Technical Report Documentation Page

<table>
<tr><td>1. Report No.
FHWA/TX-03/4197-3</td><td>2. Government Accession No.</td><td colspan="2">3. Recipient's Catalog No.</td></tr>
<tr><td colspan="2" rowspan="2">4. Title and Subtitle

ASSESSING THE ENVIRONMENTAL BENEFITS OF INTELLIGENT TRANSPORTATON SYSTEMS MEASURES: METHODOLOGIES AND APPLICATIONS</td><td colspan="2">5. Report Date
January 2003</td></tr>
<tr><td colspan="2">6. Performing Organization Code</td></tr>
<tr><td colspan="2">7. Author(s)
Tejas Mehta, Amulya Kottapalli,
Hani S. Mahmassani, Chandra Bhat</td><td colspan="2">8. Performing Organization Report No.
4197-3</td></tr>
<tr><td colspan="2" rowspan="2">9. Performing Organization Name and Address
Center for Transportation Research
The University of Texas at Austin
3208 Red River, Suite 200
Austin, TX 78705-2650</td><td colspan="2">10. Work Unit No. (TRAIS)</td></tr>
<tr><td colspan="2">11. Contract or Grant No.
0-4197</td></tr>
<tr><td colspan="2" rowspan="2">12. Sponsoring Agency Name and Address
Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, TX 78763-5080</td><td colspan="2">13. Type of Report and Period Covered
Research Report
9/1/00-08/31/02</td></tr>
<tr><td colspan="2">14. Sponsoring Agency Code</td></tr>
<tr><td colspan="4">15. Supplementary Notes
Project conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration, and the Texas Department of Transportation.</td></tr>
<tr><td colspan="4">16. Abstract
This study attempts to define a framework for comparing various modeling approaches that can be used to assess the impact of Intelligent Transportation Systems (ITS) strategies on mobile source emissions. The study begins by reviewing the connection between transportation and air quality, and by reviewing methodologies that have been employed in literature on the impact of ITS on emissions. An analysis framework is developed that provides a platform for performing a comparative evaluation of various network modeling and emission modeling approaches in the context of air quality assessment of ITS strategies. Procedures and tools required to implement such a framework are then described in some detail. Two case studies are conducted on the Fort Worth network and Houston network using this framework. Carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx) estimates from the simulation runs are then discussed and analyzed.</td></tr>
<tr><td colspan="2">17. Key Words
Intelligent Transportation Systems, Mobile Source Emissions, Air Quality</td><td colspan="2">18. Distribution Statement
No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.</td></tr>
<tr><td>19. Security Classif. (of report)
Unclassified</td><td>20. Security Classif. (of this page)
Unclassified</td><td>21. No. of pages
172</td><td>22. Price</td></tr>
</table>

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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Transportation Research
The University of Texas at Austin

Assessing the Environmental Benefits of Intelligent Transportation Systems Measures: Methodologies and Applications

Tejas Mehta
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Hani S. Mahmassani
Chandra R. Bhat

CTR Research Report: 4197-3
Report Date: January 2003
Research Project: 0-4197
Research Project Title: *Environmental Benefits of Intelligent Transportation Systems (ITS)*

This research was conducted for the Texas Department of Transportation in cooperation with the U.S. Department of Transportation, Federal Highway Administration by the Center for Transportation Research, Bureau of Engineering Research, The University of Texas at Austin.

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Acknowledgments

The authors express their appreciation to the TxDOT Project Committee members: Project Director William Knowles (RTI), Program Coordinator Dianna Noble (ENV), Project Advisor Wayne Young (ENV), and Project Advisor Al Kosik (TRF). We thank them for their contributions and insight during this research effort. This research was performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

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1. Introduction

1.1 Motivation

Air pollution results from two major sources: 1) stationary sources such as factories, industrial units, and power plants, and 2) mobile sources such as cars, trucks, and buses. The major pollutants are surface ozone, commonly known as smog, oxides of nitrogen, hydrocarbons, and carbon monoxide. These pollutants are serious health and environmental hazards. The mobile sources, or the transportation sector, have been a major source of air pollution, as can be seen from Table 1.1. To address air quality concerns, Congress enacted the U.S. Clean Air Act in 1970. The act requires state and local governments to develop strategies to address the problem and set minimum air quality standards called National Ambient Air Quality Standards (NAAQS).

Table 1.1 Pollutants by Source
Source: (USEPA 2000)

Pollutants	Transportation	Fuel Combustion	Industrial Processes	Miscellaneous
CO	78.6%	6.0%	5.4%	10.0%
Lead	13.1%	12.7%	74.2%	-
NO_x	53.3%	41.7%	3.7%	1.3%
VOC	43.5%	5.0%	47.2%	4.4%
PM_{10}	25.4%	38.6%	36.0%	-
SO_2	7.1%	85.1%	7.7%	0.1%

The Clean Air Act was amended in 1977 to emphasize the need for coordination of air quality planning with the transportation planning process of metropolitan planning organizations (CUTR 1996). The transportation sector, being a major source of air pollution, can play a very important role in improving air quality. The Clean Air Act Amendment of 1990 provides a framework for developing air quality improvement plans. It has also placed an additional requirement that transportation plans, programs, and projects conform to the purpose of State Implementation Plans (SIPs) for the attainment of NAAQS. This expanded requirement has resulted in a greater role for transportation officials in the development of air quality plans. It has also resulted in increased interaction, both collaboration and conflict, between the transportation and environmental communities (Shrouds 1994).

These developments over the past two decades have resulted in some positive results as indicated in Table 1.2.

Table 1.2 Emissions and Air Quality Trends (1990-1999)
Source: (USEPA 2000)

Pollutant	Change in Air Quality	Change in Emissions
Carbon Dioxide	-36%	-7%
Lead	-60%	-23%
Nitrogen Dioxide	-10%	+2%
Ozone	-4% (1 hr) 0% (8 hr)	-15% (VOC)
Particulate Matter (PM_{10})	-18%	-16%
Sulphur Dioxide	-36%	-21%

The challenge now lies in improving the quality of the air we breathe without adversely affecting the mobility of the nation. The demand for travel is expected to increase at about 30% in the next few years. Therefore, to simply maintain congestion at the current levels and without the introduction of productivity-enhancing technologies, the capacity of the transportation system would have to be increased by 30%. This would mean an addition of approximately 7,125 new kilometers of roadway every year, an unlikely event under current political and economic conditions. Alternatively, Intelligent Transportation System (ITS) technologies could lead to capacity improvements with the same physical infrastructure by enhancing the efficiency of the transportation system. A 20-year life cycle cost analysis for fifty major urban areas for the two options (capacity increase as compared to ITS) indicated that the ITS-based investment would "reduce the need for new roads while saving approximately 35% of the required investment in urban highways" (FHWA 1997, McGurrin 1997).

In the above context, it is important to explore transportation options that may result in potential air quality benefits. ITS constitutes one such class of strategies that could have significant air quality benefits. Quantification of these benefits is therefore an important part of any ITS assessment effort and decision-making in the context of ITS deployment.

1.2 Intelligent Transportation Systems

A Commonwealth Department of Transport and Regional Services (DOTRS 2000) study defines ITS as "a broad field encompassing a range of new and emerging technologies, such as computer systems, telecommunications, information technology, electronics, sensor technology, built into transport applications to improve the performance, efficiency and safety of all transport modes." ITS is evolving from largely demonstration projects to a mainstream set of options available to transportation agencies (Peng et al. 2000).

ITS is a collective term for a wide spectrum of "user services." User services describes what the system will do for the user. The National ITS architecture (ITERIS 2002) groups these user services into seven user services bundles for convenience. Another useful concept within the National ITS architecture is the concept of "market packages."

Market packages identify the pieces of the National ITS architecture required to implement a service. As such, they are directly grounded in the definition of the architecture. Most market packages are made up of equipment packages in two or more subsystems. Market packages are designed to address specific transportation problems and needs and can be related back to the user services and their more detailed requirements. (ITERIS 2002). Table 1.3 shows the thirty-one user services that are mentioned in the National ITS architecture. These services are grouped in seven user service bundles.

Table 1.3 User Services for National ITS Architecture
Source: (ITERIS 2002)

User Service Bundle	User Service
Travel And Traffic Management	Pre-trip Travel Information; En-route Driver Information; Route Guidance; Ride Matching And Reservation; Traveler Services Information; Traffic Control; Incident Management; Travel Demand Management; Emissions Testing And Mitigation; Highway-rail Intersection
Public Transportation Management	Public Transportation Management; En-route Transit Information; Personalized Public Transit; Public Travel Security
Electronic Payment	Electronic Payment Services
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance; Automated Roadside Safety Inspection; On-board Safety Monitoring; Commercial; Vehicle Administrative Processes; Hazardous Material Incident Response; Commercial Fleet Management
Emergency Management	Emergency Notification And Personal Security; Emergency Vehicle Management
Advanced Vehicle Safety Systems	Longitudinal Collision Avoidance; Lateral Collision Avoidance; Intersection Collision Avoidance; Vision Enhancement for Crash Avoidance; Safety Readiness; Pre-crash Restraint Deployment; Automated Vehicle Operation
Information Management	Archived Data Function

1.3 Overview of Pollutants and Emission Standards

Emissions from vehicles are generally referred to as mobile source emissions. The pollutants are classified as “criteria” pollutants and “non-criteria” pollutants. The criteria air pollutants are those for which NAAQS have been adopted. All other air pollutants are considered non-criteria pollutants.

The criteria pollutants are: carbon monoxide, lead, oxides of nitrogen, ozone, particulate matter, total suspended particles, inhalable particulate matter, and sulphur dioxide. Non-criteria pollutants are sulphates and nitrates.

The Clean Air Act, last amended in 1990, requires the Environmental Protection Agency to set NAAQS for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (USEPA 2001).

NAAQS for six principal pollutants are given in Table 1.4. Units of measure for the standards are parts per million (ppm), milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

1.4 Research Objectives

The overall goal of the study is to develop a framework that includes a wide spectrum of approaches that can be used to evaluate air quality impact of ITS. The study further provides procedures to implement this framework and demonstrate the feasibility of using these approaches to real transportation networks. The following specific objectives are addressed:

- Examine the issues involved in integrating transportation and emissions models.
- Integrate emission factor-based and modal emissions models within a dynamic simulation-assignment framework.
- Compare dynamic and static network modeling approaches for both emissions factor models and modal emissions models.
- Demonstrate the impact of information-oriented ITS strategies in a transportation network using this wide spectrum of approaches.

Table 1.4 National Ambient Air Quality Standards (NAAQS)
Source: (USEPA 2001)

POLLUTANT	STANDARD VALUE		STANDARD TYPE
Carbon Monoxide (CO)			
8-hour Average	9 ppm	(10 mg/m^3)**	Primary
1-hour Average	35 ppm	(40 mg/m^3)**	Primary
Nitrogen Dioxide (NO_2)			
Annual Arithmetic Mean	0.053 ppm	(100 µg/m^3)**	Primary & Secondary
Ozone (O_3)			
1-hour Average*	0.12 ppm	(235 µg/m^3)**	Primary & Secondary
8-hour Average	0.08 ppm	(157 µg/m^3)**	Primary & Secondary
Lead (Pb)			
Quarterly Average		1.5 µg/m^3	Primary & Secondary
Particulate < 10 micrometers (PM-10)			
Annual Arithmetic Mean		50 µg/m^3	Primary & Secondary
24-hour Average		150 µg/m^3	Primary & Secondary
Particulate < 2.5 micrometers (PM-2.5)			
Annual Arithmetic Mean		15 µg/m^3	Primary & Secondary
24-hour Average		65 µg/m^3	Primary & Secondary
Sulfur Dioxide (SO_2)			
Annual Arithmetic Mean	0.03 ppm	(80 µg/m^3)**	Primary
24-hour Average	0.14 ppm	(365 µg/m^3)**	Primary
3-hour Average	0.50 ppm	(1300 µg/m^3)**	Secondary

* The ozone 1-hour standard applies only to areas that were designated non-attainment when the ozone 8-hour standard was adopted in July 1997. This provision allows a smooth, legal, and practical transition to the 8-hour standard. ** Parenthetical value is an approximately equivalent concentration.

1.5 Structure of Report

Chapter Two provides a review of the mechanism of mobile source emissions, the interaction of travel characteristics and mobile source emissions, particularly those travel characteristics impacted by ITS. Chapter Three provides the theoretical background for the methodologies used in this study and develops the overall structure of the framework used in this study. Chapter Four describes in detail the tools and procedures used to implement the framework. Chapter Five describes the details of the experiments performed using networks for the Fort Worth and Houston areas to analyze the impact of information-oriented ITS strategies.

Chapter Six provides the interpretation and analysis of the results of the experiments. Concluding remarks and recommendations for future work are presented in Chapter Seven.

2. Background Review

2.1 Organization

This chapter provides an overview of the past work in connection with evaluating air quality impact of Intelligent Transportation Systems (ITS) strategies. First, the underlying relationships between transportation measures and mobile source emissions are presented. The frameworks and evaluation methodologies found in literature are then described and finally a review of some of the improvements in the methodologies of estimating the impact of ITS strategies on emissions is provided.

2.2 Mobile Source Emissions

One of the principal components in evaluating air quality benefits is identifying the vehicle activities that result in emissions of these pollutants from the motor vehicle systems. Two emission-producing processes, combustion products from the exhaust system and evaporation from the fuel storage and delivery system, are responsible for these emissions.

Exhaust emissions largely depend on the vehicle-operating modes. Consequently, most recent work in the area of emissions modeling has been directed toward developing modal emissions models. This is discussed in detail in the subsequent chapters. The vehicle-operating modes can be classified into start modes and hot stabilized modes.

The start modes refer to the first few minutes of operation after the engine has been started. A cold start and a hot start are differentiated by the duration between shutting off and restarting the engine. The hot stabilized mode includes all operation time except for the start mode period. The fuel-air mixture and the emission control equipment are two primary factors that cause the differences in emission amounts among operating modes. During cold start mode, the catalytic emission control systems do not provide full control until the appropriate operating temperature is reached. Moreover, a richer fuel-air mixture must be provided to start a "cold" engine. Therefore, volatile organic compounds (VOC) and particulate matter (PM) emissions are higher in the cold start mode than in the hot start mode, and reach the lowest amounts in the hot stabilized mode (Wu et al. 1996).

The ideal combustion of oxygen and fuel (HC) result in the byproduct emissions of carbon dioxide (CO_2) and water (H_2O). However the combustion is never complete and there is nitrogen (N_2) present in air which results in by-products of HC, carbon monoxide (CO), oxygen (O_2), carbon dioxide (CO_2), water (H_2O), and oxides of nitrogen (NOx) (Heywood 1988, Jacobs 1990). Another important factor is air-to-fuel ratio. In general, rich fuel mixtures produce high amounts of CO and HC because combustion is incomplete. Lean fuel mixtures (high a/f ratios) will typically produce higher amounts of NOx (especially during very hot, lean conditions) and lower amounts of CO and HC because combustion is more complete. When considering vehicle activity, high power demand (sharp accelerations, heavy loads, etc.) creates a rich fuel mixture resulting in elevated CO and HC emission rates, while NOx generally decreases. At high speeds with low acceleration rates, a lean fuel mixture develops which increases NOx emission rates (Heywood, 1988).

Evaporative emissions are composed primarily of volatile organic compounds and these emissions are highly dependent on temperature. Fig 2.1 illustrates different kinds of emissions and Table 2.1 lists the six categories of evaporative emissions along with the processes that cause these emissions.

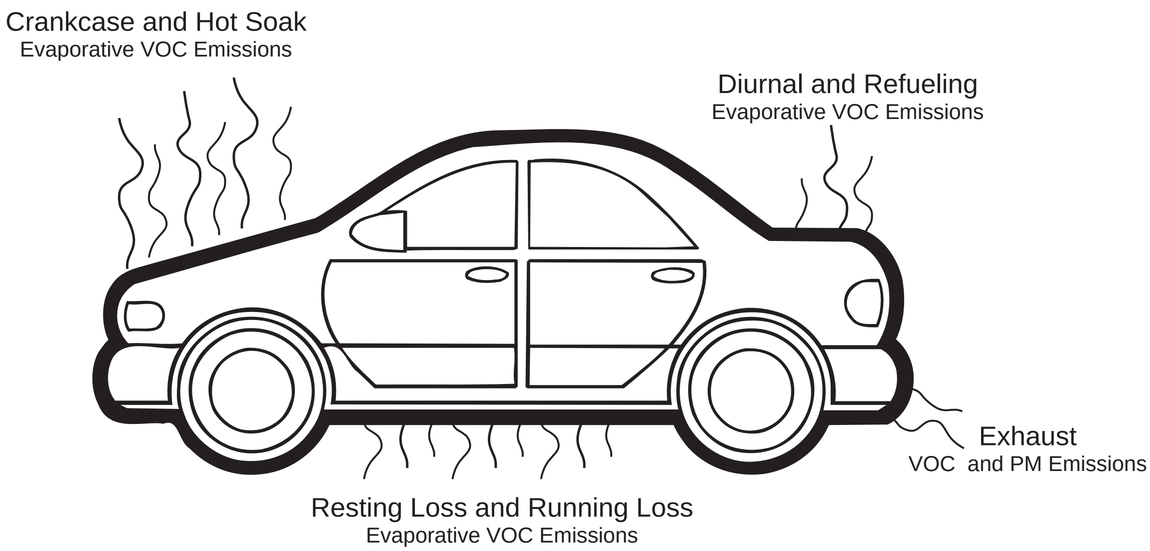

Figure 2.1 Different Types of Emissions
Source: Wu et al. 1996

Table 2.1 Categories of Evaporative Emissions
Source: (Wu et al. 1996)

Hot soak emissions:	Emissions from the carburetor or fuel injector when the engine is turned off.
Diurnal emissions:	Emissions from the "breathing" of the gasoline tank due to temperature fluctuations during a 24-hour day.
Running losses:	Emissions occurring while the vehicle is being operated. These emissions result when more fuel enters into the emission control canister than can be purged by it.
Resting losses:	Emissions that result from vapor permeating the evaporative emission control system or from the vehicle fuel tanks.
Refueling losses:	Emissions occurring while a vehicle is being refueled. There are two components: vapor space displacement and spillage. These emissions have been estimated for the area source - gasoline service stations; they are not included in the mobile source emissions.
Crankcase emissions:	Emissions that result from defective crankcase ventilation valves. They are not true evaporative emissions.

2.3 ITS and Air Quality

Deployment of ITS technologies may have significant air quality impacts, generally expected to be positive (benefits). The underlying mechanism that is expected to realize these benefits is the smoothing of traffic flow, alleviation of congestion, and in general an overall improvement in traffic flow conditions. However, it is important to be able to associate expected air quality benefits, both qualitatively and quantitatively, with particular ITS strategies, taken individually and in combination with others as part of an ITS architecture. This necessitates an understanding of the logical relationships among various ITS technology bundles and the various emission-producing activities and processes discussed above.

Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Commercial Vehicle Operations (CVO), Advanced Public Transportation Systems (APTS), and Emergency Vehicle Services (EVS) are technology bundles that have been identified early in the development and application of ITS technologies. Each of these functional areas has subsequently been specified in terms of "user services." Washington et al. (1996) provide a comprehensive qualitative assessment of the trip and travel characteristics that are most likely to be impacted by ITS technology bundles and the technology bundles that are most likely to impact these characteristics. Their assessment is summarized in the sections below.

2.3.1 Trip Characteristics Impacted by ITS

The following section summarizes the assessment by Washington et al. (1994) of the trip characteristics that are most likely to be impacted by ITS.

Vehicle Miles Traveled. The impact of information-related ITS technology on vehicle miles traveled (VMT) is uncertain at best. Better information may result in drivers making informed trip decisions in terms of route selection. Better information also makes the drivers less likely to get lost. This can result in a reduction in total VMT.

At the same time, better information may result in drivers selecting less congested roads to reduce their total travel time. In addition, if the capacity and travel speeds increase, and congestion and travel times decrease, additional vehicle trips may be undertaken. These factors may result in an increase in the total VMT. Therefore, the issue here is the behavioral response of the driver to reduced congestion and travel time.

Engine Idling. ATMS are likely to reduce the waiting times at traffic intersections. In addition, better information and AVCS have the potential to reduce time spent caught in queues and congestion, and driving in search of parking spots. All of this is most likely to reduce engine idling.

Vehicle Refueling. In parallel with the development of ITS strategies, developments in automotive technologies are producing a new generation of more fuel-efficient vehicles. These vehicles will have smaller fuel tanks, require less frequent fueling, and generally emit less pollution per mile traveled. The important consideration is the fuel efficiency of the individual vehicles, and the rate at which these might replace older model, less efficient vehicles in the present vehicle fleet.

Modal Activity. Many ITS technologies are targeted at reducing congestion. This is likely to result in reduced significant acceleration and deceleration events; even more so if the vehicles can be preprogrammed to avoid undertaking enrichment activities. The authors, however, point out that the relationships between the emission rates and modal activities are relatively uncertain.

2.3.2 Air Quality Benefits of ITS Technology Bundles

This section summarizes the assessment by Washington et al. of the ITS technology bundles that are most likely to affect air quality.

Advanced Traffic Management Systems. ATMS can be broadly classified into strategies such as signal optimization and ramp metering, which are aimed at reducing recurrent congestion, and strategies like incident detection and rapid accident response, which are aimed at reducing nonrecurrent congestion. According to Washington et al. (1994), the air quality benefits are less certain for the first type of strategies than for the latter type of strategies. There is little evidence for this claim.

Advanced Traveler Information Systems. ATIS strategies rely on acquisition and use of information by users, like onboard electronic maps, electronic route guidance, Variable/Changeable Message Signs (VMS, CMS), personal digital assistants, wireless devices, etc. These strategies are designed to provide users with information about routes and conditions of the system so as to provide a basis for travel-time minimizing strategies. An important consideration here is the impact of "perfect" information on route and mode choices.

The impact of information on route choice is likely to depend on whether the trip is being made during peak periods or otherwise. If the drivers are rerouted during peak periods, they are more likely to choose alternate routes that have shorter travel times even if it may mean traveling longer distances. If these alternate routes are congested as well, significant air quality benefits are not likely to result. If these routes are not congested, then the resulting smoothed flow may reduce emissions.

The effect of information on mode choice is not conclusive and, therefore, the associated air quality impacts are difficult to estimate.

Advanced Vehicle Control Systems. AVCS strategies are aimed at improving highway capacity by reducing headways at all speeds and by reducing the lateral space required between the vehicles. In theory, highway capacity could be doubled or quadrupled with AVCS.

AVCS technologies are likely to reduce the inertial losses occurring during congested stop-and-go conditions. This may result in air quality benefits. However, it is important to note that AVCS could also result in high-speed operations. Current empirical data suggest that the emissions are lowest at average speeds of around 40–45 mph. High-speed operations are therefore likely to offset the benefits of AVCS.

Another serious consideration is the impact of congestion that occurs at the "ends" of automated segments. Because "automation" occurs in stages, with the primary candidates being heavily congested freeways and highways, the end of the automated segments could become serious bottlenecks. This potential for congestion may offset the benefits obtained by flow smoothing. Given that deployment of any AVCS technologies does not appear likely in the near- or medium-term future, the present study will not focus on their emission-reduction potential.

Washington et al. (1994) also discuss the air quality impact of other ITS technology bundles like CVO, APTS, and EVS but the impact of these bundles are either not conclusive or not significant. However, these strategies should not be dismissed offhand, because of the potential air quality improvements possible through CVO and APTS applications.

2.3.3 Critique

Washington et al. (1994) have listed a number of assumptions in their assessment of the air quality benefits of ITS technologies. The most important of these assumptions are:

- Commute distances and vehicle fleet will remain relatively unchanged in the long run.
- Travel behavior will not change significantly.
- ITS technologies will not significantly affect mode shares.

They also point out that the assessment is based on ITS technologies implemented in isolation. If these technologies were to be implemented simultaneously with other strategies such as congestion pricing and real-time signal optimization, the synergistic effect of these strategies might be very different.

2.4 Air Quality Impact Assessment Methodologies

Air quality impact of transportation control measures (TCMs) are typically evaluated in terms of the reductions in mobile source emissions brought about by these strategies. (Cambridge Systematics 2001). There is considerable variation in the methodologies used for this type of evaluation. The framework for this type of evaluation is illustrated in Fig. 2.2.

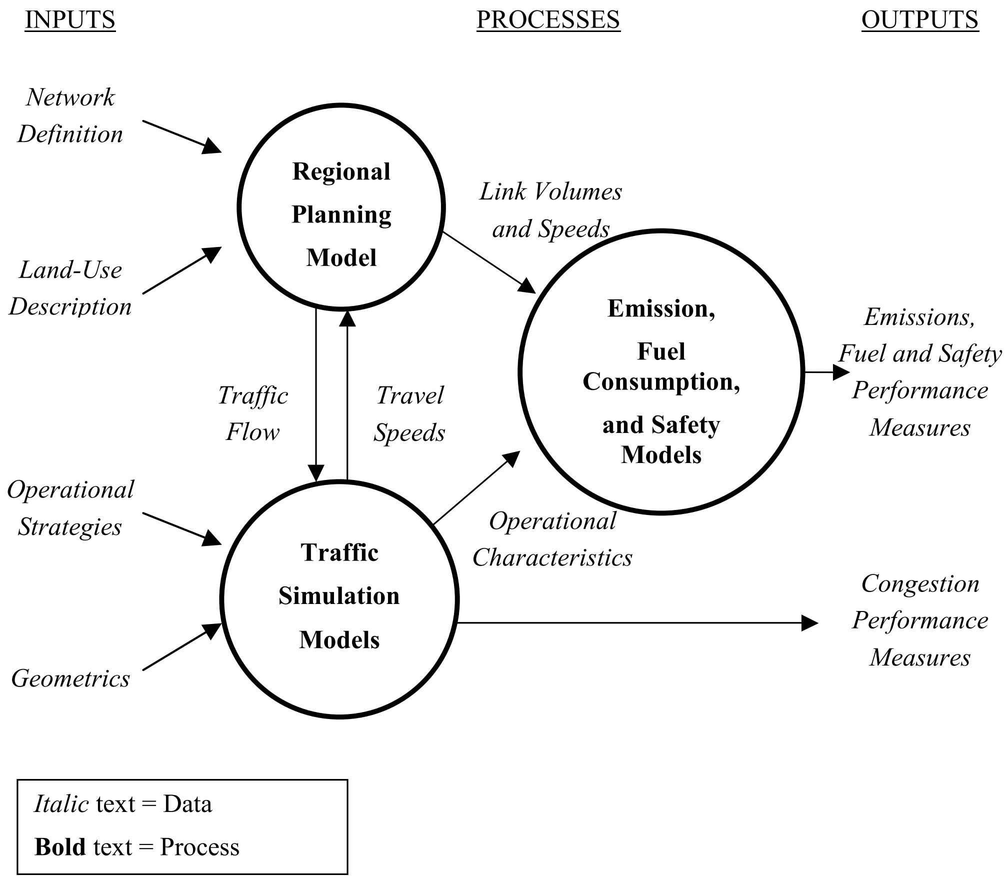

Figure 2.2 ITS Evaluation Framework
Source: USDOT 1995

There are two main stages in this framework: 1) estimating the emission-producing activities resulting from transportation sources and 2) quantifying the emissions caused by these activities.

2.4.2 Estimation of Emission-Producing Vehicle Activities

The quantification of the emission-producing activities, like number of trips, VMT, and speeds, is performed using transportation demand models such as the Urban Transportation Planning System (UTPS) generation of models. The output from these planning models (e.g., VMT and average speeds on the links of the network) is sufficient to estimate emissions on a regional basis. However, these models are not sensitive to ITS strategies and do not sufficiently represent key operational variables such as delay and queuing patterns, acceleration/deceleration events, etc. Traffic simulation models are, therefore, typically used after the planning process to represent the impact of ITS strategies. Traffic simulation is not typically undertaken as a routine element of transportation planning studies. The computer simulation models used for this purpose can be either microscopic models like TRAF-NETSIM, CORSIM, Texas Model, or macroscopic models like FREFLO and TRANSYT-7F.

Newer simulation models like AIMSUN2, INTEGRATION, Smartpath, Smartlink, DYNAMIT, and DYNASMART are better suited for simulating various ITS scenarios because they have a greater level of detail and flexibility that is required for representing new technologies.

After the vehicle activities that cause emissions have been estimated using the process outlined above, the next stage is determining a set of activity-specific emission factors that specify the rate at which the emissions are generated for each of the emission-producing activities (Mehta et al. 2001).

2.4.3 Review of Emissions Modeling Approaches

The U.S. Environmental Protection Agency (EPA) has developed a series of emission factor models called MOBILE that are the only EPA-approved models. As such, they are required for preparing state implementation plans (SIPs) and for conformity analysis. These emission factor models are, however, highly aggregate fleet estimates and average emission rates that are not specific to the fleet in operation, mode of vehicle operation, or grade of the highway facility (Bachman 1997).

There is a growing need among transportation planners for emission models that are more sensitive to the vehicle operating modes. This has resulted in much research in developing such *modal* emission models, which are highly disaggregate and can explicitly model emissions resulting from a wide range of vehicle operating modes.

A spectrum of emission modeling approaches from the highly aggregate emission factor models to the highly disaggregate modal emission models is shown in Figure 2.3.

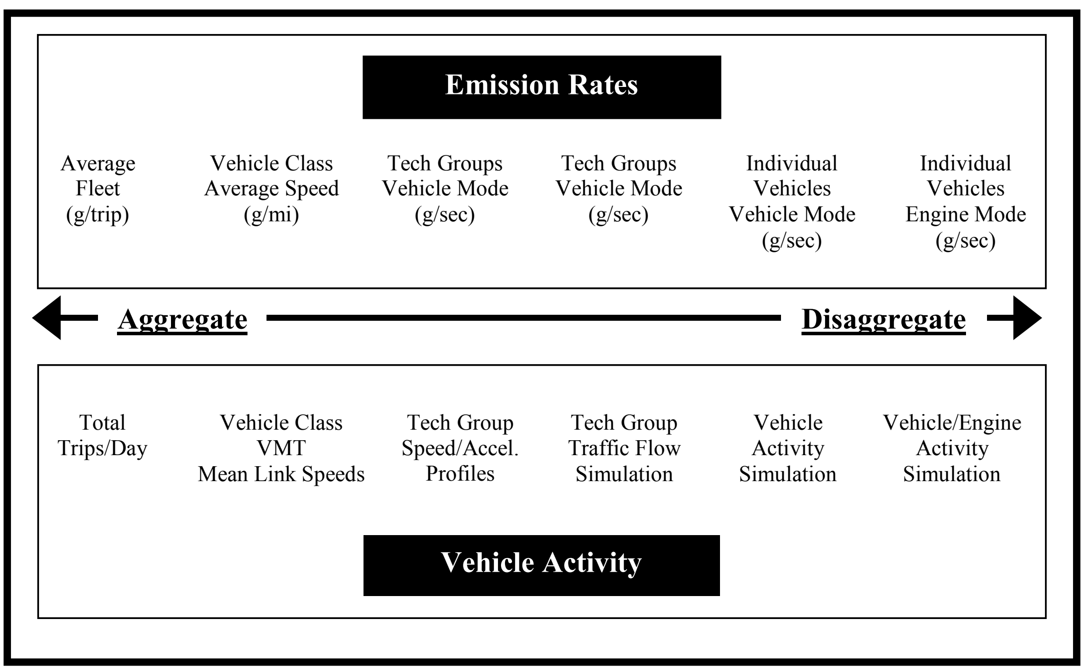

Figure 2.3 Emission Modeling Spectrum
Source: Bachman 1997

Modal Emission Models. Modal emission models predict emissions as a function of vehicle operating modes like cruising, idling, accelerating, decelerating, etc.

A Technical University of Graz research report (TU-Graz, 1998) on Methodologies for Estimating Air Pollutant Emissions from Transport (MEET) discusses in detail a number of modal emission models developed in Europe. It also provides an overview of the issues, such as data required, test procedures, etc., associated with developing such emission models. Several such models have also been developed or are being developed in the United States and are discussed hereafter.

Georgia Tech Research Partnership is developing a modal emissions model within a Geographic Information System (GIS) framework (Guensler et al. 1997, Bachman 1997, Fomunung et al. 1999) called Mobile Emissions Assessment System for Urban and Regional Evaluation (MEASURE).

MEASURE comprises several modules: vehicle technology module, vehicle activity module, vehicle emissions module, and the reporting module. The vehicle technology module takes regional vehicle registration data and outputs time-specific emission technology group distributions. The vehicle activity module takes regional planning model results and joins them with the appropriate speed and acceleration look-up tables to produce location and time-specific estimates and emission-specific modes of vehicle activity. The emission components of the model are weighted least squares regression models developed from large databases of vehicle emissions tests (Guensler et al. 1997).

In August 1995, the College of Engineering-Center for Environmental Research and Technology (CE-CERT) at the University of California-Riverside, along with researchers from the University of Michigan and Lawrence Berkeley National Laboratory, began a 4-year research project to develop a Comprehensive Modal Emissions Model (CMEM). The CMEM is a power demand modal emission model. The overall objective of that project was to develop and verify a modal emission model that accurately reflects light-duty vehicle (LDV) emissions produced as a function of the vehicle's operating mode. The model is comprehensive in the sense that it is able to predict emissions for a wide variety of LDVs in various states (e.g., poorly functioning, deteriorated, malfunctioning) (Barth 1999).

West et al. (1997) present a methodology to develop modal emissions and fuel consumption models for light-duty vehicles. They develop a set of look-up tables for CO, HC, and NOx emissions and fuel consumption as a function of velocity and acceleration for eight light-duty vehicles.

Ahn et al. (1999) developed a series of modal emissions and fuel consumption models using regression and neural networks. They incorporated these models into the INTEGRATION simulation model and analyzed the impact of various traffic control strategies.

Yu (1997) also developed a set of modal emissions models based on on-road emissions data collected from five highway locations in Houston. These models predict CO and HC emission rates in g/sec as a function of vehicle speeds and accelerations. Models are developed separately for three categories of vehicles: passenger cars, van and pickup trucks, and other trucks.

2.5 Improvements in Emissions Estimation Methodology

Most of the improvements to the current state-of-practice suggested in the literature can be classified into two categories:

1. Short-term or incremental improvements
2. Long-term or methodological improvements

2.5.1 Short-Term Improvements

These are improvements that can be fairly easily incorporated within the present emissions estimation methodological framework. These improvements are usually in terms of improving data sources, minor modifications to existing procedures, or using better statistical and analytical tools for modeling.

Stopher and Fu (1997) describe a number of improvements than can be incorporated in the conventional travel demand models. These improvements include moving diurnal factoring to occur immediately after trip generation, better capacity estimation, and post processing speeds.

Cambridge Systematics (2001) report on quantifying air quality and other benefits and costs of transportation control measures. They incorporated a program of analytical improvements in the transportation and air-quality modeling system used by the Sacramento Area Council of Governments (SACOG), and assessed the benefits of these improvements in evaluating proposed high-occupancy vehicle (HOV) lanes and freeway ramp metering.

Bhat and Nair (2000) have proposed the use of fractional split models to model VMT mix, which is an important input to the mobile emissions factor models and can significantly affect emissions estimation.

A 1997 National Cooperative Highway Research Program report proposes methods of improving transportation-related data for mobile source emissions estimates; they also perform sensitivity analysis of Mobile emissions factors to various transportation input parameters.

2.5.2 Long-Term Improvements

These improvements are usually harder to incorporate within the existing emissions estimation frameworks and entail fundamental methodological enhancements.

There seems to be a consensus emerging that disaggregate activity-based travel demand modeling and integration of traffic operational and microsimulation analytical capabilities can result in better and more responsive emissions estimation methods (Suhrbier et al. 1997).

2.6 Summary

This chapter provides a background on the nature of mobile source emissions and the connection between various travel characteristics and emissions. The potential impact of ITS on mobile source emissions is also discussed. The methodologies that have been employed to evaluate the impact of ITS on mobile source emissions are briefly described along with the trends and improvements, both incremental and methodological. The next chapter describes the main elements of the framework that is used in this study to quantify the environmental benefits of ITS.

3. Framework and Methodology

3.1 Overview

In this chapter, a systematic framework for evaluating and comparing procedures used in estimating the impact of Intelligent Transportation Systems (ITS) strategies on mobile source emissions and fuel consumption is presented. First, the two main stages in assessing the impact of transportation operational measures on mobile source emissions, namely, transportation network modeling and emissions modeling, are described in some detail, and then procedures for interfacing them within an integrated framework are presented.

3.2 Transportation Network Modeling

This stage involves quantification of the emission-producing activities, like number of trips, vehicle miles traveled (VMT), and speeds, as well as the spatial distribution of the resulting traffic over the transportation network. These are estimated by using the transportation demand models such as the Urban Transportation Planning System (UTPS) generation of models. The components of the widely used UTPS are trip generation, trip distribution, and mode choice and traffic assignment. Once these components have been executed, the resulting traffic could be simulated on a transportation network usually composed of links and nodes, though such simulation is not typically undertaken as a routine element of transportation planning studies. The computer simulation models used for this purpose can be either microscopic models like TRAF-NETSIM, CORSIM, and more recently PARAMICS and AIMSUM, or macroscopic models like FREFLO and TRANSYT-7F, usually for freeways. A new generation of models like DYNASMART, INTEGRATION, and DYNAMIT perform simulation and assignment in an integrated manner using a hybrid simulation approach with both microscopic and macroscopic elements in modeling traffic flow.

ITS strategies are aimed at improving the efficiency of the transportation system and therefore impact the supply side, though some strategies also impact the demand side, such as transportation demand management strategies and Advanced Traveler Information Systems (ATIS). However, it is ultimately the spatial distribution of the traffic on the network that determines the effectiveness of any ITS strategy. Therefore, traffic assignment is the most critical component for evaluating ITS strategies. In the transportation context, assignment refers to the process of allocating or distributing a given pattern of origin-destination (O-D) trips to the various links of a network. Traffic assignment models are broadly categorized as either static or dynamic depending on whether the state of the network is assumed to be static (i.e., at a steady state) or time dependent, respectively.

Traffic assignment models could be further classified into various categories depending on whether network stochasticity and travelers' travel time perception errors are considered in the travelers' decision making.

3.3 Static Traffic Assignment

Static assignment models assume steady-state conditions under which all travel times and flows on the network are constant over the analysis period. Wardrop's (1952) seminal work in formulating the network equilibrium concepts has formed the foundation for much of the subsequent work in this area. For long-term planning purposes, User Equilibrium (UE) models based on Wardrop's first principle are generally used. This principle stipulates that users cannot improve their own travel time by unilaterally switching routes between given origin and destination. The resulting equilibrium conditions are that the travel cost on all used routes between a given O-D pair equals the minimum route cost. The basic assumption in the UE models is that over some period of time, each traveler learns and adapts to the transportation network conditions and the available services so that equilibrium can be reached (Liu et al. 2001).

The route or the path consists of a set of directed links and the travel cost of the path is the sum of the travel cost on the links. Link cost might be a linear combination of travel time, comfort, travel distance, and toll fees, but travel time is usually dominant (Fellendorf 1998).

Wardrop's second principle states a system state under which the overall cost for all network users is minimized. This System Optimal (SO) assignment is mostly normative and is aimed at attaining some systemwide objectives like reduction in overall system travel time and VMT.

Static models are suitable for long-term planning applications, but have some serious limitations that undermine their utility for purposes of assessing the impact of ITS strategies. The major limitations are (Florian 2000):

1. Static models do not capture time-varying characteristics of traffic.
2. The link delay functions are separable and additive, hence the upstream effects of queues cannot be properly represented.
3. Real-time traffic control and route guidance strategies require temporal modeling of traffic flows, which cannot be done suitably with a static model.

These limitations, coupled with heightened interest in ITS, have stimulated considerable fundamental research and methodological development in the area of Dynamic Traffic Assignment (DTA).

3.3.1 Dynamic Traffic Assignment

There is a growing recognition among transportation professionals of the potential of DTA to address long-standing problems with the underlying assumptions of conventional static modeling methods, as well as of the potential of DTA for evaluating ITS strategies (Peeta and Ziliaskopoulos 2001).

Peeta and Ziliaskopoulos (2001) provide a comprehensive overview of the foundations and challenges of DTA. They categorize the approaches to DTA into four broad methodological categories: mathematical programming, optimal control, variational inequality, and simulation-based DTA. The first three approaches can be grouped together as analytical approaches.

3.3.2 Analytical Approaches to DTA

Mathematical Programming. Merchant and Nemhauser (1978a, 1978b) represent one of the first attempts to formulate the DTA problem as a mathematical program. The formulation is a flow-based, discrete-time, nonconvex, nonlinear programming formulation. Modifications to this model (Carey, 1987) have been proposed that offer mathematical and algorithmic advantages over the original formulation. The difficulty inherent to all mathematical programming approaches to time-dependent assignment is the nonconvexity issues arising out of the "first in first out" (FIFO) requirement (Peeta and Ziliaskopoulos 2001).

Optimal Control. In constrained optimal control theory DTA formulations, the O-D trip rates are assumed as known continuous functions of time, and link flows are sought as continuous functions of time. The constraints are defined in a continuous time setting, which results in a continuous time optimal control formulation, rather than a discrete-time mathematical program (Peeta and Ziliaskopoulos 2001).

Variational Inequality. Variational inequality (VI) provides a general formulation platform for several classes of problems in the DTA context, such as optimization, fixed-point, and complementarity. It promotes a unified approach to equilibrium and optimization problems (Peeta and Ziliaskopoulos 2001).

Simulation-Based DTA. The terminology "simulation-based DTA" can sometimes be misleading because even in simulation-based DTA models, the mathematical abstraction of the problem is typically an analytic formulation, mostly of the mathematical programming variety. Simulation is employed to represent the constraints associated with traffic flow propagation, because well-behaved analytical formulations are not currently available to represent these constraints (Peeta and Ziliaskopoulos 2001).

Mahmassani (2001) provides a review of the foundations, required capabilities, and functionalities of DTA systems in the context of DYNASMART, a DTA system originally developed at The University of Texas at Austin. He identifies two key capabilities of a DTA system: descriptive and normative dynamic traffic assignment capabilities.

The essence of ITS strategies is their ability to devise strategies for optimizing system performance in real time. The descriptive capability of the simulation is used to predict the future network condition based on the interaction between user decisions and evolving traffic dynamics. The user decisions depend on the network conditions, which in turn are a result of user decisions. Therefore, an iterative scheme needs to be devised to represent this complex interaction. Another important consideration with the descriptive capability of a DTA system is consistency. The predictions of the future traffic conditions of the network have to be consistent with the real-time data obtained from sensors and detectors and the estimated state of the system may need to be updated accordingly (Mahmassani 2001)

The normative capability is required to provide route guidance to users to optimize certain system objectives. Mahmassani (2001) identifies two ways of attaining this capability. In the first approach, a search process is used for path assignments that optimize certain systemwide objectives subject to reasonableness and acceptability requirements from the standpoint of the user. The second approach is a more "local" approach in which the user will be guided from link to link based on the conditions of neighboring links. This approach is very responsive to local conditions like incidents, but may underperform a system optimal routing strategy when traffic conditions are relatively stable and predictable (Mahmassani 2001). Figure 3.1 illustrates DYNASMART-X DTA system structure.

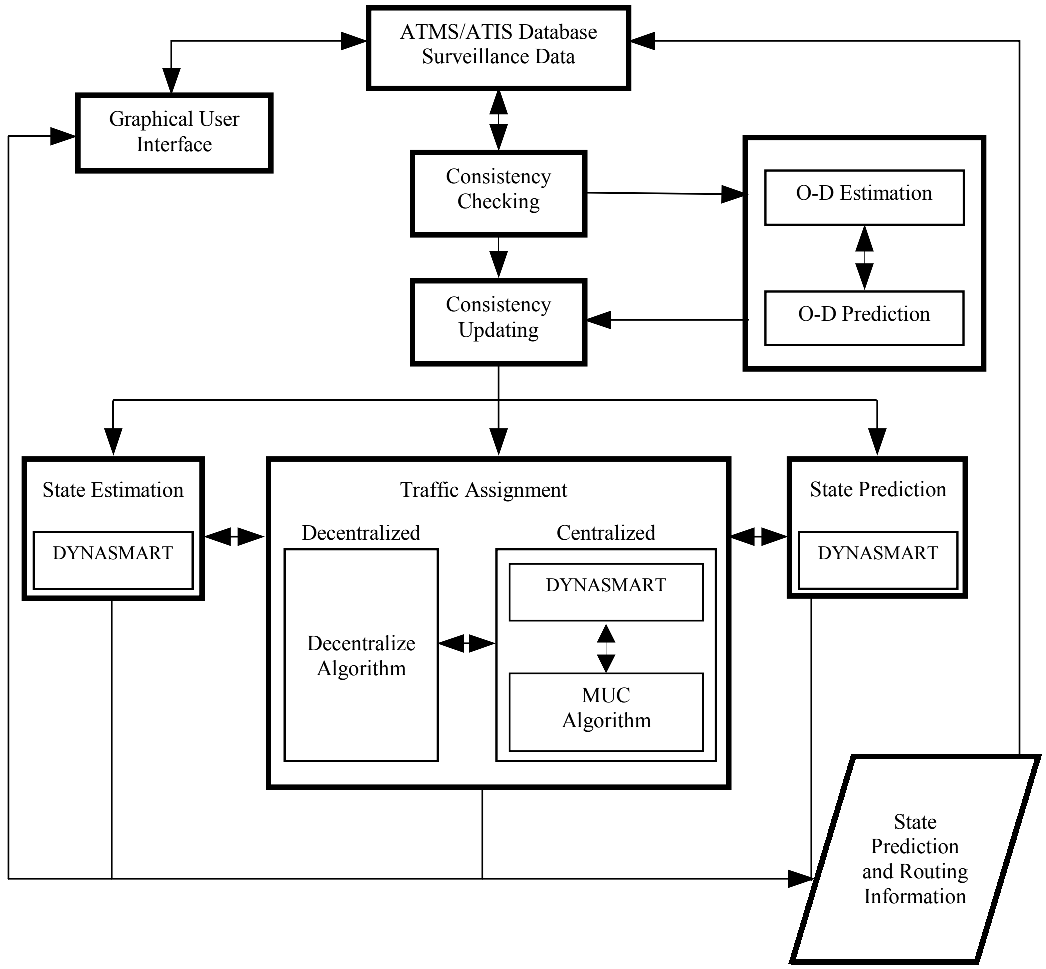

Figure 3.1 DYNASMART-X DTA System Structure
Source: Mahmassani 2001

3.4 Emissions Modeling

The current practice in emissions modeling actually comprises three different models: a mobile emission model, a photochemical model (for emission inventory), and a microscale model (for analyzing transportation improvements). The only Environmental Protection Agency (EPA) approved models for the purpose of preparing emissions inventory and state implementation plans (SIPs) are MOBILE 5/6 and EMFAC (California only). The California Air Resources Board (CARB) estimates on-road motor vehicle emissions for use in California by using a series of models called the Motor Vehicle Emission Inventory (MVEI) models. Four computer models, which form the MVEI, are CALIMFAC, WEIGHT, EMFAC, and BURDEN.

The PART5 model developed by the EPA Office of Mobile Sources calculates particle emission factors, including exhaust particulate, brakewear, tirewear, and re-entrained road dust, for particle sizes of 1-10 mm.

The MOBILE series of models, however, use average network speed as the sole descriptor of traffic characteristics of a network. MOBILE 5 has been the most widely used emissions modeling tool since its release in 1993 and is used in this research as well. The methodology used by the MOBILE series of models to estimate emission factors is based on laboratory-established emission profiles for a wide range of vehicles with different types of emission control technologies. The emission factors are produced based on average driving characteristics embodied in a predetermined driving cycle, known as the federal test procedure (FTP). Emissions of carbon monoxides (CO), oxides of nitrogen (NO_X), and hydrocarbons (HC) are integrated and collected for three sections of the cycle (called bags) and are used as base emission rates. Adjustments are made to the base emission rates through a set of correction factors. There are correction factors for each bag, which are used to adjust the basic emission rates to reflect the observed differences between the different modes of operation. There are also temperature correction factors and speed correction factors derived from limited off-cycle testing (speeds greater that 57 mi/h, accelerations greater than 3.3 mi/h-s). Once the activity-specific emission factors have been determined, the emission inventory is calculated by multiplying the activity parameters by their corresponding emission factor and summing up the emissions for each activity. This process is illustrated in Figure 3.2.

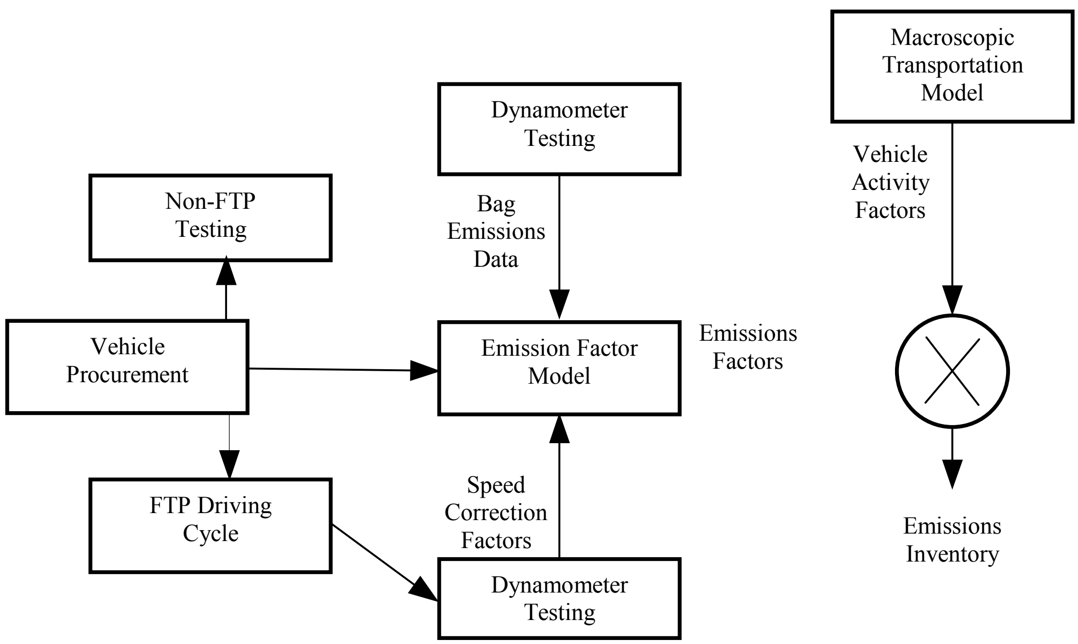

Figure 3.2 Current Emissions Inventory Process
Source: Barth and Norbeck 1996

A brief overview of the structure of MOBILE 5 and its successor MOBILE 6 is provided in the next section, while a more comprehensive discussion of the algorithms and procedures used by MOBILE 5, the tool used in this research, to develop emission factors is provided in the next chapter.

3.4.2 MOBILE 5

MOBILE 5 is a computer program that estimates HC, CO, and NOx emission factors for gasoline-fueled and diesel-fueled highway motor vehicles.

MOBILE 5 calculates emission factors for eight individual vehicle types in two regions (low and high altitude) of the country. MOBILE 5 emission factor estimates depend on various conditions such as ambient temperatures, average travel speed, operating modes, fuel volatility, and mileage accrual rates. The user can specify many of the variables affecting vehicle emissions. MOBILE 5 will estimate emission factors for any calendar year between 1960 and 2020, inclusive (USEPA 1994). The main components of MOBILE 5 are:

Basic Emission Rates (BER). These are the basic idealized emission rates based on standardized vehicles.

Fleet Characteristics. BERs characterize emissions for each specific model year in the vehicle fleet. Based on the VMT fraction for each model year, emission factors for eight categories of vehicles are produced.

Correction Factors. In calculating emission factors, BERs are multiplied by a series of correction factors to represent the varying speed, temperature, and operating mode profiles.

Fuel Characteristics. Evaporative emissions and exhaust emissions (to a lesser extent) vary with fuel volatility. BER is developed based on gasoline with volatility of 9.0 psi as measured by Reid vapor pressure (RVP). MOBILE 5a adjusts the emission factors by using RVP correction factors for the fuel with volatilities other than 9.0 psi RVP.

Emission Control Program. BER is developed for vehicles that are not affected by the vehicle control programs. Various inspection and maintenance (I/M) programs and anti-tempering programs are taken into account when estimating emission factors.

3.4.3 MOBILE 6

MOBILE 6 is the latest in the series of emission factor models developed by EPA. It was officially released on January 29, 2002 (NARA 2002). EPA's approval of MOBILE 6 is effective from January 29, 2002. However, since many agencies use MOBILE 5 for various purposes, a grace period of 2 years is provided by EPA beginning January 29, 2002, after which MOBILE 6 will be required in new transportation conformity analyses and certain SIP and motor vehicle emissions budget revisions (NARA 2002).

MOBILE 6 includes many additional features over MOBILE 5, such as facility-based emission factor estimates (different average emissions for different roadway types, even at similar average speeds), needed for transportation conformity determinations and more sophisticated application of results (e.g., photochemical air quality modeling versus simple inventory tabulation); "real-time" diurnal emission factors; updates on effects of oxygenated fuels on CO emissions and effects of in-use fuel sulfur content on all emissions; separation of "start" and "running" emissions to permit more precise temporal and spatial allocation of emissions; and updates to many other areas on the basis of new data (USEPA 1999).

3.4.4 Modal Emissions Models

Modal emissions refer to the types of emissions related to specific modes of operation. Figure 3.3 conceptually represents the relative magnitudes of exhaust emissions for a vehicle trip in space and time.

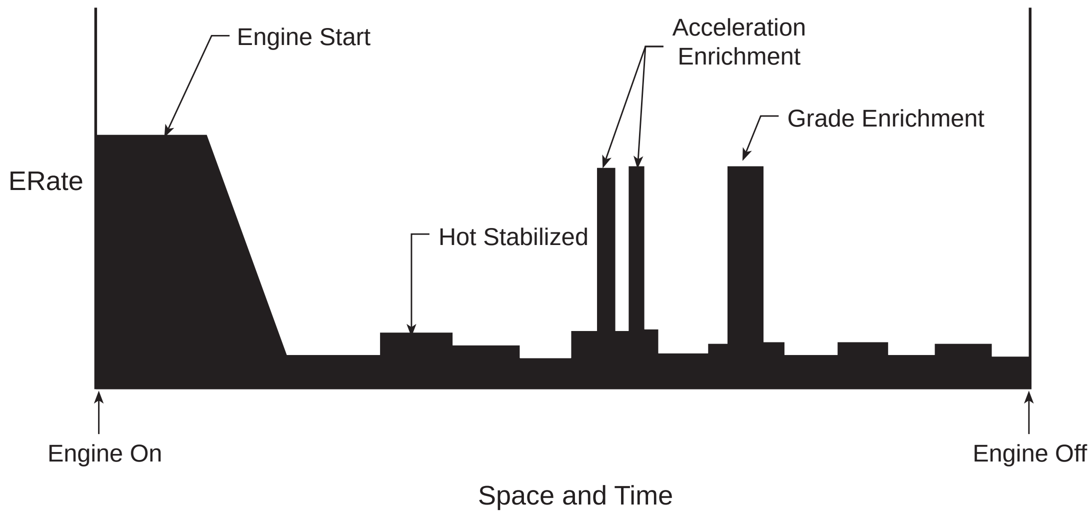

Figure 3.3 CO Emissions for a Hypothetical Vehicle Trip
Source: Bachman 1997

Barth et al. (1999) describe three approaches to developing a modal emissions model described hereafter.

Statistical Approach. This is a descriptive approach that involves characterizing vehicle-operating modes like idling, cruising, and accelerating/decelerating by developing a speed/acceleration matrix. With such a matrix, it is possible to measure the emissions associated with each "bin" or mode. A similar matrix is set up that has the vehicle activity broken down so that each bin contains the time spent in each driving mode. The product of these matrices will be the total amount of emissions produced for the specified vehicle activity with the associated emissions matrix. This approach does not, however, properly handle other variables that can affect emissions such as road grade, use of accessories, etc., unless these variables are explicitly included in the categorization and measurements are taken accordingly.

Emissions Mapping. This is also a descriptive approach. In this approach, second-by-second emission tests are performed at numerous engine-operating points, taking an average of steady-state parameters. The emissions inventory is created by deriving the vehicle-operating parameters, like engine power and speed form, on the second-by-second velocity profiles. Because this approach is based on engine power and speed, the effects of factors like grade, acceleration, and accessories are directly taken into account. Evidently, this approach is both time and cost intensive.

Power Demand Modal Emissions Modeling. This approach is based on parameterized analytical representation of emission production. In this approach, the entire emission process is broken into different components that correspond to the physical phenomena associated with vehicle operation and emission production. Each component is then modeled as an analytical representation consisting of various parameters that are characteristic of the process. These parameters vary according to the vehicle type, engine, and emission technology. The majority of these parameters are stated as specifications by the vehicle manufacturer and are readily available. Other key parameters relating to vehicle operation and emission production must be inferred from a comprehensive testing program.

The testing involved is, however, much less extensive than creating emission maps for a wide range of vehicle-operating points.

Modal emission models represent the effect of the vehicle-operating modes on emissions better than the emission factor approach. The difficulty with using the modal emission models lies in current regional modeling practices, which lack the tools for forecasting the vehicle activity modes that are needed as input to this new generation of emission models. Available forecasting options in practice are not sensitive to changes in traffic conditions brought about by current and emerging transportation planning alternatives. To address this issue, researchers at Georgia Institute of Technology, University of California at Davis, San Jose University, and California Polytechnic University in San Luis Obispo are developing a method to forecast modes of vehicle activity (Roberts and Washington 1998).

Roberts and Washington (1998) describe a research effort to define the data needs, collect the data with a variety of available instrumentation, post-process the data from differing instrumentation into a compatible database, estimate models to answer research questions, and address problems regarding the forecasting of vehicle modes of operation on freeways.

3.5 Transportation/Emission Model Interface

There is a wide range of transportation models that vary in terms of their inherent temporal and spatial resolution and level of vehicle aggregation. On one end of the spectrum, there are simulation models that produce second-by-second vehicle trajectories, and on the other end there are aggregate regional planning models that may just produce parameters like average network speed over the entire planning horizon. Barth (1997) provides a framework for interfacing modal emission models with transportation models at all these different levels of detail. Figure 3.4 illustrates this framework.

The two main components that have to be considered for interfacing transportation and emission models are 1) the vehicle fleet distribution, which represents the vehicle disaggregation in terms of vehicle operational and emission characteristics and 2) the vehicle operation, which represents the level of detail used to represent the flow of traffic through the network.

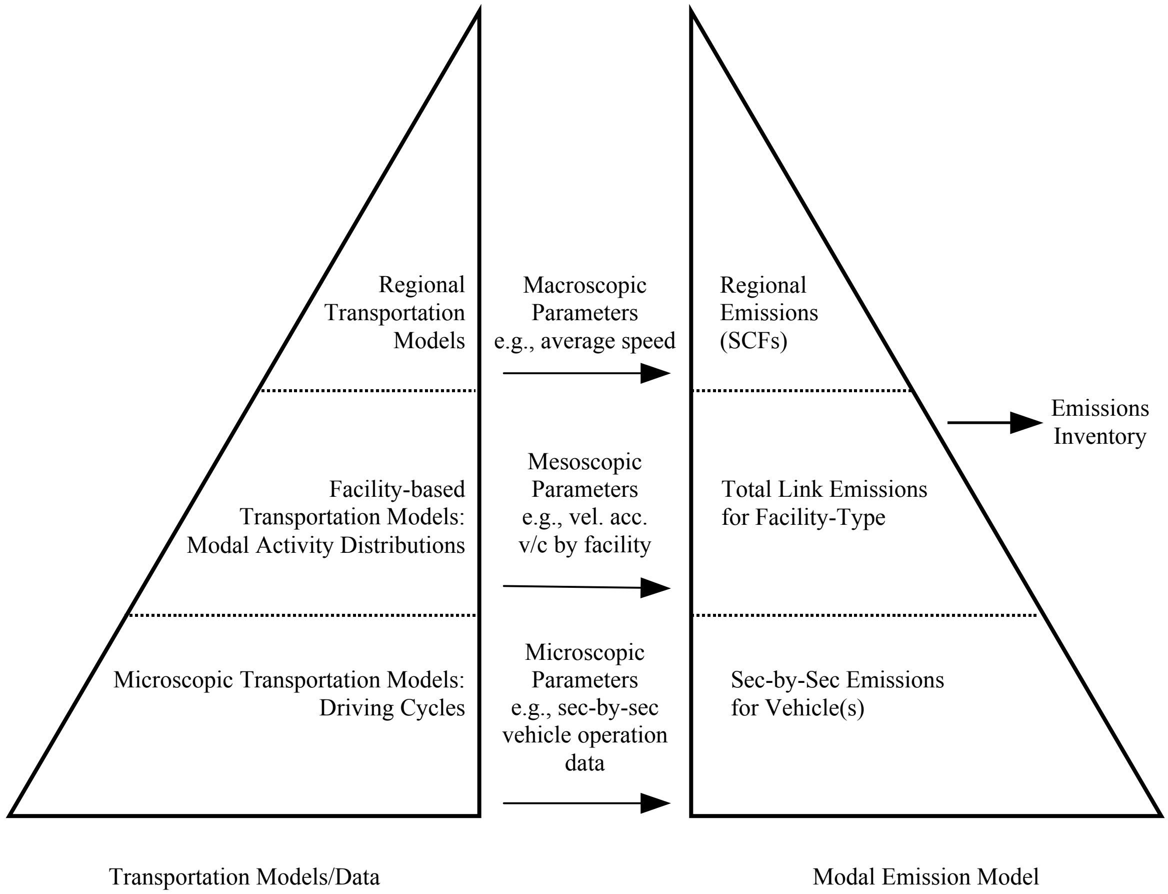

Figure 3.4 Transportation/Emissions Model Interface
Source: Barth 1997

3.5.2 Vehicle Fleet Distribution

Transportation models have different vehicle types (e.g., passenger cars, minivans, trucks, buses, motorcycles, etc.) based on their operating characteristics and how they are incorporated with a modeling or simulation framework. Similarly, emission models also have their own vehicle types (e.g., light-duty gasoline vehicle, heavy-duty diesel vehicle etc.) based on the emission characteristics. There has to be a mapping between these vehicle types to ensure consistency in applying the emission models. Table 3.1 illustrates a mapping between the Federal Highway Administration (FHWA) and MOBILE 5a vehicle types.

Figure 3.5 FHWA Vehicle Types Mapped to MOBILE 5a Vehicle Types
Source: Barth 1997

MOBILE 5a Types (Cols) FHWA Veh. Types (Rows)	**MCY**	**LDGV**	**LDGT**	**LDGT1** <6K	**LDGT2** 6-8.5K	**HDGV**	**LDDT** <8.5K	**HDDV** >8.5K
Motorcycles	**100**							
Passenger Cars		**98.8**	**1.2**					
2-Axle,4 tire Single Units				**90.62**	**3.98**	**1.76**	**2.99**	**0.65**
Buses					**20.09**		**79.91**	
2-Axle,6 tire Single Units				**10.69**	**9.92**	**50.36**	**1.89**	**27.14**
3-Axle Single Units				**0.71**	**0.01**	**14.44**	**0.01**	**84.83**
4+Axle Single Units				**0.06**	**0.45**	**4.56**	**0.36**	**94.57**
¾ Axle Single Units				**0.06**	**0.02**	**5.13**	**0.02**	**94.77**
5-Axle Single Trailer						**1.01**	**0.02**	**98.97**
6+Axle Single Trailer						**0.95**		**99.05**
4/5-Axle Multi Trailer								**100**
6-Axle Multi Trailer								**100**
7+Axle Multi Trailer								100

3.5.3 Vehicle Operation

The parameters used to capture vehicle dynamics and travel behavior depend on the fidelity level of the transportation models. Barth (1997) identifies three levels of detail used in transportation models to define how vehicles operate.

Microscopic simulation models typically produce values for speeds, accelerations, and positions for each individual vehicle at a very fine temporal resolution (second-by-second). For mesoscopic transportation models (models that still consider individual vehicles but not their dynamic operation), the vehicle/traffic operating parameters may include average velocity by roadway facility type, and volume/capacity by roadway facility type usually aggregated with respect to somewhat coarser temporal resolution than the microscopic models. Macroscopic models are generally regional-level planning models (some macroscopic models are also used for freeway operational analysis purposes) and may just produce facility level speeds and VMT estimates for the entire planning horizon (Barth 1997).

The manner in which vehicle operation is represented in the transportation model will form the basis of the framework for interfacing emission models with transportation models.

3.6 Analysis Framework

Barth's (1997) framework can be easily extended to include interfacing of emission models based on emission factors, such as EPA's MOBILE 5/6 and CARB's EMFAC. The emission factors produced by these models are typically based on average values of vehicle operating parameters such as speeds. Hence, in the framework for this study the emission factor model is interfaced within a simulation-assignment framework at a mesoscopic level. On the other hand, the emission rates produced by modal emission models are instantaneous rates and are, therefore, interfaced at a microscopic level. Barth's framework can also be extended to take into account whether a transportation network model is *static* or *dynamic,* which is an important consideration, particularly for evaluation of ITS strategies. Shazbak (2000) analyzed air quality implications of traffic management strategies using static and dynamic transportation models. He points out the lack of static transportation planning tools capable of adequately representing ITS strategies.

The objective of this research is to investigate the impact of ITS strategies on mobile source emissions, using both static and dynamic network modeling approaches in connection with modal emission models and emission factor models. The analysis framework designed for this purpose has four levels, with each level representing an enhancement over the previous level:

1. Static network modeling interfaced with emission factor model
2. Dynamic network modeling interfaced with emission factor model
3. Static network modeling interfaced with modal emission model
4. Dynamic network modeling interfaced with modal emission model

The overall structure of these levels is described below and the details of the procedures are discussed in Chapter Four

3.6.1 Level 1: Static Network Model with Emission Factor Model

This level, which corresponds to much of the current state of practice in emission estimation, involves using outputs from the four-step transportation planning process and a static traffic assignment model. The emission estimation is then performed with emission factor models such as EPA's MOBILE series of models or CARB's EMFAC (for California). This approach is suitable for preparing emissions inventories for a geographical region or for forecasting emissions for planning purposes. The s*tatic* models used have average travel time, speeds, and delays experienced in the network as the main indicators of performance.

The static transportation models typically do not have the capability to adequately represent ITS strategies. DYNASMART-P, which is a dynamic network modeling and ITS evaluation tool, is used to emulate a static assignment and produce link-specific average speeds and link-specific VMT by vehicle class. MOBILE 5 emission factors are then used to estimate emissions in the network.

3.6.2 Level 2: Dynamic Network Model-Emission Factor Model

In this case, DYNASMART-P is used to estimate the emission-producing activities. In dynamic modeling, indicators of traffic performance include queues and speeds on links for every simulation interval. This approach is therefore responsive to ITS measures and represents an improvement over using a *static* model for the purpose of air quality assessment of ITS. The output from the dynamic model, i.e., link-specific average speeds and link-specific VMT by vehicle class, can then be used with emission factors generated from MOBILE 5, but this is done at sufficiently small intervals to better capture the traffic flow dynamics.

Aggregation Levels. Within this interfacing approach, the levels of aggregation (i.e., the time intervals used for collecting the output statistics from DYNASMART-P) are varied to analyze the impact that the temporal aggregation has on emissions estimation. The emission factors vary highly non-linearly with speed and the aggregation interval will therefore be an important factor in the final emission estimates. The speeds used in MOBILE are fleet average speeds over the test cycle and not instantaneous speeds; therefore, using a very short aggregation interval may produce misleading results. At the same time, using a very long aggregation interval will reduce the sensitivity to traffic dynamics in the network. Therefore, the analysis of the trade-offs associated with using various aggregation intervals is an important question from a methodological as well as a practical standpoint.

3.6.3 Level 3: Dynamic Network Model with Modal Emissions Model

DYNASMART-P is used to emulate static assignment, and modal emissions models are interfaced with DYNASMART-P. Conventional static models used for planning do not have the capability to produce (second-by-second) estimates of vehicle speeds and acceleration required for interfacing with modal emission models. DYNASMART-P is, however, a dynamic simulation-assignment model and therefore can produce such outputs even when used to represent static assignment.

3.6.4 Level 4: Dynamic Network Models with Modal Emission Models

DYNASMART is interfaced with "modal" emission models that explicitly capture the impact of vehicle operating modes on emissions, instead of using average values. This approach therefore provides a very fine degree of resolution, both in terms of estimating emission-producing activities and emission estimation as a result of these activities. As such, this approach represents the state-of-the-art in the estimation of emission impact of transportation operational strategies.

3.7 Summary

This chapter identifies elements of transportation network modeling and emission modeling that are likely to have significant impact on estimating mobile source emissions. The tools and procedures that are used for evaluating the emission impact of transportation strategies are briefly described. A framework to interface transportation and emission models is provided along with an outline of the methodological and practical requirements of such interfacing. The next chapter describes in detail the software tools and procedures employed to implement the framework discussed in this chapter.

4. Procedures and Tools

4.1 Introduction

Several procedures and capabilities are required to implement the framework discussed in Chapter Three. In this chapter the structure and capabilities of DYNASMART-P, the software tool employed in this study, is described in some detail. An overview of the emission data and the emission-testing methods that were used at Oak Ridge National Laboratories (ORNL) and at Texas Southern University for the development of modal emission models for light-duty and heavy-duty vehicles, respectively, are also presented. Finally, the procedures for interfacing these modal emissions models, as well as MOBILE 5 with DYNASMART-P, are described.

4.2 Selection of Network Modeling Tool

One of the most important considerations in implementing the analysis framework is the selection of the tool to represent the Intelligent Transportation Systems (ITS) strategies to be analyzed and model the traffic system's performance under these strategies. Several studies (Jayakrishnan et al. 1994, Hawas et al. 1996) enumerate the capabilities that a simulation-assignment framework should typically possess to effectively evaluate network performance under ITS strategies. These capabilities are: 1) a traffic flow simulator; 2) a trip maker behavior component that would determine an appropriate path selected by the trip maker on the basis of received information regarding congestion or other network problems; and 3) a network path processing component that takes the link-level information received from the simulator and combines it into path-level information in order to assign drivers to particular paths.

Koeppen (1996) has identified additional functional capabilities, including: 1) ability to react to the time-varying changes in demand and link capacities due to disruptions in normal traffic flow (caused by lane closures, incidents, etc.) and owing to traffic control measures such as stop signs, signal coordination, ramp metering, etc.; 2) ability to differentiate between vehicles that are equipped to receive en-route information and those that are not equipped to receive such information; and 3) the ability to represent two-way communication between equipped vehicles and the information source. For non-equipped vehicles, it could simulate pre-specified paths.

Koeppen analyzed the capabilities and features of various simulation models in the context of their suitability for use in evaluating ITS strategies. The models studied were: 1) SATURN, 2) CONTRAM, 3) AIMSUM, 4) INTEGRATION, and 5) DYNASMART. She reports that while each of the first four models represents an improvement over the simulation models used earlier, their effectiveness as evaluation tools for ITS is diminished because they lack some of the key capabilities identified for this purpose. She further reports that DYNASMART is one descriptive analysis tool that has managed to successfully incorporate drivers' responses to information, traffic flow behavior, and the resulting changes in the characteristics of the network paths into an integrated simulation framework.

DYNASMART is used in this research as the core network modeling tool in the emissions evaluation methodology. DYNASMART models the evolution of traffic flows in a traffic network, which result from the travel decisions of individual travelers. DYNASMART is capable of evaluating a wide range of traffic operational strategies, including many ITS strategies, using an integrated simulation-assignment framework. The current version of the DYNASMART model used in this research is DYNASMART-P, intended for off-line operational-planning applications. The DYNASMART-P code was modified for certain portions of this study, as described in this chapter.

To implement the analysis framework, a set of models that can predict mobile source emissions resulting from different modes of vehicle operation such as accelerating, decelerating, cruising, and idling are required. A set of modal emission models developed in the form of look-up tables at ORNL for light-duty vehicles are incorporated in DYNASMART-P. For heavy-duty vehicles, ONROAD modal emissions models developed at Texas Southern University as part of a Texas Department of Transportation (TxDOT) study are incorporated in DYNASMART-P.

Procedures are also developed to interface the EPA-approved MOBILE 5 emissions factor model with DYNASMART-P to provide a capability to analyze the impact of ITS strategies on mobile source emissions in a manner that is consistent and representative of the state-of-practice in air quality analysis of transportation-related measures.

4.3 Structure and Capabilities of DYNASMART-P

DYNASMART-P is a state-of-the-art mesoscopic simulation model, with dynamic traffic assignment capabilities. The DYNASMART-P framework is designed to assign time-varying traffic demands and model the corresponding traffic patterns to evaluate network performance of Advanced Traveler Information Systems (ATIS) and/or Advanced Traffic Management Systems (ATMS) at link-specific or network-wide levels. DYNASMART-P represents the network in terms of links and nodes, and represents the demand origination and destination entities as spatial zones. Traffic simulation is performed based on the control scheme specified by the user. A conceptual framework for such a simulation-based approach is shown in Figure 4.1. A user-friendly Graphical User Interface (GUI) is provided to create and edit input files, specify parameter values, and view simulation results and statistics. DYNASMART-P needs a set of input files for demand generation, traffic simulation, and displaying the simulation results on the graphical interface.

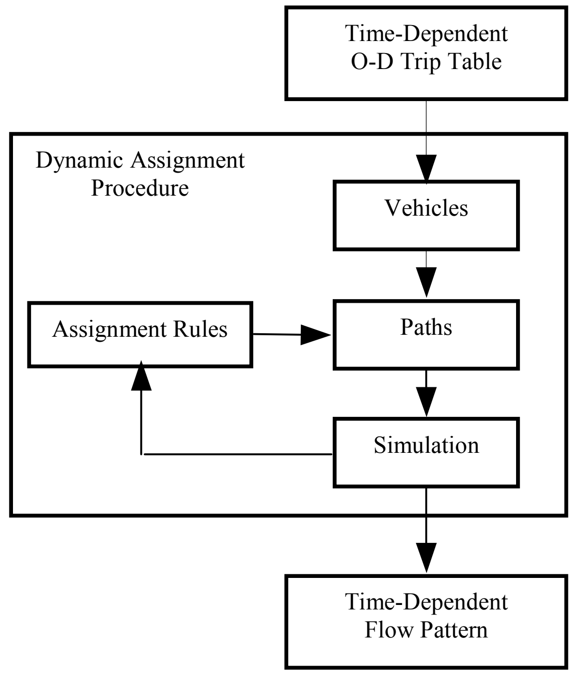

Figure 4.1 Conceptual Framework for the Simulation-Assignment Procedure
Source: Mahmassani 2001

The main components of DYNASMART-P are the simulation component, the path processing component, and the user behavior component. Figure 4.2 shows the DYNASMART-P model structure in the context of algorithmic procedures.

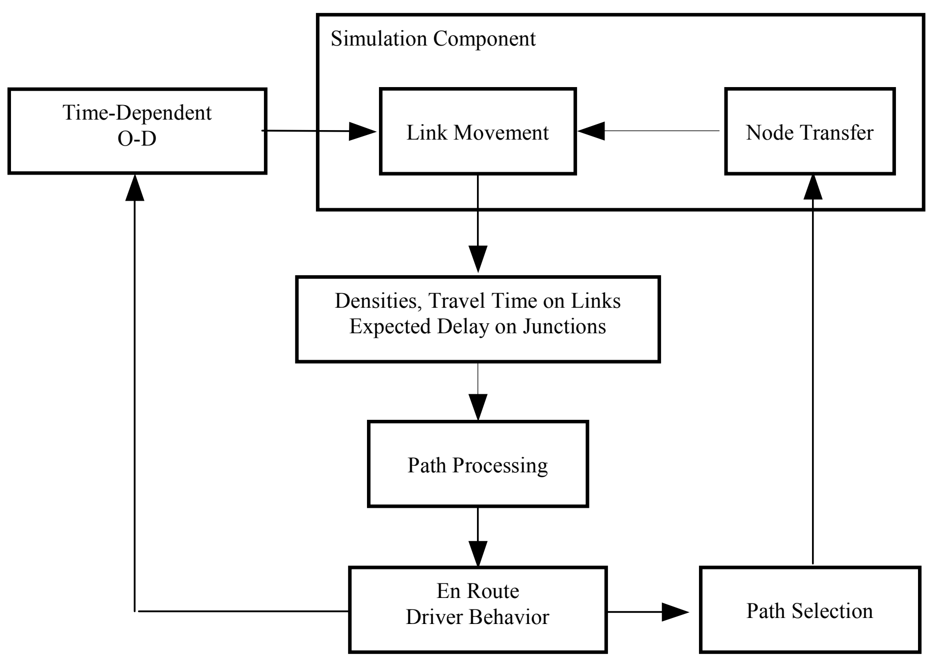

Figure 4.2 DYNASMART-P Model Structure
Source: Mahmassani 2001

4.3.2 User Behavior Component

DYNASMART-P models the route-choice decision of the travelers by a route-switching model representing boundedly-rational behavior. This means that commuters will only switch routes if the gains exceed a threshold within which the results are satisfying and sufficing for them (Mahmassani et al. 1994). This route-switching model is supported by experimental evidence presented by Mahmassani and Stephan (1988) and Srinivasan and Mahmassani (1999). Mathematically:

$$\delta_j(k) = \begin{cases} 1 & \text{if } TTC_j(k) - TTB_j(k) > \max(\eta_j . TTC_j(k), \tau_j) \\ 0 & \text{otherwise} \end{cases}$$

where for driver j,
$\delta_j(k)$: 1, indicates a route switch; 0, no switch at node k,
$TTC_j(k)$: Trip time from node k to destination on current path,
$TTB_j(k)$: Trip time along the best path,
η_j : Relative indifference threshold, and
τ_j : Minimum improvement needed for a switch.

The threshold level may reflect perceptual factors, preferential indifference, or persistence and aversion to switch. The quantity η_j governs users' responses to the supplied information and their propensity to switch.

4.3.3 Path Processing Component

The path processing component of DYNASMART-P determines the route-level attributes (e.g., travel time) for use in the user behavior component, given the link-level attributes obtained from the simulator. For this purpose, a k-shortest path algorithm with movement penalties is interfaced with the simulation model to calculate k different paths for every origin-destination (O-D) pair (Mahmassani et al. 1994).

4.3.4 Simulation Component

Most of the modifications needed for the purpose of this research are made in the simulation component of DYNASMART-P. DYNASMART-P moves vehicles individually or in packets, using established macroscopic flow relations. However, it differs from conventional macroscopic simulation models in that it keeps a record of the location and itineraries of the individual vehicles. This kind of hybrid approach to simulation has been termed as mesoscopic simulation in the literature. The two important modules of the simulation are the link movement and node transfer. These modules are described briefly here.

4.3.5 Link Movement

Most macroscopic simulation models calculate link flows using the following identity:

$$q = k.v$$

where q, k, and v are the flow (vehicle per unit time), density (vehicle per unit distance), and average speed (distance per unit time), respectively. Moving vehicles in this manner may lead to physically unrealistic speeds for links of finite length (Chang et al.1985). DYNASMART-P moves vehicles using an approach based on continuum representation of traffic described in terms of the continuity equation:

$$\frac{\partial q}{\partial x} + \frac{\partial k}{\partial t} = p(x,t)$$

where p is the net generation (vehicles per unit time and distance). The variables x and t denote the location and time, respectively. DYNASMART-P uses this continuity equation and a speed-concentration relation to model the flow. The speed-density relation employed in DYNASMART-P for this purpose is the modified Greenshield speed-concentration relation:

$$v^{ta} = v^{0a} + (v^{fa} - v^{0a})(1 - k^{ta} / k^{ja})^{\alpha}$$

where v^{ta} and k^{ta} are the average speed and density on link a at time t, respectively; v^{fa} and v^{0a} are the free mean speed and the minimum speed on link a, respectively; k^{ja} is the jam concentration; and α is a parameter that captures the sensitivity of the speed to the concentration. The model user may specify other forms for the speed-density relation.

4.3.6 Node Transfer

The node transfer component of DYNASMART-P performs the transfer of vehicles from link to link at nodes. The right of way is allocated according to the control type set for the node. The node transfer component also keeps track of vehicles entering and exiting the network and ensures the conservation of vehicles at nodes.

The output data from the node transfer component includes the number of vehicles that remain in queue and the number of vehicles added or subtracted from each link for each simulation step. The node transfer implements all the inflow and the outflow constraints that limit the number of vehicles entering and leaving each link under the prevailing traffic control. There are constraints on both outflow and inflow of the vehicles on a link in a given simulation interval depending on the queues and capacity of the current link as well as the downstream links. The node transfer component handles all these constraints.

4.4 Incorporating Modal Emissions Models in DYNASMART-P

As mentioned earlier, the process of interfacing an emission model into a transportation modeling framework has two main components: vehicle fleet distribution and vehicle operation. The following section provides a description of the models and procedures used in DYNASMART-P for both of these components.

Ramachandran (1995) incorporated modal emission models based on an emissions database developed at ORNL for a Federal Highway Administration (FHWA)-sponsored project. The details of this database are given elsewhere (McGill et al. 1985). In this study, a similar approach is followed with more recent emission data and more detailed vehicle classification.

4.4.1 Modal Emissions Models for Light-Duty Vehicles

The models incorporated in DYNASMART-P for light-duty vehicles are adapted from the look-up tables for fuel consumption and emissions as a function of vehicle speed and acceleration, developed at ORNL in the mid 1990s, and hereafter referred to as the ORNL models. The look-up tables are provided in a FHWA (1999) report. These models were designed to be incorporated within microsimulation models, such as the FHWA's TRAF series of models, to evaluate the impact of roadway design and traffic control measures on emissions and fuel consumption.

These models were selected for the following reasons:

- The structure of the models is simple as the emissions and fuel consumption are given as a function of vehicle speed and acceleration only.
- They are designed for integration within microsimulation models.
- These models have been successfully integrated within ITS simulation tools such as INTEGRATION for the purpose of evaluating the emissions and fuel consumption impact of traffic signal control (Rakha et al. 2000).

The details of the methodology used to develop these look-up tables, the testing procedures, and the validation of these models is given elsewhere (West et al. 1997). A brief description of the important aspects of the ORNL models is provided in the following sections.

4.4.2 Vehicle Selection

It is important that these models be representative of the vehicle fleet in operation in order to accurately predict emissions from the operating fleet. Initially, eight light-duty vehicles were selected based on their weight, engine size, and availability. West et al. (1997) indicate that these eight vehicles are representative of the mainstream vehicles. The average engine size for all vehicles is 3.3 liters, the average number of cylinders is 5.8, and the average curb weight is 3,300 lbs (West et al. 1997). The average sales-weighted domestic engine size for 1995 was 3.5 liters, with an average of 5.8 cylinders (Ward's 1995 and 1996). To represent the growing popularity of pickup trucks, sports utility vehicles, and minivans, the eight-vehicle sample included one light-duty truck of each type (West et al. 1997).

All the vehicles in the sample were, however, relatively new and in good working condition, with all vehicles having less than 50,000 miles on the odometer. Three additional vehicles, a 1997 Toyota Celica, a 1987 Oldsmobile Cutlass Ciera, and a 1967 Ford Mustang were therefore acquired and tested in 1997-1998. The Toyota Celica, an onboard diagnostics-2 (OBD2) compliant vehicle, was chosen to represent the state-of-the-art. The Cutlass Ciera had accumulated 75,000 miles prior to selection and so was included as an example of a higher-mileage car. The Ford Mustang was chosen in an effort to characterize older carbureted cars still in the fleet. The details of these test vehicles and the look-up tables are not provided in the FHWA report mentioned earlier and were obtained directly from ORNL for this study. Tables 4.1 and 4.2 show the specifications of the test vehicles.

Description of the Look-Up Tables. For each of the vehicles tested, look-up tables were available for carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx) emissions in mg/sec and fuel consumption in gal/hr as a function of vehicle speed (ft/sec) and acceleration (ft/sec^2). The vehicle speeds ranged from 0-110 ft/sec (0-120 km/hr) at the increment of 1 ft/sec (1.1 km/hr) and the accelerations ranged from -5 to 12 ft/sec^2 (-1.5 m/ sec^2 to 3.6 m/ sec^2) at increments of 1 ft/sec^2 (0.3 m/ sec^2). These ranges include typical driving conditions for deceleration (acceleration less than zero), idling (speed and acceleration equal to zero), cruising (acceleration equal to zero for a nonzero speed), and acceleration (acceleration greater than zero). For every vehicle, the maximum attainable deceleration decreases as speed increases. This results in some empty cells in the look-up tables. The approach used by ORNL researchers is to fill these cells with their nearest neighbor, i.e., the highest attainable acceleration at that speed (West et al. 1997).

Table 4.1 Test Vehicle and Industry Average Specifications
Source: (West et al. 1997)

Year	Make/Model (Odometer miles)	Engine PFI=Port Fuel Injection TBI=Throttle Body Injection	Transmission M=Manual, L=Automatic with lockup	Curb Weight Lbs	Rated hp
1988	Chevrolet Corsica (18k)	2.8 L pushrod V6, PFI	M5	2665	130
1994	Oldsmobile Cutlass Supreme (18k)	3.4 L DOHC V6, PFI	L4	3290	210
1994	Oldsmobile Eighty Eight (26k)	3.8 L pushrod V6, PFI	L4	3360	170
1995	Geo Prizm (22k)	1.6 L OHC I4, PFI	L3	2460	105
1993	Subaru Legacy (49k)	2.2 L DOHC flat 4, PFI	L4	2800	130
	5-car average	**2.76 L, 5.2 cyl.**		**2915**	**149**
1995	LDV industry average	2.9 L, 5.4 cyl		2900	
1994	Mercury Villager Van (13k)	3.0 L pushrod V6, PFI	L4	4020	151
1994	Jeep Grand Cherokee (25k)	4.0 L pushrod I6, PFI	L4	3820	190
1994	Chevrolet Silverado Pickup (35k)	5.7 L pushrod V8, TBI	L4	4020	200
	3-truck average	**4.23 L, 6.7 cyl.**		**3953**	**180**
1995	LDT industry average	4.6 L, 6.5 cyl.			
	8-vehicle average	**3.3 L, 5.75 cyl.**		**3300**	**160**
1995	LDV+LDT, industry avg	3.5 L, 5.8 cyl			

Table 4.2 Specifications for Vehicles Tested in 1997-1998

Year	Make/Model (Odometer miles)	Engine PFI=Port Fuel Injection TBI=Throttle Body Injection	Transmission M=Manual, L=Automatic with lockup	Curb Weight lbs
1997	Toyota Celica (5k)	1.8 L DOHC I4, PFI	L4	2520
1987	Oldsmobile Cutlass Ciera (75k)	3.8 L pushrod V6, PFI	L4	2960
1967	Ford Mustang Coupe (240K)	4.7 L pushrod V8, Carb	M3	2740

Validation. These models were validated by the researchers at ORNL using emission and fuel consumption data from a government/cooperative research program for a number of light-duty vehicles driven over four different cycles (Haskew et al. 1994). The emissions and fuel consumption were computed for each of the four cycles using composite vehicle maps. The purpose of this was to examine the effects of "off cycle" driving on emissions. "Off cycle" refers to speeds and accelerations not covered in the current Federal Test Procedure (FTP) for compliance testing of motor vehicle emissions (West et al. 1997). The emissions from the composite vehicle maps were compared with those obtained from the "hot stabilized" bags of each of the four test cycles. The resulting predictions are within the run-to-run variation in repeat dynamometer tests (West et al. 1997).

Limitations. Though the ORNL models represent an important step in providing simple, immediately usable, modal emissions procedures for integration with traffic simulation models, they have certain limitations:

- The models do not have a cold start algorithm and can only predict emissions and fuel consumption in the hot stabilized mode.
- In an attempt to keep the models simple, other parameters like engine and catalyst temperature, recent load and temperature history, etc., that may have significant impact on emissions, are neglected.
- The sample size of the test vehicles is small and therefore the weighting of the individual vehicles can significantly affect the emissions and fuel consumption maps of the composite vehicle.
- The sample of test vehicles does not contain heavy-duty or diesel vehicles.
- The sample is not representative of the current vehicle fleet in operation in terms of the age distribution of the vehicles, as most of the vehicles in the test sample are fairly new and with low mileage on their odometers.

4.4.3 Modal Emission Models for Heavy-Duty Vehicles

The ORNL models were developed based on light-duty vehicles only. It was therefore necessary to use other models to account for the emissions from heavy-duty vehicles. Data on heavy-duty emissions is scarce because heavy-duty engines are expensive

(Sierra Research 1994). There are also a number of other issues with heavy-duty diesel vehicle emissions (Barth 2001):

- Heavy-duty diesel vehicle emissions and activity patterns are not well understood.
- Engines are certified, not the vehicles themselves.
- Real-world driving conditions can affect fuel consumption and emissions greatly.
- There is a strong need to perform on-board measurements.
- Existing on-board equipment lacks sensitivity, accuracy.

ONROAD modal emission models developed at Texas Southern University for TxDOT were selected for the purpose of representing emissions from heavy-duty vehicles. The main features of these models are described here. Further details of these models are given elsewhere (Yu 1997).

Data Collection and Testing Methodology. These models differ from the models discussed previously in that they were developed based on on-road testing and not on chassis or engine dynamometer testing. The on-road data for these models were collected from five highway sites in Houston using a Remote Emissions Sensor (RES) called Smog Dog, which can simultaneously collect emission concentrations of CO, NOx, and HC, as well as vehicles' instantaneous speeds and accelerations. A video image of each detected vehicle was also recorded (Yu 1997).

The Smog Dog collects emission concentrations (in ppm) and not emission rates, which are required for developing modal emissions models. The emission concentrations are therefore converted to emission rates using linear correlation relationships presented in a research report prepared by the South Coast Air Quality Management District. Such relationships are, however, not available for NOx and therefore NOx was not considered further in developing the modal emissions models (Yu 1997).

Vehicle Types. Based on the video images of the test vehicles, the vehicles were visually classified into three broad classes: passenger cars, vans and pickup trucks, and other trucks. Detailed classification of the vehicles was not possible with the data collected. Most traffic simulation models do not have very detailed vehicle classifications, so such a coarse classification may be justified.

Model Estimation. For each of the vehicle types, regression equations were developed for CO and HC emissions rates. The models have the following general form:

$$\text{Log}\,(EMIs_x) = c_o + c_1u + c_2u^2 + c_3a + c_4a^2 + c_5t + c_6h$$

where

$EMIs_x$ = emission rate in grams/sec for emissions species EMI (CO or HC) and vehicle type x,

x = vehicle type,

u = vehicle instantaneous speed in mph,

a = vehicle acceleration rate in mph per second,

t = ambient temperature in Fahrenheit degree,

h = ambient humidity in percentage (%), and

c_0, c_1,… = model parameters.

For this study, only the models for vehicle type three, other trucks, will be used. The semi-logarithmic model form used precludes any negative emission values. Appendix A shows the regression models for all three vehicle types. It is interesting to note that for vehicle type three (heavy-duty vehicles), the emissions depend only on the instantaneous vehicle speed and not on the acceleration.

Validation. Yu (1997) converted the emission rates in grams/sec to grams/mile emission factors by dividing the emission rate by the corresponding speed. The rates were then compared with MOBILE and EMFAC emission factors for different speeds. The results indicated acceptable agreement between the emission factors for heavy-duty vehicles, particularly at low speeds (Yu 1997).

Limitations. These models provide a simple and effective way to represent emissions from heavy-duty vehicles in DYNASMART-P. However, they have certain limitations:

- The calibration data was obtained from on-road tests, which may make the emission rates network specific.
- The models do not provide a method to predict NOx emissions, which are an important component of the total emissions from heavy-duty diesel vehicles.
- The models do not consider the effect of other important variables like roadway grade, wind resistance, etc.

4.4.4 Integration of Modal Emission Models in DYNASMART-P

The modular nature of the DYNASMART-P code facilitates the addition of external modules for a variety of purposes. A module ENVIMODAL_MOD was added to DYNASMART-P for the purpose of incorporating the ORNL and ONROAD models. Several FORTRAN sub-routines were included in this module to perform the necessary tasks for this integration. The main stages in this process are described below.

Vehicle Generation

An important requirement is for the integrated models to be capable of capturing the emissions characteristics of the different vehicle types based on characteristics like size, age, etc. There are two important considerations in accomplishing this task: 1) Defining vehicle categories that recognize different emission characteristics, and 2) mapping these vehicle categories onto the existing DYNASMART-P vehicle types.

Ideally, one would want to have a large number of vehicle categories based on size (light-duty, medium-duty, heavy-duty), age (new, old), fuel type (gasoline, diesel), etc., to represent the entire spectrum of emission characteristics. However, it is very difficult to find emission data supporting such detailed classification. Furthermore, most traffic simulation models do not have or need a very detailed representation of vehicle types.

The ORNL models used in this study had only emission data for light-duty gasoline vehicles. DYNASMART-P currently recognizes passenger cars, trucks, and buses. The ORNL light-duty cars and trucks were mapped to the passenger cars in DYNASMART-P, while the ONROAD heavy-duty vehicles were mapped to the trucks in DYNASMART-P.

To account for the deterioration of emissions characteristics with mileage, additional categories were defined for passenger cars. Although mileage is the key parameter that describes the deterioration in the emission characteristics of the vehicle, registration data is typically available in terms of vehicle age in years. Although data on age of the passenger cars in the ORNL test sample was available, the data did not adequately represent the mileage accumulation (e.g., the 1988 Chevrolet Corsica and 1994 Oldsmobile Cutlass Supreme both have 18,000 miles on their odometer). It was, therefore, deemed appropriate to convert the mileage accumulated into equivalent vehicle age in years. The default mileage accumulation rates used in MOBILE 5 (Appendix B) were used as guidelines. The age categories defined were: 0-1 yrs; 1-5 yrs; 5-15 yrs; and 15 yrs and older. The vehicles were then placed in the corresponding age categories based on their odometer mileage and the default MOBILE 5 mileage accumulation rates. The emission look-up tables for the vehicles in a given age category would therefore represent the emission characteristics of that age category. Table 4.3 illustrates this classification.

The light-duty trucks in the ORNL sample were all relatively new and did not exhibit much variability in their mileage (Table 4.1), so no such classification could be designed for light-duty trucks. The ONROAD models are based on on-road testing and individual registration data on the vehicles were not available. Therefore, any further classification for heavy-duty vehicles was precluded in this study.

Table 4.3 Passenger Car Classification by Age

Age Category	Vehicle	Model Year	Mileage
<1 yrs	Toyota Celica	1997	5,000
1-5 yrs	Chevrolet Corsica	1988	18,000
	Oldsmobile Cutlass Supreme	1994	18,000
	Oldsmobile Eighty Eight	1994	26,000
	Geo Prizm	1995	22,000
	Subaru Legacy	1993	49,000
5-15 yrs	Oldsmobile Cutlass Ciera	1987	75,000
>15 yrs	Ford Mustang Coupe	1967	240,000

It is to be noted that though this particular vehicle classification system and ORNL models were adopted for this study, the implementation in DYNASMART-P is extremely general. A new input file fleet.dat is created in which the user specifies the number of light-duty classes and the distribution of these classes as well as the number of heavy-duty classes and their distribution. Four other input files; co.dat, hc.dat, nox.dat, and fuel.dat are created containing the look-up tables corresponding to the light-duty vehicle classes defined in fleet.dat. Any number of light-duty classes could be defined, as long as corresponding look-up tables are available in the ORNL format and in consistent units.

In the present implementation, while any number of heavy-duty vehicle classes may be specified, the emissions calculation for each class will be based on the ONROAD emissions model coded in DYNASMART-P. DYNASMART-P will also automatically add one more vehicle class for buses, and emissions calculations for buses will also be made using the ONROAD models.

Acceleration Calculation. The acceleration calculation procedure used in this study is based on the work done previously by Ramachandran (1995). The simulation interval in DYNASMART-P is 6 seconds; the speeds and the positions of the vehicles are updated every 6 seconds. During those 6 seconds, the vehicles are assumed to be traveling at a given average speed (so acceleration/deceleration is not explicitly represented). The resulting speed-time profile is shown in Fig 4.3

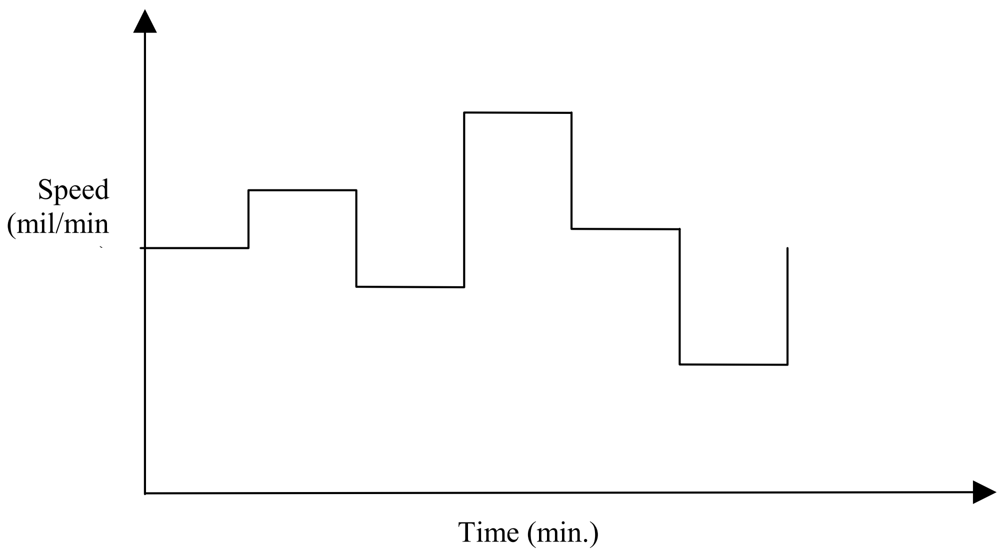

Figure 4.3 Speed-Time Profile in DYNASMART-P

To attribute accelerations to the vehicles, the vehicle is assumed to accelerate/decelerate uniformly over the 6 second simulation interval to reach the corresponding speed. The modified speed-time profile is shown in Fig 4.4.

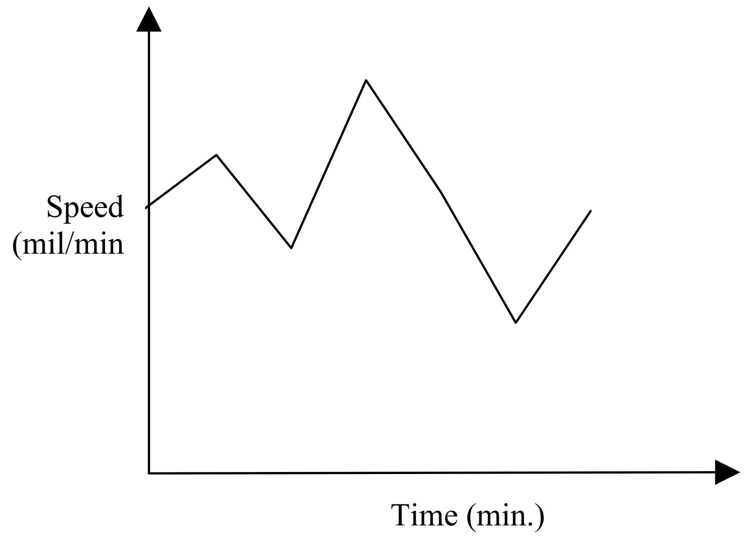

Figure 4.4 Modified Speed-Time Profile

Emission Calculation. Two options were considered for implementing the ORNL models into DYNASMART-P: 1) using statistical models, and 2) using a look-up table approach. Look-up tables were finally implemented because the ORNL data were designed to be used as look-up tables and therefore were in the format required for look-up table implementation. Secondly, and more importantly, the look-up table approach is much more flexible in terms of ease of updating the table values as more recent test data become available.

For every vehicle, speed and acceleration are calculated every simulation interval. The speeds and accelerations are checked to ensure that they do not fall outside the ranges defined in the look-up tables. If they do, then they are corrected to fall within the permissible ranges. Based on the speed and acceleration, the appropriate cell of the look-up table corresponding to the vehicle type is queried. These emission factors, which are in mg/sec, are multiplied by the simulation interval, 6 seconds, to give the emissions for that simulation interval.

Emission Statistics. Emission statistics are collected over an aggregation interval defined in the output options. Overall network emissions are also collected at the end of the simulation run. A breakdown of emissions by vehicle type and facility type (freeways, ramps, arterials, etc.) is also printed at the end of the simulation run. Fig 4.4 shows the data flow, structure, and interactions between the main components of the emissions module and the DYNASMART-P simulation component.

4.5 Interfacing DYNASMART-P with MOBILE 5

MOBILE 5 is the most widely used emission factor model for air quality analysis. Use of MOBILE 5 defines much of the current state-of-practice in emission estimation. This section describes the inputs and outputs of MOBILE 5, the exhaust emissions algorithm of MOBILE 5, and the procedures developed to interface MOBILE 5 with DYNASMART-P.

4.5.1 MOBILE 5 Inputs/Outputs

The MOBILE 5 input file consists of three sections: the control section, the one-time data section, and the scenario section. The control section consists of the series of flags that govern the execution of the program. These flags indicate whether the user wants to use default values, the format of the output, etc.

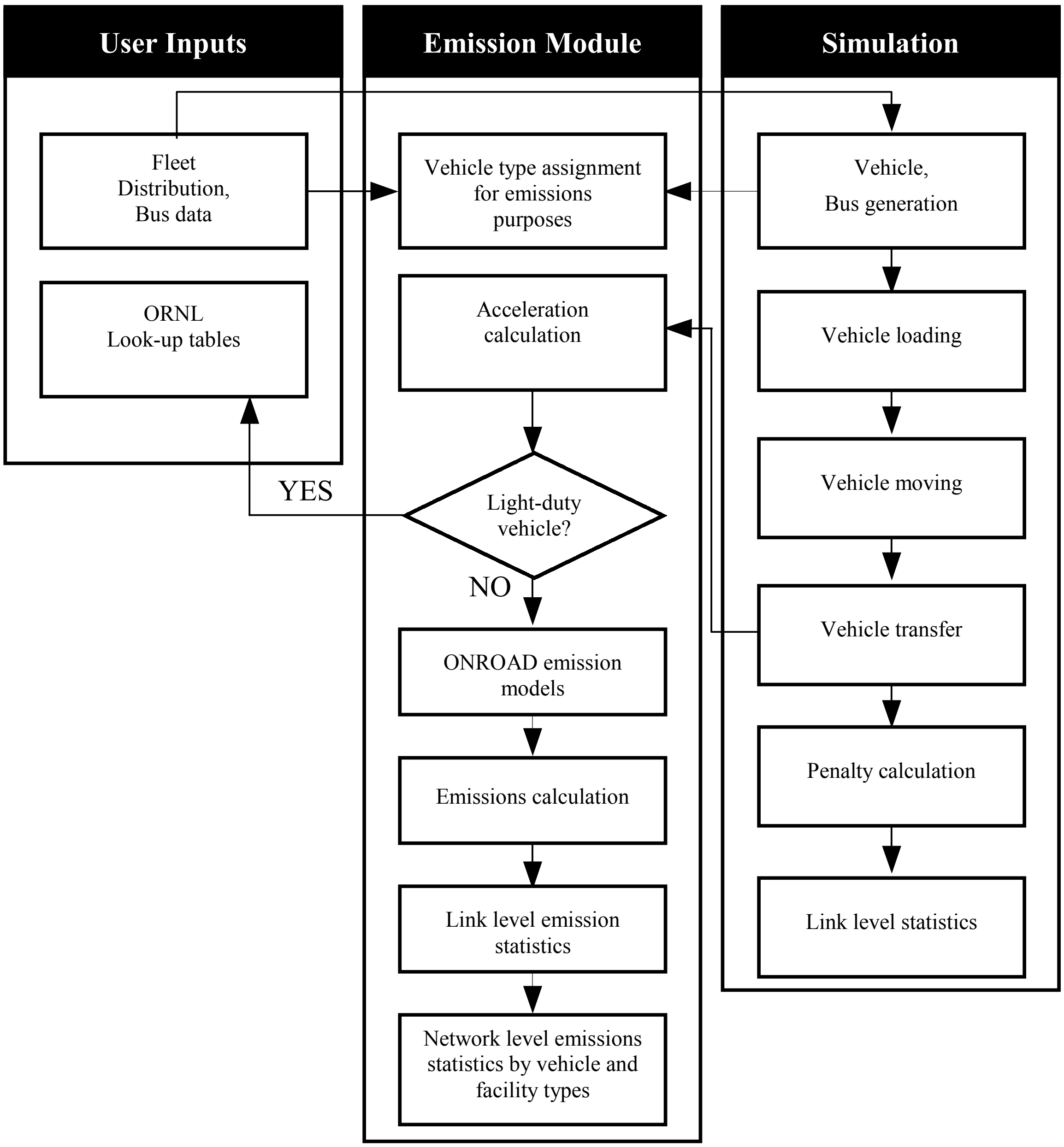

Figure 4.5 Structure of the DYNASMART-P/Modal Emission Model Integration

The onetime control section allows the user to enter different values than the MOBILE defaults, e.g., vehicle mileage accumulation rates, vehicle age distribution, etc. The scenario section of the input file defines the scenarios for which emission factors are required. Parameters describing the scenarios are inputs like region, calendar year of evaluation, average speed(s), ambient temperature, operating mode fractions, and month of evaluation.

Given the above inputs, MOBILE 5 generates emission factors in gms/mile for HC, CO, and NOx for different vehicle categories, as well as for a composite vehicle. The composite emission factors are derived from the vehicle miles traveled (VMT) mix input by the user. MOBILE 5 produces output in descriptive formats for ease of visual inspection or in spreadsheet format for post processing. Further details on MOBILE inputs and outputs are available elsewhere (USEPA 1993).

4.5.2 Mobile Exhaust Emissions Algorithm

The basic exhaust emissions data contained in the MOBILE models are based on a standardized driving cycle called the Urban Dynamometer Driving Schedule (UDDS), or “LA4 cycle.” This chassis dynamometer test cycle involves duplicating a speed-time profile from an actual road route identified in the Los Angeles area in the late 1960s and chosen to represent the typical urban area driving pattern. The driving cycle was then incorporated into EPA's FTP, the testing process used by all motor vehicle manufacturers to certify that their vehicles are capable of meeting federal emission standards (Sierra 1994).

The FTP consists of three distinct segments at a standard test cell temperature of 68° to 86°F. Because the mass emissions from each of the three segments are collected in separate tedlar bags, the three operating modes are often referred to in terms of “bags.” A complete FTP is comprised of (Sierra 1994):

- A cold start (or cold transient) portion (“Bag 1”), which corresponds to the first 3.59 miles of the UDDS (505 seconds in length);
- A stabilized portion (“Bag 2”), which is the final 3.91 miles of the UDDS (867 seconds in length); and
- A hot start (or hot transient) portion (“Bag 3”), which is the first 3.59 miles of the UDDS and follows an engine-off period of 10 minutes.

The FTP composite emission rate is calculated from the bag-specific emission results according to the following formula:

$$BER = 0.206 * BAG1 + 0.521 * BAG2 + 0.273 * BAG3$$

where
BER = composite FTP base emission rate (g/mi),
BAG1 = bag 1 emission rate (g/mi),
BAG2 = bag 2 emission rate (g/mi), and
BAG3 = bag 3 emission rate (g/mi).

Corrections for Nonstandard Conditions - Because the emission test is performed over the same standard operating conditions for all vehicles, the MOBILE emission factor models make use of a variety of correction factors to tailor the FTP results to the specific local conditions being modeled. For example, operating mode correction factors (also referred to as bag correction factors) are applied to the FTP composite emission rate to determine the emission rate of a vehicle in the cold start mode, stabilized mode, or hot start mode (Sierra 1994).

Because emission rates from motor vehicles are much higher at very low temperatures, temperature correction factors are used to account for this effect. Finally, a vehicle's emission rate is also strongly influenced by its average speed. Thus, speed correction factors modify the FTP results to account for speeds different from the FTP average of 19.6 mph (Sierra 1994).

The overall emission rate from a vehicle is the product of the basic emission rate (determined from the FTP results) and a number of correction factors that are specific to the conditions being modeled. Although the actual modeling procedure is quite elaborate, this can be simply represented by (Sierra 1994):

$$EF = BER * BCF * TCF * SCF$$

where
EF = emission factor (g/mi) corrected for operating mode, temperature, and speed;
BER = composite FTP base emission rate (g/mi);
BCF = bag (or operating mode) correction factor;
TCF = temperature correction factor; and
SCF = speed correction factor.

4.5.3 Interfacing MOBILE 5 and DYNASMART-P

A post-processing utility was developed to interface DYNASMART-P with MOBILE 5. MOBILE 5 produces emission factors for the following eight types of vehicles:

1. LDGV - light-duty gasoline vehicles (i.e., passenger cars)
2. LDGT1 - light-duty gasoline trucks (<6,000 lbs GVW)
3. LDGT2 - light-duty gasoline trucks (6,000 – 8,500 lbs GVW)
4. HDGV - heavy-duty gasoline vehicles (over 8,500 lbs GVW)
5. LDDV - light-duty diesel vehicles (i.e., passenger cars)
6. LDDT - light-duty diesel trucks (<8,500 lbs GVW)
7. HDDV - heavy-duty diesel vehicles (> 8,500 lbs GVW)
8. MC - motorcycles.

At present, DYNASMART-P models only passenger cars, trucks, and buses for traffic propagation purposes. The mapping of vehicle types was therefore necessary. The light-duty vehicle classes by MOBILE are mapped to the passenger cars in DYNASMART-P and the heavy-duty vehicle classes are mapped to the trucks in DYNASMART-P. This can be done by entering the number of light-duty classes and their proportions and the number of heavy-duty classes and their proportions in the input file fleet.dat described earlier.

MOBILE 5 is then run with a number of scenarios, each with a different speed, to generate a table of emission factors for CO, HC, and NOx for each of the vehicle types and for different speeds. The lowest speed is 2.5 mph, the next one is 5 mph, and then the speeds are incremented by 5 mph to 65 mph (the maximum speed permitted by MOBILE 5). This emission factors table is used to create an input file emfac.dat.

The DYNASMART-P code is modified so it can produce link VMTs for each of the vehicle classes at the end of a specified aggregation interval. The average speeds on the links are also produced at the end of the aggregation interval specified.

Based on the average speed for the link, the post-processing utility reads the average link speed and looks up the appropriate emission factors for all the vehicle types for this speed. These emission factors (in gms/mile) are multiplied by the corresponding VMTs to obtain the emissions in gms. The emission statistics are then aggregated over all the links for all the aggregation intervals and over all vehicle types to produce network emissions for the entire simulation horizon. A breakdown of the aggregate emissions on the basis of vehicle and facility type is also produced. Figure 4.6 illustrates this interfacing.

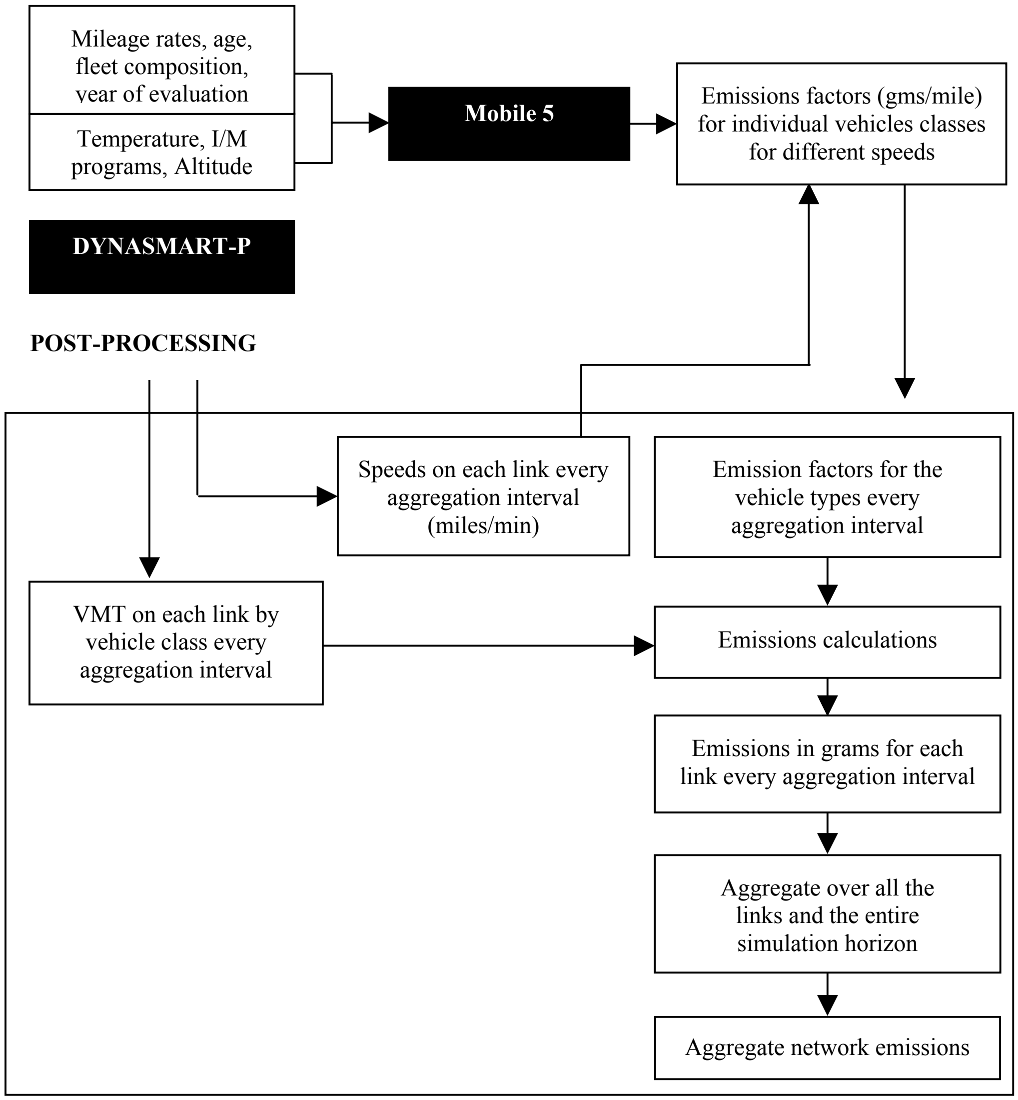

Figure 4.6 DYNASMART-P/MOBILE 5 Interface

4.6 Summary

In this chapter, the tools and procedures used in implementing the framework are described. First, DYNASMART-P, the core network modeling tool used for this study is described in some detail, followed by a discussion of the data sets and emission test procedures used for the ORNL modal emission models for light-duty vehicles and ONROAD modal emission models for heavy-duty vehicles. The integration of these models with DYNASMART-P is elaborated next. Finally MOBILE 5, the EPA-approved emission factor model is discussed along with the procedures for interfacing it with DYNASMART-P. This chapter sets the stage for Chapter Five, which describes the experiments that are designed to test the applicability of these procedures for evaluating the impact of ITS strategies on mobile source emissions.

5. Experimental Details

5.1 Introduction

This chapter describes the experiments conducted to investigate the differences in dynamic and static network modeling approaches for evaluating the impact of Intelligent Transportation System (ITS) strategies on mobile source emissions. These effects are analyzed using MOBILE 5 and modal emission models. The main objective of these experiments is to demonstrate the feasibility of applying the framework discussed in Chapter Three using the models and tools discussed in Chapter Four to analyze the impact of ITS strategies on emissions.

5.2 Static and Dynamic Modeling Using DYNASMART-P

As mentioned earlier, DYNASMART-P is a dynamic simulation-assignment model for traffic networks. It is, therefore, not designed to perform a static equilibrium assignment like conventional transportation planning tools. DYNASMART-P can, however, be used to emulate a static traffic assignment by suitably specifying appropriate input parameters. Such an assignment, while not identical to a conventional static traffic assignment, provides a suitable platform for performing an insightful comparison of static and dynamic assignment approaches for air quality assessment of ITS strategies. The parameters that need to be modified to emulate static traffic assignment using DYNASMART-P are discussed hereafter.

5.2.1 *K*-Shortest Path Parameters

The shortest path calculations in DYNASMART-P are based on a generalized link impedance measure allowing development of route assignments responsive to link travel time, tolls, and other traffic performance measures of effectiveness (MOEs). The model is also capable of reflecting the effects of congestion pricing (variable pricing to manage demand) on route assignments and origin-destination (O-D) trips (Mahmassani et al. 2001).

DYNASMART-P calculates multiple paths for each O-D pair. The storage of more than one path allows for simulation of driver decision-making. The *k*-shortest paths are found and stored at intervals from all nodes to each destination node. To find the *k*-shortest paths, DYNASMART-P employs a label-correcting algorithm using a double-ended queue data structure (Jayakrishnan et al. 1994). Given the travel times (or generalized costs) on each arc of the network, including penalties for turning movements, the algorithm solves for the least time (or cost) paths from all origins to each destination node, as well as the second, third, etc., up to the *k*-th least time (or cost) paths, where *k* is a user-specified value. In computing the shortest paths, the algorithm recognizes that different user types, e.g., high-occupancy vehicles (HOVs) versus single-occupancy vehicles (SOVs), may incur different times (or costs) on each arc. The detailed implementation of the algorithm can be found in Ziliaskopoulos (1992).

During the course of the simulation, shortest paths between each O-D pair are re-calculated after a stipulated number of simulation intervals, specified by the user. The *k* shortest paths are typically calculated every 3 minutes of simulation time. The *k* shortest paths are also updated after a certain number of simulation intervals, also specified by the user. Updating is generally done more frequently, depending on the application. In highly dynamic situations, paths could be updated every simulation interval (6 sec.). In typical planning applications, updating path travel times or costs every 30 seconds of simulation time would be more appropriate. This is done to ensure that changes in the generalized link costs as a result of traffic flow dynamics in the network are reflected in the *k*-shortest path calculations. The path updating and recalculation parameters are contained in the DYNASMART-P input file scenario.dat.

In static modeling, the intended conditions correspond to a steady state, and the link costs and associated traffic flow conditions in the network are not changing. To replicate these conditions in DYNASMART-P, the number of simulation intervals for calculating and updating the shortest paths are modified to ensure that the shortest paths are calculated and modified only once during the entire simulation horizon.

5.2.2 Temporal Demand Variation

There are two ways to specify vehicle generation in DYNASMART-P. The first method is to specify a time-dependent O-D trip table, and the second method is to specify the itineraries of all vehicles with or without their corresponding travel plans.

In dynamic modeling, time-dependent O-D trip tables are used for vehicle generation. A survey on travel characteristics conducted in 1990 in the San Francisco Bay Area (Purvis 1994) indicated that peak hour traffic pattern exhibits a “hump” as shown in Figure 5.1.

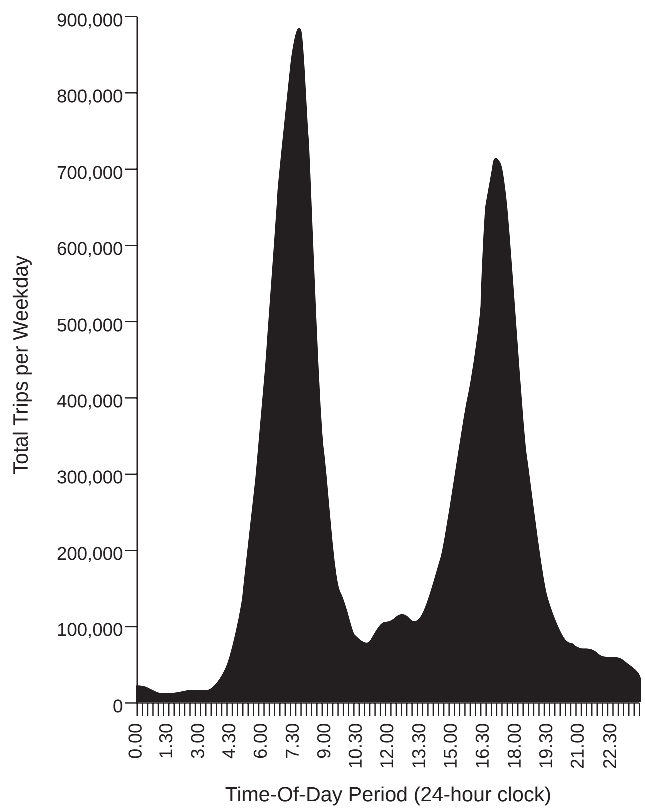

Figure 5.1 1990 Weekday Home-Based Work Trips in Motion by Time-of-Day
Source: Purvis 1994

For dynamic modeling in DYNASMART-P, a temporal loading pattern is specified by the user. A typical default distribution is the triangular example shown in Figure 5.2, for use to generate vehicles according to the temporal variation in the peak hour demand.

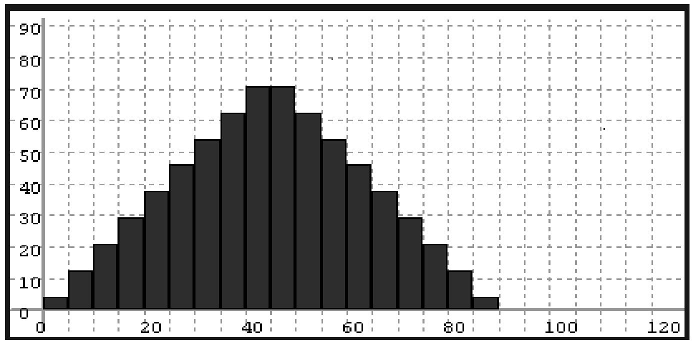

Figure 5.2 Example Dynamic Loading Pattern in DYNASMART-P

In the case of static modeling, the travel demand in the network is constant and not time dependent. In DYNASMART-P, this can be modeled using the flat loading pattern shown in Figure 5.3.

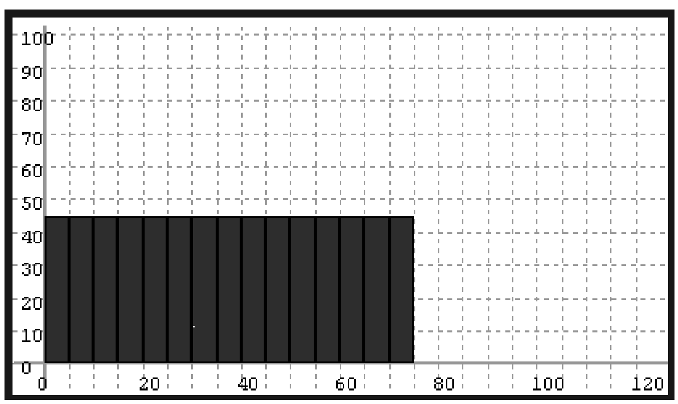

Figure 5.3 Static Loading Pattern in DYNASMART-P

5.3 Simulation Experiments

ITS strategies are generally expected to be more effective in mitigating nonrecurrent congestion, such as that caused by an incident, disabled vehicle, construction work, or a special event (sporting event, procession, etc.). In this study, the potential of information-based ITS strategies to mitigate the congestion effects of an incident are analyzed using the framework described in Chapter Three. The main elements of such an experimental design are: selection of test networks, network and traffic data, incident parameters, and definition of information-based ITS strategies.

5.3.1 Test Networks

Two test beds are used in this study to examine the potential benefits of implementing various ITS strategies. The next two sections detail the network and traffic characteristics of the test beds.

Fort Worth Network. The first test network used in this study is a portion of the Fort Worth network, which is a medium-sized highway network that represents an area in the south of the city's central business district (CBD). The DYNASMART-P representation of the network consists of 13 centroid zones, 178 nodes, and 441 links including 58-generation links. Twenty-five of these arcs represent I-35W, while the rest of the links are for the surrounding arterial network. The freeway is represented in the middle of the network with a street network on both sides and the freeway nodes are connected to the street network through entrance and exit ramps as shown in Figure 5.4. The links corresponding to the freeway, frontage roads, and ramps are uni-directional and the rest of the links in the network are bi-directional. While the freeway links have a free-flow speed of 65 mph, the rest of the links have a free-flow speed of either 30 or 40 mph. Traffic control at the intersections includes 61 actuated signals, 31 stop signs, and 1 yield sign. The remaining nodes do not have any control signs.

Vehicle Loading: The total number of vehicles loaded (generated) during the simulation horizon determines the degree of congestion in the network. In the experiments using the Fort Worth network, a total of around 30,000 vehicles are generated over a 90-minute period. This loading level results in moderate congestion in the network. The maximum simulation time for all experiments is specified as 120 minutes. The triangular loading pattern used in dynamic modeling scenarios (Figure 5.5) is suitably modified to ensure that the total number of vehicles generated and the total vehicle miles traveled (VMT) is comparable to the static modeling scenarios.

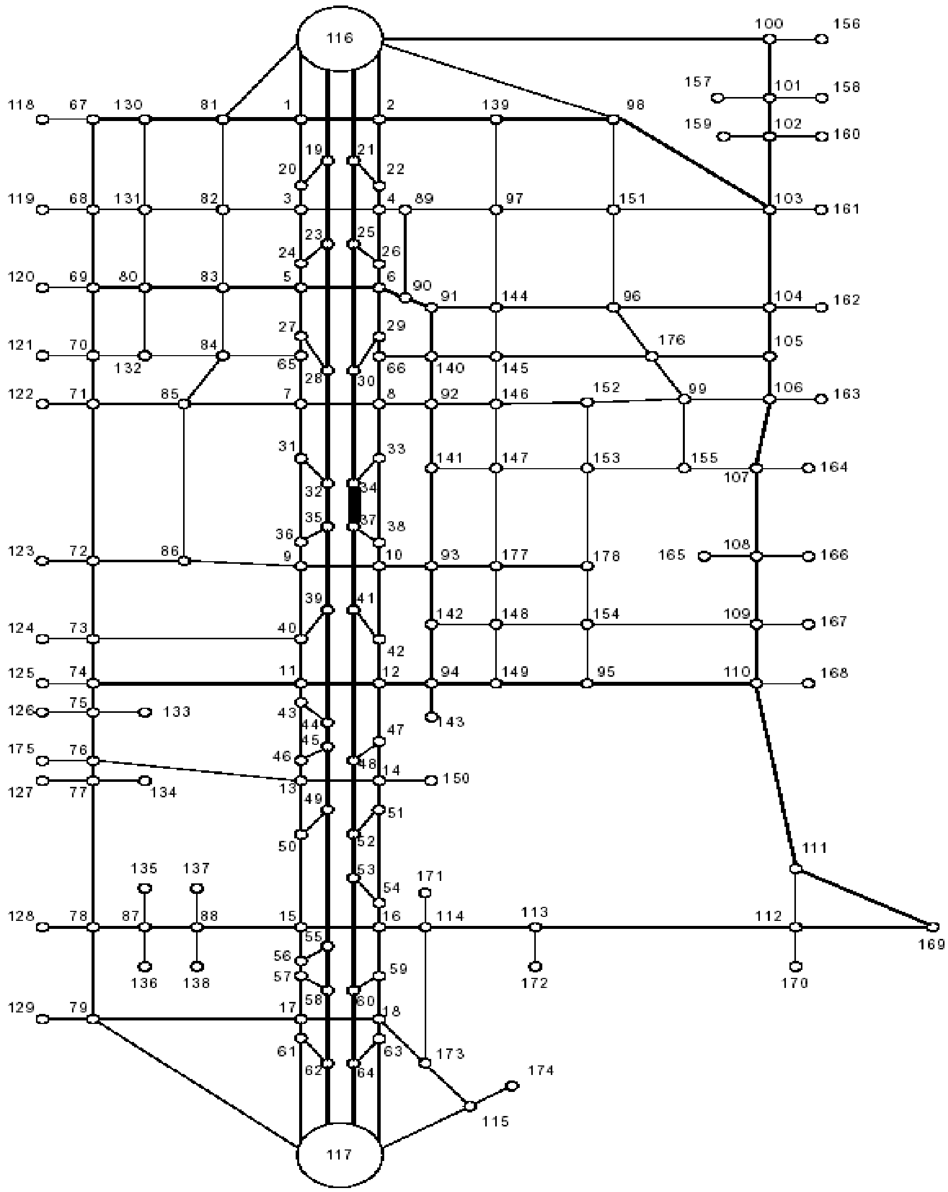

Figure 5.4 Fort Worth, Texas (Test Network)

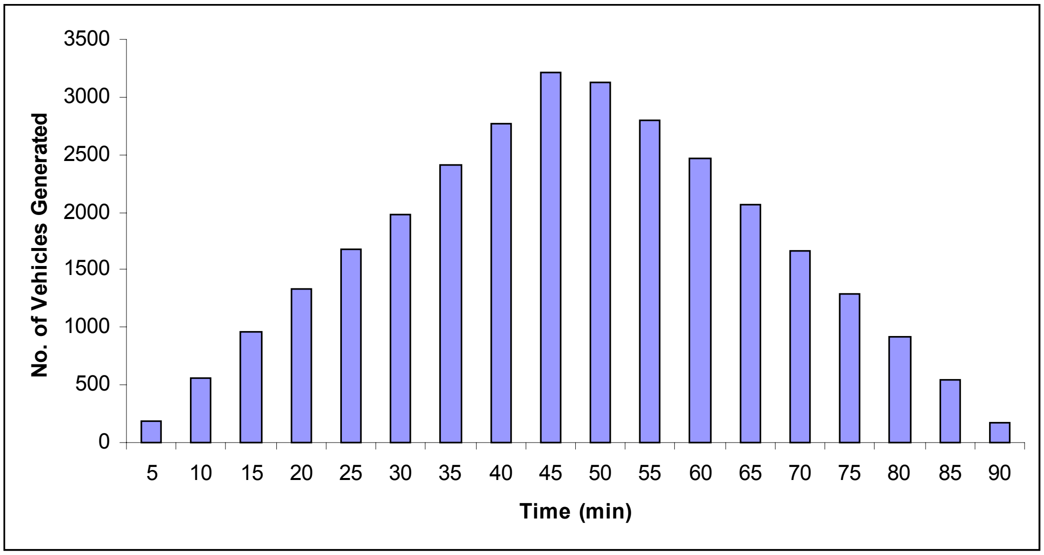

Figure 5.5 Triangular Loading Pattern Used for Dynamic Modeling

Houston Network. The second test network used in this study is the Harris County portion of the Houston-Galveston Area. This is a very large-sized network consisting of 1,500 centroid zones, 4,997 nodes, and 12,337 links. This includes 846 freeway links, 735 one-way street links, 65 HOV/HOT links, and 669 highway links. The freeway links have a free-flow speed of 70 mph, the rest of the links have a free-flow speed of either 30 or 40 mph. The traffic control system consists of 816 actuated signals. Figure 5.6 gives the network configuration. The following sections discuss the data sources and procedure adopted to prepare the data files required for the simulation experiments.

Data Sources. The primary source for the data used in this study is the Houston Galveston Area Council (HGAC). The files were obtained in the form of ESRI shape files. These files provide data on the nodes, links, zones, and demand in the network. The link file includes the number of lanes, the length in feet, and the link ID of each link. It also includes the names of the links, which can be used for graphical user interface (GUI) purposes. The links are broadly categorized into 1) freeway, 2) highway, 3) arterials, 4) HOV/HOT, 5) on/off ramps, and 6) one-way streets. The demand file includes data on vehicle trips between each zone pair.

The signal data was obtained from the Harris County Public Information Department Engineering Division's geographic information system (GIS) server. The source for the data is the Texas Department of Transportation (TxDOT) and the data provides the location of traffic signals in Harris County as of 1999.

Data Assembly. The shape files are converted to a standard geographic database format, where the layers corresponding to node, link, zone, and signal are assembled using TRANSCAD and formulated according to the requirements of DYNSMART-P. All kinds of freeways (radial, circumferential, toll roads with or without frontage roads) are clubbed into category 1. Preparation of the input files required for performing experiments using DYNASMART-P included the following steps:

Step 1: The screening and cleaning of the network included deleting insignificant streets such as ferries, major and the minor collectors. Most of the links in the downtown area were retained because these were recognized to be influential in traffic flow patterns.

Step 2: All the links, except the one-way streets as specified by the facility type, were dualized to accommodate flows in both directions.

Step 3: The interchanges in the Claire portion were modeled. This includes all the entry and exit ramp features.

Step 4: The original zone layer consisted of around 3,000 zones and there was need to aggregate these to improve the computational efficiency. Aggregation was done based on the demand levels in the zones. Further, the zones were again grouped into super zones for the purposes of DYNASMART-P.

Step 4: The signal data was used to model the signals in the network. All the signals are assumed to be actuated.

Vehicle Loading. In all the experiments on the Houston network, a total of around 189,000 vehicles are generated over a 30-minute period. The maximum simulation time for all experiments is specified as 60 minutes. The loading pattern used in dynamic modeling scenarios is shown in Figure 5.7.

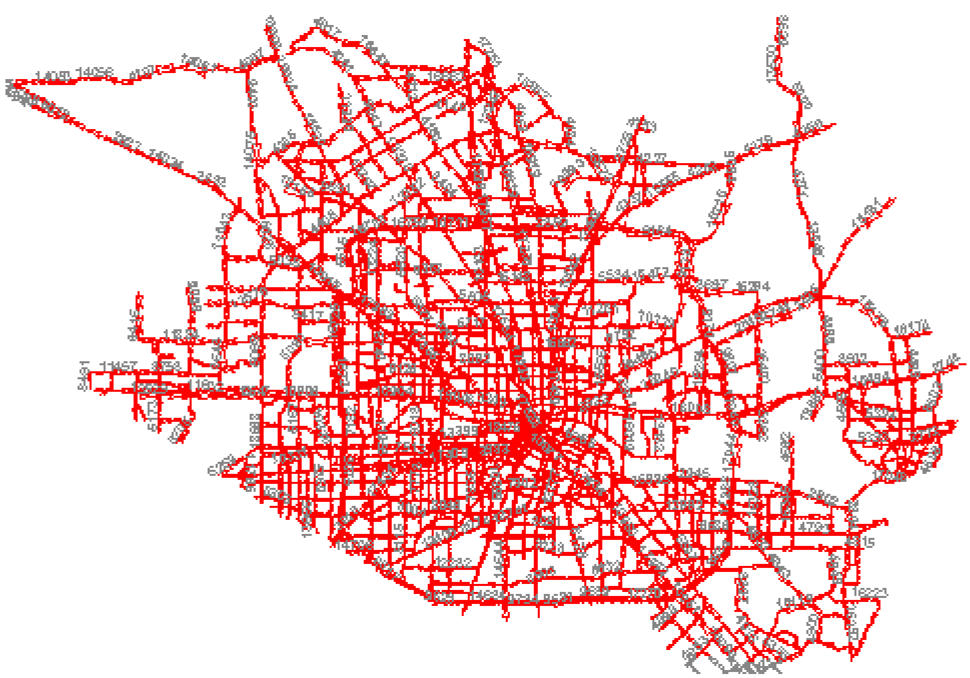

Figure 5.6 Houston, Texas (Test Network)

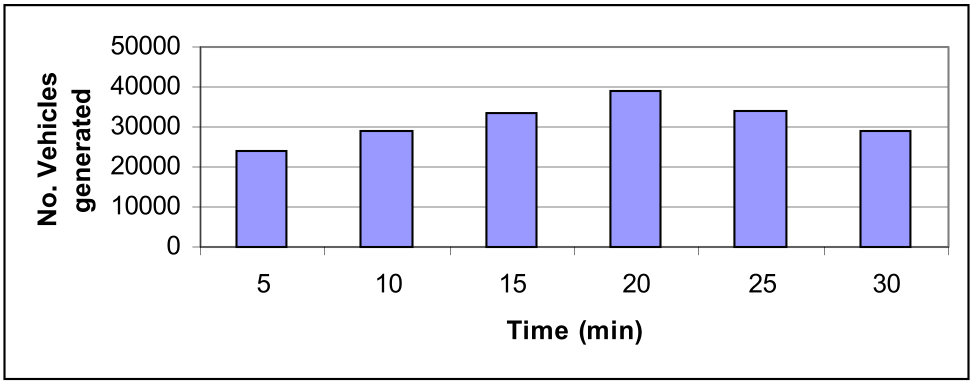

Figure 5.7 Temporal Loading Pattern Used for Dynamic Modeling

5.3.2 Emission-Related Input

The input related to emissions is of two types: 1) the distribution of vehicle classes based on emission characteristics and 2) the emission characteristics of these vehicle classes either in the form of instantaneous emission rates (as in the case of modal emission models) or emission factors based on average speeds (as in the case of MOBILE 5).

Vehicle Fleet Distribution. The categorization of the vehicle fleet into different classes based on emission characteristics is predicated to a large extent on the emissions data available for such classification. In this study, the categorization is different for the modal emission models and for MOBILE 5. For most of the work in this study, the vehicle fleet was assumed to consist entirely of light-duty vehicles and Oak Ridge National Laboratories (ORNL) models were therefore employed in modal emission calculations. However, experiments were also included to examine the impact of ITS strategies on vehicle fleets consisting of heavy-duty vehicles as well. ONROAD models were employed in modal emissions calculations for heavy-duty vehicles. Level 4 (dynamic network modeling with modal emission model) was employed in scenarios where the vehicle fleet included heavy-duty vehicles.

For modal emission models, the vehicle fleet categorization is based on size, weight, and age. The distribution of the vehicle classes is shown in Table 5.1. Detailed step-by-step calculations are shown in Appendix C.

Table 5.1 Vehicle Fleet Distribution for Modal Emission Models

Vehicle Class	Description	Fleet Proportion
	Light-Duty Vehicles	
1	Passenger Cars (< 1yr)	0.031
2	Passenger Cars (1-5 yrs)	0.207
3	Passenger Cars (5-15 yrs)	0.332
4	Passenger Cars (>15 yrs)	0.060
5	Trucks	0.370
		1.000
	Heavy-Duty Vehicles	
6	Trucks	**1.000**

For MOBILE 5, the vehicle fleet categorization is based on fuel type (gasoline, diesel) in addition to size and weight. The distribution of the vehicle classes for MOBILE 5 is shown in Table 5.2. Detailed step-by-step calculations are shown in Appendix D.

Table 5.2 Vehicle Fleet Distribution for MOBILE 5

Vehicle Class	Description	Fleet Proportion
	Light-Duty Vehicles	
1	Light-Duty Gasoline Vehicles (LDGV)	0.621
2	Light-Duty Diesel Vehicles (LDDV)	0.008
3	Light-Duty Gasoline Trucks (<6000 lbs GVW)(LDGT1)	0.357
4	Light-Duty Gasoline Trucks (6000 - 8500 lbs GVW)(LDGT2)	0.006
5	Light-Duty Diesel Trucks (<8500 lbs GVW) (LDDT)	0.008
		1.000
	Heavy-Duty Vehicles	
6	Heavy-Duty Gasoline Vehicles (>8500 lbs GVW)	0.393
7	Heavy-Duty Diesel Vehicles (>8500 lbs GVW)	0.607
		1.000

Emission Characteristics. In the case of modal emission models, the emission characteristics for each of the corresponding classes of vehicles are defined based on the ORNL models. These look-up tables are input in DYNASMART-P by means of input files co.dat, hc.dat, and nox.dat for CO, HC, and NOx emissions, respectively, as described in Chapter Four. Appendices E, F, and G show the input files co.dat, hc.dat, and nox.dat used in this study.

In the case of MOBILE 5, the emission characteristics for each of the corresponding classes of vehicles are defined based on the emission factors that are a function of the average speed on a particular link. These emission factors are obtained from MOBILE 5; the MOBILE 5 input file used for this purpose is shown in Appendix H.

5.3.3 Information-Based ITS Strategies

A variety of strategies can be employed to effectively respond to an incident. These strategies include removal, medical response, and traffic management. Providing real-time information to drivers is one of the applicable traffic management strategies. In this context, information provision strategies like Variable Message Signs (VMS), Highway Advisory Radio (HAR), and Short Messaging Systems (SMS) are particularly relevant (Kaysi et al. 2001).

VMS, also known as dynamic or changeable message signs, are a means of disseminating vital en-route travel information to the commuters. It is the most commonly used method in practice to provide en-route information (Kaysi et al. 2001).

These signs can be either fixed or portable, with most fixed signs deployed at facilities such as bridges, causeways, tunnels, or toll plazas. New designs using modular message blocks and "rail-mounted" connections that do not need wiring for each installation can make portable signs more adaptable.

The key design issues to be considered when deploying VMS are: 1) the type of information to be disseminated and 2) the location of the VMS. In DYNASMART-P, VMS can be modeled to serve three distinct functions: 1) speed advisory, 2) route advisory, and 3) congestion warning. In this study, the VMS are used to provide routing guidance to responsive users. The location of the VMS is typically selected upstream of the incident location. The VMS should also be located so that diverted vehicles have sufficient advance warning and maneuvering distance (Kaysi et al. 2001).

Apart from VMS, HAR and SMS can also be used for providing travelers with in-vehicle information. While the impacts of VMS are restricted to only those vehicles passing by, reading, and complying with the VMS messages, HAR and SMS impacts are more widespread.

5.4 Description of Scenarios with Light-Duty Vehicles Only

In the Fort Worth and Houston network case studies, a number of scenarios are constructed to analyze the mobile source emissions impact of incident management using information provision systems. The vehicle fleet in these scenarios consisted solely of light-duty vehicles. The information provision strategy considered here is to provide en-route travel information either through VMS or by disseminating information through devices such as cell phones and radio. In the latter case, the drivers need to be equipped to receive information.

All the experiments summarized in Tables 5.3 and 5.4 are performed on the Fort Worth network and of these, a selected set of experiments is done on the Houston network. The experiments are divided into four levels based on the framework discussed in Chapter Three, as follows:

- Level 1: Static network modeling with MOBILE 5 (Table 5.3, Expts. 1-4)
- Level 2: Dynamic network modeling with MOBILE 5 (Table 5.3, Expts. 5-28)

- Level 3: Static network modeling with modal emission models (Table 5.4, Expts. 29-32)
- Level 4: Dynamic network modeling with modal emission models (Table 5.4, Expts. 33- 46)

In addition, Level 2 is subdivided into levels 2A to 2F based on the time interval used for aggregating the VMT by class and average link speed:

2A: Aggregation Interval =1 min (Table 5.3, Expts. 5-8)
2B: Aggregation Interval = 5 min (Table 5.3, Expts. 9-12)
2C: Aggregation Interval =15 min (Table 5.3, Expts. 13-16)
2D: Aggregation Interval = 30 min (Table 5.3, Expts. 17-20)
2E: Aggregation Interval = 60 min (Table 5.3, Expts. 21-24)
2F: Aggregation Interval = simulation horizon (Table 5.3, Expts. 25-28)

For each of these levels, the four scenarios below are constructed.

5.4.1 Base Case

The base case scenarios are designed to study and evaluate the performance under "normal" traffic conditions. It also provides a reference against which the impact of incident and strategies for providing en-route information are compared and evaluated (Table 5.3, Expts. 1, 5, 9, 13, 17, 21, 25 and Table 5.4, Expts. 29 and 33).

5.4.2 Incident, with No ITS

In the Fort Worth case study, an hour-long incident is simulated on the freeway in the southbound direction (Fig 5.5). The incident is specified to start 30 minutes after the start of the simulation and to reduce the link capacity by 50%. In experiments on the Houston network, an incident lasting 30 minutes is introduced on a freeway link. The incident is specified to start 15 minutes after the start of the simulation and to reduce the link capacity by 40%. The vehicles follow the same path as they would in the absence of the incident. The impact of incident is therefore properly measured and evaluated (Table 5.3, Expts. 2, 6, 10, 14, 18, 22, 26 and Table 5.4, Expts. 30 and 35).

5.4.3 Incident with VMS

In these scenarios, two VMS signs are placed upstream of the incident such that responsive vehicles have sufficient advance warning and maneuvering options in terms of alternate paths (Fig 5.5). Thirty percent of the drivers are assumed to be responsive to VMS signs (Table 5.3, Expts. 3, 7, 11, 15, 19, 23, 27 and Table 5.4, Expts. 31 and 40).

5.4.4 Incident, No VMS, In-Vehicle Information

These scenarios are similar to the ones with VMS, but in these scenarios the information is supplied to the travelers by way of in-vehicle information technologies such as HAR or cell phones. Thirty percent of the drivers are assumed to be equipped with devices capable of receiving such information (Table 5.3, Expts. 4, 8, 12, 16, 20, 24, 28 and Table 5.4, Expts. 32 and 45).

Sensitivity Analysis. In addition to the scenarios described above, dynamic network modeling along with modal emission models (Level 4) is used to perform an analysis of how sensitive the emission impact is to various experimental parameters (Table 5.4, Expts. 34-46).

Incident Severity. In addition to the incident scenario with a severity of 50% discussed above, two more severity levels of 20% and 80% are also simulated. This is done to evaluate the impact of levels of capacity reduction on emissions (Table 5.4, Expts. 34-36).

Market Penetration. Four levels of market penetration, 5%, 15%, 20%, and 60%, were simulated in addition to the 30% level discussed above for both VMS and in-vehicle information. These percentages reflect the effect of market penetration of the information provision techniques on emissions (Table 5.4, Expts 37, 38, 39, 41, 42, 43, 44, 46).

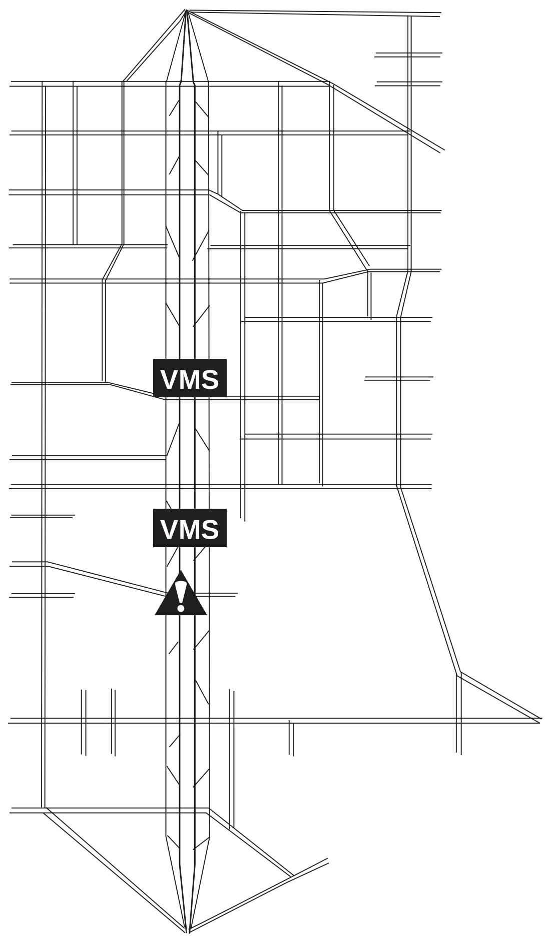

Figure 5.8 Incident and VMS Location

Table 5.3 Simulation Experiments with MOBILE 5

Experiment No.	Network Modeling	Level	Aggregation Interval	Incident Severity	Information Provision	
					Type	Market Penetration
1	*Static*	*1*	*Simulation Horizon*	*Base Case*		
2	*Static*			*50%*	*No ITS*	
3	*Static*			*50%*	*VMS*	*30%*
4	*Static*			*50%*	*In-vehicle info*	*30%*
5	*Dynamic*	*2A*	*1 minute*	*Base Case*		
6	*Dynamic*			*50%*	*No ITS*	
7	*Dynamic*			*50%*	*VMS*	*30%*
8	*Dynamic*			*50%*	*In-vehicle info*	*30%*
9	*Dynamic*	*2B*	*5 minutes*	*Base Case*		
10	*Dynamic*			*50%*	*No ITS*	
11	*Dynamic*			*50%*	*VMS*	*30%*
12	*Dynamic*			*50%*	*In-vehicle info*	*30%*
13	*Dynamic*	*2C*	*15 minutes*	*Base Case*		
14	*Dynamic*			*50%*	*No ITS*	
15	*Dynamic*			*50%*	*VMS*	*30%*
16	*Dynamic*			*50%*	*In-vehicle info*	*30%*
17	*Dynamic*	*2D*	*30 minutes*	*Base Case*		
18	*Dynamic*			*50%*	*No ITS*	
19	*Dynamic*			*50%*	*VMS*	*30%*
20	*Dynamic*			*50%*	*In-vehicle info*	*30%*
21	*Dynamic*	*2E*	*60 minutes*	*Base Case*		
22	*Dynamic*			*50%*	*No ITS*	
23	*Dynamic*			*50%*	*VMS*	*30%*
24	*Dynamic*			*50%*	*In-vehicle info*	*30%*
25	*Dynamic*	*2F*	*Simulation Horizon*	*Base Case*		
26	*Dynamic*			*50%*	*No ITS*	
27	*Dynamic*			*50%*	*VMS*	*30%*
28	*Dynamic*			*50%*	*In-vehicle info*	*30%*

Table 5.4 Simulation Experiments with Modal Emission Model

Experiment No.	Network Modeling	Level	Incident Severity	Information Provision	
				Type	**Market Penetration**
29	*Static*	*3*	*Base Case*		
30	*Static*		*50%*	*No ITS*	
31	*Static*		*50%*	*VMS*	*30%*
32	*Static*		*50%*	*In-vehicle info*	*30%*
33	*Dynamic*	*4*	*Base Case*		
34	*Dynamic*		*20%*	*No ITS*	
35	*Dynamic*		*50%*	*No ITS*	
36	*Dynamic*		*80%*	*No ITS*	
37	*Dynamic*		*50%*	*VMS*	*5%*
38	*Dynamic*		*50%*	*VMS*	*15%*
39	*Dynamic*		*50%*	*VMS*	*20%*
40	*Dynamic*		*50%*	*VMS*	*30%*
41	*Dynamic*		*50%*	*VMS*	*60%*
42	*Dynamic*		*50%*	*In-vehicle info*	*5%*
43	*Dynamic*		*50%*	*In-vehicle info*	*15%*
44	*Dynamic*		*50%*	*In-vehicle info*	*20%*
45	*Dynamic*		*50%*	*In-vehicle info*	*30%*
46	*Dynamic*		*50%*	*In-vehicle info*	*60%*

5.5 Description of Scenarios with Heavy-Duty Vehicles Included

The experiments designed to analyze scenarios where heavy-duty vehicles form part of the vehicle fleet are shown in Table 5.5. Level 4 (dynamic network modeling with modal emission model) and the Fort Worth network is used for all these scenarios. Truck percentages of 2% and 5% are examined in this study and for both of these percentages four scenarios are analyzed:

5.5.1 Base Case

The base case scenarios are designed to study and evaluate the performance under "normal" traffic conditions. They also provide a reference against which the impact of incident and strategies for providing en-route information are compared and evaluated (Table 5.5, Expts. 47 and 51).

5.5.2 Incident, with No ITS

In these scenarios, an hour-long incident is simulated on the freeway in the southbound direction (Fig 5.5). The incident is specified to start 30 minutes after the start of the simulation and to reduce the link capacity by 50%. The vehicles follow the same path as they would in the absence of the incident. The impact of incident is therefore properly measured and evaluated (Table 5.5, Expts. 48 and 52).

5.5.3 Incident with VMS

In these scenarios, two VMS signs are placed upstream of the incident such that responsive vehicles have sufficient advance warning and maneuvering options in terms of alternate paths (Fig 5.5). Thirty percent of the drivers are assumed to be responsive to VMS signs (Table 5.5, Expts. 49 and 53).

5.5.4 Incident, No VMS, In-Vehicle Information

These scenarios are similar to the ones with VMS, except that the information is supplied to the travelers by way of in-vehicle information technologies such as HAR or cell phones. Thirty percent of the drivers are assumed to be equipped with devices capable of receiving such information (Table 5.5, Expts. 50 and 54).

Table 5.5 Experiments with Heavy-Duty Vehicle Included in the Fleet

Experiment No.	Level of analysis	Proportion of trucks	Incident Severity	Information Provision	
				Type	Market Penetration
47	*4*	*2%*	*Base Case*		
48			*50%*	*No ITS*	
49			*50%*	*VMS*	*30%*
50			*50%*	*In-vehicle info*	*30%*
51	*4*	*5%*	*Base Case*		
52			*50%*	*No ITS*	
53			*50%*	*VMS*	*30%*
54			*50%*	*In-vehicle info*	*30%*

5.6 Measures of Effectiveness

The measures of effectiveness (MOE) used to evaluate the impact of information-based ITS strategies on mobile source emissions are the CO, HC, and NOx emissions in kgs/hr. Hourly CO, HC, and NOx emissions for the networks will be examined for each of the scenarios discussed. However, for scenarios where heavy-duty vehicles are included, only CO and HC emissions are considered because the corresponding modal emission model for NOx emission is not available. Recognizing that the impact of certain ITS strategies on emissions may be localized, CO, HC, and NOx emissions for certain links that are likely to be impacted by the capacity reduction on the freeway are also examined for Level 4 scenarios (dynamic network modeling with modal emission models).

5.7 Summary

This chapter has described some of the experimental parameters that are important from a network modeling and emission modeling standpoint. Subsequently some of the simulation parameters and the characteristics of the test networks are described in some detail. The experimental scenarios that are constructed in this study to examine the impact of information-based ITS strategies are then elaborated and the chapter concludes by discussing the MOE used to evaluate the impact. Chapter Six presents the results of each of the scenarios discussed in this chapter.

6. Discussion of Results

6.1 Introduction

This chapter presents a discussion of the results of the simulation experiments conducted to compare the various network modeling and emission modeling approaches and to analyze the impact on information-based Intelligent Transportation System (ITS) strategies on mobile source emissions. The discussion of results is based on the carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx) emissions estimated for the two test networks using the various network modeling and emission modeling approaches as indicated in Chapter Five. The results presented here are mainly based on the experiments, with the vehicle fleet solely comprising light-duty vehicles. A subsection of the analysis of results with heavy-duty vehicles included in the vehicle fleet is also included toward the end of this chapter. The analysis of results presented here is threefold. First, the emission estimates using each of the four approaches presented in Chapter Three (Level 1 to Level 4) are discussed and compared for each test network. Second, the impact of ITS strategies using the four levels of analysis is examined more closely using the Fort Worth network. Finally, sensitivity of emission estimates to various experimental factors is analyzed at both network as well as local level by using Level 4 (dynamic network modeling and modal emission modeling).

6.2 Comparison of Approaches

CO, HC, and NOx emissions were estimated for the test networks for the scenarios described in Chapter Five using the network modeling and emission modeling approaches outlined in Chapter Three. From a modeling standpoint, Levels 1 to 4 represent a progressive improvement in the approaches to estimating impact of transportation operational strategies on mobile source emissions. For the purpose of comparing the emissions estimated by different levels in the analysis framework, Level 2f is used to represent Level 2. This is done because in Level 2f, dynamic network modeling is used in combination with MOBILE 5 with an aggregation interval equal to the simulation horizon, which is the aggregation interval used in the case of Level 1 (static network modeling with MOBILE 5) as well.

6.2.1 Fort Worth Network

Tables 6.1, 6.2, and 6.3 show the CO, HC, and NOx emissions, respectively, in the Fort Worth network for all the levels of analysis. Figures 6.1, 6.2, and 6.3 illustrate these results graphically.

Table 6.1 Fort Worth Network: CO Emissions Using Different Levels

Scenario	CO Emissions (kg/hr)			
	Level1	Level2f	Level3	Level4
Base Case	1492.59	1735.88	1095.75	1206.56
Incident (50% severity)	1469.21	1744.72	1115.65	1220.90
In-Vehicle Info (30%)	1487.82	1558.46	1145.42	1148.42
VMS (30%)	1459.36	1815.31	1102.20	1213.77

Table 6.2 Fort Worth Network: HC Emissions Using Different Levels

Scenario	HC Emissions (kg/hr)			
	Level1	Level2f	Level3	Level4
Base Case	116.23	134.97	60.07	67.08
Incident (50% severity)	114.90	135.46	61.77	68.34
In-Vehicle Info (30%)	116.25	122.88	62.13	62.07
VMS (30%)	114.15	139.95	61.70	68.23

Table 6.3 Fort Worth Network: NOx Emissions Using Different Levels

Scenario	NOx Emissions (kg/hr)			
	Level1	Level2f	Level3	Level4
Base Case	118.61	116.22	52.06	50.75
Incident (50% severity)	121.49	119.28	54.03	52.08
In-Vehicle Info (30%)	121.68	132.98	54.58	57.53
VMS (30%)	121.28	109.79	54.02	47.81

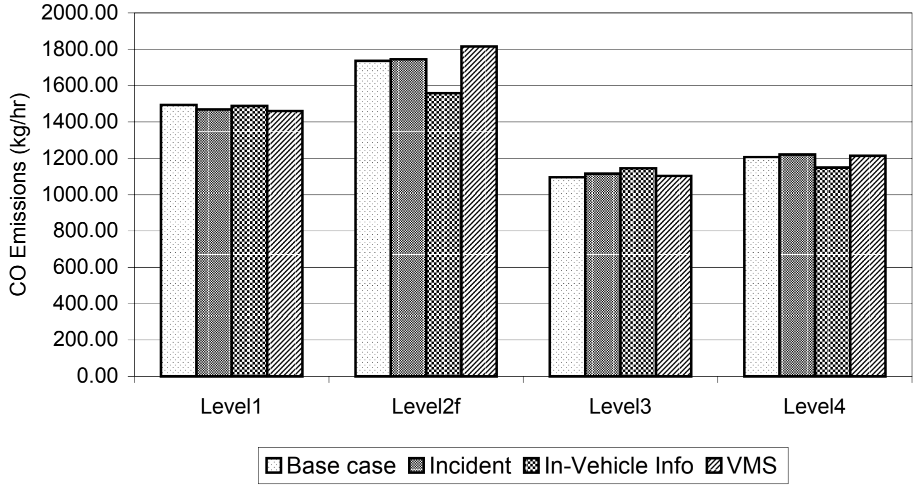

Figure 6.1 CO Emissions Using Different Levels

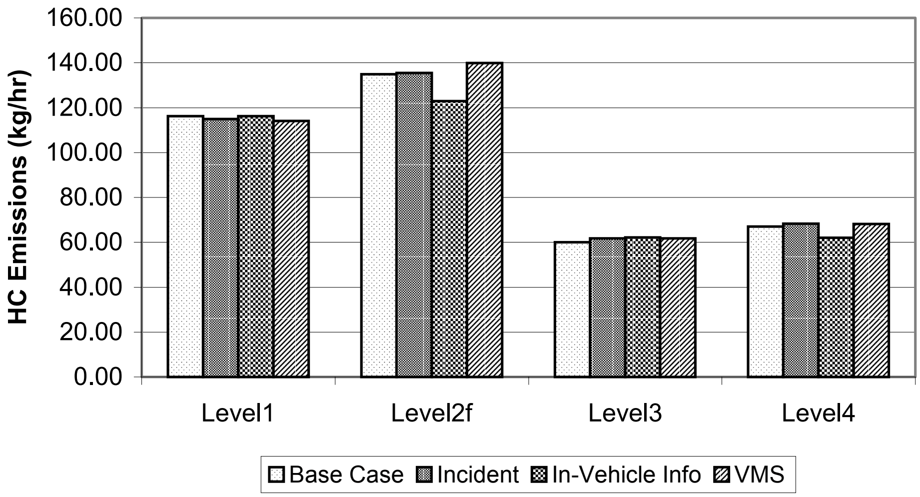

Figure 6.2 HC Emissions Using Different Levels

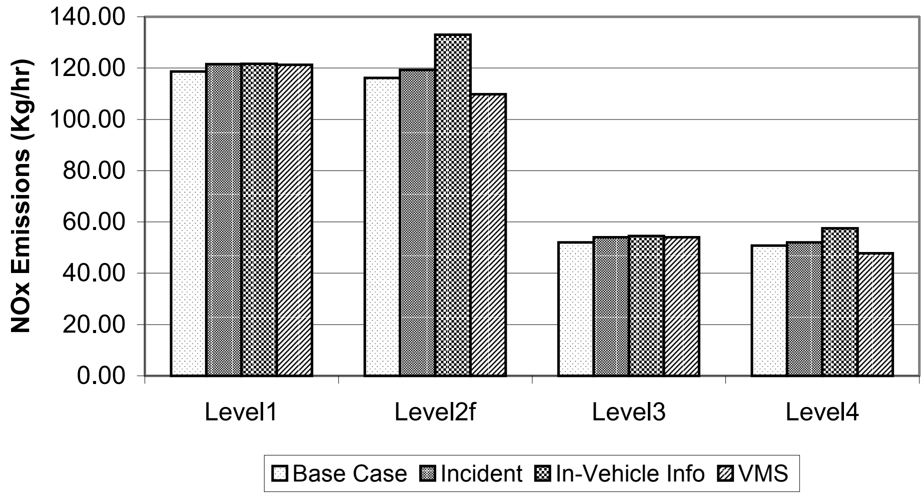

Figure 6.3 NOx Emissions Using Different Levels

As can be seen from Figures 6.1 and 6.2, the trends in CO and HC emissions are very similar for all levels. For CO and HC, the emissions estimated using dynamic network modeling are greater than the corresponding emissions estimated by using static network modeling. However, the difference is greater for emissions calculated using MOBILE 5 than the modal emission models. It can, therefore, be inferred that MOBILE 5 is more sensitive to the network modeling approach used. For NOx emissions, the static network modeling results in higher emission estimates than dynamic network modeling in general. The difference, however, is small for both MOBILE 5 and procedures based on modal emission models. This may be explained by the fact that NOx emissions are not very sensitive to vehicle speeds and therefore do not differ too much between static and dynamic network modeling.

6.2.2 Houston Network

Tables 6.4, 6.5, and 6.6 show the CO, HC, and NOx emissions, respectively, in the Houston network for all the levels of analysis. Figures 6.4, 6.5, and 6.6 illustrate these results graphically.

Table 6.4 Houston Network: CO Emissions Using Different Levels

Scenario	CO Emissions (kg/hr)			
	Level1	Level2f	Level3	Level4
Base Case	32759	32574	38521	38451
Incident (40% severity)	32865	33013	38473	38349
In-Vehicle Info (30%)	31122	30677	39543	40586
VMS (30%)	32711	33003	38382	38277

Table 6.5 Houston Network: HC Emissions Using Different Levels

Scenario	HC Emissions (kg/hr)			
	Level1	Level2f	Level3	Level4
Base Case	1994	1989	1956	1948
Incident (40% severity)	2003	2014	1952	1947
In-Vehicle Info (30%)	1869	1863	1973	2015
VMS (30%)	1993	2013	1950	1944

Table 6.6 Houston Network: NOx Emissions Using Different Levels

Scenario	NOx Emissions (kg/hr)			
	Level1	Level2f	Level3	Level4
Base Case	3995	3952	3146	3177
Incident (40% severity)	3961	3960	3144	3172
In-Vehicle Info (30%)	4236	4231	3413	3336
VMS (30%)	3964	3967	3144	3173

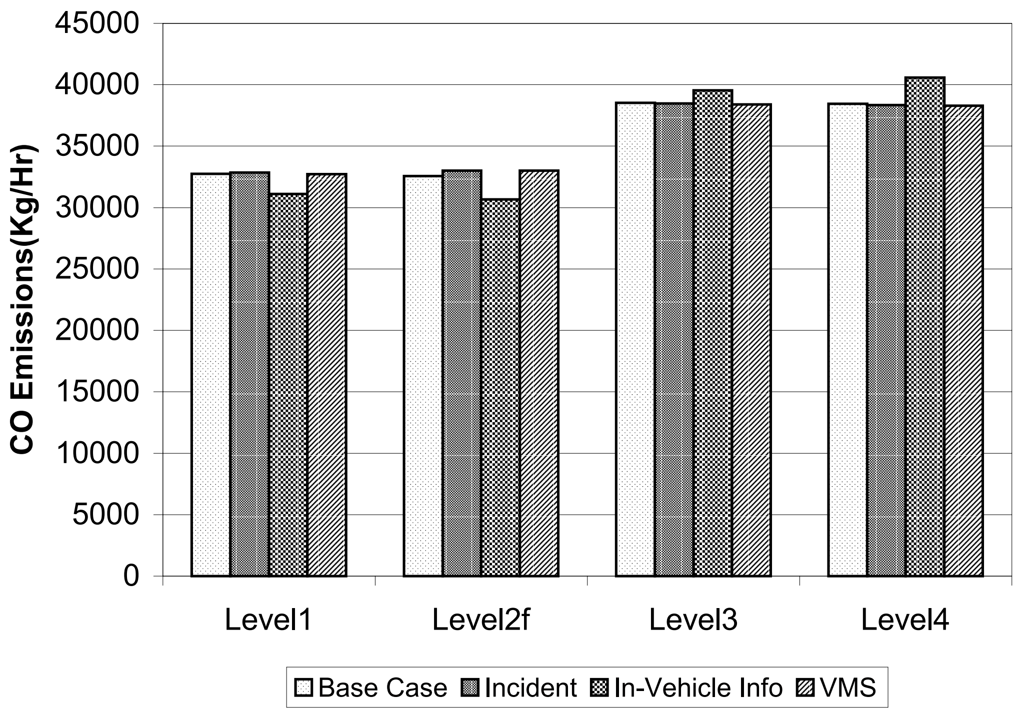

Figure 6.4 CO Emissions Using Different Levels

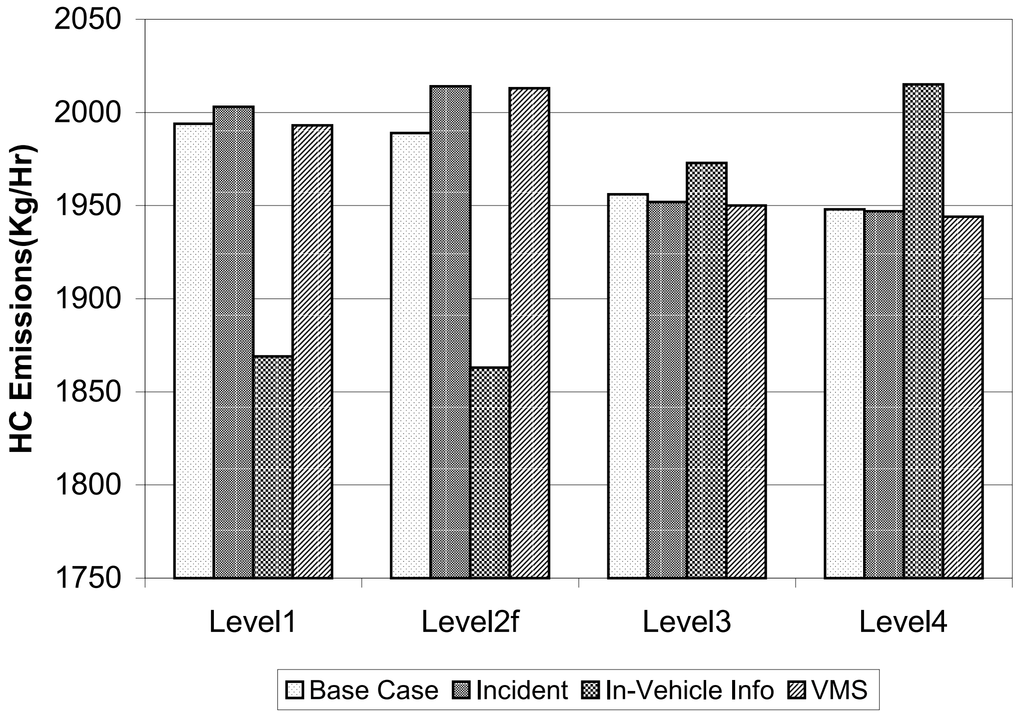

Figure 6.5 HC Emissions Using Different Levels

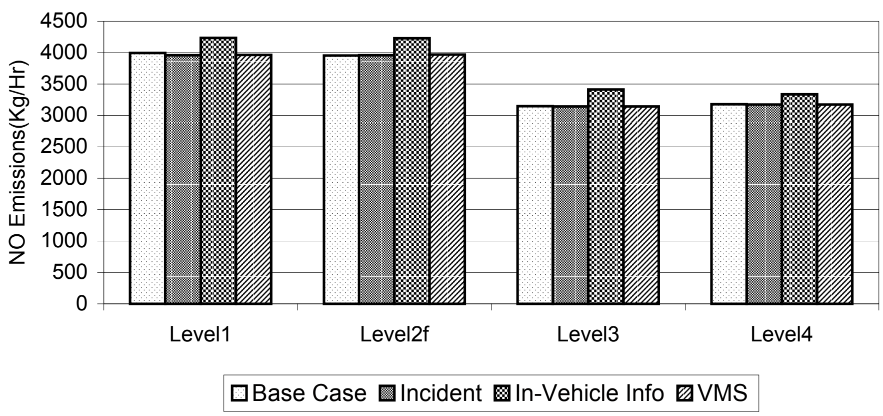

Figure 6.6 NOx Emissions Using Different Levels

The trends in CO and HC emissions are similar to those observed in the Fort Worth network. In general, the pollutant emissions estimated using static network modeling are greater than the corresponding emissions estimated by using dynamic network modeling. Similar to the Fort Worth results, the differences in static and dynamic approaches are greater for emissions calculated using MOBILE 5 than the modal emission models in this case study, implying that MOBILE 5 is more sensitive to the network modeling approach used.

6.2.3 Aggregation Intervals

The emissions, particularly CO and HC, vary highly non-linearly with vehicle speeds. In case of emissions estimated using MOBILE 5, the interval used to compute the average speeds on links is therefore an important consideration. In this study, experiments were conducted on the Fort Worth network with intervals of 1 min, 5 min, 15 min, 30 min, 60 min, and 120 min (simulation horizon) using Level 2 (dynamic modeling with MOBILE 5) to investigate the impact of aggregation intervals on emission estimates. Tables 6.8, 6.9, and 6.10 show the CO, HC, and NOx emissions, respectively, for the different levels of aggregation used in this study. These results are illustrated graphically by Figures 6.7, 6.8, and 6.9.

Table 6.7 CO Emissions Using Level 2 (Dynamic Modeling with Modal Emission Model)

	CO Emissions (kg/hr)					
	Aggregation Intervals					
Scenario	**1 min**	**5 min**	**15 min**	**30 min**	**60 min**	**120 min**
Base Case	1588.62	1605.29	1615.65	1643.98	1681.12	1735.88
Incident (50% severity)	1608.17	1623.80	1639.89	1655.73	1673.79	1744.72
In-Vehicle Info (30%)	1517.86	1527.71	1528.76	1526.68	1539.34	1558.46
VMS 30%)	1548.33	1566.56	1589.55	1665.39	1706.88	1815.31

Table 6.8 HC Emissions Using Level 2 (Dynamic Modeling with Modal Emission Model)

	HC Emissions (kg/hr)					
	Aggregation Intervals					
Scenario	**1 min**	**5 min**	**15 min**	**30 min**	**60 min**	**120 min**
Base Case	122.03	123.47	124.68	127.27	130.40	134.97
Incident (50% severity)	123.33	124.64	126.32	128.02	129.75	135.46
In-Vehicle Info (30%)	117.55	118.73	119.42	120.03	121.23	122.88
VMS 30%)	118.54	119.99	122.15	128.11	131.39	139.95

Table 6.9

Table 6.10 NOx Emissions Using Level 2
(Dynamic Modeling with Modal Emission Model)

Scenario	NOx Emissions (kg/hr)					
	Aggregation Intervals					
	1 min	**5 min**	**15 min**	**30 min**	**60 min**	**120 min**
Base Case	116.67	116.90	117.29	117.78	118.06	116.22
Incident (50% severity)	119.67	120.10	120.37	120.94	120.93	119.28
In-Vehicle Info (30%)	134.88	135.04	135.12	135.37	134.50	132.98
VMS (30%)	109.09	109.72	109.88	111.17	110.80	109.79

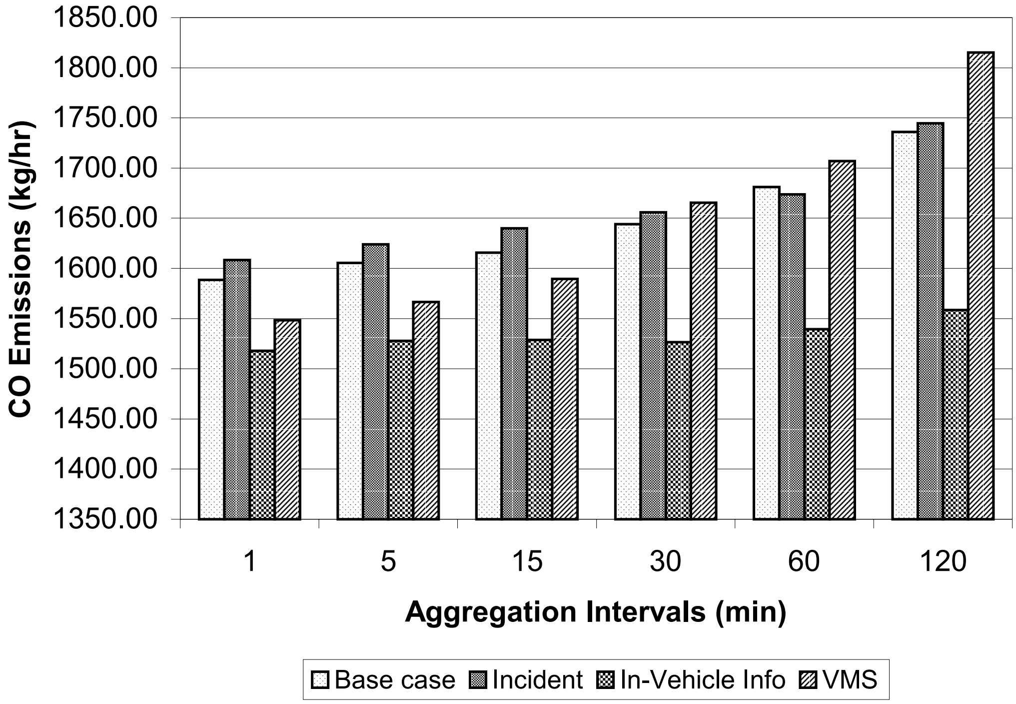

Figure 6.7 CO Emissions Using Level 2
(Dynamic Modeling with Modal Emission Model)

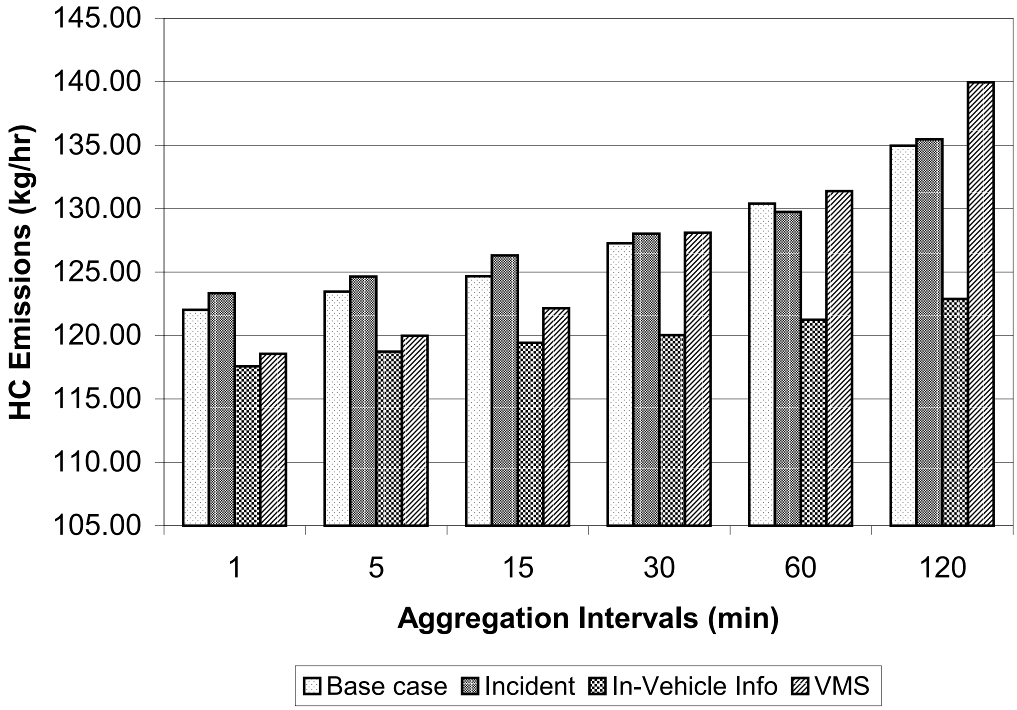

Figure 6.8 HC Emissions Using Level 2
(Dynamic Modeling with Modal Emission Model)

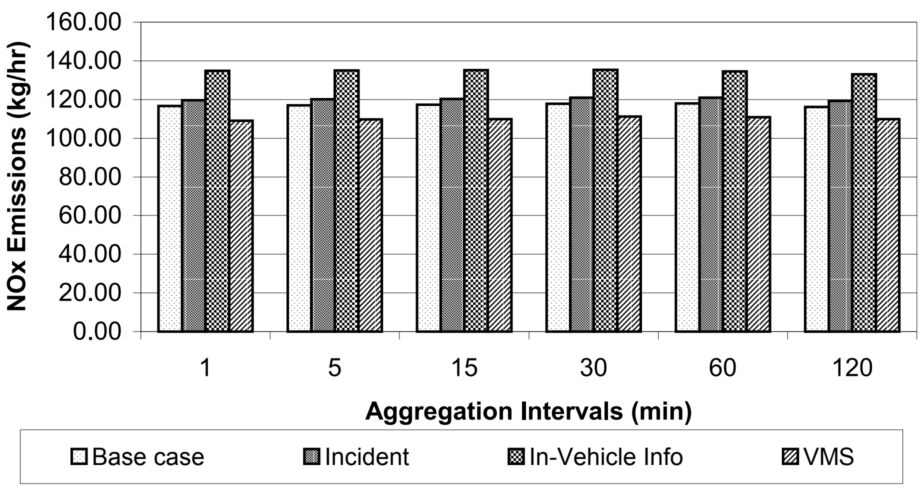

Figure 6.9 NOx Emissions Using Level 2
(Dynamic Modeling with Modal Emission Model)

CO and HC emissions are quite sensitive to the interval used to average the link speeds. In general, the coarser the aggregation interval, the greater the CO and HC emissions estimated. For the base case scenario, an aggregation interval equal to 120 min (simulation horizon) results in CO emission estimates that are 9.27% greater than the CO emissions estimated using a 1 min aggregation interval. For HC emissions, the corresponding figure is 10.6%.

For NOx emissions, the aggregation interval does not seem to have a significant impact on emission estimation, and the emission estimates are more or less constant at all levels of aggregation. This can again be explained by the fact the NOx emission factors are not very sensitive to speeds.

6.3 Impact of ITS Strategies

It is generally expected that the introduction of ITS strategies, like deployment of variable message signs (VMS) and provision of in-vehicle information to drivers to mitigate the effects of nonrecurrent congestion, would generally result in reduction in mobile source emissions. The impact of the incident using the various levels of analysis is examined at a network level first and then Level 4 (dynamic network modeling with modal emission model) is employed to investigate localized impact.

6.3.1 Network Level Impacts

This section discusses the impact of the incident using the various levels of analysis, examined at a network level using Fort Worth and Houston networks.

Fort Worth Network. The network level impact of VMS using all the levels of analysis is illustrated graphically in Figures 6.10, 6.11, and 6.12 for CO, HC, and NOx emissions, respectively. The network level impact of in-vehicle information using all the levels of analysis is illustrated graphically in Figures 6.13, 6.14, and 6.15 for CO, HC, and NOx emissions, respectively.

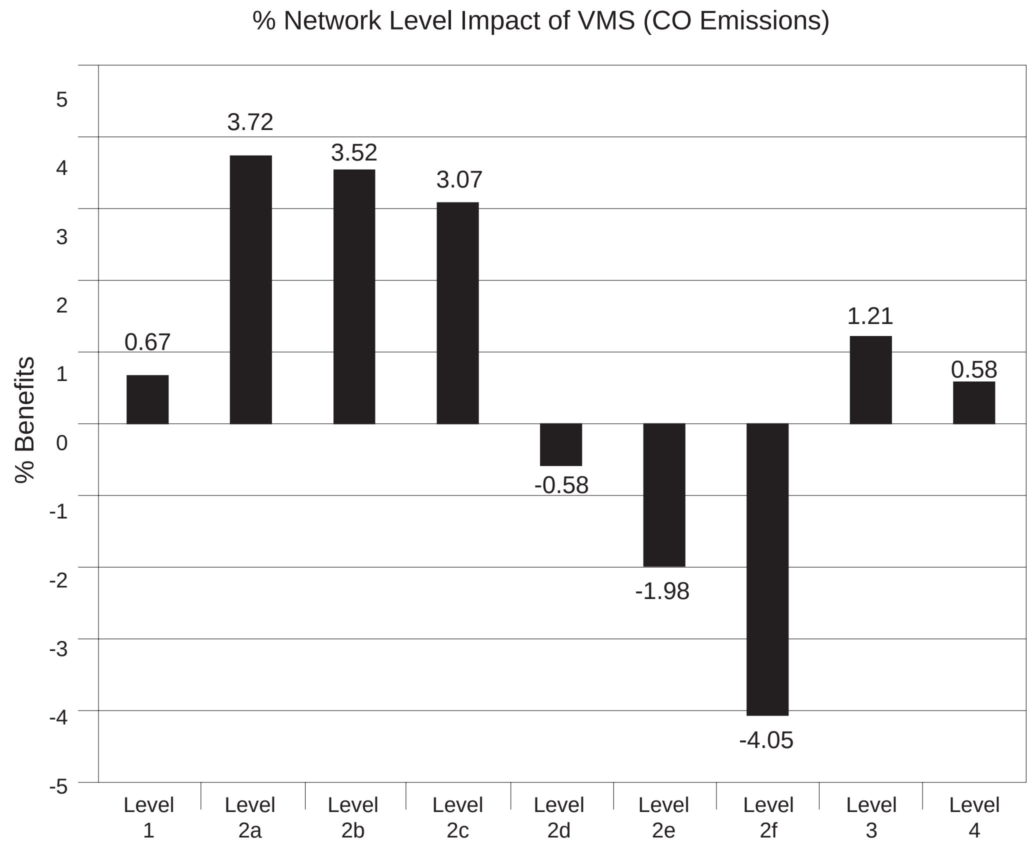

Figure 6.10 Percent Change in Network Level CO Emissions under VMS Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

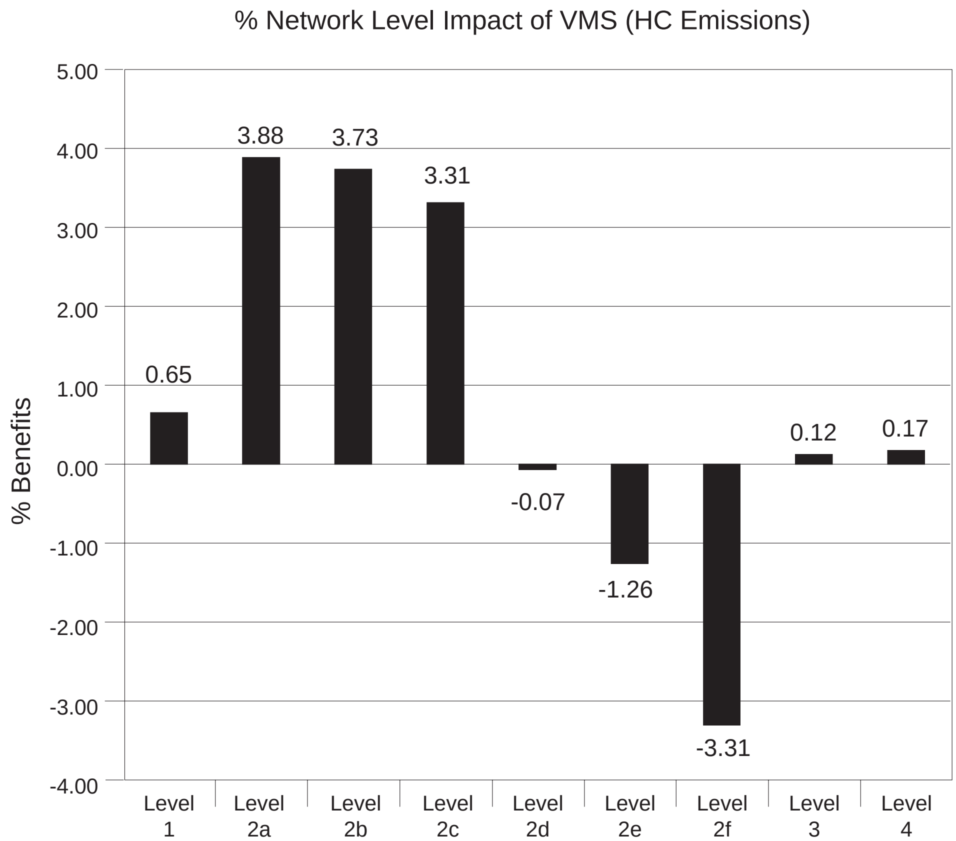

Figure 6.11 Percent Change in Network Level HC Emissions under VMS Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

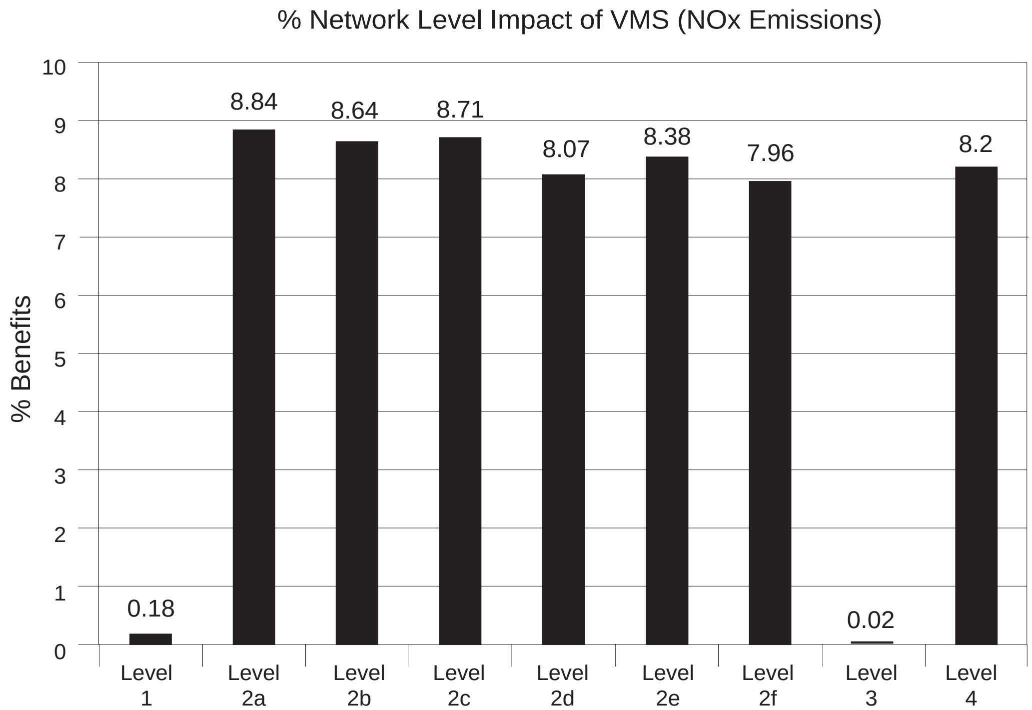

Figure 6.12 Percent Change in Network Level NOx Emissions under VMS Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

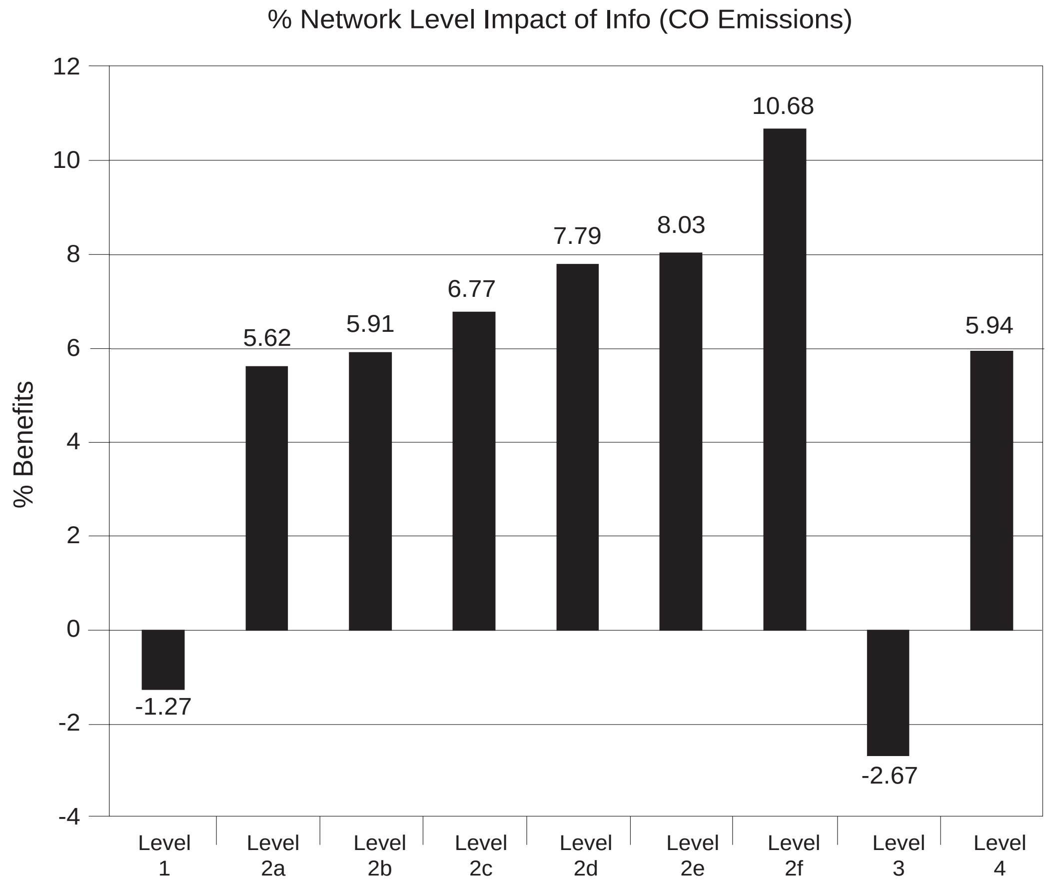

Figure 6.13 Percent Change in Network Level CO Emissions under In-Vehicle Information Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

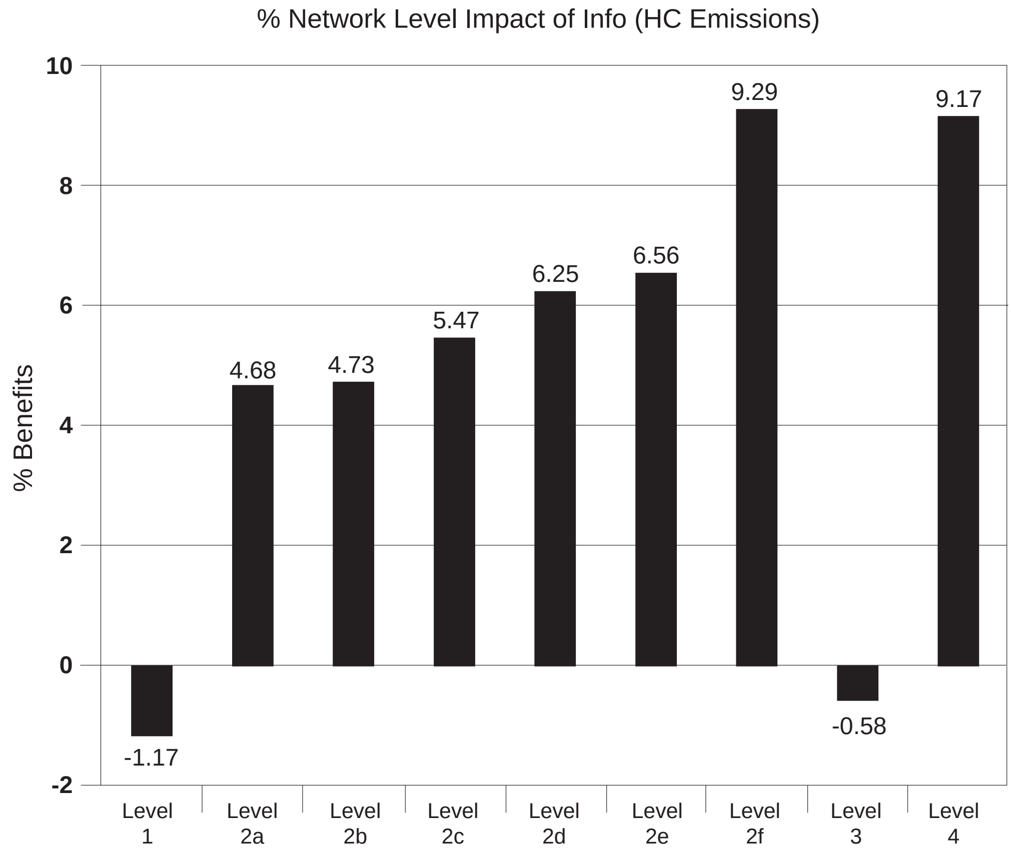

Figure 6.14 Percent Change in Network Level HC Emissions under In-Vehicle Information Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

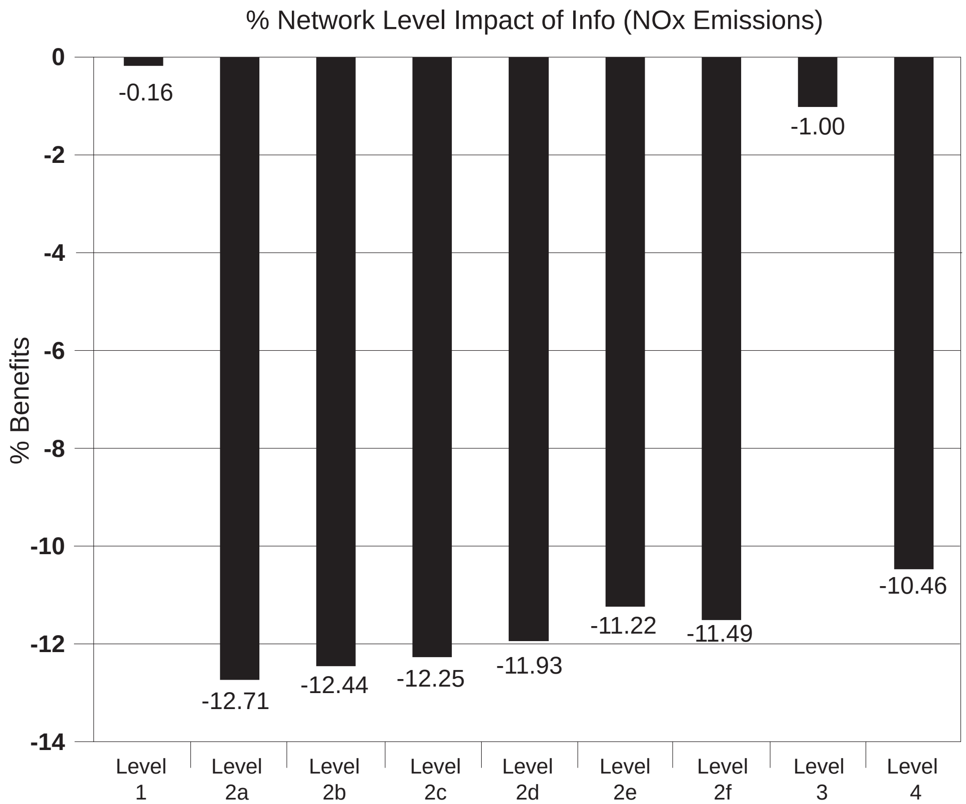

Figure 6.15 Percent Change in Network Level NOx Emissions under In-Vehicle Information Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

In general, it can be seen that all the approaches indicate a reduction in CO, HC, and NOx emissions at the network level for VMS deployment scenarios. The magnitude of these benefits for CO and HC emissions is moderate, with the greatest percentage reduction being 3.72% for CO emissions and 3.88% for HC emissions using Level 2a. Using the dynamic network modeling approaches, meaningful reduction in NOx emissions can be noted even at the network level. However, the impact of VMS is generally expected to be localized to the directly affected portion of the network as verified in the next subsection.

Another important observation is that the VMS benefits are sensitive to the aggregation interval used in Level 2 analyses for CO and HC emissions. CO and HC emission benefits are consistently underestimated as the level of aggregation becomes coarser. While the 1-minute aggregation interval estimates 3.72% benefit for CO, the 120-minute aggregation interval estimates an *increase* in CO emissions of 4.05%. The corresponding figures for HC emissions are 3.88 and 3.31%.

For scenarios with in-vehicle information, the dynamic network modeling approaches show substantially greater benefits for CO and HC emissions at the network level than VMS. The static modeling approaches (Levels 1 and 3), however, fail to capture the impact of in-vehicle information adequately. In-vehicle information also does not seem to be very effective in reducing NOx emissions at the network level, as none of the approaches indicate any reduction in NOx emissions as a result of providing in-vehicle information.

Just as with VMS, the CO and HC emissions are sensitive to the level of aggregation used in Level 2 analyses, but the trend is reversed. The benefits CO and HC emissions are consistently overestimated as the level of aggregation becomes coarser. While the 1-minute aggregation interval estimates 5.62% benefit for CO, the 120-minute aggregation interval estimates benefits for CO emissions of 10.68%. The corresponding figures for HC emissions are 4.68% and 9.29%.

Houston Network. The network level impact of VMS using all the levels of analysis is illustrated graphically in Figures 6.16, 6.17, and 6.18 for CO, HC, and NOx emissions, respectively. The network level impact of in-vehicle information using all the levels of analysis is illustrated graphically in Figures 6.19, 6.20, and 6.21 for CO, HC, and NOx emissions, respectively.

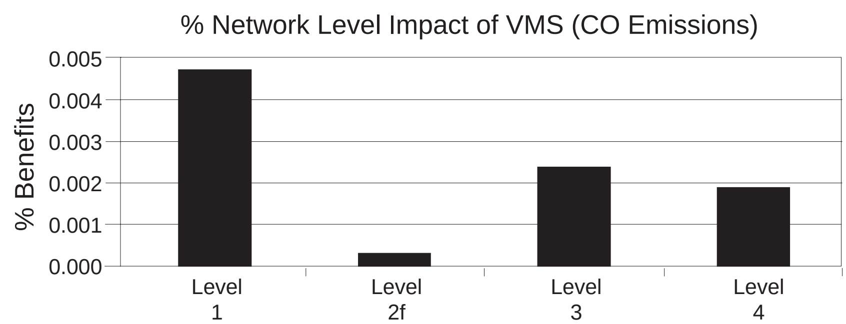

Figure 6.16 Percent Change in Network Level CO Emissions under VMS Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

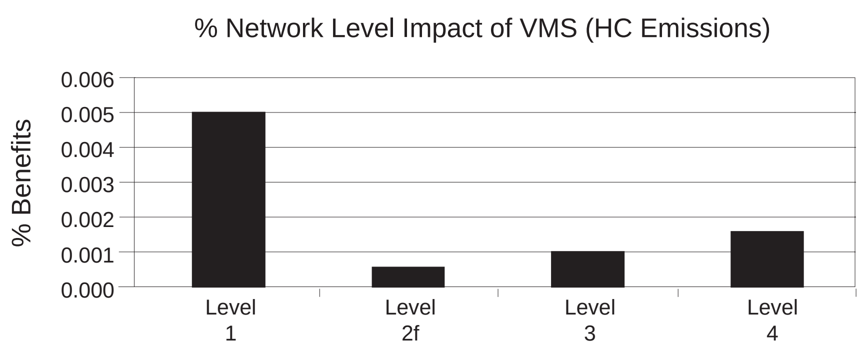

Figure 6.17 Percent Change in Network Level HC Emissions under VMS Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

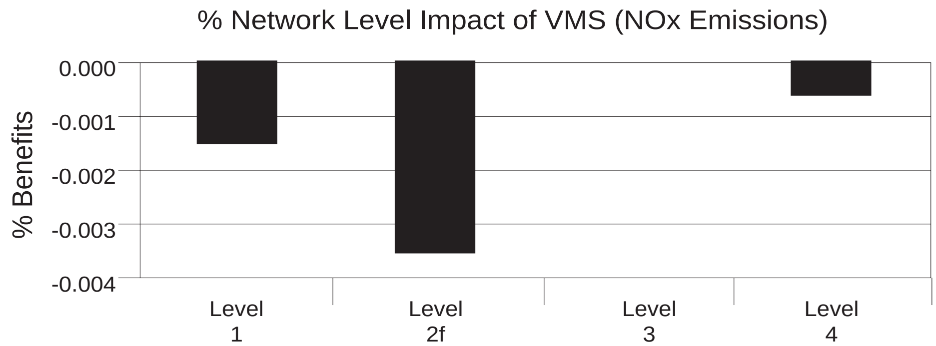

Figure 6.18 Percent Change in Network Level NOx Emissions under VMS Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

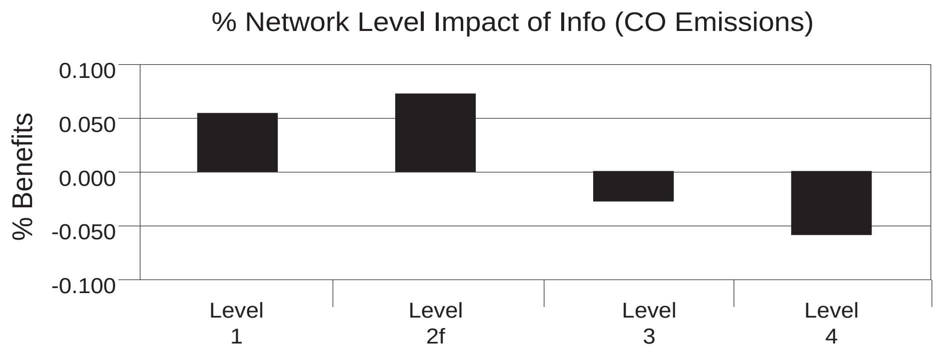

Figure 6.19 Percent Change in Network Level CO Emissions under In-Vehicle Information Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

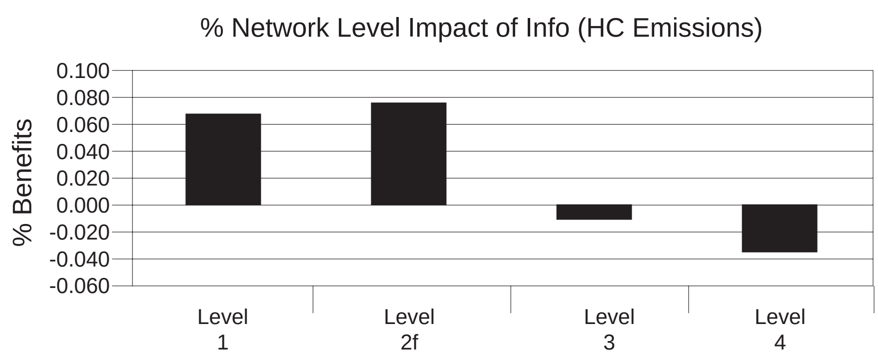

Figure 6.20 Percent Change in Network Level HC Emissions under In-Vehicle Information Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

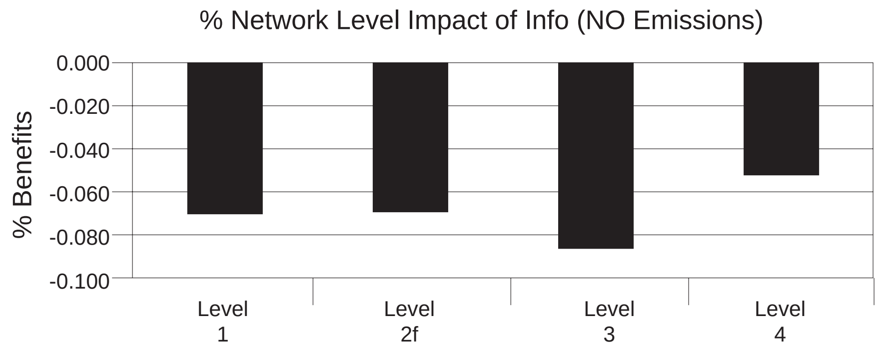

Figure 6.21 Percent Change in Network Level NOx Emissions under In-Vehicle Information Relative to Incident Conditions without ITS, Estimated Using the Various Levels of Modeling Approach

Similar to the observations from Fort Worth experiments, all the approaches indicate a reduction in CO and HC at the network level for VMS deployment scenarios. For scenarios with in-vehicle information, network modeling approaches with MOBILE 5 show benefits for CO and HC emissions. However, both VMS and in-vehicle information do not seem to be very effective in reducing NOx emissions at the network level. One possible explanation could be that NOx emissions are high during acceleration and high-speed cruising, and provision of information or VMS may lead to users choosing uncongested paths, therefore, leading to an increase in NOx emissions. In general, percentage benefits of ITS strategies on this network appear to be small because of the overall high magnitude of emissions. Hence, analysis of the localized impact, which is discussed in the next section, would be more meaningful.

The results of the experiments on the test beds have important implications for the methodological approach adopted to evaluate the impact of ITS and other operational strategies. Methods that do not recognize the variation of congestion over time, particularly assignment methods typically used in current practice or even dynamic modeling approaches that subsequently smooth out this variation over very long averaging intervals, are liable to produce qualitatively and quantitatively erroneous estimates of the impact of those strategies.

6.3.2 Localized Impact

As mentioned earlier, the impact of ITS strategies that is targeted at specific incident conditions is usually localized. To investigate the localized impact of ITS strategies on emissions, a portion of the test network surrounding the location of the incident was analyzed separately. The emissions for links (freeway segments, ramps, frontage roads, and arterials) in this portion that are most likely to be impacted by the incident and ITS strategies were examined using Level 4 (dynamic modeling with modal emission model). The results of the analysis are shown in Tables 6.10 and Table 6.11. The value in parentheses indicates the percentage change in emissions over the base case for the incident scenario, while for the ITS scenarios, it represents the percentage change in emissions relative to the incident case.

Fort Worth Network. The subnetwork involving the impacted area is shown within a box in the whole network in Figure 6.22 and a magnified view of the subnetwork with the relevant links is shown in Figure 6.23.

Table 6.11 Localized Impact of Its Strategies in Fort Worth Network

Scenario	CO (kg/hr)	HC (kg/hr)	NOx (kg/hr)
Base Case	62.95	3.94	5.61
Incident (50% severity)	100.93 (60.33%)	6.44(63.29%)	5.77 (2.76%)
In-Vehicle Info (30%)	61.56 (-39.01%)	3.98 (-38.18%)	5.60(-2.84)
VMS (30%)	84.00 (-16.77%)	5.44(-15.58%)	5.67(-1.73%)

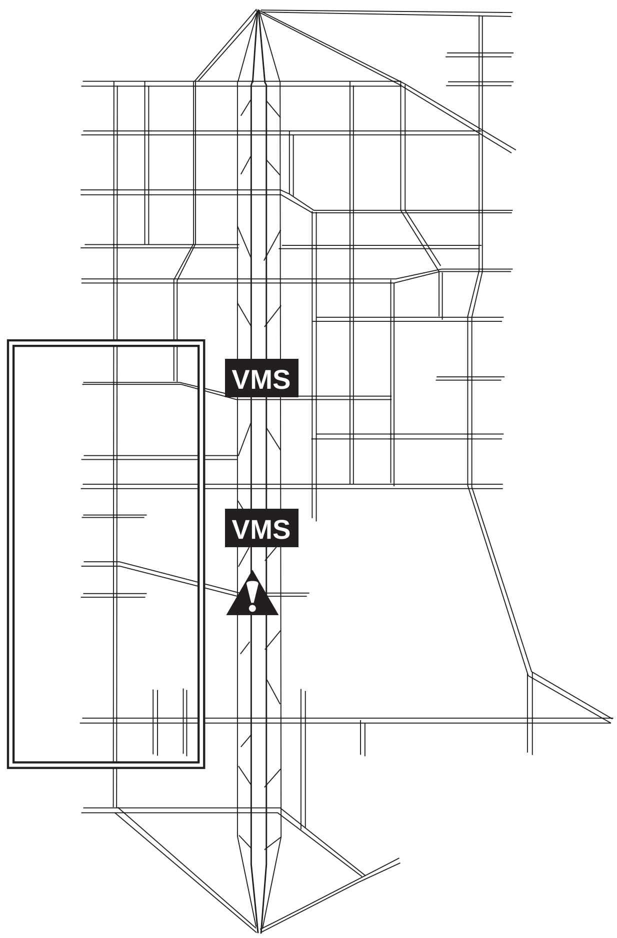

Figure 6.22 Subnetwork of Fort Worth Area Shown in a Box within the Overall Network

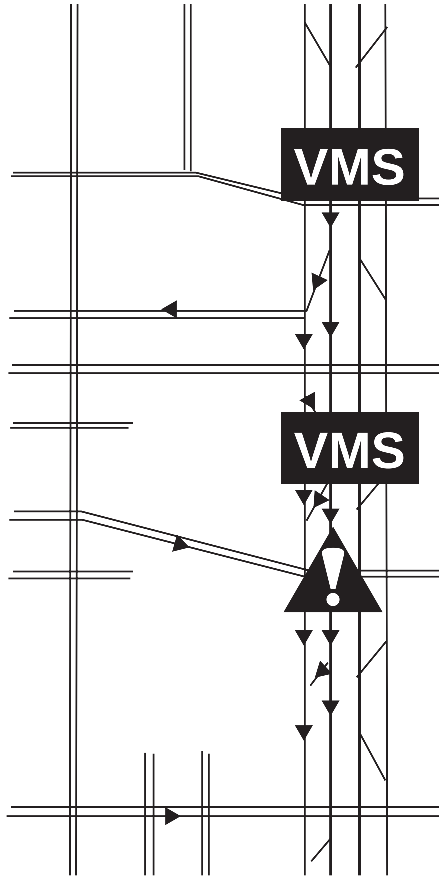

Figure 6.23 Magnified View of the Subnetwork Showing the Relevant Links

It can be seen from Table 6.10, that the incident has a very substantial impact on CO and HC emissions in the affected area. CO emissions increase by as much as 60.33% as a result of the incident, while HC emissions increase by 63.29%. The impact on NOx emissions is relatively modest with an increase of 2.76%. This can again be explained by the fact that the NOx emission rates are not very sensitive to vehicle speeds.

Both in-vehicle information and VMS seem to have the potential to greatly reduce CO and HC emissions around the vicinity of the incident in this network.

Houston Network. The analysis of the impact of ITS strategies in the impacted area is evidently more meaningful in this network.

Table 6.12 Localized Impact of ITS Strategies in Houston Network

Scenario	CO (kg/hr)	HC (kg/hr)	NOx (kg/hr)
Base Case	1523	74	133
Incident (40% severity)	1569 (0.03%)	77 (0.041%)	131 (-0.015%)
In-Vehicle Info (30%)	1579 (0.006%)	76 (-0.013)	137 (0.046%)
VMS (30%)	1520 (-0.044%)	73 (-0.052)	132 (0.008%)

It can be seen from Table 6.11 that VMS improves CO and HC emissions levels in the impacted areas. Provision of in-vehicle information reduces the HC emissions in the affected area, but in general it does not seem to improve the pollutant emissions level. This may be because users with vehicle information are informed about the prevailing conditions well in advance, and thus can be expected to travel on unaffected links at higher speeds and accelerations. As discussed earlier, this leads to higher emissions.

6.4 Sensitivity Analysis

Sensitivity analysis was performed on the Fort Worth and Houston networks to examine how sensitive the pollutant emissions are to various experimental factors. Level 4 (dynamic network modeling and modal emission models) was used throughout the sensitivity analysis. Both network level and local level results were examined.

6.4.1 Fort Worth Network

For scenarios with incident but no ITS, incident severity levels of 20%, 50%, and 80% were studied. For scenarios with VMS, response rates of 5%, 15%, 20%, 30%, and 60%, along with an incident of severity of 50%, were studied. For scenarios with in-vehicle information, market penetration levels of 5%, 15%, 20%, 30%, and 60%, along with an incident of severity of 50%, were studied. Tables 6.12, 6.13, and 6.14 show the results of sensitivity analysis for CO, HC, and NOx emissions, respectively.

Table 6.13 Sensitivity Analysis for CO Emissions (Fort Worth Study)

Scenario	CO Emissions (kg/hr)		% Change	
	LOCAL	NETWORK	LOCAL	NETWORK
Base Case	62.95	1206.56		
Incident Severity (%)				
20.00	88.95	1229.94	41.30[1]	1.94
50.00	100.93	1220.90	60.33	1.19
80.00	124.85	1258.73	98.34	4.32
In-vehicle information Penetration Rate (%)				
5.00	95.13	1212.11	-5.75[2]	-0.72
15.00	76.50	1145.82	-24.20	-6.15
20.00	67.16	1124.10	-33.46	-7.93
30.00	61.56	1148.42	-39.01	-5.94
60.00	83.24	1319.76	-17.53	8.10
VMS Response Rate (%)				
5.00	99.20	1217.84	-1.71	-0.25
15.00	86.24	1221.69	-14.56	0.06
20.00	84.93	1226.68	-15.86	0.47
30.00	84.00	1213.77	-16.77	-0.58
60.00	103.83	1217.11	2.87	-0.31

[1] Percent change for the incident scenario with no ITS, relative to the no-incident base case.

[2] Percent change for the ITS scenarios (In-vehicle information, VMS), relative to the 50% incident severity scenario with no ITS.

Table 6.14 Sensitivity Analysis for HC Emissions (Fort Worth Study)

Scenario	HC Emissions (kg/hr)		% Change	
	LOCAL	NETWORK	LOCAL	NETWORK
Base Case	3.94	67.08		
Incident Severity (%)				
20.00	5.77	69.14	46.40[3]	3.07
50.00	6.44	68.34	63.29	1.88
80.00	8.06	71.43	104.28	6.48
In-vehicle information Penetration Rate (%)				
5.00	6.09	67.21	-5.43[4]	-1.65
15.00	5.00	62.47	-22.31	-8.60
20.00	4.66	63.25	-27.58	-7.45
30.00	3.98	62.07	-38.18	-9.17
60.00	5.17	71.57	-19.69	4.72
VMS Response Rate (%)				
5.00	6.35	67.97	-1.43	-0.55
15.00	5.58	68.57	-13.38	0.34
20.00	5.40	68.64	-16.11	0.44
30.00	5.44	68.23	-15.58	-0.17
60.00	6.62	67.85	2.83	-0.72

[3] Percent change for the incident scenario with no ITS, relative to the no-incident base case.

[4] Percent change for the ITS scenarios (In-vehicle information, VMS), relative to the 50% incident severity scenario with no ITS.

Table 6.15 Sensitivity Analysis for NOx Emissions (Fort Worth Study)

Scenario	NOx Emissions (kg/hr)		% Change	
	LOCAL	NETWORK	LOCAL	NETWORK
Base Case	5.61	50.75		
Incident Severity (%)				
20.00	5.75	48.47	2.41[5]	-4.48
50.00	5.77	52.08	2.76	2.62
80.00	5.37	50.64	-4.25	-0.21
In-vehicle information Penetration Rate (%)				
5.00	5.55	53.00	-3.74[6]	1.77
15.00	5.57	56.22	-3.42	7.94
20.00	5.65	55.64	-2.06	6.85
30.00	5.60	57.53	-2.84	10.46
60.00	6.15	61.28	6.67	17.67
VMS Response Rate (%)				
5.00	5.76	52.15	-0.11	0.14
15.00	5.68	48.18	-1.57	-7.48
20.00	5.56	48.63	-3.62	-6.62
30.00	5.67	47.81	-1.73	-8.20
60.00	5.65	52.74	-2.05	1.27

Incident Severity. Figures 6.24, 6.25, and 6.26 illustrate the sensitivity of CO, HC, and NOx emissions, respectively, to incident severity at the network level.

[5] Percent change for the incident scenario with no ITS, relative to the no-incident base case.

[6] Percent change for the ITS scenarios (In-vehicle information, VMS), relative to the 50% incident severity scenario with no ITS.

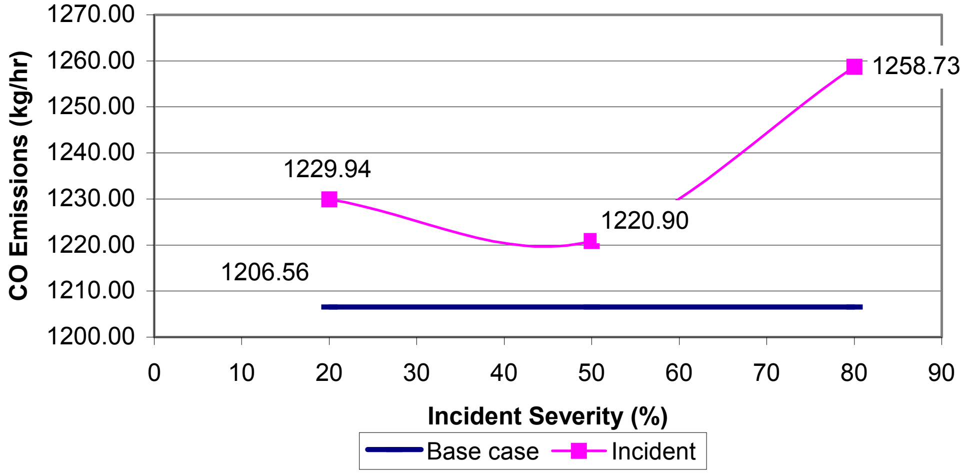

Figure 6.24 Sensitivity of CO Emissions to Incident Severity at the Network Level

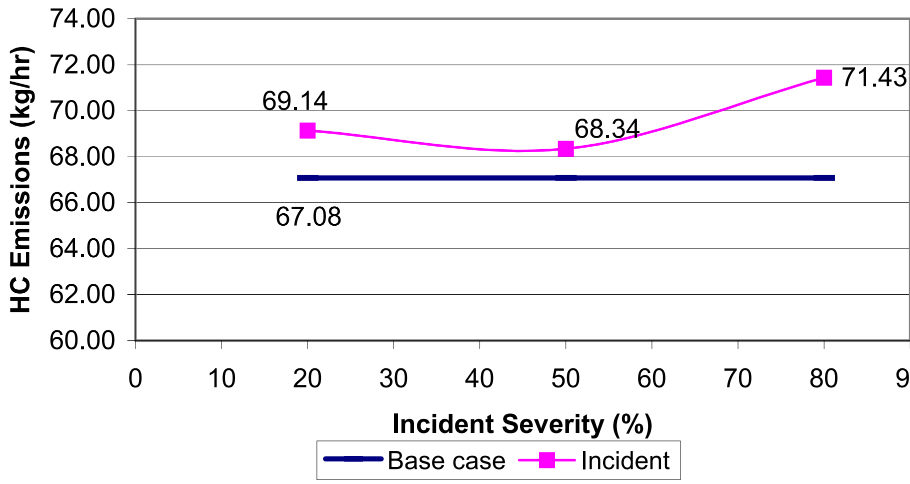

Figure 6.25 Sensitivity of HC Emissions to Incident Severity at the Network Level

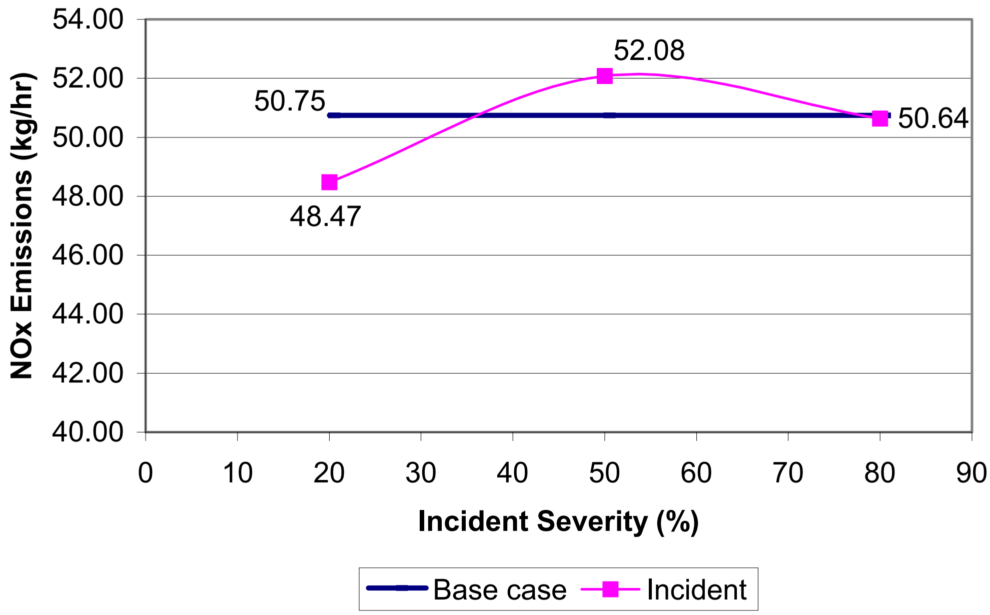

Figure 6.26 Sensitivity of NOx Emissions to Incident Severity at the Network Level

For CO and HC emissions, there is deterioration in the emissions with increasing incident severity. However, the increase in emissions is moderate at the network level. When the link capacity is reduced by 80%, the network CO emissions increase by 4.32% and HC emissions increase by 6.48%. For NOx emissions, there is no clear trend with increasing incident severity.

Figures 6.27, 6.28, and 6.29 illustrate the sensitivity of CO, HC, and NOx emissions, respectively, to incident severity at the local level.

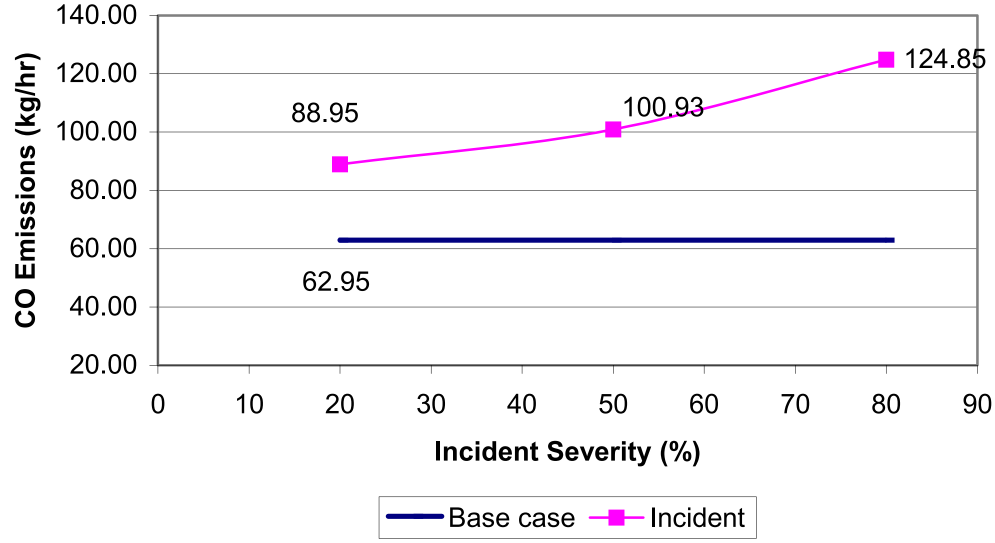

Figure 6.27 Sensitivity of CO Emissions to Incident Severity at the Local Level

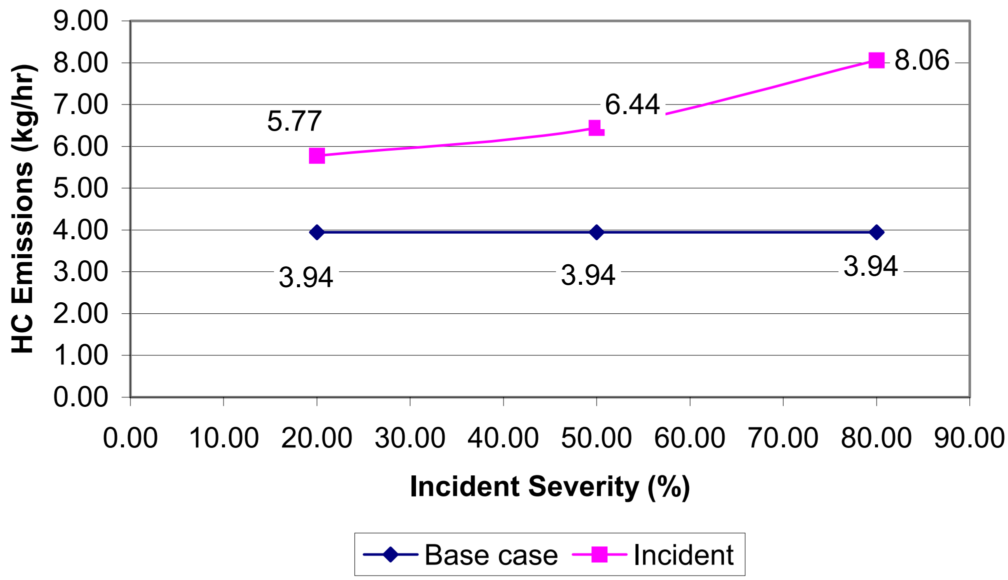

Figure 6.28 Sensitivity of HC Emissions to Incident Severity at the Local Level

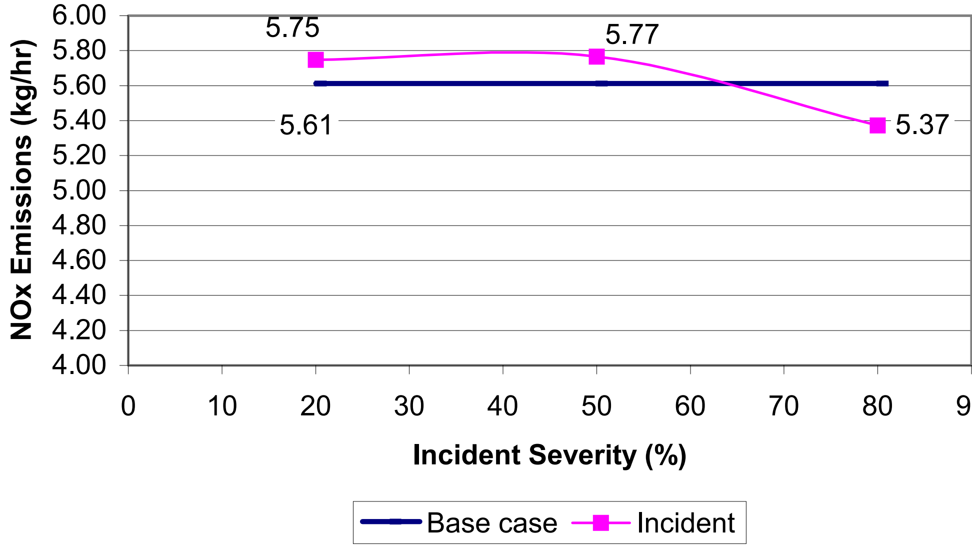

Figure 6.29 Sensitivity of NOx Emissions to Incident Severity at the Local Level

At the local level, incident severity has substantial impact on CO and HC emissions. Incident severity of 80% results in a 98.34% increase in CO emissions and a 104.28% increase in HC emissions. NOx emissions do not seem to be impacted by the level of incident severity.

Impact of In-Vehicle Information. Figures 6.30, 6.31, and 6.32 illustrate the network level sensitivity of CO, HC, and NOx emissions, respectively, to the market penetration level of in-vehicle information.

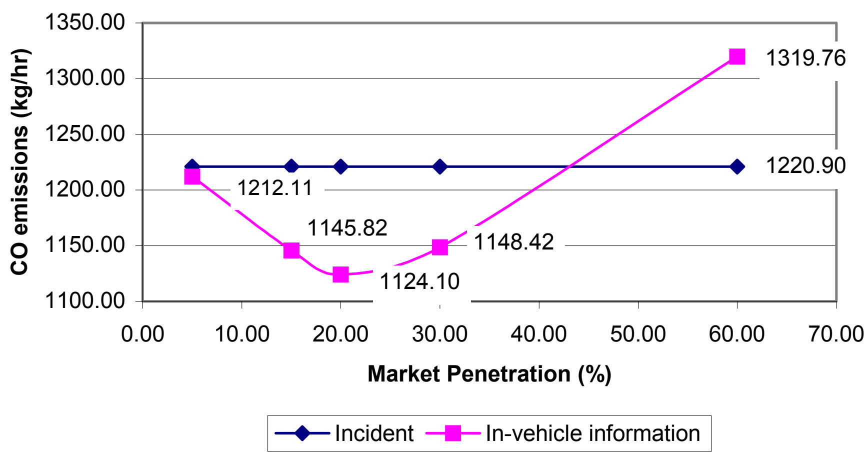

Figure 6.30 Sensitivity of CO Emissions to Market Penetration of Information at the Network Level

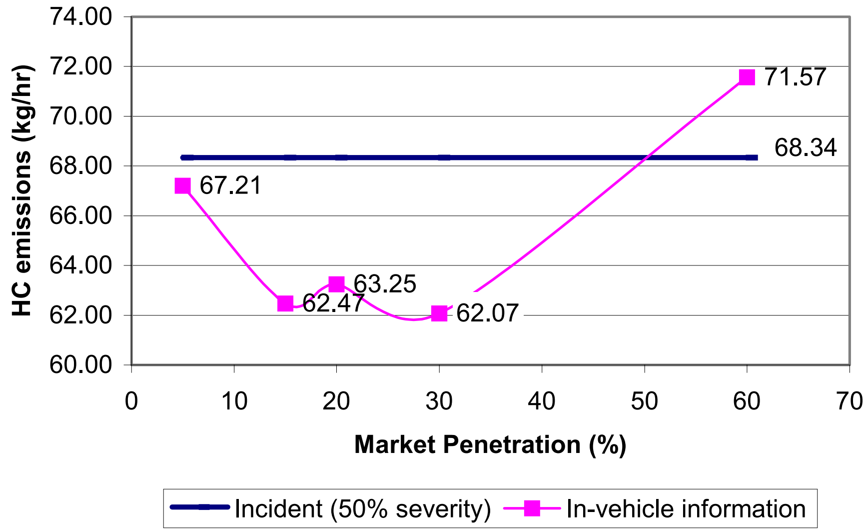

Figure 6.31 Sensitivity of HC Emissions to Market Penetration of Information at the Network Level

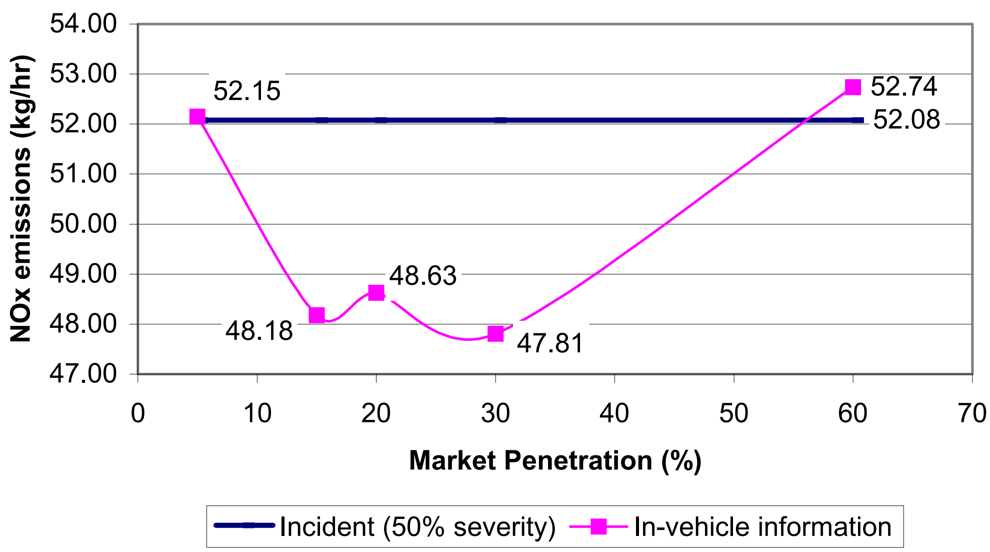

Figure 6.32 Sensitivity of NOx Emissions to Market Penetration of Information at the Network Level

It can be seen from Figures 6.30, 6.31, and 6.32 that initially, as market penetration increases, the emissions start to decrease until a certain market penetration level after which they start increasing again. The minimum emissions seem to occur around 20%–30% market penetration. As market penetration increases beyond this optimum level, the alternate diversion routes start becoming congested, which explains the increase in emissions. Previous research efforts that have used reduction in travel time in the network as a measure for evaluating the effectiveness of real-time descriptive information on prevailing trip time for mitigating congestion effects, have shown very similar trends. The "optimal" penetration levels for travel time is, however, a little higher, approaching 30%–50% (Jayakrishnan 1992; Koeppen 1996). It is important to note here that these findings pertain to one specific type of information supply strategy, namely, information on *prevailing* trip with no coordination or anticipation.

Figures 6.33, 6.34, and 6.35 illustrate the local level sensitivity of CO, HC, and NOx emissions, respectively, to the market penetration level of in-vehicle information.

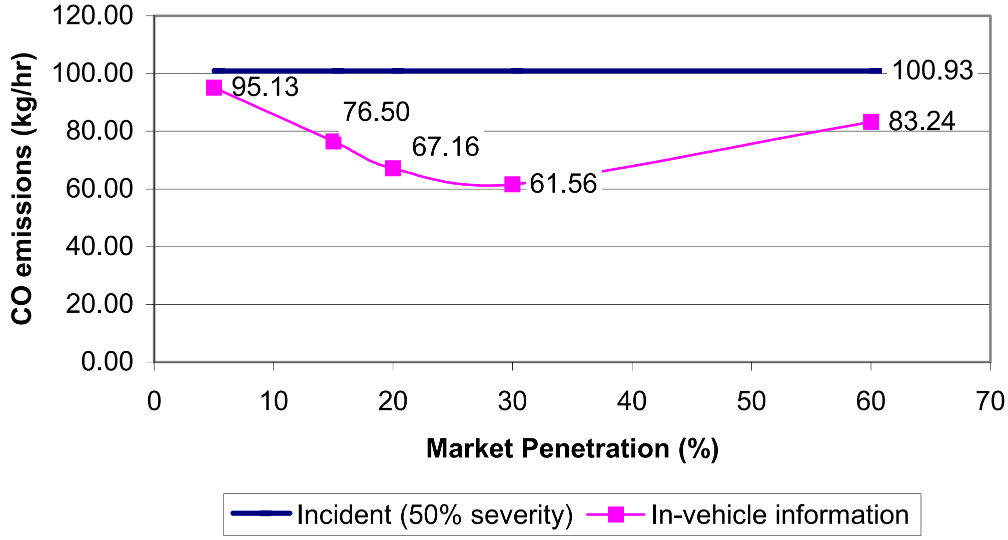

Figure 6.33 Sensitivity of CO Emissions to Market Penetration of Information at the Local Level

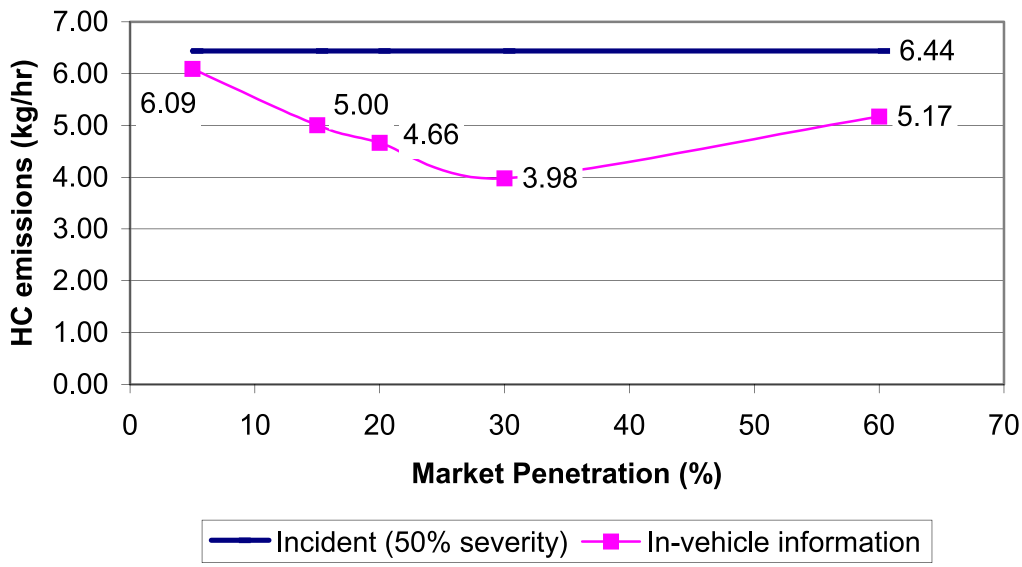

Figure 6.34 Sensitivity of HC Emissions to Market Penetration of Information at the Local Level

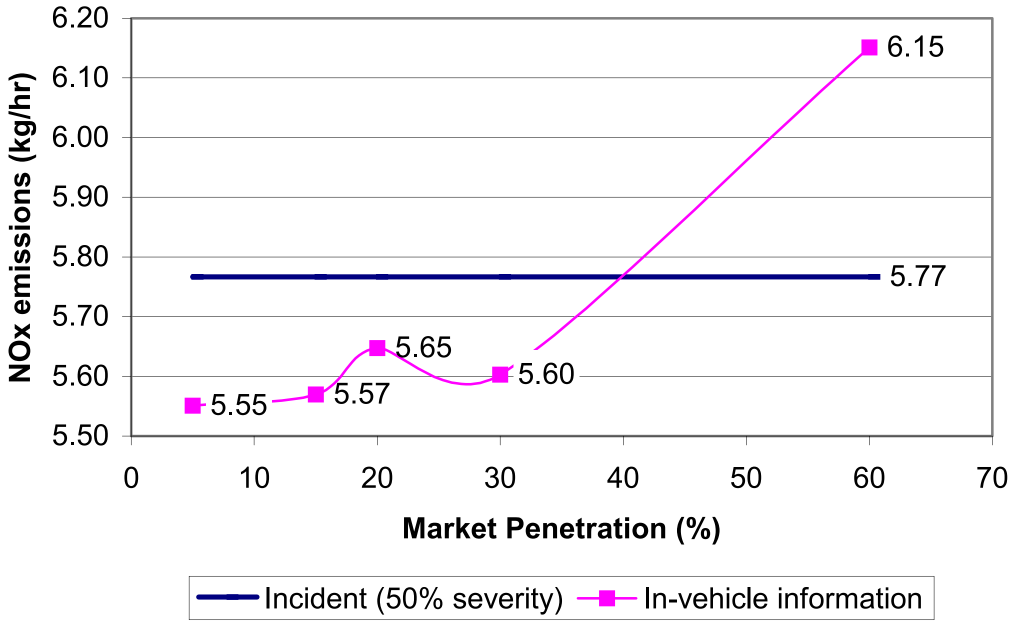

Figure 6.35 Sensitivity of NOx Emissions to Market Penetration of Information at the Local Level

For CO and HC emissions, the trends at the local level are very similar to trends at the network level with an optimum market penetration level approaching around 20%–30%. The relative magnitude of benefits, however, is much higher at the local level than at the network level. For NOx emission, the benefits are almost constant until around 30% market penetration after which the emissions start increasing again.

Impact of VMS. Figures 6.36, 6.37, and 6.38 illustrate the network level sensitivity of CO, HC, and NOx emissions, respectively, to the fraction of drivers responsive to VMS.

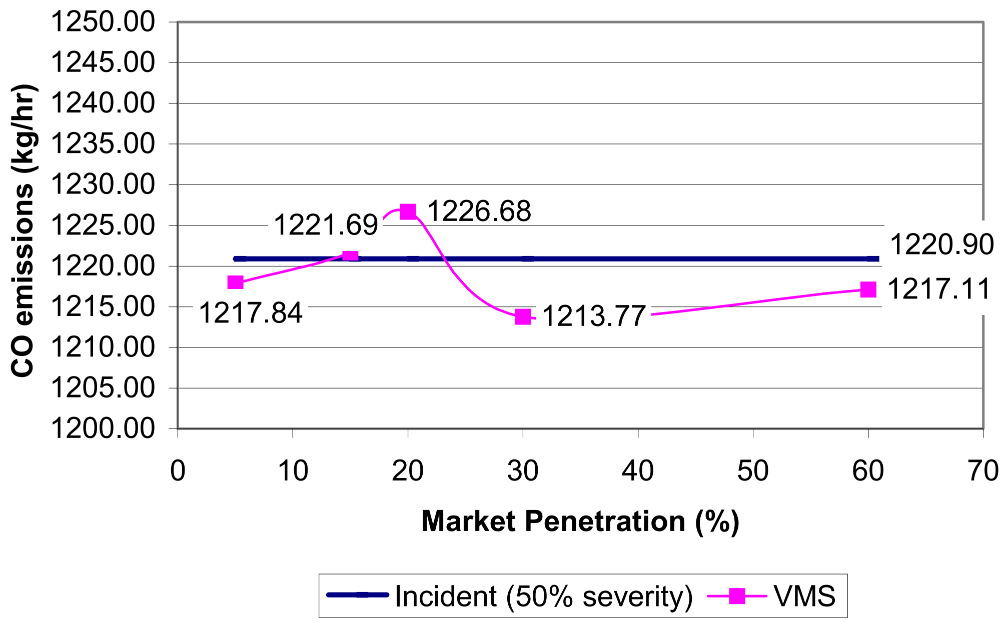

Figure 6.36 Sensitivity of CO Emissions to VMS Response Rate at the Network Level

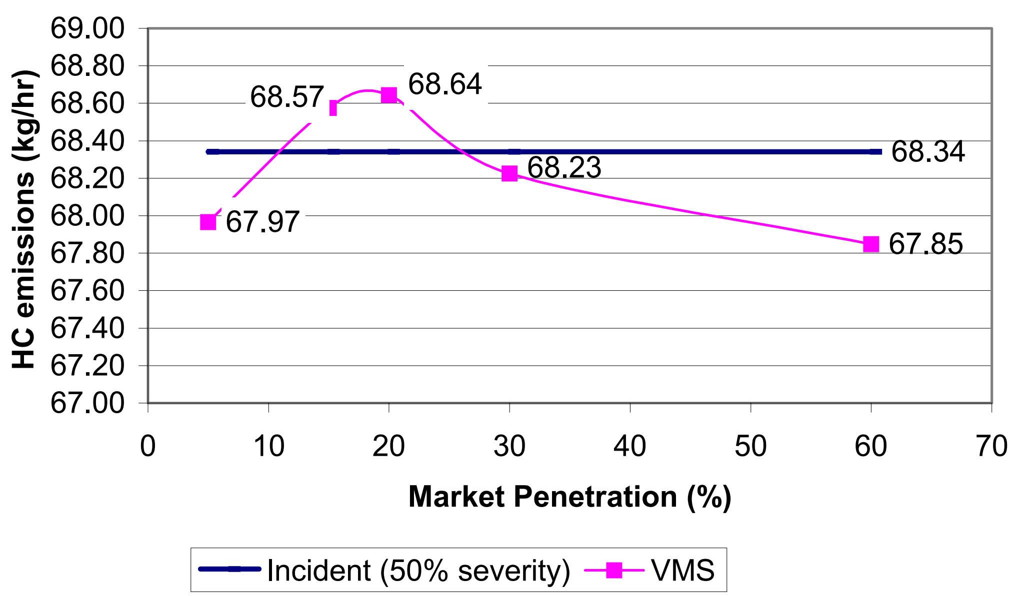

Figure 6.37 Sensitivity of HC Emissions to VMS Response Rate at the Network Level

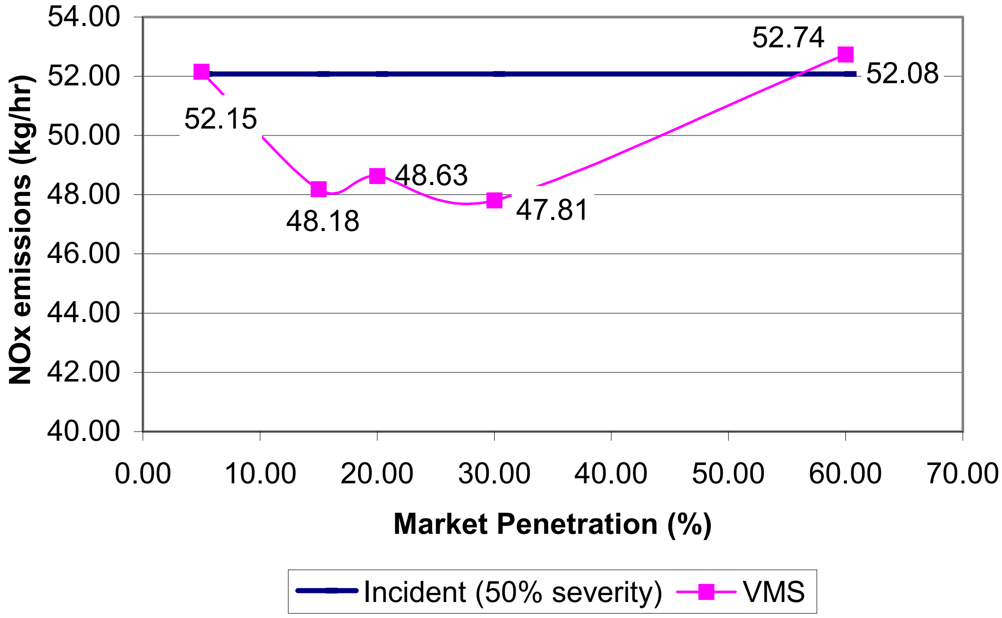

Figure 6.38 Sensitivity of HC Emissions to VMS Response Rate at the Network Level

It can be seen from Figures 6.36 and 6.37 that CO and HC emissions benefits of VMS may not be very meaningful when taken at the network level and the impact of VMS may be restricted to the affected area. VMS, however, does seem to have the potential of reducing network-wide NOx emissions to a certain extent as can be seen from Figure 6.29.

Figures 6.39, 6.40, and 6.41 illustrate the local level sensitivity of CO, HC, and NOx emissions, respectively, to the fraction of drivers responsive to VMS.

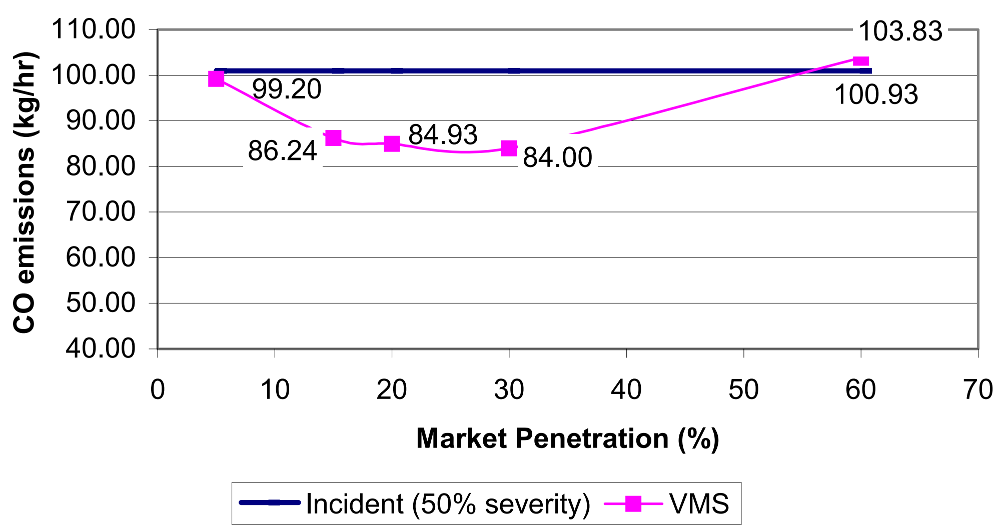

Figure 6.39 Sensitivity of CO Emissions to VMS Response Rate at the Local Level

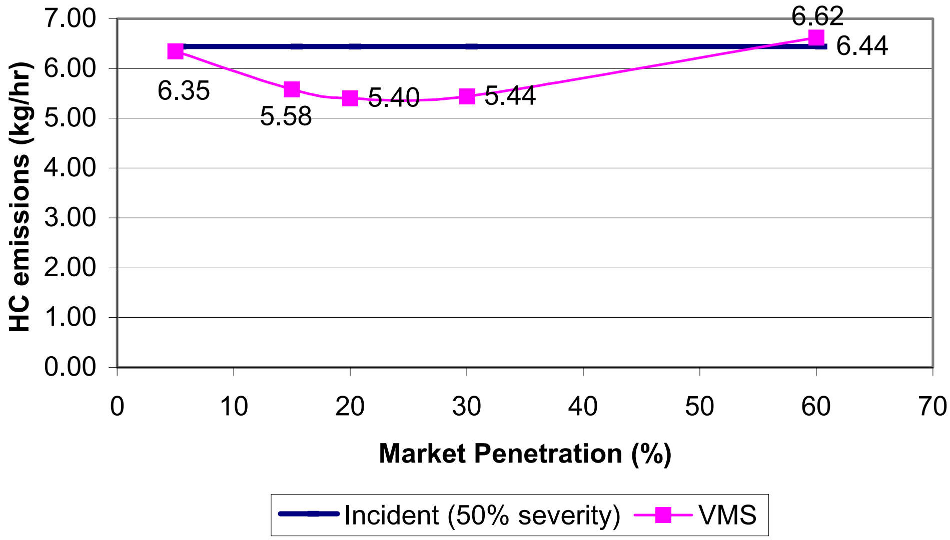

Figure 6.40 Sensitivity of HC Emissions to VMS Response Rate at the Local Level

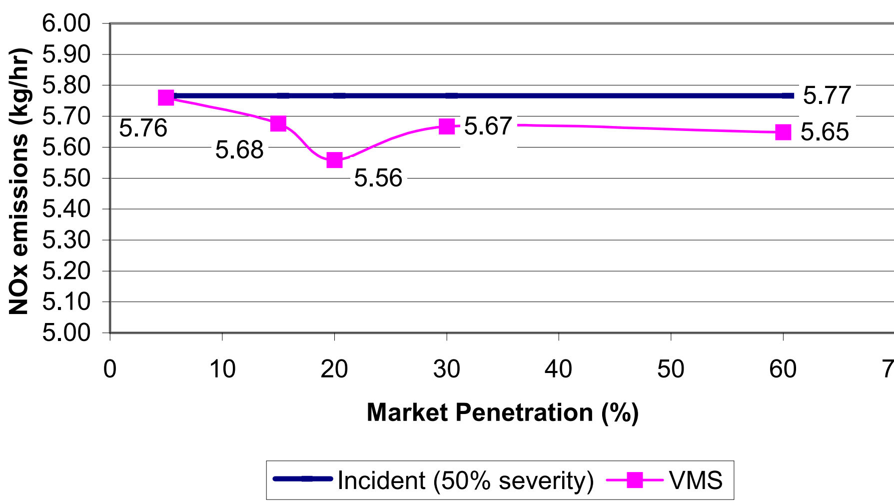

Figure 6.41 Sensitivity of NOx Emissions to VMS Response Rate at the Local Level

VMS does seem to be an effective strategy to reduce CO, HC, and NOx emissions at the local level as indicated by Figures 6.39, 6.40, and 6.41. The emissions decrease as the driver response rate increases up to a certain level and then they start increasing again. The optimum response rate seems to occur around 20%.

6.4.2 Houston Network

In this case study, for scenarios with incident but no ITS, incident severity levels of 20%, 40%, and 80% were performed. For scenarios with VMS, response rates of 10%, 30%, and 60%, along with an incident of severity of 40%, were studied. For scenarios with in-vehicle information, market penetration levels of 10%, 30% and 60%, along with an incident of severity of 40%, were studied. Tables 6.15, 6.16, and 6.17 show the results of sensitivity analysis for CO, HC, and NOx emissions, respectively.

Table 6.16 Sensitivity Analysis for CO Emissions (Houston Network)

Scenario	CO Emissions (kg/hr)		% Change	
	LOCAL	NETWORK	LOCAL	NETWORK
Base Case	1523	38451		
Incident Severity (%)				
20	1544	38468	0.014[7]	0.000
40	1569	38465	0.030	0.000
80	1550	38184	0.018	-0.007
In-vehicle information Penetration Rate (%)				
10	1553	38468	-0.010[8]	7.8E-05
30	1579	40510	0.006	5.3E-02
50	1638	40722	0.044	5.9E-02
VMS Response Rate (%)				
10	1536	38476	0.021	2.9E-04
30	1520	38398	0.031	-1.7E-03
50	1545	38525	0.015	1.6E-03

[7] Percent change for the incident scenario with no ITS, relative to the no-incident base case.

[8] Percent change for the ITS scenarios (In-vehicle information, VMS), relative to the 50% incident severity scenario with no ITS.

Table 6.17 Sensitivity Analysis for HC Emissions (Houston Network)

Scenario	HC Emissions (kg/hr)		% Change	
	LOCAL	**NETWORK**	**LOCAL**	**NETWORK**
Base Case	74	1948		
Incident Severity (%)				
20	76	1948	0.027[9]	0.000
40	77	1947	0.041	-0.001
80	76	1940	0.027	-0.004
In-vehicle information Penetration Rate (%)				
10	73	1942	-0.052[10]	-0.003
30	76	2013	-0.013	0.034
50	77	1998	0.000	0.026
VMS Response Rate (%)				
10	76	1947	-0.013	0.000
30	73	1946	-0.052	-0.001
50	76	1949	-0.013	0.001

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[9] Percent change for the incident scenario with no ITS, relative to the no-incident base case.

[10] Percent change for the ITS scenarios (In-vehicle information, VMS), relative to the 50% incident severity scenario with no ITS.

Table 6.18 Sensitivity Analysis for NOx Emissions (Houston Network)

Scenario	NO Emissions (kg/hr)		% Change	
	LOCAL	NETWORK	LOCAL	NETWORK
Base Case	133	3177		
Incident Severity (%)				
20	131	3179	-0.015[11]	0.001
40	131	3171	-0.015	-0.002
80	131	3157	-0.015	-0.006
In-vehicle information Penetration Rate (%)				
10	136	3258	0.038[12]	0.027
30	137	3330	0.046	0.050
50	147	3555	0.122	0.121
VMS Response Rate (%)				
10	130	3170	-0.008	0.000
30	132	3173	0.008	0.001
50	131	3174	0.000	0.001

From Tables 6.15 and 6.16, it can be seen that at both network and local levels, CO and HC emissions rise and fall with increasing incident severity level. When the link capacity is reduced by 80%, the network CO and HC emissions decrease compared to the base case. Similar to the observations from the Fort Worth experiments on VMS response rates, the emissions decrease as the driver response rate increases up to a certain level, and then they start increasing again. In this case study, the emissions are seen to increase with the increasing penetration levels of in-vehicle information.

The results from the two case studies suggest that though ITS strategies may have the potential to improve the emissions levels in some networks, these strategies need to be applied based on the network type and the location of incidents. Generalizing the application of these strategies to all the networks may lead to overestimation of benefits in some networks.

6.5 Results of Experiments with Heavy-Duty Vehicles Included

In this section, the impact of ITS strategies on emissions are analyzed for scenarios where heavy-duty vehicles (trucks) are included in the vehicle fleet. As indicated in Chapter Five, truck percentages of 2% and 5% are considered in the analysis. Level 4 (dynamic network modeling with modal emissions modeling) is used in the analysis. Only

[11] Percent change for the incident scenario with no ITS, relative to the no-incident base case.

[12] Percent change for the ITS scenarios (In-vehicle information, VMS), relative to the 50% incident severity scenario with no ITS.

CO and HC emissions are considered for these scenarios because ONROAD models for NOx are not available. Tables 6.17 and 6.18 show the results for CO and HC emissions, respectively.

Table 6.19 CO Emission for Scenarios Comprising Heavy-Duty Vehicles

Proportion of trucks	**Incident Severity**	**Information Provision**		**CO Emissions (kg/hr)**		**% Change**	
		Type	**Market Penetration**	**Local**	**Network**	**Local**	**Network**
2%	*Base Case*			91.82	1073.06		
	50%	*No ITS*		108.95	1098.46	18.66	2.37
	50%	*VMS*	*30%*	108.89	1092.79	-0.05	-0.52
	50%	*In-vehicle info*	*30%*	67.66	1172.06	-37.90	6.70
5%	*Base Case*			70.59	1123.30		
	50%	*No ITS*		71.39	1124.87	1.14	0.15
	50%	*VMS*	*30%*	93.66	1135.97	31.19	0.99
	50%	*In-vehicle info*	*30%*	88.72	1306.06	24.27	16.11

Table 6.20 HC Emission for Scenarios Comprising Heavy-Duty Vehicles

Proportion of trucks	**Incident Severity**	**Information Provision**		**HC Emissions (kg/hr)**		**% Change**	
		Type	**Market Penetration**	**Local**	**Network**	**Local**	**Network**
2%	*Base Case*			6.22	64.58		
	50%	*No ITS*		7.70	66.40	23.85	2.82
	50%	*VMS*	*30%*	7.52	66.01	-2.37	-0.58
	50%	*In-vehicle info*	*30%*	4.96	68.74	-35.56	3.53
5%	*Base Case*			5.74	74.11		
	50%	*No ITS*		5.75	74.85	0.19	1.01
	50%	*VMS*	*30%*	7.13	74.73	24.11	-0.17
	50%	*In-vehicle info*	*30%*	7.02	85.22	22.21	13.85

In Tables 6.18 and 6.19, the percent change column refers to the percentage change in emissions with respect to the base case, for the incident scenario, and refers to the percentage change in emissions with respect to the incident case for the scenarios with ITS strategies.

An interesting observation is that the impact of the incident, both at local and network levels, seems to diminish with an increase in the proportion of trucks in the fleet. When trucks comprise 2% of the vehicle fleet, there is a significant change in the emissions, especially at the local level; when trucks comprise 5%, the change in emissions is negligible.

It also can be seen that at 2% truck proportion, provision of information is an effective strategy, especially at the local level, while VMS, though having some benefits, is not very effective. However, when the proportion of the trucks in the vehicle fleet is increased to 5%, neither VMS nor providing in-vehicle information, seems to be effective as far as emissions are concerned.

6.6 Summary

As may be expected, the results indicate that both the network modeling approach, as well as the emission models employed, are significant factors in emission estimation. In general, it is found that dynamic modeling results in slightly higher emissions estimates than static modeling for CO and HC, while the converse is true for NOx emissions. CO and HC emissions exhibit similar trends for most scenarios, while the trends for NOx emissions generally are unpredictable. Also, emission estimates from MOBILE 5 are higher than those produced by modal emission models. MOBILE 5 is found to be more sensitive to the network modeling approach used than the modal emission-based approach. It is also observed that the interval used for averaging link speeds is also an important consideration when calculating emissions using MOBILE 5.

The aggregation interval used in the analysis is also an important factor and has significant impact on both the magnitude of the emissions calculated and the impact of ITS strategies employed. The next chapter discusses some of the important conclusions drawn and provides recommendations for future research.

7. Concluding Remarks

7.1 Summary

This study was conducted to develop a framework to compare static and dynamic network modeling, in combination with modal emission models and EPA's MOBILE 5, to assess the impact of Intelligent Transportation System (ITS) strategies on mobile source emissions. A number of modeling tools and procedures are required to implement such a framework. In this study, DYNASMART-P, a network modeling and simulation tool was used for modeling traffic dynamics in the network. Though DYNASMART-P is better suited to dynamic network modeling, it is used for quasi-static modeling as well to provide a consistent platform for comparison. Modal emission models for light-duty vehicles based on emissions data from Oak Ridge National Laboratory (ORNL) are incorporated within the DYNASMART-P simulation framework. For heavy-duty vehicles, ONROAD models developed at Texas Southern University are used. In addition, EPA-approved MOBILE 5 is also interfaced with DYNASMART-P for additional analysis.

This framework was then tested on a portion of the Fort Worth network and a portion of the Houston network. The potential of information-based ITS strategies like variable message signs (VMS) and provision of in-vehicle information, is investigated for mitigating nonrecurrent congestion resulting from an incident on a freeway corridor. The impact is studied by looking at the network-wide as well as localized carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx) emissions. VMS and in-vehicle information are selected as the target ITS strategies as they are among the easiest to deploy. The important observations based on the results of the analysis are discussed next.

7.2 Conclusions

In general, ITS strategies do seem to have potential for reducing emission levels. It is observed that the benefits of VMS are significant at the local level and not very substantial at the network level. In-vehicle information on the other hand, suggests mixed trends in benefits at the local and the network levels. This is expected because users with vehicle information are informed about the prevailing conditions well in advance and are thus diverted to alternate uncongested routes; the emissions on these routes may increase, offsetting to some degree the benefits around the location of the incident.

As market penetration and response rates for ITS technologies increase, the emissions start to decrease until a certain level beyond which they start increasing again. The optimum level is found around 20%–30%. A possible explanation for this is that as the market penetration increases, the diversion rates also increase and the alternate routes become more congested, which may result in reduced emission benefits.

When heavy-duty vehicles are included in the analysis, it is seen that when the proportion of trucks is 2%, in-vehicle information remains an effective strategy at the local level, while VMS does not seem to have significant benefits. This may be because acceleration was not found to be a significant explanatory variable for the CO and HC emission models used for heavy-duty vehicles, and therefore smoothing of traffic flow as a result of VMS might not be reflected adequately. When the truck proportion is increased to 5%, there is a substantial increase in emissions at both local and network levels, and ITS strategies do not appear to be effective. However, it should be noted that the truck proportion of 2% is more realistic and 5% is on the high side. Also, trucks are unlikely to form a high proportion of the vehicle fleet during peak hours when maximum congestion occurs.

Finally, the above observations and conclusions cannot be generalized to all the networks. The prediction of the impact of implementing various ITS strategies needs to be performed specifically for the network and the incident location. The complex nature of the pollutant emissions needs to be recognized when applying these strategies because any generalization may lead to overestimation of their benefits in some networks.

7.3 Guidelines for Selecting Modeling Approach

As mentioned earlier, both network modeling and emission modeling approaches employed are important factors in evaluating the impact of ITS strategies.

- Each of Levels 1 to 4 used in the analysis represents an improvement in realism over the preceding level, and Level 4, therefore, corresponds to a theoretically superior approach.
- Level 4 generally results in estimates of impact that are logically consistent with our expectations.
- Static network modeling approaches generally tend to underestimate CO and HC emissions while overestimating the NOx emission estimates. Therefore, caution has to be exercised while using static modeling approaches.
- Modal emission modeling, being more receptive to vehicle operating modes, is theoretically superior to MOBILE 5/6 based approaches, but the modal emission model need to be calibrated properly to ensure consistent results. Presently MOBILE 5/6 (EMFAC for California) are the only EPA-approved approaches for performing emission inventory analysis.
- MOBILE-based approaches are also more sensitive to the network modeling approach used, and therefore the network modeling approach becomes an important consideration when using MOBILE 5/6.
- When analyzing impacts of VMS on CO and HC emissions, using Level 2, i.e., dynamic network modeling and MOBILE 5, the aggregation interval is an important consideration. Using a finer temporal resolution is recommended as it results in emission estimates that are closer to Level 4 estimates. As the averaging interval becomes coarser, the benefits of VMS are not adequately captured.
- When evaluating impacts of VMS and in-vehicle information, it is advisable to look at the affected area, which usually results in more meaningful impact estimates.
- When evaluating impacts of in-vehicle information, static modeling approaches should be avoided, as these approaches fail to capture the impacts adequately.

7.4 Recommendations for Future Research

This study took a first step towards presenting an integrated framework for assessing the impact of ITS strategies on mobile source emissions. A number of recommendations can be made for future research in this direction. First, comprehensive modal emission models should be developed based on emission-testing data from a large sample of vehicles that is representative of the current vehicle fleet. Such a sample should also include heavy-duty and diesel vehicles. Procedures should also be developed to model emissions in the cold-start mode and not just in the hot transient mode. Other factors like ambient temperature and roadway grades should also be included as explanatory variables in the modal emission model.

In terms of network modeling, the validity of uniform acceleration assumption should be tested and various other functional forms for acceleration should be explored. The network representation can also be enhanced to include detailed information like roadway grades and ambient temperature. The widespread use of Geographic Information Systems (GIS) can facilitate such a task.

In this study, the ITS strategies were examined in isolation. Further studies may be conducted to analyze the impact of deploying these strategies simultaneously. Additionally, strategies for relieving congestion on arterials and frontage roads, such as signal coordination, should also be analyzed in combination with the ITS strategies included in this study.

Appendix A
ONROAD Modal Emission Models

The following are the ONROAD modal emission models (Yu 1997):

CO Aggregate Emission Rate:

$$LN(CO) = -2.2182+0.0300u-0.0184a$$

CO Emission Rate for Vehicle Type 1:

$$LN(CO1) = -2.2493+0.0312u-0.0270a$$

CO Emission Rate for Vehicle Type 2:

$$LN(CO2) = -2.1076+0.0270u$$

CO Emission Rate for Vehicle Type 3:

$$LN(CO3) = -1.9798+0.0005u^2$$

HC Aggregate Emission Rate:

$$LN(HC) = -4.9619+0.0288u-0.0445a+0.0075t$$

HC Emission Rate for Vehicle Type 1:

$$LN(HC1) = -4.4435+0.0303u-0.0430a$$

HC Emission Rate for Vehicle Type 2:

$$LN(HC2) = -5.1106+0.0250u+0.0111t$$

HC Emission Rate for Vehicle Type 3:

$$LN(HC3) = -3.859321+0.0004u^2$$

Where:

u = vehicle instantaneous speed in mph.
a = vehicle acceleration rate in mph per second.
t = ambient temperature in Fahrenheit degree.

Appendix B
EPA Default LDGV Mileage Accumulation Rates

Table B-1 EPA Default Mileage Accumulation Rates for LDGV

Model Year	Mileage
1	0.14390
2	0.13612
3	0.12875
4	0.12180
5	0.11522
6	0.10899
7	0.10310
8	0.09751
9	0.09225
10	0.08726
11	0.08254
12	0.07807
13	0.07386
14	0.06987
15	0.06608
16	0.06251
17	0.05913
18	0.05594
19	0.05291
20	0.05005
21	0.04735
22	0.04478
23	0.04237
24	0.04007
25	0.03790

Appendix C
Vehicle Fleet Distribution Calculations for Modal Emissions Models

Step 1: Determine Proportion of Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks

Total number of automobiles in use in 1999 in U.S. = 132,432,000, total number of trucks in use in 1999 in U.S. = 83,148,000 (of which 94% are light-duty trucks and the rest are heavy-duty trucks) (FHWA, 2000).

From these numbers:
Light-duty cars – 132,432,000
Light-duty trucks – 83,148,000*0.94 = 78,159,120
Heavy-duty trucks – 83,148,000*0.06 = 4,988,880

Step 2: Determine the proportion of passenger cars and light-duty trucks in the light-duty vehicles

Total Number of Light-Duty Vehicles = 132,432,000 + 78,159,120 = 210,591,120
Proportion of Light-Duty Cars = 132,432,000/210,591,120 = 0.6288
Proportion of Light-Duty Trucks (vehicle class 5) = 1 – 0.6288 = **0.3711**

Step 3: Determine the proportion of vehicle classes 1-4 based on the age for the passenger cars.

Table C-1 gives the default MOBILE 5 distribution by age for Light-Duty Gasoline Vehicles (LDGV).

Table C-1 MOBILE 5 Default Light-Duty Vehicle Age Distribution

Model Year	Percent	Cumm %	Proportion
1	0.049	0.049	0.049
2	0.079	0.128	
3	0.083	0.211	
4	0.082	0.293	
5	0.084	0.377	0.328
6	0.081	0.458	
7	0.077	0.535	
8	0.056	0.591	
9	0.050	0.641	
10	0.051	0.692	
11	0.050	0.742	
12	0.054	0.796	
13	0.047	0.843	
14	0.037	0.880	
15	0.024	0.904	0.527
>15	0.095	0.999	0.095

Using Table C-1,

Proportion of vehicle class 1 = 0.6288 * 0.049 = **0.031**

Proportion of vehicle class 2 = 0.6288 * 0.328 = **0.207**

Proportion of vehicle class 3 = 0.6288 * 0.527 = **0.332**

Proportion of vehicle class 4 = 0.6288 * 0.095 = **0.060**

Appendix D
Vehicle Fleet Distribution Calculations for MOBILE 5

Step 1: Determine Proportion of Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks

Total number of automobiles in use in 1999 in U.S. = 132,432,000, total number of trucks in use in 1999 in U.S. = 83,148,000 (of which 94% are light-duty trucks and the rest are heavy-duty trucks) (FHWA 2000).

From these numbers:
Light-duty cars – 132,432,000
Light-duty trucks – 83,148,000*0.94 = 78,159,120
Heavy-duty trucks – 83,148,000*0.06 = 4,988,880

Step 2: Determine the proportion of vehicle classes 1-7 based on MOBILE 5 classification

Table D-1 provides a mapping between EPA and TxDOT vehicle classification for Tarrant County.

Table D-1 Mapping between EPA and TxDOT Vehicle Classification

Source: (Bhat and Nair 2001)

Tarrant County

TxDOT classification	EPA MOBILE vehicle type classification							
	LDGV	LDDV	LDGT1	LDGT2	LDDT	HDGV	HDDV	MC
Autos	98.8%	1.2%	-	-	-	-	-	-
PUV	-	-	96.07%	1.81%	2.12%	-	-	-
SUV	-	-	96.07%	1.81%	2.12%	-	-	-
Trucks	-	-	-	-	-	39.31%	60.69%	-
Buses	-	-	-	-	-	20.09%	79.91%	-
Motorcycles	-	-	-	-	-	-	-	100%

Using Table D-1:

Light-Duty Vehicles

LDGV = 132,432,000 * 0.988 = 130,842,816

LDDV = 132,432,000 * 0.012 = 1,589,184

LDGT1 = 78,159,120*0.9607 = 75,087,467

LDGT2 = 78,159,120*0.0181 = 1,414,680

LDDT = 78,159,120*0.0212 = 1,656,973

Total = **210,591,120**

Proportion of Vehclass 1 = 130842816/210591120 = **0.621**

Proportion of Vehclass 2 = 1,589,184/210591120 = **0.008**

Proportion of Vehclass 3 = 75,087,467/210591120 = **0.357**

Proportion of Vehclass 4 = 1,414,680/210591120 = **0.006**

Proportion of Vehclass 5 = 1,656,973/210591120 = **0.008**

Heavy-Duty Vehicles (from Table D-1)

Proportion of Vehclass 6 = **0.393**

Proportion of Vehclass 7 = **0.607**

Appendix E
DYNASMART-P input file co.dat

(Note: Line wrapping has occurred in this file, the actual input used had no such wrapping)

0.05	0.05	0.08	0.05	0.05	0.09	0.05	0.1	0.09	0.15	0.13	0.18	0.16	25.91	0.1	22.78	330.34	458.93
0.05	0.04	0.05	0.05	0.05	0.07	0.04	0.11	0.1	0.2	0.14	0.17	0.14	0.12	0.1	0.99	330.34	500.65
0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.13	0.1	0.22	0.22	0.14	0.13	0.1	0.1	0.99	335.33	561.22
0.05	0.04	0.04	0.04	0.04	0.04	0.06	0.13	0.1	0.23	0.19	0.11	0.1	0.1	0.09	1.81	307.56	673.85
0.05	0.05	0.05	0.04	0.04	0.04	0.06	0.14	0.15	0.16	0.17	0.09	0.09	0.08	0.16	0.15	336.89	645.75
0.04	0.04	0.04	0.05	0.05	0.05	0.07	0.13	0.12	0.14	0.1	0.08	0.09	0.17	0.25	0.15	336.89	619.23
0.04	0.04	0.04	0.04	0.04	0.04	0.08	0.09	0.09	0.21	0.07	0.09	0.09	0.26	0.37	2.53	412.33	495.77
0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.14	0.12	0.09	0.08	0.17	0.36	0.29	69.25	619.23	537.54
0.04	0.03	0.03	0.04	0.04	0.05	0.07	0.08	0.25	0.07	0.08	0.16	0.25	0.16	2.53	225.92	537.54	537.54
0.04	0.03	0.04	0.04	0.04	0.03	0.65	0.19	0.18	0.09	0.17	0.36	0.29	10.48	105.1	380.55	426	381.84
0.04	0.03	0.04	0.04	0.03	1.68	0.95	0.1	0.06	0.09	0.25	0.29	2.53	105.1	315.44	592.83	177.27	426
0.04	0.04	0.05	0.03	2	1.75	0.32	0.04	0.08	0.26	0.3	0.16	36.68	244.78	512.8	346.16	69.49	69.49
0.05	0.04	0.05	0.03	2.33	1.9	0.54	0.09	0.28	0.42	0.18	2.71	106.1	459.33	262.88	91.79	33.06	33.06
0.06	0.05	0.05	0.03	2.34	0.78	0.18	0.09	0.52	0.25	0.19	12.09	405.86	398.46	16.1	14.51	24.32	75.73
0.07	0.06	0.05	0.05	1.84	1.74	0.13	0.2	0.33	0.21	0.44	108.58	361.48	1.14	1.95	27.06	69.67	69.67
0.06	0.07	0.04	0.05	0.03	0.03	0.15	0.26	0.19	0.34	239.07	312.23	1.04	1.84	20.03	31.68	57.88	57.88
0.06	0.05	0.05	0.04	0.04	0.04	0.15	0.48	0.24	148.65	255.7	0.96	1.72	17.38	28.78	29.87	40.09	170.83
0.06	0.05	0.05	0.04	0.04	0.05	0.09	0.4	0.25	148.03	1.54	1.58	16.2	23.3	28.91	21.81	242.47	242.47
0.04	0.05	0.04	0.05	0.04	0.04	0.1	0.54	0.25	0.98	5.68	14.72	20.96	25.86	19.99	34.01	371.39	371.39
0.06	0.07	0.04	0.06	0.03	1.38	0.04	0.54	0.25	1.36	11.94	18.35	14.26	16.66	20.14	111.96	579.47	579.47
0.06	0.06	0.05	0.05	1.68	1.57	0.04	0.28	0.27	5.29	6.63	9.39	13.2	16.3	240.06	839.86	913.91	1378.71
0.05	0.06	0.06	0.04	2	0.64	0.07	0.28	0.3	9.53	3.81	14.58	18.16	99.47	1233.59	1347.93	1606.58	1606.58
0.05	0.05	0.05	0.04	2	0.54	0.06	0.27	0.31	3.55	15.45	147.67	186.36	906.46	1438.31	1549.54	1629.59	1629.59
0.05	0.04	0.05	0.04	1.84	1.4	0.06	0.46	141.78	2.61	503.52	768.54	1010.36	1080.51	1316.28	1517.89	1565.86	1565.86
0.05	0.04	0.04	0.04	0.03	0.92	0.06	0.36	142.16	13.43	7.72	149.96	614.16	944.07	1659.87	1807.24	2001.91	2001.91
0.04	0.04	0.03	0.04	0.04	0.92	0.06	0.28	0.98	70.29	77.41	367.78	1116.36	1388.46	1858.74	2101.21	2101.21	2164.71
0.04	0.04	0.03	0.03	0.04	0.36	0.08	0.2	148.03	13.82	113.8	801.66	958.08	1360.51	1808.65	2111.74	2111.74	2264.32
0.03	0.03	0.03	0.03	0.04	0.2	0.08	0.21	159.76	3.03	150.09	763.98	1403.76	2377.16	2641.25	2733.76	2957.41	2956.4
0.03	0.03	0.03	0.03	0.03	0.12	0.08	0.27	191.32	6.63	222.65	1774.46	2267.01	2821.8	3030.35	3156.89	3156.89	3162.41
0.03	0.04	0.03	0.02	0.02	0.12	0.08	0.26	207.45	15.76	686.9	2253.75	2924.93	3122.77	3377.7	3442.28	3442.28	3470.13
0.04	0.04	0.03	0.02	2	0.12	0.07	112.8	177.37	16.71	882.51	2951.06	3107.73	3278.68	3530.38	3588.14	3588.14	3588.14
0.04	0.04	0.03	0.02	1.74	0.16	0.08	112.77	1.46	8.63	1198.09	3039.1	3128.13	3472.3	3648.24	3723.04	3837	3837
0.03	0.04	0.04	0.04	0.95	0.17	0.09	124.4	1.53	13.9	1519.83	2876.08	3166.34	3431.71	3765.43	4007.82	4007.82	4007.82
0.04	0.04	0.05	0.05	0.16	0.17	0.28	130.19	1.55	17.68	1213.81	3039.1	3118.68	3463.34	3864.2	4216.43	4216.43	4284.1
0.04	0.04	0.05	0.07	0.06	0.17	0.28	141.78	5.68	13.9	794.08	3064.54	3133.58	4063.97	4247.41	4430.94	4439.45	4439.45
0.04	0.04	0.03	0.05	0.06	0.17	0.48	159.66	5.68	9.39	403.97	2957.04	3864.3	4308.93	4505.59	4618.61	4617.86	4617.86
0.04	0.04	0.04	0.04	0.04	0.17	0.48	159.98	11.94	11.82	482.14	3042.22	4092.35	4386.05	4674.11	4732.87	4744.96	4744.96
0.04	0.04	0.03	0.03	0.03	0.07	0.47	153.89	12.64	11.69	526.6	2998.68	3995.46	4523.01	4772.6	4798	4821.54	4821.54
0.05	0.04	0.03	0.03	0.03	0.07	0.47	0.98	5.64	10.87	676.97	3054.57	4236.22	4683.02	4823.21	4848.21	4869.79	4869.79
0.05	0.04	0.03	0.03	0.04	0.13	0.37	1.36	11.06	20.34	752.77	3054.57	4438.8	4849.04	4921.38	4936.94	4956.33	4956.33
0.03	0.04	0.03	0.04	0.06	0.18	0.36	5.29	15.91	179.91	1116.36	3166.34	4568.72	4941.53	5030.32	5062.71	5097.77	5047.7
0.04	0.04	0.04	0.04	0.06	0.17	0.28	9.08	115.43	710.47	828.58	3233.36	4666.69	4997.39	5127.6	5162.7	5197.8	5147.79
0.04	0.04	0.04	0.04	0.06	0.07	0.2	3.23	526.55	982.79	904.85	3243.57	4764.66	5154.54	5226.67	5311.94	5311.94	5262.73
0.04	0.04	0.03	0.04	0.05	0.08	0.19	3.66	548.51	813.51	763.14	3146.89	4793.24	5302.06	5391.53	5456.74	5472.84	5362.45
0.04	0.03	0.03	0.04	0.05	0.08	0.19	2.57	16.99	367.7	1068.14	3179.86	4885.07	5445.36	5597.11	5677.67	5677.67	5456.74
0.03	0.03	0.03	0.03	0.05	0.07	0.25	3.93	149.9	572.95	1332.58	3243.03	4965.22	5588.66	5715.92	5730.29	5730.29	5597.11
0.03	0.02	0.03	0.03	0.65	0.04	0.25	3.96	150.09	676.97	1277.9	3389.6	4997.39	5712.17	5730.29	5730.29	5730.29	5715.92
0.02	0.04	0.03	1.52	0.42	0.06	0.25	10.77	645.41	942.93	1226.67	3441.16	5058.09	5727.4	5730.29	5730.29	5730.29	5715.92
0.04	0.03	0.02	1.55	0.15	0.08	101.21	13.51	222.65	958.08	1450.09	3483.98	5058.09	5727.4	5727.4	5730.29	5730.29	5592.88
0.03	0.04	0.02	1.55	0.18	0.08	0.25	15.19	295.22	910.96	1957.67	3483.98	5045.52	5673.06	5727.4	5730.29	5715.92	5379.04
0.04	0.04	0.02	1.4	0.08	0.09	0.25	16.78	331.5	1903.94	2549.45	3499.55	5003.48	5379.04	5521.24	5592.88	5456.74	5140.32
0.03	0.09	0.02	1.4	0.07	0.09	0.27	17.56	798.4	2197.04	2897.43	3499.55	4797.33	5077.71	5177.53	5277.4	5127.6	4969.25
0.07	0.07	2.32	0.43	0.07	0.2	0.24	9.47	794.08	2267.01	2981.46	3421.37	4618.16	4810.87	4921.38	5030.32	4879.68	4783.09
0.07	0.19	2.32	0.43	0.07	0.2	0.31	8.63	750.2	2628.91	3085.68	3421.37	3836.9	4420.15	4704.91	4810.87	4704.91	4704.91
2.67	1.98	3.08	0.43	0.09	0.2	0.33	7.91	1554.57	2924.93	3311.75	3421.37	3648.24	3836.9	4247.41	4505.59	4247.41	4618.16
2.67	1.98	3.08	0.78	0.09	0.27	1.41	13.18	1691.84	3090.92	3349.97	3421.37	3530.38	3648.24	3765.43	3836.9	3725.23	4505.59
3.64	2.38	3.13	0.31	0.09	0.52	1.41	17.24	2131.04	3198.71	3499.55	3530.38	3530.38	3560.2	3648.24	3648.24	3560.2	4505.59
4.28	2.9	1.6	0.18	0.2	0.39	148.65	17.24	2131.04	3198.71	3483.98	3560.2	3595.62	3560.2	3595.62	3560.2	3560.2	4505.59
0.31	2.9	3.14	0.1	0.26	0.31	148.91	17.24	1774.46	3128.13	3565.98	3648.24	3686.5	3686.5	3686.5	3648.24	3648.24	4420.15
2.92	2.9	0.24	0.18	0.45	0.32	148.03	17.68	792.91	3128.13	3625.03	3765.43	3836.1	3836.1	3781.12	3781.12	3725.23	4420.15

4.28	2.38	0.27	0.16	0.4	0.34	148.03	14.58	860.98	3185.58	3666.93	3836.9	3922.36	3922.36	3922.36	3836.9	3836.9	4081.39
2.9	2.96	0.35	0.24	0.19	0.36	1.05	18.57	903.02	3182.63	3690.25	3864.2	3958.77	3958.77	3958.77	3864.2	3864.2	3836.9
2.59	2.59	2.65	4.23	0.08	0.15	1.39	19.01	950.53	3174.94	3960.5	4081.39	4148.91	4148.91	4148.91	4081.39	4081.39	3765.43
4.58	4.58	4.25	4.95	0.09	0.14	5.35	160.57	873.25	3133.58	4171.04	4247.41	4289.1	4289.1	4289.1	4247.41	4247.41	3725.23
3.74	3.92	4.25	2.69	0.18	0.15	5.35	648.19	1843.64	3864.3	4387.66	4505.59	4512.25	4512.25	4512.25	4505.59	4420.15	3725.23
2.97	2.97	2.65	0.08	0.38	0.15	9.5	648.19	2126.32	4120.75	4576.51	4618.16	4618.61	4618.61	4618.16	4618.16	4618.16	3765.43
2.04	2.04	0.39	0.25	0.25	0.21	9.11	817.73	2194.53	4123.97	4594.36	4674.11	4688.46	4688.46	4674.11	4674.11	4674.11	3836.9
0.97	0.97	0.58	0.25	0.1	0.21	8.72	673.67	2267.01	4123.97	4609.39	4704.91	4704.91	4732.87	4704.91	4704.91	4704.91	3864.2
0.34	0.97	0.28	0.25	0.08	0.25	6.29	149.96	2197.04	4040.16	4664.96	4772.6	4772.6	4798	4772.6	4754.98	4754.98	4505.59
0.42	0.42	0.34	0.25	0.09	0.26	3.23	149.96	2628.91	4183.82	4753.71	4810.87	4810.87	4831.83	4810.87	4810.87	4783.09	4754.98
0.19	0.19	0.19	0.26	0.09	37.45	3.55	331.11	3090.92	4399.76	4768.75	4823.21	4823.21	4848.21	4823.21	4823.21	4797.33	4797.33
0.26	0.26	0.26	0.24	0.11	25.85	2.65	367.78	3198.71	4471.67	4835.97	4879.68	4879.68	4879.68	4879.68	4879.68	4860.29	4860.29
0.26	0.31	0.25	0.24	0.15	0.24	2.71	403.97	3198.71	4568.72	4891.69	4921.38	4921.38	4921.38	4921.38	4908.01	4908.01	4908.01
0.31	0.31	0.29	0.25	0.16	0.24	9.23	921.44	3125.28	4597.29	4931.01	4988.12	4988.12	4988.12	4988.12	4941.23	4941.23	4908.01
0.28	0.28	0.25	0.19	0.1	0.24	3.36	830.45	2990.88	4625.87	4984.76	5030.32	5030.32	5030.32	5030.32	4969.25	4941.23	4908.01
0.24	0.24	0.19	0.14	0.08	31.65	3.81	935.88	2990.88	4695.26	5017.29	5077.71	5077.71	5077.71	5077.71	5045.52	4969.25	4908.01
0.21	0.24	0.19	0.13	0.08	37.45	7.72	935.88	3171.73	4862.1	5090.47	5127.6	5127.6	5127.6	5127.6	5090.47	4969.25	4908.01
0.23	0.25	0.2	0.14	0.09	43.2	8.27	839.5	3311.65	4960.69	5140.32	5177.53	5177.53	5177.53	5177.53	5140.32	5003.48	4908.01
0.22	0.23	0.22	0.19	0.24	43.2	8.82	839.5	3307	5024.37	5249.96	5277.4	5226.67	5226.67	5226.67	5192.01	5003.48	4908.01
0.24	0.24	0.25	0.14	0.1	0.32	7.91	1328.45	3350.62	5078.88	5311.7	5331.93	5331.93	5331.93	5277.4	5311.7	5045.52	4908.01
0.25	0.24	0.21	0.11	0.22	0.8	7.91	1843.64	3389.6	5154.54	5379.04	5391.53	5391.53	5391.53	5391.53	5379.04	5090.47	4908.01
0.24	0.25	0.21	0.25	0.2	0.88	7.27	2126.32	3428.57	5233.61	5449.59	5521.24	5525.46	5456.74	5456.74	5449.59	5140.32	4908.01
0.21	0.21	0.26	0.19	0.23	0.88	8.82	2126.32	3441.16	5373.71	5592.88	5673.06	5673.06	5597.11	5521.24	5521.24	5192.01	4941.23
0.24	0.24	0.3	0.12	0.23	0.8	8.82	2194.53	3465.65	5373.71	5712.17	5727.4	5727.4	5727.4	5592.88	5521.24	5249.96	4969.25
0.24	0.24	0.31	0.16	0.11	4.36	9.47	2628.91	3465.65	5373.71	5727.4	5727.4	5727.4	5727.4	5673.06	5592.88	5249.96	5003.48
0.34	0.34	0.32	0.29	0.21	0.64	8.63	2924.93	3465.65	5449.59	5727.4	5727.4	5727.4	5727.4	5712.17	5673.06	5249.96	5090.47
0.34	0.34	0.32	0.32	0.2	0.59	6.93	3090.92	3499.55	5449.59	5727.4	5727.4	5727.4	5727.4	5727.4	5673.06	5311.7	5192.01
0.34	0.34	0.34	0.33	0.26	0.24	13.9	3125.28	3523.63	5592.88	5727.4	5727.4	5727.4	5727.4	5727.4	5712.17	5311.7	5249.96
0.34	0.34	0.43	0.43	0.26	0.64	14.58	3219.58	3523.63	5449.59	5727.4	5727.4	5727.4	5727.4	5673.06	5673.06	5379.04	5249.96
0.31	0.34	0.6	0.73	0.3	4.22	7.72	3125.28	3648.24	5140.32	5673.06	5727.4	5727.4	5727.4	5311.7	5673.06	5449.59	5249.96
0.24	0.34	0.6	0.73	1.47	0.76	10.19	3145.95	3648.24	4823.21	5045.52	5277.4	5391.53	5311.7	5003.48	5592.88	5449.59	5249.96
1.71	1.71	2.59	1.87	1.4	0.67	10.19	3145.95	3725.23	4505.59	4754.98	4879.68	4988.12	4941.23	4783.09	5592.88	5521.24	5311.7
4.94	4.94	2.09	7.26	1.2	1.04	7.72	3272.68	3725.23	3864.2	4247.41	4674.11	4754.98	4704.91	4618.16	5592.88	5592.88	5379.04
0.43	4.94	5.96	5.96	1.14	1.01	7.72	3307	3765.43	3836.9	3922.36	4148.91	4430.94	4247.41	4247.41	5592.88	5673.06	5449.59
0.46	0.46	10.01	10.01	0.41	1.23	13.9	3376.72	3836.9	3922.36	3922.36	3958.77	3958.77	3864.2	4081.39	5521.24	5673.06	5449.59
0.46	0.46	10.01	15.51	0.41	1.35	18.12	3334.01	3864.2	3958.77	3958.77	3958.77	3958.77	3958.77	4081.39	5379.04	5712.17	5521.24
0.39	0.39	0.39	15.51	0.33	1.88	154.12	3244.9	3864.2	3958.77	3958.77	3958.77	3958.77	3958.77	4247.41	5249.96	5712.17	5521.24
0.33	0.33	0.33	21.02	0.46	2.07	648.19	3231.2	4081.39	4081.39	4148.91	4148.91	4148.91	4148.91	4247.41	5090.47	5712.17	5592.88
0.33	0.33	0.33	0.23	0.61	7.29	866.93	3231.2	4247.41	4247.41	4289.1	4289.1	4289.1	4247.41	4081.39	4941.23	5673.06	5673.06
0.28	0.23	0.23	0.23	0.64	7.29	716.56	3253.77	4420.15	4420.15	4289.1	4289.1	4289.1	4247.41	4081.39	4797.33	5521.24	5712.17
0.23	0.23	0.18	0.18	1.03	11.12	716.56	3594.63	4420.15	4420.15	4430.94	4430.94	4430.94	4420.15	4081.39	4754.98	5379.04	5727.4
0.23	0.23	0.18	1.46	1.06	11.12	216.68	3952.82	4505.59	4505.59	4505.59	4505.59	4512.25	4505.59	4247.41	4618.16	5249.96	5727.4
0.28	0.28	1.46	1.46	2.9	13.84	403.5	4027.11	4608.83	4618.16	4618.16	4618.16	4618.16	4618.16	4505.59	4420.15	5090.47	5712.17
0.27	0.28	0.27	4.58	3.74	229.55	403.97	4233.15	4643.82	4674.11	4674.11	4674.11	4674.11	4674.11	4618.16	4247.41	4941.23	5592.88
0.27	0.27	0.27	0.27	4.39	257.56	453.58	4308.93	4662.04	4704.91	4704.91	4704.91	4704.91	4674.11	4674.11	4081.39	4797.33	5449.59
0.33	0.33	0.33	0.5	3.06	270.35	453.58	4367.73	4662.04	4704.91	4704.91	4704.91	4704.91	4704.91	4704.91	4247.41	4754.98	5311.7
0.5	0.33	0.33	0.43	3.16	270.35	439.43	4435.55	4710.71	4754.98	4754.98	4754.98	4785.38	4754.98	4704.91	4505.59	4618.16	5140.32
0.41	0.29	0.29	0.43	11.59	258.61	439.43	4435.55	4740.38	4772.6	4772.6	4772.6	4798	4772.6	4704.91	4618.16	4420.15	5003.48
0.41	0.29	0.39	0.49	23.95	270.31	519.27	4463.48	4783.09	4810.87	4831.83	4831.83	4831.83	4810.87	4704.91	4674.11	4247.41	4860.29
0.49	0.39	0.39	0.55	35.65	6.84	1034.35	4501.08	4783.09	4823.21	4848.21	4848.21	4848.21	4823.21	4704.91	4704.91	4081.39	4740.38
0.58	0.39	0.39	0.58	35.65	6.84	942.93	4577.05	4797.33	4879.68	4898.46	4898.46	4848.21	4823.21	4704.91	4704.91	4081.39	4704.91
2.31	2.33	2.43	2.60	2.93	2.48	2.61	2.67	2.94	2.53	2.35	3.84	27.36	58.70	62.33	83.38	98.26	101.74
2.37	2.40	2.54	2.65	2.88	2.39	2.36	2.74	2.94	2.49	2.45	4.20	26.59	55.90	58.86	79.63	94.07	98.18
2.42	2.49	2.69	2.59	2.50	2.40	2.19	2.60	2.87	2.44	2.69	4.91	25.21	50.12	52.69	73.06	86.51	91.64
2.53	2.61	2.92	2.56	2.37	2.43	2.06	2.43	2.64	2.59	3.46	6.16	23.33	43.02	46.23	65.42	77.07	83.43
2.64	2.71	3.15	2.48	2.20	2.39	1.96	2.22	2.45	3.07	4.99	7.94	21.21	36.01	42.51	58.34	67.65	75.44
2.80	2.79	3.32	2.38	2.10	2.34	1.92	2.20	2.54	4.23	7.19	10.03	18.96	30.93	42.88	53.24	60.43	74.24
3.00	2.85	3.36	2.30	2.03	2.25	1.99	2.22	2.79	5.67	9.22	11.59	16.51	28.79	45.47	50.83	57.44	84.25
3.26	2.94	3.28	2.33	1.98	2.16	2.36	3.06	3.77	7.13	10.77	12.38	14.68	27.94	47.81	52.20	59.79	106.45
3.54	3.06	3.14	2.59	2.12	2.37	3.54	5.41	5.66	8.51	11.54	12.27	13.68	28.62	50.73	58.38	67.94	132.77
3.80	3.20	3.06	3.08	2.78	3.40	5.80	9.17	8.54	9.67	12.15	11.84	13.50	30.50	56.43	69.44	81.22	157.99
4.00	3.32	3.16	3.93	4.22	5.26	8.88	13.21	11.85	10.93	12.65	11.27	14.72	35.15	68.94	91.79	106.06	183.03
4.11	3.42	3.48	5.01	6.46	8.19	12.04	16.22	15.25	12.41	12.91	11.34	17.03	43.86	91.63	126.57	142.61	210.82
4.07	3.59	3.94	6.09	8.80	11.15	14.56	18.05	18.38	14.40	13.33	11.91	21.43	58.06	129.54	174.72	190.28	241.17
3.91	3.92	4.41	6.59	10.46	14.07	16.36	19.24	21.70	16.40	13.85	14.02	27.85	79.56	188.66	234.94	242.61	284.31
4.32	4.56	4.73	6.49	10.65	14.96	16.95	20.50	24.74	18.34	14.72	17.53	36.87	105.37	258.53	303.77	304.16	343.14
5.44	5.39	4.90	5.98	9.69	14.26	16.63	21.82	27.33	19.62	15.83	22.34	48.63	133.73	321.68	374.96	375.00	419.89
7.02	6.36	4.97	5.57	8.13	11.80	15.34	23.21	29.14	20.42	16.93	27.83	62.81	160.49	351.76	434.11	465.46	508.23
7.68	7.12	5.06	5.28	6.97	9.91	14.23	24.52	30.05	20.38	18.08	33.70	79.00	187.84	363.67	491.91	570.80	611.47
7.28	7.65	5.26	5.12	6.23	8.68	13.50	25.68	30.44	19.84	18.97	38.92	96.84	219.37	375.29	556.79	686.25	721.81

6.24	7.84	5.62	4.98	6.04	8.72	13.65	26.54	30.04	18.77	19.35	43.80	115.37	262.70	424.60	644.73	785.21	815.12
5.42	7.78	6.08	4.87	6.13	9.28	14.16	27.15	29.00	17.52	19.76	47.83	138.03	328.80	497.29	723.12	844.09	862.40
4.92	7.47	6.55	4.80	6.62	10.63	15.07	27.52	27.32	15.93	19.96	51.79	164.08	419.01	614.57	813.02	896.15	902.45
4.64	6.96	6.95	4.79	7.29	12.12	16.10	27.87	25.30	14.52	20.52	56.96	198.48	533.29	744.17	890.70	950.92	949.04
4.50	6.38	7.17	4.96	8.19	13.70	17.57	28.30	23.20	13.24	21.66	65.30	242.97	649.66	856.29	961.97	1017.47	1009.71
4.44	5.80	7.35	5.65	9.40	15.02	19.15	28.68	20.87	12.59	23.85	79.37	303.51	762.03	939.35	1025.49	1088.08	1072.50
4.43	5.33	7.45	6.83	11.11	16.53	21.18	29.43	18.65	12.49	27.43	99.35	377.71	847.45	979.91	1083.33	1153.01	1124.82
4.77	5.03	7.62	8.38	13.02	17.98	23.36	30.27	16.85	13.26	32.84	125.46	463.58	908.15	1022.69	1158.78	1223.99	1178.23
5.50	4.99	7.72	9.77	14.94	19.49	25.89	30.84	15.30	15.09	42.49	164.50	569.67	970.50	1090.50	1263.31	1307.65	1237.36
6.68	5.17	7.79	10.95	16.73	20.95	28.05	31.08	14.20	18.66	60.00	206.19	652.79	1024.61	1187.86	1386.64	1389.51	1281.80
7.66	5.53	7.70	11.86	18.36	22.48	30.59	30.95	13.29	24.55	82.86	247.92	719.46	1099.51	1329.83	1539.54	1499.87	1335.63
8.32	5.96	7.55	12.43	19.46	23.74	32.97	30.89	12.83	33.26	113.23	299.19	781.76	1205.95	1504.90	1705.49	1639.84	1410.44
8.56	6.59	7.56	12.57	19.70	24.27	35.20	30.30	13.22	44.44	147.92	372.37	898.35	1348.62	1685.40	1858.56	1798.11	1510.43
8.68	7.34	7.90	12.44	19.07	23.79	35.73	29.40	14.31	56.78	176.01	441.91	1001.12	1543.53	1876.90	2014.49	1972.53	1656.59
8.72	8.17	8.58	12.43	18.01	22.79	34.97	28.31	16.10	68.71	209.74	555.22	1125.36	1719.31	2025.43	2141.99	2119.77	1796.20
8.76	8.84	9.73	12.96	17.01	21.63	32.65	26.94	18.38	79.67	268.09	684.66	1248.10	1895.24	2182.16	2290.36	2280.91	1970.73
8.81	9.40	11.27	13.83	16.42	20.87	30.51	25.53	21.43	94.65	334.02	813.89	1402.30	2013.33	2306.96	2420.53	2421.38	2133.50
8.89	9.79	12.91	14.79	16.29	20.37	28.81	23.86	25.54	117.54	434.74	924.09	1531.98	2126.59	2453.64	2565.89	2576.11	2322.48
8.99	9.94	13.48	15.28	16.57	20.34	28.18	22.49	32.02	155.28	548.62	1021.18	1641.56	2230.54	2601.02	2708.78	2723.00	2498.54
9.11	9.86	13.01	15.48	17.19	20.64	28.28	21.43	40.54	203.70	631.28	1100.25	1762.19	2382.92	2787.51	2875.60	2893.31	2685.12
9.22	9.86	12.35	15.63	18.04	21.25	29.14	20.71	49.98	259.20	717.64	1193.15	1889.75	2573.20	2989.45	3044.52	3064.46	2860.55
9.31	10.13	12.71	16.10	18.83	21.76	29.84	20.12	59.51	315.37	775.89	1297.56	2057.98	2706.35	3109.24	3156.54	3178.90	2979.87
9.35	10.77	14.10	16.65	19.33	22.04	30.02	19.38	67.90	370.12	815.41	1390.40	2212.95	2899.93	3280.14	3279.82	3300.02	3109.15
10.06	11.82	15.35	16.97	19.50	22.01	30.26	19.01	76.14	422.28	842.69	1505.58	2409.09	3119.72	3475.94	3433.01	3445.28	3267.93
11.44	13.13	16.02	16.92	19.44	21.95	30.49	18.92	85.97	468.41	875.38	1614.57	2609.99	3325.35	3659.58	3583.42	3583.33	3426.04
13.50	14.48	16.03	16.57	19.29	22.09	31.42	19.53	98.89	514.39	942.01	1732.91	2789.53	3495.38	3798.44	3701.02	3683.08	3563.35
14.82	15.20	15.86	16.13	19.17	22.67	32.31	20.74	113.25	553.00	1028.34	1880.10	2944.13	3627.37	3887.84	3779.36	3736.59	3664.70
15.38	15.36	15.58	15.67	19.14	23.59	33.41	22.08	130.29	597.18	1123.46	2054.72	3111.07	3757.03	3966.99	3854.85	3778.29	3752.10
15.22	15.15	15.30	15.30	19.22	24.70	33.82	24.07	147.81	630.00	1264.67	2237.04	3274.06	3870.10	4032.51	3920.54	3801.97	3799.51
15.08	15.00	15.08	15.03	19.62	25.87	33.65	26.16	169.28	680.28	1386.20	2460.63	3454.52	3998.74	4123.12	4010.70	3848.79	3844.13
15.06	15.00	15.00	14.97	20.01	26.76	33.02	28.87	191.62	738.63	1552.04	2662.64	3614.55	4115.97	4216.67	4101.90	3901.12	3870.66
15.03	15.03	14.95	15.02	20.27	26.90	32.07	31.47	219.75	779.25	1700.75	2843.61	3749.48	4223.46	4314.31	4192.59	3965.22	3894.75
14.91	15.02	14.98	15.15	20.19	26.05	30.76	34.31	243.83	852.67	1838.46	2998.39	3849.69	4306.22	4399.68	4270.02	4029.30	3915.84
15.03	15.13	15.09	15.30	19.96	24.82	28.95	37.84	272.55	918.62	1975.82	3099.06	3941.93	4382.29	4486.07	4350.68	4110.66	3961.76
15.01	14.81	14.35	15.09	19.85	24.03	27.35	42.14	291.93	968.30	2096.66	3182.46	3986.32	4400.63	4516.14	4382.89	4153.56	3985.26
15.11	14.27	13.00	14.35	19.82	23.74	26.01	46.44	325.21	1005.42	2201.64	3256.71	4010.19	4393.05	4519.07	4398.13	4185.76	4012.77
14.98	13.19	10.81	13.24	20.02	23.95	25.27	50.89	350.18	1079.73	2281.42	3314.65	3985.13	4335.38	4469.84	4372.46	4179.20	4012.59
14.97	12.53	9.33	12.54	20.51	24.75	24.81	55.36	384.43	1119.53	2358.21	3337.29	3957.94	4279.55	4346.96	4282.13	4108.15	3951.34
14.91	12.33	8.89	12.66	21.41	26.19	25.18	61.83	413.73	1161.24	2382.87	3356.18	3957.92	4250.88	4313.52	4286.10	4130.80	3985.12
14.87	12.81	9.81	13.68	22.39	27.86	25.76	69.75	461.83	1198.96	2434.14	3376.96	3975.94	4239.53	4290.78	4299.51	4163.59	4028.78
14.88	13.69	11.60	15.24	23.39	29.62	27.38	79.26	484.53	1277.43	2470.76	3427.09	4007.44	4244.39	4279.27	4317.70	4203.39	4080.64
15.29	14.91	14.05	16.87	24.41	31.69	29.59	90.58	533.60	1354.49	2551.74	3506.99	3993.97	4209.40	4226.00	4284.70	4195.36	4084.45
16.19	16.36	16.43	18.53	25.70	34.36	31.74	101.91	565.49	1439.86	2641.33	3553.74	4026.67	4225.66	4225.37	4295.27	4233.61	4132.55
17.67	18.10	18.71	20.03	26.94	37.23	33.29	114.09	617.06	1540.81	2729.54	3598.08	4066.29	4256.93	4243.45	4318.05	4284.34	4190.26
18.97	19.58	20.38	21.37	27.99	39.51	34.61	126.12	671.42	1654.32	2812.95	3610.61	4078.98	4274.24	4252.74	4328.72	4319.96	4232.16
19.84	20.64	21.61	22.42	28.63	40.92	35.67	143.30	744.82	1722.17	2882.70	3606.66	4070.26	4288.75	4264.82	4340.98	4351.28	4274.32
20.16	21.11	22.16	23.24	29.09	41.58	36.80	162.73	804.28	1778.80	2930.38	3553.43	3984.81	4246.24	4223.75	4299.51	4321.89	4262.37
20.41	21.44	22.44	23.83	29.45	42.21	38.19	185.38	863.84	1818.70	2964.55	3495.60	3890.93	4172.87	4152.60	4226.77	4255.53	4219.05
20.92	21.92	22.77	24.40	29.88	43.22	40.12	208.70	921.42	1874.92	2998.16	3450.62	3813.54	4113.72	4093.33	4163.74	4196.22	4181.19
21.95	22.85	23.54	25.13	30.50	44.82	42.78	229.09	981.45	1949.81	3039.98	3448.76	3799.03	4101.84	4079.36	4143.00	4180.11	4181.06
23.42	24.17	24.78	26.02	31.00	46.26	46.09	246.04	1042.10	2043.11	3086.73	3454.62	3781.86	4082.71	4058.93	4112.46	4157.33	4167.13
25.00	25.65	26.19	26.87	31.45	47.34	50.09	256.45	1076.30	2159.67	3146.00	3475.07	3757.71	4061.17	4042.47	4082.75	4138.50	4153.74
26.27	26.92	27.36	27.47	31.40	47.55	54.41	265.81	1132.23	2278.46	3206.40	3502.57	3717.72	4018.87	4015.73	4040.37	4107.85	4128.32
27.21	27.93	28.11	27.85	31.19	47.50	59.56	278.60	1184.00	2391.59	3259.92	3533.51	3667.93	3954.20	3979.28	3987.15	4063.71	4091.96
27.98	28.83	28.56	28.21	30.85	46.85	64.68	301.01	1249.88	2507.05	3324.08	3585.41	3756.00	4007.78	4071.22	4063.53	4143.16	4182.31
28.84	29.80	28.92	28.79	30.47	45.06	69.65	329.88	1312.90	2616.39	3386.79	3637.51	3736.68	3940.82	4046.48	4028.29	4102.89	4154.79
29.89	30.89	29.42	29.63	30.22	42.84	74.14	363.46	1373.34	2750.97	3485.05	3722.30	3761.62	3909.76	4054.16	4035.25	4096.61	4160.30
31.12	31.98	30.06	30.62	30.36	41.20	78.72	400.48	1427.81	2853.79	3556.86	3775.09	3768.63	3860.48	4032.00	4026.04	4067.72	4138.82
32.50	32.99	30.88	31.76	30.94	40.60	83.38	435.45	1485.18	2951.85	3629.85	3830.26	3789.13	3828.79	4010.77	4031.84	4050.64	4121.86
33.92	33.86	31.80	32.99	31.57	40.15	87.64	455.48	1539.45	3079.50	3733.81	3919.00	3856.22	3854.48	4026.12	4085.06	4082.38	4145.17
35.26	34.63	32.81	34.27	32.25	39.92	92.30	483.34	1602.30	3160.04	3795.83	3970.55	3896.41	3866.82	4010.38	4110.38	4093.14	4140.03
36.43	35.36	33.85	35.49	33.01	40.08	97.39	515.65	1672.59	3227.48	3849.86	4015.26	3938.71	3894.55	3997.78	4133.83	4114.39	4141.07
37.37	36.13	34.97	36.78	34.12	41.33	102.25	556.89	1741.90	3302.01	3914.84	4105.40	4032.73	3984.79	4046.03	4204.38	4198.51	4204.62
38.14	37.03	36.28	38.28	35.39	42.79	106.68	575.47	1820.55	3355.69	3954.77	4127.32	4063.16	4016.97	4041.09	4204.12	4226.85	4215.46
39.07	38.42	38.09	40.19	36.80	44.74	109.76	614.20	1884.38	3412.38	3993.43	4149.79	4097.16	4054.41	4052.08	4200.43	4262.35	4239.22
41.19	40.95	41.06	43.13	38.23	46.58	111.81	648.90	1975.13	3466.93	4029.95	4175.27	4135.61	4094.60	4075.68	4194.77	4298.22	4271.69
45.27	44.88	45.41	47.36	40.02	48.75	113.11	669.07	2047.05	3512.80	4065.75	4199.93	4173.31	4133.85	4106.74	4187.45	4326.60	4307.72
51.30	50.00	49.82	51.62	41.98	50.32	112.11	690.74	2154.65	3558.56	4113.75	4235.93	4220.08	4181.90	4150.54	4193.11	4354.06	4355.64
57.52	55.19	53.74	54.88	43.83	50.87	113.21	716.72	2235.65	3596.23	4161.97	4270.09	4262.96	4226.62	4193.37	4203.52	4369.11	4402.96
62.37	59.76	55.56	55.41	45.62	51.92	116.04	764.39	2312.36	3633.82	4210.07	4306.01	4307.30	4271.56	4237.51	4226.10	4377.82	4451.99

65.10	63.15	57.69	55.63	47.61	54.76	124.09	798.22	2389.11	3673.64	4247.84	4333.35	4346.47	4310.87	4277.63	4254.28	4378.32	4493.70
66.63	65.55	59.20	55.72	50.06	59.64	136.60	849.91	2470.30	3719.08	4278.16	4357.37	4383.34	4345.75	4313.98	4286.41	4373.91	4523.96
67.80	67.24	62.42	58.33	52.75	64.28	153.74	895.07	2584.87	3763.04	4302.84	4380.82	4413.01	4371.41	4340.57	4311.64	4362.47	4529.79
69.13	68.57	65.27	61.50	55.11	67.02	176.43	969.49	2620.56	3799.79	4328.02	4413.02	4436.95	4388.17	4356.08	4326.88	4345.81	4503.46
70.53	69.64	68.01	64.92	56.59	67.28	199.96	1010.63	2674.73	3828.06	4355.98	4453.10	4456.20	4398.62	4362.45	4332.86	4329.60	4445.43
71.88	70.45	69.27	66.95	57.53	65.56	223.11	1044.07	2700.94	3834.41	4368.30	4478.35	4459.08	4393.73	4350.55	4321.28	4304.52	4362.23
73.05	71.04	69.83	68.18	58.56	64.00	248.26	1072.17	2686.59	3793.34	4333.83	4453.84	4420.12	4351.45	4299.13	4270.33	4247.36	4252.74
73.99	71.54	70.22	69.13	59.76	63.35	269.29	1101.49	2685.40	3727.55	4270.57	4397.15	4360.68	4296.51	4234.60	4205.63	4179.41	4158.13
74.84	72.22	70.99	70.28	61.10	64.14	290.35	1135.70	2700.81	3660.92	4201.03	4333.81	4301.06	4250.04	4181.76	4150.58	4122.64	4094.68
75.68	73.13	72.15	71.63	62.05	64.83	321.67	1175.27	2704.94	3629.63	4159.55	4296.32	4269.35	4239.00	4171.40	4135.53	4106.25	4081.34
76.62	74.24	73.61	73.01	62.49	64.93	360.84	1226.77	2695.82	3580.13	4093.92	4233.69	4210.64	4200.18	4139.94	4096.93	4067.40	4044.38
77.43	75.17	74.98	74.27	62.32	63.09	409.04	1290.62	2630.51	3492.00	3985.23	4124.75	4104.96	4106.66	4055.46	4003.25	3973.92	3951.40
78.12	75.87	76.20	75.21	61.74	60.53	464.14	1369.62	2659.54	3479.83	3949.72	4088.64	4073.49	4074.79	4028.74	3965.79	3936.18	3912.70
78.60	76.34	77.25	75.82	60.90	57.80	521.24	1464.23	2753.59	3535.20	3978.77	4115.11	4109.11	4103.25	4059.52	3985.69	3953.88	3928.98
78.18	75.98	77.50	75.67	60.25	56.94	590.09	1566.98	2853.86	3582.94	3835.38	3968.23	3977.75	3963.21	3922.93	3840.49	3803.96	3777.27
76.84	74.85	76.93	75.01	60.50	57.96	653.40	1678.34	2952.24	3613.84	3831.54	3959.20	3991.68	3971.69	3938.19	3851.96	3808.07	3781.12
74.62	72.93	75.47	74.20	61.35	60.22	723.22	1793.27	3042.25	3628.17	3811.11	3932.27	3991.39	3968.79	3942.52	3859.02	3805.76	3779.79
73.12	71.70	74.59	74.25	62.89	64.71	830.99	1920.26	3133.73	3643.40	3796.62	3908.82	3992.94	3970.28	3948.64	3874.52	3810.61	3785.74
72.36	71.07	74.24	75.09	65.15	71.10	924.41	2060.66	3237.95	3679.02	3807.54	3907.44	4008.57	3987.71	3967.00	3907.77	3833.12	3806.70
72.37	71.04	74.46	76.29	67.63	79.75	1019.87	2187.11	3336.02	3721.76	3829.25	3913.83	4022.76	4004.80	3982.50	3941.25	3856.95	3825.51
72.34	70.93	74.54	77.23	70.05	90.81	1066.02	2287.14	3420.64	3769.46	3859.87	3928.79	4038.47	4023.44	3998.60	3974.32	3882.78	3844.61
72.37	70.87	74.54	77.75	71.21	96.37	1123.95	2319.92	3448.05	3778.83	3859.23	3917.71	4026.04	4012.81	3986.17	3972.49	3877.05	3833.96
38.15	38.15	37.64	37.64	38.15	36.91	36.24	34.54	30.63	26.57	25.6	24.76	24.14	21.63	18.92	17.66	20.67	24.4
38.15	38.15	38.15	38.15	38.15	36.91	36.24	34.54	32.08	26.57	25.2	24.63	23.72	21.63	18.57	17.66	20.67	24.4
38.15	38.15	38.15	38.15	38.15	36.91	36.24	35.96	32.08	26.57	25.2	24.63	23.72	20.68	18.57	17.66	21.18	25.4
38.15	38.15	38.15	38.15	38.15	38.15	37.53	35.96	33.47	26.81	25.2	24.16	22.9	20.26	18.2	18.01	21.18	25.4
39.44	39.44	39.44	39.44	39.44	38.15	38.84	37.4	34.93	26.81	25.2	24.16	22.55	19.75	18.01	18.09	21.72	26.57
39.44	39.44	39.44	39.44	39.44	40.18	38.84	38.84	34.93	27.12	24.69	23.44	22	19.35	17.75	18.09	21.72	26.57
39.44	39.44	40.79	41.56	41.56	41.56	40.18	40.3	36.45	27.12	24.69	23.44	21.06	18.57	17.49	18.19	22.33	29.84
40.79	41.56	41.56	41.56	41.56	42.4	42.4	41.75	37.65	27.12	24.69	22.81	20.12	18.01	17.55	19.42	25.4	31.87
41.56	41.56	42.98	43.82	43.82	43.82	44.6	42.35	37.65	27.51	24.08	22.6	20.12	17.75	18.01	19.75	25.4	31.87
41.56	42.98	43.82	43.82	45.95	45.95	44.6	44.14	36.96	26.5	24.08	21.93	19.25	17.78	18.09	21.18	29.84	34.27
41.56	42.98	43.82	45.95	45.95	46.47	46.47	44.09	37.35	26.5	24.08	21.69	19.25	17.66	19.13	23.52	31.87	40.08
42.98	43.82	45.95	47.6	47.6	47.67	46.67	44.83	35.9	25.4	23.58	20.99	18.54	17.97	19.13	24.4	36.62	52.97
42.98	45.24	45.95	47.6	47.67	47.67	47.35	43.84	34.17	25.4	23.58	20.99	18.54	18.01	20.67	28.13	47.32	64.25
42.98	45.24	47.6	47.67	48.44	47.95	46.59	43.84	34.17	24.24	22.83	20.06	18.08	18.62	22.73	31.24	64.25	90.35
43.82	45.95	47.6	48.44	47.95	47.95	46.59	42.4	32.21	23.04	22	19.38	17.99	19.75	22.73	38.28	78.52	129.01
45.24	45.95	47.6	47.95	47.95	47.04	45.38	40.58	30.08	23.04	22.17	18.64	17.96	19.75	25.45	42.42	112.25	161.37
45.24	47.21	47.6	47.95	47.04	47.04	45.38	40.58	30.08	21.81	21.29	18.52	18.13	21.35	27.52	49.6	161.37	229.21
45.24	47.21	47.67	47.95	47.04	47.04	45.38	40.58	30.08	21.81	20.36	18.12	18.69	23.42	32.04	67.84	200.91	317.83
45.24	47.21	47.67	47.95	47.04	47.04	45.38	38.43	27.86	21.81	19.55	17.89	19.23	24.84	34.85	82.19	283.91	389.86
45.24	47.6	47.67	47.95	47.04	46.59	45.38	37.55	27.86	20.58	19.55	17.84	20.41	27.85	39.12	118.82	389.86	517.47
45.24	47.6	47.67	47.95	47.04	45.38	43.77	37.55	27.86	20.58	18.73	17.94	21.16	29.69	50.71	172.85	389.86	618.61
45.95	47.6	47.67	47.04	46.59	45.38	43.23	37.55	27.86	20.58	17.86	18.21	22.75	34.93	69.75	213	472.42	780.35
45.95	47.6	47.35	47.04	45.38	45.38	43.23	37.55	27.17	19.35	17.99	18.54	23.5	38.14	100.82	304.18	618.61	906.97
45.95	47.6	47.35	47.04	45.38	43.77	41.32	35.23	25.08	20	17.26	18.98	23.5	49.17	148.72	368.54	729.46	906.97
45.95	47.6	47.35	45.38	43.77	43.77	41.32	34.28	24.67	19.59	17.43	19.42	25.44	56.02	180.45	441.19	848.44	1039.93
47.21	47.67	47.35	45.38	43.77	43.77	41.32	31.89	22.65	20.25	16.9	19.98	26.16	64.44	264.33	596.19	1039.93	1229.09
47.21	47.67	47.35	45.38	43.77	41.79	39.11	30.99	22.65	19.84	17.13	19.98	26.84	93.91	316.29	694.82	1176.94	1373.2
47.21	47.67	46.59	45.38	43.77	41.32	38.43	30.99	21.13	20.37	17.13	21.1	29.17	110.84	521.44	891.76	1315.78	1516.93
47.21	47.67	46.59	45.38	41.79	41.32	38.43	27.86	21.43	19.36	17.33	21.1	30.38	166.59	601.49	1011.32	1454.5	1516.93
47.21	47.67	46.59	45.38	41.32	41.32	38.43	27.86	21.81	19.8	17.42	21.76	34.3	196.35	685.45	1133.13	1591.69	1658.77
48.55	47.67	46.59	43.77	41.32	41.32	37.55	27.17	20.58	20.13	17.42	22.28	36.75	289.95	896.24	1496.14	1726.58	1797.89
48.55	47.67	46.59	43.23	41.32	40.58	35.23	27.17	21.13	20.13	17.68	23.11	48.27	335.77	996.85	1624.92	1859.1	1934.15
48.55	47.35	46.59	43.23	41.32	38.43	35.23	27.17	21.13	20.36	17.68	24.15	48.27	475.98	1242.73	1752.02	1989.81	2068.08
48.55	47.35	45.38	43.23	40.58	38.43	34.28	26.58	21.13	20.36	17.94	24.68	68.36	538.81	1354.77	1878.01	2119.72	2200.69
48.44	47.35	44.75	43.23	40.58	37.55	34.28	24.67	21.69	19.55	17.94	26.84	101.55	728.52	1618.88	2119.72	2249.98	2333.14
48.44	46.59	44.75	40.58	38.43	37.55	34.28	24.67	20.65	19.55	18.54	27.55	153.31	951.14	1859.55	2249.98	2466.37	2466.37
47.95	46.59	43.23	40.58	38.43	35.23	31.89	24.67	20.65	19.55	18.54	30.38	207.12	1135.88	1982.18	2381.52	2600.72	2600.72
47.95	46.59	43.23	38.43	35.23	35.23	30.99	22.75	20.65	18.73	18.98	36.75	305.28	1407.88	2107.54	2514.63	2735.51	2735.51
47.95	45.38	41.32	38.43	35.23	31.89	28.61	22.75	19.59	18.73	19.98	39.81	436.73	1625.88	2235.81	2648.6	2868.76	2868.76
47.04	45.38	41.32	38.43	35.23	31.89	28.61	22.65	20.25	17.86	19.98	54.16	548.34	1931.94	2523.54	2781.42	2909.6	2997.06
47.04	45.38	41.32	36.04	32.73	31.89	28.61	20.94	19.22	17.05	20.54	61.3	608.27	2183.52	2783.16	3028.28	3028.28	3115.55
47.04	43.77	41.32	36.04	32.73	29.39	25.6	20.94	19.22	17.05	21.62	69.81	815.02	2311.2	2901.79	3131.41	3131.41	3218.24
45.71	43.77	39.11	36.04	32.73	29.39	25.6	19.27	19.22	16.64	22.05	79.8	891.88	2435.78	3005.26	3131.41	3212.29	3212.29
45.71	43.77	39.11	36.04	29.39	26.2	23.35	19.61	18.81	16.64	22.38	120.81	973.35	2552.31	3086.86	3086.86	3264.15	3264.15
45.71	43.77	39.11	33.47	29.39	26.2	22.99	20.06	18.81	16.18	23.22	138.67	1060.23	2654.75	2980.44	3139.85	3280.96	3280.96
45.71	43.77	39.11	32.73	29.39	25.6	20.94	18.71	18.32	16.52	23.36	158.55	1060.23	2736.51	3000.52	3158.26	3258.18	3258.18
45.38	41.79	38.43	32.73	28.61	23.35	20.87	19.35	18.32	16.34	23.36	180.58	1152.91	2736.51	2982.32	3137.59	3193.4	3086.89
45.38	41.32	38.43	32.73	26.2	22.99	20.94	18.13	17.74	16.34	23.49	268.13	1251.13	2791.05	2923.61	2972.4	3086.89	2941.76

43.77	41.32	36.04	31.89	25.6	22.99	19.27	18.87	17.74	16.37	25	302.08	1561.35	2812.61	2824.79	2831.34	2763.89	2763.89
43.77	41.32	36.04	29.39	25.6	22.75	19.61	18.87	17.74	16.37	25.57	339.52	1784.4	2796.98	2689.06	2658.22	2461.21	2461.21
43.77	41.32	35.23	29.39	22.99	20.87	19.61	19.59	16.72	16.85	26.42	536.94	1888.74	2923.61	2522.23	2461.21	2250.17	2250.17
41.79	39.11	35.23	28.61	22.99	20.87	19.61	18.5	17.12	17.16	26.42	596.79	2215.92	2689.06	2461.21	2250.17	2035.83	2035.83
41.79	39.11	32.73	26.2	22.99	20.94	20.06	18.5	17.12	17.16	31.72	808.61	2347.39	2522.23	2250.17	2035.83	2035.83	1829.02
41.79	39.11	32.73	26.2	20.94	20.94	18.71	18.5	17.12	17.16	34.27	972.98	2370.42	2332.38	2035.83	1829.02	1829.02	1639.91
39.53	36.66	30.14	26.2	20.87	19.27	18.71	18.5	16.17	17.67	37.52	1252.08	2587.22	2332.38	1829.02	1829.02	1829.02	1639.91
39.53	36.66	30.14	23.81	20.87	19.61	19.35	18.16	16.52	18.87	59.2	1346.95	2536.41	2129.13	1829.02	1829.02	1639.91	1639.91
37.05	34.05	27.51	23.35	19.05	18.14	18.13	18.16	15.71	19.67	88.27	1659.25	2536.41	2129.13	1829.02	1639.91	1639.91	1639.91
37.19	31.35	27.51	21.15	17.67	18.71	18.13	17.76	16.05	20.08	101.14	1745.79	2536.41	2129.13	1829.02	1829.02	1829.02	1639.91
34.58	31.35	24.91	19.05	17.67	17.4	17.73	17.76	15.44	21.12	133.67	1745.79	2742.07	2332.38	1829.02	1829.02	1829.02	1829.02
34.58	31.35	24.91	18.98	16.73	16.93	17.42	17.27	15.48	21.77	201.17	1981.21	2742.07	2522.23	2035.83	2035.83	2035.83	2035.83
34.58	28.63	21.9	17.12	17.4	17.73	18.16	16.72	15.87	22.35	201.17	1981.21	2796.98	2689.06	2250.17	2250.17	2250.17	2250.17
31.92	28.63	21.9	17.32	16.93	17.42	17.76	16.17	16.37	22.35	262.73	1888.74	2812.61	2972.4	2658.22	2461.21	2461.21	2658.22
31.92	28.63	21.9	17.32	17.73	18.16	17.27	16.05	17.67	22.88	339.52	2008.98	2736.51	3137.59	2831.34	2831.34	2831.34	2831.34
31.92	28.63	21.9	17.67	17.42	17.76	17.12	16.36	18.69	23.49	302.08	1892.26	2844.43	3158.26	3075.53	2972.4	3075.53	3193.4
31.92	28.63	21.9	18.14	18.16	17.27	17.43	16.52	19.6	24.63	387.65	1656.2	2623.06	3086.86	3158.26	3258.18	3280.96	3280.96
31.92	28.63	21.48	18.71	18.81	18.12	17.05	17.13	20.61	26.51	439.36	1741.03	2496.43	3005.26	3086.86	3264.15	3264.15	3212.29
34.58	28.63	21.48	18.71	19.8	18.6	17.43	17.84	21.62	33.7	391.99	1625.88	2366.16	2783.16	3131.41	3131.41	3131.41	3131.41
34.58	31.35	23.81	19.35	20.13	18.73	17.13	18.56	22.28	39.81	491.24	1515.06	2235.81	2655.44	3028.28	3028.28	3028.28	3028.28
34.58	31.35	23.35	20	20.36	17.99	17.51	19.42	23.56	48.27	436.73	1407.88	2107.54	2523.54	2909.6	2909.6	2909.6	2909.6
34.43	30.81	23.35	20.65	20.49	18.14	17.68	19.93	24.68	54.16	436.73	1407.88	2107.54	2523.54	2781.42	2781.42	2781.42	2781.42
34.43	30.81	22.99	20.65	20.53	18.16	17.84	21.15	26.16	68.36	538.81	1407.88	1982.18	2523.54	2648.6	2781.42	2648.6	2648.6
34.05	30.14	22.75	21.25	20.5	18.16	18.21	21.15	29.17	68.36	538.81	1303.32	1982.18	2390.98	2648.6	2648.6	2648.6	2648.6
34.05	29.39	22.65	21.79	19.65	18.15	18.51	21.89	29.17	87.01	538.81	1407.88	1982.18	2523.54	2648.6	2523.54	2523.54	2523.54
34.05	26.2	21.43	21.33	19.61	18.15	18.51	21.89	29.17	101.55	538.81	1407.88	1982.18	2523.54	2523.54	2523.54	2523.54	2523.54
33.47	25.6	21.81	21.72	19.61	18.12	18.51	22.55	30.38	101.55	538.81	1407.88	2107.54	2523.54	2523.54	2523.54	2523.54	2523.54
30.81	25.6	21.13	21.09	18.82	17.83	18.51	23.5	34.3	101.55	604.13	1407.88	2107.54	2523.54	2655.44	2523.54	2523.54	2523.54
30.81	22.99	20	20.36	18.8	17.83	18.92	23.5	34.3	118.38	604.13	1407.88	2107.54	2523.54	2655.44	2655.44	2496.43	2496.43
30.14	22.99	20.65	20.36	18.14	17.68	18.92	24.15	36.75	118.38	604.13	1231.57	1931.94	2655.44	2655.44	2655.44	2496.43	2496.43
30.14	22.75	20.65	19.55	18.14	17.68	19.42	23.11	36.75	118.38	604.13	1231.57	1931.94	2655.44	2655.44	2655.44	2496.43	2496.43
30.14	22.75	20.25	19.55	17.68	17.94	19.42	24.15	36.75	118.38	671.78	1330.71	1931.94	2496.43	2655.44	2783.16	2623.06	2623.06
29.39	20.94	20.25	19.55	17.68	17.94	19.93	24.68	39.81	137.54	671.78	1330.71	1931.94	2496.43	2655.44	2783.16	2783.16	2623.06
28.61	20.94	20.84	18.73	17.51	18.54	20.52	24.68	39.81	137.54	671.78	1330.71	2056.37	2496.43	2655.44	2783.16	2783.16	2901.79
28.61	21.13	21.33	18.8	17.51	18.54	21.76	25.13	43.64	159.01	741.91	1515.06	2056.37	2496.43	2783.16	2783.16	2901.79	2901.79
27.86	21.43	21.33	18.8	17.68	19.42	21.76	26.84	54.16	207.12	741.91	1625.88	2056.37	2496.43	2783.16	2901.79	2901.79	2901.79
27.17	21.43	20.79	18.82	17.94	19.93	23.11	30.38	61.3	238	971.23	1625.88	2056.37	2496.43	2783.16	2901.79	3005.26	3005.26
27.17	21.81	21.09	18.14	17.94	20.52	24.15	31.85	78.71	305.28	971.23	1625.88	2056.37	2496.43	2783.16	3005.26	3131.41	3131.41
26.58	21.81	21.09	18.14	18.21	21.15	26.16	36.75	118.38	347.33	971.23	1741.03	2056.37	2496.43	2901.79	3131.41	3212.29	3212.29
26.58	22.24	21.09	18.16	18.92	21.89	26.16	48.27	137.54	347.33	1231.57	1931.94	2235.81	2655.44	2901.79	3212.29	3212.29	3212.29
24.67	22.24	21.09	18.16	18.92	22.55	28.09	48.27	178.84	491.24	1231.57	1931.94	2366.16	2783.16	3005.26	3212.29	3264.15	3264.15
24.67	22.24	21.09	18.16	18.92	23.5	29.17	68.36	207.12	491.24	1231.57	1931.94	2366.16	2783.16	3005.26	3212.29	3264.15	3264.15
24.38	21.13	21.09	17.68	19.93	24.15	32.3	68.36	265.95	604.13	1231.57	1931.94	2366.16	2783.16	3131.41	3212.29	3349.31	3349.31
22.65	21.13	21.09	17.68	19.93	24.15	34.3	101.55	265.95	604.13	1231.57	1931.94	2366.16	2783.16	3131.41	3212.29	3298.41	3298.41
20.94	20.58	20.13	17.57	20.52	26.16	39.62	101.55	265.95	604.13	1231.57	1811.17	2235.81	2783.16	3131.41	3212.29	3298.41	3298.41
20.94	19.35	19.8	17.13	20.52	26.16	43.48	130.62	384.82	728.52	1407.88	1811.17	2235.81	2783.16	3028.28	3131.41	3218.24	3218.24
19.05	18.13	18.78	17.13	21.1	26.84	48.27	153.31	384.82	728.52	1303.32	1811.17	2235.81	2655.44	3028.28	3028.28	3115.55	3115.55
17.32	17.4	18.32	16.84	21.62	30.38	59.69	153.31	384.82	807.29	1303.32	1693.95	2107.54	2523.54	2909.6	2909.6	2997.06	2997.06
17.32	16.13	17.27	16.52	22.7	31.85	87.01	229.55	475.98	951.14	1303.32	1693.95	1982.18	2390.98	2781.42	2781.42	2868.76	2868.76
15.69	14.12	15.68	16.34	22.7	39.81	101.55	289.95	538.81	951.14	1466.8	1738.83	1982.18	2390.98	2514.63	2648.6	2735.51	2735.51
13.76	14.12	15.68	16.37	23.01	39.81	153.31	335.77	651.68	1098.31	1466.8	1738.83	1859.55	2259.85	2381.52	2514.63	2514.63	2600.72
12.29	12.18	14.1	15.87	23.22	54.16	178.84	475.98	651.68	1098.31	1466.8	1738.83	2003.94	2130.92	2381.52	2381.52	2381.52	2381.52
11.97	11.11	13.32	16.07	24.37	61.3	229.55	475.98	860.97	1098.31	1618.88	1738.83	1878.01	2003.94	2249.98	2249.98	2249.98	2381.52
10.61	11.11	13.32	17.11	24.63	69.81	265.95	651.68	860.97	1354.77	1618.88	1878.01	1878.01	2003.94	2119.72	2119.72	2249.98	2249.98
10.38	10.21	12.72	17.82	24.63	90.87	265.95	651.68	860.97	1354.77	1618.88	1878.01	1878.01	2003.94	2119.72	2119.72	2119.72	2249.98
9.18	9.53	12.86	18.36	27.26	104.89	305.28	651.68	860.97	1354.77	1618.88	1878.01	1878.01	2003.94	2003.94	2119.72	2119.72	2119.72
8.52	10.26	12.77	19.22	27.26	104.89	305.28	538.81	951.14	1200.38	1618.88	1878.01	1878.01	2003.94	2003.94	2003.94	2119.72	2119.72
7.85	9.79	13.15	19.67	27.26	104.89	305.28	538.81	951.14	1200.38	1618.88	1878.01	1878.01	2003.94	2003.94	2003.94	2119.72	2119.72
8.3	10.25	13.7	20.55	27.26	104.89	305.28	538.81	951.14	1200.38	1618.88	1878.01	1878.01	2003.94	2003.94	2003.94	2119.72	2119.72
7.94	10.25	13.7	20.85	30.8	104.89	305.28	538.81	860.97	1200.38	1618.88	1878.01	2003.94	2003.94	2003.94	2003.94	2119.72	2119.72
8.48	10.87	13.7	20.85	32.63	104.89	305.28	538.81	728.52	1200.38	1618.88	1878.01	2003.94	2003.94	2003.94	2003.94	2119.72	2119.72
8.43	10.87	14.57	20.85	32.63	104.89	305.28	538.81	728.52	1200.38	1618.88	2003.94	2003.94	2003.94	2003.94	2003.94	2119.72	2119.72
9	10.87	14.57	21.12	32.63	104.89	305.28	538.81	728.52	1200.38	1618.88	2003.94	2003.94	2003.94	2003.94	2003.94	2119.72	2119.72
438.14	438.14	438.14	457.81	504.69	408.81	367.92	387.72	358.52	363.2	366.01	377.12	468.93	492.67	425.11	425.49	406.09	413.78
438.14	438.14	438.14	457.81	504.69	408.81	362.25	374.3	353.25	363.2	366.01	377.12	469.42	468.93	425.11	425.49	436.5	435.58
438.14	438.14	438.14	457.81	510.78	395.67	365.35	360.88	350.6	359.88	358.87	367.27	446.38	469.42	425.25	426.26	436.5	435.58
438.14	438.14	438.14	456.31	511.29	401.02	396.83	367.59	355.47	360.27	353.25	369.04	425.49	447.39	425.49	461.99	460.62	518.96
438.14	438.14	438.14	456.31	514.2	406.86	418.85	388.63	359.17	355.47	350.03	361.11	405.99	426.26	426.26	489.44	552.41	636.6
438.14	438.14	438.14	453.78	514.73	436.03	462.55	426.36	360.77	349.89	347.55	354.78	388.59	413.78	413.78	552.41	675.48	765.07
438.14	438.14	438.14	453.78	511.95	469.02	506.72	466.29	376.97	350.46	345.08	346.58	377.9	414.74	435.58	675.48	765.07	1129.54

438.14	438.14	438.14	453.78	511.95	507.06	514.23	468.2	376.97	343.27	343.41	342.33	364.63	398.08	490.61	675.48	814.24	1129.54
438.14	438.14	438.14	453.78	498.9	514.23	511.95	469.02	363.03	343.27	343.41	342.33	375.69	449.44	576.11	675.48	1192.49	1472.76
438.14	438.14	438.14	453.78	482.32	498.9	498.9	506.72	363.03	341.58	342.79	335.64	368.77	533.57	576.11	765.07	1192.49	1472.76
438.14	438.14	438.14	456.31	484.35	482.32	484.35	514.2	376.97	343.27	342.79	335.64	368.77	533.57	656.7	723.35	1129.54	1472.76
438.14	438.14	438.14	445.12	457.81	457.81	457.81	511.29	375.76	343.97	342.79	332.31	418.68	517.52	629.09	1077.11	1129.54	1472.76
438.14	438.14	441.42	446.53	446.53	446.53	446.05	493.62	386.27	349.89	345.79	337.01	418.68	517.52	936.22	1077.11	1397.3	1601.29
438.14	441.42	441.42	444.9	444.14	443.35	438.49	452.79	380.43	355.47	349.34	337.01	418.68	517.52	936.22	1077.11	1397.3	1601.29
435.29	441.42	443.87	444.14	441.55	441.55	437.41	426.38	384.21	354.51	353.82	351.38	375.69	533.57	983.9	1333.84	1518.54	1601.29
435.29	439.74	443.87	449.71	450.49	437.41	426.54	390.07	370.47	359.88	367.27	361.45	385.25	552.95	983.9	1333.84	1518.54	1601.29
435.29	439.74	447.39	450.74	450.49	432.21	409.94	376.82	367.84	363.2	373.27	373.77	414.74	576.11	1030.03	1448.4	1601.29	1938
439.74	439.74	447.39	450.74	449.11	426.54	409.94	368.51	361.37	370.25	402.14	406.09	413.78	490.61	1077.11	1518.54	1816.92	1938
439.74	439.74	447.39	450.74	449.11	426.54	384.71	361.56	360.81	392.87	419.5	425.49	461.99	552.41	1129.54	1601.29	1938	2317.92
439.74	439.74	447.39	450.74	432.21	416.87	380.69	363.93	365.4	409.84	463.58	471.03	472.98	590.32	1192.49	1703.44	2084.17	2519.33
439.74	439.74	447.39	450.49	426.54	409.94	365.26	363.93	374.27	416.97	477.86	516.99	519.58	588.53	1364.79	1975.19	2253.03	2730.89
439.74	439.74	447.39	437.41	426.54	409.94	366.32	370.02	374.27	433.71	497.69	537.85	539.15	621.35	1474.63	2135.77	2435.19	2932.87
439.74	443.95	447.39	437.41	420.93	384.71	366.32	370.02	374.27	433.71	505.45	569.19	575.47	619.31	1717.96	2297.91	2775.31	3103.26
439.74	443.95	447.39	432.21	420.93	384.71	366.32	372.29	385.35	448.99	519.43	573.87	585.56	637.96	1943.02	2569.84	2898.97	3223.42
443.95	443.95	449.71	446.78	415.69	380.69	370.43	372.29	392.72	448.99	517.94	577.76	602.32	669.56	2035.93	2658.69	3007.96	3285.1
443.95	447.39	450.74	446.78	415.69	379.07	370.43	382.39	392.72	462.04	526.62	590.51	608.59	685.65	1538.14	2738.5	3001.78	3241.67
443.95	447.39	450.49	443.64	410.88	395.78	370.02	382.39	392.72	462.04	533.94	583.05	624.03	727.97	1628.04	2746.08	2939.32	3105.51
447.39	449.71	463.68	463.67	435.06	395.78	370.02	382.39	392.72	472.47	540.67	591.75	635.84	790.17	1804.8	2748.98	2914.8	3039.08
447.39	449.71	464.79	463.67	435.06	395.78	370.02	382.39	405.93	487.23	540.67	601.95	663.78	826.77	1873.33	2775.31	2927.77	3059.86
449.71	450.74	464.82	461.14	457	395.78	370.02	385.35	405.93	496.39	562.89	614.96	709.46	1042.91	1933.88	2699.57	2969.37	3031.04
449.71	461.55	464.82	477.01	451.02	392.55	378.07	396.72	417.76	503.88	562.89	627.34	763.03	1106.44	1928.02	2744.83	3107.84	3107.84
461.55	463.68	463.67	473.43	451.02	392.55	378.07	396.72	436.2	511.57	583.05	631.66	791.87	1129.8	1896.17	2778.21	3193.97	3283.17
461.55	463.68	478.62	467.57	443.01	389.13	386.37	406.82	447.93	511.57	583.05	640.87	819.44	1153.01	1897.18	2881.25	3057.67	3369.16
461.55	464.79	477.01	459.21	432.89	384.88	393.45	414.53	456.85	517.88	597	640.87	842.86	1180.38	1921.67	2949.82	3202.31	3511.63
463.68	477.3	473.43	459.21	420.71	379.26	398.26	419.27	456.85	533.94	597	651.3	871	1214.45	1971.05	3104.17	3272.91	3565
463.68	478.6	473.43	448.33	406.68	371.96	400.18	419.27	462.98	533.94	597	663.78	871	1485.11	2041.22	3185.14	3416.22	3660.97
463.68	478.6	473.43	420.71	379.35	371.96	400.18	420.98	462.98	533.94	594.76	646.13	995.57	1540.24	2125.2	3270.51	3501.69	3501.69
463.68	464.82	467.57	420.71	379.35	363.02	385.04	413.49	462.98	533.94	594.76	660.88	1027.27	1540.24	2216.21	3477.7	3607.67	3607.67
464.79	464.82	451.02	420.71	379.35	363.02	385.04	413.49	462.98	533.94	601	681.38	1180.38	1935.27	2309.97	3612.08	3902.8	3740.67
464.79	464.82	451.02	404.05	372.53	363.02	385.04	413.49	462.98	540.67	608.47	681.38	1411.83	1935.27	3030.8	3953.09	4090.8	4090.8
464.79	464.82	457	404.05	372.53	370.81	388.19	413.49	462.98	555.65	608.47	721.59	1441.25	2216.21	3147.16	4151.17	4296.9	4296.9
477.3	464.82	435.06	396.26	379.26	375.96	400.18	419.27	462.98	555.65	624.03	751.43	1745.43	2216.21	3277.72	4356.24	4510.69	4510.69
478.6	464.82	439.76	396.26	379.26	386.32	398.26	414.53	472.47	568.57	635.84	864.12	1745.43	2823.71	3277.72	4356.24	4721.52	4721.52
478.6	464.82	415.69	401.59	384.88	381.82	401.95	417.76	487.23	584.46	646.13	900.07	1745.43	2823.71	3771.26	4558.09	4920.4	4920.4
464.82	464.82	415.69	392.55	379.72	386.37	396.72	422.09	482.12	594.76	681.38	1078.45	1921.67	2823.71	3771.26	4558.09	4920.4	5101.13
464.82	464.82	415.69	392.55	379.72	378.07	392.72	433.71	482.12	594.76	706.13	1106.44	1921.67	3185.14	3771.26	4356.24	4920.4	5101.13
464.79	464.82	415.69	392.55	376.09	382.39	392.72	433.71	494.33	608.47	721.59	1383.32	1921.67	3185.14	3740.67	4510.69	4721.52	4920.4
464.79	464.82	410.88	392.55	376.09	382.39	406.52	445.41	494.33	608.47	751.43	1383.32	2461.26	3104.17	3607.67	4090.8	4510.69	4721.52
464.79	464.82	410.88	392.55	376.09	396.72	406.52	445.41	505.45	616.37	864.12	1740.12	2461.26	3104.17	3501.69	3740.67	4090.8	4296.9
464.79	464.82	406.31	392.55	376.09	396.72	433.71	451.08	519.43	624.03	864.12	1740.12	2461.26	3025.32	3416.22	3501.69	3740.67	3902.8
477.3	463.67	406.31	389.13	381.82	396.72	433.71	467.65	519.43	616.37	864.12	1740.12	2778.21	3129.81	3272.91	3611.59	3660.97	3607.67
478.6	463.67	429.36	389.13	381.82	396.72	422.09	461.59	517.94	616.37	826.77	1933.88	2778.21	3057.67	3202.31	3511.63	3565	3660.97
478.6	461.14	429.36	389.13	376.09	392.79	422.09	461.59	517.94	616.37	826.77	1933.88	2778.21	3057.67	3129.81	3446.44	3511.63	3565
478.62	461.14	422.43	389.13	376.09	382.39	422.09	461.59	517.94	616.37	826.77	1933.88	2778.21	3057.67	3369.16	3369.16	3446.44	3511.63
477.01	473.43	422.43	389.13	376.09	382.39	422.09	475.64	540.47	608.47	826.77	1933.88	2778.21	3057.67	3369.16	3369.16	3369.16	3446.44
473.43	467.57	422.43	389.13	376.09	382.39	422.09	475.64	540.47	608.47	826.77	1928.02	2989.6	3057.67	3369.16	3369.16	3369.16	3446.44
473.43	467.57	443.01	389.13	376.09	382.39	422.09	475.64	548.44	615.33	826.77	1928.02	3057.67	3057.67	3369.16	3369.16	3446.44	3446.44
467.57	467.57	432.89	396.26	381.82	382.39	422.09	475.64	561.38	615.33	826.77	1910.72	3057.67	3129.81	3446.44	3446.44	3446.44	3511.63
467.57	459.21	432.89	389.83	379.97	392.79	422.09	494.18	561.38	624.03	1042.91	2443.67	3129.81	3202.31	3511.63	3761.18	3511.63	3511.63
467.57	459.21	432.89	389.83	379.97	392.79	436.2	494.18	561.38	632.57	1042.91	2443.67	3202.31	3202.31	3511.63	3804.05	3565	3565
467.57	459.21	432.89	389.83	379.97	392.79	436.2	507.3	584.46	660.88	1368.54	2461.26	3202.31	3272.91	3565	3611.59	3611.59	3611.59
459.21	459.21	420.71	381.96	378.93	393.45	448.99	507.3	584.46	672.44	1739.53	2500.1	3272.91	3611.59	3611.59	3660.97	3660.97	3416.22
469.54	448.33	420.71	392.42	379.26	393.45	462.04	517.94	588.94	694.82	1727.52	2949.82	3342.59	3660.97	3660.97	3725.43	3725.43	3501.69
469.54	458.33	406.68	392.42	371.96	408.77	462.04	530.99	594.76	826.77	1896.17	3025.32	3342.59	3416.22	3725.43	3816.8	3607.67	3607.67
458.33	444.56	419.78	379.35	371.96	412.63	472.47	540.47	608.47	864.12	1897.18	3104.17	3416.22	3501.69	3816.8	3942.99	3740.67	3740.67
449.48	444.56	402.96	391.19	363.02	412.63	472.47	548.44	624.03	1078.45	1921.67	3185.14	3501.69	3607.67	3740.67	3942.99	3902.8	3902.8
449.48	433.16	411.09	374.86	363.02	420.98	480.3	548.44	635.84	1106.44	1971.05	3270.51	3607.67	3740.67	3902.8	3902.8	4090.8	4090.8
433.16	415.22	392.75	374.86	352.88	420.16	485.9	555.65	635.84	1106.44	2560.45	3365.74	3607.67	3902.8	4090.8	4090.8	4296.9	4296.9
415.22	396.49	392.75	358.5	363.69	437.84	509.14	562.89	663.78	1129.8	2638.29	3365.74	3740.67	3902.8	4296.9	4296.9	4296.9	4510.69
396.49	396.49	374.48	358.5	355.32	437.08	509.14	562.89	670.15	1129.8	2125.2	3477.7	3612.08	4090.8	4296.9	4151.17	4151.17	4510.69
377.91	377.91	374.48	337.21	379.76	435.86	514.23	570.83	670.15	1153.01	2125.2	3612.08	3771.26	4090.8	4510.69	4151.17	4356.24	4510.69
377.91	377.91	357.26	337.21	373.41	470.43	519.62	570.83	670.15	1153.01	2125.2	3612.08	3771.26	4296.9	4510.69	3767.64	3767.64	4721.52
360.56	360.56	357.26	327.83	367.31	472.55	519.62	579.92	670.15	1153.01	2125.2	3612.08	3771.26	4296.9	4510.69	2999.31	2999.31	4721.52
360.56	360.56	342.11	319.24	382.54	472.55	526.1	579.92	670.15	1153.01	2125.2	3612.08	3902.8	4296.9	4510.69	2719.3	3146.96	4558.09
360.56	345.68	342.11	313.37	382.54	476.33	536.72	601.95	691.4	1153.01	2125.2	3477.7	3902.8	4296.9	4510.69	2719.3	2854.62	4558.09
360.56	345.68	330.11	313.37	381.42	502.42	564.49	614.96	709.46	1153.01	2125.2	3477.7	3902.8	4299.87	4296.9	2854.62	2991.66	4747.43
347.42	345.68	330.11	310.57	406.26	534.23	579.92	631.66	782.54	1396.26	2125.2	3365.74	3902.8	4299.87	4296.9	3294.61	3433.19	4747.43

347.42	345.68	322.48	310.83	406.26	545.25	601.95	651.3	900.07	1720.82	2638.29	3270.51	3740.67	4105.67	4090.8	3553.36	3647.95	5063.59
347.42	334.82	320.67	310.83	414.69	574.89	618.9	685.26	1106.44	1720.82	2638.29	3270.51	3607.67	3942.99	3902.8	4567.74	4726.13	5186.18
347.42	334.82	310.68	313.9	414.69	574.89	640.87	706.13	1383.32	1897.18	2560.45	3185.14	3816.8	3816.8	3942.99	5063.59	4779.44	5376.53
337.88	330.04	310.36	313.9	428.94	590.3	651.3	751.43	1389.53	1897.18	2949.82	3104.17	3660.97	3660.97	3816.8	5186.18	5376.53	5376.53
337.88	330.04	303.57	320.06	441.97	601.83	651.3	864.12	1727.52	2461.26	2881.25	3025.32	3611.59	3611.59	3660.97	5260.65	5376.53	5376.53
337.88	320.67	305.03	326.2	441.97	601.83	670.15	900.07	1727.52	2443.67	2881.25	2949.82	3565	3511.63	3565	4920.4	5398.84	5398.84
330.04	320.67	310.3	343.53	463.5	614.16	670.15	900.07	1727.52	2443.67	2823.39	3057.67	3446.44	3369.16	3761.18	4510.69	4920.4	4920.4
334.11	326.45	319.47	392.11	489.3	640.08	691.4	900.07	1727.52	2441.89	2778.21	2989.6	3283.17	3524.96	3621.82	4105.67	4296.9	4296.9
350.4	315.19	319.47	392.11	489.3	640.08	691.4	900.07	1727.52	2441.89	2778.21	2928.87	3193.97	3305.38	3524.96	3660.97	3816.8	3816.8
382.39	325.81	334.76	420.96	546.21	657.65	734.84	900.07	1739.53	2446.5	2744.83	2928.87	3107.84	3201.67	3305.38	3511.63	3611.59	3611.59
432.66	325.81	334.76	476.93	564.74	673.98	734.84	900.07	1739.53	2446.5	2719.99	2877.22	3031.04	3201.67	3305.38	3621.82	3446.44	3446.44
501.6	342.59	345.52	476.93	598.77	680.94	734.84	933.55	1739.53	2446.5	2719.99	2834.8	3031.04	3201.67	3201.67	3416.6	3416.6	3416.6
501.6	365.24	367.28	524.28	598.77	680.94	734.84	933.55	1739.53	2446.5	2719.99	3031.04	3031.04	3201.67	3201.67	3305.38	3305.38	3305.38
586.4	365.24	383.22	524.28	607.04	697.93	791.87	933.55	1739.53	2446.5	2719.99	3031.04	3201.67	3201.67	3201.67	3201.67	3201.67	3201.67
509.94	342.77	383.22	580.68	620.23	697.93	791.87	933.55	1383.32	2446.5	2719.99	3031.04	3201.67	3201.67	3201.67	3201.67	3201.67	3201.67
567.24	358.51	400.91	580.68	620.23	697.93	819.44	964.9	1389.53	1910.72	2744.83	3107.84	3305.38	3305.38	3305.38	3436.08	3436.08	3436.08
421.72	358.51	400.91	610.96	632.65	714.03	783.64	964.9	1389.53	1910.72	2744.83	3107.84	3305.38	3305.38	3305.38	3557.87	3436.08	3436.08
449.84	361.7	487.23	610.96	632.65	714.03	783.64	964.9	1396.26	1896.17	2778.21	2928.87	3193.97	3416.6	3416.6	3557.87	3557.87	3557.87
449.84	361.7	487.23	634.72	644.3	729.42	805.76	995.57	1396.26	1896.17	2778.21	2928.87	3193.97	3416.6	3682.75	3557.87	3557.87	3557.87
473.31	374.13	509.41	634.72	644.3	729.42	805.76	1027.27	1720.82	1897.18	2823.39	2989.6	3283.17	3524.96	3798.11	3682.75	3416.6	3416.6
473.31	374.13	560.68	648.19	671.23	745.03	870.18	1180.38	1720.82	2461.26	2823.39	2989.6	3283.17	3524.96	3524.96	3524.96	3524.96	3524.96
686.56	384.95	576.96	648.19	671.23	766.53	870.18	1214.45	1921.67	2500.1	2881.25	3057.67	3369.16	3369.16	3621.82	3621.82	3621.82	3621.82
686.56	400.82	582.67	653.17	708.37	783.02	924.29	1441.25	1921.67	2500.1	3057.67	3369.16	3369.16	3369.16	3621.82	3701.29	3701.29	3701.29
693.2	408.41	622.16	661.19	728.18	809.97	1096.35	1485.11	2560.45	2949.82	3129.81	3446.44	3446.44	3446.44	3701.29	3761.18	3511.63	3511.63
970.16	408.41	615.18	673.65	757.12	863.81	1255.16	1792.42	2560.45	2949.82	3129.81	3446.44	3446.44	3446.44	3701.29	3511.63	3565	3565
682.06	398.4	628.75	684.55	778.26	915.93	1300.19	1857.88	2638.29	3025.32	3202.31	3511.63	3511.63	3511.63	3511.63	3804.05	3565	3565
682.06	400.52	613.13	706.61	812.23	936.23	1300.19	2041.22	2638.29	3202.31	3511.63	3511.63	3511.63	3511.63	3511.63	3804.05	3804.05	3804.05
486.03	415.74	631.63	706.61	812.23	936.23	1601.61	2125.2	2727.7	3272.91	3565	3565	3565	3565	3272.91	3804.05	3804.05	3804.05
411.7	425.11	641.8	737.32	859.77	953.97	1601.61	2125.2	2727.7	3272.91	3565	3565	3565	3272.91	3272.91	3804.05	4133.83	4133.83
400.19	453.92	641.8	737.32	859.77	953.97	1664.56	2216.21	2823.71	3342.59	3611.59	3611.59	3611.59	3342.59	3185.14	3837.57	4133.83	4133.83
414.1	510.9	636.72	778.54	924.12	968.94	1664.56	2018.25	2823.71	3342.59	3611.59	3611.59	3611.59	3342.59	3185.14	3837.57	4330.97	4330.97
420.03	531.57	679.36	778.54	952.91	968.94	1664.56	2018.25	2823.71	3416.22	3660.97	3660.97	3611.59	3416.22	3185.14	4133.83	4330.97	4330.97
446.03	531.57	679.36	778.54	952.91	968.94	1726.45	2309.97	2924.27	3416.22	3660.97	3660.97	3660.97	3416.22	3270.51	4133.83	4330.97	4330.97
446.03	531.57	679.36	778.54	952.91	981.68	1726.45	2309.97	2924.27	3416.22	3660.97	3660.97	3660.97	3416.22	3270.51	4133.83	4330.97	4330.97
2.87	2.87	3.09	2.51	2.47	2.60	2.94	3.82	6.64	12.57	23.17	39.03	51.65	61.83	64.43	69.18	69.87	80.64
2.87	2.88	3.11	2.54	2.53	2.63	2.88	3.85	6.87	13.78	25.64	40.69	52.20	61.77	64.49	68.37	69.29	80.86
2.87	2.90	3.04	2.62	2.65	2.66	2.86	4.14	7.21	16.19	29.65	43.14	53.46	62.02	64.01	66.10	67.48	77.10
2.87	2.91	3.01	2.70	2.75	2.76	2.88	4.05	7.88	19.54	34.11	45.99	55.94	62.28	61.78	61.73	63.22	75.05
2.87	2.93	3.00	2.83	2.82	2.86	2.94	4.09	8.58	23.57	38.57	49.79	58.02	61.22	57.03	55.02	56.59	65.48
2.86	2.93	3.00	2.94	2.79	2.90	3.04	4.17	10.04	27.24	43.17	54.99	59.75	54.98	52.81	47.41	48.57	53.84
2.85	2.94	3.01	3.01	2.67	2.84	3.11	4.54	12.17	31.30	49.19	58.18	58.74	50.01	45.24	41.02	41.47	42.74
2.84	2.93	3.02	3.08	2.59	2.69	3.08	5.10	14.53	34.37	54.11	58.01	52.25	40.89	39.89	39.70	39.19	33.07
2.83	2.92	3.04	3.14	2.59	2.49	2.93	5.64	15.63	36.44	55.40	53.69	44.41	36.22	37.24	36.07	33.12	34.91
2.83	2.91	3.07	3.19	2.65	2.30	2.69	5.75	15.30	36.44	51.21	45.24	38.20	35.37	35.78	32.09	33.53	40.69
2.86	2.90	3.09	3.22	2.74	2.19	2.42	5.20	13.41	32.08	42.88	37.02	36.75	36.89	34.73	32.04	42.63	54.82
2.90	2.91	3.12	3.24	2.87	2.23	2.31	4.59	11.34	25.89	35.08	34.17	36.85	37.97	32.22	35.64	53.99	71.60
2.97	2.93	3.14	3.24	2.95	2.47	2.34	4.41	10.38	21.09	27.81	34.07	38.69	38.87	32.86	44.45	72.02	91.67
3.01	2.95	3.16	3.20	2.90	2.61	2.44	4.71	10.18	18.92	27.71	37.24	41.49	37.31	38.25	57.28	91.10	106.99
3.04	2.98	3.15	3.09	2.91	2.79	2.77	5.82	11.10	20.31	32.71	37.72	44.03	38.50	45.77	76.74	107.18	113.72
3.04	3.01	3.10	2.91	2.73	2.66	2.85	6.53	13.03	23.68	36.11	40.89	45.96	43.71	64.70	104.01	123.08	117.46
3.07	3.05	3.01	2.70	2.54	2.55	3.02	7.61	14.81	29.19	39.72	42.42	45.24	55.75	97.38	141.81	133.73	111.12
3.14	3.12	2.89	2.48	2.38	2.27	3.20	8.02	16.86	33.75	39.65	42.74	50.77	83.35	145.82	178.98	136.70	106.36
3.24	3.19	2.73	2.29	2.23	2.19	3.29	8.27	17.66	35.25	38.78	44.64	69.37	126.68	205.48	208.08	140.47	123.31
3.37	3.24	2.52	2.12	1.98	2.16	3.55	8.32	17.09	39.04	36.45	52.61	101.37	184.91	255.88	221.18	169.74	182.96
3.46	3.24	2.28	2.01	1.89	1.97	3.61	8.40	16.76	37.10	36.62	70.89	160.33	257.54	293.57	229.04	209.13	244.57
3.48	3.17	2.04	1.95	1.83	2.09	3.84	8.36	16.15	35.02	40.74	104.07	235.15	332.21	338.94	230.27	252.89	284.63
3.44	3.07	1.90	1.95	1.81	2.54	4.24	8.57	16.53	33.15	49.89	154.34	330.46	430.83	374.38	247.82	273.02	279.44
3.39	3.02	1.94	2.00	1.94	3.33	4.54	9.42	17.30	33.03	64.94	229.58	442.23	518.40	424.46	290.39	302.69	281.55
3.42	3.03	2.12	2.07	2.24	4.12	4.67	10.17	18.47	33.56	89.14	329.45	588.57	617.65	491.25	381.97	395.38	339.61
3.47	3.11	2.30	2.12	2.57	4.52	4.70	10.96	19.97	35.33	117.36	458.81	724.64	707.01	589.03	583.65	603.50	503.12
3.55	3.19	2.39	2.14	2.70	4.44	4.64	12.39	22.29	38.24	163.50	596.88	855.52	853.84	865.08	1010.77	902.13	734.42
3.63	3.32	2.41	2.18	2.46	3.93	5.17	13.71	25.26	43.41	214.55	746.85	973.86	1083.22	1181.83	1403.52	1210.94	998.69
3.78	3.53	2.45	2.23	2.05	3.23	5.22	14.55	28.99	51.03	293.85	878.64	1064.60	1326.80	1585.74	1680.69	1324.06	1072.58
4.08	3.85	2.57	2.32	1.69	2.65	5.33	15.18	32.48	61.68	361.21	967.28	1180.51	1578.63	1905.95	1815.87	1275.35	989.14
4.57	4.25	2.76	2.40	1.51	2.39	5.49	15.69	37.09	74.24	436.77	1021.12	1300.71	1808.74	2036.08	1840.55	1348.96	1059.28
5.25	4.70	2.99	2.50	1.48	2.37	5.79	16.02	37.57	87.96	498.02	1086.43	1358.66	1960.50	1956.19	1834.44	1420.01	1218.81
6.09	5.20	3.32	2.65	1.53	2.46	6.12	15.14	36.88	102.32	547.69	1150.71	1333.68	2090.40	1779.01	1723.21	1385.58	1351.79
7.08	5.80	3.81	2.89	1.67	2.52	6.86	15.47	35.66	117.62	586.54	1144.26	1367.34	2259.39	1814.37	1751.98	1238.47	1297.23
8.04	6.50	4.42	3.24	1.96	2.86	7.19	15.95	34.89	133.09	614.44	1111.57	1377.75	2299.20	1902.81	1671.38	1091.17	1121.17
8.74	7.15	5.06	3.68	2.33	3.19	7.66	16.69	34.21	147.78	632.85	1053.43	1311.53	2293.01	1909.10	1717.96	1066.88	963.21

8.98	7.59	5.62	4.13	2.79	3.58	8.58	18.26	33.77	160.79	641.13	996.67	1313.16	2353.41	2219.88	2058.14	1792.04	1488.84
8.66	7.68	6.00	4.48	3.51	4.08	9.29	19.63	33.02	174.03	637.63	959.29	1327.41	2899.74	2877.80	2750.37	2521.84	1923.57
7.99	7.46	6.16	4.61	3.93	4.35	10.15	23.02	32.76	192.30	649.92	940.38	1280.51	2665.18	2601.87	3448.24	3304.03	2401.67
7.18	6.98	6.04	4.52	4.34	4.43	10.37	28.84	33.76	211.35	672.41	942.11	1406.27	2844.99	2653.90	3342.76	3284.23	3050.02
6.50	6.41	5.64	4.24	4.39	4.70	10.89	31.22	37.69	243.85	691.59	947.20	1589.00	2924.77	3032.42	3839.56	3823.91	3574.52
5.91	5.76	5.05	3.90	4.20	4.55	10.83	33.29	46.80	272.46	702.30	950.49	1662.95	3237.70	3100.50	4177.88	4123.25	3862.48
5.40	5.12	4.38	3.61	3.87	4.62	11.17	36.16	63.84	302.95	711.04	962.34	1913.50	2934.50	3065.93	4419.81	4305.07	4039.29
4.91	4.49	3.75	3.45	3.51	4.93	12.75	42.56	88.86	350.22	710.75	973.31	2050.99	3023.72	2974.59	4457.37	4360.56	4097.90
4.48	3.95	3.24	3.48	3.34	5.49	15.64	52.04	116.76	391.71	725.41	994.87	2235.80	3551.53	3609.74	4308.71	4371.60	4126.55
4.19	3.60	2.99	3.66	3.42	6.01	18.65	62.06	142.28	430.06	759.02	1022.93	2318.82	4146.33	4238.19	4775.87	5086.89	4875.76
3.97	3.41	2.97	4.05	3.63	6.22	20.80	69.03	161.39	480.44	801.89	1045.88	2494.76	4152.63	4410.72	5075.59	5010.59	4849.30
3.86	3.41	3.21	4.42	3.76	6.07	20.25	70.34	173.43	507.37	869.76	1054.22	2551.77	4698.15	5109.38	4979.24	4945.10	4839.55
3.87	3.56	3.57	4.72	3.84	5.63	18.76	65.60	171.77	521.51	886.27	1036.68	2458.00	4719.45	5320.65	5599.75	5583.06	5528.22
3.89	3.72	3.86	4.75	3.83	5.04	15.62	54.56	157.52	528.76	890.23	1049.97	2626.54	4791.38	5398.64	5750.80	5739.09	5718.93
3.88	3.83	3.95	4.51	3.62	3.99	12.03	41.97	147.42	518.12	915.09	1124.87	2849.82	4828.00	5356.62	5855.90	5840.64	5836.07
3.75	3.78	3.85	4.12	3.31	3.99	9.04	32.01	137.14	540.01	997.62	1276.02	3288.47	4869.84	5336.18	5979.77	5953.19	5947.55
3.63	3.64	3.64	3.78	3.16	3.77	7.56	28.29	144.89	606.26	1185.69	1519.14	3344.13	4905.06	5340.21	5313.42	5271.39	5253.67
3.38	3.45	3.47	3.54	3.05	3.80	7.64	28.76	162.08	676.99	1434.20	1741.79	4063.21	4941.34	5324.76	5301.52	5244.69	5209.86
3.15	3.22	3.25	3.42	3.00	3.87	7.89	31.50	184.06	768.92	1675.20	1926.08	4712.29	4968.40	5440.63	5423.04	5357.21	5305.00
2.96	3.02	3.08	3.27	3.00	4.04	7.30	35.04	208.98	900.12	1836.05	2184.53	4811.97	4996.59	5475.72	5465.78	5398.01	5334.21
2.91	2.96	3.04	3.16	3.44	4.10	7.42	40.02	257.83	1070.55	1932.94	2256.55	4807.20	5029.90	5355.48	5356.42	5291.93	5225.35
3.09	3.03	3.24	3.11	3.48	4.13	7.57	47.64	301.55	1269.32	2043.62	2260.25	4779.40	5067.36	5253.09	5270.16	5209.90	5148.09
3.60	3.35	3.66	3.12	3.53	4.54	8.13	59.20	351.92	1427.28	2272.10	2246.44	4716.56	4972.70	4762.89	4803.28	4746.40	4690.19
4.37	3.94	4.25	3.17	3.58	4.70	9.05	76.26	406.57	1583.81	2241.74	2129.40	4794.59	4979.76	4813.15	4881.88	4827.22	4770.40
5.38	4.83	4.91	3.34	3.69	4.72	12.88	98.82	464.52	1807.40	2095.76	2288.11	4934.97	5021.62	4849.57	4946.02	4895.60	4830.89
6.31	5.74	5.60	3.51	3.80	4.78	14.26	120.94	517.46	1783.44	1979.81	2834.98	5088.47	5170.19	5115.16	5233.24	5191.09	5115.87
7.20	6.60	6.25	3.81	4.27	4.88	15.14	141.40	555.04	1680.72	1819.46	3376.87	5096.39	5387.55	5357.38	5489.82	5462.02	5381.35
7.85	7.40	6.95	4.20	4.47	5.32	16.44	161.37	577.84	1567.52	2042.40	3372.37	3940.30	5592.93	5720.25	5861.42	5852.99	5776.38
8.15	7.96	7.48	4.58	4.89	6.31	18.81	187.94	599.89	1542.88	2456.60	3242.73	3223.60	5667.81	5786.04	5933.31	5947.89	5884.75
8.14	8.27	7.81	4.86	5.12	6.51	21.75	211.58	640.60	1510.46	2727.70	3106.19	2950.72	5078.99	5180.91	5332.58	5370.83	5327.14
7.95	8.29	7.87	5.05	5.14	6.73	24.69	240.83	681.63	1530.04	3250.50	3051.87	3055.05	5022.22	5102.89	5257.40	5318.59	5294.87
7.71	8.12	7.72	5.15	5.19	6.11	27.97	267.45	724.83	1502.58	3313.32	2973.75	2909.50	5041.77	5100.38	5253.09	5335.21	5329.25
7.41	7.83	7.45	5.19	5.05	5.95	30.59	299.88	777.53	1478.97	2992.57	2723.18	3560.22	5100.33	5138.13	5282.10	5383.43	5392.44
7.14	7.48	7.11	5.11	4.84	6.27	33.21	312.22	789.41	1814.96	3020.64	2747.65	4056.49	5146.73	5168.21	5297.55	5415.30	5438.39
6.91	7.05	6.62	4.90	4.55	6.51	36.33	321.61	793.93	2140.26	3246.82	2854.95	4112.71	4123.22	4133.69	4246.67	4377.13	4414.10
6.67	6.52	6.01	4.60	4.31	6.47	39.80	333.19	818.44	2022.95	3241.08	3391.70	4830.55	4852.71	4859.00	4958.29	5094.04	5143.00
6.33	5.94	5.33	4.29	4.25	6.54	44.56	348.69	850.67	1966.01	3181.60	3738.14	4542.45	4565.24	4572.44	4660.74	4793.29	4851.77
5.80	5.24	4.74	4.04	4.33	7.75	50.56	375.74	892.85	2245.96	2986.76	3838.15	5385.49	5397.50	5409.32	5488.78	5609.76	5674.51
5.11	4.56	4.34	4.41	4.46	8.00	57.27	392.95	918.34	2335.74	3081.25	4034.09	4066.70	4059.47	4074.02	4144.52	4251.10	4320.86
4.38	3.96	4.13	4.33	4.60	8.23	64.15	407.56	936.60	2521.93	3039.56	3958.54	3992.28	3965.79	3977.49	4035.88	4126.91	4198.39
3.84	3.57	3.98	4.28	4.80	8.47	71.58	421.49	945.06	2452.14	3273.56	4122.50	4033.30	3996.03	3999.05	4039.59	4114.41	4183.72
3.47	3.42	3.85	3.70	4.97	8.67	83.66	436.98	954.94	2501.40	3963.76	4381.90	4110.29	4079.41	4074.17	4090.50	4146.29	4210.00
3.38	3.40	3.69	3.64	5.02	9.87	92.32	454.49	965.45	2632.38	4197.19	5037.59	5012.49	4998.57	4989.66	4982.33	5020.93	5081.44
3.47	3.27	3.51	3.67	5.28	11.33	97.80	483.39	984.08	2780.62	4346.12	5153.30	5139.45	5146.38	5135.91	5108.45	5135.88	5197.95
3.50	3.32	3.44	3.74	5.73	13.39	107.75	491.55	958.21	2967.80	4926.70	5088.38	5094.04	5111.41	5094.22	5054.28	5080.81	5148.29
3.56	3.39	3.52	3.82	6.39	15.49	118.36	503.15	957.73	3200.24	5031.63	5336.65	5364.64	5385.33	5355.24	5304.59	5335.05	5405.21
3.63	3.52	3.68	3.81	7.36	19.36	128.12	547.54	948.58	3112.61	5681.95	5122.80	5162.54	5177.76	5133.01	5076.45	5113.28	5180.90
3.69	3.74	3.85	3.90	8.26	23.06	135.22	590.81	942.10	3005.39	5772.24	4977.19	5015.23	5024.67	4969.69	4910.94	4953.89	5015.80
3.79	4.08	4.14	4.26	8.63	25.97	137.03	597.51	940.42	3468.36	5815.06	4928.59	4954.47	4956.18	4894.26	4840.31	4895.41	4957.99
4.01	4.58	4.64	4.96	8.86	27.68	133.10	594.12	946.89	3570.67	5792.31	4901.50	4915.06	4912.25	4846.69	4798.23	4871.81	4949.72
4.47	5.19	5.44	5.85	9.85	27.64	125.16	586.32	970.08	3525.74	5708.25	5498.43	5503.35	5498.63	5433.77	5390.04	5487.38	5595.04
5.15	5.88	6.40	6.68	11.42	25.17	114.53	548.40	1040.10	3033.03	5545.86	5528.12	5527.41	5523.91	5468.07	5428.70	5548.13	5690.88
6.02	6.56	7.17	7.28	13.84	22.24	103.52	552.07	1212.62	3484.73	5379.70	5394.28	5385.76	5382.63	5341.62	5310.06	5446.10	5616.58
6.84	7.15	7.69	7.63	17.98	19.17	92.01	546.57	1598.49	4167.62	5341.46	5353.63	5331.35	5324.38	5298.75	5278.33	5419.54	5597.48
7.52	7.55	7.96	7.81	20.40	16.82	83.47	543.94	1847.05	4821.93	5299.71	5313.00	5271.74	5254.21	5238.09	5229.66	5363.05	5520.18
7.91	7.81	8.02	7.87	21.79	17.46	80.45	627.69	2020.93	4875.08	5406.63	5426.62	5367.53	5332.89	5317.84	5320.22	5434.86	5544.96
8.13	7.94	8.15	7.89	22.64	17.21	83.52	692.54	2108.01	4945.06	5449.82	5481.95	5414.67	5359.99	5336.56	5344.94	5438.69	5497.92
8.37	8.29	8.59	7.92	22.19	17.00	90.91	758.18	2232.06	5017.82	5570.35	5618.07	5556.49	5484.44	5444.69	5451.32	5528.68	5556.93
8.85	8.86	9.45	8.24	22.65	17.99	99.66	796.43	2247.82	5046.47	5610.94	5673.89	5628.65	5548.12	5487.34	5481.57	5549.09	5580.14
9.64	9.59	10.64	8.96	23.69	17.63	108.21	895.83	2236.04	5001.96	5581.68	5657.08	5630.90	5552.50	5471.18	5446.21	5507.13	5559.48
10.66	10.39	11.76	10.16	24.92	17.15	118.11	951.30	2180.87	4974.60	5230.96	5315.69	5305.38	5237.98	5140.72	5093.86	5146.05	5218.04
11.69	11.15	12.58	11.44	26.87	18.69	124.58	991.14	2994.51	5002.75	5280.90	5373.80	5376.20	5322.91	5215.66	5149.54	5186.96	5257.29
12.52	11.94	13.05	12.57	28.07	20.25	131.13	1051.57	2983.02	5152.27	5385.85	5489.76	5506.27	5465.30	5352.26	5270.82	5288.72	5340.09
13.10	12.61	13.35	13.32	28.32	19.11	131.17	1053.44	3372.23	5322.41	5551.78	5671.81	5707.94	5674.08	5556.37	5464.41	5463.17	5488.24
13.44	13.15	13.53	13.78	27.67	19.21	132.97	1056.50	3335.28	5491.94	5759.48	5900.97	5962.30	5931.04	5807.98	5708.00	5693.23	5699.77
13.62	13.50	13.74	14.04	24.11	19.78	132.71	1080.99	3637.71	5463.17	5884.89	6048.72	6137.47	6106.88	5977.47	5869.65	5846.47	5844.51
13.73	13.66	13.94	14.31	26.08	20.70	133.17	1405.84	3531.32	5337.18	5912.43	6095.65	6209.66	6181.43	6046.59	5928.79	5899.21	5896.24
13.87	13.82	14.51	14.84	26.81	22.99	136.07	1660.04	3178.16	5153.24	5828.55	6025.18	6159.03	6136.77	5999.31	5869.79	5832.11	5829.50
14.46	14.48	16.16	16.24	28.74	26.82	156.75	1816.60	2954.80	4972.18	5644.03	5851.32	5999.03	5987.23	5852.17	5710.11	5661.36	5657.89
16.15	16.23	19.65	19.90	34.08	35.83	156.87	1727.95	2766.85	4787.55	5418.43	5637.13	5794.75	5796.97	5669.39	5515.94	5453.42	5447.13

19.72	19.76	25.14	27.00	40.26	43.05	161.04	1980.37	2551.82	4639.46	5216.08	5447.82	5615.24	5633.79	5517.52	5355.64	5278.02	5267.29
25.54	25.43	32.04	37.69	51.29	51.05	156.81	2173.72	2456.05	4513.49	5079.29	5320.39	5500.18	5535.56	5431.65	5265.86	5173.70	5157.22
32.96	32.14	39.56	49.18	61.07	67.90	176.92	2478.79	2652.72	4461.76	5012.93	5254.70	5449.58	5501.32	5408.68	5242.99	5138.53	5115.83
40.18	38.04	46.17	58.55	71.40	74.74	246.71	2598.10	2695.31	4486.24	5010.71	5246.21	5455.73	5521.18	5436.92	5273.31	5160.03	5131.73
44.74	41.37	50.29	63.47	88.87	78.99	280.22	2668.91	2750.62	4605.55	5010.57	5239.68	5458.47	5532.15	5452.44	5290.50	5172.61	5141.00

Appendix F
DYNASMART-P input file hc.dat

(Note: Line wrapping has occurred in this file, the actual input used had no such wrapping)

0.16	0.16	0.17	0.15	0.16	0.22	0.16	0.42	0.38	0.43	0.26	0.2	0.22	0.93	0.38	1.48	9.07	12.27
0.16	0.17	0.15	0.15	0.16	0.17	0.17	0.46	0.35	0.5	0.35	0.19	0.2	0.25	0.38	0.79	9.07	13.28
0.18	0.18	0.16	0.16	0.16	0.16	0.18	0.42	0.35	0.44	0.28	0.17	0.2	0.28	0.38	0.79	9.11	14.97
0.22	0.18	0.17	0.17	0.17	0.17	0.2	0.42	0.34	0.41	0.35	0.24	0.34	0.29	0.32	0.74	8.39	17.98
0.22	0.22	0.21	0.18	0.18	0.18	0.2	0.43	0.28	0.29	0.31	0.38	0.33	0.19	0.55	0.64	9.32	17.31
0.23	0.22	0.22	0.22	0.22	0.22	0.25	0.49	0.3	0.25	0.42	0.35	0.22	0.5	0.63	0.64	9.32	16.67
0.23	0.23	0.23	0.23	0.23	0.25	0.37	0.38	0.35	0.24	0.39	0.23	0.22	0.63	1.01	0.63	11.38	13.83
0.24	0.24	0.24	0.24	0.24	0.34	0.35	0.36	0.35	0.44	0.35	0.22	0.49	1	0.74	2.79	16.67	14.84
0.28	0.24	0.24	0.26	0.26	0.25	0.28	0.45	0.48	0.39	0.24	0.49	0.7	0.61	0.63	6.83	14.84	14.84
0.28	0.27	0.26	0.3	0.28	0.3	0.65	0.64	0.55	0.23	0.5	1	0.75	0.95	3.57	10.65	12.14	11.04
0.28	0.27	0.3	0.29	0.27	1	0.73	0.71	0.35	0.25	0.63	0.74	0.63	3.57	9.11	16.02	6.12	12.14
0.3	0.28	0.31	0.28	1.11	1.53	1.08	0.42	0.41	0.72	0.75	0.61	2.03	7.41	14.11	10.16	3.5	3.5
0.31	0.3	0.32	0.3	1.22	1.93	1.11	0.3	1.04	1.1	0.63	1.04	4.23	12.84	8.11	4.01	4.56	4.56
0.27	0.26	0.34	0.3	1.78	1.44	0.87	0.66	1.38	0.72	0.41	2.14	11.56	11.28	2.17	3.53	6.24	7.7
0.25	0.25	0.31	0.31	1.05	1	0.84	1.09	0.93	0.44	1.63	4.34	10.2	1.82	1.98	6.01	7.33	7.33
0.2	0.25	0.25	0.31	0.28	0.33	0.79	1.31	0.56	1.63	7.44	8.93	1.79	2.04	4.46	6.77	5.36	5.36
0.2	0.22	0.26	0.28	0.3	0.28	0.79	1.44	1.53	5.15	7.7	1.8	2.08	4.03	5.58	5.15	3.21	4.62
0.2	0.22	0.26	0.28	0.3	0.27	0.75	1.15	1.47	5.15	2.12	2.12	3.82	4.55	4.95	2.25	5.41	5.41
0.18	0.22	0.25	0.32	0.27	0.31	0.73	1.48	1.51	1.72	2.13	3.54	4.24	4.68	2.33	2.47	7.23	7.23
0.2	0.25	0.25	0.32	0.3	0.88	0.4	1.46	1.53	2.08	3.04	4.12	2.55	2.28	2.32	3.67	10.13	10.13
0.2	0.25	0.31	0.25	1	1.44	0.41	1.01	1.63	2.17	2.95	2.59	2.29	2.45	5.33	13.53	14.64	20.82
0.22	0.25	0.36	0.28	1.1	1.34	0.31	0.93	1.63	2.57	2.87	2.83	2.69	3.48	18.5	20.22	24.16	24.16
0.22	0.24	0.34	0.28	1.1	1.25	0.32	0.84	1.56	3.12	2.69	3.74	4.27	13.93	21.41	28.12	29.86	29.86
0.22	0.23	0.32	0.27	1.05	1.36	0.34	1.2	4.96	3.85	8.5	12.2	15.56	17.87	29.22	33.77	41.01	41.01
0.24	0.23	0.28	0.3	0.31	0.74	0.37	0.9	4.95	3.75	2.26	4.17	17.64	26.14	37.62	40.94	39.13	39.13
0.23	0.23	0.24	0.26	0.29	0.74	0.36	0.79	1.72	2.7	4.05	11.82	24.7	29.37	30.92	34.34	34.34	35.3
0.23	0.24	0.24	0.23	0.3	0.55	0.25	0.49	5.15	3.77	5.19	14.89	18.95	23.9	28.54	31.64	31.64	33.19
0.24	0.24	0.23	0.26	0.29	0.46	0.24	0.95	5.56	3.58	6.14	17.33	23.74	33.2	35.34	35.97	36.64	36.84
0.24	0.24	0.26	0.28	0.27	0.42	0.45	1.63	5.95	2.95	8.03	25.67	29.14	34.69	36.5	38.55	38.55	38.8
0.24	0.26	0.28	0.28	0.34	0.42	0.24	1.56	6.39	4	14.81	30.78	38.33	40.39	45.86	46.53	46.53	46.84
0.26	0.3	0.28	0.32	1.11	0.42	0.34	4.21	6.18	4.05	17.45	41.05	42.81	45.41	47.46	48.19	48.19	48.19
0.26	0.3	0.28	0.34	1	0.76	0.23	3.65	2.07	2.65	21.37	40.37	40.64	46.74	49.02	50	53.83	53.83
0.26	0.3	0.27	0.28	0.73	0.74	0.34	4.51	2.14	2.85	23.32	37.29	45.36	51.85	55.26	57.91	57.91	57.91
0.28	0.3	0.31	0.24	0.49	0.74	0.9	4.66	2.15	2.56	21.6	40.37	50.43	53.31	56.4	57.81	57.81	58.21
0.28	0.3	0.32	0.33	0.35	0.74	0.9	4.96	2.13	2.85	14.73	40.71	49.98	57.17	58.43	60.23	60.19	60.19
0.28	0.3	0.27	0.32	0.24	0.74	1.27	5.44	2.13	2.59	12.75	38.31	55.02	57.94	61.61	62.73	62.74	62.74
0.28	0.28	0.26	0.3	0.26	0.74	1.27	5.08	3.04	2.65	14.26	41.19	54.88	57.51	63.47	64.24	64.45	64.45
0.3	0.28	0.26	0.28	0.28	0.47	1.24	5.35	3.78	2.41	15.38	43.24	49.74	59.64	63.26	63.68	64.07	64.07
0.31	0.3	0.26	0.28	0.28	0.47	1.22	1.72	2.93	2.62	18.87	43.95	54.26	60.53	62.75	63.19	63.61	63.61
0.31	0.3	0.26	0.28	0.26	0.43	0.92	2.08	2.9	2.45	20.51	43.95	57.09	62.22	63.69	64.03	64.42	64.42
0.27	0.26	0.26	0.28	0.27	0.59	0.9	2.17	2.63	4.18	24.7	45.36	58.75	63.07	64.72	65.49	66.34	65.54
0.26	0.26	0.26	0.3	0.27	0.63	0.81	2.48	3.31	11.13	22.14	43.65	59.82	63.51	66.25	67.14	68.03	67.18
0.26	0.26	0.26	0.3	0.27	0.67	0.51	3.15	8.56	15.18	23.79	43.46	60.89	66.12	67.91	69.65	69.65	68.83
0.3	0.28	0.26	0.28	0.25	0.68	0.94	3.22	9.14	12.84	21.48	43.45	61.34	69.04	70.84	72.09	72.47	70.5
0.28	0.28	0.28	0.29	0.25	0.68	0.94	3.81	2.38	7.84	27.34	43.79	62.36	71.89	74.86	76.22	76.22	72.09
0.28	0.28	0.28	0.28	0.27	0.67	1.61	3.18	5.88	16.57	28.5	44.93	63.21	74.75	76.83	76.96	76.96	74.86
0.28	0.28	0.27	0.3	0.65	0.45	1.53	3.1	6.14	18.87	22.9	45.54	63.51	76.83	76.96	76.96	76.96	76.83
0.28	0.29	0.31	0.94	0.92	0.32	1.53	3.68	13.79	17.39	22.12	45.13	64.5	76.98	76.96	76.96	76.96	76.83
0.29	0.32	0.32	0.94	0.92	0.29	3.9	3.21	8.03	18.95	24.83	45.75	64.5	76.98	76.98	76.96	76.96	74.81
0.32	0.33	0.35	0.94	0.87	0.29	1.53	3.45	9.93	19.17	29.3	45.75	64.65	76.21	76.98	76.96	76.83	70.55
0.33	0.33	0.35	1.36	0.37	0.64	1.55	3.68	10.87	27.72	34.83	47.04	64.12	70.55	73.38	74.81	72.09	66.14
0.37	0.35	0.35	1.36	0.25	0.64	1.63	4.09	17.69	29.37	36.37	47.04	62.32	65.43	67.09	68.77	66.25	63.84
0.38	0.38	1.22	1.17	0.25	1.09	0.92	2.75	14.73	29.14	36.24	47.32	62.7	63.05	63.69	64.72	63.3	62.61
0.38	0.42	1.22	1.17	0.26	1.05	1.63	2.65	17.07	33.73	37.5	47.32	56.51	60.23	63.71	63.05	63.71	63.71
1.33	1.09	1.5	1.17	0.3	0.98	1.63	2.7	23.75	38.33	45.17	47.32	49.02	56.51	58.43	61.61	58.43	62.7
1.33	1.09	1.5	1.26	0.3	1.15	1.6	2.86	23.64	42.7	46.37	47.32	47.46	49.02	55.26	56.51	52.42	61.61
2.3	1.23	2.1	0.5	0.64	1.38	1.6	2.58	29.33	42.64	47.04	47.46	47.46	46.86	49.02	49.02	46.86	61.61
3.23	1.87	1.88	0.28	1.07	1	5.15	2.58	29.33	42.64	45.75	46.86	47.35	46.86	47.35	46.86	46.86	61.61
0.36	1.87	1.99	0.8	1.31	0.86	4.75	2.58	25.67	40.64	47.95	49.02	49.52	49.52	49.52	49.02	49.02	60.23
1.66	1.87	0.32	1.27	1.43	0.89	5.15	2.56	17.86	40.64	53.86	55.26	55.96	55.96	53.13	53.13	52.42	60.23

3.23	1.23	0.33	1.13	1.42	0.94	5.15	2.83	15.98	43.04	55.12	56.51	57.21	57.21	57.21	56.51	56.51	57.04
1.87	2.3	0.39	0.32	1.31	0.99	1.78	2.52	16.71	49.23	55.18	56.4	57.07	57.07	57.07	56.4	56.4	56.51
1.89	1.89	1.62	2.58	0.25	0.62	2.1	2.5	18.81	50.93	56.37	57.04	57.43	57.43	57.43	57.04	57.04	55.26
2.9	2.9	2.51	2.84	0.24	0.62	2.18	3.92	18.77	49.98	58.03	58.43	58.63	58.63	58.63	58.43	58.43	52.42
2.31	2.5	2.51	1.54	1.27	0.62	2.18	10.25	27.1	55.02	60.05	61.61	61.68	61.68	61.68	61.61	60.23	52.42
2.02	2.02	1.62	0.56	1.42	0.84	2.61	10.25	28.75	57.5	61.81	62.7	62.73	62.73	62.7	62.7	62.7	55.26
1.52	1.52	0.42	1.71	0.9	1.39	2.54	12.89	28.51	55.32	61.8	63.47	63.78	63.78	63.47	63.47	63.47	56.51
0.89	0.89	0.56	1.71	0.69	1.42	2.4	10.99	29.14	55.32	61.81	63.71	63.71	64.24	63.71	63.71	63.71	56.4
0.73	0.89	0.67	1.7	0.68	1.36	3.37	4.17	29.37	51.74	62.14	63.26	63.26	63.68	63.26	63.83	63.83	61.61
0.82	0.82	0.73	1.45	0.71	1.34	3.15	4.17	33.73	53.25	62.14	63.05	63.05	63.37	63.05	63.05	62.61	63.83
1.12	1.12	1.12	1.61	0.76	2.24	3.12	10.47	42.7	57.01	61.87	62.75	62.75	63.19	62.75	62.75	62.32	62.32
1.89	1.89	1.89	1.75	1.05	1.9	3.88	11.82	42.64	57.61	62.48	63.3	63.3	63.3	63.3	63.3	62.91	62.91
1.89	2.15	1.89	1.74	0.9	1.1	3.9	12.75	42.64	58.75	63.01	63.69	63.69	63.69	63.69	63.38	63.38	63.38
2.15	2.15	1.92	1.53	0.85	1.1	3.94	20.77	43.16	59.2	63.37	64.23	64.23	64.23	64.23	63.66	63.66	63.38
2.22	2.22	1.91	1.32	0.86	1.13	3.23	15.43	39.02	59.64	63.71	64.72	64.72	64.72	64.72	63.84	63.66	63.38
2.01	2.01	1.54	0.94	0.68	2.07	2.87	18.55	39.02	60.27	63.98	65.43	65.43	65.43	65.43	64.65	63.84	63.38
1.88	2.01	1.54	1.2	0.68	2.24	2.87	18.55	43.97	61.96	65.31	66.25	66.25	66.25	66.25	65.31	63.84	63.38
2	2.13	1.66	1.03	0.77	1.92	2.83	18.42	44.48	63.04	66.14	67.09	67.09	67.09	67.09	66.14	64.12	63.38
1.91	2	1.78	1.36	1.09	1.92	2.79	18.42	43.21	63.72	68.08	68.77	67.91	67.91	67.91	67.03	64.12	63.38
2.05	2.09	2.12	1.16	0.92	0.95	2.7	23.04	45.01	64.65	69.24	69.74	69.74	69.74	68.77	69.24	64.65	63.38
2.06	2.09	1.78	0.93	1.02	1.52	2.7	27.1	45.54	66.12	70.55	70.84	70.84	70.84	70.84	70.55	65.31	63.38
2	2.06	1.44	1.53	0.96	1.61	2.76	28.75	46.07	67.7	71.95	73.38	73.44	72.09	72.09	71.95	66.14	63.38
1.66	1.69	1.7	1	0.84	1.61	2.79	28.75	45.13	70.46	74.81	76.21	76.21	74.86	73.38	73.38	67.03	63.66
1.7	1.69	1.8	0.97	0.84	1.52	2.79	28.51	46.57	70.46	76.83	76.98	76.98	76.98	74.81	73.38	68.08	63.84
1.7	1.69	1.9	1.17	0.95	1.83	2.75	33.73	46.57	70.46	76.98	76.98	76.98	76.98	76.21	74.81	68.08	64.12
2.19	2.21	2.02	1.64	1.18	1.42	2.65	38.33	46.57	71.95	76.98	76.98	76.98	76.98	76.83	76.21	68.08	65.31
2.14	2.14	2.07	1.98	1.26	1.4	2.74	42.7	47.04	71.95	76.98	76.98	76.98	76.98	76.98	76.21	69.24	67.03
2.14	2.14	2.14	2.11	1.71	0.86	2.85	43.16	46.33	74.81	76.98	76.98	76.98	76.98	76.98	76.83	69.24	68.08
2.14	2.14	2.09	2.09	1.66	1.42	2.83	43.04	46.33	71.95	76.98	76.98	76.98	76.98	76.21	76.21	70.55	68.08
2.14	2.14	1.91	1.94	1.26	1.56	2.72	43.16	49.02	66.14	76.21	76.98	76.98	76.98	69.24	76.21	71.95	68.08
1.87	1.89	1.91	1.94	2.03	1.06	2.53	43.53	49.02	62.75	64.65	68.77	70.84	69.24	64.12	74.81	71.95	68.08
2.21	2.21	2.25	2.15	2.04	0.95	2.53	43.53	52.42	61.61	63.83	63.3	64.23	63.66	62.61	74.81	73.38	69.24
2.27	2.27	2.23	2.36	1.72	1.7	2.72	43.95	52.42	56.4	58.43	63.47	63.83	63.71	62.7	74.81	74.81	70.55
2.12	2.27	2.28	2.28	1.77	1.68	2.72	43.21	55.26	56.51	57.21	57.43	60.23	58.43	58.43	74.81	76.21	71.95
2.09	2.09	2.26	2.26	1.78	1.79	2.85	45.5	56.51	57.21	57.21	57.07	57.07	56.4	57.04	73.38	76.21	71.95
2.09	2.09	2.26	2.39	1.68	1.99	2.54	47.48	56.4	57.07	57.07	57.07	57.07	57.07	57.04	70.55	76.83	73.38
2.3	2.3	2.3	2.39	1.94	3.29	3.83	49.88	56.4	57.07	57.07	57.07	57.07	57.07	58.43	68.08	76.83	73.38
2.55	2.55	2.55	2.51	1.91	3.4	10.25	51.42	57.04	57.04	57.43	57.43	57.43	57.43	58.43	65.31	76.83	74.81
2.55	2.55	2.55	2.23	2.43	3.3	13.57	51.42	58.43	58.43	58.63	58.63	58.63	58.43	57.04	63.66	76.21	76.21
2.92	2.23	2.23	2.23	2.44	3.3	11.56	51.22	60.23	60.23	58.63	58.63	58.63	58.43	57.04	62.32	73.38	76.83
2.4	2.4	1.82	1.82	2.79	3.46	11.56	53.18	60.23	60.23	60.23	60.23	60.23	60.23	57.04	63.83	70.55	76.98
2.4	2.4	1.82	1.37	2.82	3.46	5.07	56.09	61.61	61.61	61.61	61.61	61.68	61.61	58.43	62.7	68.08	76.98
1.83	1.83	1.37	1.37	3.42	1.95	12.3	56.81	62.49	62.7	62.7	62.7	62.7	62.7	61.61	60.23	65.31	76.83
2.13	1.83	2.13	1.55	2.61	4.43	12.75	58.09	62.83	63.47	63.47	63.47	63.47	63.47	62.7	58.43	63.66	74.81
2.13	2.13	2.13	2.13	2.49	4.82	13.91	57.94	62.86	63.71	63.71	63.71	63.71	63.47	63.47	57.04	62.32	71.95
2.65	2.65	2.65	3.39	1.29	4.95	13.91	59.11	62.86	63.71	63.71	63.71	63.71	63.71	63.71	58.43	63.83	69.24
3.39	2.65	2.65	2.61	1.27	4.95	13.19	58.86	63	63.83	63.83	63.83	64.4	63.83	63.71	61.61	62.7	66.14
2.71	2.24	2.24	2.61	0.77	5.29	13.19	58.86	62.73	63.26	63.26	63.26	63.68	63.26	63.71	62.7	60.23	64.12
2.71	2.24	1.59	1.76	1.72	5.47	15.4	59.11	62.61	63.05	63.37	63.37	63.37	63.05	63.71	63.47	58.43	62.91
1.82	1.59	1.59	1.22	1.9	2.11	23.2	59.7	62.61	62.75	63.19	63.19	63.19	62.75	63.71	63.71	57.04	62.73
1.28	1.59	1.59	1.28	1.9	2.11	17.39	60.61	62.32	63.3	63.69	63.69	63.19	62.75	63.71	63.71	57.04	63.71
0.61	0.61	0.63	0.65	0.71	0.54	0.53	0.65	0.74	0.66	0.68	0.76	2.16	4.27	4.53	4.65	5.16	5.64
0.62	0.63	0.65	0.66	0.68	0.53	0.49	0.65	0.73	0.65	0.67	0.80	2.12	4.09	4.33	4.43	4.93	5.44
0.64	0.65	0.67	0.67	0.60	0.52	0.46	0.61	0.71	0.62	0.67	0.86	2.07	3.73	3.97	4.02	4.52	5.06
0.66	0.67	0.71	0.66	0.57	0.53	0.43	0.55	0.62	0.58	0.69	0.94	2.03	3.33	3.55	3.54	4.01	4.58
0.68	0.69	0.74	0.64	0.55	0.53	0.42	0.49	0.56	0.54	0.79	1.09	2.01	2.88	3.16	3.08	3.49	4.06
0.69	0.69	0.76	0.60	0.55	0.53	0.40	0.46	0.53	0.60	1.01	1.29	2.00	2.48	2.88	2.74	3.08	3.67
0.71	0.69	0.76	0.55	0.54	0.52	0.40	0.43	0.49	0.76	1.27	1.50	1.90	2.21	2.72	2.58	2.86	3.50
0.74	0.69	0.73	0.52	0.51	0.49	0.42	0.46	0.52	0.99	1.44	1.64	1.81	2.09	2.65	2.66	2.92	3.68
0.76	0.70	0.68	0.52	0.49	0.49	0.48	0.62	0.67	1.24	1.48	1.69	1.75	2.19	2.73	3.03	3.30	4.21
0.79	0.71	0.61	0.54	0.49	0.52	0.60	0.87	0.93	1.35	1.47	1.68	1.74	2.43	3.02	3.66	3.98	5.02
0.81	0.71	0.56	0.56	0.54	0.58	0.78	1.15	1.26	1.38	1.50	1.64	1.82	2.81	3.62	4.59	4.96	6.06
0.82	0.68	0.55	0.59	0.60	0.71	0.98	1.33	1.54	1.36	1.54	1.64	1.94	3.23	4.46	5.64	6.03	7.13
0.80	0.64	0.56	0.62	0.67	0.88	1.16	1.42	1.67	1.41	1.62	1.60	2.18	3.76	5.70	6.77	7.14	8.13
0.75	0.62	0.58	0.64	0.72	1.08	1.26	1.47	1.69	1.51	1.67	1.68	2.52	4.39	7.44	8.24	8.20	9.36
0.69	0.63	0.60	0.65	0.72	1.14	1.29	1.51	1.63	1.65	1.74	1.89	3.01	5.13	9.61	10.05	9.59	10.95
0.67	0.64	0.61	0.65	0.69	1.06	1.27	1.56	1.54	1.77	1.81	2.21	3.69	6.10	11.57	12.10	11.32	12.93
0.68	0.66	0.61	0.64	0.64	0.84	1.19	1.58	1.59	1.91	1.90	2.65	4.47	7.25	12.57	13.71	14.00	15.27
0.68	0.68	0.61	0.62	0.59	0.67	1.12	1.62	1.68	2.00	2.01	3.11	5.32	8.56	12.96	15.47	17.37	18.31
0.66	0.69	0.61	0.61	0.54	0.57	1.09	1.60	1.85	2.05	2.12	3.51	6.14	9.86	13.17	17.60	21.31	21.89

0.62	0.70	0.61	0.60	0.50	0.54	1.14	1.56	1.96	2.05	2.20	3.81	6.87	11.27	14.33	20.82	24.69	25.32
0.60	0.70	0.62	0.59	0.48	0.56	1.22	1.53	1.99	2.00	2.28	4.01	7.63	13.26	16.21	23.68	26.91	27.42
0.59	0.68	0.64	0.59	0.47	0.65	1.29	1.48	1.96	1.90	2.36	4.18	8.33	16.20	19.68	26.81	28.77	29.22
0.59	0.66	0.66	0.58	0.48	0.80	1.33	1.49	1.89	1.83	2.42	4.35	9.09	20.19	23.97	29.31	30.51	30.69
0.59	0.63	0.68	0.58	0.51	0.96	1.38	1.48	1.85	1.77	2.52	4.60	9.94	24.41	28.13	31.79	32.39	32.39
0.58	0.61	0.69	0.59	0.58	1.08	1.40	1.53	1.78	1.80	2.63	4.98	11.20	28.40	31.51	34.01	34.39	34.15
0.59	0.60	0.70	0.61	0.73	1.18	1.40	1.63	1.72	1.83	2.79	5.52	13.25	31.34	32.96	35.65	36.09	35.62
0.60	0.59	0.70	0.66	0.91	1.26	1.38	1.77	1.67	1.92	2.99	6.28	16.42	33.01	34.24	38.18	38.31	37.51
0.63	0.59	0.70	0.71	1.06	1.30	1.37	1.82	1.61	2.04	3.19	7.38	20.94	34.40	36.44	42.81	41.17	39.80
0.67	0.59	0.70	0.78	1.15	1.29	1.32	1.82	1.59	2.13	3.57	8.54	24.57	34.59	40.36	49.61	44.97	41.26
0.70	0.60	0.70	0.84	1.20	1.23	1.31	1.79	1.60	2.20	4.11	9.54	27.03	35.05	48.05	59.22	52.48	43.00
0.72	0.62	0.70	0.89	1.23	1.18	1.39	1.79	1.62	2.32	5.05	10.85	28.63	36.91	58.71	69.57	63.52	45.55
0.72	0.65	0.71	0.91	1.23	1.18	1.57	1.75	1.68	2.50	6.19	12.81	31.24	42.34	69.57	79.63	76.76	48.80
0.72	0.69	0.73	0.93	1.22	1.24	1.65	1.71	1.74	2.79	7.13	14.63	32.59	52.68	79.36	88.79	88.61	52.76
0.72	0.72	0.76	0.99	1.19	1.31	1.62	1.68	1.81	3.18	8.12	18.32	34.13	64.82	86.91	98.96	99.27	55.38
0.73	0.75	0.85	1.10	1.15	1.35	1.41	1.66	1.89	3.60	9.74	22.91	36.08	76.31	96.79	109.69	108.28	59.38
0.73	0.76	0.99	1.20	1.11	1.36	1.25	1.67	2.00	4.13	11.69	27.32	39.47	84.76	107.82	121.09	117.68	65.20
0.74	0.78	1.17	1.28	1.12	1.36	1.16	1.67	2.10	4.80	15.18	29.98	44.72	91.98	120.11	129.47	125.44	73.70
0.75	0.80	1.22	1.32	1.16	1.37	1.17	1.66	2.21	5.84	19.65	32.20	52.94	99.79	129.69	136.28	132.32	81.98
0.76	0.81	1.16	1.34	1.21	1.38	1.26	1.67	2.35	7.24	23.23	33.96	63.93	109.82	137.22	141.19	137.83	90.03
0.76	0.82	1.07	1.37	1.26	1.38	1.43	1.65	2.59	9.08	26.63	36.82	76.61	121.02	142.75	145.74	142.57	98.87
0.77	0.84	1.10	1.39	1.30	1.37	1.55	1.66	2.87	11.42	28.74	40.92	90.12	131.43	147.03	148.86	146.04	109.88
0.77	0.87	1.24	1.41	1.32	1.37	1.61	1.65	3.13	14.08	30.03	48.09	104.07	140.17	151.55	152.34	149.89	122.57
0.84	0.94	1.36	1.41	1.33	1.37	1.71	1.67	3.36	16.73	30.82	58.33	117.59	146.53	156.05	156.20	153.95	133.86
0.96	1.06	1.40	1.40	1.34	1.38	1.76	1.66	3.63	19.09	30.95	71.54	127.90	150.97	160.57	160.54	158.15	142.29
1.14	1.20	1.37	1.37	1.34	1.40	1.86	1.67	4.01	21.27	32.72	85.32	134.67	154.78	164.51	164.79	161.74	149.34
1.25	1.28	1.35	1.34	1.34	1.43	1.96	1.74	4.51	23.22	34.71	98.07	138.98	158.74	168.14	169.12	164.81	156.11
1.29	1.29	1.31	1.30	1.33	1.42	2.10	1.83	5.05	25.18	39.45	108.16	142.89	162.64	171.30	173.13	167.15	162.19
1.28	1.27	1.28	1.26	1.31	1.43	2.15	1.94	5.60	26.46	47.02	117.69	147.93	167.25	175.32	177.90	169.91	167.05
1.27	1.26	1.26	1.22	1.33	1.35	2.19	2.03	6.14	28.01	58.26	126.79	153.00	171.61	178.91	181.78	172.49	169.76
1.28	1.27	1.26	1.21	1.33	1.33	2.18	2.16	6.67	29.37	71.80	135.58	158.17	176.19	182.65	185.21	175.63	171.33
1.28	1.28	1.25	1.20	1.35	1.32	2.14	2.31	7.30	29.62	86.21	143.52	163.09	180.65	186.43	187.94	179.43	172.53
1.25	1.25	1.26	1.19	1.36	1.40	2.03	2.43	7.90	31.51	99.72	151.21	168.02	184.67	190.33	190.42	183.51	174.07
1.28	1.28	1.26	1.18	1.36	1.52	1.87	2.56	8.77	33.73	112.35	158.94	172.99	187.46	193.42	192.15	186.91	175.94
1.28	1.26	1.17	1.16	1.36	1.60	1.74	2.69	9.52	36.79	123.26	166.52	178.69	189.65	196.16	194.02	190.02	179.26
1.29	1.23	1.05	1.10	1.36	1.66	1.68	2.79	10.83	39.48	132.37	173.50	184.86	191.65	198.80	196.44	193.17	184.05
1.25	1.12	0.83	1.00	1.36	1.67	1.67	2.93	11.96	43.96	139.23	179.36	189.81	192.96	200.82	198.85	195.75	189.01
1.22	1.05	0.67	0.91	1.37	1.68	1.68	3.08	13.54	48.71	144.01	184.20	193.85	194.37	201.39	200.31	196.86	192.41
1.18	1.01	0.61	0.92	1.39	1.63	1.73	3.27	15.19	55.81	146.05	187.75	197.55	196.35	203.44	203.51	199.34	196.49
1.16	1.03	0.65	1.02	1.39	1.54	1.78	3.45	17.58	63.53	147.01	190.49	201.18	198.83	205.52	206.63	201.74	199.70
1.14	1.09	0.79	1.17	1.40	1.47	1.85	3.64	19.17	71.73	147.84	193.16	204.73	201.68	207.57	209.32	204.11	202.25
1.16	1.15	1.01	1.27	1.40	1.49	1.95	3.91	21.51	78.58	150.06	195.67	207.23	203.79	208.56	210.54	205.68	203.53
1.18	1.21	1.20	1.38	1.44	1.63	2.01	4.20	22.95	85.93	152.46	197.41	210.36	206.64	210.19	212.16	208.28	205.42
1.24	1.28	1.37	1.47	1.46	1.84	2.05	4.55	25.15	93.89	155.28	198.27	212.85	209.44	211.84	213.75	211.23	207.39
1.27	1.34	1.47	1.56	1.50	1.97	2.11	4.84	27.45	100.55	157.53	197.89	213.32	211.67	213.12	215.03	213.82	209.16
1.31	1.42	1.59	1.65	1.51	2.00	2.15	5.23	29.63	102.82	159.07	197.11	212.28	213.64	214.39	216.36	216.13	211.32
1.37	1.51	1.69	1.75	1.57	1.94	2.20	5.68	31.12	100.79	159.52	195.58	208.91	215.99	216.29	218.30	218.66	214.55
1.46	1.63	1.78	1.84	1.60	1.86	2.25	6.30	31.42	96.62	158.99	194.02	206.04	218.30	218.33	220.31	220.92	218.17
1.56	1.72	1.85	1.91	1.61	1.83	2.28	7.00	31.80	93.72	158.10	192.70	205.40	220.47	220.40	222.19	222.88	221.50
1.64	1.79	1.88	1.96	1.62	1.84	2.31	7.65	32.37	92.62	157.05	191.01	205.96	222.27	222.21	223.70	224.43	223.98
1.71	1.82	1.90	2.00	1.60	1.84	2.34	8.20	33.33	93.05	156.72	189.28	206.16	223.52	223.54	224.69	225.47	225.40
1.77	1.85	1.93	2.04	1.63	1.89	2.42	8.54	34.07	95.28	156.87	187.55	204.74	223.91	224.19	225.03	225.90	225.85
1.82	1.90	1.98	2.09	1.63	1.93	2.51	8.86	35.38	99.41	158.10	186.84	202.49	223.10	224.13	224.74	225.72	225.55
1.87	1.97	2.06	2.15	1.63	1.97	2.64	9.32	36.77	105.15	159.67	186.87	200.10	220.32	223.21	223.67	224.77	224.47
1.93	2.06	2.16	2.23	1.68	1.98	2.80	10.02	38.11	109.77	161.89	187.81	198.47	215.48	221.72	222.12	223.28	223.01
1.99	2.15	2.25	2.33	1.77	1.86	3.03	10.97	39.78	113.91	164.06	188.51	197.09	208.87	219.69	220.15	221.35	221.29
2.06	2.25	2.34	2.43	1.88	1.75	3.26	12.16	41.35	118.32	166.58	189.21	195.82	201.91	217.37	218.19	219.38	219.72
2.16	2.33	2.40	2.52	1.97	1.67	3.50	13.59	43.03	124.08	168.93	189.27	194.10	195.63	214.22	216.10	217.30	218.12
2.27	2.40	2.44	2.59	2.04	1.74	3.73	14.98	45.32	130.04	171.36	189.33	192.37	191.21	209.94	214.22	215.45	216.77
2.39	2.45	2.46	2.61	2.08	1.80	3.92	15.83	49.24	135.53	173.93	189.56	191.23	189.01	204.57	212.82	214.17	215.88
2.50	2.49	2.47	2.63	2.11	1.87	4.10	16.73	55.27	139.63	176.27	189.80	190.43	188.34	198.05	211.40	212.97	214.92
2.59	2.53	2.45	2.62	2.12	1.85	4.23	17.93	62.56	142.92	178.57	190.31	190.36	188.93	191.89	210.03	212.03	214.05
2.66	2.58	2.43	2.60	2.12	1.79	4.33	19.70	69.70	146.08	181.26	191.22	190.95	190.72	187.70	208.64	211.61	213.55
2.71	2.61	2.42	2.58	2.13	1.70	4.43	20.96	74.75	149.31	183.55	192.21	191.69	192.81	185.87	206.20	211.23	212.94
2.75	2.67	2.41	2.58	2.16	1.72	4.47	22.89	78.13	152.87	185.87	193.61	192.74	195.14	186.57	202.79	211.26	212.63
2.87	2.80	2.44	2.64	2.20	1.91	4.53	24.37	80.92	156.35	188.07	195.69	194.27	197.38	189.22	198.76	211.73	212.77
3.17	3.05	2.51	2.73	2.31	2.24	4.58	24.86	84.44	159.44	190.77	198.37	196.44	199.69	193.28	195.53	212.80	213.76
3.63	3.39	2.62	2.85	2.47	2.52	4.55	25.13	89.82	161.16	193.02	200.69	198.40	201.16	197.26	193.38	213.17	214.80
4.05	3.71	2.74	2.90	2.66	2.69	4.60	25.28	95.57	162.19	195.10	202.60	200.29	202.18	200.85	193.23	212.40	216.07
4.23	3.94	2.81	2.91	2.84	2.76	4.64	26.43	101.41	162.91	196.55	203.84	202.01	202.73	203.61	194.72	209.92	217.27

4.24	4.06	2.97	2.98	2.97	2.86	4.73	27.42	106.51	164.25	197.13	204.06	203.41	202.90	205.28	197.20	205.90	218.12
4.19	4.11	3.18	3.16	3.01	2.98	4.84	28.75	112.03	166.44	196.99	203.65	204.56	202.78	205.85	199.90	201.44	218.28
4.20	4.15	3.54	3.50	3.04	3.10	5.01	31.03	118.67	169.41	196.94	203.42	205.43	202.53	205.52	202.38	197.84	217.12
4.24	4.19	3.83	3.81	3.06	3.18	5.31	33.75	125.32	172.68	197.60	204.42	206.19	202.30	204.61	204.25	195.96	213.79
4.30	4.22	4.05	4.01	3.01	3.24	5.72	36.16	131.73	175.99	199.30	206.64	207.07	202.33	203.46	205.36	195.80	207.97
4.37	4.24	4.11	4.09	2.98	3.26	6.25	38.23	136.60	178.85	201.25	208.90	207.96	202.40	202.02	205.31	196.61	200.91
4.42	4.24	4.11	4.10	3.08	3.28	7.01	40.43	139.93	181.39	203.35	210.57	209.24	202.90	200.90	204.66	198.17	195.25
4.46	4.23	4.10	4.14	3.21	3.35	7.81	42.71	142.37	183.49	204.92	211.01	210.28	203.57	200.13	203.56	199.92	192.70
4.51	4.27	4.15	4.24	3.35	3.42	8.77	45.92	144.41	185.11	205.57	210.40	210.52	204.21	199.82	202.32	201.49	192.81
4.57	4.35	4.25	4.39	3.44	3.50	10.37	49.86	146.25	186.68	205.49	208.93	209.62	204.83	200.15	201.29	202.73	194.64
4.67	4.48	4.40	4.55	3.50	3.52	12.42	55.61	148.61	188.02	204.81	207.13	207.94	205.11	200.60	200.11	202.98	196.67
4.75	4.57	4.52	4.66	3.52	3.45	14.89	63.65	151.01	189.06	204.04	205.20	205.91	204.94	200.41	198.21	201.61	197.93
4.80	4.63	4.60	4.71	3.49	3.31	17.78	73.17	155.88	192.03	205.64	206.04	206.55	206.57	201.39	197.65	200.82	200.02
4.82	4.64	4.65	4.73	3.35	3.20	21.61	83.01	161.92	195.59	208.38	207.88	208.30	208.77	202.72	197.69	200.07	201.72
4.66	4.48	4.53	4.60	3.21	3.20	26.16	93.60	168.51	198.90	209.02	207.70	208.29	208.80	202.55	196.49	197.64	200.72
4.32	4.16	4.25	4.32	3.08	3.23	31.55	104.54	174.71	201.19	210.16	207.90	209.18	209.67	204.33	197.42	197.07	200.54
3.80	3.68	3.79	3.92	3.04	3.32	37.84	114.86	180.02	202.50	210.03	207.00	209.35	209.67	205.97	198.47	196.52	199.60
3.46	3.36	3.49	3.68	3.09	3.40	48.39	123.08	184.22	203.25	209.38	205.62	209.09	209.15	207.05	199.38	196.01	198.31
3.27	3.18	3.33	3.59	3.14	3.47	62.09	129.32	188.07	204.45	209.21	204.82	208.84	208.56	207.55	200.37	195.88	197.26
3.25	3.16	3.33	3.62	3.15	3.54	77.23	133.54	191.45	206.21	209.50	204.46	208.37	207.74	207.19	201.31	195.95	196.37
3.23	3.15	3.34	3.64	3.16	3.61	87.75	136.25	194.36	208.47	210.35	204.70	208.07	207.14	206.62	202.47	196.44	195.99
3.24	3.15	3.32	3.64	3.15	3.64	93.51	137.24	195.77	209.67	210.68	204.56	207.51	206.40	205.80	202.91	196.49	195.49
2.10	2.10	2.09	2.09	2.10	2.05	2.01	1.90	1.68	1.48	1.40	1.40	1.40	1.40	1.36	1.33	1.35	1.44
2.10	2.10	2.10	2.10	2.10	2.05	2.01	1.90	1.75	1.48	1.41	1.40	1.41	1.40	1.36	1.33	1.35	1.44
2.10	2.10	2.10	2.10	2.10	2.05	2.01	1.95	1.75	1.48	1.41	1.40	1.41	1.39	1.36	1.33	1.38	1.48
2.10	2.10	2.10	2.10	2.10	2.10	2.05	1.95	1.81	1.51	1.41	1.41	1.41	1.39	1.36	1.32	1.38	1.48
2.14	2.14	2.14	2.14	2.14	2.10	2.10	2.00	1.86	1.51	1.41	1.41	1.41	1.38	1.34	1.34	1.41	1.53
2.14	2.14	2.14	2.14	2.14	2.14	2.10	2.05	1.86	1.54	1.41	1.41	1.41	1.38	1.34	1.34	1.41	1.53
2.14	2.14	2.17	2.18	2.18	2.18	2.14	2.10	1.92	1.54	1.41	1.41	1.40	1.36	1.35	1.35	1.45	1.54
2.17	2.18	2.18	2.18	2.18	2.18	2.18	2.14	1.95	1.54	1.41	1.41	1.38	1.34	1.34	1.36	1.48	1.59
2.18	2.18	2.21	2.22	2.22	2.22	2.22	2.14	1.95	1.58	1.40	1.41	1.38	1.34	1.32	1.39	1.48	1.59
2.18	2.21	2.22	2.22	2.26	2.26	2.22	2.18	1.93	1.55	1.40	1.40	1.37	1.33	1.34	1.38	1.54	1.64
2.18	2.21	2.22	2.26	2.26	2.26	2.26	2.17	1.96	1.55	1.40	1.40	1.37	1.33	1.34	1.41	1.59	1.68
2.21	2.22	2.26	2.29	2.29	2.28	2.25	2.19	1.93	1.53	1.40	1.39	1.35	1.32	1.34	1.44	1.62	1.80
2.21	2.25	2.26	2.29	2.28	2.28	2.28	2.17	1.89	1.53	1.40	1.39	1.35	1.32	1.35	1.49	1.73	1.89
2.21	2.25	2.29	2.28	2.31	2.30	2.26	2.17	1.89	1.50	1.39	1.38	1.33	1.31	1.37	1.51	1.89	2.10
2.22	2.26	2.29	2.31	2.30	2.30	2.26	2.15	1.85	1.47	1.38	1.36	1.31	1.31	1.37	1.60	2.00	2.37
2.25	2.26	2.29	2.30	2.30	2.29	2.24	2.11	1.80	1.47	1.39	1.34	1.31	1.31	1.41	1.66	2.25	2.57
2.25	2.29	2.29	2.30	2.29	2.29	2.24	2.11	1.80	1.43	1.37	1.34	1.30	1.32	1.42	1.73	2.57	2.97
2.25	2.29	2.28	2.30	2.29	2.29	2.24	2.11	1.80	1.43	1.36	1.32	1.29	1.35	1.49	1.90	2.82	3.43
2.25	2.29	2.28	2.30	2.29	2.29	2.24	2.06	1.75	1.43	1.35	1.30	1.28	1.36	1.54	2.02	3.27	3.80
2.25	2.29	2.28	2.30	2.29	2.26	2.24	2.03	1.75	1.40	1.35	1.29	1.29	1.41	1.59	2.30	3.80	4.39
2.25	2.29	2.28	2.30	2.29	2.24	2.21	2.03	1.75	1.40	1.33	1.29	1.30	1.44	1.73	2.66	3.80	4.86
2.26	2.29	2.28	2.29	2.26	2.24	2.18	2.03	1.75	1.40	1.32	1.28	1.32	1.53	1.93	2.91	4.21	5.55
2.26	2.29	2.28	2.29	2.24	2.24	2.18	2.03	1.71	1.37	1.32	1.29	1.36	1.59	2.20	3.41	4.86	6.11
2.26	2.29	2.28	2.29	2.24	2.21	2.14	1.98	1.65	1.36	1.30	1.30	1.36	1.74	2.55	3.77	5.37	6.11
2.26	2.29	2.28	2.24	2.21	2.21	2.14	1.94	1.62	1.34	1.31	1.30	1.41	1.85	2.79	4.16	5.91	6.71
2.29	2.28	2.28	2.24	2.21	2.21	2.14	1.88	1.54	1.34	1.30	1.32	1.47	1.99	3.29	4.87	6.71	7.50
2.29	2.28	2.28	2.24	2.21	2.17	2.10	1.84	1.54	1.33	1.30	1.32	1.54	2.27	3.61	5.36	7.33	8.15
2.29	2.28	2.26	2.24	2.21	2.14	2.06	1.84	1.47	1.34	1.30	1.35	1.55	2.46	4.70	6.21	7.97	8.82
2.29	2.28	2.26	2.24	2.17	2.14	2.06	1.75	1.45	1.32	1.30	1.35	1.64	2.88	5.15	6.78	8.62	8.82
2.29	2.28	2.26	2.24	2.14	2.14	2.06	1.75	1.43	1.33	1.29	1.35	1.67	3.15	5.62	7.37	9.28	9.49
2.32	2.28	2.26	2.21	2.14	2.14	2.03	1.71	1.40	1.34	1.29	1.40	1.78	3.72	6.56	8.98	9.95	10.17
2.32	2.28	2.26	2.18	2.14	2.11	1.98	1.71	1.39	1.34	1.29	1.40	1.97	4.06	7.11	9.63	10.61	10.84
2.32	2.28	2.26	2.18	2.14	2.06	1.98	1.71	1.39	1.36	1.29	1.40	1.97	4.81	8.15	10.27	11.26	11.50
2.32	2.28	2.24	2.18	2.11	2.06	1.94	1.67	1.39	1.36	1.29	1.46	2.21	5.23	8.75	10.90	11.89	12.15
2.31	2.28	2.21	2.18	2.11	2.03	1.94	1.62	1.39	1.35	1.29	1.54	2.52	6.14	9.84	11.89	12.50	12.77
2.31	2.26	2.21	2.11	2.06	2.03	1.94	1.62	1.36	1.35	1.29	1.63	2.93	7.15	11.05	12.50	13.36	13.36
2.30	2.26	2.18	2.11	2.06	1.98	1.88	1.62	1.36	1.35	1.29	1.64	3.49	8.21	11.64	13.09	13.91	13.91
2.30	2.26	2.18	2.06	1.98	1.98	1.84	1.57	1.36	1.33	1.30	1.78	4.09	9.35	12.19	13.63	14.41	14.41
2.30	2.24	2.14	2.06	1.98	1.88	1.79	1.57	1.34	1.33	1.32	1.92	4.82	10.43	12.71	14.13	14.86	14.86
2.29	2.24	2.14	2.06	1.98	1.88	1.79	1.54	1.34	1.32	1.32	2.12	5.64	11.60	13.71	14.57	14.94	15.23
2.29	2.24	2.14	2.01	1.92	1.88	1.79	1.49	1.32	1.30	1.36	2.31	6.06	12.55	14.51	15.23	15.23	15.53
2.29	2.21	2.14	2.01	1.92	1.82	1.69	1.49	1.32	1.30	1.40	2.51	7.03	12.96	14.79	15.43	15.43	15.73
2.26	2.21	2.10	2.01	1.92	1.82	1.69	1.44	1.32	1.29	1.47	2.73	7.49	13.30	14.99	15.43	15.54	15.54
2.26	2.21	2.10	2.01	1.82	1.72	1.63	1.42	1.30	1.29	1.56	3.10	7.95	13.57	15.10	15.10	15.54	15.54
2.26	2.21	2.10	1.95	1.82	1.72	1.60	1.41	1.30	1.28	1.65	3.37	8.39	13.76	14.54	15.10	15.44	15.44
2.26	2.21	2.10	1.92	1.82	1.69	1.54	1.37	1.30	1.29	1.78	3.66	8.39	13.87	14.44	15.00	15.22	15.22
2.24	2.17	2.06	1.92	1.79	1.63	1.51	1.37	1.30	1.29	1.78	3.96	8.80	13.87	14.24	14.79	14.90	14.48
2.24	2.14	2.06	1.92	1.72	1.60	1.49	1.33	1.29	1.29	1.93	4.51	9.20	13.87	13.94	14.07	14.48	13.98

2.21	2.14	2.01	1.88	1.69	1.60	1.44	1.33	1.29	1.30	2.07	4.84	10.33	13.78	13.55	13.58	13.41	13.41
2.21	2.14	2.01	1.82	1.69	1.57	1.42	1.33	1.29	1.30	2.26	5.18	10.96	13.59	13.07	13.02	12.42	12.42
2.21	2.14	1.98	1.82	1.60	1.51	1.42	1.34	1.27	1.30	2.47	6.25	11.19	13.94	12.53	12.42	11.79	11.79
2.17	2.10	1.98	1.79	1.60	1.51	1.42	1.31	1.28	1.33	2.47	6.59	12.20	13.07	12.42	11.79	11.16	11.16
2.17	2.10	1.92	1.72	1.60	1.49	1.41	1.31	1.28	1.33	2.66	7.48	12.30	12.53	11.79	11.16	11.16	10.57
2.17	2.10	1.92	1.72	1.54	1.49	1.37	1.31	1.28	1.33	2.91	8.10	12.21	11.94	11.16	10.57	10.57	10.02
2.12	2.04	1.85	1.72	1.51	1.44	1.37	1.31	1.26	1.37	3.16	9.10	12.84	11.94	10.57	10.57	10.57	10.02
2.12	2.04	1.85	1.66	1.51	1.42	1.37	1.29	1.28	1.43	3.66	9.34	12.57	11.34	10.57	10.57	10.02	10.02
2.06	1.98	1.78	1.63	1.46	1.38	1.33	1.29	1.26	1.50	3.92	10.35	12.57	11.34	10.57	10.02	10.02	10.02
2.08	1.90	1.78	1.56	1.39	1.37	1.33	1.28	1.27	1.51	4.19	10.49	12.57	11.34	10.57	10.57	10.57	10.02
2.00	1.90	1.71	1.50	1.39	1.33	1.30	1.28	1.27	1.60	4.25	10.49	13.30	11.94	10.57	10.57	10.57	10.57
2.00	1.90	1.71	1.48	1.33	1.29	1.28	1.27	1.27	1.72	4.66	11.35	13.30	12.53	11.16	11.16	11.16	11.16
2.00	1.82	1.61	1.41	1.33	1.30	1.29	1.27	1.29	1.86	4.66	11.35	13.59	13.07	11.79	11.79	11.79	11.79
1.92	1.82	1.61	1.40	1.29	1.28	1.28	1.26	1.30	1.84	4.88	11.19	13.78	14.07	13.02	12.42	12.42	13.02
1.92	1.82	1.61	1.40	1.30	1.29	1.27	1.27	1.33	1.96	5.18	11.78	13.87	14.79	13.58	13.58	13.58	13.58
1.92	1.82	1.61	1.39	1.28	1.28	1.28	1.28	1.37	1.93	4.84	11.47	14.43	15.00	14.48	14.07	14.48	14.90
1.92	1.82	1.61	1.38	1.29	1.27	1.30	1.29	1.37	1.90	5.18	10.69	13.95	15.10	15.00	15.22	15.44	15.44
1.92	1.82	1.59	1.37	1.30	1.30	1.30	1.29	1.42	1.89	5.20	10.94	13.60	14.99	15.10	15.54	15.54	15.54
2.00	1.82	1.59	1.37	1.33	1.33	1.31	1.29	1.40	1.89	4.82	10.43	13.18	14.51	15.43	15.43	15.43	15.43
2.00	1.90	1.66	1.37	1.34	1.33	1.30	1.30	1.40	1.92	5.22	9.90	12.71	14.14	15.23	15.23	15.23	15.23
2.00	1.90	1.63	1.36	1.36	1.32	1.30	1.30	1.46	1.97	4.82	9.35	12.19	13.71	14.94	14.94	14.94	14.94
1.99	1.88	1.63	1.36	1.36	1.33	1.29	1.29	1.46	2.12	4.82	9.35	12.19	13.71	14.57	14.57	14.57	14.57
1.99	1.88	1.60	1.36	1.37	1.33	1.29	1.32	1.47	2.21	5.23	9.35	11.64	13.71	14.13	14.57	14.13	14.13
1.98	1.85	1.57	1.37	1.38	1.33	1.28	1.32	1.55	2.21	5.23	8.79	11.64	13.22	14.13	14.13	14.13	14.13
1.98	1.82	1.54	1.37	1.36	1.33	1.28	1.32	1.55	2.32	5.23	9.35	11.64	13.71	14.13	13.71	13.71	13.71
1.98	1.72	1.45	1.36	1.36	1.33	1.28	1.32	1.55	2.52	5.23	9.35	11.64	13.71	13.71	13.71	13.71	13.71
1.95	1.69	1.43	1.37	1.36	1.32	1.28	1.35	1.64	2.52	5.23	9.35	12.19	13.71	13.71	13.71	13.71	13.71
1.88	1.69	1.39	1.36	1.34	1.31	1.28	1.36	1.67	2.52	5.67	9.35	12.19	13.71	14.14	13.71	13.71	13.71
1.88	1.60	1.36	1.36	1.35	1.31	1.28	1.36	1.67	2.75	5.67	9.35	12.19	13.71	14.14	14.14	13.60	13.60
1.85	1.60	1.36	1.36	1.33	1.29	1.28	1.40	1.78	2.75	5.67	8.73	11.60	14.14	14.14	14.14	13.60	13.60
1.85	1.57	1.36	1.35	1.33	1.29	1.30	1.40	1.78	2.75	5.67	8.73	11.60	14.14	14.14	14.14	13.60	13.60
1.85	1.57	1.34	1.35	1.31	1.29	1.30	1.40	1.78	2.75	6.12	9.25	11.60	13.60	14.14	14.51	13.95	13.95
1.82	1.49	1.34	1.35	1.31	1.29	1.29	1.46	1.92	3.00	6.12	9.25	11.60	13.60	14.14	14.51	14.51	13.95
1.79	1.49	1.35	1.33	1.30	1.29	1.32	1.46	1.92	3.00	6.12	9.25	12.10	13.60	14.14	14.51	14.51	14.79
1.79	1.47	1.36	1.34	1.30	1.29	1.35	1.54	2.07	3.27	6.57	9.90	12.10	13.60	14.51	14.51	14.79	14.79
1.75	1.45	1.36	1.34	1.29	1.30	1.35	1.54	2.12	3.49	6.57	10.43	12.10	13.60	14.51	14.79	14.79	14.79
1.71	1.45	1.35	1.34	1.29	1.29	1.40	1.64	2.31	3.80	7.61	10.43	12.10	13.60	14.51	14.79	14.99	14.99
1.71	1.43	1.36	1.33	1.29	1.32	1.40	1.76	2.40	4.09	7.61	10.43	12.10	13.60	14.51	14.99	15.43	15.43
1.67	1.43	1.36	1.33	1.28	1.32	1.47	1.78	2.75	4.45	7.61	10.94	12.10	13.60	14.79	15.43	15.54	15.54
1.67	1.42	1.36	1.33	1.28	1.32	1.47	1.97	3.00	4.45	8.73	11.60	12.71	14.14	14.79	15.54	15.54	15.54
1.62	1.42	1.36	1.33	1.28	1.35	1.48	1.97	3.20	5.22	8.73	11.60	13.18	14.51	14.99	15.54	15.54	15.54
1.62	1.42	1.36	1.33	1.28	1.36	1.55	2.21	3.49	5.22	8.73	11.60	13.18	14.51	14.99	15.54	15.54	15.54
1.58	1.39	1.36	1.31	1.29	1.40	1.58	2.21	3.76	5.67	8.73	11.60	13.18	14.51	15.43	15.54	15.84	15.84
1.54	1.39	1.36	1.31	1.29	1.40	1.67	2.52	3.76	5.67	8.73	11.60	13.18	14.51	15.43	15.54	15.84	15.84
1.49	1.40	1.34	1.31	1.32	1.47	1.71	2.52	3.76	5.67	8.73	11.06	12.71	14.51	15.43	15.54	15.84	15.84
1.49	1.37	1.33	1.30	1.32	1.47	1.83	2.68	4.43	6.14	9.35	11.06	12.71	14.51	15.23	15.43	15.73	15.73
1.46	1.33	1.31	1.30	1.35	1.54	1.97	2.93	4.43	6.14	8.79	11.06	12.71	14.14	15.23	15.23	15.53	15.53
1.40	1.33	1.30	1.29	1.40	1.64	2.04	2.93	4.43	6.63	8.79	10.51	12.19	13.71	14.94	14.94	15.23	15.23
1.40	1.29	1.27	1.29	1.46	1.76	2.32	3.44	4.81	7.15	8.79	10.51	11.64	13.22	14.57	14.57	14.86	14.86
1.35	1.25	1.23	1.29	1.46	1.92	2.52	3.72	5.23	7.15	9.34	10.45	11.64	13.22	13.63	14.13	14.41	14.41
1.29	1.25	1.23	1.30	1.55	1.92	2.93	4.06	5.67	7.66	9.34	10.45	11.05	12.69	13.09	13.63	13.63	13.91
1.24	1.20	1.20	1.29	1.65	2.12	3.20	4.81	5.67	7.66	9.34	10.45	11.52	12.12	13.09	13.09	13.09	13.09
1.24	1.16	1.18	1.32	1.76	2.31	3.44	4.81	6.63	7.66	9.84	10.45	10.90	11.52	12.50	12.50	12.50	13.09
1.18	1.16	1.18	1.36	1.90	2.51	3.76	5.67	6.63	8.75	9.84	10.90	10.90	11.52	11.89	11.89	12.50	12.50
1.17	1.13	1.17	1.42	1.90	2.61	3.76	5.67	6.63	8.75	9.84	10.90	10.90	11.52	11.89	11.89	11.89	12.50
1.12	1.10	1.19	1.42	2.05	2.84	4.09	5.67	6.63	8.75	9.84	10.90	10.90	11.52	11.52	11.89	11.89	11.89
1.09	1.11	1.20	1.50	2.05	2.84	4.09	5.23	7.15	8.23	9.84	10.90	10.90	11.52	11.52	11.52	11.89	11.89
1.06	1.10	1.22	1.50	2.05	2.84	4.09	5.23	7.15	8.23	9.84	10.90	10.90	11.52	11.52	11.52	11.89	11.89
1.07	1.11	1.26	1.60	2.05	2.84	4.09	5.23	7.15	8.23	9.84	10.90	10.90	11.52	11.52	11.52	11.89	11.89
1.05	1.11	1.26	1.60	2.04	2.84	4.09	5.23	6.63	8.23	9.84	10.90	11.52	11.52	11.52	11.52	11.89	11.89
1.07	1.13	1.26	1.60	2.22	2.84	4.09	5.23	6.14	8.23	9.84	10.90	11.52	11.52	11.52	11.52	11.89	11.89
1.06	1.13	1.30	1.60	2.22	2.84	4.09	5.23	6.14	8.23	9.84	11.52	11.52	11.52	11.52	11.52	11.89	11.89
1.08	1.13	1.30	1.60	2.22	2.84	4.09	5.23	6.14	8.23	9.84	11.52	11.52	11.52	11.52	11.52	11.89	11.89
31.39	31.39	31.39	33.56	34.53	34.40	41.07	43.18	41.14	40.47	41.80	44.24	48.97	49.77	47.42	48.50	47.97	48.67
31.39	31.39	31.39	33.56	34.53	34.40	40.06	42.27	39.92	40.47	41.80	44.24	49.49	48.97	47.42	48.50	49.48	49.28
31.39	31.39	31.39	33.56	34.00	33.90	37.76	39.33	38.70	40.05	40.63	43.26	48.73	49.49	47.98	48.74	49.48	49.28
31.39	31.39	31.39	31.87	33.95	33.40	35.20	36.89	36.96	37.52	39.92	44.14	48.50	49.24	48.50	50.23	50.10	51.00
31.39	31.39	31.39	31.87	33.72	32.89	33.78	34.61	35.20	36.96	39.70	43.23	47.74	48.74	48.74	50.86	51.78	52.37
31.39	31.39	31.39	30.62	33.60	32.84	33.32	33.35	34.65	36.63	39.07	42.32	47.16	48.67	48.67	51.78	53.20	54.14
31.39	31.39	31.39	30.62	33.35	33.11	33.60	33.20	33.44	35.89	38.16	42.54	46.89	48.41	49.28	53.20	54.14	57.84

31.39	31.39	31.39	30.62	33.35	33.59	33.54	33.14	33.44	36.45	38.63	41.92	45.96	47.48	50.17	53.20	55.00	57.84
31.39	31.39	31.39	30.62	32.58	33.54	33.35	33.11	34.00	36.45	38.63	41.92	45.64	48.39	50.63	53.20	58.87	61.72
31.39	31.39	31.39	30.62	31.99	32.58	32.58	33.60	34.00	36.53	40.11	42.57	44.82	48.74	50.63	54.14	58.87	61.72
31.39	31.39	31.39	31.87	32.82	31.99	32.82	33.72	33.44	36.45	40.11	42.57	44.82	48.74	51.50	53.29	57.84	61.72
31.39	31.39	31.39	33.19	33.56	33.56	33.56	33.95	33.65	36.98	40.11	42.71	45.77	47.82	50.53	56.87	57.84	61.72
31.39	31.39	33.08	35.40	35.40	35.40	38.05	35.29	34.06	36.63	40.72	43.23	45.77	47.82	53.67	56.87	60.54	63.03
31.39	33.08	33.08	37.75	40.70	41.11	44.46	39.79	35.52	36.96	40.19	43.23	45.77	47.82	53.67	56.87	60.54	63.03
31.78	33.08	35.20	40.70	43.95	43.95	47.37	45.00	36.14	38.12	41.17	44.65	45.64	48.74	54.83	59.46	61.78	63.03
31.78	33.21	35.20	39.72	45.66	47.37	54.10	49.90	37.90	40.05	43.26	45.47	46.55	49.69	54.83	59.46	61.78	63.03
31.78	33.21	37.18	42.58	45.66	50.80	57.53	51.79	39.50	40.47	43.48	46.32	48.41	50.63	55.89	60.62	63.03	66.93
33.21	33.21	37.18	42.58	48.85	54.10	57.53	53.18	40.43	41.50	45.37	47.97	48.67	50.17	56.87	61.78	65.26	66.93
33.21	33.21	37.18	42.58	48.85	54.10	58.70	49.09	43.21	42.79	45.93	48.50	50.23	51.78	57.84	63.03	66.93	71.42
33.21	33.21	37.18	42.58	50.80	54.60	60.21	49.47	43.84	43.56	47.58	49.96	50.20	52.54	58.87	64.50	68.92	74.10
33.21	33.21	37.18	45.66	54.10	57.53	54.06	49.47	44.30	43.57	47.53	50.98	51.36	52.91	61.36	68.23	71.20	76.94
33.21	33.21	37.18	47.37	54.10	57.53	54.43	49.48	44.30	44.31	48.34	51.32	51.69	53.54	62.87	70.43	73.68	79.71
33.21	35.01	37.18	47.37	57.20	58.70	54.43	49.48	44.30	44.31	48.48	52.34	53.03	54.12	66.24	72.67	78.46	82.12
33.21	35.01	37.18	50.80	57.20	58.70	54.43	45.66	44.59	45.02	49.25	52.52	53.36	55.11	69.97	76.75	80.37	83.96
35.01	35.01	39.72	52.08	60.03	60.21	54.32	45.66	43.29	45.02	49.22	52.87	54.54	61.14	72.47	78.54	83.10	85.85
35.01	37.18	42.58	52.08	60.03	61.19	54.32	45.75	43.29	45.69	49.89	53.93	55.17	69.85	89.55	82.88	84.35	86.31
35.01	37.18	45.66	55.30	62.59	64.08	49.48	45.75	43.29	45.69	50.52	53.69	56.95	115.57	114.58	86.59	88.52	88.04
37.18	39.72	43.94	52.49	61.67	64.08	49.48	45.75	43.29	46.30	51.11	54.24	58.31	221.44	210.35	100.38	92.10	92.57
37.18	39.72	46.62	52.49	61.67	64.08	49.48	45.75	43.73	47.23	51.11	54.82	70.75	296.49	282.14	123.84	102.30	95.86
39.72	42.58	49.46	55.75	59.25	64.08	49.48	44.59	43.73	47.88	52.50	55.50	85.23	478.05	445.37	164.24	108.09	113.44
39.72	41.43	49.46	52.74	62.90	65.38	49.17	44.71	44.06	48.35	52.50	56.13	162.19	660.91	514.44	196.34	117.60	117.60
41.43	43.94	52.49	56.33	62.90	65.38	49.17	44.71	44.38	48.98	53.69	56.37	179.54	708.26	572.21	202.53	120.00	120.38
41.43	43.94	49.66	60.32	66.52	66.08	48.57	44.68	44.92	48.98	53.69	57.16	190.80	715.15	551.43	190.15	155.83	118.87
41.43	46.62	52.74	64.50	69.81	66.08	47.74	44.51	45.38	49.57	54.43	57.16	262.61	682.00	501.62	174.41	134.26	112.06
43.94	44.84	56.33	64.50	72.41	65.32	46.77	44.24	45.38	50.52	54.43	60.06	267.38	615.76	432.23	137.79	122.64	107.99
43.94	47.06	56.33	68.53	74.02	63.80	45.73	44.24	45.74	50.52	54.43	70.75	267.38	547.94	354.76	122.05	104.75	101.16
43.94	47.06	56.33	72.41	71.50	63.80	45.73	43.89	45.74	50.52	54.16	65.11	559.99	445.02	279.91	109.97	99.53	99.53
43.94	49.46	60.32	72.41	71.50	61.67	46.83	43.93	45.74	50.52	54.16	83.25	536.74	445.02	215.45	97.04	96.64	96.64
46.62	49.46	62.90	72.41	71.50	61.67	46.83	43.93	45.74	50.52	54.65	99.47	682.00	309.10	165.35	94.98	95.94	95.62
46.62	49.46	62.90	71.41	66.73	61.67	46.83	43.93	45.74	51.11	55.13	99.47	712.17	309.10	110.48	95.62	97.08	97.08
46.62	49.46	59.25	71.41	66.73	55.50	48.38	43.93	45.74	51.92	55.13	154.07	641.75	215.45	99.95	97.01	98.63	98.63
44.84	49.46	61.67	67.85	65.32	57.63	45.73	44.24	45.74	51.92	56.95	187.58	565.03	215.45	94.47	98.52	100.25	100.25
47.06	49.46	58.51	67.85	65.32	51.49	46.77	44.51	46.30	52.59	58.31	377.97	565.03	152.61	94.47	98.52	101.76	101.76
47.06	49.46	60.03	66.62	66.08	52.78	45.38	44.06	47.23	53.42	65.11	455.22	565.03	152.61	94.75	99.93	103.09	103.09
49.46	49.46	60.03	65.38	61.49	48.57	44.71	43.77	46.95	54.16	99.47	579.93	501.62	152.61	94.75	99.93	103.09	104.27
49.46	49.46	60.03	65.38	61.49	49.17	43.29	44.31	46.95	54.16	119.38	660.91	501.62	122.05	94.75	98.52	103.09	104.27
46.62	49.46	60.03	65.38	53.75	45.75	43.29	44.31	47.74	55.13	154.07	686.17	501.62	122.05	95.62	100.25	101.76	103.09
46.62	49.46	62.59	65.38	53.75	45.75	43.08	45.05	47.74	55.13	187.58	686.17	315.92	137.79	96.64	97.08	100.25	101.76
46.62	49.46	62.59	65.38	53.75	44.71	43.08	45.05	48.48	55.70	377.97	511.87	315.92	137.79	99.53	95.62	97.08	98.63
46.62	49.46	64.82	65.38	53.75	44.71	44.31	45.45	49.25	56.95	377.97	511.87	315.92	155.98	104.75	99.53	95.62	95.94
44.84	52.49	64.82	66.08	52.78	44.71	44.31	46.20	49.25	55.70	377.97	511.87	202.53	145.95	122.64	104.23	101.16	96.64
47.06	52.49	64.73	66.08	52.78	44.71	43.77	45.80	49.22	55.70	296.49	445.37	202.53	155.83	134.26	112.06	107.99	101.16
47.06	55.75	64.73	66.08	53.75	45.65	43.77	45.80	49.22	55.70	296.49	445.37	202.53	155.83	145.95	115.89	112.06	107.99
49.66	55.75	67.53	66.08	53.75	45.75	43.77	45.80	49.22	55.70	296.49	445.37	202.53	155.83	118.87	118.87	115.89	112.06
52.74	56.33	67.53	66.08	53.75	45.75	43.77	46.53	50.68	55.13	296.49	445.37	202.53	155.83	118.87	118.87	118.87	115.89
56.33	60.32	67.53	66.08	53.75	45.75	43.77	46.53	50.68	55.13	296.49	514.44	162.00	155.83	118.87	118.87	118.87	115.89
56.33	60.32	66.52	66.08	53.75	45.75	43.77	46.53	51.32	55.93	296.49	514.44	155.83	155.83	118.87	118.87	115.89	115.89
60.32	60.32	69.81	67.85	52.78	45.75	43.77	46.53	52.01	55.93	296.49	559.31	155.83	145.95	115.89	115.89	115.89	112.06
60.32	64.50	69.81	68.34	60.75	45.65	43.77	47.67	52.01	56.95	478.05	322.58	145.95	134.26	112.06	108.84	112.06	112.06
60.32	64.50	69.81	68.34	60.75	45.65	44.38	47.67	52.01	60.94	478.05	322.58	134.26	134.26	112.06	107.35	107.99	107.99
60.32	64.50	69.81	68.34	60.75	45.65	44.38	48.50	53.42	83.25	599.21	315.92	134.26	122.64	107.99	104.23	104.23	104.23
64.50	64.50	72.41	67.98	59.43	47.74	45.02	48.50	53.42	98.32	589.78	293.73	122.64	104.23	104.23	101.16	101.16	104.75
62.44	68.53	72.41	72.00	65.32	47.74	45.69	49.22	53.66	123.36	638.75	174.41	112.53	101.16	101.16	99.02	99.02	99.53
62.44	66.97	74.02	72.00	63.80	44.97	45.69	49.99	54.16	296.49	572.21	155.98	112.53	104.75	99.02	97.90	96.64	96.64
66.97	71.06	74.52	71.50	63.80	44.47	46.30	50.68	55.13	377.97	551.43	137.79	104.75	99.53	97.90	97.75	95.62	95.62
70.22	71.06	75.85	74.43	61.67	44.47	46.30	51.32	56.95	579.93	501.62	122.05	99.53	96.64	95.62	97.75	95.94	95.94
70.22	73.96	76.42	73.62	61.67	43.89	46.85	51.32	58.31	660.91	432.23	109.97	96.64	95.62	95.94	95.94	97.08	97.08
73.96	76.60	77.22	73.62	59.14	43.51	47.32	51.92	58.31	660.91	260.53	101.78	96.64	95.94	97.08	97.08	98.63	98.63
76.60	77.93	77.22	71.79	53.24	44.23	49.02	52.50	70.75	708.26	222.32	101.78	95.62	95.94	98.63	98.63	98.63	100.25
77.93	77.93	76.77	71.79	51.07	44.11	49.02	52.50	62.16	708.26	279.91	97.04	94.98	97.08	98.63	97.01	97.01	100.25
77.97	77.97	76.77	64.79	45.44	44.04	49.54	53.08	62.16	715.15	279.91	94.98	94.75	97.08	100.25	97.01	98.52	100.25
77.97	77.97	75.32	64.79	44.31	46.49	50.08	53.08	62.16	715.15	279.91	94.98	94.75	98.63	100.25	93.03	93.03	101.76
76.90	76.90	75.32	56.75	43.52	46.80	50.08	53.67	62.16	715.15	279.91	94.98	94.75	98.63	100.25	85.71	85.71	101.76
76.90	76.90	73.26	54.53	42.28	46.80	50.65	53.67	62.16	715.15	279.91	94.98	95.94	98.63	100.25	83.16	86.13	99.93
76.90	75.10	73.26	52.94	42.28	47.29	51.28	54.82	64.46	715.15	279.91	97.04	95.94	98.63	100.25	83.16	83.33	99.93
76.90	75.10	71.04	52.94	42.51	49.13	52.92	55.50	85.23	715.15	279.91	97.04	95.94	99.71	98.63	83.33	83.84	101.14
76.00	75.10	71.04	52.06	43.70	51.30	53.67	56.37	219.73	746.72	279.91	101.78	95.94	99.71	98.63	86.80	87.44	101.14

76.00	75.10	69.04	51.83	43.70	51.92	54.82	60.06	455.22	624.08	222.32	109.97	95.62	98.43	97.08	87.94	88.31	103.15
76.00	73.01	67.56	51.83	45.49	53.57	55.73	77.65	660.91	624.08	222.32	109.97	96.64	97.75	95.94	97.76	98.97	104.14
76.00	73.01	64.51	52.15	45.49	53.57	57.16	119.38	686.17	551.43	260.53	122.05	97.90	97.90	97.75	103.15	99.76	106.55
73.98	71.06	63.77	52.15	48.41	54.28	60.06	187.58	738.02	551.43	174.41	137.79	101.16	101.16	97.90	104.14	106.55	106.55
73.98	71.06	60.05	50.37	48.88	54.90	60.06	377.97	638.75	315.92	190.15	155.98	104.23	104.23	101.16	105.41	106.55	106.55
73.98	67.56	60.12	51.22	48.88	54.90	62.16	455.22	638.75	322.58	190.15	174.41	107.99	112.06	107.99	103.09	106.61	106.61
71.06	67.56	56.76	48.71	53.15	55.52	62.16	455.22	638.75	322.58	200.24	155.83	115.89	118.87	108.84	100.25	103.09	103.09
69.60	66.75	52.90	50.37	53.63	56.71	64.46	455.22	638.75	312.07	202.53	162.00	120.38	109.66	110.16	98.43	98.63	98.63
68.87	63.72	52.90	50.37	53.63	56.71	64.46	455.22	638.75	312.07	202.53	163.11	120.00	105.96	109.66	101.16	97.90	97.90
69.01	64.29	52.41	51.45	56.42	57.54	92.62	455.22	589.78	286.21	196.34	163.11	117.60	102.93	105.96	112.06	104.23	104.23
70.07	64.29	52.41	58.28	55.17	58.25	92.62	455.22	589.78	286.21	182.75	158.74	113.44	102.93	105.96	110.16	115.89	115.89
72.01	65.40	53.94	58.28	55.85	58.57	92.62	516.82	589.78	286.21	182.75	149.61	113.44	102.93	102.93	108.25	108.25	108.25
72.01	66.95	52.74	65.35	55.85	58.57	92.62	516.82	589.78	286.21	182.75	113.44	113.44	102.93	102.93	105.96	105.96	105.96
74.68	66.95	55.58	65.35	55.72	59.23	179.54	516.82	589.78	286.21	182.75	113.44	102.93	102.93	102.93	102.93	102.93	102.93
73.16	64.69	55.58	70.42	56.41	59.23	179.54	516.82	686.17	286.21	182.75	113.44	102.93	102.93	102.93	102.93	102.93	102.93
75.75	66.51	58.92	70.42	56.41	59.23	190.80	553.41	738.02	559.31	196.34	117.60	105.96	105.96	105.96	104.33	104.33	104.33
70.89	66.51	58.92	75.77	56.96	59.74	103.14	553.41	738.02	559.31	196.34	117.60	105.96	105.96	105.96	108.24	104.33	104.33
73.02	64.45	70.17	75.77	56.96	59.74	103.14	553.41	746.72	572.21	202.53	163.11	120.00	108.25	108.25	108.24	108.24	108.24
73.02	64.45	70.17	79.53	57.33	60.08	104.91	559.99	746.72	572.21	202.53	163.11	120.00	108.25	111.50	108.24	108.24	108.24
75.08	66.98	74.67	79.53	57.33	60.08	104.91	536.74	624.08	551.43	200.24	162.00	120.38	109.66	113.89	111.50	108.25	108.25
75.08	66.98	80.18	69.50	57.19	60.26	190.35	682.00	624.08	315.92	200.24	162.00	120.38	109.66	109.66	109.66	109.66	109.66
82.22	69.83	82.74	69.50	57.19	62.07	190.35	615.76	501.62	293.73	190.15	155.83	118.87	118.87	110.16	110.16	110.16	110.16
82.22	72.99	82.74	62.16	57.90	62.05	242.20	641.75	501.62	293.73	155.83	118.87	118.87	118.87	110.16	109.85	109.85	109.85
83.35	75.24	84.35	58.32	58.79	70.26	423.26	547.94	260.53	174.41	145.95	115.89	115.89	115.89	109.85	108.84	112.06	112.06
89.42	75.24	81.08	58.03	58.88	95.75	527.75	484.37	260.53	174.41	145.95	115.89	115.89	115.89	109.85	112.06	107.99	107.99
83.86	75.74	80.47	57.36	59.98	163.20	430.85	395.09	222.32	155.98	134.26	112.06	112.06	112.06	112.06	107.35	107.99	107.99
83.86	78.24	75.40	57.20	60.08	144.32	430.85	354.76	222.32	134.26	112.06	112.06	112.06	112.06	112.06	107.35	107.35	107.35
80.57	76.99	72.38	57.20	60.08	144.32	345.98	279.91	184.90	122.64	107.99	107.99	107.99	107.99	122.64	107.35	107.35	107.35
79.09	77.58	61.87	57.12	60.34	125.05	345.98	279.91	184.90	122.64	107.99	107.99	107.99	122.64	122.64	107.35	113.27	113.27
80.10	74.91	61.87	57.12	60.34	125.05	260.26	215.45	152.61	112.53	104.23	104.23	104.23	112.53	122.05	105.59	113.27	113.27
78.74	72.14	59.25	57.18	60.84	107.44	260.26	235.03	152.61	112.53	104.23	104.23	104.23	112.53	122.05	105.59	118.52	118.52
77.97	66.34	57.48	57.18	60.22	107.44	260.26	235.03	152.61	104.75	101.16	101.16	104.23	104.75	122.05	113.27	118.52	118.52
73.88	66.34	57.48	57.18	60.22	107.44	192.84	165.35	127.69	104.75	101.16	101.16	101.16	104.75	109.97	113.27	118.52	118.52
73.88	66.34	57.48	57.18	60.22	92.90	192.84	165.35	127.69	104.75	101.16	101.16	101.16	104.75	109.97	113.27	118.52	118.52
0.72	0.72	0.61	0.44	0.54	0.57	0.59	0.60	0.68	0.86	1.21	1.88	2.03	2.57	2.05	3.21	3.02	4.11
0.72	0.72	0.59	0.45	0.57	0.58	0.59	0.61	0.70	0.95	1.41	1.89	2.18	2.25	2.09	3.34	3.10	4.09
0.72	0.72	0.57	0.47	0.63	0.62	0.59	0.62	0.74	1.19	1.65	2.01	2.06	1.96	2.38	3.36	3.22	4.20
0.72	0.72	0.56	0.51	0.68	0.68	0.62	0.65	0.80	1.53	1.86	1.91	1.79	1.98	2.57	3.20	3.31	4.29
0.72	0.72	0.55	0.56	0.67	0.70	0.66	0.67	0.87	1.79	1.96	1.72	1.67	2.14	2.70	3.00	3.32	4.20
0.71	0.72	0.55	0.59	0.59	0.68	0.70	0.69	0.97	1.90	1.87	1.53	1.86	2.33	2.63	2.89	3.24	3.86
0.71	0.70	0.54	0.61	0.51	0.60	0.68	0.72	1.20	1.76	1.74	1.64	2.16	2.34	2.74	2.94	3.20	3.40
0.70	0.69	0.54	0.61	0.45	0.50	0.58	0.74	1.34	1.48	1.65	1.90	2.32	2.52	2.80	2.97	3.13	2.96
0.70	0.66	0.53	0.62	0.43	0.41	0.46	0.77	1.20	1.24	1.70	2.05	2.55	2.66	2.82	2.98	3.03	2.57
0.69	0.64	0.53	0.61	0.42	0.35	0.36	0.64	0.87	1.14	1.78	2.11	2.90	2.75	2.78	2.87	2.75	2.35
0.69	0.61	0.53	0.62	0.42	0.32	0.31	0.49	0.61	1.23	1.83	2.29	3.20	2.83	2.73	2.68	2.49	2.31
0.68	0.58	0.52	0.61	0.44	0.33	0.29	0.35	0.63	1.33	1.93	2.72	3.31	2.93	2.63	2.49	2.39	2.44
0.68	0.54	0.51	0.59	0.44	0.35	0.31	0.37	0.76	1.49	2.11	3.04	3.35	3.01	2.56	2.41	2.48	2.60
0.68	0.51	0.51	0.56	0.44	0.39	0.34	0.43	0.90	1.62	2.27	3.35	3.50	3.09	2.54	2.48	2.65	2.75
0.68	0.50	0.51	0.52	0.42	0.40	0.36	0.50	1.04	1.74	2.53	3.75	3.86	3.10	2.59	2.71	2.88	2.89
0.68	0.50	0.49	0.47	0.40	0.40	0.36	0.57	1.18	1.88	2.85	4.18	4.10	3.11	2.80	3.09	3.13	3.09
0.68	0.51	0.48	0.41	0.37	0.36	0.35	0.63	1.31	2.15	3.07	4.25	3.96	3.20	3.14	3.56	3.40	3.36
0.67	0.52	0.44	0.37	0.35	0.34	0.36	0.67	1.44	2.47	3.15	3.81	3.59	3.41	3.66	4.07	3.67	3.92
0.67	0.52	0.41	0.35	0.33	0.31	0.37	0.71	1.54	2.67	2.99	3.26	3.36	3.84	4.41	4.58	4.21	4.97
0.64	0.51	0.38	0.35	0.32	0.28	0.36	0.73	1.61	2.67	2.81	2.91	3.64	4.48	5.18	5.00	5.30	6.60
0.63	0.50	0.35	0.35	0.31	0.25	0.36	0.73	1.66	2.62	2.57	2.75	4.14	5.28	5.94	5.25	6.85	8.31
0.61	0.49	0.34	0.34	0.30	0.24	0.37	0.74	1.74	2.60	2.40	2.92	5.04	6.30	6.61	5.65	8.49	9.50
0.58	0.48	0.32	0.33	0.29	0.26	0.41	0.77	1.85	2.56	2.34	3.40	6.08	7.43	7.50	6.64	9.32	9.33
0.55	0.47	0.31	0.31	0.28	0.30	0.43	0.84	2.01	2.50	2.35	4.39	7.66	9.13	9.05	7.92	8.52	7.94
0.51	0.45	0.32	0.31	0.28	0.33	0.43	0.91	2.15	2.48	2.46	6.10	9.69	11.10	10.67	8.50	8.27	7.42
0.49	0.43	0.32	0.31	0.29	0.34	0.43	0.99	2.26	2.56	2.70	8.36	11.89	12.88	12.19	11.06	10.87	9.05
0.47	0.43	0.32	0.32	0.30	0.33	0.43	1.06	2.35	2.77	3.09	10.89	13.74	14.50	14.38	15.73	15.82	14.21
0.47	0.43	0.33	0.32	0.29	0.32	0.44	1.14	2.47	3.05	3.68	13.22	15.30	17.17	19.07	21.57	19.55	17.49
0.47	0.45	0.34	0.33	0.26	0.29	0.46	1.21	2.63	3.33	4.43	15.21	17.11	20.57	24.10	25.17	19.60	17.92
0.48	0.48	0.36	0.34	0.23	0.26	0.47	1.26	2.80	3.51	5.36	16.84	19.03	23.74	28.70	26.40	20.17	17.71
0.52	0.52	0.38	0.35	0.22	0.26	0.48	1.30	2.97	3.56	6.37	17.93	20.75	26.08	30.46	29.38	22.96	19.67
0.58	0.56	0.40	0.35	0.22	0.26	0.50	1.34	3.06	3.46	7.49	18.63	21.84	28.84	30.65	31.95	26.52	24.13
0.67	0.59	0.43	0.35	0.22	0.26	0.52	1.38	3.08	3.28	8.54	18.90	22.90	32.01	30.24	34.73	28.19	27.99
0.77	0.62	0.48	0.36	0.22	0.26	0.54	1.43	2.98	3.06	9.53	19.04	23.97	35.28	32.16	37.74	28.77	29.69
0.87	0.65	0.54	0.36	0.23	0.27	0.56	1.53	2.86	2.89	10.31	19.07	25.95	37.90	36.04	41.38	30.57	29.08
0.94	0.70	0.60	0.37	0.24	0.29	0.59	1.63	2.74	2.74	10.95	18.99	28.09	40.69	40.88	43.64	32.21	31.15

0.95	0.73	0.65	0.38	0.27	0.32	0.64	1.73	2.59	2.64	11.43	18.88	30.31	43.85	45.34	44.11	32.93	33.30
0.91	0.75	0.68	0.39	0.29	0.35	0.72	1.80	2.39	2.64	11.89	18.89	31.74	45.20	49.06	44.97	33.75	34.20
0.82	0.74	0.69	0.39	0.33	0.38	0.78	1.92	2.19	2.76	12.35	19.34	32.76	45.19	51.69	47.57	36.83	32.93
0.74	0.71	0.67	0.38	0.35	0.39	0.84	2.11	2.05	3.07	12.82	20.28	33.77	44.91	52.43	49.57	40.06	34.45
0.67	0.66	0.64	0.36	0.37	0.42	0.86	2.27	2.01	3.46	13.26	21.49	35.22	47.49	53.67	52.17	43.15	35.53
0.63	0.61	0.58	0.33	0.36	0.43	0.87	2.32	2.01	3.86	13.68	22.71	37.73	50.95	55.06	55.60	46.88	37.09
0.59	0.56	0.51	0.31	0.34	0.47	0.89	2.29	2.06	4.26	14.10	24.14	40.77	53.99	56.51	59.40	51.34	39.44
0.56	0.51	0.46	0.30	0.33	0.50	0.93	2.35	2.15	4.83	14.52	25.79	43.91	54.57	56.70	61.23	55.05	41.42
0.54	0.49	0.43	0.32	0.35	0.54	1.00	2.56	2.28	5.55	14.98	27.90	45.90	54.18	55.93	61.87	58.84	44.38
0.54	0.50	0.44	0.37	0.41	0.60	1.10	2.85	2.46	6.42	15.84	29.96	45.58	52.76	54.89	61.16	62.19	48.47
0.58	0.56	0.50	0.46	0.51	0.69	1.17	3.12	2.68	7.19	17.19	31.71	43.66	51.32	54.22	59.45	61.26	49.96
0.67	0.67	0.62	0.59	0.61	0.79	1.23	3.26	2.89	7.89	18.79	32.60	41.78	50.25	54.80	57.98	60.92	53.22
0.78	0.82	0.77	0.72	0.72	0.89	1.28	3.26	3.03	8.51	19.90	32.43	41.96	49.66	54.75	56.71	60.30	56.05
0.87	0.93	0.91	0.82	0.79	0.94	1.33	3.20	3.08	9.08	20.22	32.16	43.96	49.38	54.65	56.21	60.10	58.35
0.92	1.00	0.98	0.85	0.82	0.93	1.36	3.13	3.05	9.72	20.42	32.84	46.88	48.64	53.64	55.07	58.97	58.50
0.92	0.99	0.97	0.83	0.82	0.89	1.40	3.03	2.99	10.45	21.67	35.04	49.24	47.59	53.84	54.34	57.95	58.12
0.86	0.93	0.91	0.77	0.81	0.85	1.43	2.90	2.94	11.41	24.05	38.40	50.90	46.86	54.49	53.99	57.03	57.66
0.81	0.86	0.84	0.72	0.79	0.83	1.48	2.76	3.08	12.78	27.63	41.09	51.87	46.64	55.06	54.15	56.37	57.54
0.76	0.80	0.79	0.67	0.78	0.84	1.53	2.67	3.41	14.44	30.46	42.68	52.83	46.75	55.25	54.24	55.53	57.20
0.73	0.76	0.77	0.63	0.78	0.87	1.61	2.66	3.95	16.95	32.04	42.88	53.36	47.02	55.05	54.28	54.61	56.61
0.72	0.76	0.76	0.60	0.79	0.88	1.69	2.68	4.59	19.97	32.40	43.03	52.99	47.54	55.11	54.89	54.35	56.34
0.72	0.79	0.77	0.60	0.82	0.88	1.78	2.68	5.33	23.21	33.46	42.66	51.22	47.86	55.54	56.06	54.78	56.34
0.77	0.84	0.81	0.62	0.85	0.89	1.84	2.67	6.17	26.26	34.96	41.72	49.52	48.75	47.70	49.01	47.17	47.96
0.83	0.92	0.87	0.65	0.88	0.89	1.86	2.66	7.12	29.01	35.67	40.88	50.01	50.20	48.28	50.27	48.13	47.99
0.89	1.00	0.93	0.70	0.92	0.90	1.85	2.70	8.19	30.93	35.43	42.53	52.75	52.97	50.04	52.51	50.40	49.42
0.93	1.05	0.99	0.75	0.98	0.93	1.83	2.74	9.31	31.36	34.97	45.88	56.27	56.34	52.58	55.33	53.57	51.92
0.95	1.07	1.04	0.80	1.02	0.96	1.81	2.79	10.40	30.48	36.11	49.10	57.25	59.78	55.67	58.57	57.36	55.31
0.95	1.07	1.05	0.85	1.04	1.00	1.79	2.91	11.38	29.31	38.49	49.79	56.56	62.37	58.57	61.54	60.92	58.76
0.95	1.07	1.06	0.89	1.01	1.01	1.77	3.07	12.28	28.88	42.45	49.28	54.49	62.69	59.65	62.60	62.47	60.54
0.94	1.07	1.07	0.92	0.94	1.01	1.75	3.34	13.22	29.07	46.23	49.16	53.39	56.64	54.49	57.21	57.47	55.97
0.95	1.08	1.10	0.94	0.86	1.02	1.75	3.63	14.17	30.08	49.13	50.97	54.14	56.23	54.96	57.08	57.70	56.65
0.95	1.08	1.12	0.95	0.81	1.05	1.76	3.97	15.08	30.97	50.08	52.91	55.57	57.35	57.07	58.14	59.20	58.43
0.96	1.10	1.13	0.95	0.78	1.11	1.79	4.26	15.82	32.02	50.07	53.32	56.33	57.38	58.38	58.04	59.63	58.93
0.93	1.11	1.12	0.96	0.79	1.17	1.82	4.51	16.52	33.00	49.69	51.02	54.79	55.51	58.05	56.21	58.31	57.56
0.91	1.09	1.09	0.98	0.81	1.21	1.84	4.72	17.31	34.21	50.03	48.35	52.05	52.39	56.44	53.47	55.85	55.04
0.89	1.05	1.03	0.99	0.84	1.20	1.83	4.86	18.30	35.30	51.01	48.73	50.31	50.16	55.25	51.95	54.19	53.39
0.87	0.98	0.97	1.00	0.86	1.16	1.78	5.03	19.35	36.20	52.69	51.80	51.68	50.73	56.09	53.53	55.16	54.53
0.85	0.96	0.93	1.01	0.89	1.11	1.70	5.21	20.39	37.04	54.66	55.41	53.23	51.00	55.82	55.02	55.66	55.38
0.85	0.92	0.90	0.99	0.89	1.08	1.62	5.53	21.31	38.39	56.43	57.15	55.94	51.97	55.60	57.29	56.72	56.97
0.85	0.91	0.88	0.97	0.87	1.05	1.57	5.91	22.07	40.49	57.83	58.73	57.97	52.24	54.30	58.63	56.86	57.70
0.85	0.89	0.87	0.90	0.81	1.01	1.55	6.33	22.66	43.05	58.01	60.31	58.15	51.43	51.66	58.17	55.46	56.80
0.84	0.88	0.85	0.82	0.75	0.99	1.56	6.77	23.06	45.83	57.66	60.93	59.59	53.30	51.50	59.29	56.13	57.68
0.84	0.87	0.82	0.75	0.69	1.00	1.55	7.39	23.52	48.44	57.18	60.78	59.91	55.34	51.56	59.60	56.52	57.96
0.84	0.85	0.78	0.72	0.67	1.03	1.54	8.25	24.08	50.59	57.30	61.26	60.51	58.10	52.94	60.39	57.75	58.85
0.82	0.82	0.75	0.71	0.67	1.08	1.54	9.19	24.49	52.24	57.46	62.00	61.14	60.45	55.16	61.37	59.23	59.98
0.79	0.78	0.74	0.72	0.67	1.17	1.55	10.06	24.93	52.99	56.99	60.65	59.62	59.83	55.81	60.37	58.61	59.17
0.76	0.75	0.75	0.72	0.70	1.30	1.57	10.72	25.32	53.09	56.42	58.20	57.09	57.57	55.73	58.45	56.90	57.55
0.76	0.75	0.79	0.73	0.74	1.45	1.62	11.24	26.05	52.52	56.17	56.06	55.13	55.63	55.80	56.89	55.50	56.44
0.76	0.77	0.83	0.74	0.77	1.55	1.66	11.59	26.94	51.86	56.08	55.61	55.04	55.55	56.84	56.78	55.65	56.87
0.77	0.80	0.86	0.75	0.79	1.62	1.69	11.80	27.73	51.19	55.74	55.45	55.21	55.80	57.18	56.56	55.80	57.09
0.78	0.81	0.86	0.77	0.79	1.61	1.68	11.97	28.17	50.67	54.72	54.66	54.53	55.19	56.20	55.37	54.98	56.11
0.77	0.80	0.85	0.78	0.82	1.53	1.66	12.24	29.17	49.70	54.27	54.41	54.10	54.77	55.48	54.53	54.41	55.23
0.77	0.80	0.84	0.76	0.90	1.39	1.62	12.73	32.36	49.55	54.18	54.47	53.77	54.40	55.09	54.00	53.96	54.43
0.79	0.80	0.82	0.73	1.03	1.23	1.60	13.52	37.59	49.67	54.82	55.20	54.00	54.49	55.35	54.15	54.03	54.14
0.80	0.79	0.81	0.72	1.14	1.16	1.59	14.73	42.48	50.01	55.61	56.03	54.35	54.60	55.63	54.45	54.12	53.84
0.84	0.80	0.82	0.73	1.21	1.16	1.56	15.97	45.54	49.69	57.47	57.92	55.94	55.81	56.91	55.87	55.33	54.61
0.89	0.84	0.86	0.76	1.23	1.19	1.55	17.26	47.45	49.12	59.02	59.47	57.57	56.91	57.95	57.11	56.46	55.23
0.96	0.93	0.95	0.81	1.28	1.22	1.57	18.55	49.08	51.82	60.10	60.58	59.08	57.89	58.72	58.04	57.49	55.72
1.04	1.03	1.07	0.88	1.31	1.25	1.69	20.19	50.34	51.81	60.29	60.79	59.87	58.37	58.80	58.20	57.92	55.74
1.13	1.13	1.20	0.99	1.34	1.25	1.89	21.96	49.94	51.45	59.16	59.69	59.28	57.83	57.73	57.13	57.13	54.88
1.21	1.19	1.30	1.11	1.36	1.20	2.16	23.72	49.31	51.45	52.64	53.26	53.12	52.07	51.40	50.77	50.92	49.02
1.28	1.23	1.35	1.23	1.38	1.15	2.45	25.86	48.38	51.71	51.94	52.84	52.76	52.24	51.11	50.43	50.53	49.22
1.34	1.27	1.38	1.31	1.37	1.13	2.72	27.54	48.23	53.86	53.08	54.47	54.35	54.28	52.91	52.18	52.14	51.33
1.39	1.32	1.41	1.38	1.33	1.18	3.01	29.06	48.62	56.37	55.01	57.05	56.88	57.07	55.72	54.93	54.77	54.21
1.43	1.38	1.44	1.44	1.29	1.25	3.31	29.49	49.77	59.18	57.21	59.81	59.60	59.89	58.73	57.88	57.68	57.21
1.45	1.43	1.47	1.49	1.27	1.33	3.66	30.13	51.59	60.91	58.89	61.65	61.40	61.71	60.81	59.94	59.73	59.35
1.47	1.46	1.51	1.54	1.28	1.43	3.97	30.69	52.27	61.24	59.76	62.08	61.75	62.05	61.36	60.55	60.33	60.11
1.49	1.50	1.57	1.61	1.36	1.59	4.45	31.07	51.61	60.23	59.88	61.30	60.86	61.15	60.60	59.93	59.66	59.57
1.54	1.56	1.72	1.72	1.50	1.87	4.91	30.51	49.81	58.43	59.37	59.80	59.25	59.50	59.03	58.59	58.22	58.21
1.68	1.72	2.01	1.94	1.77	2.23	5.48	30.61	47.96	56.23	58.49	58.26	57.67	57.81	57.40	57.27	56.74	56.74

1.98	2.03	2.49	2.51	2.15	2.66	5.93	32.06	46.68	53.23	57.27	56.78	56.29	56.26	55.93	56.10	55.41	55.39
2.49	2.53	3.11	3.40	2.63	3.19	6.48	34.68	46.07	50.65	56.07	55.57	55.37	55.11	54.85	55.27	54.48	54.43
3.18	3.16	3.68	4.49	3.11	3.72	7.33	36.58	46.29	49.15	55.33	54.77	55.02	54.52	54.31	54.86	54.08	53.98
3.96	3.68	4.31	5.25	3.57	4.23	8.92	37.58	47.01	49.17	55.55	54.84	55.55	54.86	54.67	55.27	54.56	54.41
4.49	3.98	4.71	5.66	3.87	4.51	10.26	37.99	47.61	49.53	55.86	55.02	56.01	55.21	55.05	55.63	55.00	54.81

Appendix G
DYNASMART-P input file nox.dat

(Note: Line wrapping has occurred in this file; the actual input used had no such wrapping)

0.71	0.71	0.49	0.58	0.71	0.74	0.71	0.25	0.08	0.12	0.03	1.02	2.08	3.32	3.34	1.13	2.19	3.16
0.71	0.91	0.58	0.58	0.71	0.62	0.91	0.27	0.06	0.1	0.12	1.35	2.19	3.65	3.34	0.94	2.19	4.63
0.9	0.9	0.71	0.71	0.71	0.71	0.82	0.33	0.05	0.08	0.35	1.56	2.5	4	3.34	0.94	5.21	6.73
0.67	0.9	0.91	0.91	0.91	0.91	0.81	0.33	0.05	0.11	0.47	1.53	2.53	2.88	3.34	2.24	6.52	6.99
0.54	0.54	0.76	0.9	0.9	0.9	0.81	0.29	0.02	0.31	0.71	1.98	1.93	2.3	2.15	0.94	7.87	6.74
0.55	0.61	0.61	0.54	0.54	0.54	0.57	0.16	0.03	0.47	1.35	1.45	1.49	1.9	2.63	0.94	7.87	6.03
0.51	0.51	0.55	0.55	0.55	0.6	0.48	0.08	0.04	0.52	1.81	1.31	1.86	2.66	2.28	5.05	7.97	4.17
0.57	0.57	0.57	0.57	0.57	0.48	0.31	0.09	0.12	1.04	1.56	1.83	2.14	2.45	2.19	11.49	6.03	4.15
0.51	0.53	0.53	0.39	0.39	0.28	0.27	0.13	0.05	1.81	1.65	2.21	3.01	0.56	5.05	9.51	4.15	4.15
0.51	0.47	0.39	0.35	0.32	0.22	0.27	0.15	0.42	1.04	1.9	2.45	2.18	8.74	9.62	8.85	2.25	2.08
0.51	0.47	0.35	0.25	0.23	0.24	0.26	0.17	0.88	1.49	2.63	2.19	5.05	9.62	9.01	5.09	1.88	2.25
0.54	0.51	0.42	0.23	0.24	0.25	0.12	0.33	0.89	2.42	1.9	0.5	11.82	5.94	5.24	1.93	1.94	1.94
0.51	0.54	0.47	0.22	0.2	0.21	0.25	0.23	2.08	1.92	0.67	6.66	11.23	5.44	1.53	1.51	3.29	3.29
0.59	0.6	0.48	0.22	0.25	0.15	0.23	0.33	1.61	0.56	0.81	13.11	5.63	3.49	1.12	2.73	4.61	4.87
0.57	0.51	0.51	0.28	0.24	0.21	0.1	0.53	0.68	0.66	6.07	6.92	2.65	0.97	1.48	4.3	4.74	4.74
0.81	0.57	0.6	0.42	0.23	0.15	0.1	1.86	0.75	4.71	5.38	2.32	0.87	1.25	3.11	4.81	3.63	3.63
0.81	0.67	0.6	0.51	0.35	0.23	0.1	1.48	2.27	4.06	1.83	1.25	1.03	2.68	3.89	3.92	2.37	1.99
0.81	0.67	0.6	0.51	0.35	0.24	0.17	1.7	2.41	2.55	1.14	0.81	2.55	3.07	3.65	1.97	2.09	2.09
0.9	0.67	0.6	0.47	0.25	0.15	0.17	1.54	2.84	2.11	0.83	2.39	2.87	3.44	1.88	2.06	2.42	2.42
0.81	0.57	0.6	0.29	0.22	0.24	0.3	1.56	3.06	0.67	2.17	2.93	1.87	1.76	1.99	2.35	2.77	2.77
0.81	0.51	0.51	0.28	0.24	0.25	0.32	2.1	3.57	0.67	1.17	1.29	1.58	1.7	2.24	2.96	3.09	3.37
0.67	0.51	0.45	0.23	0.2	0.14	0.36	2.18	4.03	2.01	0.67	1.28	1.61	1.81	2.77	3.19	3.87	3.87
0.54	0.51	0.48	0.23	0.2	0.13	0.4	2.28	4.4	0.92	0.8	0.91	1.07	1.89	3.01	10.55	11.5	11.5
0.54	0.55	0.47	0.25	0.24	0.27	0.43	1.81	3.86	0.6	1.23	1.66	2.12	4.59	17.1	20.08	27.78	27.78
0.51	0.55	0.51	0.35	0.22	0.28	0.51	1.7	2.68	0.67	0.67	1	10.81	16.56	20.49	22.36	14.32	14.32
0.55	0.51	0.57	0.39	0.25	0.28	0.65	0.6	2.11	0.58	1.95	6.8	11.31	13.15	6.26	6.78	6.78	7.14
0.51	0.44	0.53	0.45	0.35	0.28	0.67	0.69	2.55	0.72	2.71	2.83	3.75	4.27	4.74	4.98	4.98	5.1
0.57	0.57	0.45	0.39	0.25	0.27	0.71	1.62	2.49	0.63	3.3	2.97	3.7	4.11	4.17	4.32	4.29	4.29
0.57	0.53	0.39	0.34	0.23	0.29	0.84	3.57	2.34	1.17	4.46	5.23	5.66	4.53	4.6	4.78	4.78	4.76
0.53	0.39	0.34	0.24	0.16	0.29	0.71	3.49	2.21	2.74	5.47	3.38	4.2	4.48	4.49	4.58	4.58	4.62
0.39	0.35	0.25	0.2	0.24	0.29	1.04	2.91	2	2.81	3.03	3.88	3.22	3.68	3.99	4.11	4.11	4.11
0.39	0.35	0.23	0.16	0.21	0.29	0.85	2.87	1.29	1.23	2.89	2.67	2.68	3.22	3.43	3.48	2.74	2.74
0.39	0.35	0.25	0.23	0.26	0.25	1	3.29	0.56	1.22	5.68	2.23	2.37	2.2	2.29	2.2	2.2	2.2
0.32	0.35	0.28	0.29	0.29	0.1	2.21	3.48	0.59	0.99	2.91	2.67	2.13	2.15	2.19	2.18	2.18	2.2
0.32	0.35	0.47	0.3	0.13	0.1	2.21	3.86	0.83	1.22	2.79	2.72	2.14	1.81	1.98	1.88	1.9	1.9
0.32	0.35	0.47	0.47	0.31	0.1	1.73	4.28	0.83	1.29	7.38	2.35	1.7	1.71	1.73	1.59	1.59	1.59
0.32	0.32	0.39	0.35	0.26	0.25	1.73	2.3	2.17	1.64	8.52	2.6	1.51	1.53	1.47	1.46	1.46	1.46
0.35	0.32	0.39	0.34	0.25	0.28	1.76	2.52	2.54	1.46	9.28	2.28	1.55	1.57	1.54	1.53	1.51	1.51
0.42	0.35	0.39	0.34	0.25	0.23	1.79	2.11	1.02	1.25	11.11	2.31	1.66	1.77	1.63	1.62	1.61	1.61
0.42	0.35	0.39	0.34	0.26	0.14	1.7	0.67	0.95	1.23	12.09	2.31	1.85	1.95	1.83	1.82	1.79	1.79
0.47	0.39	0.39	0.32	0.26	0.13	1.7	0.67	0.84	1.04	11.31	2.37	1.88	2.07	1.97	1.88	1.77	1.79
0.39	0.39	0.39	0.35	0.26	0.1	0.61	1.98	0.77	1.46	13.08	2.87	1.96	2.24	1.95	1.85	1.75	1.76
0.39	0.39	0.39	0.35	0.26	0.17	0.71	0.88	1.17	2.06	14.07	3.22	2.04	2.44	1.96	1.83	1.83	1.83
0.35	0.32	0.39	0.32	0.28	0.17	1.47	0.87	1.29	2.1	13.43	4.17	2.01	2.18	1.97	1.9	1.82	1.84
0.32	0.34	0.34	0.25	0.28	0.17	1.47	0.58	0.7	2.54	16.23	4.21	2.07	1.92	1.67	1.56	1.56	1.9
0.25	0.25	0.25	0.23	0.25	0.17	3.14	0.89	3.12	10.09	13.08	3.6	2.11	1.66	1.51	1.5	1.5	1.67
0.25	0.24	0.23	0.22	0.27	0.39	3.06	0.95	3.3	11.11	5.86	3.63	2.24	1.49	1.5	1.5	1.5	1.51
0.24	0.24	0.21	0.24	0.29	0.4	3.06	2.4	4.87	3.88	4.09	3.41	2.28	1.49	1.5	1.5	1.5	1.51
0.24	0.2	0.2	0.21	0.1	0.27	2.52	2.3	4.46	3.75	4.4	3.51	2.28	1.49	1.49	1.5	1.5	1.67
0.2	0.2	0.16	0.21	0.23	0.27	3.06	2.42	5.63	3.8	4.13	3.51	2.06	1.54	1.49	1.5	1.51	2.04
0.2	0.2	0.16	0.27	0.27	0.37	3.27	2.52	6.22	5.52	3.99	3.92	2.03	2.04	1.8	1.67	1.9	2.13
0.15	0.2	0.16	0.27	0.27	0.37	3.57	2.87	7.24	5.34	4.08	3.92	1.66	1.97	1.94	1.99	1.95	1.99
0.15	0.15	0.22	0.12	0.27	0.53	1.74	1.43	2.79	5.66	4.44	4	1.6	1.56	1.83	1.97	1.74	1.58
0.15	0.16	0.22	0.12	0.28	0.65	4.26	1.23	2.94	3.95	4.67	4	2.19	1.86	1.46	1.56	1.46	1.46
0.21	0.19	0.21	0.12	0.18	0.81	4.48	1.18	5.64	4.2	4.4	4	3.43	2.19	1.98	1.73	1.98	1.6
0.21	0.19	0.21	0.26	0.22	2.01	4.86	1.15	6.09	4.06	3.84	4	3.99	3.43	2.29	2.19	2.68	1.73
0.26	0.17	0.26	0.26	0.37	1.61	4.86	0.95	3.81	3.03	3.92	3.99	3.99	3.66	3.43	3.43	3.66	1.73
0.32	0.22	0.19	0.28	0.59	1.71	4.06	0.95	3.81	3.03	3.51	3.66	3.73	3.66	3.73	3.66	3.66	1.73
0.04	0.22	0.2	0.05	1.86	0.65	2.26	0.95	5.23	2.68	3.34	3.43	3.45	3.45	3.45	3.43	3.43	1.86
0.16	0.22	0.03	0.11	1.33	0.66	2.55	0.99	3.1	2.68	2.25	2.29	2.31	2.31	2.71	2.71	2.68	1.86

0.32	0.17	0.04	0.1	1.1	0.68	2.55	1.28	3.26	2.81	2.17	2.19	2.19	2.19	2.19	2.19	2.19	2.13
0.22	0.24	0.04	0.03	0.12	0.7	2.06	1.07	3.59	2.13	2.17	2.19	2.2	2.2	2.2	2.19	2.19	2.19
0.21	0.21	0.16	0.25	0.04	0.91	0.64	1.11	3.65	2.14	2.07	2.13	2.15	2.15	2.15	2.13	2.13	2.29
0.3	0.3	0.25	0.27	0.03	0.92	0.68	0.96	3.67	2.14	1.91	1.98	2.01	2.01	2.01	1.98	1.98	2.68
0.24	0.27	0.25	0.15	0.11	0.91	0.68	1.34	5.53	1.7	1.8	1.73	1.72	1.72	1.72	1.73	1.86	2.68
0.22	0.22	0.16	0.03	1.06	1.07	1.96	1.34	5.32	1.47	1.63	1.6	1.59	1.59	1.6	1.6	1.6	2.29
0.17	0.17	0.05	0.7	0.87	1.01	1.94	1.75	5.64	1.56	1.49	1.47	1.47	1.47	1.47	1.47	1.47	2.19
0.1	0.1	0.06	0.7	1.01	1.21	1.94	1.79	5.66	1.56	1.48	1.46	1.46	1.46	1.46	1.46	1.46	2.19
0.08	0.1	0.07	0.61	0.64	1.31	2.09	1	5.34	1.58	1.51	1.54	1.54	1.53	1.54	1.5	1.5	1.73
0.09	0.09	0.08	0.49	0.57	1.09	0.88	1	3.95	1.56	1.6	1.56	1.56	1.54	1.56	1.56	1.58	1.5
0.13	0.13	0.13	0.42	0.48	0.33	0.92	6.06	4.06	1.75	1.69	1.63	1.63	1.62	1.63	1.63	1.66	1.66
0.23	0.23	0.23	0.34	0.78	0.15	0.61	6.8	3.03	1.82	1.79	1.74	1.74	1.74	1.74	1.74	1.77	1.77
0.23	0.26	0.23	0.38	0.66	0.32	0.63	7.38	3.03	1.88	1.88	1.83	1.83	1.83	1.83	1.86	1.86	1.86
0.26	0.26	0.27	0.45	0.75	0.32	0.82	9.13	3.28	1.86	1.95	1.96	1.96	1.96	1.96	1.93	1.93	1.86
0.27	0.27	0.42	0.81	0.96	0.37	0.64	3.02	4.3	1.83	2.06	1.97	1.97	1.97	1.97	1.99	1.93	1.86
0.24	0.24	0.37	0.62	0.62	0.21	0.67	3.32	4.3	1.93	2.16	1.97	1.97	1.97	1.97	2.06	1.99	1.86
0.22	0.24	0.37	0.7	0.64	0.33	1.27	3.32	3.43	2.12	2.1	1.95	1.95	1.95	1.95	2.1	1.99	1.86
0.25	0.29	0.35	0.57	0.99	1.63	1.32	3.47	3.42	2.15	2.13	1.94	1.94	1.94	1.94	2.13	2.03	1.86
0.24	0.25	0.33	0.74	1.38	1.63	1.37	3.47	3.1	2.46	2.16	1.99	1.96	1.96	1.96	2.17	2.03	1.86
0.25	0.25	0.4	0.49	0.93	2.81	1.18	3.4	3.53	2.55	2.13	2	2	2	1.99	2.13	2.06	1.86
0.24	0.25	0.33	0.36	0.07	1.45	1.18	5.53	3.63	2.44	2.04	1.97	1.97	1.97	1.97	2.04	2.1	1.86
0.24	0.24	0.15	0.11	0.51	1.35	1.14	5.32	3.74	2.27	1.93	1.8	1.8	1.9	1.9	1.93	2.13	1.86
0.18	0.19	0.15	0.11	1.55	1.35	1.37	5.32	3.41	2.05	1.67	1.54	1.54	1.67	1.8	1.8	2.17	1.93
0.17	0.17	0.14	0.63	1.48	1.45	1.37	5.64	3.83	2.05	1.49	1.49	1.49	1.49	1.67	1.8	2.16	1.99
0.17	0.17	0.16	0.56	1.02	0.51	1.43	3.95	3.83	2.05	1.49	1.49	1.49	1.49	1.54	1.67	2.16	2.03
0.2	0.2	0.17	0.12	0.07	1.2	1.23	4.2	3.83	1.93	1.49	1.49	1.49	1.49	1.49	1.54	2.16	2.1
0.2	0.2	0.2	0.17	0.12	1.11	0.92	4.06	3.92	1.93	1.49	1.49	1.49	1.49	1.49	1.54	2.13	2.17
0.2	0.2	0.2	0.2	0.15	1.69	1.22	3.28	3.59	1.67	1.49	1.49	1.49	1.49	1.49	1.49	2.13	2.16
0.21	0.21	0.21	0.21	0.19	1.2	1.28	3.12	3.59	1.93	1.49	1.49	1.49	1.49	1.54	1.54	2.04	2.16
0.21	0.21	0.19	0.19	0.24	1.34	0.99	3.28	3.43	2.13	1.54	1.49	1.49	1.49	2.13	1.54	1.93	2.16
0.19	0.19	0.19	0.19	0.34	2.12	1.35	3.35	3.43	1.63	2.06	1.99	1.97	2.13	2.03	1.67	1.93	2.16
0.21	0.21	0.22	0.21	0.34	2.14	1.35	3.35	2.68	1.73	1.5	1.74	1.96	1.93	1.58	1.67	1.8	2.13
0.2	0.2	0.21	0.21	0.3	1.38	0.99	3.32	2.68	2.19	1.98	1.47	1.5	1.46	1.6	1.67	1.67	2.04
0.2	0.2	0.2	0.2	0.3	1.35	0.99	3.1	2.29	2.19	2.19	2.15	1.88	1.98	1.98	1.67	1.54	1.93
0.19	0.19	0.19	0.19	0.27	1.4	1.22	3.08	2.19	2.19	2.19	2.2	2.2	2.19	2.13	1.8	1.54	1.93
0.19	0.19	0.19	0.19	0.27	1.32	1.03	2.46	2.19	2.2	2.2	2.2	2.2	2.2	2.13	2.04	1.49	1.8
0.19	0.19	0.19	0.19	0.76	0.4	0.93	2.15	2.19	2.2	2.2	2.2	2.2	2.2	1.98	2.16	1.49	1.8
0.22	0.22	0.22	0.18	0.87	0.41	1.34	2.14	2.13	2.13	2.15	2.15	2.15	2.15	1.98	2.1	1.49	1.67
0.22	0.22	0.22	0.19	0.7	0.39	1.84	2.14	1.98	1.98	2.01	2.01	2.01	1.98	2.13	1.93	1.54	1.54
0.27	0.19	0.19	0.19	0.68	0.39	1.88	2.15	1.86	1.86	2.01	2.01	2.01	1.98	2.13	1.66	1.8	1.49
0.22	0.22	0.15	0.15	0.23	0.37	1.88	1.96	1.86	1.86	1.88	1.88	1.88	1.86	2.13	1.5	2.04	1.49
0.22	0.22	0.15	0.1	0.24	0.37	1.15	1.75	1.73	1.73	1.73	1.73	1.72	1.73	1.98	1.6	2.16	1.49
0.13	0.13	0.1	0.1	0.28	0.29	7.23	1.79	1.61	1.6	1.6	1.6	1.6	1.6	1.73	1.86	2.1	1.49
0.15	0.13	0.15	0.11	0.27	0.78	7.38	1.68	1.48	1.47	1.47	1.47	1.47	1.47	1.6	1.98	1.93	1.67
0.15	0.15	0.15	0.15	0.28	0.82	8.09	1.71	1.47	1.46	1.46	1.46	1.46	1.47	1.47	2.13	1.66	1.93
0.19	0.19	0.19	0.24	0.53	1.1	8.09	1.71	1.47	1.46	1.46	1.46	1.46	1.46	1.46	1.98	1.5	2.13
0.24	0.19	0.19	0.18	0.55	1.1	7.81	1.66	1.51	1.5	1.5	1.5	1.5	1.5	1.46	1.73	1.6	2.13
0.18	0.15	0.15	0.18	1.14	1.17	7.81	1.66	1.55	1.54	1.54	1.54	1.53	1.54	1.46	1.6	1.86	2.03
0.18	0.15	0.13	0.18	1.3	1.16	9	1.51	1.58	1.56	1.54	1.54	1.54	1.56	1.46	1.47	1.98	1.77
0.16	0.13	0.13	0.22	1.29	0.7	10.53	1.5	1.58	1.63	1.62	1.62	1.62	1.63	1.46	1.46	2.13	1.55
0.18	0.13	0.13	0.18	1.29	0.7	3.88	1.54	1.66	1.74	1.73	1.73	1.62	1.63	1.46	1.46	2.13	1.46
0.582	0.582	0.664	0.772	0.926	0.91	1.2	1.282	1.296	1.26	1.132	1.18	1.496	3.05	7.19	8.57	8.302	7.712
0.582	0.608	0.686	0.764	0.862	0.862	1.104	1.286	1.32	1.32	1.228	1.274	1.524	3.008	6.992	8.444	8.202	7.598
0.512	0.524	0.594	0.714	0.754	0.806	1.046	1.222	1.448	1.446	1.414	1.462	1.638	2.924	6.618	8.128	7.936	7.336
0.412	0.426	0.49	0.618	0.674	0.726	0.99	1.222	1.462	1.638	1.686	1.754	1.824	3.142	6.408	7.706	7.584	7.054
0.326	0.34	0.384	0.46	0.526	0.558	0.924	1.236	1.484	1.74	2	2.116	2.286	3.812	6.332	7.364	7.354	6.954
0.25	0.256	0.298	0.374	0.372	0.464	0.828	1.302	1.59	1.844	2.276	2.524	2.946	5.002	6.774	7.34	7.468	7.248
0.184	0.196	0.232	0.222	0.294	0.362	0.752	1.28	1.55	1.932	2.48	2.892	3.678	5.386	7.13	8.008	8.286	8.244
0.182	0.19	0.176	0.166	0.172	0.264	0.636	1.206	1.632	2.038	2.68	3.234	4.446	6.134	7.644	8.228	8.628	8.718
0.15	0.192	0.172	0.152	0.156	0.196	0.644	1.282	1.752	2.294	2.788	3.474	4.974	6.696	8.244	9.412	9.882	10.012
0.156	0.21	0.168	0.126	0.13	0.184	0.674	1.342	1.886	2.42	2.962	3.766	5.192	7.822	8.852	9.96	10.454	10.548
0.164	0.222	0.172	0.126	0.132	0.23	0.71	1.492	2.048	2.692	3.144	4.084	5.34	8.49	9.636	11.352	11.862	11.85
0.2	0.234	0.178	0.158	0.17	0.252	0.768	1.616	2.254	2.76	3.3	4.844	5.842	8.73	10.172	11.86	12.414	12.282
0.21	0.234	0.184	0.168	0.182	0.334	0.958	1.722	2.322	2.82	3.926	5.788	6.954	9.472	11.288	13.076	13.718	13.474
0.216	0.228	0.19	0.182	0.196	0.36	1.004	1.882	2.382	2.742	4.828	6.824	8.322	10.31	12.322	14.16	14.91	14.576
0.218	0.22	0.194	0.196	0.258	0.47	1.06	1.872	2.316	2.642	6.316	7.994	9.136	11.02	13.704	15.622	16.468	16.068
0.22	0.216	0.194	0.244	0.27	0.5	1.242	1.878	2.174	2.66	7.19	8.508	9.744	12.092	14.656	16.636	17.536	17.09
0.226	0.22	0.192	0.246	0.284	0.53	1.296	1.874	2.204	2.938	7.604	8.992	9.842	12.85	15.446	17.488	18.386	17.906
0.224	0.224	0.198	0.252	0.3	0.474	1.342	1.94	2.114	3.4	7.496	8.968	10.66	14.076	16.576	18.668	19.488	18.976
0.224	0.21	0.198	0.216	0.318	0.51	1.384	1.944	2.18	4.202	7.716	9.542	11.87	14.922	17.23	19.404	20.06	19.508

0.224	0.206	0.194	0.218	0.308	0.554	1.418	1.934	2.314	5.348	8.634	10.304	13.004	16	18.206	20.546	20.936	20.318
0.196	0.202	0.198	0.228	0.334	0.604	1.458	1.976	2.494	6.428	9.67	11.388	14.47	16.554	18.8	21.288	21.316	20.62
0.186	0.172	0.196	0.24	0.372	0.658	1.466	1.99	2.768	7.178	10.954	12.364	15.474	17.226	19.696	22.294	21.902	21.116
0.176	0.17	0.172	0.258	0.404	0.704	1.506	2.164	3.058	7.52	11.726	13.054	16.442	17.618	20.452	22.944	22.134	21.282
0.166	0.164	0.174	0.248	0.436	0.746	1.602	2.184	3.448	7.848	12.568	13.81	17.078	18.248	21.556	23.624	22.462	21.578
0.166	0.164	0.178	0.262	0.456	0.794	1.602	2.276	3.858	8.426	13.058	14.49	17.466	19.124	22.84	24.456	23.014	22.148
0.166	0.162	0.176	0.298	0.474	0.834	1.652	2.318	4.274	9.206	13.658	15.136	17.706	20.156	24.178	25.212	23.558	22.724
0.162	0.164	0.204	0.302	0.494	0.964	1.656	2.508	4.878	10.216	13.998	15.716	17.94	21.32	25.288	25.932	24.11	23.308
0.162	0.19	0.204	0.306	0.552	1	1.792	2.564	5.372	11.794	14.416	16.446	18.394	22.518	26.47	26.56	24.624	23.84
0.188	0.192	0.204	0.314	0.566	1.03	1.798	2.682	5.886	12.866	14.954	17.05	18.972	23.71	27.348	27.094	25.162	24.41
0.192	0.194	0.25	0.358	0.652	1.046	1.792	2.802	6.736	13.718	15.55	17.8	19.602	24.832	28.402	27.452	25.684	25.034
0.242	0.24	0.25	0.414	0.66	1.176	1.798	2.934	7.444	14.706	16.45	18.51	20.316	25.792	29.33	27.37	25.902	25.474
0.242	0.24	0.31	0.426	0.742	1.202	1.808	3.036	8.268	15.194	17.472	19.236	20.9	26.286	29.408	27.106	26.006	25.866
0.24	0.3	0.322	0.506	0.736	1.214	1.812	3.134	8.948	15.554	18.288	19.864	21.33	25.898	28.208	26.256	25.516	25.652
0.302	0.314	0.408	0.504	0.854	1.218	1.948	3.274	9.576	15.604	18.956	20.528	21.772	24.338	25.662	25.468	25.036	25.366
0.4	0.4	0.412	0.63	0.854	1.354	1.982	3.392	10.13	15.498	19.56	21.156	22.11	22.714	24.04	24.452	24.256	24.706
0.402	0.404	0.544	0.634	0.852	1.362	2.044	3.652	10.302	15.326	20.038	21.756	22.836	22.836	24.558	23.36	23.306	23.812
0.406	0.532	0.548	0.642	0.98	1.368	2.12	3.912	10.856	15.064	20.526	22.3	22.822	24.052	25.648	21.752	21.746	22.254
0.514	0.538	0.55	0.794	1.026	1.384	2.15	4.222	11.298	15.184	21.04	22.82	23.05	25.63	26.386	20.066	20.05	20.484
0.548	0.542	0.668	0.802	1.046	1.508	2.236	4.692	11.694	15.194	21.604	23.21	22.618	25.282	24.846	18.57	18.526	18.836
0.554	0.55	0.672	0.812	1.168	1.556	2.404	5.046	12.15	15.522	22.176	23.408	22.99	23.196	22.194	17.972	17.938	18.134
0.562	0.558	0.682	0.818	1.178	1.568	2.398	5.424	12.264	16.044	22.688	23.734	22.782	20.472	19.25	19.084	19.11	19.24
0.568	0.684	0.692	0.822	1.176	1.562	2.45	5.536	12.162	16.526	23.172	23.734	22.462	17.132	15.936	16.246	16.37	16.498
0.694	0.698	0.708	0.79	1.162	1.596	2.572	6.194	12.31	16.898	23.51	23.718	21.89	15.048	14.326	15.092	15.322	15.496
0.712	0.72	0.726	0.786	1.134	1.59	2.62	6.632	12.224	17.336	23.78	23.698	20.902	13.046	12.9	13.996	14.31	14.546
0.732	0.744	0.748	0.784	1.112	1.574	2.618	7.19	12.332	17.598	23.622	23.07	19.916	11.66	11.928	13.174	13.54	13.816
0.88	0.9	0.9	0.916	1.174	1.6	2.662	7.512	12.652	17.85	23.592	22.494	18.796	10.786	11.168	12.392	12.776	13.058
0.918	0.932	0.91	0.92	1.16	1.598	2.76	8.192	12.988	18.25	23.474	21.68	17.928	10.244	10.54	11.628	12.004	12.256
1.01	1.014	1.002	1.004	1.156	1.648	2.756	8.81	13.396	18.836	23.292	20.502	16.24	9.832	10.136	11.026	11.374	11.576
1.058	1.062	1.036	1.008	1.192	1.642	2.788	9.234	13.87	19.67	22.916	19.278	14.876	9.74	9.968	10.66	10.964	11.114
1.14	1.14	1.064	1.042	1.2	1.636	2.866	9.834	14.214	20.466	22.324	17.878	13.8	9.548	9.736	10.262	10.508	10.626
1.204	1.21	1.126	0.992	1.152	1.662	3.042	10.726	14.676	21.506	21.332	16.558	12.95	9.404	9.652	10.054	10.246	10.348
1.206	1.19	1.12	0.998	1.162	1.698	3.146	11.314	15.078	22.188	20.624	15.558	12.994	9.412	9.754	10.072	10.222	10.314
1.232	1.236	1.194	1.002	1.172	1.72	3.294	11.71	15.658	22.828	19.772	14.434	13.364	10.4	9.792	10.06	10.176	10.264
1.224	1.226	1.122	0.892	1.076	1.738	3.442	12.382	15.962	23.392	19.446	13.356	12.478	11.076	9.842	10.078	10.176	10.256
1.222	1.226	1.118	0.888	1.088	1.684	3.75	12.584	16.546	23.838	19.128	12.882	11.528	12.16	10.104	10.324	10.412	10.48
1.108	1.108	1.004	0.888	1.094	1.694	3.82	12.86	17.024	24.24	19.044	12.128	9.908	11.274	10.25	10.45	10.532	10.588
0.996	0.996	0.872	0.89	1.094	1.812	3.902	12.932	17.306	25.01	18.97	11.444	10.012	11.196	11.476	11.654	11.73	11.78
0.984	0.978	0.87	0.894	0.966	1.728	4.228	13.294	17.868	26.026	19.206	10.692	9.352	10.978	11.312	11.47	11.536	11.578
0.988	0.986	0.75	0.772	0.966	1.72	4.612	13.214	18.498	27.084	19.21	10.242	8.806	11.662	12.05	12.182	12.232	12.266
0.976	0.924	0.9	0.78	0.97	1.716	4.986	13.016	19.044	27.746	18.8	9.758	8.628	12.632	13.058	13.156	13.192	13.214
0.924	0.928	0.818	0.654	0.976	1.7	5.52	12.932	19.99	28.034	17.876	10.016	8.664	13.286	13.714	13.786	13.808	13.814
0.878	0.894	0.962	0.814	1.008	1.71	5.964	13.056	20.862	27.98	17.35	10.164	9.408	13.506	13.906	13.958	13.966	13.954
0.91	0.914	0.924	0.848	1.018	1.736	6.42	13.208	21.684	28.002	16.65	10.246	9.884	13.934	14.274	14.312	14.302	14.28
0.944	0.948	1.022	0.878	1.046	1.784	6.948	13.216	22.276	27.646	16.556	10.522	10.432	14.564	14.832	14.862	14.836	14.804
0.856	0.864	1.046	0.944	0.938	1.834	7.176	13.254	22.712	27.976	17.324	11.636	10.562	15.108	15.294	15.318	15.278	15.24
0.852	0.86	0.99	0.952	1.094	1.88	7.436	13.276	23.038	27.878	18.848	13.062	10.374	13.752	13.862	13.884	13.826	13.786
0.832	0.842	0.964	1.002	1.122	1.924	7.704	13.376	23.23	28.692	20.856	15.502	10.606	11.592	11.648	11.666	11.596	11.56
0.824	0.836	0.924	1.066	1.138	1.968	8.064	13.58	23.538	29.44	21.854	16.608	10.546	11.412	11.428	11.448	11.376	11.344
0.726	0.836	0.944	1.024	1.154	2.032	8.394	13.572	23.848	29.654	21.62	17.012	10.524	11.232	11.228	11.258	11.196	11.172
0.764	0.776	0.908	1.048	1.026	1.972	8.69	13.63	24.17	28.932	21.394	16.862	10.234	10.774	10.77	10.808	10.768	10.754
0.8	0.818	0.92	1.02	1.172	2.112	8.836	13.418	24.402	27.816	19.982	16.718	10.054	10.42	10.424	10.474	10.46	10.454
0.726	0.744	0.838	1.022	1.174	2.142	9.18	13.606	24.332	26.494	18.616	16.07	9.714	9.916	9.932	9.992	9.998	9.992
0.722	0.744	0.83	0.928	1.168	2.144	9.508	13.96	24.23	24.828	17.226	15.526	9.848	9.904	9.926	9.994	10.008	9.988
0.648	0.65	0.706	0.794	1.3	2.158	9.736	14.502	24.446	23.168	17.232	15.348	14.396	14.326	14.342	14.418	14.422	14.372
0.594	0.638	0.67	0.756	1.264	2.008	10.42	15.078	24.442	21.674	16.234	15.596	14.81	14.646	14.642	14.726	14.704	14.61
0.598	0.634	0.574	0.65	1.236	2.004	10.812	15.808	24.612	20.586	15.408	16.042	15.442	15.222	15.182	15.276	15.224	15.086
0.604	0.576	0.562	0.656	1.224	2.194	11.096	16.76	24.802	19.594	14.764	16.316	15.894	15.652	15.57	15.664	15.594	15.416
0.608	0.578	0.564	0.682	1.392	2.34	11.368	17.848	25.438	18.854	15.068	16.648	16.372	16.14	16.014	16.1	16.022	15.822
0.612	0.582	0.574	0.644	1.358	2.378	11.482	18.868	25.552	18.538	15.034	16.622	16.448	16.242	16.09	16.148	16.076	15.878
0.62	0.588	0.592	0.766	1.39	2.462	11.952	19.676	25.92	18.288	14.92	17.25	17.142	16.98	16.82	16.84	16.782	16.606
0.62	0.65	0.616	0.81	1.348	2.578	12.288	20.24	25.6	17.35	14.424	16.766	16.696	16.584	16.444	16.43	16.38	16.244
0.632	0.666	0.644	0.842	1.4	2.54	12.394	20.642	24.952	16.476	14.01	13.286	13.24	13.172	13.076	13.044	13	12.902
0.696	0.682	0.674	0.874	1.374	2.504	12.592	21.134	24.428	15.738	13.878	13.338	13.304	13.272	13.23	13.208	13.162	13.102
0.702	0.696	0.696	0.89	1.318	2.458	12.432	21.67	24.094	15.35	13.588	13.188	13.162	13.156	13.172	13.182	13.13	13.098
0.694	0.698	0.714	0.906	1.338	2.782	12.684	22.178	23.9	14.994	13.432	13.132	13.108	13.12	13.182	13.24	13.18	13.168
0.626	0.69	0.74	0.94	1.368	3	13.024	22.67	24.284	14.86	13.04	12.81	12.784	12.806	12.896	13.002	12.94	12.94
0.614	0.688	0.806	1.098	1.388	3.18	12.9	23.228	24.296	14.572	12.652	12.462	12.434	12.466	12.566	12.708	12.646	12.65
0.604	0.69	0.9	1.176	1.306	3.354	13.252	23.94	24.316	14.182	12.154	11.988	11.956	11.992	12.094	12.25	12.192	12.202
0.6	0.692	1.044	1.338	1.356	3.426	13.334	24.726	23.418	13.768	11.704	11.56	11.528	11.566	11.656	11.81	11.756	11.766

0.644	0.692	1.054	1.316	1.422	3.794	13.32	25.502	22.28	13.322	11.286	11.162	11.128	11.172	11.242	11.376	11.332	11.34
0.688	0.728	1.002	1.322	1.34	3.792	13.412	26.206	21.35	12.874	10.754	10.654	10.626	10.668	10.724	10.83	10.798	10.802
0.7	0.708	0.95	1.296	1.412	3.796	13.56	26.56	20.388	12.382	10.438	10.37	10.344	10.388	10.432	10.514	10.492	10.486
0.712	0.75	0.842	1.264	1.58	3.806	13.488	26.81	19.95	12.146	10.488	10.452	10.438	10.482	10.516	10.58	10.566	10.554
0.724	0.76	0.838	1.258	1.634	4.104	13.6	27.058	18.492	14.532	10.768	10.768	10.764	10.812	10.84	10.892	10.888	10.87
0.734	0.736	0.84	1.184	1.576	4.312	13.692	27.422	18.36	14.616	11.204	11.23	11.236	11.28	11.312	11.356	11.356	11.342
0.742	0.748	0.79	1.164	1.716	4.514	14.304	27.578	17.264	14.208	11.722	11.766	11.774	11.824	11.852	11.888	11.9	11.892
0.756	0.762	0.804	1.082	1.768	4.906	14.822	27.538	16.41	10.952	12.066	12.116	12.126	12.172	12.198	12.232	12.246	12.25
0.758	0.784	0.826	1.116	1.822	5.102	15.51	27.4	14.766	10.414	12.296	12.342	12.35	12.39	12.416	12.444	12.458	12.474
0.766	0.824	0.832	1.164	1.868	5.47	16.31	27.25	13.752	10.236	12.19	12.232	12.234	12.268	12.286	12.312	12.328	12.352
0.782	0.838	0.842	1.078	1.892	5.496	16.888	26.952	13.114	9.874	11.608	11.644	11.636	11.658	11.674	11.696	11.71	11.738
0.81	0.844	0.85	1.182	1.918	5.714	17.688	26.422	12.774	9.73	11.368	11.394	11.378	11.392	11.4	11.418	11.432	11.458
0.856	0.864	0.872	1.17	1.966	5.76	18.202	25.958	12.666	9.748	11.022	11.042	11.014	11.022	11.02	11.028	11.04	11.058
0.862	0.87	0.878	1.296	1.986	6.458	18.738	25.594	12.452	9.978	10.824	10.838	10.802	10.802	10.792	10.79	10.796	10.804
0.932	0.942	0.95	1.428	2.242	7.238	19.458	25.892	12.294	10.146	10.416	10.42	10.376	10.368	10.346	10.334	10.336	10.33
1.038	1.044	1.148	1.478	2.266	7.794	19.904	25.878	12.17	10.194	10.528	10.522	10.464	10.444	10.41	10.394	10.392	10.384
1.282	1.288	1.296	1.368	2.328	8.212	20.396	25.554	12.14	10.048	10.424	10.4	10.332	10.3	10.244	10.232	10.232	10.22
1.422	1.432	1.44	1.172	2.394	8.466	21	24.564	12.108	9.888	10.28	10.232	10.146	10.094	10.016	10.014	10.02	10.022
1.422	1.306	1.156	1.09	2.478	8.898	21.654	23.826	12.136	9.966	10.354	10.28	10.17	10.096	9.99	10.014	10.026	10.046
1.226	1.164	1.008	1.096	2.544	9.022	22.232	23.586	12.22	10.008	10.38	10.28	10.138	10.042	9.916	9.966	9.986	10.034
1.09	1.114	1.034	1.114	2.716	8.938	22.728	23.594	12.168	10.186	10.534	10.412	10.244	10.13	9.984	10.056	10.088	10.16
1.196	1.114	1.01	1.066	2.788	8.828	23.126	23.588	12.058	10.184	10.518	10.382	10.198	10.074	9.918	10.006	10.042	10.13
0.2	0.2	0.18	0.18	0.2	0.23	0.32	0.62	1.62	3.14	4.19	4.97	5.56	7.04	8.78	10.81	14.5	17.8
0.2	0.2	0.2	0.2	0.2	0.23	0.32	0.62	1.29	3.14	4.23	5.15	5.8	7.04	9.05	10.81	14.5	17.8
0.2	0.2	0.2	0.2	0.2	0.23	0.32	0.54	1.29	3.14	4.23	5.15	5.8	7.6	9.05	10.81	15.27	18.88
0.2	0.2	0.2	0.2	0.2	0.2	0.28	0.54	1.17	2.98	4.23	5.39	6.29	7.85	9.34	11.67	15.27	18.88
0.18	0.18	0.18	0.18	0.18	0.2	0.25	0.48	1.05	2.98	4.23	5.39	6.52	8.17	9.72	12.16	16.13	20.04
0.18	0.18	0.18	0.18	0.18	0.22	0.25	0.43	1.05	2.82	4.44	5.85	6.8	8.43	10.04	12.16	16.13	20.04
0.18	0.18	0.17	0.2	0.2	0.2	0.22	0.38	0.95	2.82	4.44	5.85	7.35	9.05	10.39	12.71	17.09	20.79
0.17	0.2	0.2	0.2	0.2	0.25	0.25	0.34	1	2.82	4.44	6.12	7.92	9.72	11.22	13.9	18.88	22.04
0.2	0.2	0.19	0.23	0.23	0.23	0.28	0.42	1	2.66	4.66	6.34	7.92	10.04	11.67	14.64	18.88	22.04
0.2	0.19	0.23	0.23	0.26	0.26	0.28	0.46	1.16	2.86	4.66	6.63	8.51	10.44	12.16	15.27	20.79	23.35
0.2	0.19	0.23	0.26	0.26	0.32	0.32	0.55	1.19	2.86	4.66	6.87	8.51	10.81	13.25	16.82	22.04	24.07
0.19	0.23	0.26	0.3	0.3	0.35	0.38	0.58	1.35	3.06	5.06	7.18	9.13	11.24	13.25	17.8	22.78	26.08
0.19	0.22	0.26	0.3	0.35	0.35	0.42	0.68	1.5	3.06	5.06	7.18	9.13	11.67	14.5	19.61	24.78	26.74
0.19	0.22	0.3	0.35	0.33	0.39	0.48	0.68	1.5	3.25	5.3	7.75	9.79	12.15	15.93	20.36	26.74	28.6
0.23	0.26	0.3	0.33	0.39	0.39	0.48	0.78	1.66	3.44	5.56	8.09	10.18	13.2	15.93	22.29	27.41	30.33
0.22	0.26	0.3	0.39	0.39	0.45	0.56	0.88	1.81	3.44	5.76	8.71	10.5	13.2	17.53	23.51	29.23	30.92
0.22	0.25	0.3	0.39	0.45	0.45	0.56	0.88	1.81	3.63	6.04	8.96	10.91	14.41	18.28	24.26	30.92	32.45
0.22	0.25	0.35	0.39	0.45	0.45	0.56	0.88	1.81	3.63	6.34	9.34	11.74	15.8	20.08	26.21	31.55	33.82
0.22	0.25	0.35	0.39	0.45	0.45	0.56	0.98	1.97	3.63	6.9	10	12.25	16.54	21.15	26.98	33.07	34.42
0.22	0.3	0.35	0.39	0.45	0.48	0.56	1.1	1.97	3.83	6.9	10.43	13.29	18.18	21.97	28.84	34.42	35.6
0.22	0.3	0.35	0.39	0.45	0.56	0.64	1.1	1.97	3.83	7.5	10.92	13.96	19.08	23.92	30.6	34.42	36.21
0.26	0.3	0.35	0.45	0.48	0.56	0.7	1.1	1.97	3.83	7.92	11.19	15.28	20.95	25.81	31.38	35.07	37.12
0.26	0.3	0.42	0.45	0.56	0.56	0.7	1.1	2.15	4.03	8.14	11.74	16.18	22.02	27.76	33	36.21	37.66
0.26	0.3	0.42	0.45	0.56	0.64	0.79	1.22	2.31	4.21	8.6	12.37	16.18	24.02	29.65	33.82	36.83	37.66
0.26	0.3	0.42	0.56	0.64	0.64	0.79	1.35	2.5	4.62	8.82	12.68	17.83	25.24	30.7	34.7	37.45	38.15
0.25	0.35	0.42	0.56	0.64	0.64	0.79	1.48	2.87	4.8	9.32	13.41	18.98	26.56	32.49	36.06	38.15	38.6
0.25	0.35	0.42	0.56	0.64	0.72	0.88	1.64	2.87	5.24	9.52	13.41	20.26	28.62	33.59	36.9	38.59	38.87
0.25	0.35	0.48	0.56	0.64	0.79	0.98	1.64	3.25	5.43	9.52	14.64	20.95	30.05	36.31	37.9	38.96	39.05
0.25	0.35	0.48	0.56	0.72	0.79	0.98	1.97	3.45	5.71	9.72	14.64	22.34	32.05	37.47	38.6	39.25	39.05
0.25	0.35	0.48	0.56	0.79	0.79	0.98	1.97	3.63	5.92	10.45	15.09	23.03	33.56	38.69	39.26	39.46	39.14
0.28	0.35	0.48	0.64	0.79	0.79	1.1	2.15	3.83	6.13	10.45	16.08	24.51	35.46	39.72	39.91	39.59	39.15
0.28	0.35	0.48	0.7	0.79	0.88	1.22	2.15	4.01	6.13	10.67	16.61	26.72	37.05	40.8	40.23	39.64	39.06
0.28	0.42	0.48	0.7	0.79	0.98	1.22	2.15	4.01	6.34	10.67	17.19	26.72	38.76	41.17	40.48	39.62	38.91
0.28	0.42	0.56	0.7	0.88	0.98	1.35	2.33	4.01	6.34	10.92	18.34	28.92	40.41	41.98	40.65	39.52	38.68
0.33	0.42	0.61	0.7	0.88	1.1	1.35	2.5	4.19	6.9	10.92	20.26	31.07	41.76	41.53	39.52	39.34	38.37
0.33	0.48	0.61	0.88	0.98	1.1	1.35	2.5	4.4	6.9	11.74	21.66	33.16	42.65	42.29	39.34	37.98	37.98
0.39	0.48	0.7	0.88	0.98	1.22	1.48	2.5	4.4	6.9	11.74	22.34	36.61	45.41	42.51	39.06	37.51	37.51
0.39	0.48	0.7	0.98	1.22	1.22	1.64	2.67	4.4	7.5	12.37	24.51	38.66	45.08	42.58	38.68	36.95	36.95
0.39	0.56	0.79	0.98	1.22	1.48	1.79	2.67	4.62	7.5	13.41	26.07	40.54	46.75	42.49	38.18	36.29	36.29
0.45	0.56	0.79	0.98	1.22	1.48	1.79	2.87	4.8	7.92	13.41	28.32	44.45	44.86	39.96	37.57	36.84	35.54
0.45	0.56	0.79	1.09	1.34	1.48	1.79	3.05	5.05	8.39	14.26	29.99	46.53	44.83	38.72	36.02	36.02	34.72
0.45	0.64	0.79	1.09	1.34	1.62	2.12	3.05	5.05	8.39	15.62	31.69	47.79	44.46	37.9	35.12	35.12	33.83
0.51	0.64	0.88	1.09	1.34	1.62	2.12	3.24	5.05	9.12	16.74	33.43	49.66	43.87	36.99	35.12	34.18	34.18
0.51	0.64	0.88	1.09	1.62	1.93	2.27	3.44	5.52	9.12	17.97	35.8	51.43	43.08	36.02	36.02	33.22	33.22
0.51	0.64	0.88	1.2	1.62	1.93	2.47	3.64	5.52	9.73	19.81	37.66	53.01	42.15	37.34	35.03	32.28	32.28
0.51	0.64	0.88	1.34	1.62	2.12	2.64	3.83	6.04	9.89	21.26	39.6	53.01	41.12	36.32	34.05	31.37	31.37
0.56	0.72	0.98	1.34	1.79	2.27	2.85	4.03	6.04	10.57	21.26	41.62	54.32	41.12	35.35	33.11	30.5	29.67
0.56	0.79	0.98	1.34	1.93	2.47	3.05	4.24	6.62	10.57	22.75	44.38	55.29	40.05	34.44	31.39	29.67	28.87

0.64	0.79	1.09	1.48	2.12	2.47	3.24	4.43	6.62	11.36	24.91	46.65	53.35	39	33.6	30.58	28.08	28.08
0.64	0.79	1.09	1.62	2.12	2.67	3.44	4.43	6.62	11.36	26.43	48.98	53.04	38	32.8	29.79	29	29
0.64	0.79	1.22	1.62	2.47	2.85	3.44	4.62	7.05	11.45	27.88	53.86	52.4	34.44	32.02	29	28.19	28.19
0.72	0.88	1.22	1.79	2.47	2.85	3.44	4.86	7.26	12.32	27.88	55.94	48.38	32.8	29	28.19	27.35	27.35
0.72	0.88	1.34	1.93	2.47	3.05	3.64	4.86	7.26	12.32	30.17	57.21	46.22	32.02	28.19	27.35	27.35	26.51
0.72	0.88	1.34	1.93	2.64	3.05	3.83	4.86	7.26	12.32	31.53	59.47	45.13	31.24	27.35	26.51	26.51	25.69
0.8	0.98	1.46	1.93	2.85	3.24	3.83	4.86	7.77	13.33	32.8	58.29	40.97	31.24	26.51	26.51	26.51	25.69
0.8	0.98	1.46	2.08	2.85	3.44	4.03	5.32	7.98	14.44	36.77	58.21	40.04	30.45	26.51	26.51	25.69	25.69
0.88	1.08	1.58	2.27	3.03	3.63	4.24	5.32	8.56	15.69	39.9	55.28	40.04	30.45	26.51	25.69	25.69	25.69
0.8	1.17	1.58	2.44	3.43	3.83	4.24	5.83	8.75	15.65	41.56	54.46	40.04	30.45	26.51	26.51	26.51	25.69
0.87	1.17	1.71	2.61	3.43	4.04	4.67	5.83	9.42	16.96	43.35	54.46	37.08	31.24	26.51	26.51	26.51	26.51
0.87	1.17	1.71	2.82	3.84	4.47	5.12	6.41	10.33	18.34	46.95	51.52	37.08	32.02	27.35	27.35	27.35	27.35
0.87	1.28	2.04	3.01	4.04	4.67	5.32	7.05	11.28	19.83	46.95	51.52	38	32.8	28.19	28.19	28.19	28.19
0.95	1.28	2.04	3.22	4.47	5.12	5.83	7.77	11.36	20.01	48.19	52.4	39	31.39	29.79	29	29	29.79
0.95	1.28	2.04	3.22	4.67	5.32	6.41	8.75	12.38	22.21	48.98	50.01	41.12	33.11	30.58	30.58	30.58	30.58
0.95	1.28	2.04	3.43	5.12	5.83	7.26	8.94	13.41	22.75	46.65	50.44	39.37	34.05	32.22	31.39	32.22	30.5
0.95	1.28	2.04	3.63	5.32	6.41	7.48	9.89	13.7	23.37	46.97	50.34	41.1	36.02	34.05	31.37	32.28	32.28
0.95	1.28	2.23	3.83	5.52	6.83	8.39	10.86	14.93	24.03	44.71	47.31	41.75	36.99	36.02	33.22	33.22	34.18
0.87	1.28	2.23	3.83	5.92	7.27	8.82	11.23	15.62	25.4	42.58	46.75	42.22	38.72	35.12	35.12	35.12	35.12
0.87	1.17	2.08	4.03	6.13	7.5	9.52	12.1	16.08	26.07	42.45	45.99	42.49	39.41	36.02	36.02	36.02	36.02
0.87	1.17	2.27	4.21	6.34	8.14	9.94	12.68	17.74	26.72	40.54	45.08	42.58	39.96	36.84	36.84	36.84	36.84
0.97	1.31	2.27	4.4	6.56	8.6	10.18	13.05	18.34	28.32	40.54	45.08	42.58	39.96	37.57	37.57	37.57	37.57
0.97	1.31	2.47	4.4	6.79	8.84	10.43	14.22	18.98	28.92	40.41	45.08	42.51	39.96	38.18	37.57	38.18	38.18
1.08	1.46	2.67	4.58	7.02	8.84	11.19	14.22	20.95	28.92	40.41	44.07	42.51	40.36	38.18	38.18	38.18	38.18
1.08	1.62	2.87	4.75	7.36	9.09	11.5	14.72	20.95	29.49	40.41	45.08	42.51	39.96	38.18	39.96	39.96	39.96
1.08	1.93	3.45	5.17	7.6	9.09	11.5	14.72	20.95	31.07	40.41	45.08	42.51	39.96	39.96	39.96	39.96	39.96
1.2	2.12	3.63	5.36	7.6	9.34	11.5	15.6	22.34	31.07	40.41	45.08	42.58	39.96	39.96	39.96	39.96	39.96
1.31	2.12	4.01	5.83	7.97	9.74	11.5	16.18	23.03	31.07	42.16	45.08	42.58	39.96	39.41	39.96	39.96	39.96
1.31	2.47	4.21	6.34	8.21	9.74	12.05	16.18	23.03	32.73	42.16	45.08	42.58	39.96	39.41	39.41	41.75	41.75
1.46	2.47	4.4	6.34	8.6	10.18	12.05	17.19	24.51	32.73	42.16	46.73	44.86	39.41	39.41	39.41	41.75	41.75
1.46	2.67	4.4	6.9	8.6	10.18	12.68	16.61	24.51	32.73	42.16	46.73	44.86	39.41	39.41	39.41	41.75	41.75
1.46	2.67	4.8	6.9	9.26	10.92	12.68	17.19	24.51	32.73	43.99	47.95	44.86	41.75	39.41	38.72	41.1	41.1
1.62	3.05	4.8	6.9	9.26	10.92	13.05	18.34	26.07	34.46	43.99	47.95	44.86	41.75	39.41	38.72	38.72	41.1
1.79	3.05	4.99	7.5	9.94	11.74	13.79	18.34	26.07	34.46	43.99	47.95	44.96	41.75	39.41	38.72	38.72	37.9
1.79	3.25	5.17	7.73	9.94	11.74	15.09	19.61	27.69	36.26	45.88	45.99	44.96	41.75	38.72	38.72	37.9	37.9
1.97	3.45	5.17	7.73	10.18	12.68	15.09	20.26	28.32	36.61	45.88	46.75	44.96	41.75	38.72	37.9	37.9	37.9
2.15	3.45	5.63	7.97	10.92	13.05	16.61	22.34	29.99	38.47	46.68	46.75	44.96	41.75	38.72	37.9	36.99	36.99
2.15	3.63	5.83	8.6	10.92	13.79	17.19	23.83	30.55	38.66	46.68	46.75	44.96	41.75	38.72	36.99	35.12	35.12
2.33	3.63	5.83	8.6	11.19	14.22	18.98	24.51	32.73	40.56	46.68	47.31	44.96	41.75	37.9	35.12	34.18	34.18
2.33	3.81	5.83	8.84	12.05	14.72	18.98	26.72	34.46	40.56	46.73	44.86	42.49	39.41	37.9	34.18	34.18	34.18
2.5	3.81	5.83	8.84	12.05	15.6	19.68	26.72	34.84	42.45	46.73	44.86	42.22	38.72	36.99	34.18	33.22	33.22
2.5	3.81	5.83	8.84	12.05	16.18	20.95	28.92	36.61	42.45	46.73	44.86	42.22	38.72	36.99	34.18	33.22	33.22
2.7	4.01	5.83	9.26	13.05	17.19	21.67	28.92	36.86	42.16	46.73	44.86	42.22	38.72	35.12	34.18	31.98	31.98
2.87	4.01	5.83	9.26	13.05	17.19	23.03	31.07	36.86	42.16	46.73	44.86	42.22	38.72	35.12	34.18	32.91	32.91
3.05	3.83	6.13	9.03	13.79	18.98	23.75	31.07	36.86	42.16	46.73	44.55	42.49	38.72	35.12	34.18	32.91	32.91
3.05	4.03	5.92	9.52	13.79	18.98	25.19	31.57	38.74	41.76	45.08	44.55	42.49	38.72	36.02	35.12	33.83	33.83
3.03	4.24	6.24	9.52	14.64	20.26	26.72	33.16	38.74	41.76	44.07	44.55	42.49	39.41	36.02	36.02	34.72	34.72
3.22	4.04	6.04	10.07	15.62	22.34	27.35	33.16	38.74	43.37	44.07	44.07	42.58	39.96	36.84	36.84	35.54	35.54
3.22	4.27	6.41	9.89	17.2	23.83	29.49	35.17	38.76	42.65	44.07	44.07	42.51	40.36	37.57	37.57	36.29	36.29
3.43	4.33	6.63	10.57	17.2	26.07	31.07	35.46	40.41	42.65	42.75	41.96	42.51	40.36	38.68	38.18	36.95	36.95
3.45	4.33	6.63	11.36	18.45	26.07	33.16	37.05	40.21	41.9	42.75	41.96	42.29	40.62	39.06	38.68	38.68	37.51
3.71	4.42	6.94	11.28	19.81	28.32	34.84	38.76	40.21	41.9	42.75	41.96	40.75	40.74	39.06	39.06	39.06	39.06
3.5	4.77	7.58	12.26	21.85	29.99	35.17	38.76	41.29	41.9	41.53	41.96	40.65	40.75	39.34	39.34	39.34	39.06
3.81	4.77	7.58	13.35	23.37	31.69	36.86	40.21	41.29	41.98	41.53	40.65	40.65	40.75	39.52	39.52	39.34	39.34
3.6	5.18	8.36	14.59	23.37	32.25	36.86	40.21	41.29	41.98	41.53	40.65	40.65	40.75	39.52	39.52	39.52	39.34
3.94	5.67	9.51	14.49	25.61	34	38.66	40.21	41.29	41.98	41.53	40.65	40.65	40.75	40.75	39.52	39.52	39.52
4.56	5.88	10.64	15.8	25.61	34	38.66	40.41	42.65	43	41.53	40.65	40.65	40.75	40.75	40.75	39.52	39.52
5.03	6.49	10.79	15.69	25.61	34	38.66	40.41	42.65	43	41.53	40.65	40.65	40.75	40.75	40.75	39.52	39.52
5.25	7.46	12.2	17.06	25.61	34	38.66	40.41	42.65	43	41.53	40.65	40.65	40.75	40.75	40.75	39.52	39.52
5.82	7.46	12.2	16.97	26.33	34	38.66	40.41	41.29	43	41.53	40.65	40.75	40.75	40.75	40.75	39.52	39.52
6.05	8.63	12.2	16.97	27.95	34	38.66	40.41	41.76	43	41.53	40.65	40.75	40.75	40.75	40.75	39.52	39.52
6.74	8.63	13.68	16.97	27.95	34	38.66	40.41	41.76	43	41.53	40.75	40.75	40.75	40.75	40.75	39.52	39.52
6.99	8.63	13.68	16.96	27.95	34	38.66	40.41	41.76	43	41.53	40.75	40.75	40.75	40.75	40.75	39.52	39.52
0.72	0.72	0.72	1.2	4.06	16.93	45.73	56.14	49.74	44.68	52.16	62.7	84.18	87.72	77.39	82.84	79.92	83.51
0.72	0.72	0.72	1.2	4.06	16.93	42.06	52.96	44.53	44.68	52.16	62.7	87.32	84.18	77.39	82.84	87.63	85.43
0.72	0.72	0.72	1.2	3.1	17.41	33.2	40.32	39.24	44.51	47.47	57.77	83.82	87.32	80.25	84.07	87.63	85.43
0.72	0.72	0.72	0.96	3.6	15.32	20.28	30.59	31.99	34.21	44.53	60.35	82.84	86.55	82.84	91.16	89.27	88.66
0.72	0.72	0.72	0.96	2.99	13.21	14.32	20.35	24.34	31.99	42.71	54.96	78.77	84.07	84.07	92.37	91.22	83.96
0.72	0.72	0.72	0.81	2.64	10.26	8.55	12.47	21.96	30.01	38.93	49.5	75.2	83.51	83.51	91.22	86.05	81.72
0.72	0.72	0.72	0.81	1.97	7.44	4.11	7.92	17	26.67	34.49	46.27	73.03	80.68	85.43	86.05	81.72	63.71

0.72	0.72	0.72	0.81	1.97	3.94	2.46	7.59	17	27.36	33.52	42.05	66.91	75.03	85.26	86.05	83.08	63.71
0.72	0.72	0.72	0.81	1.36	2.46	1.97	7.44	19.09	27.36	33.52	42.05	62.28	75.29	76.95	86.05	65.09	52.71
0.72	0.72	0.72	0.81	1.15	1.36	1.36	4.11	19.09	26.72	36.32	43.49	56.19	66.05	76.95	81.72	65.09	52.71
0.72	0.72	0.72	0.96	1.4	1.15	1.4	2.99	17	27.36	36.32	43.49	56.19	66.05	73.19	79.77	63.71	52.71
0.72	0.72	0.72	0.93	1.2	1.2	1.2	3.6	17.88	29.84	36.32	44.09	56.34	59.95	68.44	61.85	63.71	52.71
0.72	0.72	0.83	1.16	1.16	1.16	1.48	5.49	18.91	30.01	39.9	47.99	56.34	59.95	52.98	61.85	51.23	47.46
0.72	0.83	0.83	1.25	1.6	1.92	2.47	7.9	24.11	31.99	41.72	47.99	56.34	59.95	52.98	61.85	51.23	47.46
0.63	0.83	1	1.6	2.03	2.03	2.56	7.57	24.21	36.98	46.92	58.36	62.28	66.05	56.45	49.42	45.98	47.46
0.63	0.68	1	1.1	1.66	2.56	3.83	11.25	28.34	44.51	57.77	64.18	68.74	71.88	56.45	49.42	45.98	47.46
0.63	0.68	0.91	1.35	1.66	3.17	5.57	13.08	27.07	44.68	59.71	69.9	80.68	76.95	59.44	44.25	47.46	41.03
0.68	0.68	0.91	1.35	2.01	3.83	5.57	14.85	30.13	48.42	67.72	79.92	83.51	85.26	61.85	45.98	39.73	41.03
0.68	0.68	0.91	1.35	2.01	3.83	9.24	21.52	28.8	51.55	69.45	82.84	91.16	91.22	63.71	47.46	41.03	38.5
0.68	0.68	0.91	1.35	3.17	4.7	10.54	23.34	30.88	54.05	75.64	90.08	91.32	93.25	65.09	48.69	42.27	40.06
0.68	0.68	0.91	1.66	3.83	5.57	16.57	23.34	32.85	51.47	73.83	94.59	97.25	100.27	66.95	50.68	43.5	41.68
0.68	0.68	0.91	2.56	3.83	5.57	18.27	25.13	32.85	54.26	77.28	95.52	98.53	103.28	67.74	51.59	44.73	43.29
0.68	0.77	0.91	2.56	4.55	9.24	18.27	25.13	32.85	54.26	77.11	101.18	107.09	111.97	69.64	52.51	47.21	44.81
0.68	0.77	0.91	3.17	4.55	9.24	18.27	30.35	34.84	57.28	81.13	102.48	108.96	116.38	71.84	54.34	48.36	46.17
0.77	0.77	1.1	2.41	5.3	10.54	20.03	30.35	39.72	57.28	80.7	105.29	118.08	125.4	72.68	55.15	50.44	48.46
0.77	0.91	1.35	2.41	5.3	11.92	20.03	32.27	39.72	60.53	84.98	113.63	122.29	129.6	98.89	56.46	51.47	49.55
0.77	0.91	1.66	2.83	6.08	8.47	25.13	32.27	39.72	60.53	89.26	110.49	129.77	136.69	98.48	57.11	54	52.27
0.91	1.1	1.06	1.6	3.74	8.47	25.13	32.27	39.72	64.01	93.38	113.4	133.22	142.34	97.08	59.1	55.64	55.87
0.91	1.1	1.22	1.6	3.74	8.47	25.13	32.27	42.06	69.26	93.38	116	139.26	144.94	97.38	62.73	59.43	57.72
1.1	1.35	1.41	1.81	2.03	8.47	25.13	34.84	42.06	73.12	102.39	123.19	146.02	141.19	102.06	68.22	61.31	62.98
1.1	0.91	1.41	0.91	2.28	9.57	27.01	36.97	44.56	75.72	102.39	126.12	150.53	145.76	106.15	74.27	64.35	64.35
0.91	1.06	1.6	0.98	2.28	9.57	27.01	36.97	52.23	79.8	110.49	128.66	153.11	147.74	114.72	77.03	65.42	66.28
0.91	1.06	0.86	1.06	2.57	10.77	29.04	39.27	55.29	79.8	110.49	133.2	155.32	149.27	117.91	80.91	75.25	67.12
0.91	1.22	0.91	1.19	2.93	12.06	31.24	41.77	58.5	83.87	117.14	133.2	155.43	150.34	119.97	82.14	77.78	69.77
1.06	0.78	0.98	1.19	3.37	13.43	33.62	44.42	58.5	89.26	117.14	136.68	157.12	151.11	121.06	84.58	79.46	72
1.06	0.82	0.98	1.38	3.9	14.86	36.12	44.42	61.82	89.26	117.14	139.26	157.12	142.41	121.64	86.33	84.26	78.17
1.06	0.82	0.98	3.37	7.82	14.86	36.12	47.15	61.82	89.26	115.64	135.87	154.81	143.26	122.2	88.5	86.95	86.95
1.06	1.41	1.06	3.37	7.82	16.31	33.02	44.31	61.82	89.26	115.64	138.11	155.76	143.26	123.16	92.96	89.28	89.28
1.22	1.41	2.28	3.37	7.82	16.31	33.02	44.31	61.82	89.26	119.24	141.36	150.34	130.34	124.64	94.36	91.06	90.76
1.22	1.41	2.28	6.14	12.3	16.31	33.02	44.31	61.82	93.38	123.03	141.36	140.44	130.34	102	93.85	90.12	90.12
1.22	1.41	2.03	6.14	12.3	22.13	30.64	44.31	61.82	98.53	123.03	145.3	141.6	123.16	103.72	91.98	88.12	88.12
0.78	1.41	3.74	8.83	13.43	20.26	36.12	44.42	61.82	98.53	129.77	148.25	127.95	123.16	104.95	89.46	85.47	85.47
0.82	1.41	3.27	8.83	13.43	26.04	33.62	41.77	64.01	103.27	133.22	147.45	127.95	98.76	104.95	89.46	82.63	82.63
0.82	1.41	5.3	7.84	12.06	23.9	36.59	44.56	69.26	109.67	135.87	149.81	127.95	98.76	94.69	86.71	79.99	79.99
1.41	1.41	5.3	9.57	14.96	29.04	36.97	49.35	68.08	115.64	141.36	143.49	119.97	98.76	94.69	86.71	79.99	77.84
1.41	1.41	5.3	9.57	14.96	27.01	39.72	54.26	68.08	115.64	144.54	145.76	119.97	86.33	94.69	89.46	79.99	77.84
1.22	1.41	5.3	9.57	21.9	32.27	39.72	54.26	72.77	123.03	145.3	133.18	119.97	86.33	90.76	85.47	82.63	79.99
1.22	1.41	6.08	9.57	21.9	32.27	46.63	59.28	72.77	123.03	148.25	133.18	92.98	84.58	89.28	90.12	85.47	82.63
1.22	1.41	6.08	9.57	21.9	36.97	46.63	59.28	77.11	126.5	147.45	111.77	92.98	84.58	86.95	90.76	90.12	88.12
1.22	1.41	6.93	9.57	21.9	36.97	54.26	61.74	81.13	129.77	147.45	111.77	92.98	83.26	84.26	86.95	90.76	91.06
0.78	1.6	6.93	10.77	23.9	36.97	54.26	64.73	81.13	126.5	147.45	111.77	77.03	76.46	79.46	74.88	78.17	89.28
0.82	1.6	4.25	10.77	23.9	36.97	49.35	62.29	80.7	126.5	144.94	102.06	77.03	75.25	77.78	69.77	72	78.17
0.82	1.81	4.25	10.77	21.9	34.34	49.35	62.29	80.7	126.5	144.94	102.06	77.03	75.25	76.46	68.2	69.77	72
0.86	1.81	4.81	10.77	21.9	32.27	49.35	62.29	80.7	126.5	144.94	102.06	77.03	75.25	67.12	67.12	68.2	69.77
0.91	0.98	4.81	10.77	21.9	32.27	49.35	65.62	89.89	123.03	144.94	102.06	77.03	75.25	67.12	67.12	67.12	68.2
0.98	1.06	4.81	10.77	21.9	32.27	49.35	65.62	89.89	123.03	144.94	106.15	73.87	75.25	67.12	67.12	67.12	68.2
0.98	1.06	2.57	10.77	21.9	32.27	49.35	65.62	94.32	126.17	144.94	106.15	75.25	75.25	67.12	67.12	68.2	68.2
1.06	1.06	2.93	8.83	23.9	32.27	49.35	65.62	99.01	126.17	144.94	110.62	75.25	76.46	68.2	68.2	68.2	69.77
1.06	1.19	2.93	9.91	16.64	34.34	49.35	71.77	99.01	129.77	141.19	89.9	76.46	77.78	69.77	64.87	69.77	69.77
1.06	1.19	2.93	9.91	16.64	34.34	52.23	71.77	99.01	132.42	141.19	89.9	77.78	77.78	69.77	67.14	72	72
1.06	1.19	2.93	9.91	16.64	34.34	52.23	76.59	109.67	138.11	130.24	92.98	77.78	79.46	72	74.88	74.88	74.88
1.19	1.19	3.37	11.07	18.42	31.24	57.28	76.59	109.67	139.06	115.55	95.08	79.46	74.88	74.88	78.17	78.17	84.26
0.49	1.38	3.37	6.94	13.43	31.24	60.53	80.7	111.6	142.23	119.63	82.14	81.65	78.17	78.17	81.42	81.42	86.95
0.49	0.58	3.9	6.94	14.86	39.04	60.53	85.44	115.64	144.94	114.72	83.26	81.65	84.26	81.42	84.1	89.28	89.28
0.58	0.74	1.99	7.82	14.86	41.63	64.01	89.89	123.03	147.45	117.91	84.58	84.26	86.95	84.1	85.7	90.76	90.76
0.35	0.74	2.44	4.53	16.31	41.63	64.01	94.32	129.77	143.49	119.97	86.33	86.95	89.28	90.76	85.7	91.06	91.06
0.35	0.52	1.29	5.22	16.31	47.15	67.65	94.32	133.22	145.76	121.06	88.5	89.28	90.76	91.06	91.06	90.12	90.12
0.52	0.76	1.68	5.22	17.71	49.87	71.34	98.53	133.22	145.76	96.32	90.86	89.28	91.06	90.12	90.12	88.12	88.12
0.76	1.07	1.68	5.92	23.96	55.79	81.04	102.39	139.26	147.74	97.06	90.86	90.76	91.06	88.12	88.12	88.12	85.47
1.07	1.07	2.1	5.92	25.71	58.58	81.04	102.39	140.21	147.74	122.2	92.96	94.36	90.12	88.12	91.98	91.98	85.47
1.41	1.41	2.1	10.51	35.35	61.19	84.81	105.79	140.21	149.27	122.2	94.36	94.69	90.12	85.47	91.98	89.46	85.47
1.41	1.41	2.5	10.51	37.57	71.42	88.29	105.79	140.21	149.27	122.2	94.36	94.69	88.12	85.47	102.92	102.92	82.63
1.73	1.73	2.5	16.9	39.58	74.15	88.29	108.74	140.21	149.27	122.2	94.36	94.69	88.12	85.47	128.37	128.37	82.63
1.73	1.73	2.83	17.74	48.01	74.15	91.4	108.74	140.21	149.27	122.2	94.36	91.06	88.12	85.47	138.69	126.19	86.71
1.73	2	2.83	18.42	48.01	76.53	94.69	116	143.78	149.27	122.2	92.96	91.06	88.12	85.47	138.69	136.64	86.71
1.73	2	3.03	18.42	49.65	84.21	103.58	123.19	146.02	149.27	122.2	92.96	91.06	84.8	88.12	136.64	134.19	84.17
1.67	2	3.03	18.93	57.46	94.09	108.74	128.66	150.99	138.62	122.2	90.86	91.06	84.8	88.12	123.68	121.25	84.17

1.67	2	3.09	19.31	57.46	97.52	116	136.68	149.81	126.14	97.06	88.5	90.76	85.93	90.12	119.26	117.95	80.74
1.67	2.16	3	19.31	58.33	106.13	125.56	142.65	145.76	126.14	97.06	88.5	89.28	85.7	91.06	92.55	92.38	80
1.67	2.16	4.85	19.58	58.33	106.13	133.2	144.54	133.18	117.91	96.32	86.33	84.1	84.1	85.7	80.74	92.8	79.8
1.81	2.18	4.71	19.58	58.52	111.3	136.68	148.25	136.12	117.91	82.14	84.58	78.17	78.17	84.1	80	79.8	79.8
1.81	2.18	7.96	23.4	61.97	113.6	136.68	147.45	119.63	92.98	80.91	83.26	74.88	74.88	78.17	76.29	79.8	79.8
1.81	3	7.91	23.55	61.97	113.6	140.21	149.81	119.63	89.9	80.91	82.14	72	69.77	72	79.99	75.33	75.33
2.18	3	13.04	31.61	61.5	115.8	140.21	149.81	119.63	89.9	79.25	75.25	68.2	67.12	64.87	85.47	79.99	79.99
2.07	2.79	19.76	43.09	69.05	123.83	143.78	149.81	119.63	86.03	77.03	73.87	66.28	62.19	62.59	85.93	88.12	88.12
1.85	4.51	19.76	43.09	69.05	123.83	143.78	149.81	119.63	86.03	77.03	72.14	65.42	61.42	62.19	78.17	84.1	84.1
1.57	4.27	23.57	50.66	82.47	132.68	149.23	149.81	115.55	81.85	74.27	72.14	64.35	60.6	61.42	69.77	74.88	74.88
1.28	4.27	23.57	56.5	92.27	136.33	149.23	149.81	115.55	81.85	71.23	70.01	62.98	60.6	61.42	62.59	68.2	68.2
1.01	4.05	23.46	56.5	102.39	139.21	149.23	151.88	115.55	81.85	71.23	67.6	62.98	60.6	60.6	61.89	61.89	61.89
1.01	3.87	30.79	58.35	102.39	139.21	149.23	151.88	115.55	81.85	71.23	62.98	62.98	60.6	60.6	61.42	61.42	61.42
0.79	3.87	30.07	58.35	106.46	142.92	153.11	151.88	115.55	81.85	71.23	62.98	60.6	60.6	60.6	60.6	60.6	60.6
1.57	7.61	30.07	65.72	107.9	142.92	153.11	151.88	133.18	81.85	71.23	62.98	60.6	60.6	60.6	60.6	60.6	60.6
1.48	7.56	29.28	65.72	107.9	142.92	155.32	153.55	136.12	110.62	74.27	64.35	61.42	61.42	61.42	58.24	58.24	58.24
3.64	7.56	29.28	64.82	109.61	146.46	154.69	153.55	136.12	110.62	74.27	64.35	61.42	61.42	61.42	59.09	58.24	58.24
3.62	13.07	37.23	64.82	109.61	146.46	154.69	153.55	138.62	114.72	77.03	72.14	65.42	61.89	61.89	59.09	59.09	59.09
3.62	13.07	37.23	64.96	111.75	149.73	156.89	154.81	138.62	114.72	77.03	72.14	65.42	61.89	59.5	59.09	59.09	59.09
3.68	12.96	36.62	64.96	111.75	149.73	156.89	155.76	126.14	117.91	79.25	73.87	66.28	62.19	59.61	59.5	61.89	61.89
3.68	12.96	42.79	86.87	123.32	152.7	158.9	150.34	126.14	92.98	79.25	73.87	66.28	62.19	62.19	62.19	62.19	62.19
1.82	12.84	43.55	86.87	123.32	156.12	158.9	151.11	119.97	95.08	80.91	75.25	67.12	67.12	62.59	62.59	62.59	62.59
1.82	7.52	45.91	102.67	135.67	158.54	160.18	141.6	119.97	95.08	75.25	67.12	67.12	67.12	62.59	63.4	63.4	63.4
2.23	7.6	53.93	113.01	143.99	160.27	157.78	142.41	96.32	82.14	76.46	68.2	68.2	68.2	63.4	64.87	69.77	69.77
1.39	7.6	58.32	116.7	147.08	163.17	151.92	128.95	96.32	82.14	76.46	68.2	68.2	68.2	63.4	69.77	72	72
2.83	12.73	63.17	121.29	155.96	162.68	153.13	129.58	97.06	83.26	77.78	69.77	69.77	69.77	69.77	67.14	72	72
2.83	12.77	68.72	125.25	158.52	165.22	153.13	121.64	97.06	77.78	69.77	69.77	69.77	69.77	69.77	67.14	67.14	67.14
5.06	19.44	79.99	125.25	158.52	165.22	144.58	122.2	97.75	79.46	72	72	72	72	79.46	67.14	67.14	67.14
7.98	24.14	103.94	129.3	160.96	168.38	144.58	122.2	97.75	79.46	72	72	72	79.46	79.46	67.14	64.09	64.09
12.86	33.96	103.94	129.3	160.96	168.38	146.6	123.16	98.76	81.65	74.88	74.88	74.88	81.65	86.33	70.14	64.09	64.09
19.83	49.66	108.72	133.24	163.26	172.15	146.6	131.58	98.76	81.65	74.88	74.88	74.88	81.65	86.33	70.14	59.86	59.86
24.98	64.56	119.57	133.24	154.56	172.15	146.6	131.58	98.76	84.26	78.17	78.17	74.88	84.26	86.33	64.09	59.86	59.86
36.05	64.56	119.57	133.24	154.56	172.15	149.31	124.64	100.22	84.26	78.17	78.17	78.17	84.26	88.5	64.09	59.86	59.86
36.05	64.56	119.57	133.24	154.56	176.4	149.31	124.64	100.22	84.26	78.17	78.17	78.17	84.26	88.5	64.09	59.86	59.86
0.1823	0.1823	0.1789	0.1822	0.1822	0.1921	0.2317	0.3208	0.5058	0.7866	1.111	1.3828	1.8359	2.5748	3.8824	5.8476	12.0639	19.2017
0.1823	0.1823	0.1789	0.1822	0.1822	0.1921	0.2317	0.3703	0.5421	0.8134	1.1544	1.4463	2.0401	2.8821	4.2537	6.0322	12.2807	16.9664
0.1823	0.1823	0.1789	0.1822	0.1822	0.1888	0.2317	0.4627	0.6874	0.8999	1.2805	1.6476	2.4215	3.6644	4.836	6.6195	13.0002	17.2613
0.1823	0.1823	0.1789	0.1789	0.1789	0.1855	0.2284	0.598	0.9053	1.1316	1.5428	2.1122	3.0963	5.3199	6.2204	7.9846	13.8257	19.4185
0.1823	0.1823	0.1789	0.1789	0.1822	0.1888	0.2251	0.6937	1.1134	1.4558	2.1078	2.9416	4.5006	7.7153	9.4743	10.6304	13.3057	22.2879
0.1823	0.1823	0.1789	0.1822	0.1822	0.1888	0.2318	0.7598	1.2424	1.9824	3.3181	5.1774	6.7526	11.0341	12.9703	12.0605	12.5799	25.1701
0.1823	0.1823	0.1789	0.1855	0.1855	0.1954	0.2351	0.7598	1.3321	2.8536	5.7233	8.3375	10.0478	13.9425	15.4043	14.2052	15.6866	29.3174
0.179	0.179	0.1789	0.1888	0.1921	0.2053	0.245	0.7667	1.4827	3.6498	8.6028	11.4351	13.138	15.9465	16.2591	17.4486	22.1503	34.2787
0.179	0.179	0.1822	0.1921	0.1987	0.2186	0.2583	0.7784	1.6328	4.2988	10.9396	13.2838	16.444	16.8606	16.8132	22.9325	29.3479	36.9141
0.179	0.1756	0.1822	0.1954	0.2053	0.2387	0.285	0.8257	1.8464	4.4256	12.2874	14.5909	18.0428	18.67	19.6359	27.8973	33.7945	37.6582
0.1757	0.1723	0.1855	0.1987	0.2284	0.2487	0.3316	0.9875	2.1471	5.1423	13.166	16.0286	19.704	20.988	22.7833	30.9147	36.8133	39.0945
0.1757	0.1723	0.1855	0.1987	0.2515	0.2751	0.3613	1.3838	2.8856	6.1619	14.6078	17.8887	21.0349	23.7233	27.4485	33.6595	37.537	39.6758
0.179	0.1756	0.1855	0.202	0.2779	0.2947	0.4073	2.0865	3.7251	8.0122	15.9961	19.8848	23.2154	25.4173	31.415	35.6947	37.416	39.7855
0.179	0.1756	0.1855	0.1987	0.3175	0.3473	0.483	2.7697	4.5676	9.815	17.0992	22.5123	25.4196	27.3706	35.2528	36.7302	39.2413	40.7531
0.1823	0.1822	0.1888	0.202	0.3637	0.4067	0.5953	3.3659	5.2071	11.4672	17.2228	25.5367	27.0347	29.4939	36.7043	37.6745	41.0523	41.1007
0.1889	0.1855	0.1921	0.202	0.4034	0.4793	0.7443	3.7636	5.8055	12.9308	16.846	27.7302	28.5269	32.4795	36.7725	37.6287	40.4036	41.7562
0.2021	0.1954	0.1954	0.2053	0.3869	0.496	0.9298	4.2784	6.8775	14.1406	17.1024	28.3574	29.309	35.9858	36.5771	37.3385	39.4012	44.6419
0.2219	0.2086	0.202	0.212	0.3673	0.4997	1.0923	4.7519	8.295	14.6243	18.5861	27.7194	30.0549	38.1688	36.6573	37.071	41.3449	49.0355
0.2483	0.2284	0.2119	0.222	0.341	0.4838	1.2181	5.1214	9.9416	14.46	20.9071	27.5172	30.992	39.5691	36.9387	37.5508	45.8612	50.7417
0.2813	0.2482	0.2219	0.2287	0.3446	0.4746	1.1755	5.4163	11.3252	14.3817	22.831	28.6436	33.3065	39.1038	37.7362	40.4294	48.8387	48.6209
0.3143	0.2746	0.2385	0.2421	0.3482	0.4586	1.1428	5.6263	12.2682	15.4437	24.4683	29.6285	35.5849	39.2749	42.8126	46.6001	50.7121	48.0272
0.3473	0.2977	0.2586	0.2589	0.365	0.4589	1.1269	5.967	13.0321	17.6081	26.9857	30.7647	37.9279	39.6338	43.9425	47.7259	46.5139	44.7244
0.3737	0.3208	0.2854	0.2724	0.3786	0.4925	1.3126	6.3339	13.7364	20.3598	29.2701	30.3813	39.1687	40.2898	44.2739	46.2005	44.4215	44.8805
0.4001	0.3472	0.3088	0.2892	0.3888	0.5262	1.5114	6.8679	14.5903	23.3235	29.3524	30.6907	38.6354	42.1066	45.0417	45.7105	47.3191	48.983
0.4298	0.3769	0.3354	0.2992	0.3924	0.5566	1.7242	7.2966	15.5688	25.5628	28.0053	30.6688	36.7309	43.6078	47.031	48.8158	52.1128	53.8362
0.4628	0.4133	0.3653	0.3092	0.4093	0.5767	1.888	7.7015	16.6116	27.8994	26.95	31.2604	36.5056	46.3749	51.6976	52.4944	55.3829	57.289
0.5024	0.4562	0.3917	0.3225	0.4195	0.5967	2.1444	8.5821	17.3073	29.8751	27.5902	32.0604	40.9985	49.2164	54.3277	52.9167	55.2485	57.7871
0.5552	0.5123	0.4246	0.3425	0.4227	0.6064	2.3468	9.6494	17.8011	31.6982	28.4961	34.194	47.4686	51.6641	54.4396	50.8289	52.9971	56.4857
0.6344	0.5849	0.4639	0.359	0.4292	0.6026	2.5023	10.608	18.3135	32.6486	29.4256	37.8519	52.9606	52.8282	53.0474	49.5137	52.8747	55.3975
0.74	0.6806	0.5096	0.3888	0.4425	0.6023	2.5712	11.3168	18.8975	32.8541	30.4348	42.3244	55.158	54.0133	52.2476	54.2139	54.349	56.1868
0.8786	0.8093	0.5852	0.4218	0.4593	0.6092	2.6604	12.0202	20.0612	32.6367	31.5222	45.6122	56.8203	56.752	55.7969	60.1972	58.0845	58.6653
1.0535	0.9611	0.6941	0.4681	0.4795	0.6294	2.8815	12.6999	21.1499	31.925	32.3887	47.6866	58.9224	59.3762	61.3955	64.4155	59.7819	59.6896
1.2482	1.1328	0.8294	0.5309	0.4862	0.639	3.1638	13.1575	22.7979	31.4048	33.2433	49.6493	61.8792	60.4479	69.1432	65.8612	61.5899	58.4707
1.4396	1.2945	0.9746	0.6035	0.4961	0.6913	3.5631	13.6216	24.0553	31.1909	34.0881	51.9701	63.9989	59.206	72.9722	67.4763	65.4972	58.4752
1.6079	1.4332	1.1164	0.6928	0.5291	0.7667	3.9387	14.3602	25.3631	31.7689	34.6136	54.7644	63.7771	58.7104	72.967	71.938	70.6664	63.9334
1.73	1.5222	1.2484	0.7954	0.5755	0.8493	4.3767	15.083	26.0999	32.7665	35.0948	57.1544	62.9595	59.0926	71.1175	78.4111	77.09	70.8784

1.8026	1.5716	1.3541	0.8949	0.6585	0.9322	4.8097	15.7813	26.8057	33.9717	35.2787	59.8742	62.4614	62.417	73.1949	85.3737	82.8695	79.6301
1.8158	1.5914	1.4168	0.9746	0.7218	1.0119	5.644	16.4576	27.6036	34.0588	35.9488	62.0265	63.4549	64.9559	76.4628	88.416	84.3474	84.5404
1.7861	1.5848	1.4332	1.0179	0.8214	1.1671	6.3122	17.0675	28.6098	32.9196	36.8002	63.542	64.1821	66.8374	80.151	89.7514	83.4626	88.4142
1.7268	1.5518	1.4035	1.0214	0.8777	1.3646	7.2858	17.3009	29.5949	31.3118	38.0718	63.9695	64.2405	65.893	81.9759	89.2675	80.8909	78.769
1.6377	1.4958	1.3242	0.9785	0.924	1.6115	7.9	17.1389	29.5802	30.519	40.1659	63.9127	63.3332	64.2495	83.4225	85.6754	78.944	77.4095
1.5289	1.4001	1.2021	0.9058	0.9071	1.7596	8.6419	17.0775	29.1568	30.7248	43.2713	63.4327	61.5867	61.1762	83.2615	76.1626	73.37	72.5483
1.3969	1.2715	1.057	0.8199	0.8503	1.8521	9.2736	17.5994	28.7357	31.52	46.6142	62.589	60.3612	57.8976	81.6916	64.2113	65.257	65.1514
1.2519	1.1131	0.8953	0.7409	0.7967	1.793	10.0613	18.7653	28.8986	32.5697	49.3826	61.6196	59.2402	57.9171	82.7201	60.8129	62.0127	62.4879
1.1232	0.9846	0.77	0.6786	0.7335	1.7802	10.8054	20.4359	29.899	33.843	50.7278	60.1991	59.3257	58.6459	83.9257	64.5183	60.2947	61.1263
0.998	0.8625	0.6811	0.6625	0.7004	1.7409	11.4023	22.3472	30.5907	35.8668	52.098	58.7295	59.7285	58.2093	83.2709	70.9479	60.5977	61.5283
0.8859	0.7703	0.632	0.6662	0.6709	1.7647	11.7127	24.4749	30.4886	37.6618	53.47	57.5104	61.7196	58.5459	81.6568	77.2852	77.9815	78.8065
0.764	0.6714	0.5894	0.6763	0.6542	1.7889	11.711	26.4962	29.8236	38.9824	55.0277	57.8366	64.0341	58.8901	78.9835	79.6531	80.125	80.7322
0.6618	0.6056	0.5532	0.6699	0.7069	1.8072	11.5468	28.0863	29.1404	39.8176	56.1723	59.7657	65.6523	60.7027	78.0127	79.5298	79.9093	80.2888
0.5926	0.5629	0.5301	0.6633	0.7664	1.7629	11.4044	29.0982	28.9157	41.0408	58.8839	62.9256	64.9145	61.4172	77.1329	78.3793	78.7555	78.97
0.5432	0.5332	0.5168	0.6633	0.8433	1.7611	11.6492	29.5709	28.8844	43.2363	61.8621	64.9423	63.74	61.8637	77.9424	78.4409	78.8567	79.0052
0.5233	0.53	0.5135	0.6666	0.9208	1.7821	12.2031	29.6976	29.2952	45.8953	64.0304	64.3775	61.3813	60.1654	76.9841	77.3526	77.7981	77.9763
0.53	0.5366	0.5268	0.6766	1.0145	1.9681	12.9187	30.1253	30.1504	48.5416	63.5257	62.1144	61.775	61.1575	78.7608	78.9159	79.3449	79.6188
0.5466	0.5432	0.5433	0.6932	1.1079	2.1481	13.5781	30.22	30.6094	51.5184	61.045	60.6726	61.5265	61.9471	79.71	79.7199	80.0829	80.4723
0.5566	0.5598	0.5598	0.7064	1.168	2.414	14.285	30.8575	31.0666	53.9375	59.2562	60.3445	59.9127	62.0812	79.2226	79.1269	79.3744	79.8463
0.5666	0.5631	0.5698	0.7163	1.3668	2.6136	15.0854	30.8819	31.2842	55.8797	59.8802	59.6966	57.4653	61.1272	77.9743	77.839	77.9446	78.4264
0.57	0.5699	0.5699	0.7266	1.5657	2.7298	15.8496	31.0718	31.9625	56.7095	61.7262	58.5822	56.8419	60.9028	78.0276	77.9187	77.8692	78.2751
0.5768	0.5667	0.5668	0.754	1.8237	2.836	16.2976	30.3424	32.5613	57.451	62.3203	59.2886	59.7126	62.1795	78.5661	78.5133	78.3384	78.5826
0.5803	0.5701	0.5637	0.8256	1.9571	2.9849	16.3286	30.1649	33.4994	57.9007	61.3752	62.4212	63.1995	63.4851	63.0792	63.0825	62.8218	62.8812
0.5904	0.5802	0.5738	0.9615	2.1105	3.345	16.1346	29.6678	34.6532	57.969	61.8116	66.2816	64.5243	63.7159	63.178	63.211	62.9272	62.8216
0.6004	0.5903	0.5838	1.1313	2.2013	3.609	15.7846	29.8111	36.6781	58.0426	64.3613	69.3349	63.9868	63.0651	62.3721	62.4084	62.151	61.9464
0.6103	0.597	0.5904	1.2501	2.2751	3.9062	15.8347	29.0561	38.5567	59.3238	68.4869	71.4666	63.6944	62.6538	61.7562	61.7628	61.5714	61.3503
0.6169	0.6036	0.5937	1.2399	2.322	4.1048	16.2728	28.9141	40.1389	61.7697	72.8654	72.2026	64.7425	62.0546	60.8699	60.827	60.7181	60.5366
0.6369	0.6136	0.6037	1.1345	2.3661	4.5944	16.804	28.5696	41.3053	63.9734	77.0555	72.4601	66.6814	61.4878	59.9302	59.8246	59.7883	59.6662
0.6603	0.6269	0.607	1.0257	2.342	4.9799	17.1057	29.1365	43.3793	65.3837	78.6451	74.8307	72.7873	61.6044	59.6112	59.4297	59.4396	59.367
0.677	0.6303	0.6105	0.9373	2.3692	5.2641	17.4137	29.3368	46.2777	66.9784	79.0353	79.8238	80.5219	75.7666	73.3312	73.0606	73.087	73.0309
0.6971	0.6338	0.6141	0.8762	2.4132	5.1176	17.8163	29.3977	49.6218	68.3425	77.7149	85.416	88.2316	83.5753	80.7637	80.4007	80.4139	80.3446
0.7107	0.6375	0.6212	0.8321	2.5883	5.0637	18.5745	28.8394	52.8346	68.9865	76.3107	87.9439	90.6095	86.2469	83.1746	82.7126	82.6928	82.5905
0.7177	0.6444	0.6314	0.8083	2.7498	5.1987	19.3369	28.7123	55.2376	68.545	73.9543	88.9048	91.0615	87.184	83.983	83.422	83.356	83.2042
0.7216	0.6547	0.645	0.8015	2.8841	5.6524	20.0812	29.0637	56.9141	67.6313	71.3674	89.8738	91.4462	88.2089	84.9947	84.3314	84.2093	84.0113
0.7154	0.6718	0.6621	0.7948	2.976	6.0621	20.8181	29.8292	57.6557	66.0115	69.4058	90.6223	92.056	89.5513	86.4163	85.6507	85.4593	85.2151
0.7158	0.6856	0.6894	0.7882	2.9045	6.4022	21.7296	30.5755	58.1961	64.4623	69.1865	87.3132	90.4287	88.683	85.713	84.8418	84.5778	84.2973
0.7262	0.713	0.71	0.7816	2.7142	6.8996	22.7254	31.6429	58.4781	63.4339	71.93	82.4302	85.6552	84.6256	81.913	80.9428	80.6062	80.3026
0.7367	0.7234	0.7203	0.9665	2.5421	7.4417	23.4324	32.6476	58.8492	64.3542	75.9785	79.4574	78.9759	78.5733	76.2072	75.1644	74.7651	74.4549
0.7504	0.7577	0.7238	1.1379	2.4991	8.1389	23.3038	33.9068	58.8442	66.6433	78.5184	78.6153	73.3546	73.4404	71.5033	70.4176	69.9754	69.6883
0.7642	0.7683	0.7205	1.3126	2.6556	8.1081	23.0508	35.0802	58.6996	68.074	79.0462	75.1636	71.1083	71.5109	70.0325	68.9534	68.4914	68.2472
0.7814	0.8158	0.7138	1.1278	2.708	7.8632	22.423	36.6438	58.7513	67.9638	77.2116	68.0638	72.4551	72.9897	71.9436	70.9239	70.4652	70.2771
0.7886	0.8427	0.7475	0.9501	2.7341	7.4984	22.3082	37.5413	59.4462	65.332	76.693	60.4621	73.7026	74.2075	73.5277	72.6037	72.1615	72.0262
0.7853	0.8664	0.7883	0.7792	2.612	7.6769	22.423	39.0265	60.2087	63.8767	75.2273	55.9369	56.3791	56.7586	56.3593	55.564	55.1383	55.0294
0.8182	0.8465	0.8259	0.7964	2.4872	8.1325	22.9646	40.8306	61.3129	63.5118	75.3146	57.2393	57.3746	57.6122	57.4406	56.7839	56.3615	56.2526
0.8017	0.83	0.8398	0.8432	2.3511	8.9009	23.6253	43.3861	62.2504	63.6275	74.2758	63.6457	63.5203	63.6589	63.6886	63.1771	62.7415	62.6029
0.8015	0.8267	0.8434	0.8799	2.3439	9.7828	24.2822	44.5026	63.068	63.0587	74.6369	71.7785	71.465	71.5838	71.7983	71.4287	70.9568	70.772
0.7717	0.8266	0.8567	0.89	2.7169	10.7319	25.056	44.9679	63.2223	61.2135	72.3596	77.4132	77.0139	77.1822	77.5617	77.3109	76.7862	76.5585
0.798	0.8366	0.8668	0.8868	3.0834	11.2234	26.2159	45.3158	62.9705	59.367	68.9606	78.8787	78.5058	78.7632	79.2516	79.0767	78.4959	78.2286
0.8216	0.8465	0.8767	0.8833	3.2456	11.3409	27.3043	46.4813	63.0906	57.9831	67.67	78.7954	78.5182	78.868	79.3894	79.2343	78.6007	78.3004
0.8454	0.8564	0.8898	0.8726	3.2245	11.3402	28.6182	48.4415	63.3498	57.367	68.4753	78.545	78.3833	78.7958	79.2842	79.0862	78.4031	78.0731
0.8691	0.8526	0.8724	0.8582	3.3505	11.4062	29.4642	52.1903	64.7442	57.7469	72.6676	79.3444	79.2586	79.6843	80.0935	79.8097	79.0804	78.7075
0.8689	0.8419	0.8348	0.8539	3.71	11.7272	30.408	56.3417	66.1549	56.7057	74.0253	78.1148	78.0422	78.4382	78.7484	78.3557	77.5736	77.1545
0.8614	0.8311	0.8208	0.8764	4.7109	11.8937	31.1241	59.7281	65.72	56.5925	76.1295	76.0239	75.9183	76.245	76.4628	75.9678	75.123	74.6478
0.8673	0.8506	0.8706	0.9325	5.9008	12.4029	31.8179	61.5591	63.037	57.4747	78.2534	78.2171	78.0653	78.3062	78.4415	77.8673	76.9499	76.412
0.9136	0.9072	0.9841	1.0354	7.1193	13.4281	32.181	62.2445	60.1073	56.6193	77.2983	77.3082	77.1366	77.295	77.3577	76.7373	75.7407	75.1335
1.0005	0.9876	1.1207	1.1751	7.6044	14.8785	32.7358	62.0497	58.3525	56.0522	74.5087	74.5417	74.3932	74.4889	74.4889	73.8487	72.7861	72.1096
1.0638	1.0609	1.2365	1.3544	8.0715	16.347	33.3314	60.8221	56.4562	55.5083	69.8749	69.9211	69.8287	69.8848	69.832	69.2017	68.0962	67.3603
1.1591	1.1131	1.311	1.5396	8.597	17.1364	34.3304	60.0884	53.5256	55.3876	65.0304	65.0799	65.0502	65.0964	65.004	64.4034	63.2979	62.5191
1.184	1.1575	1.3846	1.7237	9.2973	18.246	34.6997	60.3312	52.6109	57.0403	60.8219	60.8648	60.8879	60.9407	60.8285	60.2774	59.2214	58.4327
1.2649	1.2381	1.4746	1.8767	9.674	19.4561	35.1449	60.7155	54.1155	59.1287	58.9238	58.9601	59.0063	59.0657	58.9601	58.4783	57.518	56.7623
1.3197	1.3658	1.6319	2.0463	9.7217	20.0992	36.1151	60.5997	58.578	62.0585	61.7747	61.7945	61.8407	61.9034	61.8209	61.4315	60.6098	59.9234
1.4606	1.5401	1.8328	2.2396	9.3798	20.0218	37.4068	59.2352	62.2823	63.5104	63.1078	63.1111	63.1408	63.1969	63.1474	62.8669	62.2069	61.6261
1.6317	1.7544	2.0606	2.4637	9.2037	20.3652	39.194	57.9248	64.3396	63.8933	63.3554	63.3323	63.3389	63.3818	63.3686	63.2069	62.7218	62.2598
1.8428	1.9953	2.295	2.6748	9.5205	22.7905	40.1154	56.8178	64.0632	62.5023	61.8291	61.7697	61.7466	61.7664	61.7928	61.7499	61.4364	61.0932
2.0905	2.2427	2.5328	2.8562	10.8478	26.5471	40.7074	57.0078	62.9292	60.6327	59.8539	59.7384	59.6724	59.6757	59.7351	59.8011	59.6427	59.4084
2.3414	2.467	2.7541	3.0048	12.2322	29.4594	40.6488	58.8014	62.6977	60.2857	59.4376	59.2495	59.1274	59.1076	59.1967	59.365	59.3386	59.1967
2.5758	2.688	2.9525	3.1305	13.5214	30.6479	40.697	60.5497	62.4871	60.3829	59.515	59.2345	59.0398	58.9903	59.0992	59.3599	59.4457	59.3731
2.8005	2.8961	3.1014	3.2267	14.0583	30.7792	40.9954	62.2846	62.6374	61.1051	60.2405	59.8577	59.5739	59.4848	59.6102	59.9501	60.1316	60.1151
3.0023	3.0847	3.2242	3.2964	14.7676	29.4066	41.3702	62.7913	63.2047	62.2814	61.4267	60.9383	60.5621	60.4235	60.5522	60.9581	61.2287	61.2485
3.168	3.2273	3.3208	3.3464	15.0941	27.9786	41.9382	63.2932	65.4501	65.3092	64.4479	63.8572	63.4018	63.1972	63.316	63.778	64.1278	64.1806

3.3043	3.3241	3.4147	3.4205	14.4729	26.389	42.5598	62.8452	69.256	70.0375	69.1531	68.4667	67.9486	67.6714	67.7704	68.272	68.6944	68.7835
3.3816	3.418	3.4889	3.5052	13.3737	25.9954	43.8898	62.0534	73.701	75.5211	74.6037	73.8249	73.2639	72.9174	72.9867	73.5114	74.0031	74.1219
3.4626	3.5125	3.5397	3.5938	12.5898	26.5812	45.853	61.0799	77.3229	80.1829	79.2358	78.3844	77.7937	77.3878	77.4208	77.9554	78.5065	78.6583
3.5343	3.5732	3.6042	3.6979	12.7088	27.0128	47.8845	60.6361	79.665	82.9675	81.994	81.0898	80.4826	80.0305	80.0371	80.575	81.1723	81.3439
3.6022	3.6003	3.6484	3.7715	12.9465	27.6065	49.0723	60.2828	80.7365	84.1363	83.1562	82.2223	81.6085	81.1333	81.1201	81.6613	82.2784	82.4665

Appendix H
MOBILE 5 Input File

```
1       PROMPT
1       TAMFLG
1       SPDFLG
1       VMFLAG
4       MYMRFG
1       NEWFLG
1       IMFLAG
1       ALHFLG
1       ATPFLG
1       RLFLAG
2       LOCFLG
1       TEMFLG
6       OUTFMT
4       PRTFLG
1       IDLFLG
1       NMHFLG
2       HCFLAG
.14390 .13612 .12875 .12180 .11522 .10899 .10310 .09751 .09225 .08726  LDGV miles
.08254 .07807 .07386 .06987 .06608 .06251 .05913 .05594 .05291 .05005
.04735 .04478 .04237 .04007 .03790
.15442 .14508 .13631 .12807 .12032 .11305 .10621 .09979 .09376 .08809  LDGT1 miles
.08276 .07776 .07306 .06864 .06449 .06059 .05693 .05348 .05025 .04721
.04436 .04168 .03916 .03679 .03456
.14779 .14259 .13758 .13275 .12809 .12359 .11924 .11505 .11101 .10711  LDGT2 miles
.10335 .09972 .09621 .09283 .08957 .08642 .08339 .08046 .07763 .07490
.07227 .06973 .06728 .06492 .06264
.17251 .16185 .15185 .14246 .13365 .12539 .11764 .11037 .10355 .09715  HDGV miles
.09114 .08551 .08022 .07526 .07061 .06625 .06215 .05831 .05471 .05132
.04815 .04517 .04238 .03976 .03730
.17825 .16478 .15233 .14081 .13017 .12033 .11124 .10283 .09506 .08788  LDDV miles
.08123 .07509 .06942 .06417 .05932 .05484 .05069 .04686 .04332 .04005
.03702 .03422 .03163 .02924 .02703
.21004 .19125 .17415 .15858 .14440 .13149 .11973 .10902 .09927 .09040  LDDT miles
.08231 .07495 .06825 .06215 .05659 .05153 .04692 .04272 .03890 .03543
.03226 .02937 .02675 .02435 .02218
.17251 .16185 .15185 .14246 .13365 .12539 .11764 .11037 .10355 .09715  HDDV miles
.09114 .08551 .08022 .07526 .07061 .06625 .06215 .05831 .05471 .05132
.04815 .04517 .04238 .03976 .03730
.04786 .04475 .04164 .03853 .03543 .03232 .02921 .02611 .02300 .01989  MC miles
.01678 .01368 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000
.00000 .00000 .00000 .00000 .00000
.049 .079 .083 .082 .084 .081 .077 .056 .050 .051          LDGV reg.
.050 .054 .047 .037 .024 .019 .014 .015 .011 .008
.006 .005 .004 .003 .010
.063 .084 .084 .084 .084 .069 .059 .044 .036 .031          LDGT1 reg.
.030 .053 .047 .046 .036 .028 .017 .022 .017 .014
.009 .008 .008 .005 .025
.054 .072 .072 .072 .072 .052 .050 .034 .054 .031          LDGT2 reg.
.028 .080 .084 .049 .039 .030 .018 .023 .018 .015
.009 .008 .009 .006 .026
.023 .047 .047 .047 .047 .038 .033 .021 .026 .029          HDGV reg.
.034 .064 .054 .058 .051 .038 .043 .041 .035 .029
.021 .022 .022 .014 .117
.049 .079 .083 .082 .084 .081 .077 .056 .050 .051          LDDV reg.
.050 .054 .047 .037 .024 .019 .014 .015 .011 .008
.006 .005 .004 .003 .010
.063 .084 .084 .084 .084 .069 .059 .044 .036 .031          LDDT reg.
.030 .053 .047 .046 .036 .028 .017 .022 .017 .014
.009 .008 .008 .005 .025
.034 .067 .067 .067 .067 .073 .061 .040 .041 .051          HDDV reg.
.053 .066 .055 .057 .045 .019 .023 .028 .024 .016
.011 .009 .007 .005 .016
.144 .168 .135 .109 .088 .070 .056 .045 .036 .029          MC reg.
```

.023 .097 .000 .000 .000 .000 .000 .000 .000 .000
.000 .000 .000 .000 .000
Scenario title. C 72. 92. 11.5 08.7 92 1 1 1   Local Area Parameter record
1 97 2.5 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 5.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 10.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 15.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 20.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 25.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 30.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 35.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 40.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 45.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 50.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 55.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 60.0 75.0 20.6 27.3 20.6 01   Scenario description record
1 97 65.0 75.0 20.6 27.3 20.6 01   Scenario description record
00000000000000000000000000000000000000000000000000000000000000000000000000000000

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