as trip generation. Car use is dominant in Villa Fontana, Mexico, Centro América, Los Robles, Bolonia, etc., while bus is preferred in Mercado Oriental, Airport Zona Franca, Mercado Boer, Linda Vista, Bello Horizonte, San Judas, Villa Progreso, etc.



**Figure 2.3.5 Generation of Person Trips by Traffic Zone**

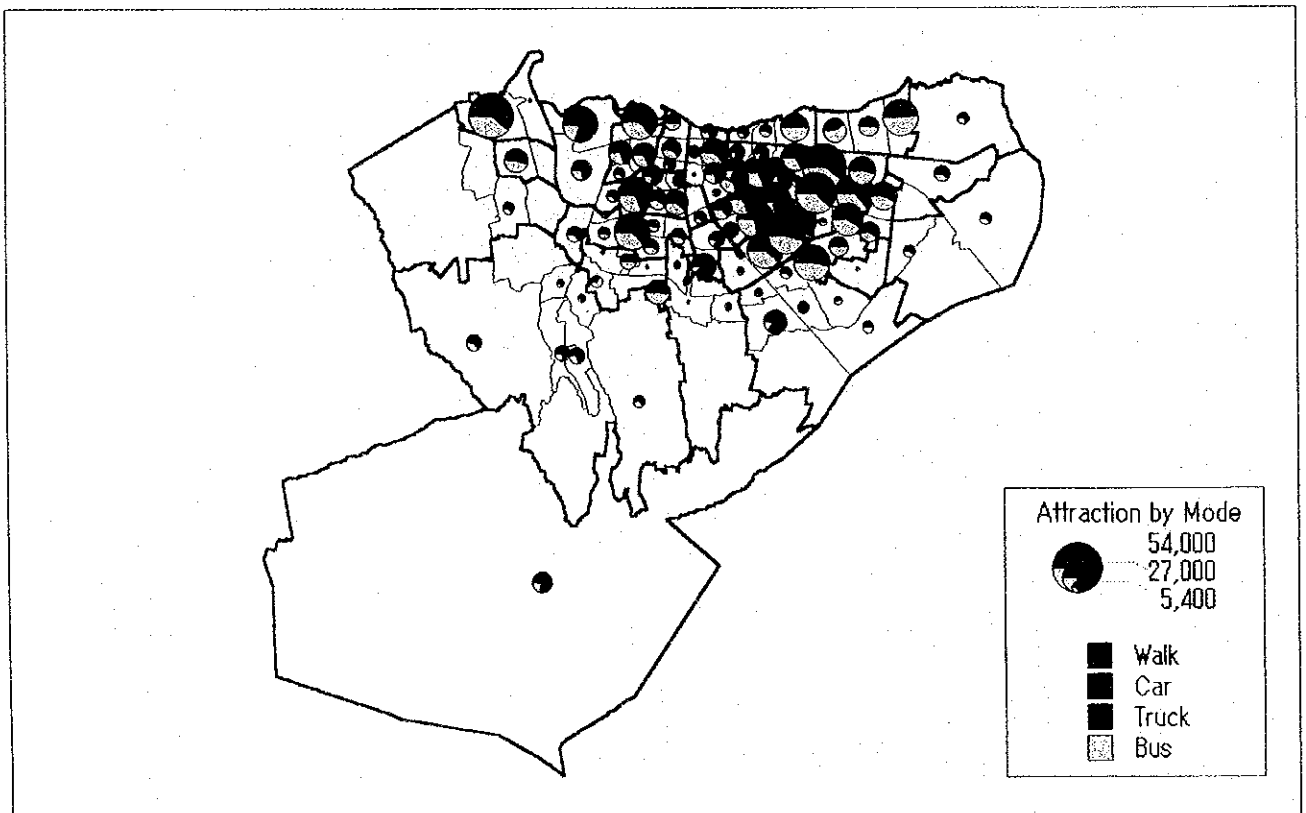
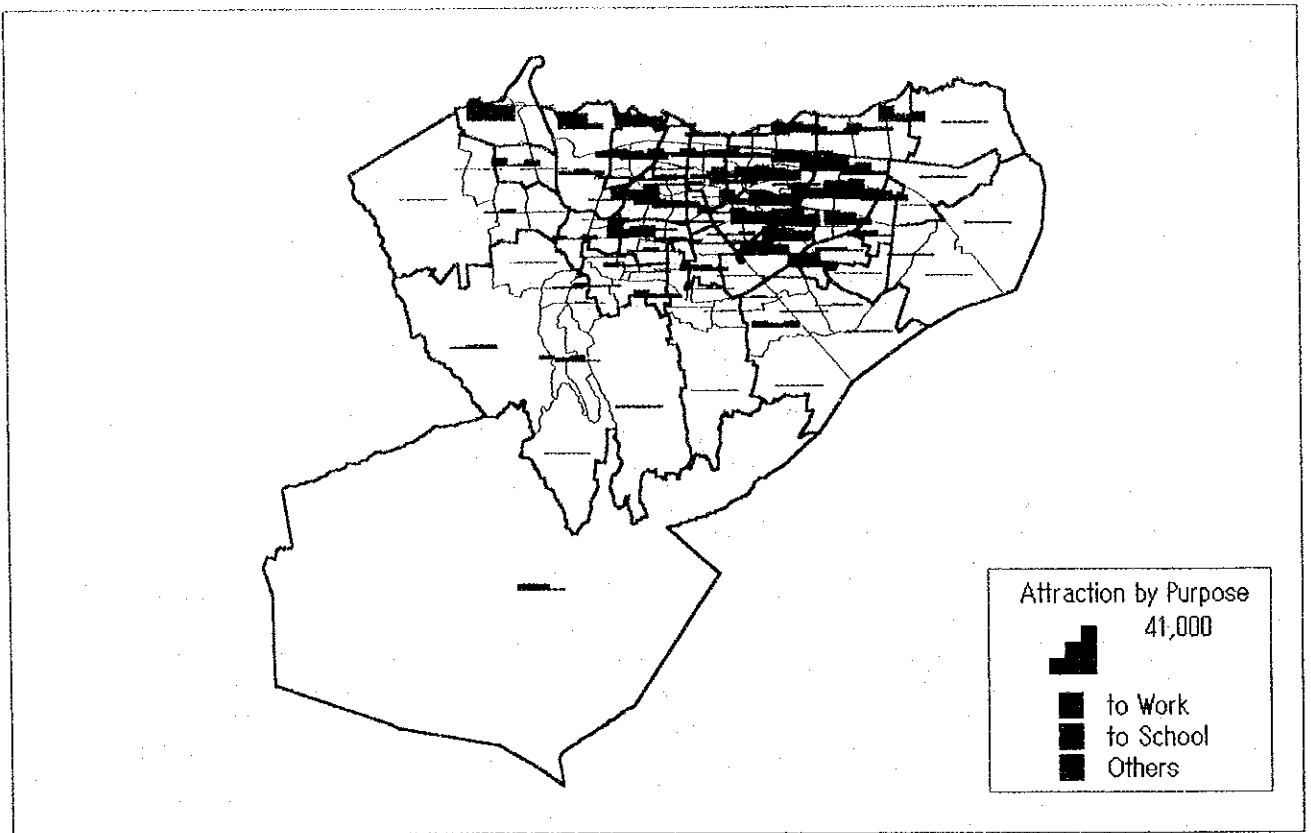


Figure 2.3.6 Attraction of Person Trips by Traffic Zone

### 2.3.4 Trip Distribution

Figure 2.3.7 illustrates the desire lines of person-trips by purpose in Managua as of 1998.

- “To Work” trips concentrate in the existing commercial area of central Managua including Mercado Oriental and Mercado Huembes. The distribution of trips to these areas is comparatively equal among zones regardless of trip distance. The zone of Mercado Oriental attracts the largest number of “To Work” trips at about 42,400 per day.
- “To School” trips generally have a short travel distance because most of primary and secondary school pupils go to school within the residing zone. Attraction of this trip is large in the zones where large universities exist. In some suburban zones, “To School” trips to the adjacent zones are remarkable.
- Similarly to “To Work” trips, the distribution of “Private” trips is relatively equal among zones concentrating in the commercial zones in central Managua. Ciudad Sandino generates a large number of “Private” trips.
- Densely populated area such as Ciudad Sandino and Central Managua generates a considerable number of trips attracted to business/commercial zones.

### 2.3.5 Travel Time

#### 1) Peak Hour

Table 2.3.6 and 2.3.7 show the number of trips generated and attracted by hour, respectively. The peak hour for “To Work” trips is 7:00 to 8:00 a.m., and during the 3-hour period from 6:00 to 9:00 a.m. more than 70% of “To Work” trips (about 350 thousand a day) are generated and attracted. The peak hour for “To School” trips is 6:00 to 7:00 a.m. for generation (departure) and 7:00 to 8:00 a.m. for attraction (arrival). The hour 12:00 a.m. to 1:00 p.m. also shows a peak in the case of “To School” trips.

“Private” and “Business” trips do not show a large fluctuation having relatively a flat distribution during daytime.

As a whole, the peak hour is 6:00 to 7:00 a.m. for generation (14.5% or 340 thousand a day) and 7:00 to 8:00 a.m. for attraction (15.0% or 352 thousand a day).

#### 2) Travel Time

Table 2.3.5 presents the average travel time by travel mode. “Walk” mode (including bicycle) has a relatively long travel time at 21.5 minutes. The difference of about 9 minutes between car and bus can be attributed to bus waiting time, access time to/from bus stops and the difference in running speed. The travel time by truck is in between bus and car due to a large number of trucks used as private cars.

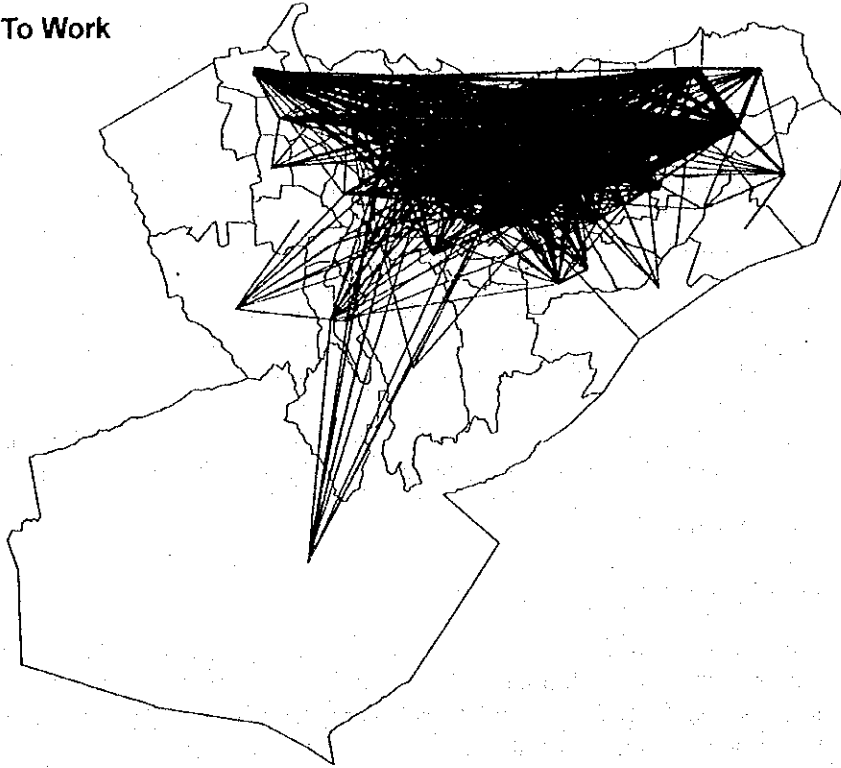
**Table 2.3.5**  
**Average Trip Time by Mode, 1998**

Mode	Average Trips Time (Minute)
Walk	21.5
Car	35.6
Truck	38.2
Bus	44.8
M/C	30.4

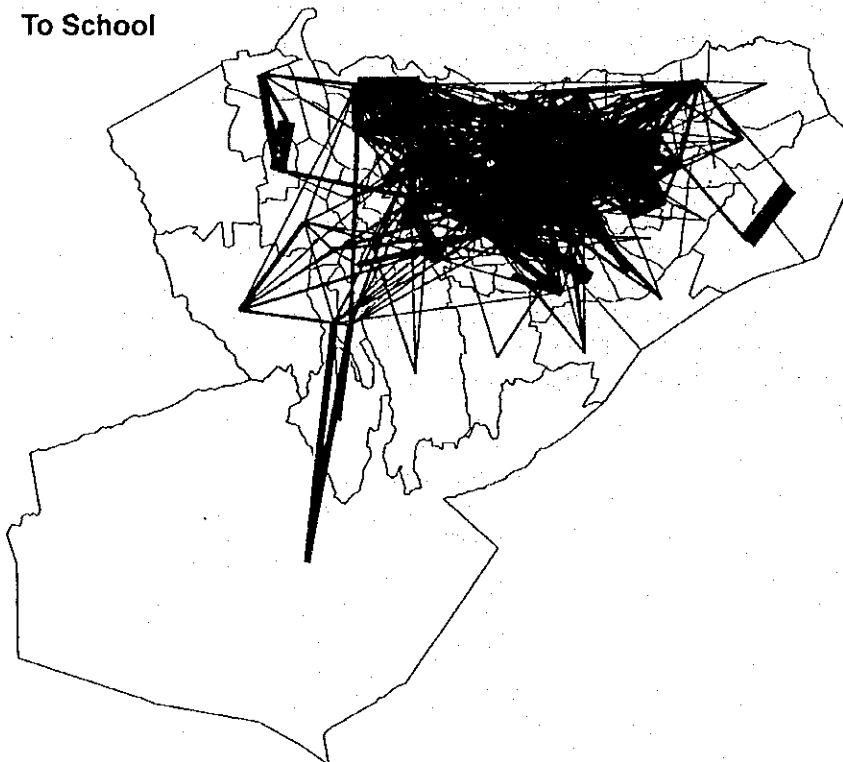


Figure 2.3.7  
Desire Lines of Trips by Purpose, 1998

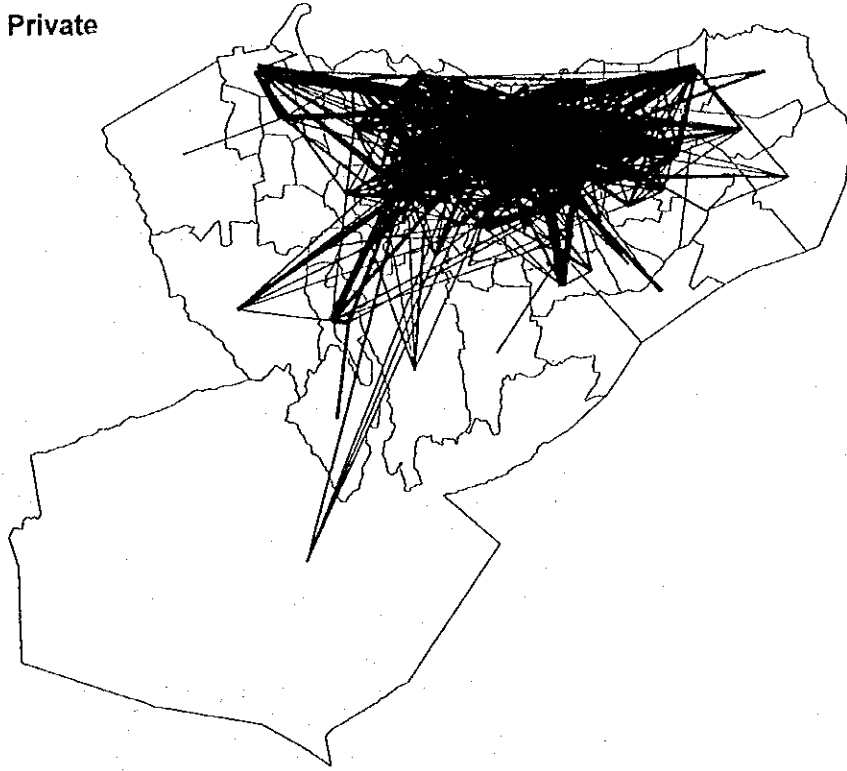
To Work



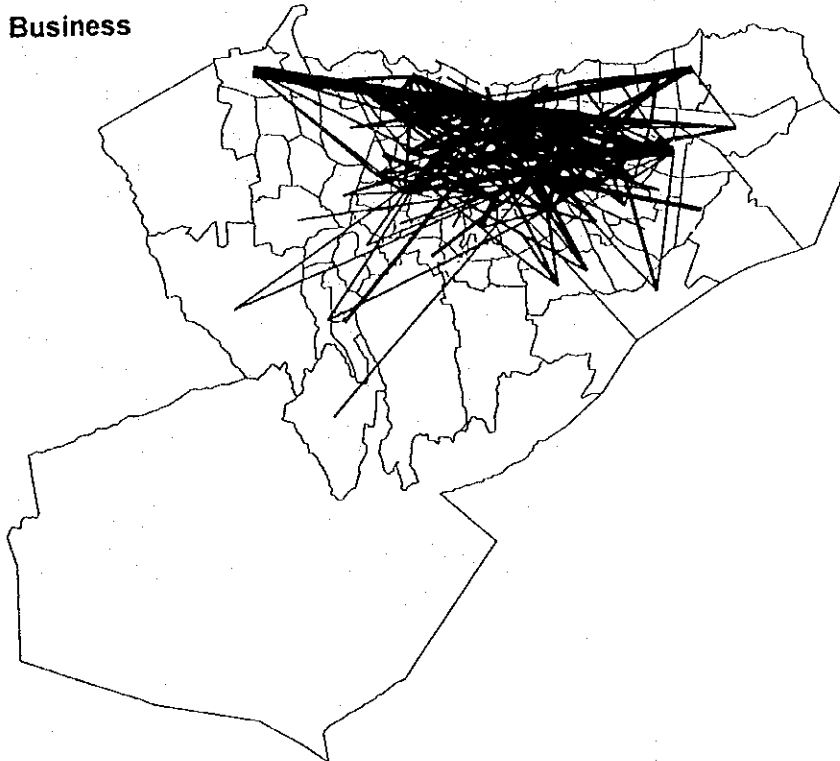
To School



**Private**



**Business**



**Table 2.3.6**  
**Number of Trips Generated by Hour, 1998**

Hour	to Home	to Work	to School	Personal Activity	Business Activity	Total
0 - 1	0.4	0.1	0.2	0.1	0.0	0.8
1 - 2	1.6	0.6	0.2	0.3	0.0	2.7
2 - 3	0.8	0.3	0.3	1.0	0.1	2.5
3 - 4	1.2	0.5	0.1	0.9	0.0	2.7
4 - 5	1.6	6.7	0.2	1.8	1.4	11.6
5 - 6	4.1	39.4	9.6	5.8	4.6	63.5
6 - 7	9.5	125.2	178.1	18.4	9.1	340.2
7 - 8	11.9	161.0	47.8	26.4	10.7	257.9
8 - 9	11.1	50.8	7.0	36.1	10.6	115.6
9 - 10	16.9	12.3	2.3	33.7	7.9	73.1
10 - 11	31.6	6.0	2.0	22.2	6.7	68.5
11 - 12	67.3	4.5	11.6	16.5	3.6	103.6
12 - 13	223.6	8.3	85.7	12.6	2.5	332.6
13 - 14	43.0	14.7	10.2	13.7	3.4	84.9
14 - 15	28.8	10.1	2.9	21.9	6.5	70.1
15 - 16	36.5	4.4	1.6	18.8	3.8	65.2
16 - 17	70.0	4.3	2.4	13.7	2.2	92.6
17 - 18	273.0	8.8	28.5	15.7	1.8	327.8
18 - 19	119.4	4.2	7.3	12.2	1.0	144.0
19 - 20	58.7	2.8	0.8	6.4	1.2	70.0
20 - 21	41.1	0.8	0.1	2.9	0.4	45.3
21 - 22	55.8	0.9	0.5	2.0	0.2	59.3
22 - 23	10.5	0.3	0.0	0.2	0.2	11.2
23 - 24	6.8	0.3	0.1	0.4	0.2	7.6
<b>Total</b>	<b>1,125.2</b>	<b>466.9</b>	<b>399.4</b>	<b>283.7</b>	<b>78.1</b>	<b>2,353.3</b>

**Table 2.3.7**  
**Number of Trips Attracted by Hour, 1998**

Hour	to Home	to Work	to School	Personal Activity	Business Activity	Total
0 - 1	0.3	0.0	0.0	0.1	0.0	0.4
1 - 2	1.0	0.5	0.1	0.3	0.0	1.9
2 - 3	1.3	0.3	0.4	0.6	0.2	2.8
3 - 4	0.7	0.1	0.1	1.0	0.1	1.9
4 - 5	1.4	3.6	0.0	1.4	0.6	7.0
5 - 6	2.3	15.6	1.0	2.9	1.9	23.7
6 - 7	6.6	75.1	88.2	13.7	6.1	189.7
7 - 8	13.3	166.7	136.7	24.9	10.9	352.6
8 - 9	11.8	111.8	14.4	33.4	12.0	183.4
9 - 10	13.0	18.9	3.2	37.3	8.4	80.9
10 - 11	23.8	6.6	1.9	24.6	7.7	64.7
11 - 12	47.3	5.1	3.6	16.9	3.5	76.4
12 - 13	194.9	6.7	69.0	15.5	4.4	290.5
13 - 14	82.9	13.8	33.1	11.6	3.4	144.8
14 - 15	32.9	13.0	4.5	20.1	5.7	76.2
15 - 16	33.2	4.7	1.5	20.5	3.9	63.9
16 - 17	49.3	3.7	2.3	15.6	2.5	73.5
17 - 18	181.4	6.9	15.9	14.4	1.7	220.3
18 - 19	187.4	6.9	20.8	14.0	1.8	230.9
19 - 20	92.0	3.6	1.3	8.2	1.5	106.5
20 - 21	51.1	1.7	0.3	3.3	0.8	57.2
21 - 22	61.4	0.9	0.4	2.6	0.3	65.6
22 - 23	24.1	0.5	0.2	0.3	0.3	25.3
23 - 24	11.7	0.3	0.5	0.4	0.3	13.2
<b>Total</b>	<b>1,125.2</b>	<b>466.9</b>	<b>399.4</b>	<b>283.7</b>	<b>78.1</b>	<b>2,353.3</b>