FINAL REPORT

to the

FLORIDA DEPARTMENT OF TRANSPORTATION
RESEARCH OFFICE

on Project

"Updates and Enhancements to LOSPLAN to
Support the Q/LOS Handbook and SIS Analysis"

FDOT Contract BD-545, RPWO #66 (UF Project 00058922)

May 2007

University of Florida
Transportation Research Center

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16. Abstract

The last major revision of the LOSPLAN suite of software packages was in 2003, concurrent with the release of the 2002 Quality/Level of Service Handbook. Since this time, some issues with the HCM 2000 have been identified in recently released errata, most notably the two-lane highway analysis methodology. Also, the FDOT Systems Planning Office has carried out several research projects in the last few years that impact the level of service analysis methodologies for the handbook and software. Furthermore, the FDOT is currently revising its LOS rule 14-94, which will result in necessary changes to the LOSPLAN software.

The objective of this project was to update the LOSPLAN software to incorporate new FDOT sponsored research results on level of service analysis, errata releases of the HCM 2000, changes in the state of Florida LOS rule, and some selected calculation and usability features requested by current users.

The objective was accomplished by making updates and enhancements to the ARTPLAN, FREEPLAN, and HIGHPLAN user interface and computational methodologies, as well as to the electronic help and computational methodologies documentation. The updated software can be found at the following URL: http://www.dot.state.fl.us/planning/systems/sm/los/los_sw2.htm#software

The updates and enhancements to the LOSPLAN software support the current requirements for usability, functionality, robustness, and computational completeness and accuracy to support the mission of the level of service program of the Systems Planning Office.

17. Key Words	18. Distribution Statement
Level of Service Analysis, LOSPLAN Software, ARTPLAN, HIGHPLAN, FREEPLAN	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA, 22161

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Updates and Enhancements to LOSPLAN to Support the Q/LOS Handbook and SIS Analysis

May 2007

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data published herein. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Acknowledgments

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Table of Contents

Chapter 1: Overview

The first section of this chapter outlines general changes to each of the LOSPLAN programs. The second section lists the specific data input fields that have changed between the LOSPLAN 2002 and LOSPLAN 2007 program versions.

General Changes

ARTPLAN

ARTPLAN 2007 maintains much of the same look and feel of ARTPLAN 2002. All of the previous features, such as input validation, dynamic field value updating, separately formatted reports for printing, context sensitive help, and data exchange capability with other XML compliant transportation software applications, are maintained in this version well as all. Major new features include the capability to analyze the off-peak direction and to analyze up to 14 segments. The multimodal input screens have also been changed such that the data for all active segments can be viewed at the same time. Many other user interface (UI) enhancements have been made to this version, particularly with respect to screen navigation, such as 'Back' and 'Next' buttons and tabs at the bottom of the screen, in addition to the toolbar buttons and menu selections.

Major changes to the analysis methodology include a revised calculation procedure for adjusted saturation flow rate (based on FDOT final report DO2319, "Guidelines for Quantifying the Influence of Area Type and Other Factors on Saturation Flow Rate"), additional performance measures, such as free-flow delay and LOS threshold delay, and inclusion of a left-turn queue spillover calculation. In addition, input data validation has been enhanced with respect to critical variables, such as AADT/hourly volume and weighted g/C ratio.

HIGHPLAN

HIGHPLAN 2007 maintains much of the same look and feel of HIGHPLAN 2002. All of the previous features, such as input validation, dynamic field value updating, separately formatted reports for printing, context sensitive help, and data exchange capability with other XML compliant transportation software applications, are maintained in this version as well.

Major changes to the analysis methodology include revisions to the calculation of Percent Time Spent Following (PTSF) for two-lane highways (based on NCHRP Report 20-7(160). As a result of implementing the PTSF calculation revisions, HIGHPLAN now uses PTSF (or ATS under certain conditions) as the service measure for ‘rural undeveloped’ highways instead of v/c ratio (as was used in HIGHPLAN 2002). Additional performance measures have been added as well, namely free-flow delay and LOS threshold delay. Input data validation has also been enhanced with respect to critical variables, such as AADT/hourly volume.

FREEPLAN

FREEPLAN 2007 maintains much of the same look and feel of FREEPLAN 2002. All of the previous features, such as input validation, dynamic field value updating, separately formatted reports for printing, context sensitive help, and data exchange capability with other XML compliant transportation software applications, are maintained in this version as well.

The analysis methodology has been expanded to incorporate the effects of ramp metering, accel/decel lane extensions, auxiliary lanes, off-ramp queuing, and oversaturation. Additional performance measures have been added as well, namely free-flow delay and LOS threshold delay. Input data validation has also been enhanced with respect to critical variables, such as AADT/hourly volume.

Data Input Field Changes

This section identifies the differences between the data input fields of the LOSPLAN 2002 and LOSPLAN 2007 programs.

ARTPLAN

Project Properties

Changed
Area Type (list of choices)
Study Period (list of choices)

Added
Modal Analysis
Type of Analysis

Facility Data

Changed

% Turns Excl. Lanes	→	% Left Turns, % Right Turns
Left Turn Lanes	→	Exclusive Left Turn Lane(s), Exclusive Right Turn Lane(s)
Signals/Mile	→	# of Signals, Arterial Length

Added
Storage Length
Left g/C
Peak Dir. Hourly Volume (input for ‘Dir Hr Demand Vol’ study period)
Off Peak inputs for:
- Off Peak Dir. Hourly Volume (input for ‘Dir Hr Demand Vol’ study period)
- % Heavy Vehicles
- % Left Turns
- % Right Turns
- Arrival Type

Removed
Local Adj. Factor

Intersection Data

Changed
% Turns Excl. Lanes → % Left Turns, % Right Turns

Added
Left g/C
Excl. Lanes—Right
Off Peak inputs for all inputs available for Peak direction

Segment Data

Added
Thru Lanes
Off Peak inputs for all inputs available for Peak direction

HIGHPLAN

Changed
Area Type (list of choices)
Study Period (list of choices)

Added
Segment Length
Peak Dir. Hr. Vol. (input for 'Dir Hr Demand Vol' study period)
Off Peak inputs for:
  Off-peak Dir. Hr. Vol. (input for 'Dir Hr Demand Vol' study period)

FREEPLAN

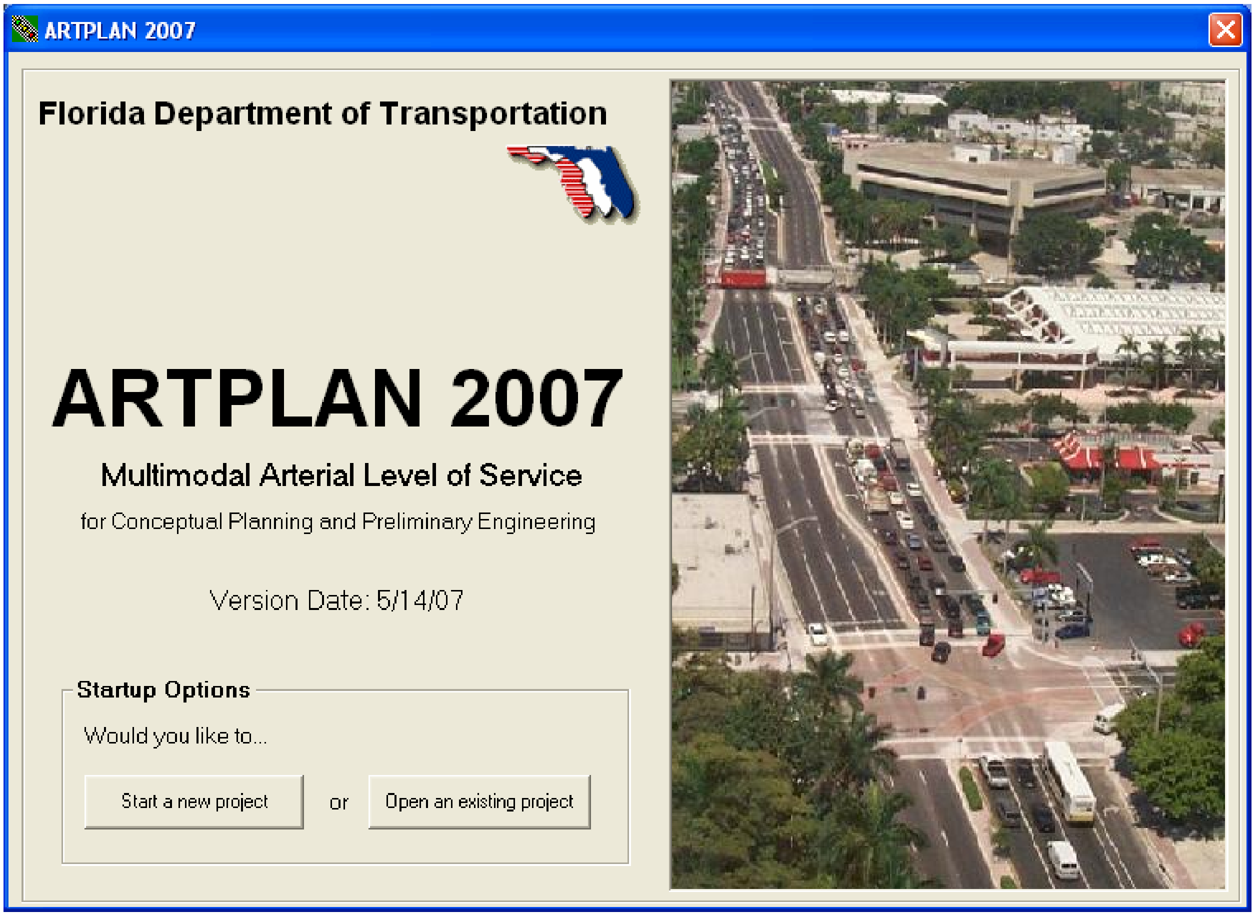
Added
Freeway Length
Aux Lanes (Y/N)
Ramp Metering (Y/N)
Accel/Decel Lanes to 1500 feet (Y/N)
Aux Lanes number per segment
Ramp Analysis (Y/N)
Off ramp length
Signal Location (at end of ramp, downstream from off ramp, no signal)
Signal Type (actuated or pretimed?)

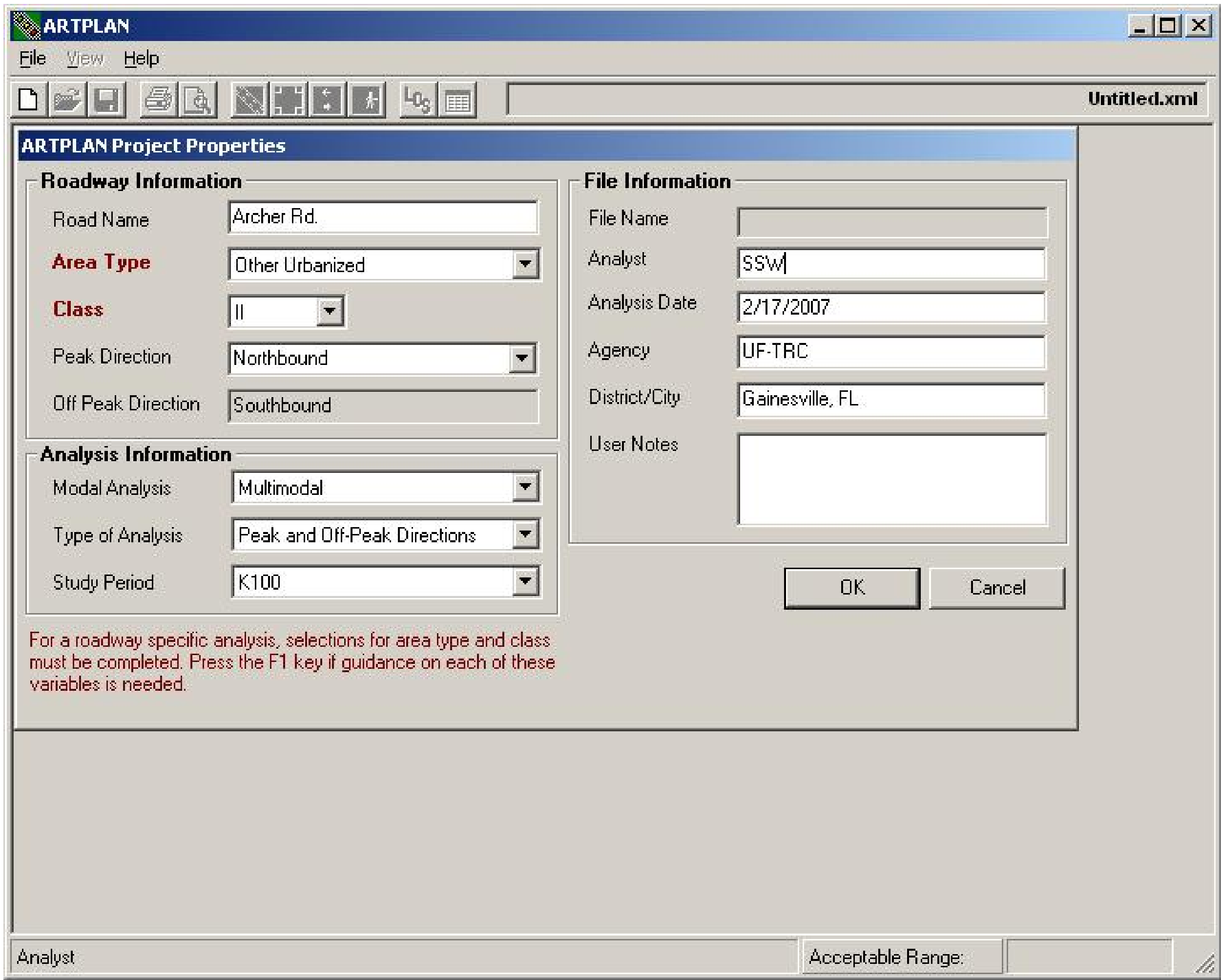
Cycle Length
g/C Ratio
Percent off ramp volume moving on right turn on red
Distance to signal from off ramp’s end
Arrival flow rate to signal not from ramp
Arrival type of vehicles on arterial
Number of lanes on arterial at signal

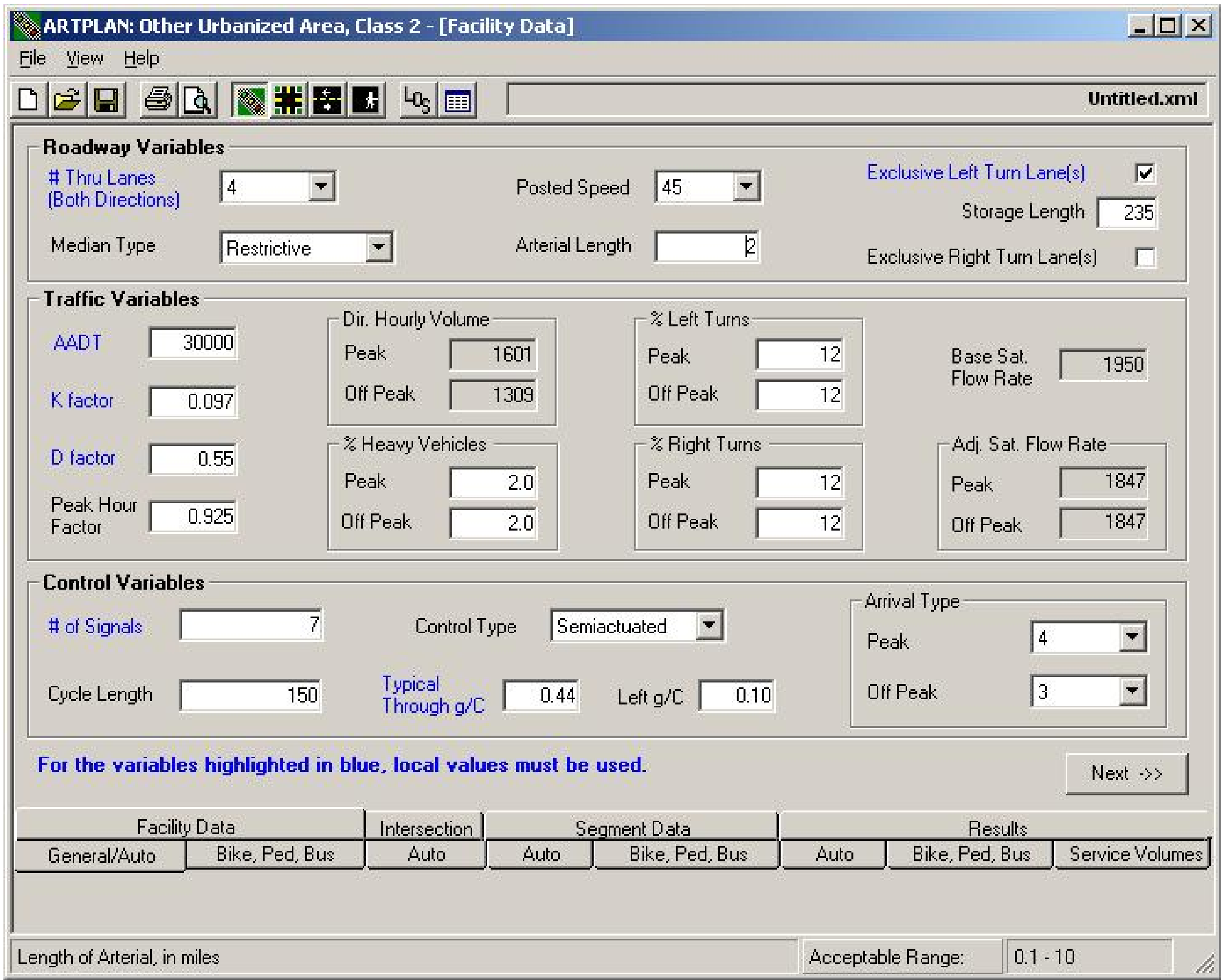
User Interface Screen Shots

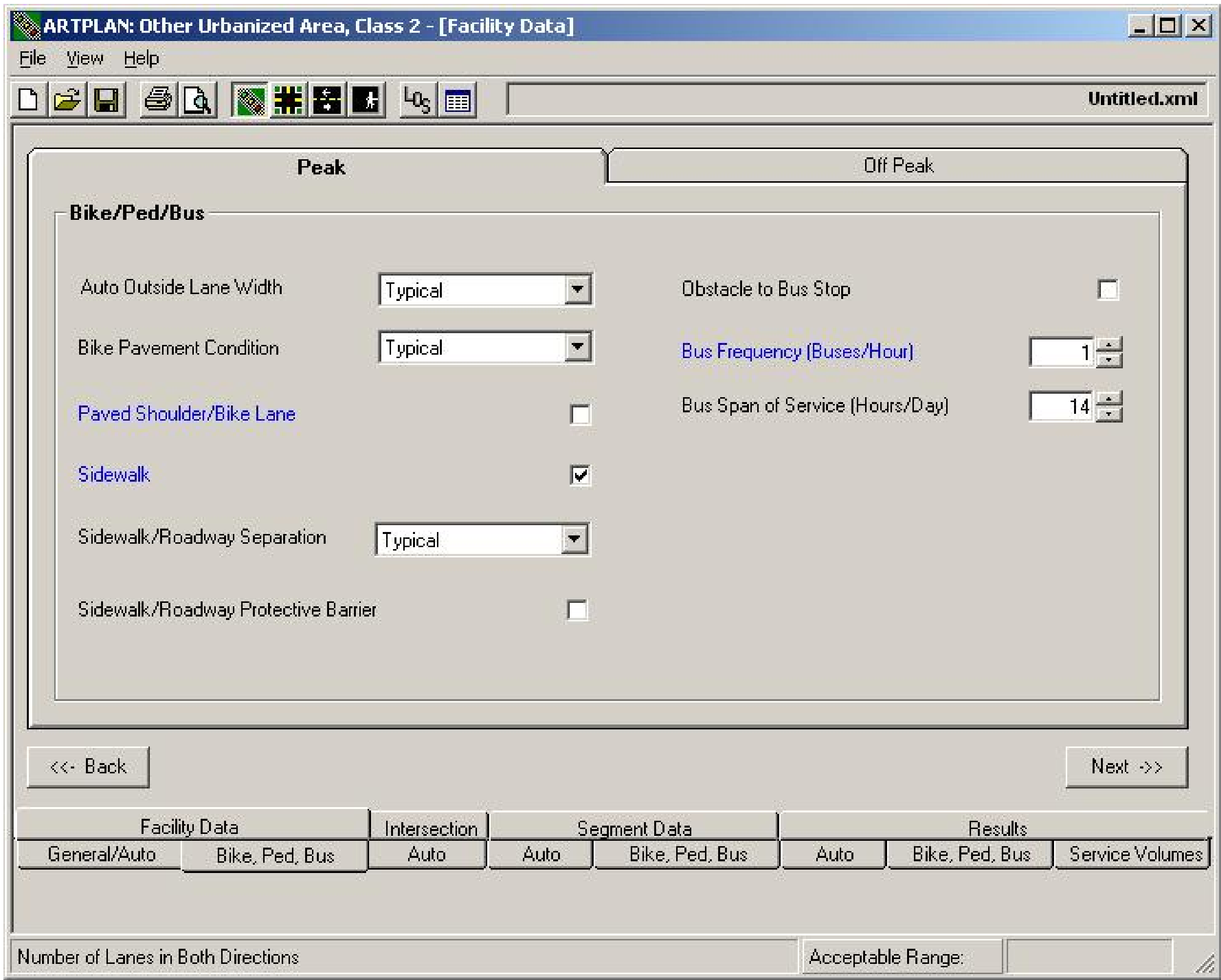
This section includes screen shots, for each individual screen, from all three LOSPLAN 2007 programs.

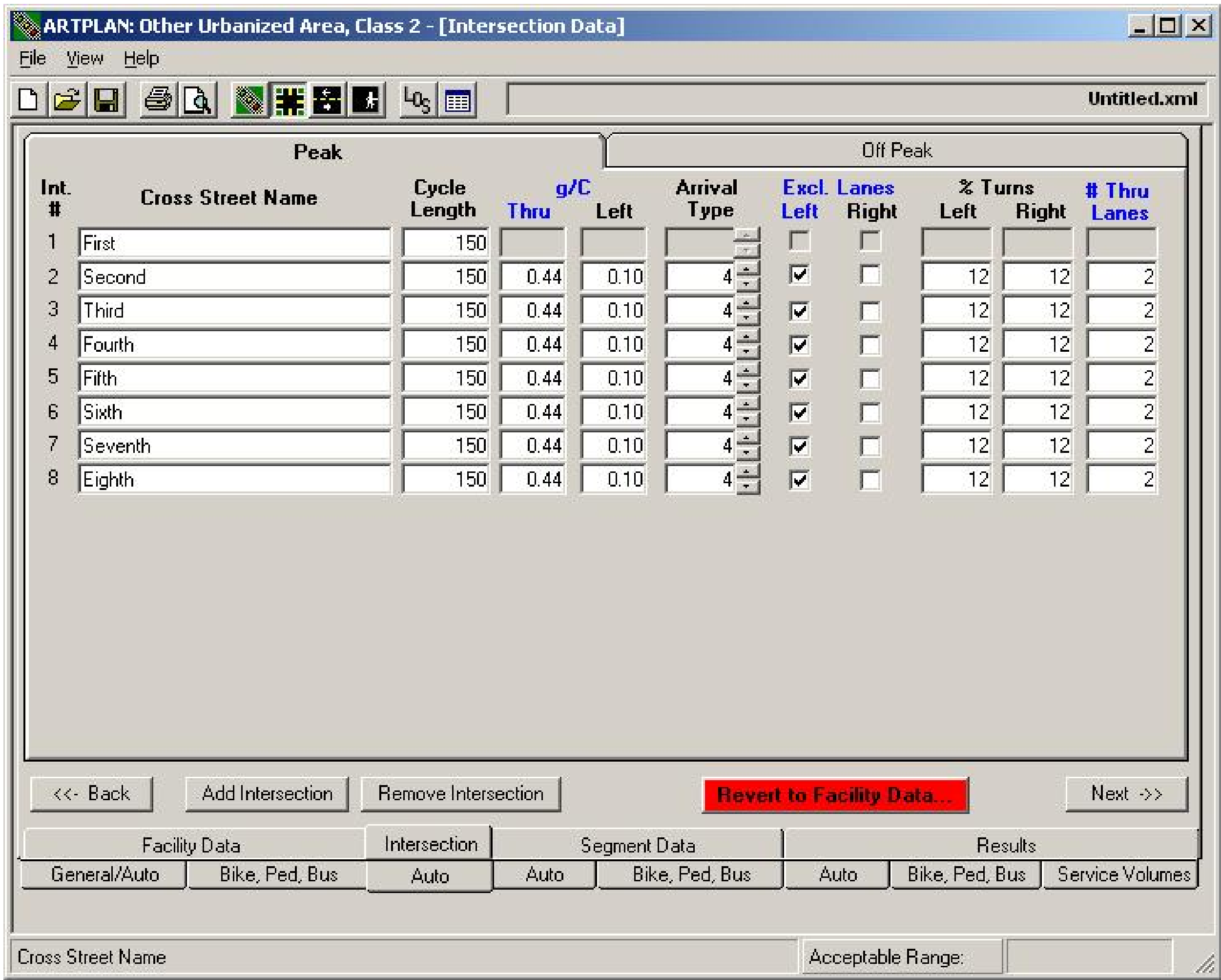
<u>ARTPLAN</u>

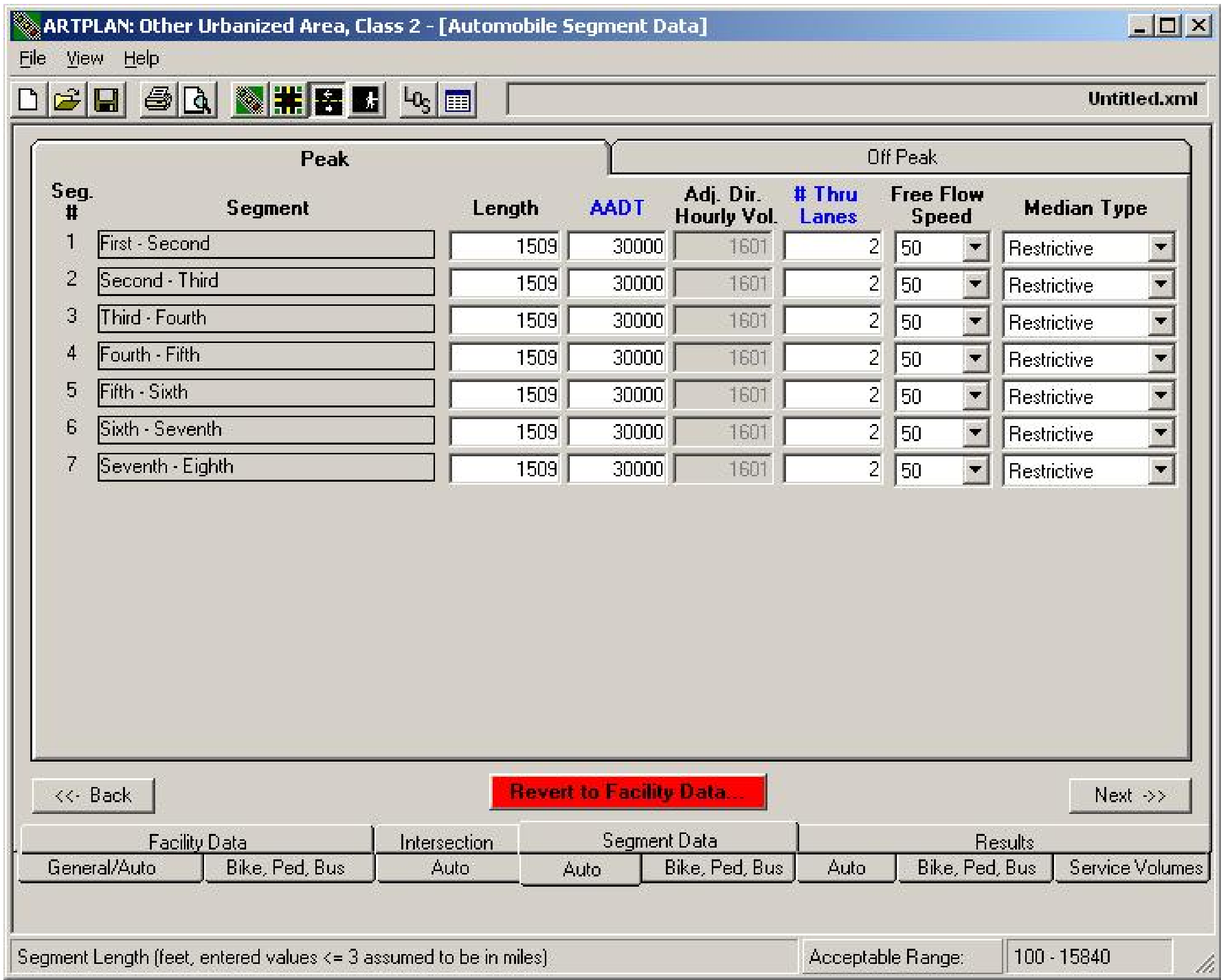


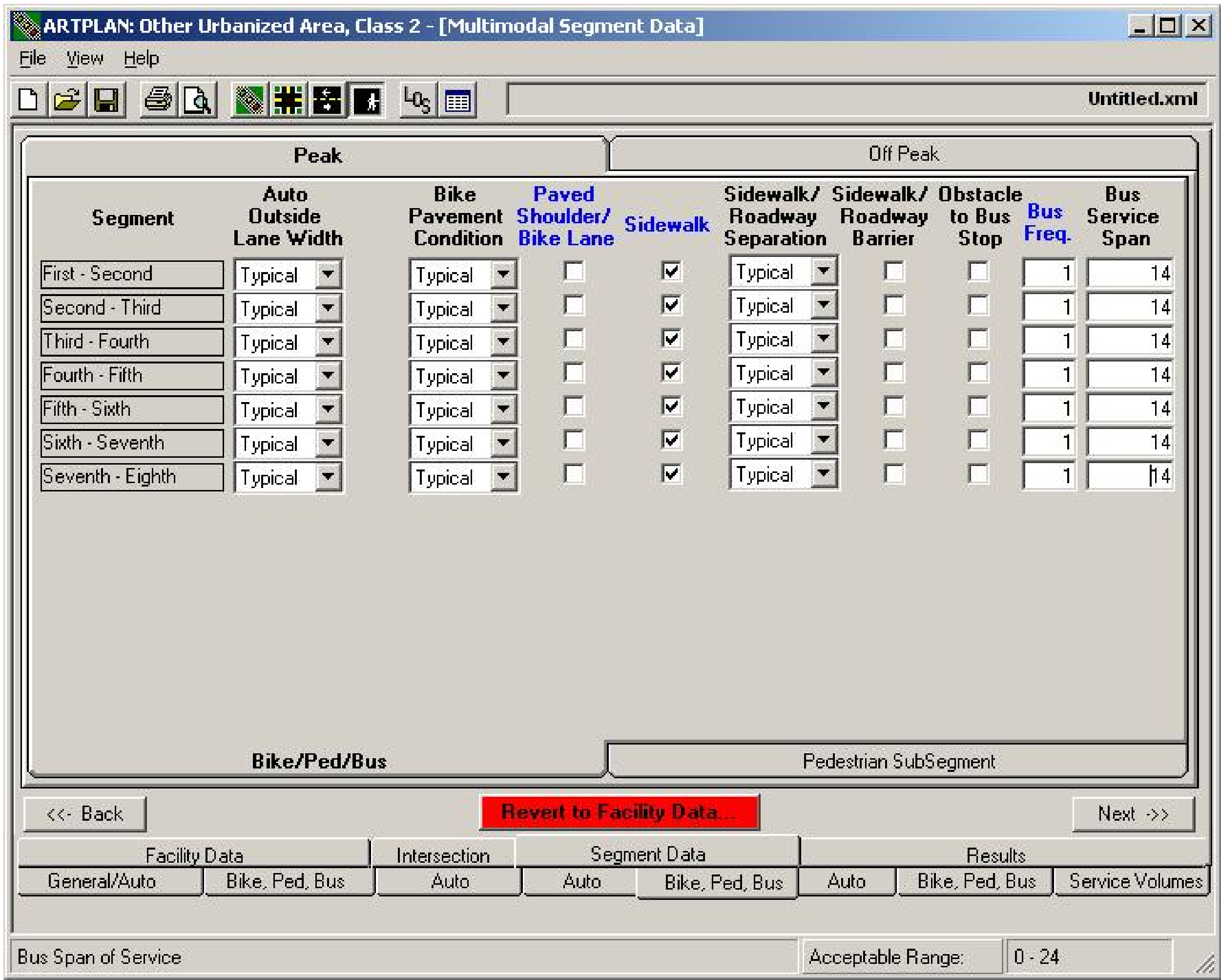

ARTPLAN
File View Help
Untitled.xml
ARTPLAN Project Properties
Roadway Information
Road Name
Archer Rd.
Area Type
Other Urbanized
Class
II
Peak Direction
Northbound
Off Peak Direction
Southbound
Analysis Information
Modal Analysis
Multimodal
Type of Analysis
Peak and Off-Peak Directions
Study Period
K100
For a roadway specific analysis, selections for area type and class must be completed. Press the F1 key if guidance on each of these variables is needed.
File Information
File Name
Analyst
SSW
Analysis Date
2/17/2007
Agency
UF-TRC
District/City
Gainesville, FL
User Notes
OK
Cancel
Analyst
Acceptable Range:

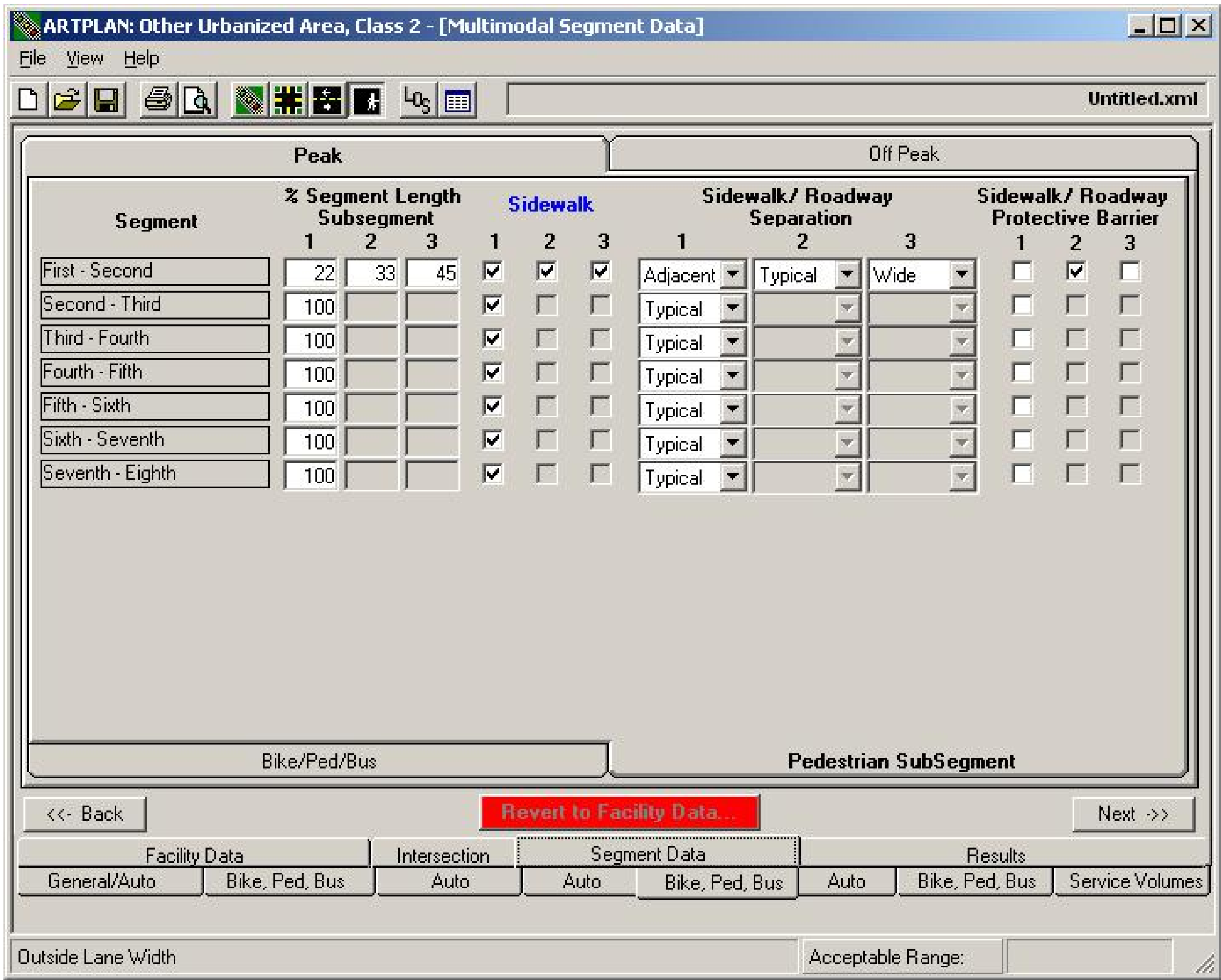

ARTPLAN: Other Urbanized Area, Class 2 - [Facility Data]
File View Help
Untitled.xml
Roadway Variables
Thru Lanes (Both Directions) 4
Posted Speed 45
Exclusive Left Turn Lane(s)
Storage Length 235
Median Type Restrictive
Arterial Length 2
Exclusive Right Turn Lane(s)
Traffic Variables
AADT 30000
K factor 0.097
D factor 0.55
Peak Hour Factor 0.925
Dir. Hourly Volume
Peak 1601
Off Peak 1309
% Heavy Vehicles
Peak 2.0
Off Peak 2.0
% Left Turns
Peak 12
Off Peak 12
% Right Turns
Peak 12
Off Peak 12
Base Sat. Flow Rate 1950
Adj. Sat. Flow Rate
Peak 1847
Off Peak 1847
Control Variables
# of Signals 7
Control Type Semiactuated
Arrival Type
Peak 4
Off Peak 3
Cycle Length 150
Typical Through g/C 0.44
Left g/C 0.10
For the variables highlighted in blue, local values must be used.
Next ->>
Facility Data
General/Auto
Bike, Ped, Bus
Intersection
Auto
Segment Data
Auto
Bike, Ped, Bus
Results
Auto
Bike, Ped, Bus
Service Volumes
Length of Arterial, in miles
Acceptable Range:
0.1 - 10

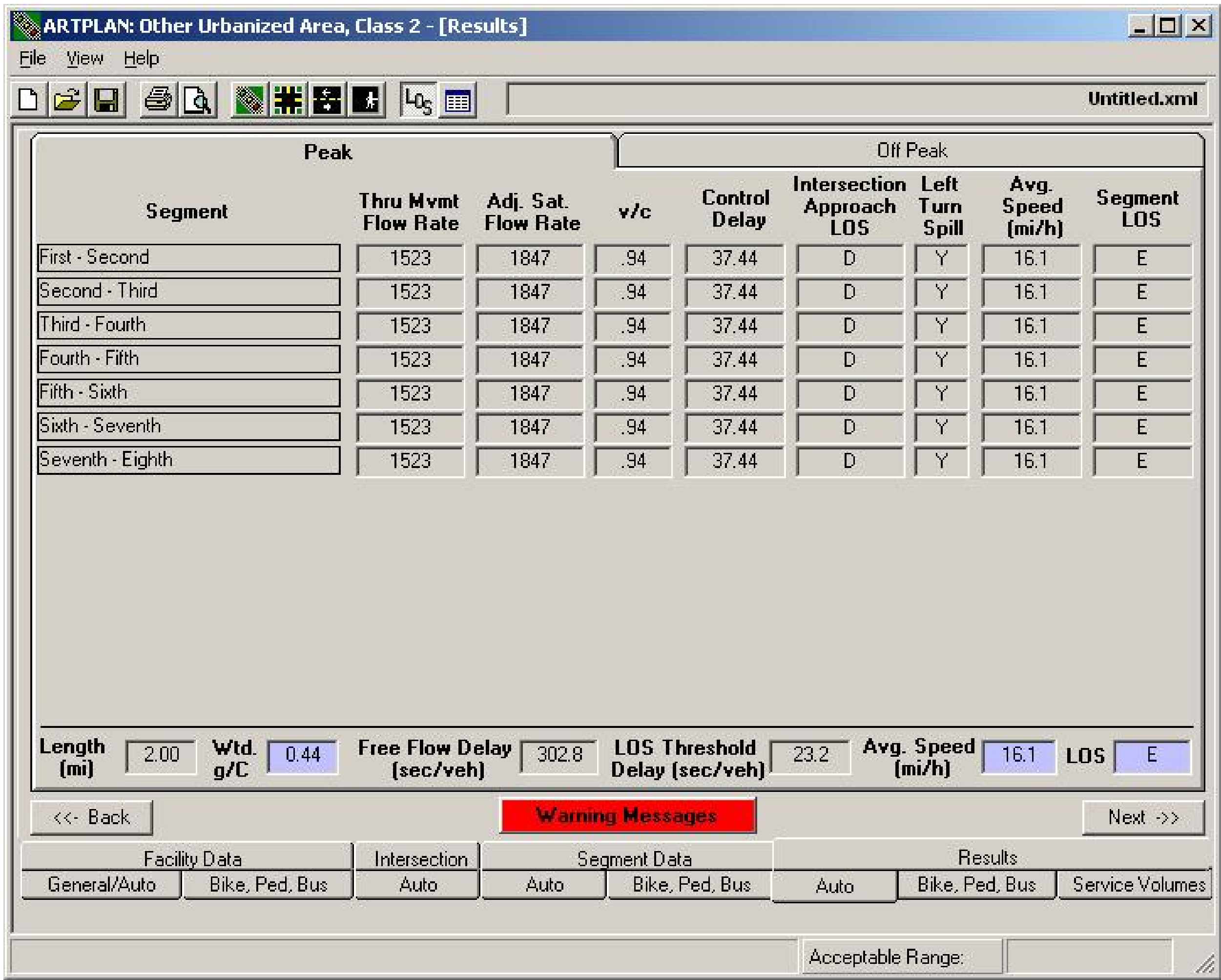

ARTPLAN: Other Urbanized Area, Class 2 - [Facility Data]
File View Help
Untitled.xml
Peak
Off Peak
Bike/Ped/Bus
Auto Outside Lane Width
Typical
Bike Pavement Condition
Typical
Paved Shoulder/Bike Lane
Sidewalk
Sidewalk/Roadway Separation
Typical
Sidewalk/Roadway Protective Barrier
Obstacle to Bus Stop
Bus Frequency (Buses/Hour)
1
Bus Span of Service (Hours/Day)
14
<<- Back
Next ->>
Facility Data
General/Auto
Bike, Ped, Bus
Intersection
Auto
Segment Data
Auto
Bike, Ped, Bus
Results
Auto
Bike, Ped, Bus
Service Volumes
Number of Lanes in Both Directions
Acceptable Range:


ARTPLAN: Other Urbanized Area, Class 2 - [Intersection Data]
File View Help
Untitled.xml
Peak
Off Peak
Int. #
Cross Street Name
Cycle Length
g/C
Thru
Left
Arrival Type
Excl. Lanes
Left
Right
% Turns
Left
Right
Thru Lanes
1 First 150
2 Second 150 0.44 0.10 4 12 12 2
3 Third 150 0.44 0.10 4 12 12 2
4 Fourth 150 0.44 0.10 4 12 12 2
5 Fifth 150 0.44 0.10 4 12 12 2
6 Sixth 150 0.44 0.10 4 12 12 2
7 Seventh 150 0.44 0.10 4 12 12 2
8 Eighth 150 0.44 0.10 4 12 12 2
<<- Back
Add Intersection
Remove Intersection
Revert to Facility Data...
Next ->>
Facility Data
Intersection
Segment Data
Results
General/Auto
Bike, Ped, Bus
Auto
Auto
Bike, Ped, Bus
Auto
Bike, Ped, Bus
Service Volumes
Cross Street Name
Acceptable Range:

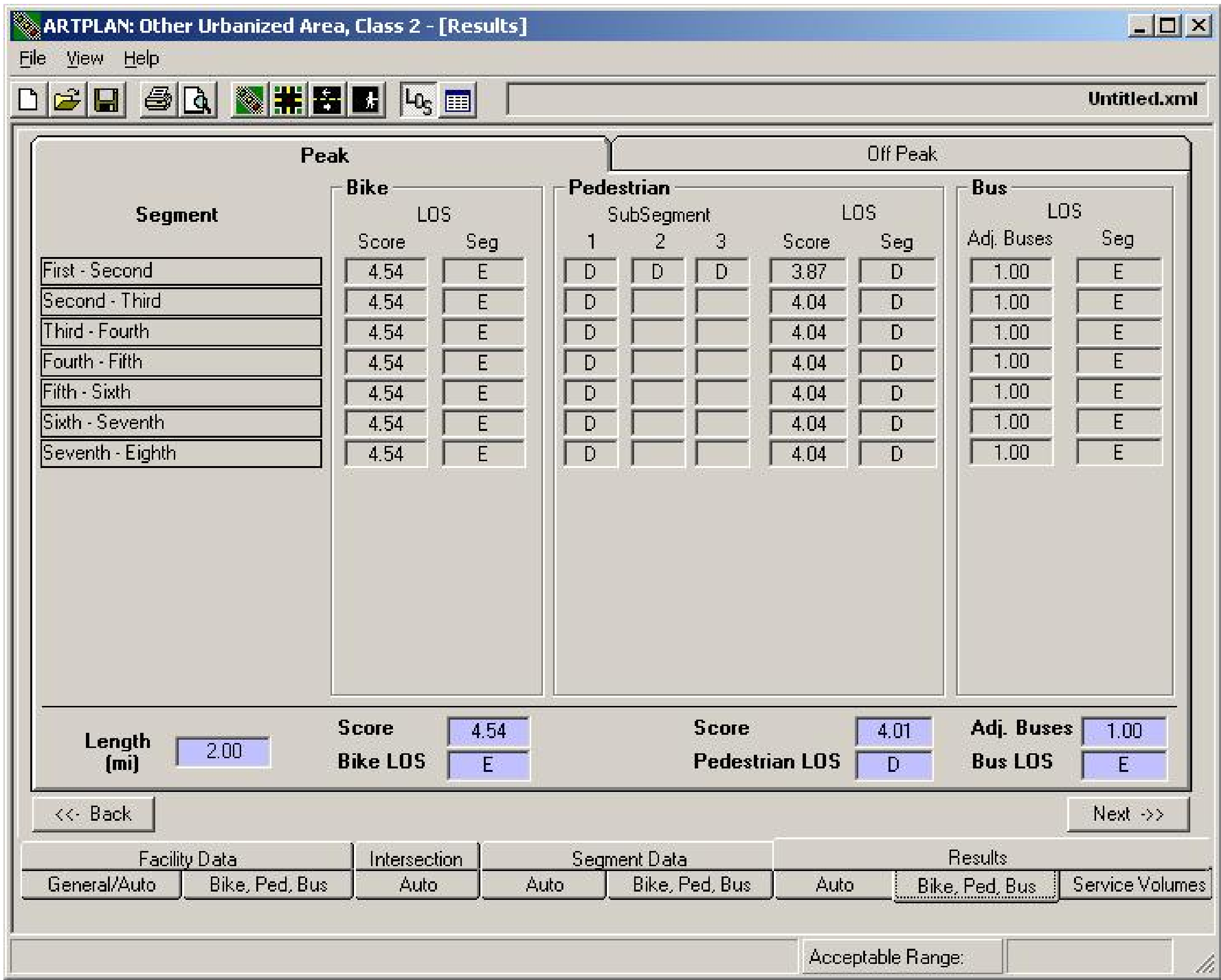

ARTPLAN: Other Urbanized Area, Class 2 - [Automobile Segment Data]
File View Help
Untitled.xml
Peak
Off Peak
Seg. # | Segment | Length | AADT | Adj. Dir. Hourly Vol. | # Thru Lanes | Free Flow Speed | Median Type
1 | First - Second | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
2 | Second - Third | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
3 | Third - Fourth | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
4 | Fourth - Fifth | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
5 | Fifth - Sixth | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
6 | Sixth - Seventh | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
7 | Seventh - Eighth | 1509 | 30000 | 1601 | 2 | 50 | Restrictive
<<- Back
Revert to Facility Data...
Next ->>
Facility Data
Intersection
Segment Data
Results
General/Auto
Bike, Ped, Bus
Auto
Auto
Bike, Ped, Bus
Auto
Bike, Ped, Bus
Service Volumes
Segment Length (feet, entered values <= 3 assumed to be in miles)
Acceptable Range:
100 - 15840

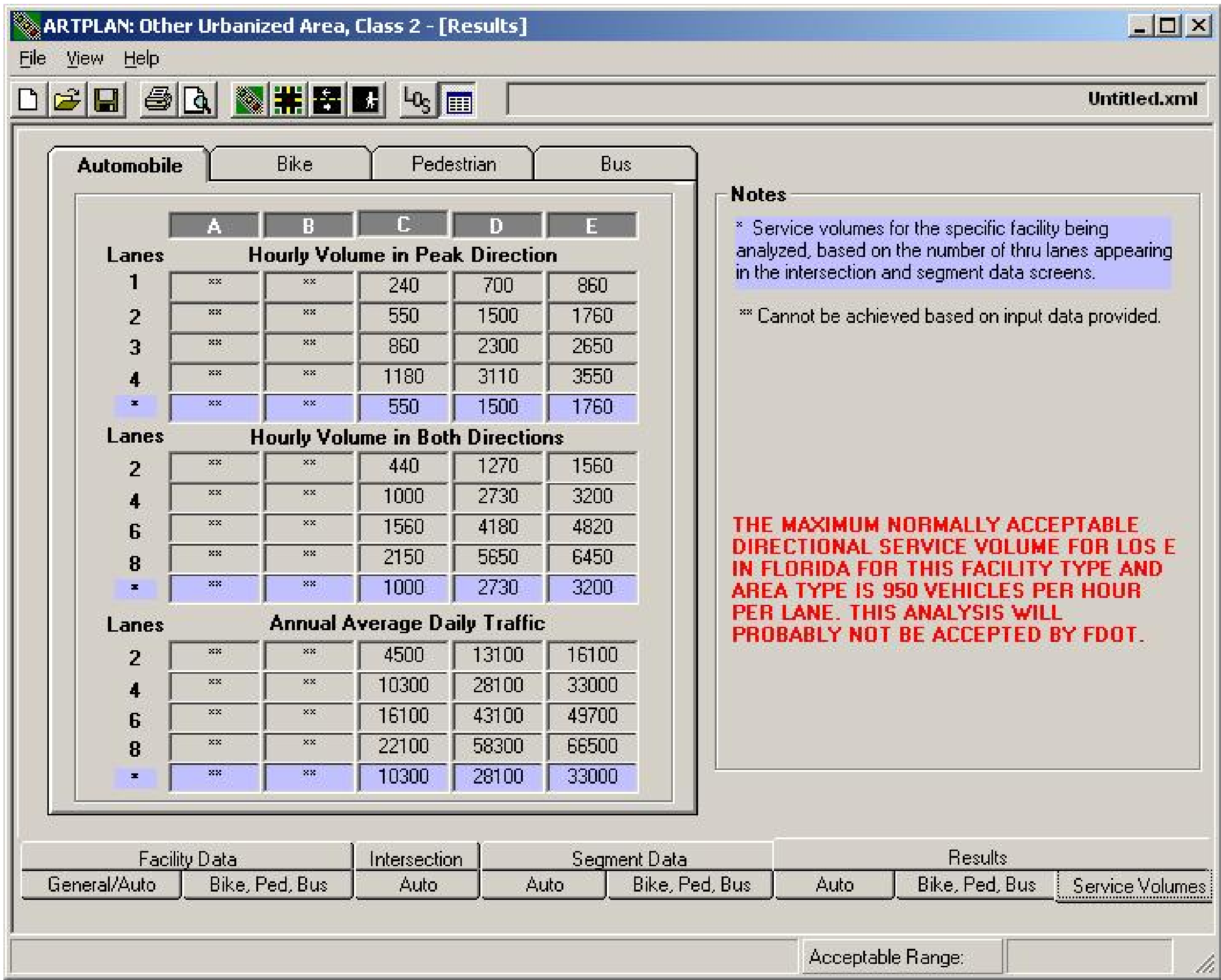

ARTPLAN: Other Urbanized Area, Class 2 - [Multimodal Segment Data]
File View Help
Untitled.xml
Peak
Off Peak
Segment
Auto Outside Lane Width
Bike Pavement Condition
Paved Shoulder/ Bike Lane
Sidewalk
Sidewalk/ Roadway Separation
Sidewalk/ Roadway Barrier
Obstacle to Bus Stop
Bus Freq.
Bus Service Span
First - Second
Second - Third
Third - Fourth
Fourth - Fifth
Fifth - Sixth
Sixth - Seventh
Seventh - Eighth
Typical
1
14
Bike/Ped/Bus
Pedestrian SubSegment
<<- Back
Revert to Facility Data...
Next ->>
Facility Data
Intersection
Segment Data
Results
General/Auto
Bike, Ped, Bus
Auto
Auto
Bike, Ped, Bus
Auto
Bike, Ped, Bus
Service Volumes
Bus Span of Service
Acceptable Range:
0 - 24


ARTPLAN: Other Urbanized Area, Class 2 - [Multimodal Segment Data]
File View Help
Untitled.xml
Peak
Off Peak
Segment
% Segment Length Subsegment
Sidewalk
Sidewalk/ Roadway Separation
Sidewalk/ Roadway Protective Barrier
First - Second
Second - Third
Third - Fourth
Fourth - Fifth
Fifth - Sixth
Sixth - Seventh
Seventh - Eighth
22
33
45
100
Adjacent
Typical
Wide
Bike/Ped/Bus
Pedestrian SubSegment
<<- Back
Revert to Facility Data...
Next ->>
Facility Data
Intersection
Segment Data
Results
General/Auto
Bike, Ped, Bus
Auto
Service Volumes
Outside Lane Width
Acceptable Range:



Segment	Thru Mvmt Flow Rate	Adj. Sat. Flow Rate	v/c	Control Delay	Intersection Approach LOS	Left Turn Spill	Avg. Speed (mi/h)	Segment LOS
First - Second	1523	1847	.94	37.44	D	Y	16.1	E
Second - Third	1523	1847	.94	37.44	D	Y	16.1	E
Third - Fourth	1523	1847	.94	37.44	D	Y	16.1	E
Fourth - Fifth	1523	1847	.94	37.44	D	Y	16.1	E
Fifth - Sixth	1523	1847	.94	37.44	D	Y	16.1	E
Sixth - Seventh	1523	1847	.94	37.44	D	Y	16.1	E
Seventh - Eighth	1523	1847	.94	37.44	D	Y	16.1	E


ARTPLAN: Other Urbanized Area, Class 2 - [Results]
File View Help
Untitled.xml
Peak
Off Peak
Segment
Bike
LOS
Score Seg
Pedestrian
SubSegment
1 2 3
LOS
Score Seg
Bus
LOS
Adj. Buses Seg
First - Second 4.54 E D D D 3.87 D 1.00 E
Second - Third 4.54 E D 4.04 D 1.00 E
Third - Fourth 4.54 E D 4.04 D 1.00 E
Fourth - Fifth 4.54 E D 4.04 D 1.00 E
Fifth - Sixth 4.54 E D 4.04 D 1.00 E
Sixth - Seventh 4.54 E D 4.04 D 1.00 E
Seventh - Eighth 4.54 E D 4.04 D 1.00 E
Length (mi) 2.00
Score 4.54
Bike LOS E
Score 4.01
Pedestrian LOS D
Adj. Buses 1.00
Bus LOS E
<<- Back
Next ->>
Facility Data
General/Auto
Bike, Ped, Bus
Intersection
Auto
Segment Data
Auto
Bike, Ped, Bus
Results
Auto
Bike, Ped, Bus
Service Volumes
Acceptable Range:



ARTPLAN: Other Urbanized Area, Class 2 - [Results]

File View Help

Untitled.xml

Automobile | Bike | Pedestrian | Bus

Lanes	A	B	C	D	E
Hourly Volume in Peak Direction					
1	**	**	240	700	860
2	**	**	550	1500	1760
3	**	**	860	2300	2650
4	**	**	1180	3110	3550
*	**	**	550	1500	1760
Hourly Volume in Both Directions					
2	**	**	440	1270	1560
4	**	**	1000	2730	3200
6	**	**	1560	4180	4820
8	**	**	2150	5650	6450
*	**	**	1000	2730	3200
Annual Average Daily Traffic					
2	**	**	4500	13100	16100
4	**	**	10300	28100	33000
6	**	**	16100	43100	49700
8	**	**	22100	58300	66500
*	**	**	10300	28100	33000

Notes

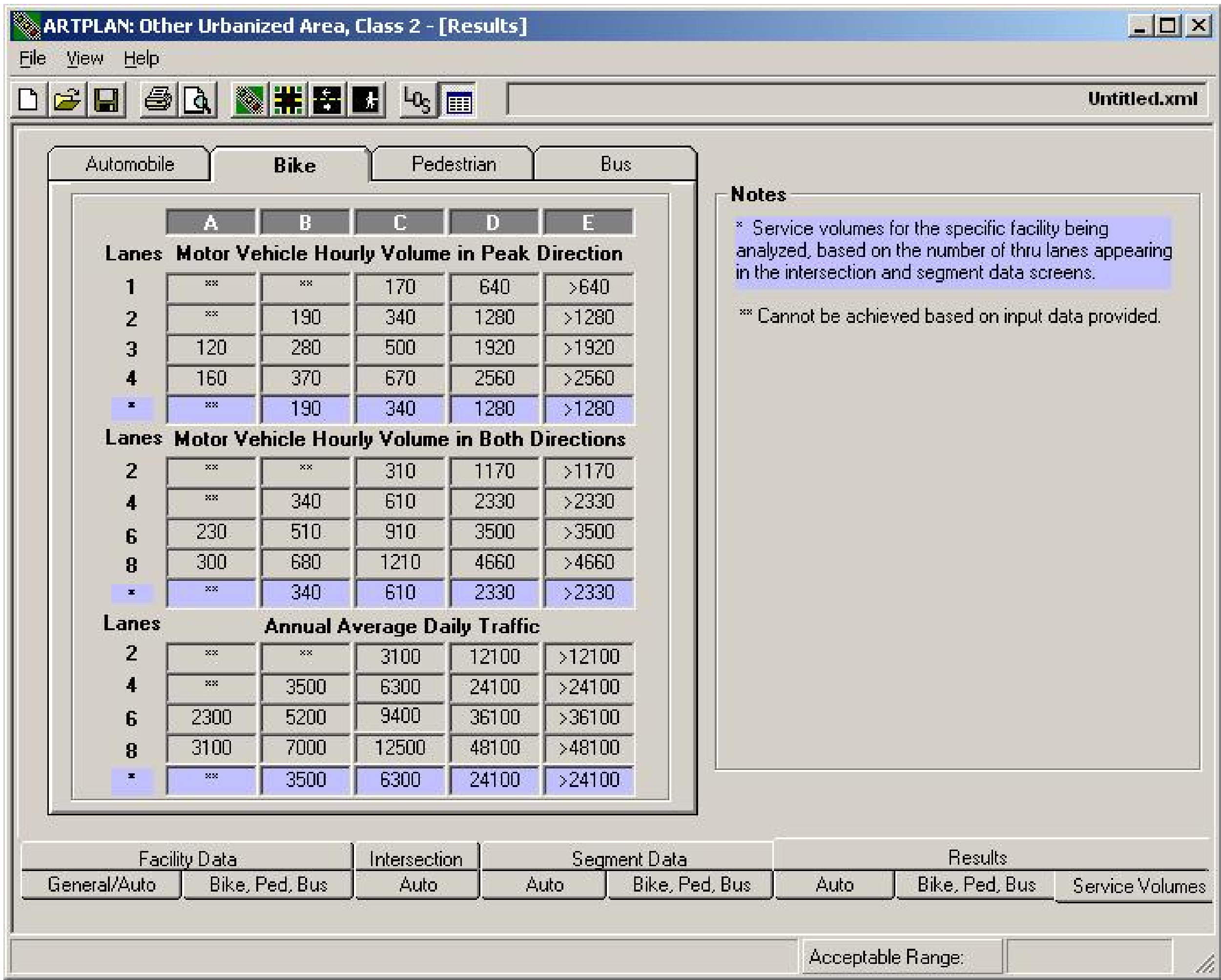
* Service volumes for the specific facility being analyzed, based on the number of thru lanes appearing in the intersection and segment data screens.

** Cannot be achieved based on input data provided.

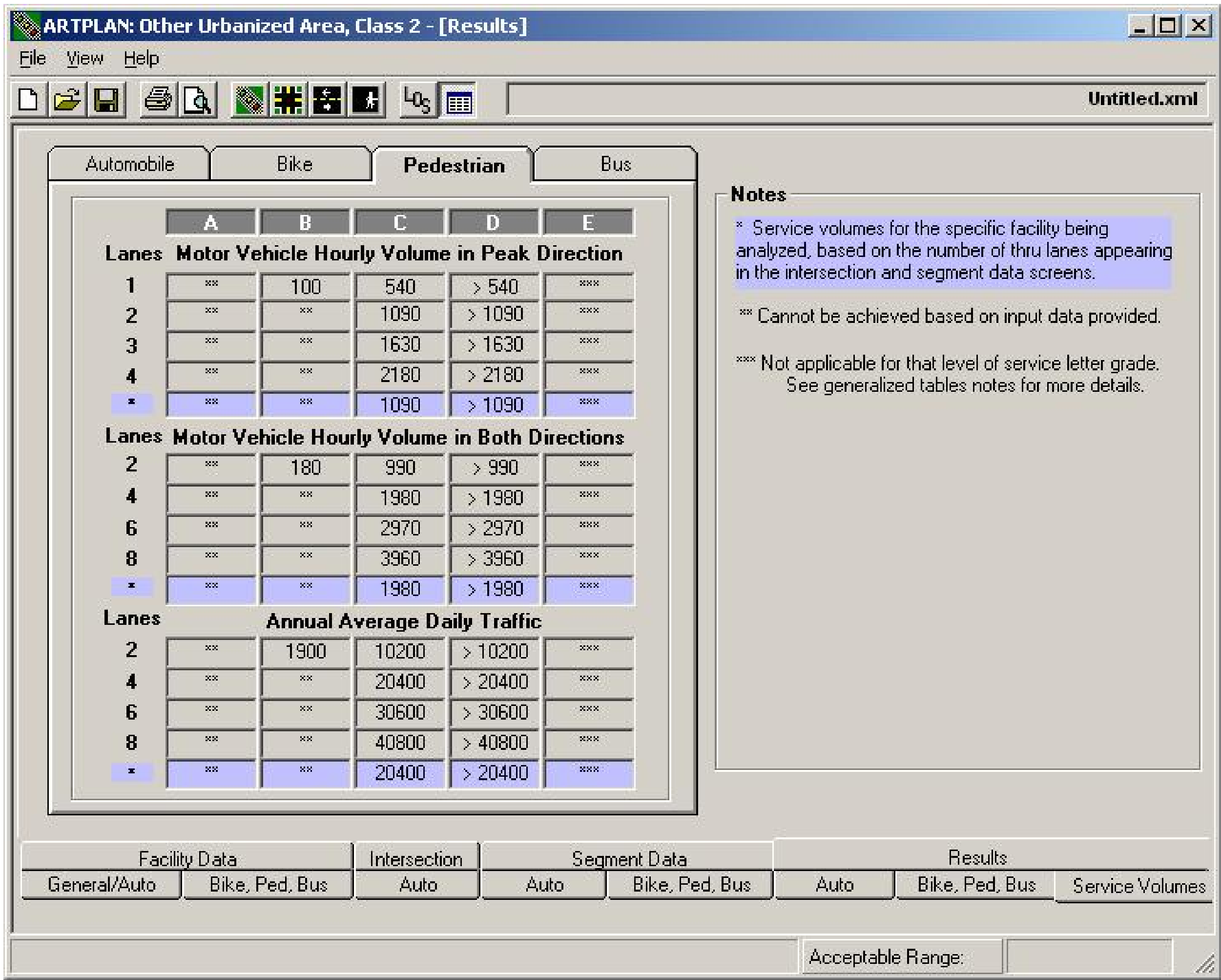
THE MAXIMUM NORMALLY ACCEPTABLE DIRECTIONAL SERVICE VOLUME FOR LOS E IN FLORIDA FOR THIS FACILITY TYPE AND AREA TYPE IS 950 VEHICLES PER HOUR PER LANE. THIS ANALYSIS WILL PROBABLY NOT BE ACCEPTED BY FDOT.

Facility Data: General/Auto | Bike, Ped, Bus — Intersection: Auto — Segment Data: Auto | Bike, Ped, Bus — Results: Auto | Bike, Ped, Bus | Service Volumes

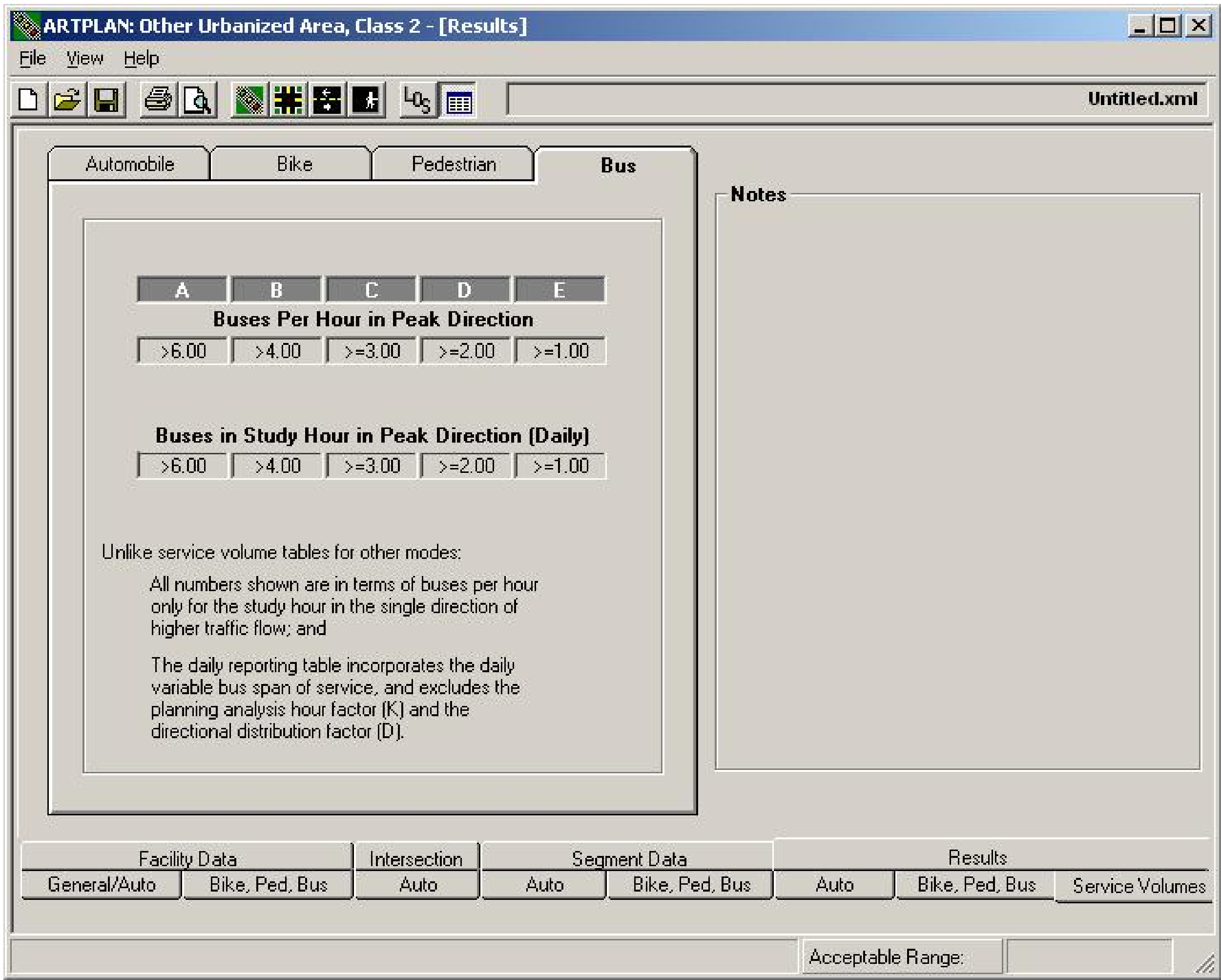
Acceptable Range:



	A	B	C	D	E
Lanes	**Motor Vehicle Hourly Volume in Peak Direction**				
1	**	**	170	640	>640
2	**	190	340	1280	>1280
3	120	280	500	1920	>1920
4	160	370	670	2560	>2560
*	**	190	340	1280	>1280
Lanes	**Motor Vehicle Hourly Volume in Both Directions**				
2	**	**	310	1170	>1170
4	**	340	610	2330	>2330
6	230	510	910	3500	>3500
8	300	680	1210	4660	>4660
*	**	340	610	2330	>2330
Lanes	**Annual Average Daily Traffic**				
2	**	**	3100	12100	>12100
4	**	3500	6300	24100	>24100
6	2300	5200	9400	36100	>36100
8	3100	7000	12500	48100	>48100
*	**	3500	6300	24100	>24100

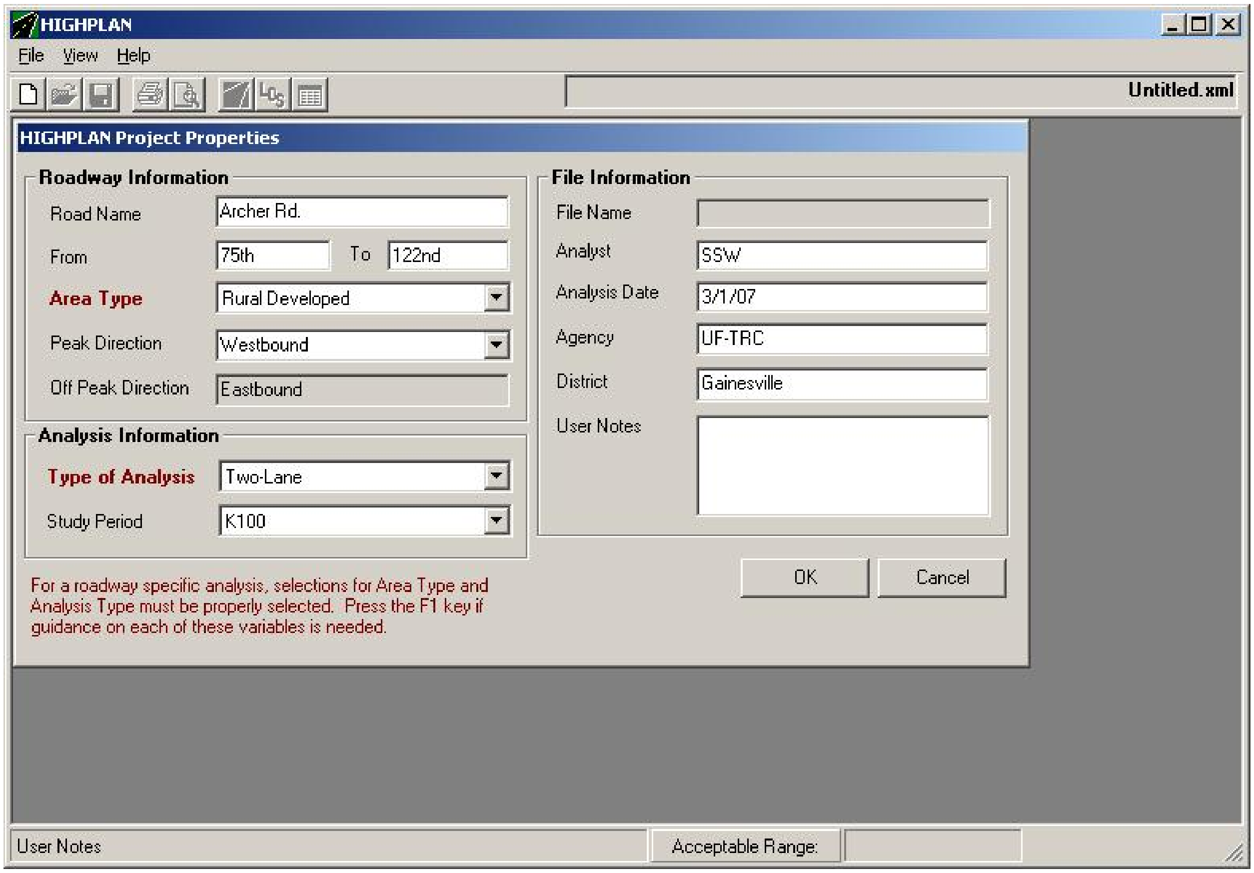


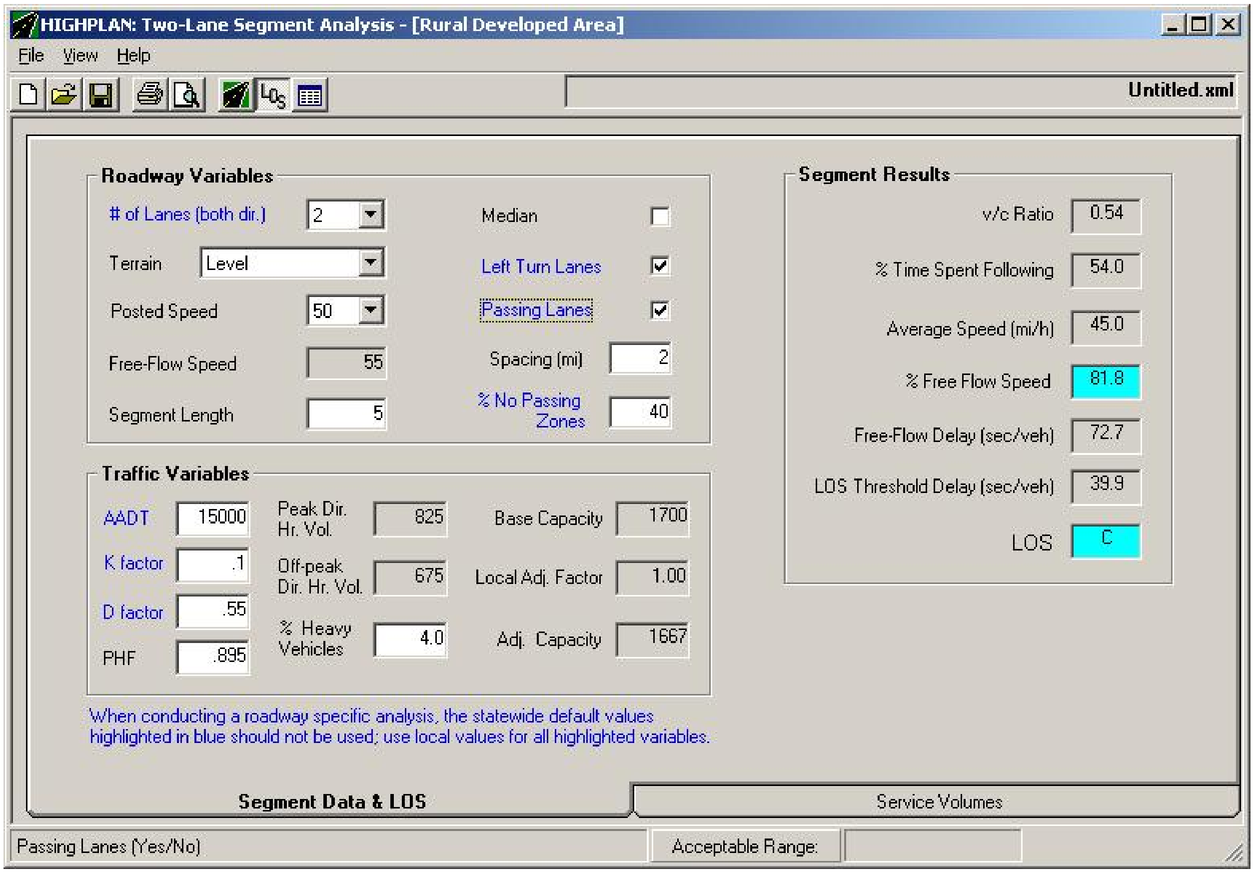
Lanes	A	B	C	D	E
	Motor Vehicle Hourly Volume in Peak Direction				
1	**	100	540	> 540	***
2	**	**	1090	> 1090	***
3	**	**	1630	> 1630	***
4	**	**	2180	> 2180	***
*	**	**	1090	> 1090	***
Lanes	**Motor Vehicle Hourly Volume in Both Directions**				
2	**	180	990	> 990	***
4	**	**	1980	> 1980	***
6	**	**	2970	> 2970	***
8	**	**	3960	> 3960	***
*	**	**	1980	> 1980	***
Lanes	**Annual Average Daily Traffic**				
2	**	1900	10200	> 10200	***
4	**	**	20400	> 20400	***
6	**	**	30600	> 30600	***
8	**	**	40800	> 40800	***
*	**	**	20400	> 20400	***

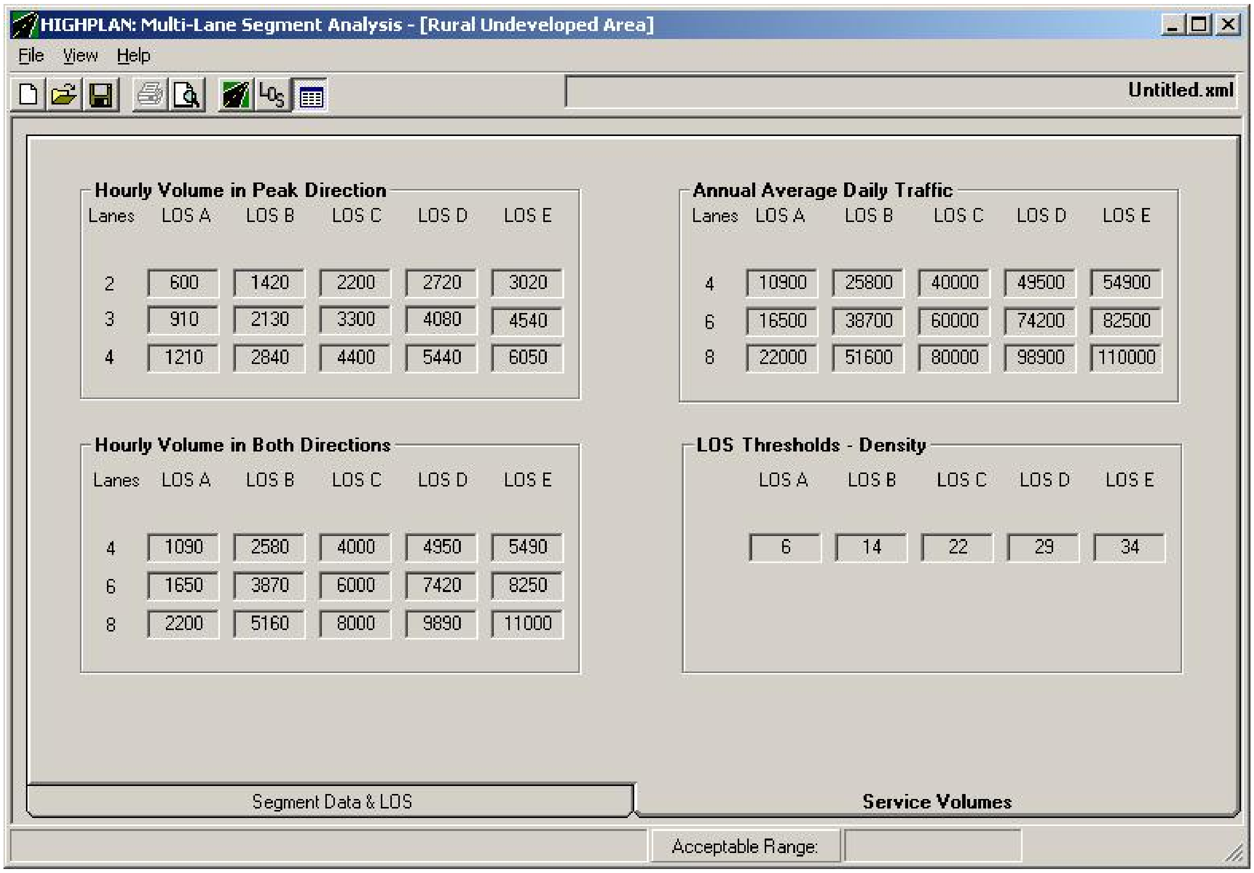

ARTPLAN: Other Urbanized Area, Class 2 - [Results]
File View Help
Untitled.xml
Automobile
Bike
Pedestrian
Bus
Notes
A B C D E
Buses Per Hour in Peak Direction
>6.00 >4.00 >=3.00 >=2.00 >=1.00
Buses in Study Hour in Peak Direction (Daily)
>6.00 >4.00 >=3.00 >=2.00 >=1.00
Unlike service volume tables for other modes:
All numbers shown are in terms of buses per hour only for the study hour in the single direction of higher traffic flow; and
The daily reporting table incorporates the daily variable bus span of service, and excludes the planning analysis hour factor (K) and the directional distribution factor (D).
Facility Data
General/Auto
Bike, Ped, Bus
Intersection
Auto
Segment Data
Auto
Bike, Ped, Bus
Results
Auto
Bike, Ped, Bus
Service Volumes
Acceptable Range:

HIGHPLAN


HIGHPLAN 2007
Florida Department of Transportation
HIGHPLAN 2007
Multilane and Two-Lane Highway
Level of Service
for Conceptual Planning and Preliminary Engineering
Version Date: 4/30/07
Startup Options
Would you like to...
Start a new project
or
Open an existing project

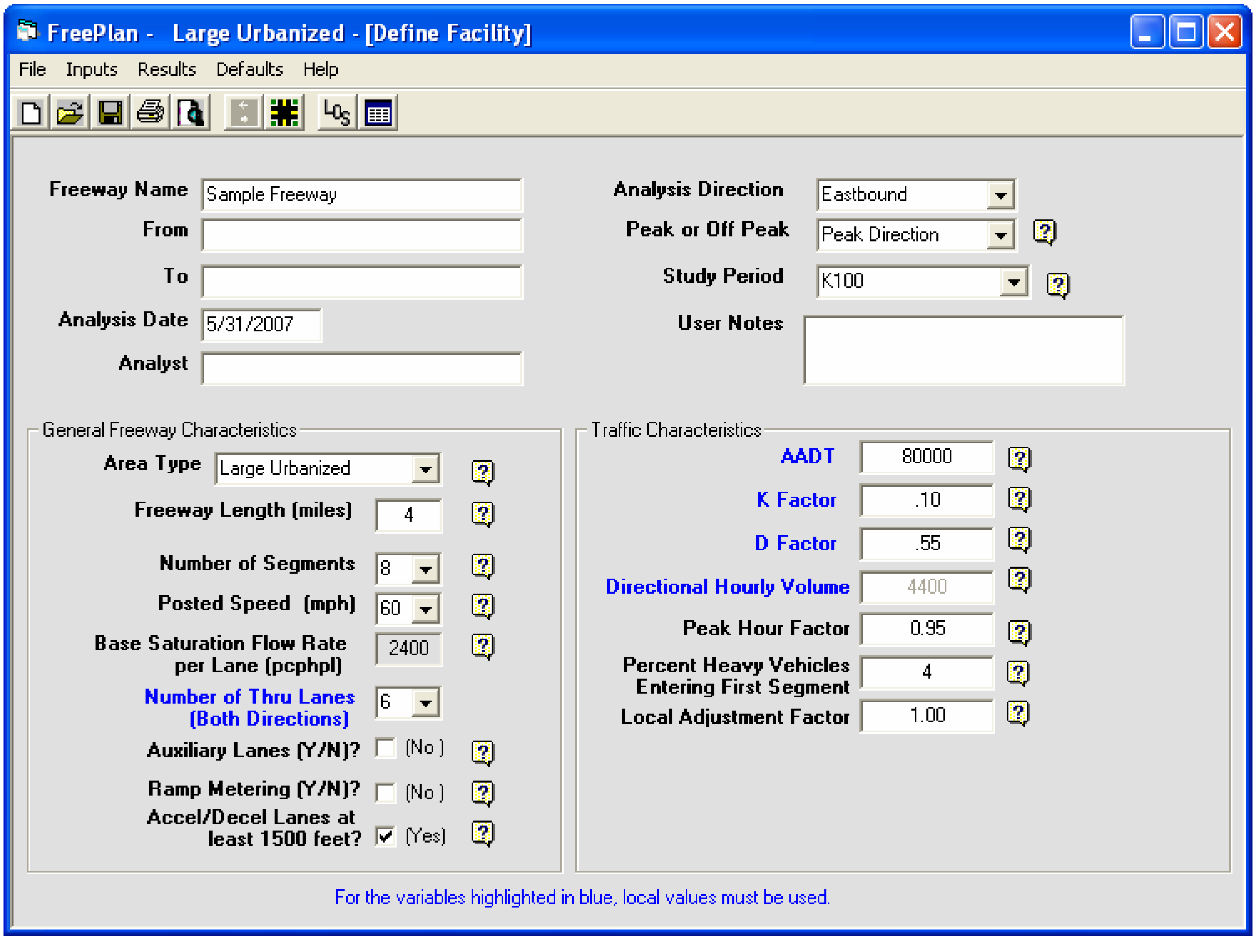

HIGHPLAN
File View Help
Untitled.xml
HIGHPLAN Project Properties
Roadway Information
Road Name
Archer Rd.
From
75th
To
122nd
Area Type
Rural Developed
Peak Direction
Westbound
Off Peak Direction
Eastbound
Analysis Information
Type of Analysis
Two-Lane
Study Period
K100
For a roadway specific analysis, selections for Area Type and Analysis Type must be properly selected. Press the F1 key if guidance on each of these variables is needed.
File Information
File Name
Analyst
SSW
Analysis Date
3/1/07
Agency
UF-TRC
District
Gainesville
User Notes
OK
Cancel
User Notes
Acceptable Range:

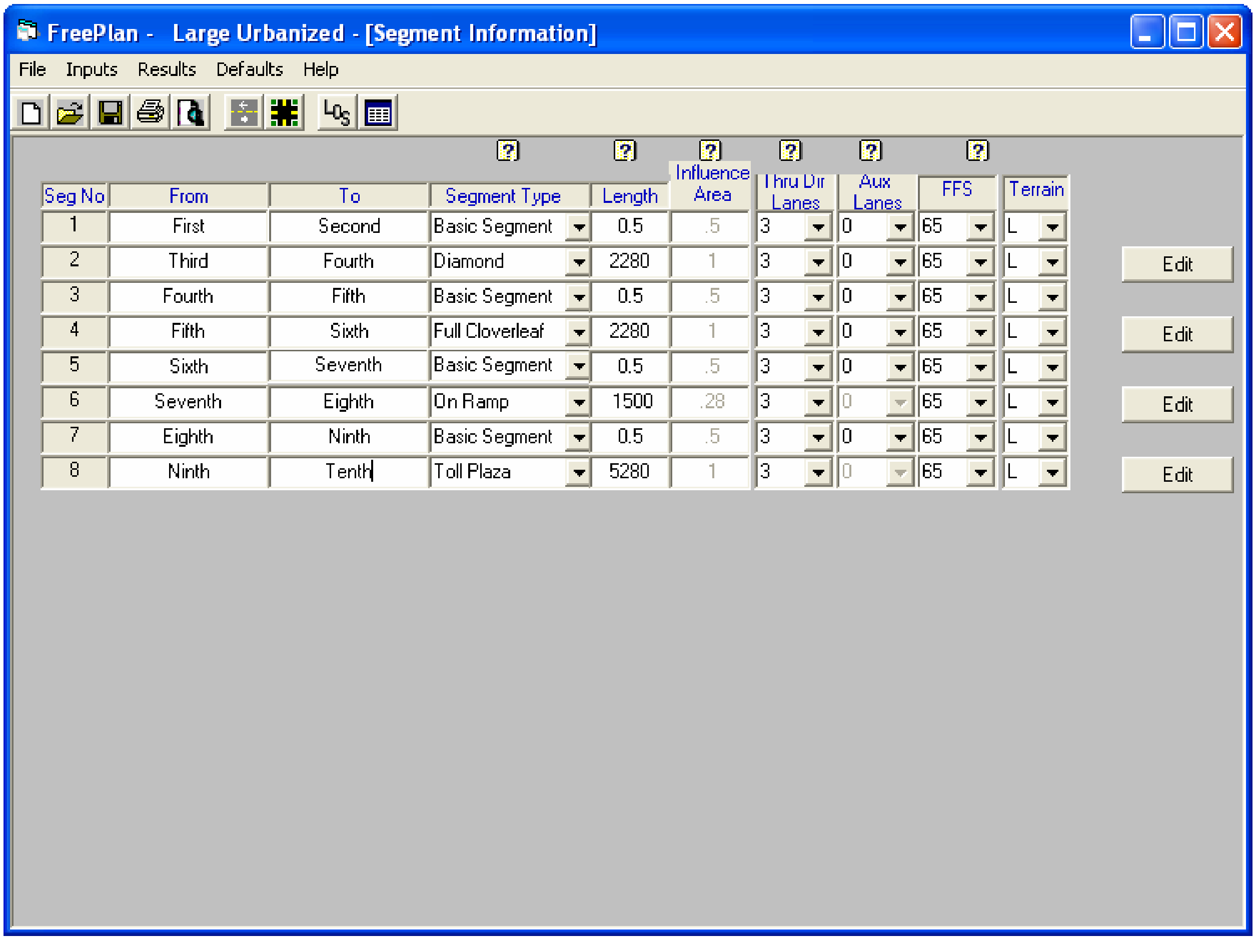

HIGHPLAN: Two-Lane Segment Analysis - [Rural Developed Area]
File View Help
Untitled.xml
Roadway Variables
# of Lanes (both dir.) 2
Terrain Level
Posted Speed 50
Free-Flow Speed 55
Segment Length 5
Median
Left Turn Lanes
Passing Lanes
Spacing (mi) 2
% No Passing Zones 40
Traffic Variables
AADT 15000
K factor .1
D factor .55
PHF .895
Peak Dir. Hr. Vol. 825
Off-peak Dir. Hr. Vol. 675
% Heavy Vehicles 4.0
Base Capacity 1700
Local Adj. Factor 1.00
Adj. Capacity 1667
When conducting a roadway specific analysis, the statewide default values highlighted in blue should not be used; use local values for all highlighted variables.
Segment Results
v/c Ratio 0.54
% Time Spent Following 54.0
Average Speed (mi/h) 45.0
% Free Flow Speed 81.8
Free-Flow Delay (sec/veh) 72.7
LOS Threshold Delay (sec/veh) 39.9
LOS C
Segment Data & LOS
Service Volumes
Passing Lanes (Yes/No)
Acceptable Range:


HIGHPLAN: Multi-Lane Segment Analysis - [Rural Undeveloped Area]
File View Help
Untitled.xml
Hourly Volume in Peak Direction
Lanes LOS A LOS B LOS C LOS D LOS E
2 600 1420 2200 2720 3020
3 910 2130 3300 4080 4540
4 1210 2840 4400 5440 6050
Annual Average Daily Traffic
Lanes LOS A LOS B LOS C LOS D LOS E
4 10900 25800 40000 49500 54900
6 16500 38700 60000 74200 82500
8 22000 51600 80000 98900 110000
Hourly Volume in Both Directions
Lanes LOS A LOS B LOS C LOS D LOS E
4 1090 2580 4000 4950 5490
6 1650 3870 6000 7420 8250
8 2200 5160 8000 9890 11000
LOS Thresholds - Density
LOS A LOS B LOS C LOS D LOS E
6 14 22 29 34
Segment Data & LOS
Service Volumes
Acceptable Range:

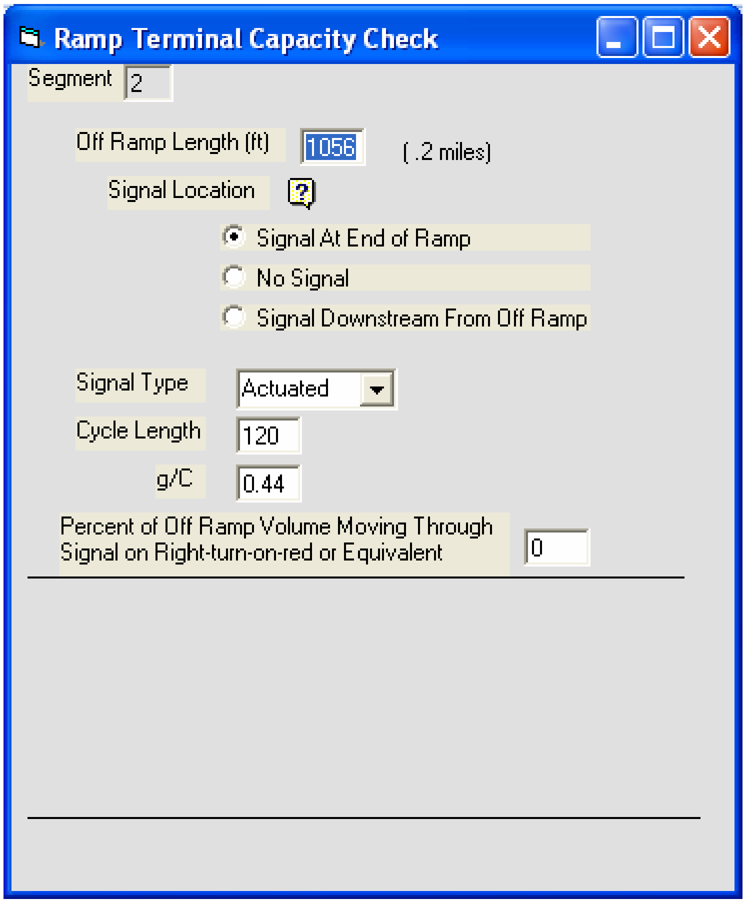
FREEPLAN

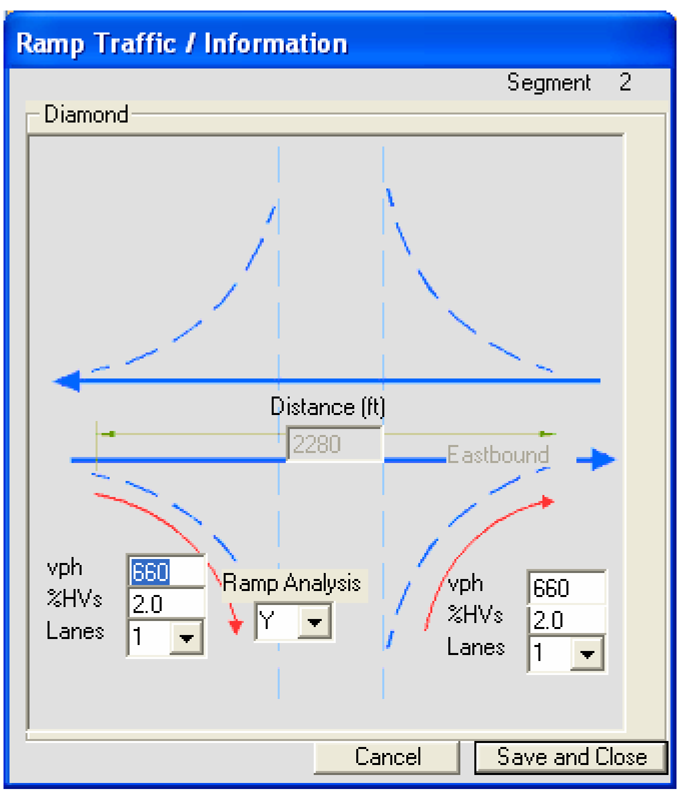

Florida Department of Transportation
FREEPLAN 2007
Freeway Level of Service
for Conceptual Planning and Preliminary Engineering
Version Date: 5/14/07
Startup Options
Would you like to...
Start a new project
or
Open an existing project

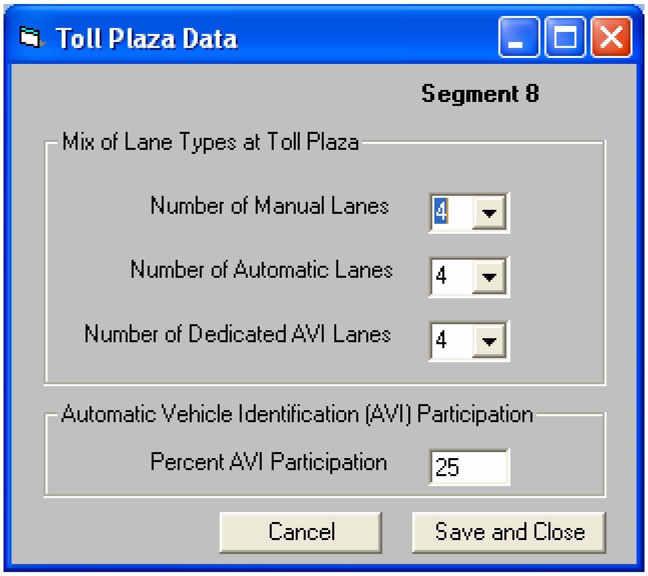

FreePlan - Large Urbanized - [Define Facility]
File Inputs Results Defaults Help
Freeway Name
Sample Freeway
From
To
Analysis Date
5/31/2007
Analyst
Analysis Direction
Eastbound
Peak or Off Peak
Peak Direction
Study Period
K100
User Notes
General Freeway Characteristics
Area Type
Large Urbanized
Freeway Length (miles)
4
Number of Segments
8
Posted Speed (mph)
60
Base Saturation Flow Rate per Lane (pcphpl)
2400
Number of Thru Lanes (Both Directions)
6
Auxiliary Lanes (Y/N)?
(No)
Ramp Metering (Y/N)?
(No)
Accel/Decel Lanes at least 1500 feet?
(Yes)
Traffic Characteristics
AADT
80000
K Factor
.10
D Factor
.55
Directional Hourly Volume
4400
Peak Hour Factor
0.95
Percent Heavy Vehicles Entering First Segment
4
Local Adjustment Factor
1.00
For the variables highlighted in blue, local values must be used.

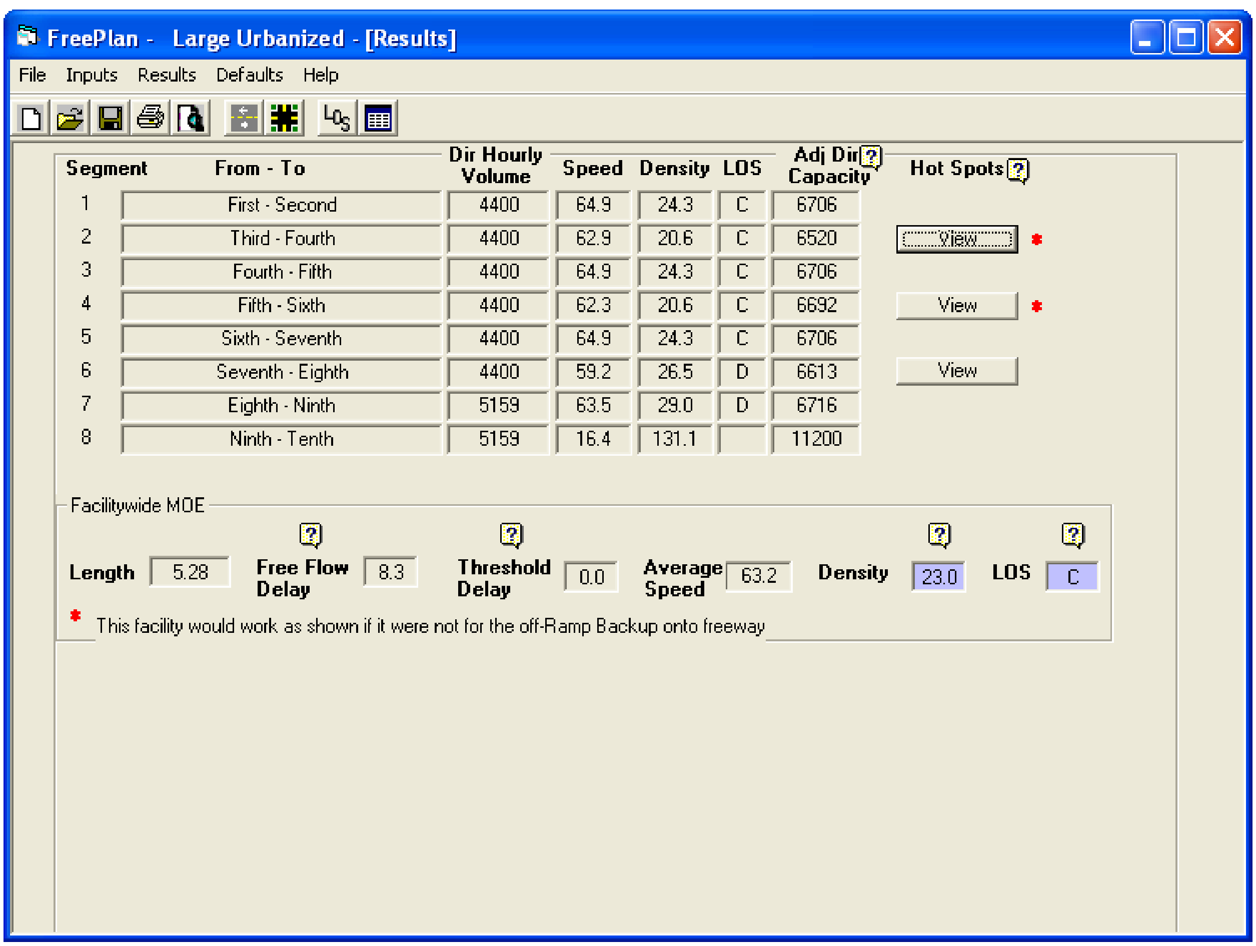


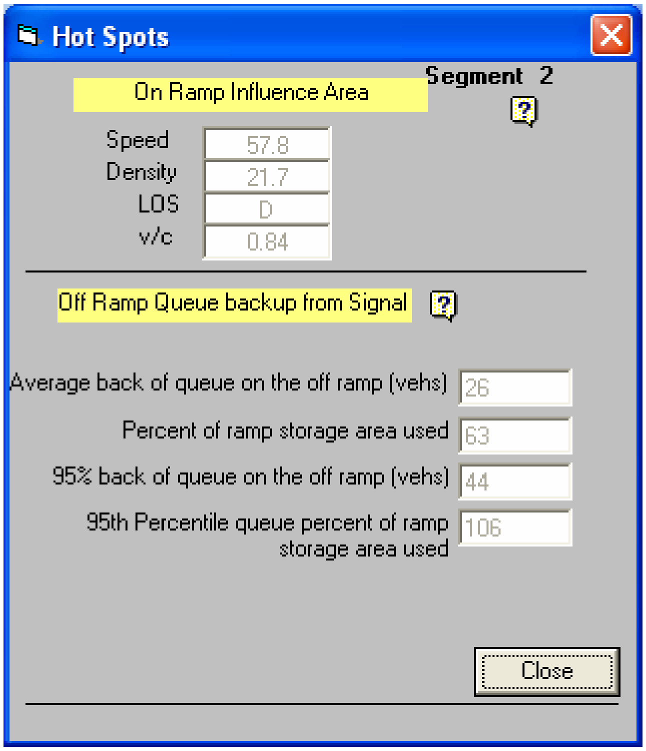
Seg No	From	To	Segment Type	Length	Influence Area	Thru Dir Lanes	Aux Lanes	FFS	Terrain
1	First	Second	Basic Segment	0.5	.5	3	0	65	L
2	Third	Fourth	Diamond	2280	1	3	0	65	L
3	Fourth	Fifth	Basic Segment	0.5	.5	3	0	65	L
4	Fifth	Sixth	Full Cloverleaf	2280	1	3	0	65	L
5	Sixth	Seventh	Basic Segment	0.5	.5	3	0	65	L
6	Seventh	Eighth	On Ramp	1500	.28	3	0	65	L
7	Eighth	Ninth	Basic Segment	0.5	.5	3	0	65	L
8	Ninth	Tenth	Toll Plaza	5280	1	3	0	65	L

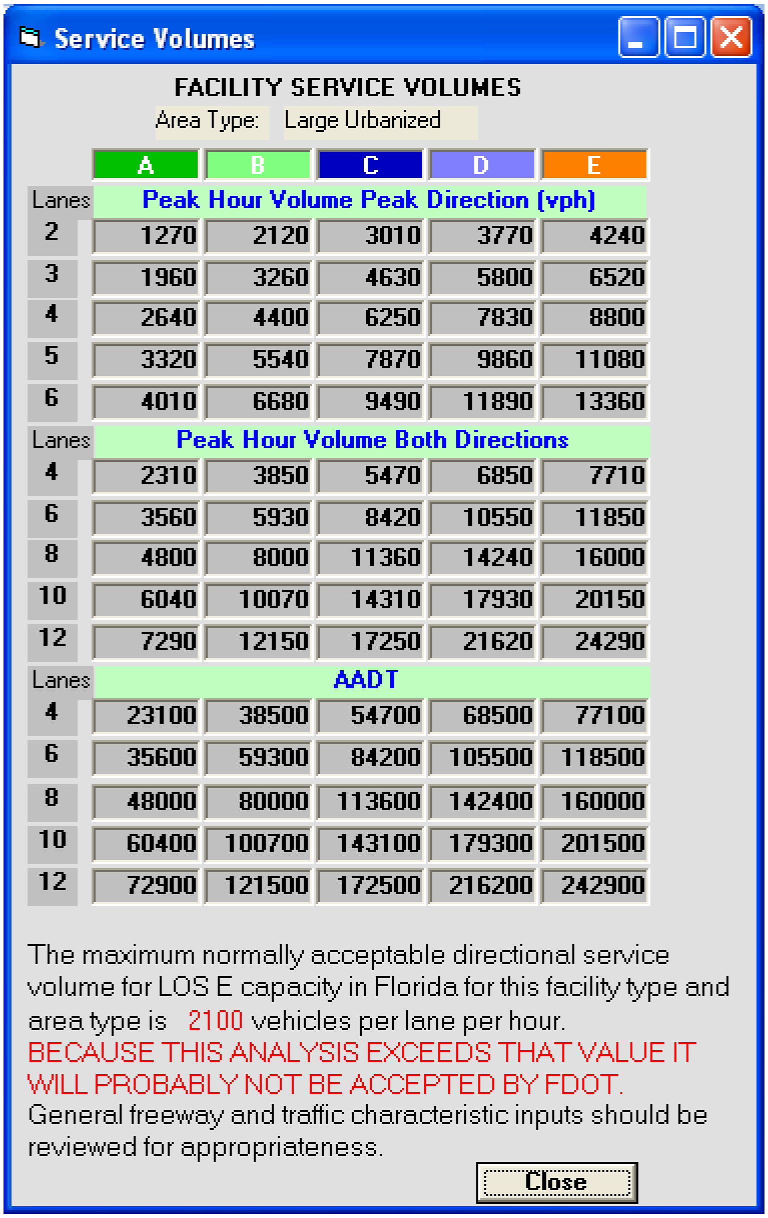

Ramp Terminal Capacity Check
Segment 2
Off Ramp Length (ft) 1056 (.2 miles)
Signal Location
Signal At End of Ramp
No Signal
Signal Downstream From Off Ramp
Signal Type Actuated
Cycle Length 120
g/C 0.44
Percent of Off Ramp Volume Moving Through Signal on Right-turn-on-red or Equivalent 0


Ramp Traffic / Information
Segment 2
Diamond
Distance (ft)
2280
Eastbound
vph 660
%HVs 2.0
Lanes 1
Ramp Analysis Y
vph 660
%HVs 2.0
Lanes 1
Cancel
Save and Close


Toll Plaza Data
Segment 8
Mix of Lane Types at Toll Plaza
Number of Manual Lanes 4
Number of Automatic Lanes 4
Number of Dedicated AVI Lanes 4
Automatic Vehicle Identification (AVI) Participation
Percent AVI Participation 25
Cancel
Save and Close


FreePlan - Large Urbanized - [Results]
File Inputs Results Defaults Help
Segment From - To Dir Hourly Volume Speed Density LOS Adj Dir Capacity Hot Spots
1 First - Second 4400 64.9 24.3 C 6706
2 Third - Fourth 4400 62.9 20.6 C 6520 View *
3 Fourth - Fifth 4400 64.9 24.3 C 6706
4 Fifth - Sixth 4400 62.3 20.6 C 6692 View *
5 Sixth - Seventh 4400 64.9 24.3 C 6706
6 Seventh - Eighth 4400 59.2 26.5 D 6613 View
7 Eighth - Ninth 5159 63.5 29.0 D 6716
8 Ninth - Tenth 5159 16.4 131.1 11200
Facilitywide MOE
Length 5.28
Free Flow Delay 8.3
Threshold Delay 0.0
Average Speed 63.2
Density 23.0
LOS C
* This facility would work as shown if it were not for the off-Ramp Backup onto freeway


Hot Spots
On Ramp Influence Area
Segment 2
Speed
57.8
Density
21.7
LOS
D
v/c
0.84
Off Ramp Queue backup from Signal
Average back of queue on the off ramp (vehs)
26
Percent of ramp storage area used
63
95% back of queue on the off ramp (vehs)
44
95th Percentile queue percent of ramp storage area used
106
Close



Service Volumes

FACILITY SERVICE VOLUMES

Area Type: Large Urbanized

Lanes	A	B	C	D	E
Peak Hour Volume Peak Direction (vph)					
2	1270	2120	3010	3770	4240
3	1960	3260	4630	5800	6520
4	2640	4400	6250	7830	8800
5	3320	5540	7870	9860	11080
6	4010	6680	9490	11890	13360
Peak Hour Volume Both Directions					
4	2310	3850	5470	6850	7710
6	3560	5930	8420	10550	11850
8	4800	8000	11360	14240	16000
10	6040	10070	14310	17930	20150
12	7290	12150	17250	21620	24290
AADT					
4	23100	38500	54700	68500	77100
6	35600	59300	84200	105500	118500
8	48000	80000	113600	142400	160000
10	60400	100700	143100	179300	201500
12	72900	121500	172500	216200	242900

The maximum normally acceptable directional service volume for LOS E capacity in Florida for this facility type and area type is 2100 vehicles per lane per hour.
BECAUSE THIS ANALYSIS EXCEEDS THAT VALUE IT WILL PROBABLY NOT BE ACCEPTED BY FDOT.
General freeway and traffic characteristic inputs should be reviewed for appropriateness.

Close

Chapter 2: Computational Methodology Documentation

ARTPLAN Computational Methodology

Dr. Scott Washburn
University of Florida
Transportation Research Center

For Version 6.0.0 (updated 7/21/2006)

General Facility Data Inputs

Roadway Variables:

$AreaType := 2$ 1 = Large Urbanized, 2 = Other Urbanized, 3 = Transitioning/Urban, 4 = Rural Developed

$Class := 2$ $ThruLanes := 4$ both directions

$PostedSpeed := 45$ $MedianType := 2$ 0 = None, 1 = NonRestrictive, 2 = Restrictive

$InsideLaneWidth := 12$ $LeftTurnBay := 1$ 0 = No, 1 = Yes

$OutsideLaneWidth := 12$ $RightTurnBay := 0$ 0 = No, 1 = Yes

Traffic Variables:

$AADT := 30000$ $PHF := 0.925$ $\%LeftTurns := 12$ $BaseSatFlowRate := 1950$

$Kfactor := 0.095$ $\%HV := 2$ $\%RightTurns := 12$

$Dfactor := 0.55$

Intersection and Segment Data Inputs

Intersection Data:

Int_1 No Inputs Required

Int_2 $Cycle_1 := 120$ $gC_1 := 0.44$ $ArrivalType_1 := 4$ $\%LeftTurns_1 := 12$ $\%RightTurns_1 := 12$ $NumDirLanes_1 := 2$

Int_3 $Cycle_2 := 120$ $gC_2 := 0.44$ $ArrivalType_2 := 4$ $\%LeftTurns_2 := 12$ $\%RightTurns_2 := 12$ $NumDirLanes_2 := 2$

Segment Data:

Seg_1

$Length_1 := 1760$

$AADT_1 := 30000$

$HourlyDirVol_1 := AADT_1 \cdot Kfactor \cdot Dfactor$

$HourlyDirVol_1 = 1568$

$FFS_1 := 50$

Seg_2

$Length_2 := 1760$

$AADT_2 := 30000$

$HourlyDirVol_2 := AADT_2 \cdot Kfactor \cdot Dfactor$

$HourlyDirVol_2 = 1568$

$FFS_2 := 50$

Signal Data:

$Sig_1 := 0$ No Inputs Required

$Sig_2 := 1$ 0 = Pretimed, 1 = Semi Actuated, 2 = Fully Actuated

$Sig_3 := 1$ 0 = Pretimed, 1 = Semi Actuated, 2 = Fully Actuated

Computational Steps

1. Calculate the Saturation Flow Rate Adjustment Factors

A. Calculate the population adjustment factor

$$\text{Population(AreaType)} := \left| \begin{array}{l} \text{out} \leftarrow 1.5 \ \text{ if } \ \text{AreaType} = 1 \\ \text{out} \leftarrow 0.4 \ \text{ if } \ \text{AreaType} = 2 \\ \text{out} \leftarrow 0.03 \ \text{ if } \ \text{AreaType} = 3 \\ \text{out} \leftarrow 0.003 \ \text{ if } \ \text{AreaType} = 4 \end{array} \right.$$

$$\text{Population(AreaType)} = 0.4$$

$$\text{PopFact} := \frac{1}{\text{Population(AreaType)}^{-0.018}} \qquad \text{PopFact} = 0.984$$

B. Calculate the number of lanes adjustment factor

$$N := \frac{\text{ThruLanes}}{2} \qquad E_{CL} := 1.03$$

$$\text{NumLanesFact} := \frac{1}{1 + \frac{1}{N} \cdot \left(E_{CL} - 1\right)} \qquad \text{NumLanesFact} = 0.985$$

C. Calculate the posted speed adjustment factor

$$\text{SpeedFact} := \frac{1}{1 - 0.0066(\text{PostedSpeed} - 50)} \qquad \text{SpeedFact} = 0.968$$

D. Calculate the traffic pressure adjustment factor

$$\%\text{Turns}(\%\text{LT}, \%\text{RT}) := \left| \begin{array}{l} \%\text{LT} \ \text{ if } \ \text{LeftTurnBay} = 1 \wedge \text{RightTurnBay} = 0 \\ \%\text{RT} \ \text{ if } \ \text{LeftTurnBay} = 0 \wedge \text{RightTurnBay} = 1 \\ \%\text{LT} + \%\text{RT} \ \text{ if } \ \text{LeftTurnBay} = 1 \wedge \text{RightTurnBay} = 1 \\ 0 \ \text{ otherwise} \end{array} \right.$$

$$\%\text{Turns}_1 := \%\text{Turns}\left(\%\text{LeftTurns}_1, \%\text{RightTurns}_1\right) \qquad \%\text{Turns}_1 = 12$$

$$\text{ThruMvmtFlowRate}_1 := \frac{\text{HourlyDirVol}_1}{\text{PHF}} \cdot \left[1 - \left(\frac{\%\text{Turns}_1}{100}\right)\right] \qquad \text{ThruMvmtFlowRate}_1 = 1491.2$$

$Cycle_1 := 120$

$$v_1 := \frac{ThruMvmtFlowRate_1 \cdot Cycle_1}{N \cdot 3600} \qquad v_1 = 24.854$$

$$TrafFact := \frac{1}{1 - 0.0032\left(v_1 - 20\right)} \qquad TrafFact = 1.016$$

E. Calculate the lane width adjustment factor

$$AvgLaneWidth_1 := \frac{\left[InsideLaneWidth \cdot \left(NumDirLanes_2 - 1\right)\right] + OutsideLaneWidth}{NumDirLanes_2}$$

$$LaneWidthFact_1 := 1 + \frac{AvgLaneWidth_1 - 12}{30} \qquad LaneWidthFact_1 = 1.0$$

F. Determine the Median adjustment factor

$$MedianFact(Median) := \left| \begin{array}{l} out \leftarrow 0.95 \ \text{ if } \ Median = 0 \\ out \leftarrow 1.0 \ \text{ if } \ Median = 1 \\ out \leftarrow 1.0 \ \text{ if } \ Median = 2 \\ out \end{array} \right.$$

$MedianFact(MedianType) = 1$

$$MedianFact_1 := MedianFact(MedianType) \qquad MedianFact_1 = 1.0$$

G. Determine the left turn bay adjustment factor

$$LeftTurnFact(LeftTurnBay) := \left| \begin{array}{l} out \leftarrow 0.8 \ \text{ if } \ LeftTurnBay = 0 \\ out \leftarrow 1.0 \ \text{ if } \ LeftTurnBay = 1 \\ out \end{array} \right.$$

$LeftTurnFact(LeftTurnBay) = 1$

$$LeftTurnFact_1 := LeftTurnFact(LeftTurnBay) \qquad LeftTurnFact_1 = 1.0$$

H. Determine the right turn adjustment factor

$$E_{RT}(RightTurnBay) := \left| \begin{array}{l} out \leftarrow 1.07 \ \text{ if } \ RightTurnBay = 0 \\ out \leftarrow 1.0 \ \text{ if } \ RightTurnBay = 1 \\ out \end{array} \right.$$

$E_{RT}(\text{RightTurnBay}) = 1.07$

$$\text{RightTurnFact} := \left[\frac{1}{1 + \frac{\%\text{RightTurns}_1}{100}\cdot\left(E_{RT}(\text{RightTurnBay}) - 1\right)}\right] \qquad \text{RightTurnFact} = 0.992$$

I. Calculate the heavy vehicle adjustment factor

$E_T := 1.74$ (per Q/LOS Handbook)

$$f_{HV1} := \frac{1}{1 + \left[\frac{\%HV}{100}\cdot\left(E_T - 1\right)\right]} \qquad f_{HV1} = 0.985$$

2. Calculate the Adjusted Saturation Flow Rate

$$\text{FactAdj} := \text{LaneWidthFact}_1\cdot\text{MedianFact}_1\cdot f_{HV1}\cdot\text{PopFact}\cdot\text{TrafFact}\cdot\text{NumLanesFact}\cdot\text{SpeedFact}\cdot\text{LeftTurnFact}_1\cdot\text{RightTurnFact}$$

$\text{FactAdj} = 0.931$

$$\text{AdjSatFlowRate}_1 := \text{BaseSatFlowRate}\cdot\text{FactAdj} \qquad \text{AdjSatFlowRate}_1 = 1816$$

3. Calculate signal delay

A. Calculate volume to capacity ratio (v/c)

Sig_1

$c := \text{AdjSatFlowRate}_1\cdot gC_1 \qquad c = 799$

$$\text{ThruMvmtFlowRate}_1 := \frac{\text{HourlyDirVol}_1}{\text{PHF}}\cdot\left[1 - \left(\frac{\%\text{Turns}_1}{100}\right)\right] \qquad \text{ThruMvmtFlowRate}_1 = 1491.2$$

$$vc_1 := \frac{\text{ThruMvmtFlowRate}_1}{c\cdot\text{NumDirLanes}_1} \qquad vc_1 = 0.933$$

Sig_2

$c := \text{AdjSatFlowRate}_1\cdot gC_2 \qquad c = 799$

$\%\text{Turns}_2 := \%\text{Turns}\left(\%\text{LeftTurns}_2, \%\text{RightTurns}_2\right) \qquad \%\text{Turns}_2 = 12$

$$\text{ThruMvmtFlowRate}_2 := \frac{\text{HourlyDirVol}_1}{\text{PHF}}\cdot\left[1 - \left(\frac{\%\text{Turns}_2}{100}\right)\right] \qquad \text{ThruMvmtFlowRate}_2 = 1491.2$$

$$vc_2 := \frac{ThruMvmtFlowRate_2}{c \cdot NumDirLanes_2} \qquad \boxed{vc_2 = 0.933}$$

B. Calculate uniform delay (d_1)

$$d_{1\_1} := \frac{0.5 \cdot Cycle_2 \cdot \left(1 - gC_2\right)^2}{1 - \left(vc_2 \cdot gC_2\right)} \qquad \boxed{d_{1\_1} = 31.92}$$

Equation 15-2 HCM 2000

C. Calculate incremetal delay (d_2)

Determine k, signal controller mode delay adjustment factor

If the intersection is operating under pretimed mode, k = 0.5.

$$kfactor(Signal) := \left| \begin{array}{l} out \leftarrow 0.5 \ \text{ if } \ Signal = 0 \\ out \leftarrow 0.5 \ \text{ if } \ Signal = 1 \\ \text{if } \ Signal = 2 \\ \quad \left| \begin{array}{l} out \leftarrow 0.11 \ \text{ if } \ vc_2 < 0.5 \\ out \leftarrow (1 - 2 \cdot 0.11) \cdot \left(vc_2 - 0.5\right) + 0.11 \ \text{ otherwise} \end{array} \right. \\ out \end{array} \right.$$

From Exhibit 15-6 HCM 2000

$$kfactor\left(Sig_2\right) = 0.5 \qquad k_1 := kfactor\left(Sig_2\right) \qquad \boxed{k_1 = 0.5}$$

Determine I, the upstream filtering/metering adjustment factor

If the v/c ratio for the upstream signal is greater than 1, then I = 0.09.

When there is no upstream signal, use the v/c ratio for that intersection.

$$Ifactor := \left| \begin{array}{l} out \leftarrow 0.09 \ \text{ if } \ vc_1 \geq 1.0 \\ out \leftarrow 1.0 - 0.91 \cdot vc_1^{\,2.68} \ \text{ if } \ vc_1 < 1.0 \\ out \end{array} \right.$$

From Exhibit 15-7 HCM 2000

$$Ifactor = 0.244 \qquad I_1 := Ifactor \qquad \boxed{I_1 = 0.244}$$

<u>Calculation:</u>

$T := 0.25$ (ARTPLAN default)

$$d_{2\_1} := 900 \cdot T \cdot \left[\left(vc_2 - 1\right) + \sqrt{\left(vc_2 - 1\right)^2 + \frac{8 \cdot k_1 \cdot I_1 \cdot vc_2}{T \cdot c \cdot NumDirLanes_2}}\right]$$

Equation 15-3 HCM 2000

$d_{2\_1} = 3.444$

D. Calculate progression adjustment factor (PF)

Determine f_{PA} and R_p based on Arrival Type.

Determine Platoon Ratio

$$R_p(\text{ArrivalType}) := \left| \begin{array}{l} \text{out} \leftarrow 0.333 \ \text{ if } \ \text{ArrivalType} = 1 \\ \text{out} \leftarrow 0.667 \ \text{ if } \ \text{ArrivalType} = 2 \\ \text{out} \leftarrow 1.0 \ \text{ if } \ \text{ArrivalType} = 3 \\ \text{out} \leftarrow 1.333 \ \text{ if } \ \text{ArrivalType} = 4 \\ \text{out} \leftarrow 1.667 \ \text{ if } \ \text{ArrivalType} = 5 \\ \text{out} \leftarrow 2 \ \text{ otherwise} \\ \text{out} \end{array} \right.$$

From Exhibit 15-4
HCM 2000

$R_p(\text{ArrivalType}_2) = 1.333$ $\qquad R_{p\_1} := R_p(\text{ArrivalType}_2)$ $\qquad R_{p\_1} = 1.333$

Calculate supplemental adjustment factor for platoon arrival during the green

$$f_{PA}(\text{ArrivalType}) := \left| \begin{array}{l} \text{out} \leftarrow 1.0 \ \text{ if } \ \text{ArrivalType} = 1 \\ \text{out} \leftarrow 0.93 \ \text{ if } \ \text{ArrivalType} = 2 \\ \text{out} \leftarrow 1.0 \ \text{ if } \ \text{ArrivalType} = 3 \\ \text{out} \leftarrow 1.15 \ \text{ if } \ \text{ArrivalType} = 4 \\ \text{out} \leftarrow 1.0 \ \text{ if } \ \text{ArrivalType} = 5 \\ \text{out} \leftarrow 1 \ \text{ otherwise} \\ \text{out} \end{array} \right.$$

From Exhibit 15-5
HCM 2000

$f_{PA}(\text{ArrivalType}_2) = 1.15$ $\qquad f_{PA\_1} := f_{PA}(\text{ArrivalType}_2)$ $\qquad f_{PA\_1} = 1.15$

Calculate the percent arrivals on green

$$\%\text{Green}(gC_2) := \left| \begin{array}{l} \text{out} \leftarrow 1.0 \ \text{ if } \ (R_{p\_1} \cdot gC_2) > 1.0 \\ \text{out} \leftarrow R_{p\_1} \cdot gC_2 \ \text{ otherwise} \\ \text{out} \end{array} \right.$$

Equation 15-4
HCM 2000

$\%\text{Green}(gC_2) = 0.587$ $\qquad \%\text{Green}_1 := \%\text{Green}(gC_2)$ $\qquad \%\text{Green}_1 = 0.587$

Calculate the Progression Adjustment Factor (PF)

$$PF(gC_2) := \left| \begin{array}{l} out \leftarrow \dfrac{(1 - \%Green_1) \cdot f_{PA\_1}}{1 - gC_2} \quad \text{if } gC_2 \neq 1.0 \\ out \leftarrow 0 \quad \text{otherwise} \\ out \end{array} \right.$$

Equation 15-5
HCM 2000

$PF(gC_2) = 0.849$ $\qquad PF_1 := PF(gC_2)$ $\qquad PF_1 = 0.849$

e. Calculate the total signal delay

$$CtrlDelay_1 := d_{1\_1} \cdot PF_1 + d_{2\_1}$$

Equation 15-1
HCM 2000

$CtrlDelay_1 = 30.55$

7. Calculate the Segment Running Time/Speed

Calculations:

$Sigs_1 := \dfrac{5280}{Length_1}$ $\qquad Sigs_1 = 3$ $\qquad$ signals/mi

$v\_temp := \dfrac{HourlyDirVol_1}{NumDirLanes_1}$ $\qquad v\_temp = 783.75$ $\qquad$ not adjusted by PHF

$$RunSpeed_1 := \left| \begin{array}{l} out \leftarrow 56.941 - 1.53944 \cdot Sigs_1 - 0.00721 \cdot v\_temp \quad \text{if } FFS_1 = 55 \\ out \leftarrow 51.888 - 1.14222 \cdot Sigs_1 - 0.00795 \cdot v\_temp \quad \text{if } FFS_1 = 50 \\ out \leftarrow 46.574 - 0.89222 \cdot Sigs_1 - 0.00604 \cdot v\_temp \quad \text{if } FFS_1 = 45 \\ out \leftarrow 39.69506 - 0.10306 \cdot Sigs_1 - 0.00585 \cdot v\_temp \quad \text{if } FFS_1 = 40 \\ out \leftarrow 35.23011 - 0.21722 \cdot Sigs_1 - 0.00517 \cdot v\_temp \quad \text{if } FFS_1 = 35 \\ out \leftarrow 29.893 - 0.05611 \cdot Sigs_1 - 0.00398 \cdot v\_temp \quad \text{if } FFS_1 = 30 \\ out \leftarrow 25.58418 - 0.00095 \cdot Sigs_1 - 0.00356 \cdot v\_temp \quad \text{if } FFS_1 = 25 \\ out \end{array} \right.$$

Regression
Equations

ARTPLAN uses specific array values for running time, rather than the above regression equations, so results do not match.

$RunSpeed_1 = 42.2$ $\qquad$ mi/h $\qquad$ running time

$SegRunTime_1 := \dfrac{3600}{RunSpeed_1}$ $\qquad SegRunTime_1 = 85.2$ $\qquad$ seconds/mile

$$L_1 := \frac{Length_1}{5280}$$ $L_1 = 0.333$ miles

$TotTravTime_1 := SegRunTime_1 \cdot L_1 + CtrlDelay_1$ $TotTravTime_1 = 59.0$ seconds

$$S_{A1} := \frac{3600 \cdot L_1}{TotTravTime_1}$$

Equation 15-6
HCM 2000

$S_{A1} = 20.35$ mi/h segment running speed

8. Determine Segment LOS.

Calculations:

$$
LOS(Class, S_A) := \begin{array}{|l}
\text{if } Class = 1 \\
\quad \begin{array}{|l}
out \leftarrow \text{"A"} \quad \text{if } S_A > 42 \\
out \leftarrow \text{"B"} \quad \text{if } 34 < S_A \le 42 \\
out \leftarrow \text{"C"} \quad \text{if } 27 < S_A \le 34 \\
out \leftarrow \text{"D"} \quad \text{if } 21 < S_A \le 27 \\
out \leftarrow \text{"E"} \quad \text{if } 16 < S_A \le 21 \\
out \leftarrow \text{"F"} \quad \text{if } S_A \le 16
\end{array} \\
\text{if } Class = 2 \\
\quad \begin{array}{|l}
out \leftarrow \text{"A"} \quad \text{if } S_A > 35 \\
out \leftarrow \text{"B"} \quad \text{if } 28 < S_A \le 35 \\
out \leftarrow \text{"C"} \quad \text{if } 22 < S_A \le 28 \\
out \leftarrow \text{"D"} \quad \text{if } 17 < S_A \le 22 \\
out \leftarrow \text{"E"} \quad \text{if } 13 < S_A \le 17 \\
out \leftarrow \text{"F"} \quad \text{if } S_A \le 13
\end{array} \\
\text{if } Class = 3 \\
\quad \begin{array}{|l}
out \leftarrow \text{"A"} \quad \text{if } S_A > 30 \\
out \leftarrow \text{"B"} \quad \text{if } 24 < S_A \le 30 \\
out \leftarrow \text{"C"} \quad \text{if } 18 < S_A \le 24 \\
out \leftarrow \text{"D"} \quad \text{if } 14 < S_A \le 18 \\
out \leftarrow \text{"E"} \quad \text{if } 10 < S_A \le 14 \\
out \leftarrow \text{"F"} \quad \text{if } S_A \le 10
\end{array} \\
\text{if } Class = 4 \\
\quad \begin{array}{|l}
out \leftarrow \text{"A"} \quad \text{if } S_A > 25 \\
out \leftarrow \text{"B"} \quad \text{if } 19 < S_A \le 25 \\
out \leftarrow \text{"C"} \quad \text{if } 13 < S_A \le 19 \\
out \leftarrow \text{"D"} \quad \text{if } 9 < S_A \le 13 \\
out \leftarrow \text{"E"} \quad \text{if } 7 < S_A \le 9 \\
out \leftarrow \text{"F"} \quad \text{if } S_A \le 7
\end{array} \\
out
\end{array}
$$

$LOS(Class, S_{A1}) = \text{"D"}$

From Exhibit 15-2
HCM 2000

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Service Volume Example

From Exhibit 15-2 HCM 2000, for a Class II Arterial, the average speed (S_A) threshold for LOS C is 22.0 mi/h.

Using the procedure documented in the level of service computations file, the following results are obtained for an AADT input of 25200.

Calculating Average Speed (S_A) gives:

$\text{SegRunTime} := 83.3$ seconds/mile $\qquad$ $\text{CtrlDelay} := 26.75$ seconds

$\text{Length} := 0.333$ miles

$\text{TotTravTime} := \text{SegRunTime} \cdot \text{Length} + \text{CtrlDelay}$

$\text{TotTravTime} = 54.5$ seconds

$$S_A := \frac{3600 \cdot \text{Length}}{\text{TotTravTime}}$$

$S_A = 22.0$ mi/h

Thus, the maximum service volume (AADT) for LOS C for the conditions in the example calculations file is 25200. Note that ARTPLAN gives 25600 due to the difference in the running time calculation (i.e., table versus equation).

HIGHPLAN Computational Methodology

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Version 2.0.0 (updated 7/21/2006)

Two-Lane Segment (w/o passing lane)

Inputs and Initial Computations

1. Input Roadway and Traffic Data

Roadway Variables

$AreaType := 2$ 1 = Urbanized, 2 = Transitioning/Urban, 3 = Rural developed, 4 = Rural undeveloped

$Class := 1$

$Median := 0$ 0 = No, 1 = Yes

$NumberofLanes := 2$

$LeftTurnLane := 1$ 0 = No, 1 = Yes

$AnalysisType := 0$ 0 = Segment, 1 = Facility

$\%NPZ := 60$

$Terrain := 2$ Level = 1, Rolling = 2

$PresencePassingLane := 1$ 0 = No, 1 = Yes

$PostedSpeed := 50$ mi/hr

$Spacing := 5$ mi

Traffic Variables

$AADT := 10000$ $PercentHeavyVehicles := 0.04$ $P_T := PercentHeavyVehicles$

$K := 0.096$ $BaseCapacity := 1700$

$D := 0.55$ $LocalAdjustmentFactor := 0.95$ $LAF := LocalAdjustmentFactor$

$PHF := 0.91$

2. Calculate DDHV (Design Directional Hour Volume)

$$DDHV := AADT \cdot K \cdot D$$

$$DDHV = 528$$

3. Determine adjustment for the presence of a median and/or left turn lanes

Left Turn Lane Adjustment (LTadj) = -0.2 for left turn lanes NOT present, LTadj = 0 otherwise.

Median Adjustment (MedAdj) = 0.05 for median present, MadAdj = 0 otherwise.

Left Turn Lane:

$$LTadj(LeftTurnLane) := \left| \begin{array}{l} out \leftarrow -0.2 \;\; \text{if} \;\; LeftTurnLane = 0 \\ out \leftarrow 0 \;\; \text{if} \;\; LeftTurnLane = 1 \\ out \end{array} \right.$$

$LTadj(LeftTurnLane) = 0$ $\quad$ $LTadj := LTadj(LeftTurnLane)$ $\quad$ $LTadj = 0$

Median:

$$MedAdj(Median) := \left| \begin{array}{l} out \leftarrow 0 \;\; \text{if} \;\; Median = 0 \\ out \leftarrow 0.05 \;\; \text{if} \;\; Median = 1 \\ out \end{array} \right.$$

$MedAdj(Median) = 0$ $\quad$ $MedAdj := MedAdj(Median)$ $\quad$ $MedAdj = 0$

Final Adjustment Value for Left Turn Lane and Median:

$$AdjMedLTL := 1 + LTadj + MedAdj$$

$AdjMedLTL = 1$

4. Determine Facility Adjustment Factor (FacAdj)

FacAdj = 1.0 for Analysis Type = Segment

FacAdj = 0.9 for Analysis Type = Facility

$$FacAdj(AnalysisType) := \left| \begin{array}{l} out \leftarrow 1.0 \;\; \text{if} \;\; AnalysisType = 0 \\ out \leftarrow 0.9 \;\; \text{if} \;\; AnalysisType = 1 \\ out \end{array} \right.$$

$FacAdj(AnalysisType) = 1$ $\quad$ $FacAdj := FacAdj(AnalysisType)$ $\quad$ $FacAdj = 1$

5. Calculate Adjusted Volume (AdjVol)

$$AdjVol := \frac{DDHV}{PHF \cdot LAF \cdot AdjMedLTL \cdot FacAdj}$$

$AdjVol = 610.8$ veh/h $\quad$ $V := AdjVol$ $\quad$ $V = 610.8$ veh/h

Calculations for Percent Time Spent Following (PTSF)

6. Determine E_T (Truck passenger car equivalency factor)

$$
\mathrm{PCEs}(\mathrm{Terrain}, V) := \left|
\begin{array}{l}
\text{if Terrain} = 1 \\
\quad \left|
\begin{array}{l}
E_T \leftarrow 1.1 \ \text{ if } \ 0 \le V \le 300 \\
E_T \leftarrow 1.1 \ \text{ if } \ 300 < V \le 600 \\
E_T \leftarrow 1.0 \ \text{ if } \ V > 600 \\
E_R \leftarrow 1.0 \\
\text{out} \leftarrow \begin{pmatrix} E_T \\ E_R \end{pmatrix} \\
\text{out}
\end{array}
\right. \\
\text{if Terrain} = 2 \\
\quad \left|
\begin{array}{l}
E_T \leftarrow 1.8 \ \text{ if } \ 0 \le V \le 300 \\
E_T \leftarrow 1.5 \ \text{ if } \ 300 < V \le 600 \\
E_T \leftarrow 1.0 \ \text{ if } \ V > 600 \\
E_R \leftarrow 1.0 \\
\text{out} \leftarrow \begin{pmatrix} E_T \\ E_R \end{pmatrix} \\
\text{out}
\end{array}
\right. \\
\text{out}
\end{array}
\right.
$$

From Exhibit 20-10
HCM 2000

$$\mathrm{PCEs}(\mathrm{Terrain}, V) = \begin{pmatrix} 1.0 \\ 1.0 \end{pmatrix}$$

$$E_T := \mathrm{PCEs}(\mathrm{Terrain}, V)_1 \qquad E_T = 1.0$$

$$E_R := \mathrm{PCEs}(\mathrm{Terrain}, V)_2 \qquad E_R = 1.0$$

7. Calculate heavy vehicle factor (f_{HV})

$$f_{HV} := \frac{1}{1 + P_T \cdot (E_T - 1)}$$

Equation 20-4
HCM 2000

$$f_{HV} = 1$$

8. Determine grade adjustment factor (f_G)

$$f_G(\text{Terrain}, V) := \left| \begin{array}{l} \text{if Terrain} = 1 \\ \quad \left| \begin{array}{l} f_G \leftarrow 1.0 \\ out \leftarrow f_G \\ out \end{array} \right. \\ \text{if Terrain} = 2 \\ \quad \left| \begin{array}{l} f_G \leftarrow 0.77 \ \text{ if } 0 \le V \le 300 \\ f_G \leftarrow 0.94 \ \text{ if } 300 < V \le 600 \\ f_G \leftarrow 1.0 \ \text{ if } V > 600 \\ out \leftarrow f_G \\ out \end{array} \right. \\ out \end{array} \right.$$

From Exhibit 20-8
HCM 2000

$f_G(\text{Terrain}, V) = 1$ $\quad f_G := f_G(\text{Terrain}, V)$ $\quad f_G = 1.0$

9. Calculate forward direction volume (v_d)

$$v_d := \frac{V}{PHF \cdot f_G \cdot f_{HV}}$$

Equation 20-12
HCM 2000

Since the PHF was already accounted for in Step 5, the following equation is used:

$$v_d := \frac{AdjVol}{f_G \cdot f_{HV}}$$

$v_d = 610.8$ pc/hr

Check this value against flow range used for Exhbits 20-10 and 20-8, and repeat steps 6 through 9 as necessary.

10. Calculate opposing direction volume (v_o).

$$v_o := \frac{V_o}{PHF \cdot f_G \cdot f_{HV}}$$

From Equation 20-13
HCM 2000

The "equivalent" is performed by the following equation:

$$v_o := \frac{v_d \cdot (1 - D)}{D}$$

$v_o = 499.7$

f_G and f_{HV} are not currently accounted for in the determination of v_o as they are in the HCM 2000 methodology. Additionally, the PHF is assumed to be the same in the off-peak direction.

11. Determine values of coefficients 'a' and 'b' for HCM Equation 20-17

Look up values from HCM Exhibit 20-21 (linear interpolation if necessary).

Input:

v_o is rounded to the nearest 10 veh/h.

$v_{o\_rd} := \text{round}(v_o, -1)$ $\quad v_{o\_rd} = 500$ pc/hr

From Exhibit, for v_o = 400; $\quad a_1 := -0.0022$ $\quad b_1 := 0.923$

From Exhibit, for v_o = 600; $\quad a_2 := -0.0033$ $\quad b_2 := 0.870$

From Exhibit 20-21 HCM 2000 (per NCHRP 20-7 revisions)

Interpolation:

$$a := a_1 + (v_{o\_rd} - 400) \cdot \left(\frac{a_1 - a_2}{400 - 600} \right)$$

$a = -0.0028$

$$b := b_1 + (v_{o\_rd} - 400) \cdot \frac{b_1 - b_2}{400 - 600}$$

$b = 0.8965$

12. Calculate base percent time spent following (BPTSF)

$$BPTSF_d := 100 \cdot \left(1 - e^{a \cdot v_d^{\,b}}\right)$$

Equation 20-17 HCM 2000

$BPTSF_d = 57.9$

13. Determine adjustment for % no-passing zones in analysis direction (f_{np}) for HCM Equation

20-16

Look up value from HCM Exhibit 20-20 (linear interpolation if necessary, by both volume and percent no-passing zone).

Input:

$PostedSpeed = 50$ $\%NPZ = 60$ $v_o = 499.7$

$FFS := PostedSpeed + 5$

$FFS = 55$

Interpolation:

$v_p := v_d + v_o$ $v_p = 1110$

$$f_{np} := 41.3 + (v_p - 800)\cdot\left(\frac{41.3 - 25.8}{800 - 1400}\right)$$

$f_{np} = 33.3$

From Exhibit 20-20 HCM 2000 (per NCHRP 20-7 revisions)

14. Calculate percent time spent following (PTSF)

$$PTSF_d := BPTSF_d + f_{np}\cdot\left(\frac{v_d}{v_p}\right)$$

$PTSF_d = 76.2$

Equation 20-16 HCM 2000 (per NCHRP 20-7 revisions)

Procedure if passing lanes are present

See separate example document.

Calculations for Average Travel Speed (ATS)

6. Determine E_T (Truck passenger car equivalency factor)

$$
\mathrm{PCEs}(\mathrm{Terrain}, V) :=
\begin{array}{|l}
\text{if Terrain} = 1 \\
\quad \begin{array}{|l}
E_T \leftarrow 1.7 \text{ if } 0 \le V \le 300 \\
E_T \leftarrow 1.2 \text{ if } 300 < V \le 600 \\
E_T \leftarrow 1.1 \text{ if } V > 600 \\
E_R \leftarrow 1.0 \\
\text{out} \leftarrow \begin{pmatrix} E_T \\ E_R \end{pmatrix} \\
\text{out}
\end{array} \\
\text{if Terrain} = 2 \\
\quad \begin{array}{|l}
E_T \leftarrow 2.5 \text{ if } 0 \le V \le 300 \\
E_T \leftarrow 1.9 \text{ if } 300 < V \le 600 \\
E_T \leftarrow 1.5 \text{ if } V > 600 \\
E_R \leftarrow 1.1 \\
\text{out} \leftarrow \begin{pmatrix} E_T \\ E_R \end{pmatrix} \\
\text{out}
\end{array} \\
\text{out}
\end{array}
$$

From Exhibit 20-9
HCM 2000

$$\mathrm{PCEs}(\mathrm{Terrain}, V) = \begin{pmatrix} 1.5 \\ 1.1 \end{pmatrix}$$

$E_T := \mathrm{PCEs}(\mathrm{Terrain}, V)_1$ $\quad E_T = 1.5$

$E_R := \mathrm{PCEs}(\mathrm{Terrain}, V)_2$ $\quad E_R = 1.1$

7. Calculate heavy vehicle factor (f_{HV})

$$f_{HV} := \frac{1}{1 + P_T \cdot (E_T - 1)}$$

Equation 20-4
HCM 2000

$f_{HV} = 0.98$

8. Determine grade adjustment factor (f_G)

$$f_G(\mathrm{Terrain}, V) := \begin{array}{|l} \text{if Terrain} = 1 \\ \quad \begin{array}{|l} f_G \leftarrow 1.0 \\ out \leftarrow f_G \\ out \end{array} \\ \text{if Terrain} = 2 \\ \quad \begin{array}{|l} f_G \leftarrow 0.71 \quad \text{if } 0 \le V \le 300 \\ f_G \leftarrow 0.93 \quad \text{if } 300 < V \le 600 \\ f_G \leftarrow 0.99 \quad \text{if } V > 600 \\ out \leftarrow f_G \\ out \end{array} \\ out \end{array}$$

From Exhibit 20-7
HCM 2000

$f_G(\mathrm{Terrain}, V) = 0.99$ $\qquad f_G := f_G(\mathrm{Terrain}, V)$ $\qquad f_G = 0.99$

9. Calculate forward direction volume (v_d)

$$v_d := \frac{V}{PHF \cdot f_G \cdot f_{HV}}$$

Equation 20-12
HCM 2000

Since the PHF was already accounted for in Step 5, the following equation is used:

$$v_d := \frac{AdjVol}{f_G \cdot f_{HV}}$$

$v_d = 629.3$ pc/h

Check this value against flow range used for Exhbits 20-10 and 20-8, and repeat steps 6 through 9 as necessary.

10. Calculate opposing direction volume (v_o)

$$v_o := \frac{V_o}{PHF \cdot f_G \cdot f_{HV}}$$

Equation 20-13
HCM 2000

The "equivalent" is performed by the following equation:

$$v_o := \frac{v_d \cdot (1 - D)}{D}$$

$v_o = 514.9$ pc/h

f_G and f_{HV} are not currently accounted for in the determination of v_o as they are in the HCM 2000 methodology. Additionally, the PHF is assumed to be the same in the off-peak direction.

11. Determine adjustment for % no-passing zones in analysis direction (f_{np}) for HCM Equation 20-15

Look up value from HCM Exhibit 20-19 (linear interpolation if necessary, by both volume and percent no-passing zone).

Input:

$PostedSpeed = 50$ $\%NPZ = 60$ $v_o = 514.9$

$FFS := PostedSpeed + 5$

$FFS = 55$

Interpolation:

This example only calls for interpolation by volume,

$$f_{np} := 2.4 + (v_o - 400)\cdot\left(\frac{2.4 - 1.6}{400 - 600}\right)$$

$f_{np} = 1.94$

12. Calculate average travel speed (ATS)

Input:

$FFS_d := FFS$ $FFS_d = 55$ from inputs

$v_d = 629.3$ from step 9

$v_o = 514.9$ from step 10

$f_{np} = 1.94$ from step 11

Calculation:

$$ATS_d := FFS_d - 0.00776\cdot(v_d + v_o) - f_{np}$$

Equation 20-5
HCM 2000

$ATS_d = 44.2$ mi/h

Procedure if passing lanes are present

See separate example document.

Service Volumes

See separate example document.

Determine Level of Service

$$
\mathrm{Los}(\mathrm{Class},\mathrm{PTSF},\mathrm{ATS},\mathrm{FFS}) := \left|
\begin{array}{l}
\text{if Class} = 1 \\
\quad \left|
\begin{array}{l}
\mathrm{out}_1 \leftarrow \text{"A"} \quad \text{if } \mathrm{PTSF} \le 35 \\
\mathrm{out}_1 \leftarrow \text{"B"} \quad \text{if } 35 < \mathrm{PTSF} \le 50 \\
\mathrm{out}_1 \leftarrow \text{"C"} \quad \text{if } 50 < \mathrm{PTSF} \le 65 \\
\mathrm{out}_1 \leftarrow \text{"D"} \quad \text{if } 65 < \mathrm{PTSF} \le 80 \\
\mathrm{out}_1 \leftarrow \text{"E"} \quad \text{if } \mathrm{PTSF} > 80 \\
\mathrm{out}_2 \leftarrow \text{"A"} \quad \text{if } \mathrm{ATS} > 55 \\
\mathrm{out}_2 \leftarrow \text{"B"} \quad \text{if } 50 < \mathrm{ATS} \le 55 \\
\mathrm{out}_2 \leftarrow \text{"C"} \quad \text{if } 45 < \mathrm{ATS} \le 50 \\
\mathrm{out}_2 \leftarrow \text{"D"} \quad \text{if } 40 < \mathrm{ATS} \le 45 \\
\mathrm{out}_2 \leftarrow \text{"E"} \quad \text{if } \mathrm{ATS} \le 40 \\
\mathrm{out} \leftarrow \begin{pmatrix} \mathrm{out}_1 \\ \mathrm{out}_2 \end{pmatrix}
\end{array}
\right. \\
\text{if Class} = 2 \\
\quad \left|
\begin{array}{l}
\mathrm{out} \leftarrow \text{"A"} \quad \text{if } \mathrm{PTSF} \le 40 \\
\mathrm{out} \leftarrow \text{"B"} \quad \text{if } 40 < \mathrm{PTSF} \le 55 \\
\mathrm{out} \leftarrow \text{"C"} \quad \text{if } 55 < \mathrm{PTSF} \le 70 \\
\mathrm{out} \leftarrow \text{"D"} \quad \text{if } 70 < \mathrm{PTSF} \le 85 \\
\mathrm{out} \leftarrow \text{"E"} \quad \text{if } \mathrm{PTSF} > 80 \\
\mathrm{out}
\end{array}
\right. \\
\text{if Class} = 3 \\
\quad \left|
\begin{array}{l}
\mathrm{out} \leftarrow \text{"A"} \quad \text{if } \dfrac{\mathrm{ATS}}{\mathrm{FFS}} > 0.917 \\
\mathrm{out} \leftarrow \text{"B"} \quad \text{if } 0.833 < \dfrac{\mathrm{ATS}}{\mathrm{FFS}} \le 0.917 \\
\mathrm{out} \leftarrow \text{"C"} \quad \text{if } 0.750 < \dfrac{\mathrm{ATS}}{\mathrm{FFS}} \le 0.833
\end{array}
\right.
\end{array}
\right.
$$

From Exhibit 20-2
HCM 2000

From Exhibit 20-4
HCM 2000

$$
\left|\;\begin{array}{l}
\left|\;\begin{array}{l}
out \leftarrow \text{"D"} \quad \text{if } 0.667 < \dfrac{ATS}{FFS} \le 0.750 \\
out \leftarrow \text{"E"} \quad \text{if } 0.583 < \dfrac{ATS}{FFS} \le 0.667 \\
out \leftarrow \text{"F"} \quad \text{if } \dfrac{ATS}{FFS} \le 0.583 \\
out
\end{array}\right. \\
out
\end{array}\right.
$$

$$
\mathrm{Los}\left(\mathrm{Class}, \mathrm{PTSF}_d, \mathrm{ATS}_d, \mathrm{FFS}\right) = \begin{pmatrix} \text{"D"} \\ \text{"D"} \end{pmatrix}
$$

If Class 1, the LOWER LOS GOVERNS

HIGHPLAN Computational Methodology

Version 2.0.0 (updated 7/21/2006)

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Methodology When Passing Lane is Included (based on Sample Problem 1)

$ORIGIN \equiv 1$

1. Input Roadway and Traffic Data.

Roadway Variables

$PassingLaneSpacing := 2$ mi

$L_u := 0 \quad L_{pl} := 1$ FDOT default values

Traffic Variables

$DirFlowRate := 610.8$ veh/h calculated previously, v_d, Directional Flow Rate
Step 9, Example 3

2. Determine the Downstream Length of Roadway Affected by Passing Lanes on Directional Segments (for Level or Rolling Terrain)

L_{de} = Downstream Length of Affected Roadway, in miles

Interpolation:

$v_d := DirFlowRate$

$$L_{de1} := 8.1 + (v_d - 400)\cdot\frac{5.7 - 8.1}{700 - 400}$$ $L_{de1} = 6.414$ PTSF From Exhibit 20-23 HCM 2000

$L_{de2} := 1.7$ ATS

3. Determine the Factors for Estimation of Average Travel Speed and Percent Time Spent Following within a Passing Lane.

Calculations:

$$f_{pl}(DirFlowRate) := \begin{array}{|l} \text{if } 0 \le DirFlowRate < 300 \\ \quad \begin{array}{|l} out_1 \leftarrow 0.58 \\ out_2 \leftarrow 1.08 \end{array} \\ \text{if } 300 \le DirFlowRate < 600 \\ \quad \begin{array}{|l} out_1 \leftarrow 0.61 \\ out_2 \leftarrow 1.10 \end{array} \\ \text{if } DirFlowRate \ge 600 \\ \quad \begin{array}{|l} out_1 \leftarrow 0.62 \\ out_2 \leftarrow 1.11 \end{array} \\ out \leftarrow \begin{pmatrix} out_1 \\ out_2 \end{pmatrix} \\ out \end{array}$$

From Exhibit 20-24
HCM 2000

$$f_{pl}(DirFlowRate) = \begin{pmatrix} 0.62 \\ 1.11 \end{pmatrix}$$

$$f_{pl} := f_{pl}(DirFlowRate)$$

$$f_{pl} = \begin{pmatrix} 0.62 \\ 1.11 \end{pmatrix}$$

f_{pl} in miles for PTSF
f_{pl} in miles for ATS

4. Adjust Percent Time Spent Following for Passing Lanes

a. Calculate L_d, the length of the two-lane highway downstream of the passing lane and beyond its effective length (mi).

Calculations:

$$L_{d1} := PassingLaneSpacing - \left(L_u + L_{pl} + L_{de1}\right)$$

$L_{d1} = -5.414$ mi

b. Calculate PTSF using either Equation 20-19 or Equation 20-20 from HCM 2000

Input:

$PTSF_d := 76.2$ calculated previously, PTSF without passing lanes
Step 14, Example 3

Calculations:

$$PTSF_{pl}\left(L_{de1}, f_{pl}, L_{d1}\right) := \left| \begin{array}{l} \text{if } L_{d1} \geq 0 \\ \quad \left| \begin{array}{l} out \leftarrow \dfrac{PTSF_d \cdot \left[L_u + L_{d1} + f_{pl_1} \cdot L_{pl} + \left(\dfrac{1 + f_{pl}}{2}\right) \cdot L_{de1}\right]}{PassingLaneSpacing} \\ out \end{array} \right. \\ \text{if } L_{d1} < 0 \\ \quad \left| \begin{array}{l} out \leftarrow \dfrac{PTSF_d \cdot \left[L_u + f_{pl} \cdot L_{pl} + f_{pl} \cdot \left(L_{de1} + L_{d1}\right) + \left(\dfrac{1 - f_{pl}}{2}\right) \cdot \left[\dfrac{\left(L_{de1} + L_{d1}\right)^2}{L_{de1}}\right]\right]}{PassingLaneSpacing} \\ out \end{array} \right. \\ out \end{array} \right.$$

$$PTSF_{pl}\left(L_{de1}, f_{pl_1}, L_{d1}\right) = 48.4$$

4. Adjust Average Travel Speed for Passing Lanes

a. Calculate Ld, the length of the two-lane highway downstream of the passing lane and beyond its effective length (mi).

Calculations:

$$L_{d2} := PassingLaneSpacing - \left(L_u + L_{pl} + L_{de2}\right)$$

$$L_{d2} = -0.7$$

b. Calculate PTSF using either Equation 20-21 or Equation 20-22 from HCM 2000

Input:

$ATS_d := 44.2$	mi/h	calculated previously, ATS without passing lanes Step 12, Example 3

Calculations:

$$ATS_{pl}\left(L_{de2}, f_{pl}, L_{d2}\right) := \left| \begin{array}{l} \text{if } L_{d2} \geq 0 \\ \quad \left| \begin{array}{l} out \leftarrow \dfrac{ATS_d \cdot PassingLaneSpacing}{L_u + \dfrac{L_{pl}}{f_{pl}} + \dfrac{2 \cdot \left(L_{de2} + L_{d2}\right)}{1 + f_{pl} + \left(f_{pl} - 1\right) \cdot \left[\dfrac{L_{de2} \cdot \left(L_{de2} + L_{d2}\right)}{L_{de2}}\right]}} \\ out \end{array} \right. \\ \text{if } L_{d2} < 0 \\ \quad \left| \begin{array}{l} out \leftarrow \dfrac{ATS_d \cdot PassingLaneSpacing}{L_u + \dfrac{L_{pl}}{f_{pl}} + \dfrac{2 \cdot \left(L_{de2} + L_{d2}\right)}{1 + f_{pl} + \left(f_{pl} - 1\right) \cdot \dfrac{L_{de2} - \left(L_{de2} + L_{d2}\right)}{L_{de2}}}} \\ out \end{array} \right. \\ out \end{array} \right.$$

$$ATS_{pl}\left(L_{de2}, f_{pl_2}, L_{d2}\right) = 48.3$$

HIGHPLAN Computational Methodology

Version 2.0.0 (updated 7/21/2006)

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Application of the HIGHPLAN Computational Steps to a Multilane Highway Segment

Inputs and Initial Computations

1. Input Roadway and Traffic Data

Roadway Variables

$\text{AreaType} := 1$ 1 = Urbanized, 2 = Transitioning/Urban, 3 = Rural developed, 4 = Rural undeveloped

$\text{NumberofLanes} := 4$

$\text{PostedSpeed} := 45$ mi/hr

$\text{AnalysisType} := 0$ 0 = Segment, 1 = Facility

$\text{Median} := 0$ 0 = No, 1 = Yes

$\text{Terrain} := 2$ Level = 1, Rolling = 2

$\text{LeftTurnLane} := 0$ 0 = No, 1 = Yes

Traffic Variables

$\text{AADT} := 40000$

$\text{PercentHeavyVehicles} := 0.02$

$P_T := \text{PercentHeavyVehicles}$

$K := 0.095$

$\text{BaseCapacity} := 2000$

$D := 0.55$

$\text{LocalAdjustmentFactor} := 1.0$

$\text{LAF} := \text{LocalAdjustmentFactor}$

$\text{PHF} := 0.925$

2. Calculate DDHV (Design Directional Hour Volume)

$\text{DDHV} := \text{AADT}\cdot K\cdot D$

$\text{DDHV} = 2090$

3. Determine E_T (Truck passenger car equivalency factor)

$$\text{PCE}(\text{Terrain}) := \left| \begin{array}{l} \text{out} \leftarrow 1.5 \ \text{ if } \ \text{Terrain} = 1 \\ \text{out} \leftarrow 2.5 \ \text{ if } \ \text{Terrain} = 2 \\ \text{out} \end{array} \right.$$

From Exhibit 21-8
HCM 2000

$PCE(Terrain) = 2.5$ $E_T := PCE(Terrain)$ $E_T = 2.5$

4. Calculate heavy vehicle factor (f_{HV})

$$f_{HV} := \frac{1}{1 + P_T \cdot (E_T - 1)}$$

Equation 21-4
HCM 2000

$f_{HV} = 0.971$

5. Calculate Base Analysis Volume (v_p)

$$v_p := \frac{DDHV}{PHF \cdot \frac{NumberofLanes}{2} \cdot f_{HV} \cdot LAF}$$

Equation 21-3
HCM 2000

$v_p = 1163.6$ veh/h

6. Determine adjustment for the presence of a median and/or left turn lanes

Left Turn Lane Adjustment (LTadj) = -0.2 for left turn lanes NOT present, LTadj = 0 otherwise. Median Adjustment (MedAdj) = -0.05 for no median present, MedAdj = 0 otherwise. Note: The presence of a median, but no left turn lanes is not a valid option per FDOT guidance.

Left Turn Lane:

$$LTadj(LeftTurnLane) := \left| \begin{array}{l} out \leftarrow -0.2 \ \text{ if } \ LeftTurnLane = 0 \\ out \leftarrow 0 \ \text{ if } \ LeftTurnLane = 1 \\ out \end{array} \right.$$

$LTadj(LeftTurnLane) = -0.2$ $LTadj := LTadj(LeftTurnLane)$ $LTadj = -0.2$

Median:

$$MedAdj(Median) := \left| \begin{array}{l} out \leftarrow -0.05 \ \text{ if } \ Median = 0 \\ out \leftarrow 0 \ \text{ if } \ Median = 1 \\ out \end{array} \right.$$

$MedAdj(Median) = -0.05$ $MedAdj := MedAdj(Median)$ $MedAdj = -0.05$

Final Adjustment Value for Left Turn Lane and Median:

$AdjMedLTL := (1 + LTadj + MedAdj)$ $AdjMedLTL = 0.75$

7. Determine Facility Adjustment Factor (FacAdj)

FacAdj = 1.0 for Analysis Type = Segment

FacAdj = 0.9 for Analysis Type = Facility

$$\text{FacAdj(AnalysisType)} := \left| \begin{array}{l} \text{out} \leftarrow 1.0 \ \text{ if } \ \text{AnalysisType} = 0 \\ \text{out} \leftarrow 0.9 \ \text{ if } \ \text{AnalysisType} = 1 \\ \text{out} \end{array} \right.$$

$\text{FacAdj(AnalysisType)} = 1$ $\text{FacAdj} := \text{FacAdj(AnalysisType)}$ $\text{FacAdj} = 1$

8. Calculate Adjusted Analysis Volume (AdjVol)

$$\text{AdjVol} := \frac{v_p}{\text{AdjMedLTL} \cdot \text{FacAdj}}$$

$\text{AdjVol} = 1551.5$ veh/h $V := \text{AdjVol}$ $V = 1551.5$ veh/h

9. Determine Average Passenger Car Speed

$\text{FFS} := \text{PostedSpeed} + 5$

$\text{FFS} = 50$

Exhibit 21-3
HCM 2000

$$\text{Speed(FFS, AdjVol)} := \left| \begin{array}{l} \text{out} \leftarrow \text{FFS} \ \text{ if } \ \text{AdjVol} \le 1400 \\ \text{if } \ \text{AdjVol} > 1400 \\ \quad \left| \begin{array}{l} \text{out} \leftarrow \text{FFS} - \left(\frac{3}{10} \cdot \text{FFS} - 13\right) \cdot \left(\frac{\text{AdjVol} - 1400}{28 \cdot \text{FFS} - 880}\right)^{1.31} \ \text{ if } \ \text{FFS} > 55 \\ \text{out} \leftarrow \text{FFS} - \left(\frac{34}{205} \cdot \text{FFS} - \frac{219}{41}\right) \cdot \left(\frac{\text{AdjVol} - 1400}{\frac{171}{5} \cdot \text{FFS} - 1181}\right)^{1.31} \ \text{ if } \ 50 < \text{FFS} \le 55 \\ \text{out} \leftarrow \text{FFS} - \left(\frac{10}{43} \cdot \text{FFS} - \frac{350}{43}\right) \cdot \left(\frac{\text{AdjVol} - 1400}{33 \cdot \text{FFS} - 1050}\right)^{1.31} \ \text{ if } \ 45 < \text{FFS} \le 50 \\ \text{out} \leftarrow \text{FFS} - \left(\frac{1}{5} \cdot \text{FFS} - \frac{56}{9}\right) \cdot \left(\frac{\text{AdjVol} - 1400}{36 \cdot \text{FFS} - 1120}\right)^{1.31} \ \text{ if } \ \text{FFS} = 45 \end{array} \right. \end{array} \right.$$

$\text{Speed(FFS, AdjVol)} = 49.4$ $S := \text{Speed(FFS, AdjVol)}$ $S = 49.4$ mi/h

10. Calculate density

$$D := \frac{AdjVol}{S}$$

$D = 31.4$ pc/mi/ln

Equation 21-5
HCM 2000

Determine Level of Service

$$LOS(FFS, D) := \begin{array}{|l} \text{if } FFS \geq 60 \\ \quad \begin{array}{|l} out \leftarrow \text{"A"} \quad \text{if } D \leq 11 \\ out \leftarrow \text{"B"} \quad \text{if } 11 < D \leq 18 \\ out \leftarrow \text{"C"} \quad \text{if } 18 < D \leq 26 \\ out \leftarrow \text{"D"} \quad \text{if } 26 < D \leq 35 \\ out \leftarrow \text{"E"} \quad \text{if } 35 < D \leq 40 \\ out \leftarrow \text{"F"} \quad \text{if } D > 40 \end{array} \\ \text{if } 55 \leq FFS < 60 \\ \quad \begin{array}{|l} out \leftarrow \text{"A"} \quad \text{if } D \leq 11 \\ out \leftarrow \text{"B"} \quad \text{if } 11 < D \leq 18 \\ out \leftarrow \text{"C"} \quad \text{if } 18 < D \leq 26 \\ out \leftarrow \text{"D"} \quad \text{if } 26 < D \leq 35 \\ out \leftarrow \text{"E"} \quad \text{if } 35 < D \leq 41 \\ out \leftarrow \text{"F"} \quad \text{if } D > 41 \end{array} \\ \text{if } 50 \leq FFS < 55 \\ \quad \begin{array}{|l} out \leftarrow \text{"A"} \quad \text{if } D \leq 11 \\ out \leftarrow \text{"B"} \quad \text{if } 11 < D \leq 18 \\ out \leftarrow \text{"C"} \quad \text{if } 18 < D \leq 26 \\ out \leftarrow \text{"D"} \quad \text{if } 26 < D \leq 35 \\ out \leftarrow \text{"E"} \quad \text{if } 35 < D \leq 43 \\ out \leftarrow \text{"F"} \quad \text{if } D > 43 \end{array} \\ \text{if } 45 \leq FFS < 50 \\ \quad \begin{array}{|l} out \leftarrow \text{"A"} \quad \text{if } D \leq 11 \\ out \leftarrow \text{"B"} \quad \text{if } 11 < D \leq 18 \\ out \leftarrow \text{"C"} \quad \text{if } 18 < D \leq 26 \\ out \leftarrow \text{"D"} \quad \text{if } 26 < D \leq 35 \\ out \leftarrow \text{"E"} \quad \text{if } 35 < D \leq 45 \\ out \leftarrow \text{"F"} \quad \text{if } D > 45 \end{array} \end{array}$$

From Exhibit 21-2
HCM 2000

$LOS(FFS, D) = \text{"D"}$