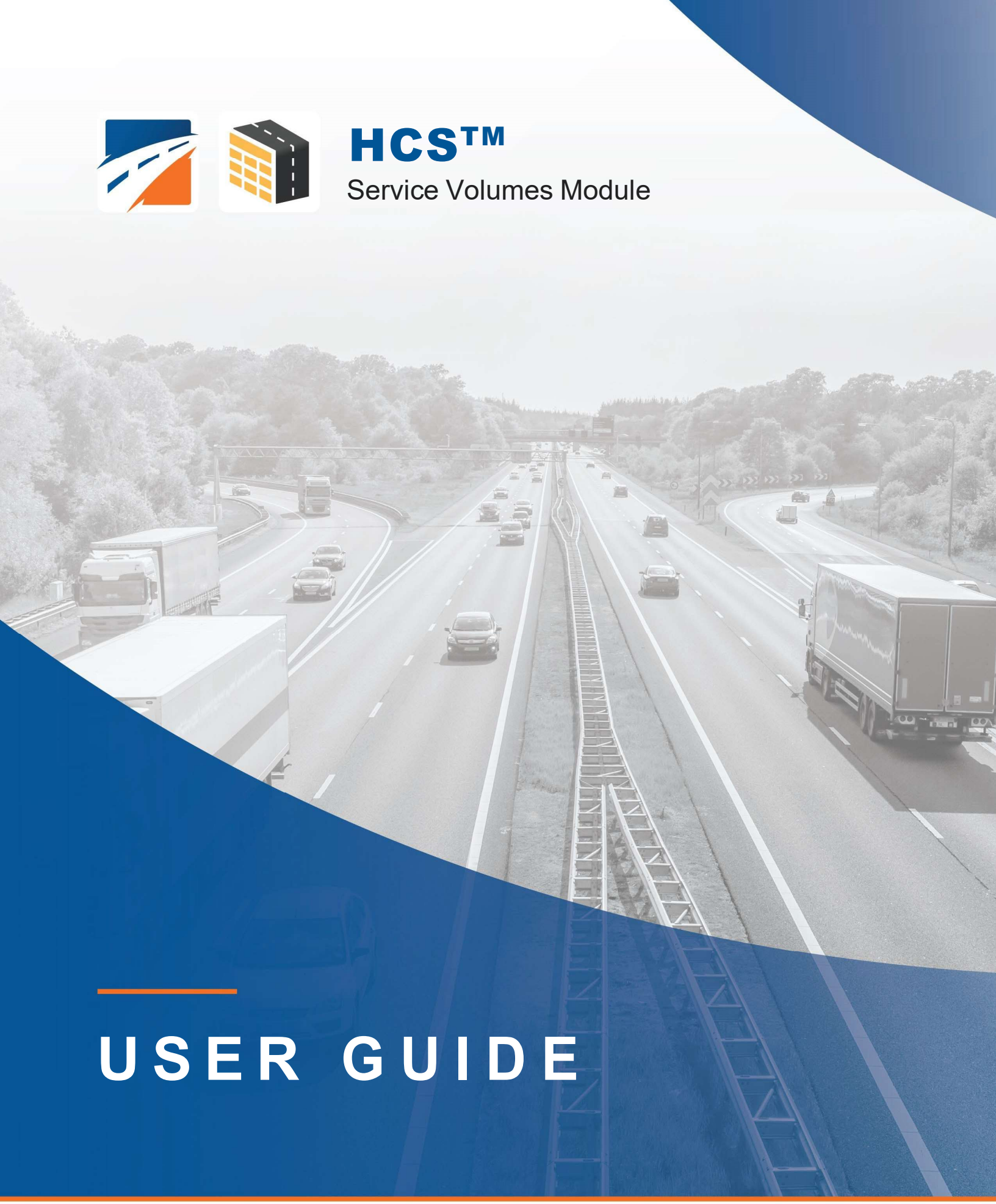
HCS™

Service Volumes Module



USER GUIDE

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Introduction

License Agreement

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Acknowledgements

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We acknowledge the Transportation Research Board (TRB), the USDOT's Federal Highway Administration (FHWA), the American Traffic Safety Services Association (ATSSA), the Institute of Transportation Engineers (ITE), and the American Association of State Highway and Transportation Officials (AASHTO) for all text, figures, and references included in HCS and express our sincere appreciation for permission to include this information.

Trademarks and Copyrights

Getting Started

System Requirements

HCS is designed for standard Windows installations. For optimal performance, the system should be Windows 10 or newer. While HCS may be compatible with older versions of Windows, any installation and operational issues arising from using these older versions will be the sole responsibility of the end user.

Getting Started

To begin, click on File then New (or the "New File…" button on the Start page).

Normal Windows keyboard and mouse functions are available. Tabbing, clicking to a new field, or pressing the Enter key will trigger a recalculation and update the report.

General Controls

Menu Items

New – Creates a new Service Volumes file (*.xsv) and starts a new analysis project; shortcut is Ctrl+N

> **Basic Freeway Segment** – Creates a new Service Volumes file (*.xsv) and starts a new Basic Freeway Segment analysis project
>
> **Multilane Highway Segment** – Creates a new Service Volumes file (*.xsv) and starts a new Multilane Highway Segment analysis project
>
> **Merge Freeway Segment** – Creates a new Service Volumes file (*.xsv) and starts a new Merge Freeway Segment analysis project
>
> **Diverge Freeway Segment** – Creates a new Service Volumes file (*.xsv) and starts a new Diverge Freeway Segment analysis project
>
> **Weaving Freeway Segment** – Creates a new Service Volumes file (*.xsv) and starts a new Weaving Freeway Segment analysis project

Open – Opens an existing Service Volumes file (*.xsv) or Freeways file (*.xuf); shortcut is Ctrl+O

Example Folder – Opens folder with all HCS examples in File Explorer

Save – Saves an open Service Volumes file (*.xsv) using the current file name; shortcut is Ctrl+S

Save As… – Saves an open Service Volumes file (*.xsv) using a specified file name; shortcut is F12

Close – Closes an existing Service Volumes file (*.xsv); shortcut is Ctrl+W

Units

> **USC Units** – Changes the units of the current file to U.S. Customary
>
> **Metric Units** – Changes the units of the current file to Metric

Print – Brings up printer selection and prints a Service Volumes report to the printer or specified file type; shortcut is Ctrl+P

Print Preview – Displays preview of current report before printing; shortcut is Ctrl+F2

View

> **Page View** – Changes the view to display inputs and report by pages; shortcut is F9
>
> **Full View**
>
> > **Report -> Right** – Changes the view to display both the input screen and report simultaneously; the report is displayed on the right portion of the screen; shortcut is F10
> >
> > **Report -> Bottom** – Changes the view to display both the input screen and report simultaneously; the report is displayed on the bottom portion of the screen; shortcut is F11

Report

> **Formatted Report** – Displays formatted report including the most important values; shortcut is F4
>
> **Text Report** – Displays text report with input, intermediary, and final results; shortcut is F6

Default Settings – Opens a dialog box for the user to input defaults for Analyst, Agency, and Jurisdiction, which will be applied to all new files; also allows selection of USC or SI units, which will be applied to all new files; shortcut is Alt+F

Help

Contents – Provides access to glossary, acknowledgements, copyrights, and information on the HCM procedures; shortcut is Ctrl+F1

Index – Allows user to search keywords within the glossary

Search – Allows the user to search for any word within the glossary

User Guide – Opens a comprehensive user guide in PDF format; shortcut is Ctrl+G

HCM Reference Guide – Opens a reference guide for the HCM in PDF format

HCS Updates – Sends the HCS version number anonymously without any personally identifiable information to McTrans to check for a newer version

HCM/HCS Training – Opens the McTrans Training Page in the default web browser to view the latest training opportunities

HCQS Web Page – Opens the TRB Highway Capacity and Quality of Service Committee page in the default web browser

Support

Frequently Asked Questions – Opens the McTrans support page for HCS in the default web browser

HCS Overview – Opens the McTrans HCS Overview page in the default web browser

McTrans Website – Opens the McTrans home page in the default web browser

E-mail McTrans – Composes a new e-mail addressed to McTrans in the default e-mail client with registration number, serial key, module, and version number already populated in the Subject field

About HCS – Opens an about window with software version information, EULA, general acknowledgements, contact information, and other relevant links

Exit – Exits the *HCS* Service Volumes module; shortcut is Alt+F4

Service Volumes

HCM Chapter 12

The Highway Capacity Software (*HCS*) faithfully implements the methodology prescribed in the Highway Capacity Manual (HCM) for analyzing Basic Freeway and Multilane Highway Segments. These segments are outside the influence of merging, diverging, and weaving maneuvers. In the case of multilane highways, they are also outside the influence of signalized intersections.

PLANNING AND PRELIMINARY ENGINEERING ANALYSIS

A frequent objective of planning or preliminary engineering analysis is to develop a general idea of the number of lanes that will be required to deliver a target LOS. The primary differences are that many default values will be used and the demand volume will be usually expressed as an AADT. Thus, a planning and preliminary engineering analysis starts by converting the demand expressed as an AADT to an estimate of the directional peak-hour demand volume (DDHV):

$$V = DDHV = AADT \times K \times D$$

where K is the proportion of AADT occurring during the peak hour and D is the proportion of peak-hour volume traveling in the peak direction.

Once the hourly demand volume is estimated, the methodology follows the same path as that for design analysis. Additional details and discussion on planning applications can be found in the *Planning and Preliminary Engineering Applications Guide to the HCM* in Volume 4.

HCM Chapter 13

The Highway Capacity Software (*HCS*) faithfully implements the methodology prescribed in the Highway Capacity Manual (HCM) for analyzing Freeway Weaving Segments.

SERVICE VOLUMES AND SERVICE FLOW RATES

The methodology uses demand volumes in vehicles per hour converted to demand flow rates in passenger cars per hour. Therefore, service flow rates and service volumes would originally be estimated in terms of flow rates in passenger cars per hour. They would then be converted back to demand volumes in vehicles per hour.

Service volumes and service flow rates for weaving segments are stated in terms of the maximum volume (or flow) levels that can be accommodated without violating the definition of the LOS. The volume ratio, the proportion of total traffic that weaves, is held constant. Any change in the volume ratio would cause a change in all service volumes or service flow rates.

A large number of characteristics will influence service volumes and service flow rates, including the PHF, percent heavy vehicles, and any of the weaving segment's geometric attributes. Therefore, the definition of a representative "typical" case with broadly applicable results is virtually impossible. Each base must be individually considered.

HCM Chapter 14

The Highway Capacity Software (*HCS*) faithfully implements the methodology prescribed in the Highway Capacity Manual (HCM) for analyzing Freeway Merge and Diverge Segments.

SERVICE VOLUMES AND SERVICE FLOW RATES

For ramp-freeway junctions, service flow rate or service volumes could be defined in several ways. It might be argued that since ramp-freeway junction capacities are usually limited by the upstream or downstream freeway segment, service flow rates and service volumes should be based on basic freeway criteria applied to the upstream or downstream freeway segments. This, however, would ignore the levels of service defined for the ramp influence area, which are the only unique service descriptors for ramps.

Levels of service for ramp-freeway junctions related to the density within the ramp influence area. The methodology estimates this density by using a series of algorithms affected by demand flows on the freeway, ramp, and adjacent ramps; ramp geometrics; and distances to adjacent ramps. The methodology uses demand volumes in vehicles per hour converted to demand flow rates in passenger cars per hour. Therefore, service flow rates and service volumes would originally be estimated in terms of flow rates in passenger cars per hour. They would then be converted back to demand volumes per hour.

Because the balance of ramp and freeway demands has a significant impact on densities, there are several ways to consider service flow rates and volumes:

- The limiting total upstream demand volume that produces a given LOS within the ramp influence area. The split between arriving freeway volume and ramp volume would have to be specified.
- The limiting volume entering the ramp influence area that produces a given LOS within the ramp influence area. Since this relies on the approaching freeway volume, the split between freeway and ramp demand would still have to be specified.
- The limiting ramp volume that produces a given LOS within the ramp influence area, based on a fixed upstream freeway demand.

All of these concepts are viable for establishing a ramp service flow rate or service volume.

In addition to different ways of interpreting a service volume or service flow rate, a large number of characteristics will influence the result, including the PHF, percentage of heavy vehicles, length of acceleration or deceleration lane(s), ramp FFS, and any relevant data for adjacent ramps. Therefore, defining a representative “typical” case with broadly applicable results is virtually impossible. Each case must be individually considered.

Service Volumes Data

Project Properties

The Project Properties section provides fields for both general and site information. The general information can be entered into the respective fields: Analyst, Agency, Date, and Time Analyzed. The site information can be entered into the respective fields: Jurisdiction, Analysis Year, and Project Description.

Geometric Data

For both basic freeway and multilane highway segments, the number of lanes in the analysis direction is entered. The user chooses the type of Terrain (Level, Rolling, or Specific Grade). If Specific Grade is chosen, fields for Percent Grade and Grade Length will enable for the user to change.

For both merge and diverge freeway segments, the number of lanes, Free-Flow Speed, and Terrain Type are entered for both the freeway and the ramp. If Specific Grade is chosen for Terrain Type, then Percent Grade and Grade Length will enable for the user to change. Freeway Length, Ramp Side, the lengths of acceleration/deceleration lanes, and indication of a Highway or C-D Roadway. Calculation Approaches is specified for merge freeway segments.

For weaving freeway segments, the number of lanes in the analysis direction is entered. The user chooses the type of Terrain (Level, Rolling, or Specific Grade). If Specific Grade is chosen, fields for Percent Grade and Grade Length will enable for the user to change. Free-Flow Speed, Weaving Configuration, Number of Maneuver Lanes, Short Length, Interchange Density, Minimum Freeway-to-Ramp Lane Changes, Minimum Ramp-to-Freeway Lane Changes, and Minimum Ramp-to-Ramp Lane Changes can also be entered.

Demand Data

For basic freeway, multilane highway, and weaving freeway segments, Target LOS, Peak Hour Factor, Total Trucks, Percent Single-Unit Trucks, Percent Tractor-Trailers, *K*-factor, and *D*-factor are included as inputs. Basic freeway and freeway weaving segments allow input of Proportion of CAVs. Freeway weaving segments also require the Percent of Ramp-to-Freeway Flow, Percent of Ramp-to-Ramp Flow, and Percent of Freeway-to-Ramp Flow.

For both merge and diverge freeway segments, Target LOS, *K*-Factor, *D*-Factor, and Proportion of CAVs are specified. Peak Hour Factor, Total Trucks, Single-Unit Trucks, Tractor-Trailers, Driver Population, and Proportion of On-./Off-Ramp Demand can be entered for both the freeway and the ramp. Proportion of Flow in Lane 1 and 2 can also be entered for merge freeway segments.

Maximum Service Flow Rates

The maximum service flow rate (MSF) is determined by the target LOS specified. The exhibits below provide values from the base speed-flow curves of the HCM exhibits for each LOS. When using these exhibits, the FFS should be rounded to the nearest 5 mi/h and no interpolation is permitted.

Maximum Service Flow Rates for Basic Freeway Segments under Base Conditions:

FFS (mi/h)	Maximum Service Flow Rates for Target LOS (pc/h/ln)				
	A	B	C	D	E
75	820	1,310	1,750	2,110	2,400
70	770	1,250	1,690	2,080	2,400
65	710	1,170	1,630	2,030	2,350
60	660	1,080	1,560	2,010	2,300
55	600	990	1,430	1,900	2,250

Note: All values rounded to the nearest 10 pc/h/ln.

Maximum Service Flow Rates for Multilane Highway Segments under Base Conditions:

FFS (mi/h)	Maximum Service Flow Rates for Target LOS (pc/h/ln)				
	A	B	C	D	E
60	660	1,080	1,550	1,980	2,200
55	600	990	1,430	1,850	2,100
50	550	900	1,300	1,710	2,000
45	290	810	1,170	1,550	1,900

Note: FFS is measured in kilometers per hour for metric units.

Basic Freeway Service Volumes Report

The report page shows a formatted report version of the analysis in dynamic form, reacting to changes in the Basic page. All or a portion can be copied to the Windows clipboard for insertion into other files by right-clicking into the report and selecting Copy.

Both formatted and text reports are available for viewing and printing. The formatted report provides data and results that most important to the user, and are displayed in a clean and more presentable fashion. The text report provides more details to the user, rather than a summary.

The user can switch between reports by clicking on the button found at the bottom of the Report page or by using the menu items or shortcuts.

Multilane Highway Service Volumes Report

The report page shows a formatted report version of the analysis in dynamic form, reacting to changes in the Multilane page. All or a portion can be copied to the Windows clipboard for insertion into other files by right-clicking into the report and selecting Copy.

Both formatted and text reports are available for viewing and printing. The formatted report provides data and results that most important to the user, and are displayed in a clean and more presentable fashion. The text report provides more details to the user, rather than a summary.

The user can switch between reports by clicking on the button found at the bottom of the Report page or by using the menu items or shortcuts.

Freeway Merge Service Volumes Report

The report page shows a formatted report version of the analysis in dynamic form, reacting to changes in the Merge page. All or a portion can be copied to the Windows clipboard for insertion into other files by right-clicking into the report and selecting Copy.

Both formatted and text reports are available for viewing and printing. The formatted report provides data and results that most important to the user, and are displayed in a clean and more presentable fashion. The text report provides more details to the user, rather than a summary.

The user can switch between reports by clicking on the button found at the bottom of the Report page or by using the menu items or shortcuts.

Freeway Diverge Service Volumes Report

The report page shows a formatted report version of the analysis in dynamic form, reacting to changes in the Diverge page. All or a portion can be copied to the Windows clipboard for insertion into other files by right-clicking into the report and selecting Copy.

Both formatted and text reports are available for viewing and printing. The formatted report provides data and results that most important to the user, and are displayed in a clean and more presentable fashion. The text report provides more details to the user, rather than a summary.

The user can switch between reports by clicking on the button found at the bottom of the Report page or by using the menu items or shortcuts.

Freeway Weaving Service Volumes Report

The report page shows a formatted report version of the analysis in dynamic form, reacting to changes in the Weaving page. All or a portion can be copied to the Windows clipboard for insertion into other files by right-clicking into the report and selecting Copy.

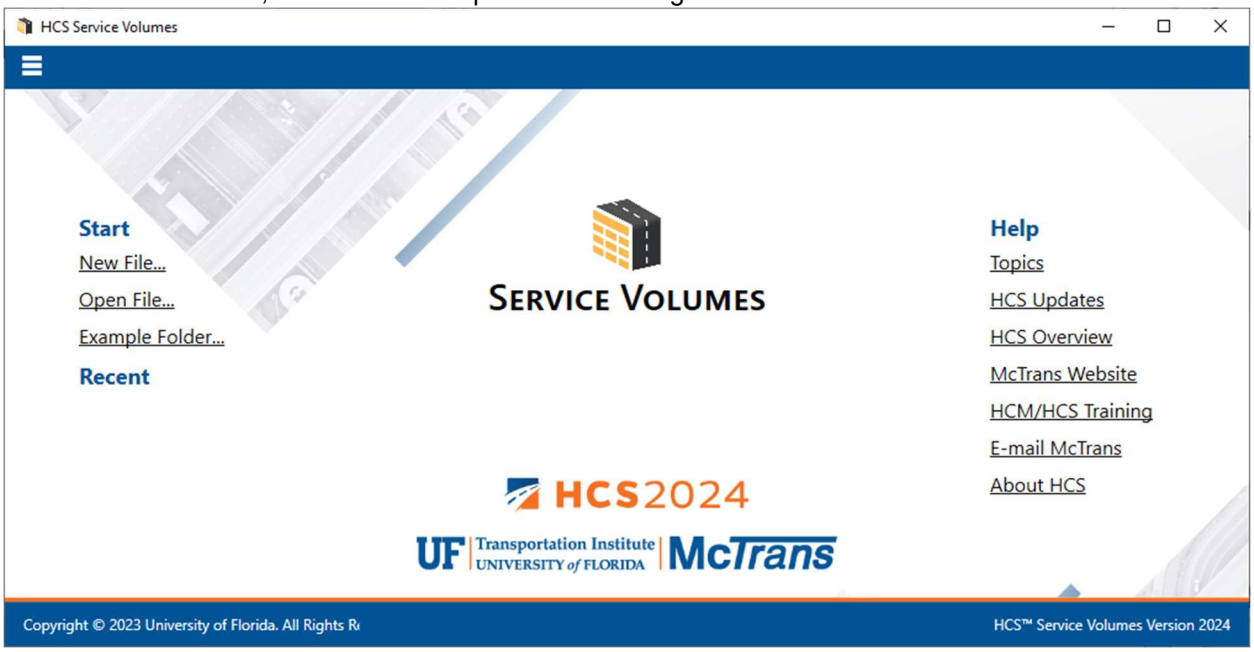
Both formatted and text reports are available for viewing and printing. The formatted report provides data and results that most important to the user, and are displayed in a clean and more presentable fashion. The text report provides more details to the user, rather than a summary.

The user can switch between reports by clicking on the button found at the bottom of the Report page or by using the menu items or shortcuts.

How To

Create a New File

1. From the Start screen, there are three options for creating a new file:

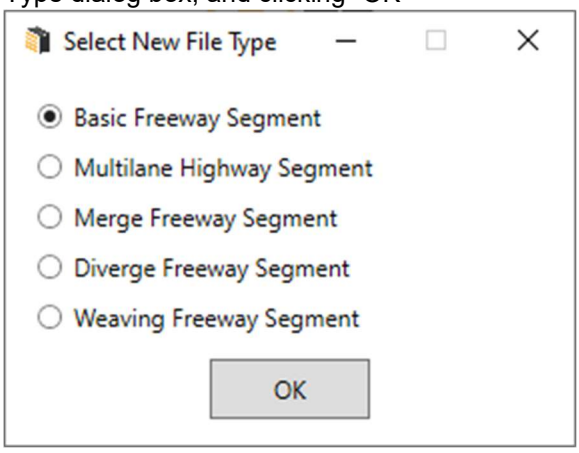


Note: A new file can be created if an existing file is already open; you do not need to start from the Start screen.

a. Selecting *File* > *New* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over “New”, and then selecting one of the analysis types.

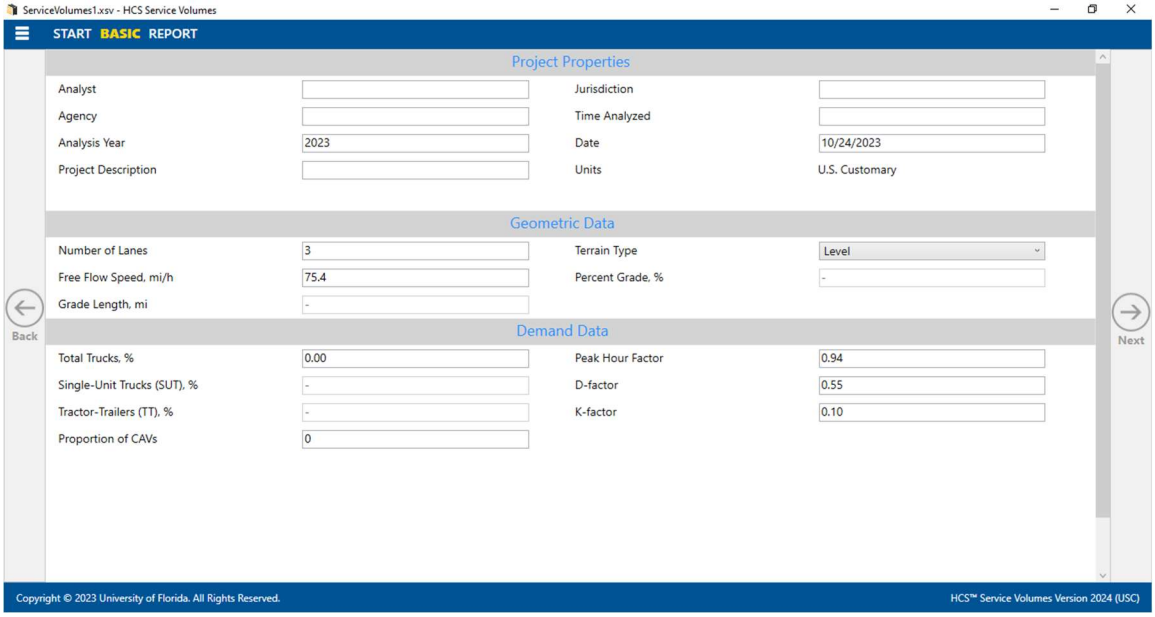
b. Selecting “New File…” from the Start screen; this can be found below in the red box. A Select New File Type dialog box will pop up after selecting “New File…” which allows you to choose the desired analysis type.

c. Using the keyboard shortcut “Ctrl+N”, selecting one of the analysis types from the Select New File Type dialog box, and clicking “OK”



2. Once a new file is created, you will be brought to the input page of the selected analysis type if in Page View or the input screen split with the report either on the right or the bottom of the screen if in Full View.

a. Page View



i. If Basic Freeway Segment was selected, you will be brought to the Basic page.

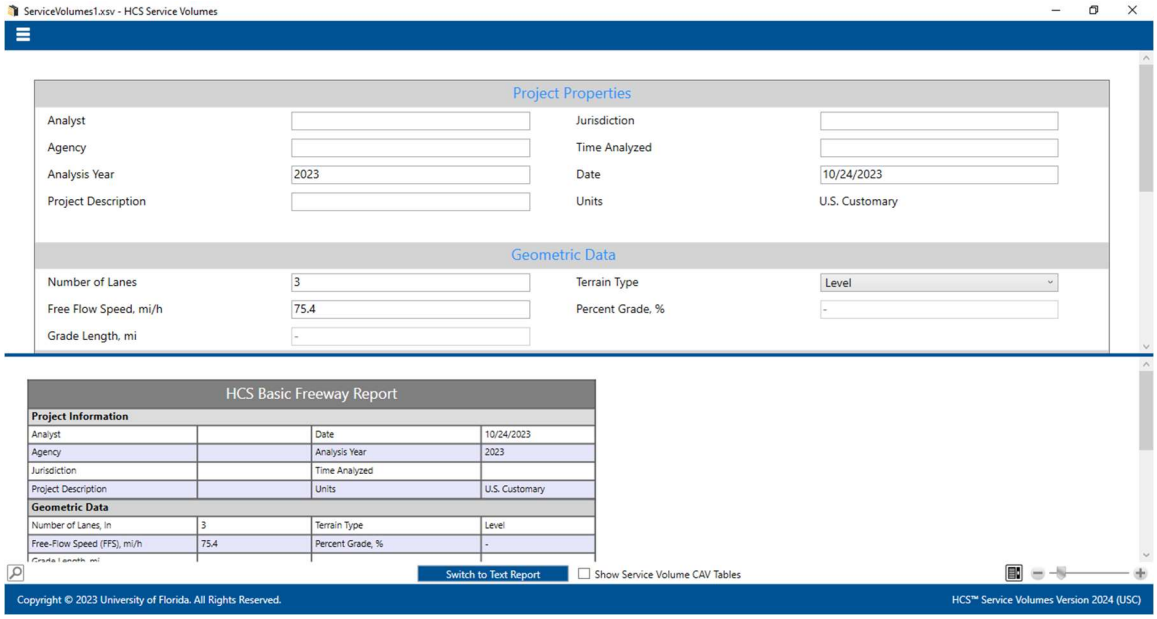
ii. If Multilane Highway Segment was selected, you will be brought to the Multilane page.

iii. If Merge Freeway Segment was selected, you will be brought to the Merge page.

iv. If Diverge Freeway Segment was selected, you will be brought to the Diverge page.

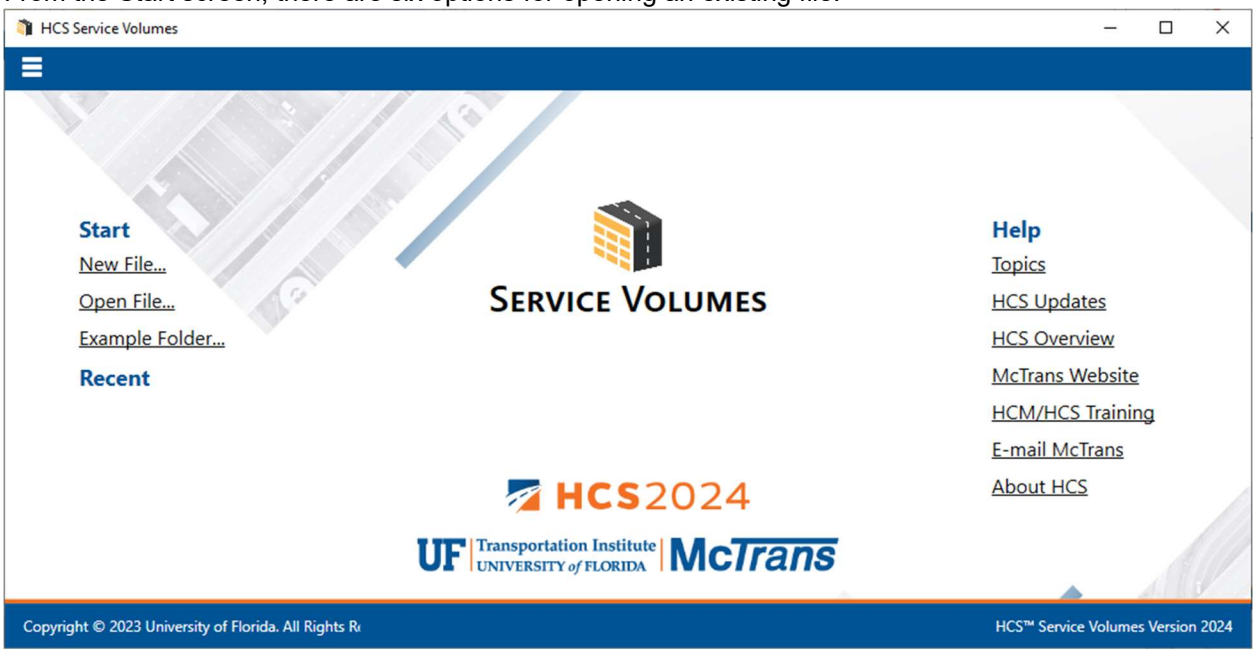
v. If Weaving Freeway Segment was selected, you will be brought to the Weaving page.

b. Full View



Open an Existing File

1. From the Start screen, there are six options for opening an existing file:



Note: A file can be opened even if another file is currently open; you do not need to start from the Start screen.

a. Selecting *File* > *Open* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Open”

b. Selecting “Open File…” from the Start screen; this can be found below in the red box

c. Using the keyboard shortcut “Ctrl+O”

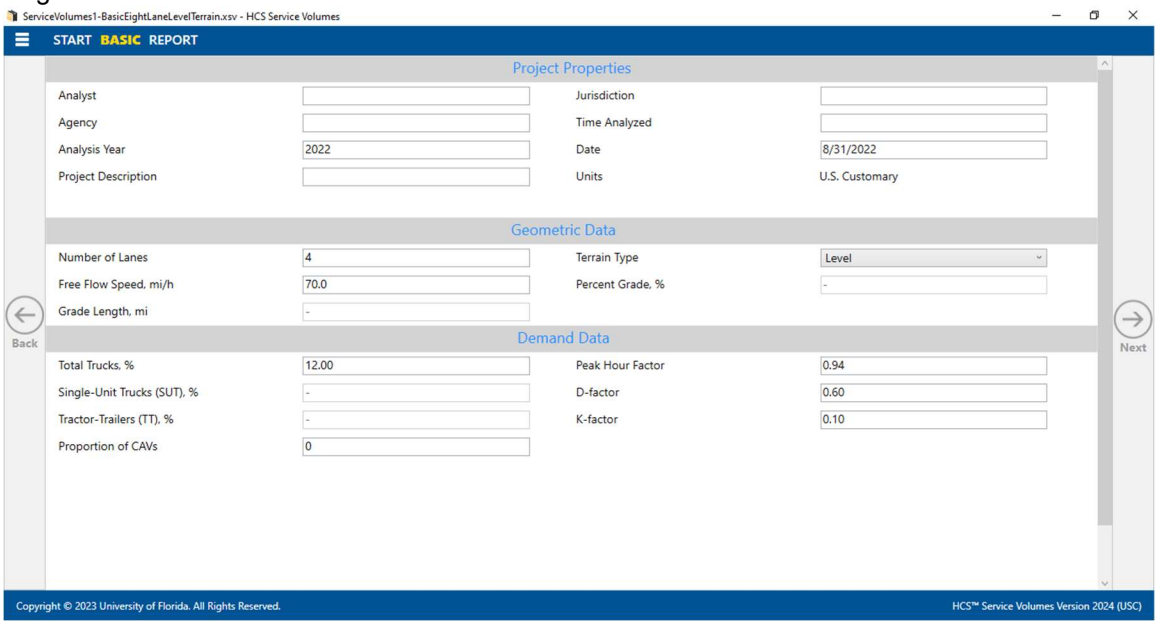
d. Selecting a file under the Recent files list from the Start screen; this can be found below in the red box

e. Selecting *File* > *Example Folder* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Example Folder”. Opening the example folder will open the path of the HCS example files in File Explorer. The desired example file can be double-clicked or right-clicked and selecting ‘Open’, which will open the example file in the Service Volumes program.

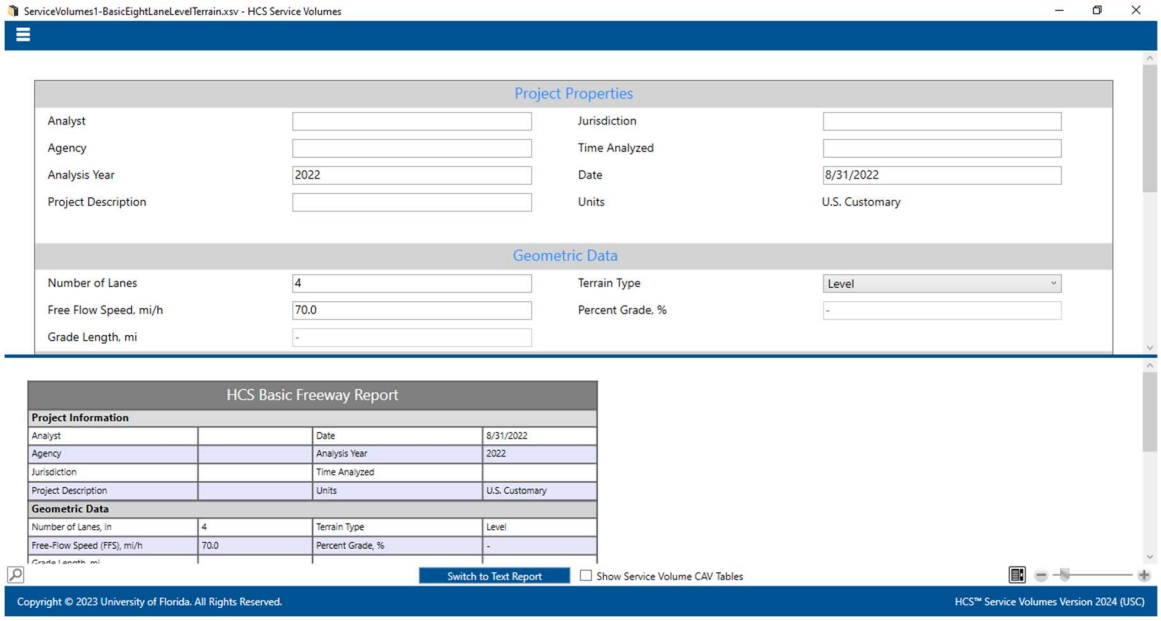
f. Selecting “Example Folder…” from the Start screen; this can be found below in the red box. Opening the example folder will open the path of the HCS example files in File Explorer. The desired example file can be double-clicked or right-clicked and selecting ‘Open’, which will open the example file in the Service Volumes program.

2. Once an existing file is opened, you will be brought to the corresponding input page if in Page View or the input screen split with the report either on the right or the bottom of the screen if in Full View

   a. Page View



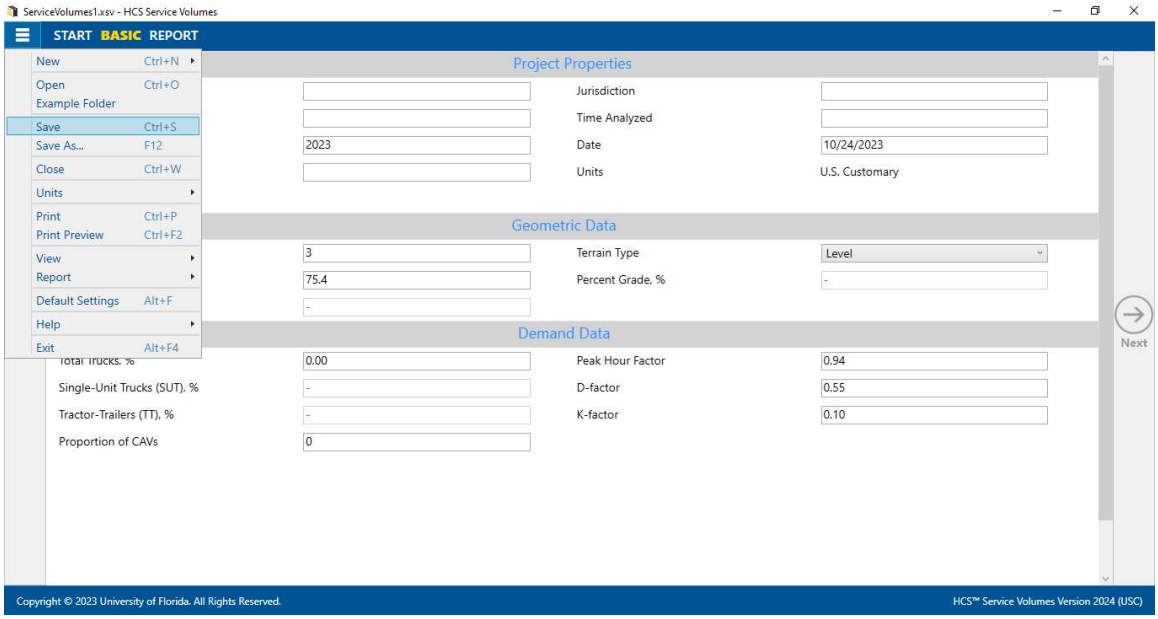
b. Full View



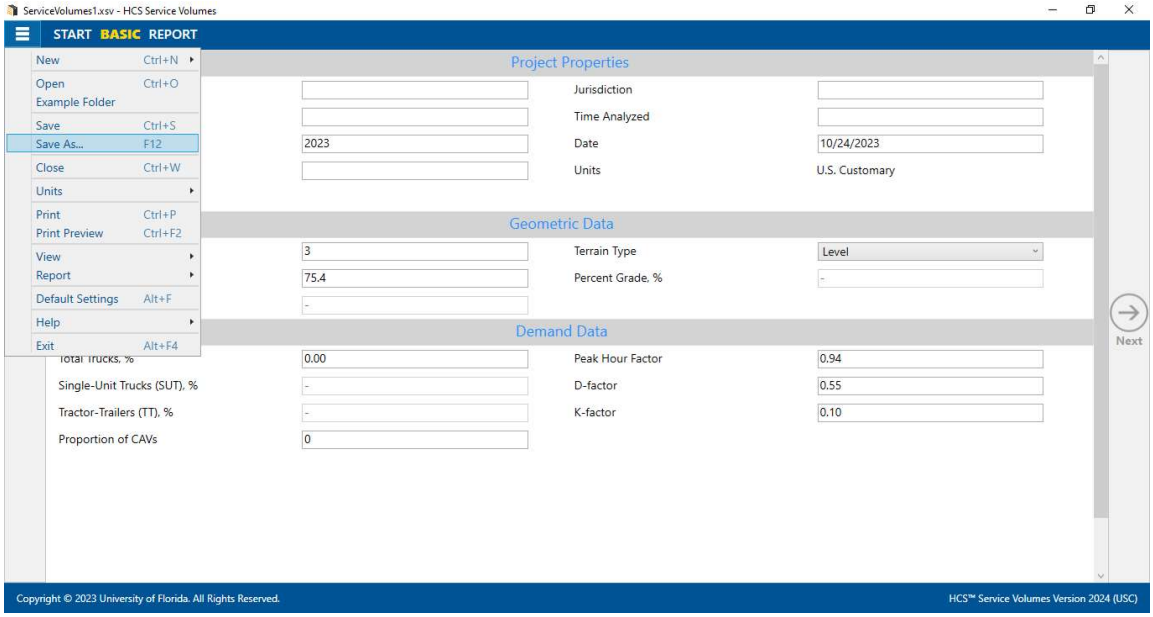
Save a File

1. There are five options for saving an open file:

   a. Selecting *File* > *Save* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Save”



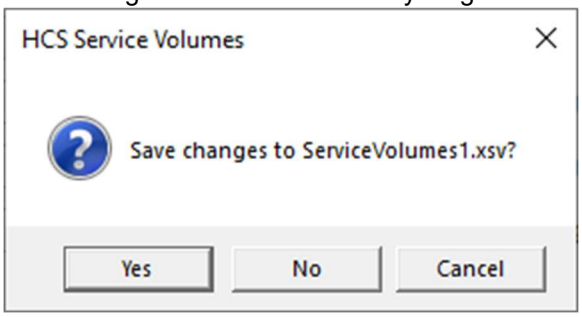
b. Selecting *File* > *Save As…* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Save As…”



c. Using the keyboard shortcut “Ctrl+S” for Save

d. Using the keyboard shortcut “F12” for Save As

e. Exiting the program or closing the file without saving changes beforehand; this will prompt you to save changes to the file before anything is closed



i. Selecting “Yes” will save the file if it is an existing file. If the file has not been previously saved, the Save As dialog box will pop up allowing you to change the file name and save it.

ii. Selecting “No” will exit the program or close the file without saving the file

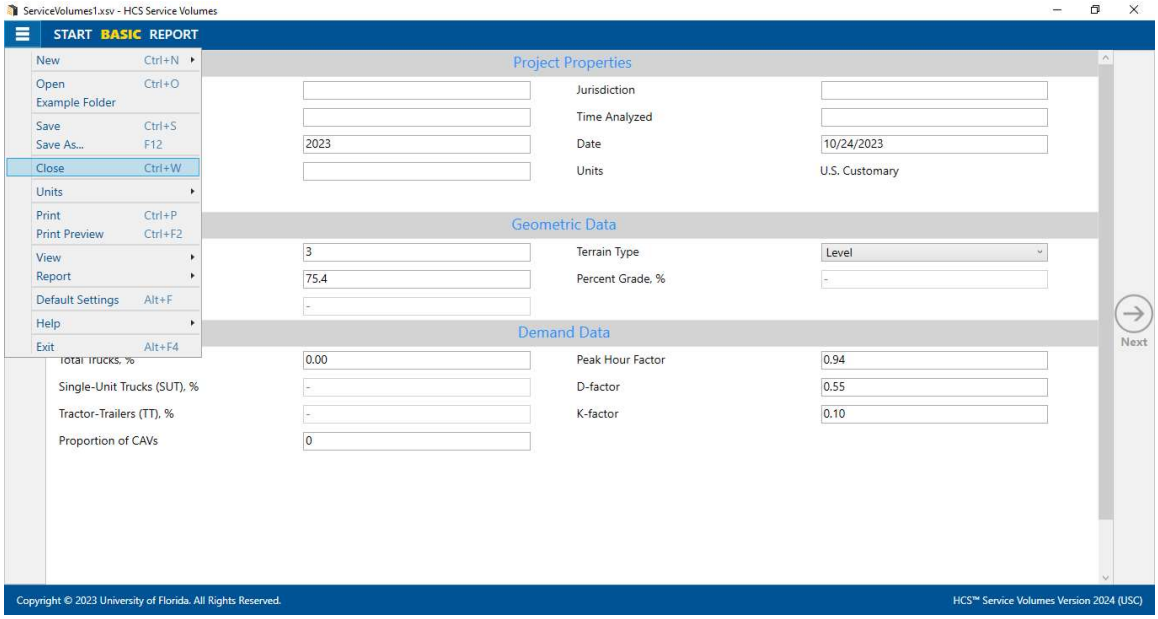
iii. Selecting “Cancel” will prevent the file from closing

Note: Using Save with an existing file will save a file without prompting you to specify a file name. Using Save with a new file will bring up the Save As dialog box for you to specify a file name for saving. Using Save As will always bring up the Save As dialog box for you to specify a file name for saving.

Close a File

1. There are three options for closing an open file:

a. Selecting *File* > *Close* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Close”

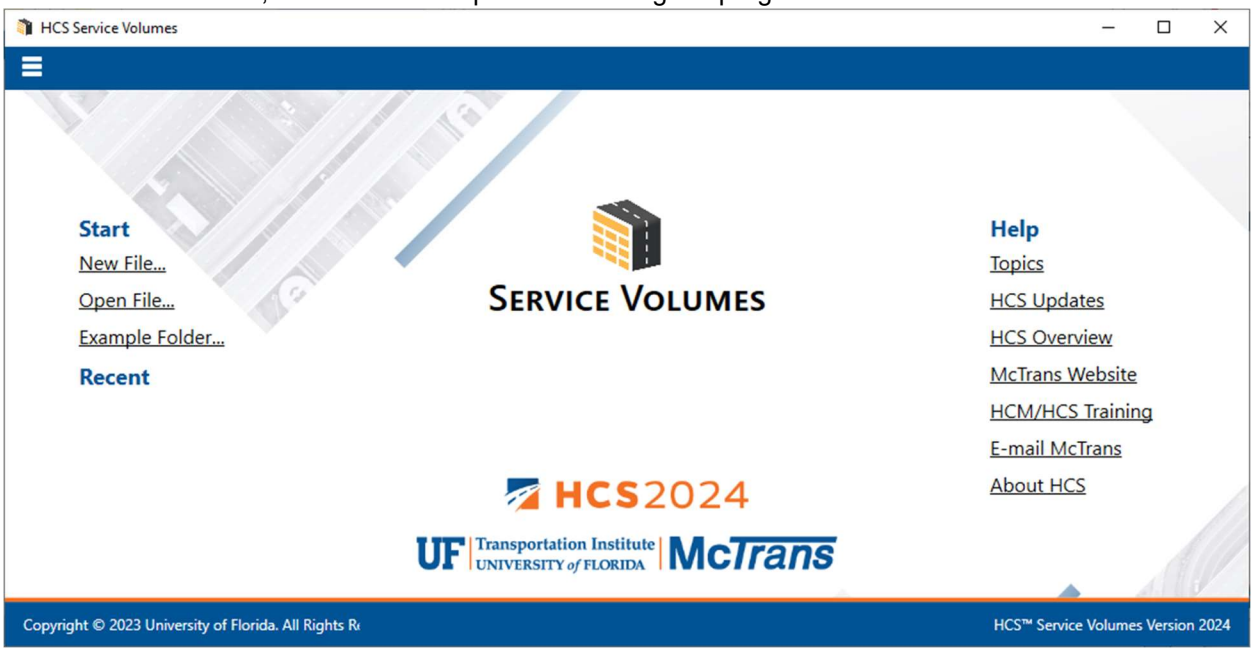


b. Using the keyboard shortcut “Ctrl+W”

c. Exiting the program itself; please see *How To: Exit the Program*

Exit the Program

1. From the Start screen, there are three options for exiting the program:

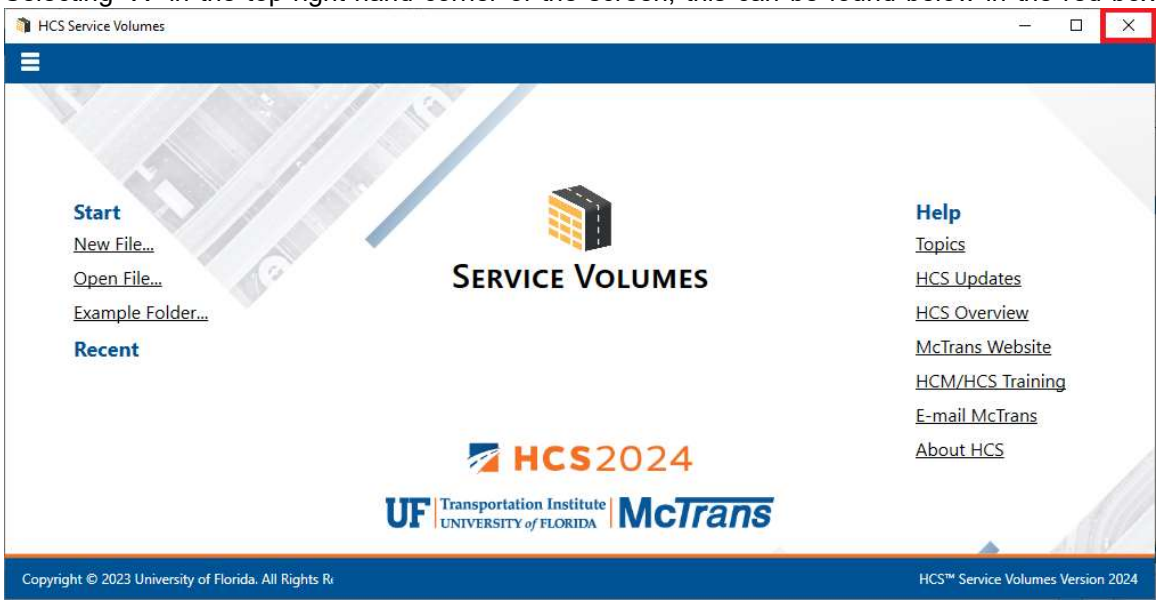


Note: The program can be exited even if a file is still open; you do not need to start from the Start screen.

a. Selecting *File* > *Exit* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Exit”

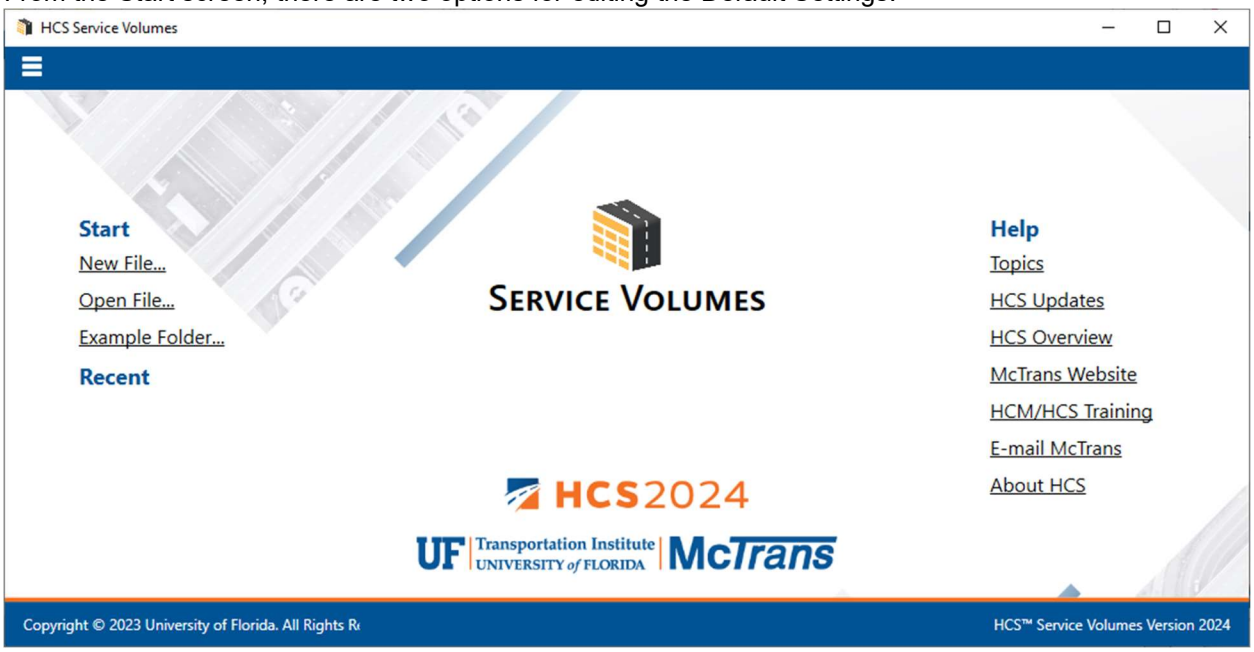
b. Using the keyboard shortcut “Alt+F4”

c. Selecting “X” in the top right-hand corner of the screen; this can be found below in the red box



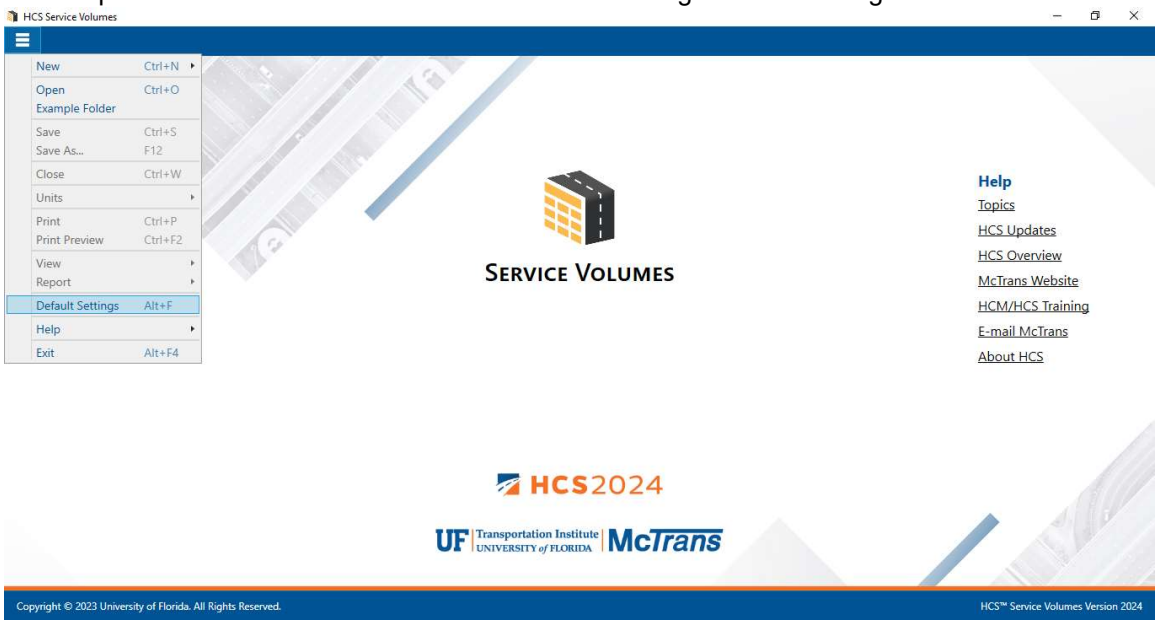
Edit the Default Settings

1. From the Start screen, there are two options for editing the Default Settings.



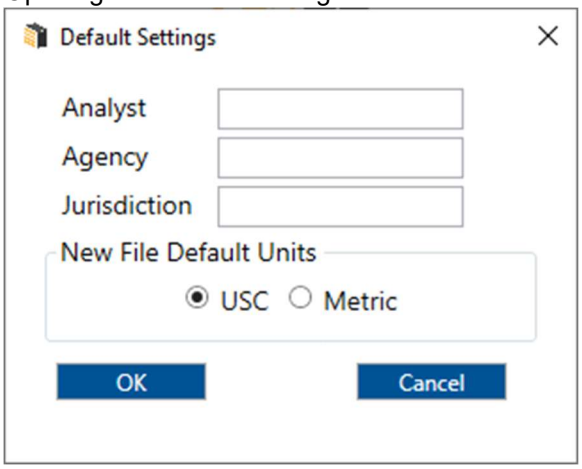
Note: The Default Settings can be changed even if an existing file is already open; you do not need to start from the Start screen.

   a. Selecting *File* > *Default Settings* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Default Settings”



   b. Using the keyboard shortcut “Alt+F”

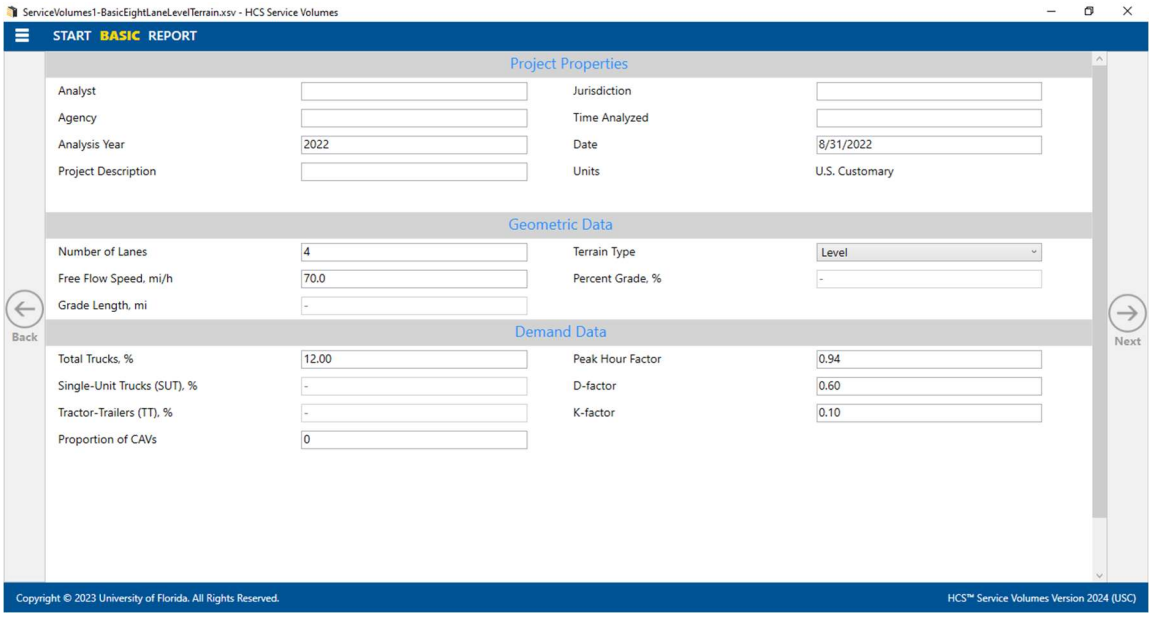
2. Opening the Default Settings will cause a Default Settings window to pop up:



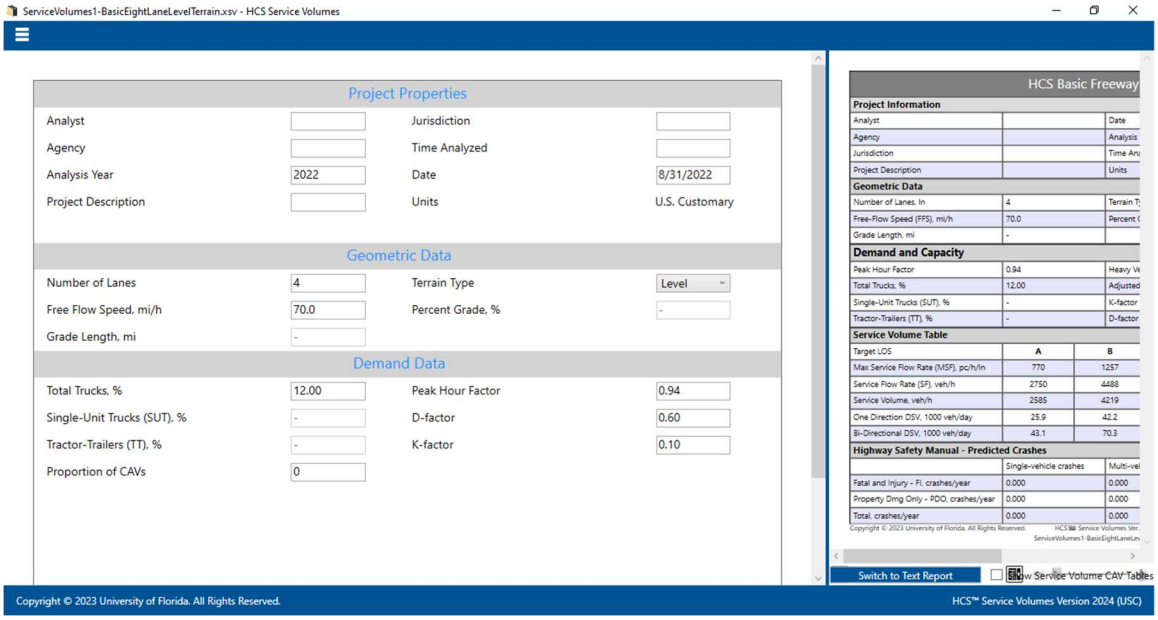
3. You can specify Analyst, Agency, and Jurisdiction by clicking in the corresponding text boxes and typing the desired text.
4. Under 'Units', you are given the option of running the analysis in either *U.S. Customary (USC)* or *SI (Metric)* units.
5. Clicking "OK" will save the changes made and close the Default Settings window; clicking "Cancel" will close the Default Settings window without saving any changes.
6. When a new file is created, the Analyst, Agency, and Jurisdiction fields will automatically be populated with the text specified in the Default Settings.
7. When starting a new file, the inputs and results will display according to the units specified in the Default Settings.

Change the View

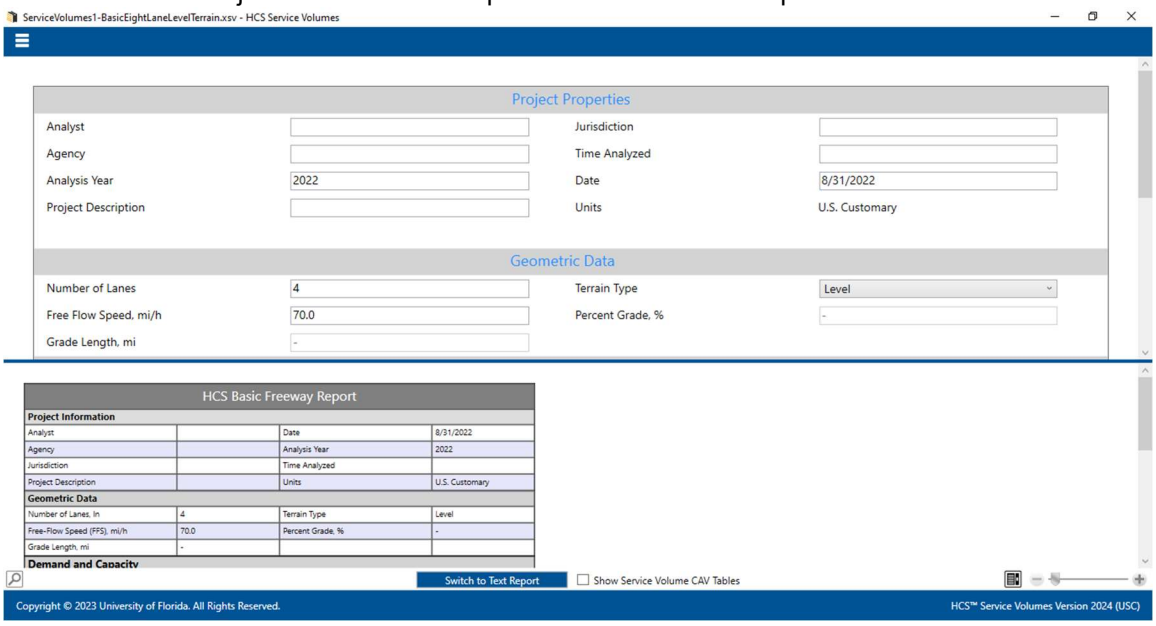
1. When a file is open, there are three main options for the view of the program:
    a. Page View: the inputs and results reports are separated into pages as seen below. You can navigate between pages using the "Back" and "Next" buttons or by clicking the page names found at the top of the screen.



b. Full View with the report on the right of the screen: the screen is split with all inputs on the left side and the results reports on the right side. You can access all inputs and view all of the current report by using the corresponding scroll bars. There is also a screen splitter that can be moved to adjust the views of the input screen and results report.



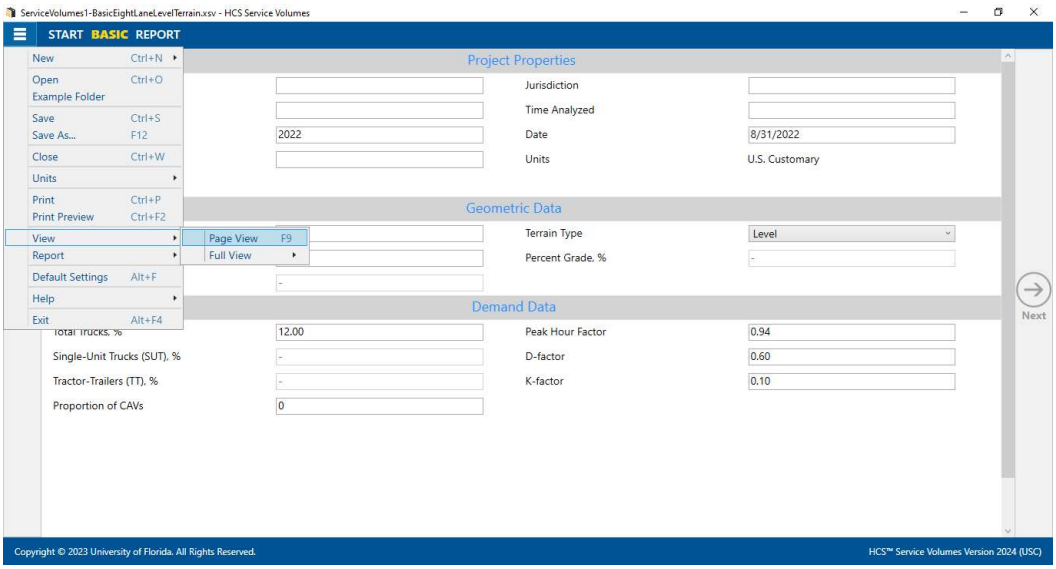
c. Full View with the report on the bottom of the screen: the screen is split with all inputs on the top of the screen and the results reports on the bottom of the screen. You can access all inputs and view all of the current report by using the corresponding scroll bars. There is also a screen splitter that can be moved to adjust the view of the input screen and results report.



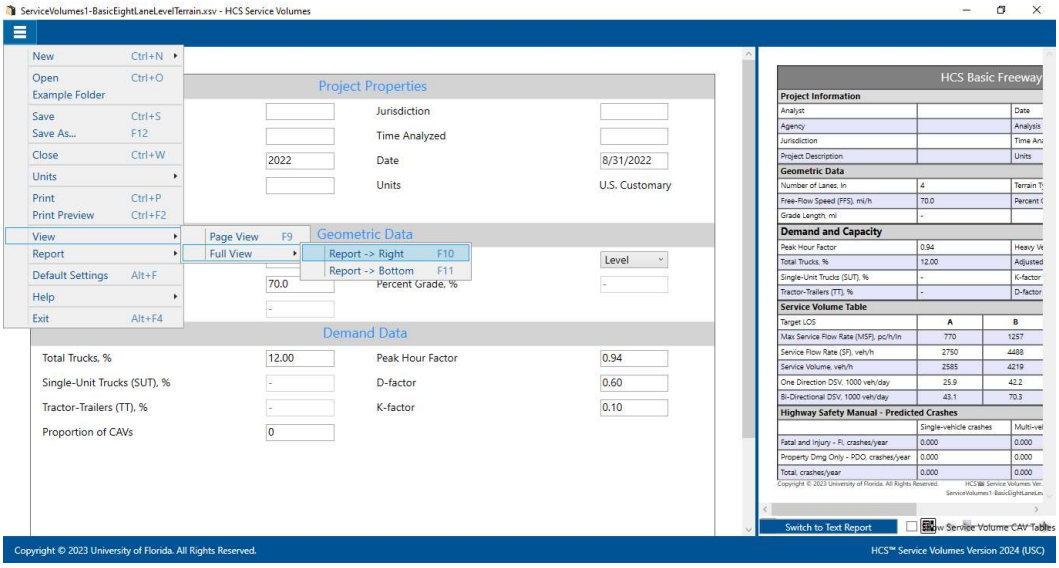
2. Views can be changed by using the main menu items or the keyboard shortcuts.

   a. Main Menu Items

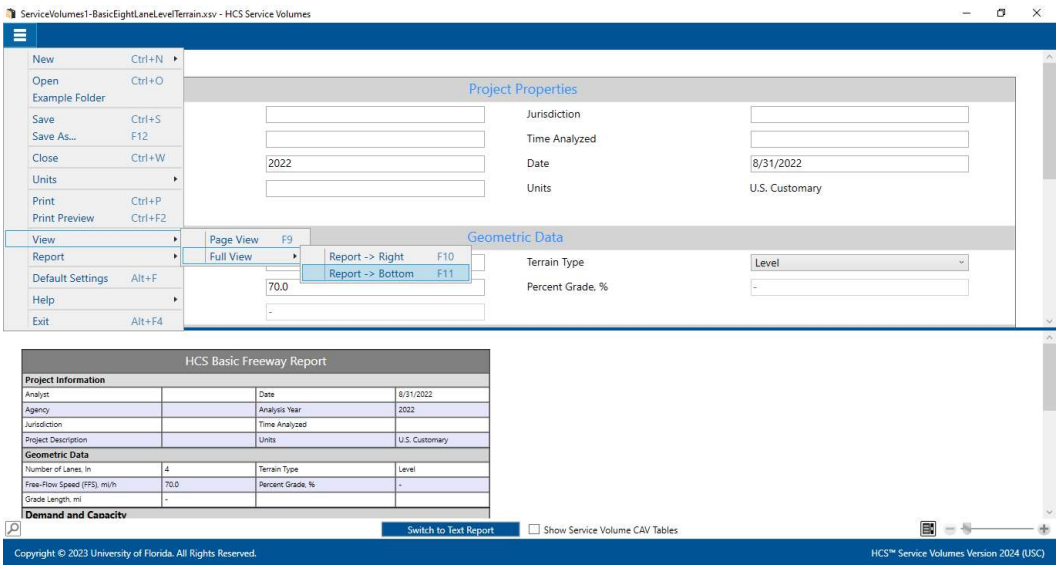
      i. To switch to Page View, select *File* > *View* > *Page View* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over “View”, and then selecting “Page View”.



ii. To switch to Full View with the report on the right of the screen, select *File* > *View* > *Full View* > *Report* -> *Right* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over "View", hovering over "Full View", and then selecting "Report -> Right".



iii. To switch to Full View with the report on the bottom of the screen, select *File* > *View* > *Full View* > *Report* -> *Bottom* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over "View", hovering over "Full View", and then selecting "Report -> Bottom".



b. Keyboard Shortcuts

   i. Page View: keyboard shortcut is “F9”

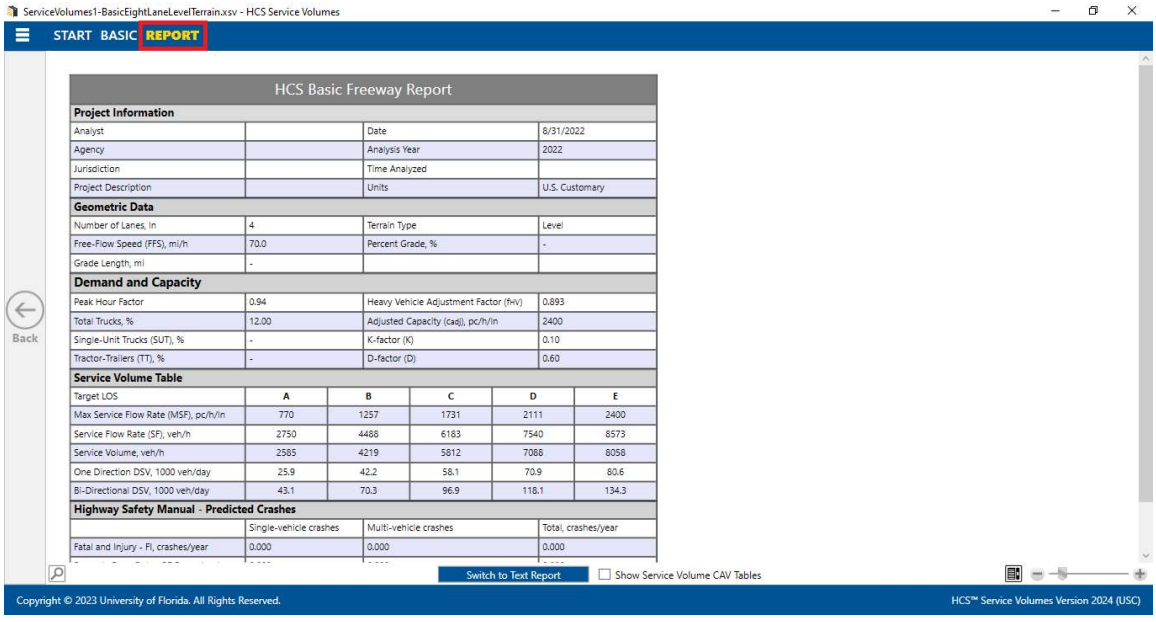
   ii. Full View with report on the right of the screen: keyboard shortcut is “F10”

   iii. Full View with report on the bottom of the screen: keyboard shortcut is “F11”

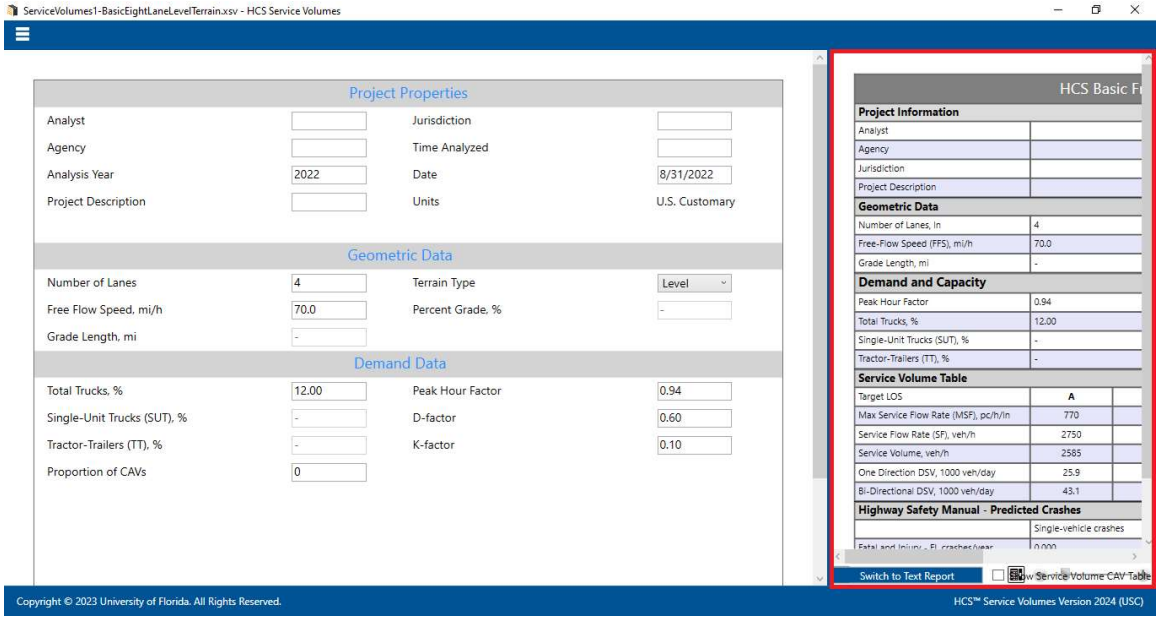
View Results of the Analysis

1. After editing all the necessary inputs, results of the analysis can be found in the form of reports. Reports can be found on the Report page if using Page View or on the results portion of the split screen if using Full View.

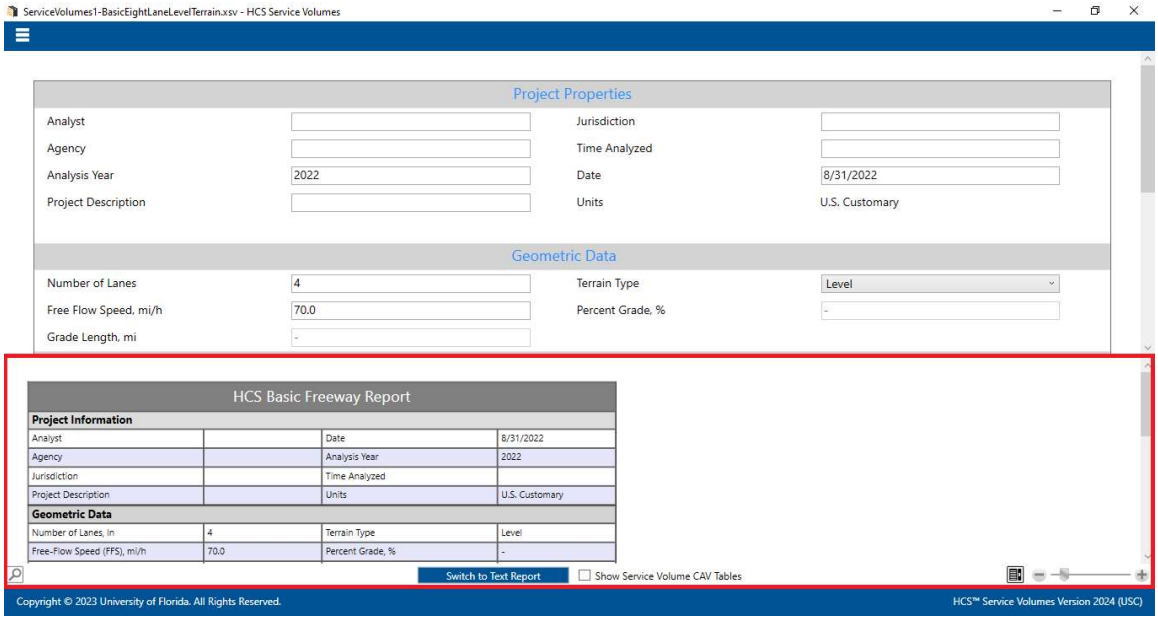
   a. Page View with Report page displayed



b. Full View with the report on the right of the screen



c. Full View with the report on the bottom of the screen



2. There are two types of reports: Formatted and Text

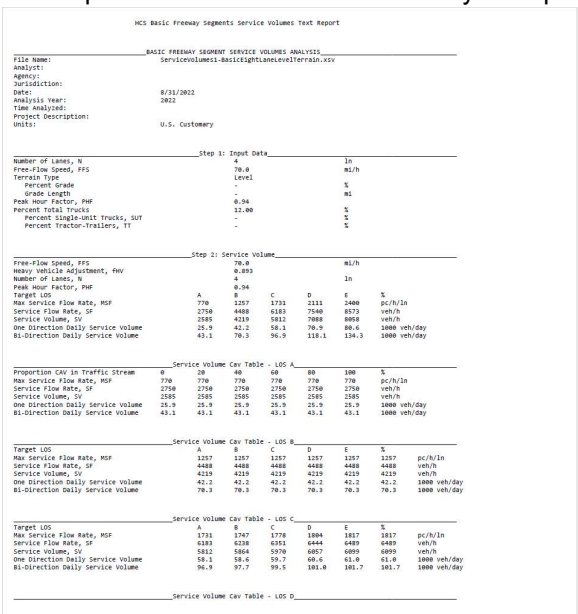
   a. Formatted reports show the most important results in a presentable format

HCS Basic Freeway Report			
Project Information			
Analyst		Date	8/31/2022
Agency		Analysis Year	2022
Jurisdiction		Time Analyzed	
Project Description		Units	U.S. Customary
Geometric Data			
Number of Lanes, ln	4	Terrain Type	Level
Free-Flow Speed (FFS), mi/h	70.0	Percent Grade, %	-
Grade Length, mi	-		
Demand and Capacity			
Peak Hour Factor	0.94	Heavy Vehicle Adjustment Factor (fHV)	0.893
Total Trucks, %	12.00	Adjusted Capacity (cadj), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	K-factor (K)	0.10
Tractor-Trailers (TT), %	-	D-factor (D)	0.60

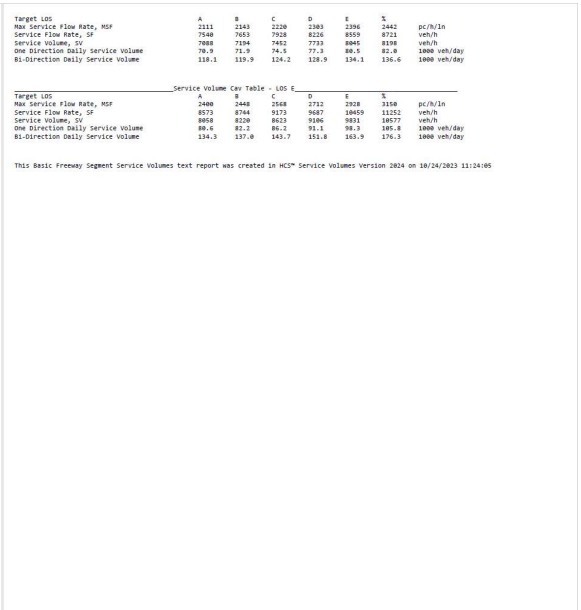
Service Volume Table					
Target LOS	**A**	**B**	**C**	**D**	**E**
Max Service Flow Rate (MSF), pc/h/ln	770	1257	1731	2111	2400
Service Flow Rate (SF), veh/h	2750	4488	6183	7540	8573
Service Volume, veh/h	2585	4219	5812	7088	8058
One Direction DSV, 1000 veh/day	25.9	42.2	58.1	70.9	80.6
Bi-Directional DSV, 1000 veh/day	43.1	70.3	96.9	118.1	134.3

Service Volume CAV Table - LOS A						
Proportion CAV in Traffic Stream	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Max Service Flow Rate (MSF), pc/h/ln	770	770	770	770	770	770
Service Flow Rate (SF), veh/h	2750	2750	2750	2750	2750	2750
Service Volume, veh/h	2585	2585	2585	2585	2585	2585
One Direction DSV, 1000 veh/day	25.9	25.9	25.9	25.9	25.9	25.9
Bi-Directional DSV, 1000 veh/day	43.1	43.1	43.1	43.1	43.1	43.1
Service Volume CAV Table - LOS B						
Proportion CAV in Traffic Stream	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Max Service Flow Rate (MSF), pc/h/ln	1257	1257	1257	1257	1257	1257
Service Flow Rate (SF), veh/h	4488	4488	4488	4488	4488	4488
Service Volume, veh/h	4219	4219	4219	4219	4219	4219
One Direction DSV, 1000 veh/day	42.2	42.2	42.2	42.2	42.2	42.2
Bi-Directional DSV, 1000 veh/day	70.3	70.3	70.3	70.3	70.3	70.3
Service Volume CAV Table - LOS C						
Proportion CAV in Traffic Stream	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Max Service Flow Rate (MSF), pc/h/ln	1731	1747	1778	1804	1817	1817
Service Flow Rate (SF), veh/h	6183	6238	6351	6444	6489	6489
Service Volume, veh/h	5812	5864	5970	6057	6099	6099
One Direction DSV, 1000 veh/day	58.1	58.6	59.7	60.6	61.0	61.0
Bi-Directional DSV, 1000 veh/day	96.9	97.7	99.5	101.0	101.7	101.7
Service Volume CAV Table - LOS D						
Proportion CAV in Traffic Stream	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Max Service Flow Rate (MSF), pc/h/ln	2111	2143	2220	2303	2396	2442
Service Flow Rate (SF), veh/h	7540	7653	7928	8226	8559	8721
Service Volume, veh/h	7088	7194	7452	7733	8045	8198
One Direction DSV, 1000 veh/day	70.9	71.9	74.5	77.3	80.5	82.0
Bi-Directional DSV, 1000 veh/day	118.1	119.9	124.2	128.9	134.1	136.6
Service Volume CAV Table - LOS E						
Proportion CAV in Traffic Stream	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**
Max Service Flow Rate (MSF), pc/h/ln	2400	2448	2568	2712	2928	3150
Service Flow Rate (SF), veh/h	8573	8744	9173	9687	10459	11252
Service Volume, veh/h	8058	8220	8623	9106	9831	10577
One Direction DSV, 1000 veh/day	80.6	82.2	86.2	91.1	98.3	105.8
Bi-Directional DSV, 1000 veh/day	134.3	137.0	143.7	151.8	163.9	176.3

   b. Text reports show a more detailed analysis in plain text



```
                    HCS Basic Freeway Segments Service Volumes Text Report

_____BASIC FREEWAY SEGMENT SERVICE VOLUMES ANALYSIS_____
File Name:                      ServiceVolumes1-BasicEightLaneLevelTerrain.xsv
Analyst:
Agency:
Jurisdiction:
Date:                           8/31/2022
Analysis Year:                  2022
Time Analyzed:
Project Description:
Units:                          U.S. Customary

_____Step 1: Input Data_____
Number of Lanes, N                      4                       ln
Free-Flow Speed, FFS                    70.0                    mi/h
Terrain Type                            Level
   Percent Grade                        -                       %
   Grade Length                         -                       mi
Peak Hour Factor, PHF                   0.94
Percent Total Trucks                    12.00                   %
   Percent Single-Unit Trucks, SUT      -                       %
   Percent Tractor-Trailers, TT         -                       %


_____Step 2: Service Volume_____
Free-Flow Speed, FFS                    70.0                    mi/h
Heavy Vehicle Adjustment, fHV           0.893
Number of Lanes, N                      4                       ln
Peak Hour Factor, PHF                   0.94
Target LOS                      A       B       C       D       E       %
Max Service Flow Rate, MSF      770     1257    1731    2111    2400    pc/h/ln
Service Flow Rate, SF           2750    4488    6183    7540    8573    veh/h
Service Volume, SV              2585    4219    5812    7088    8058    veh/h
One Direction Daily Service Volume      25.9    42.2    58.1    70.9    80.6    1000 veh/day
Bi-Direction Daily Service Volume       43.1    70.3    96.9    118.1   134.3   1000 veh/day


_____Service Volume Cav Table - LOS A_____
Proportion CAV in Traffic Stream        0       20      40      60      80      100     %
Max Service Flow Rate, MSF      770     770     770     770     770     770     pc/h/ln
Service Flow Rate, SF           2750    2750    2750    2750    2750    2750    veh/h
Service Volume, SV              2585    2585    2585    2585    2585    2585    veh/h
One Direction Daily Service Volume      25.9    25.9    25.9    25.9    25.9    25.9    1000 veh/day
Bi-Direction Daily Service Volume       43.1    43.1    43.1    43.1    43.1    43.1    1000 veh/day


_____Service Volume Cav Table - LOS B_____
Target LOS                      A       B       C       D       E       %
Max Service Flow Rate, MSF      1257    1257    1257    1257    1257    1257    pc/h/ln
Service Flow Rate, SF           4488    4488    4488    4488    4488    4488    veh/h
Service Volume, SV              4219    4219    4219    4219    4219    4219    veh/h
One Direction Daily Service Volume      42.2    42.2    42.2    42.2    42.2    42.2    1000 veh/day
Bi-Direction Daily Service Volume       70.3    70.3    70.3    70.3    70.3    70.3    1000 veh/day


_____Service Volume Cav Table - LOS C_____
Target LOS                      A       B       C       D       E       %
Max Service Flow Rate, MSF      1731    1747    1778    1804    1817    1817    pc/h/ln
Service Flow Rate, SF           6183    6238    6351    6444    6489    6489    veh/h
Service Volume, SV              5812    5864    5970    6057    6099    6099    veh/h
One Direction Daily Service Volume      58.1    58.6    59.7    60.6    61.0    1000 veh/day
Bi-Direction Daily Service Volume       96.9    97.7    99.5    101.0   101.7   1000 veh/day


_____Service Volume Cav Table - LOS D_____
```

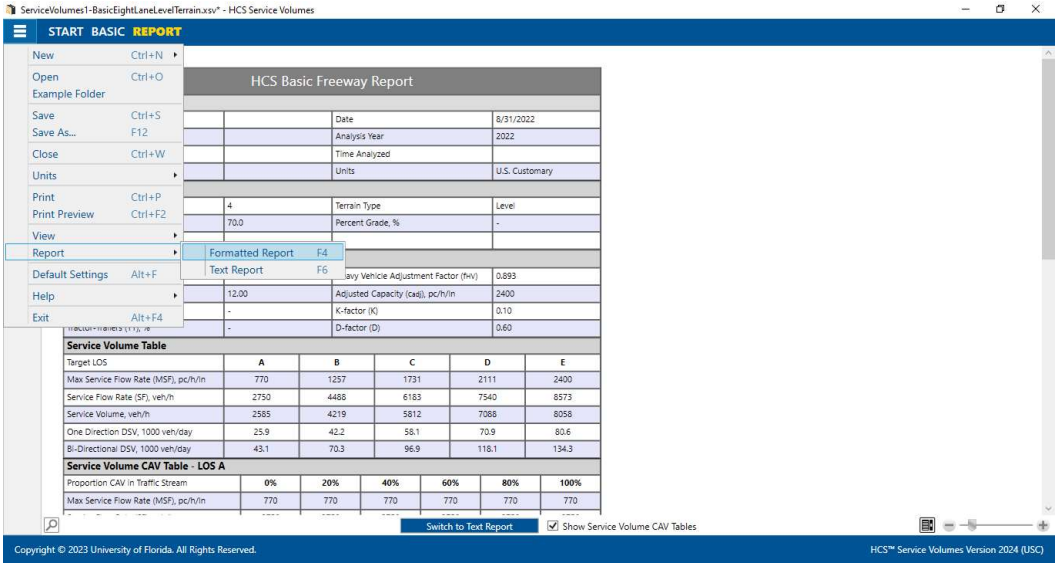


```
Target LOS                      A       B       C       D       E       %
Max Service Flow Rate, MSF      2111    2143    2220    2303    2396    2442    pc/h/ln
Service Flow Rate, SF           7540    7653    7928    8226    8559    8721    veh/h
Service Volume, SV              7088    7194    7452    7733    8045    8198    veh/h
One Direction Daily Service Volume      70.9    71.9    74.5    77.3    80.5    82.0    1000 veh/day
Bi-Direction Daily Service Volume       118.1   119.9   124.2   128.9   134.1   136.6   1000 veh/day


_____Service Volume Cav Table - LOS E_____
Target LOS                      A       B       C       D       E       %
Max Service Flow Rate, MSF      2400    2448    2568    2712    2928    3150    pc/h/ln
Service Flow Rate, SF           8573    8744    9173    9687    10459   11252   veh/h
Service Volume, SV              8058    8220    8623    9106    9831    10577   veh/h
One Direction Daily Service Volume      80.6    82.2    86.2    91.1    98.3    105.8   1000 veh/day
Bi-Direction Daily Service Volume       134.3   137.0   143.7   151.8   163.9   176.3   1000 veh/day


This Basic Freeway Segment Service Volumes text report was created in HCS™ Service Volumes Version 2024 on 10/24/2023 11:24:05
```

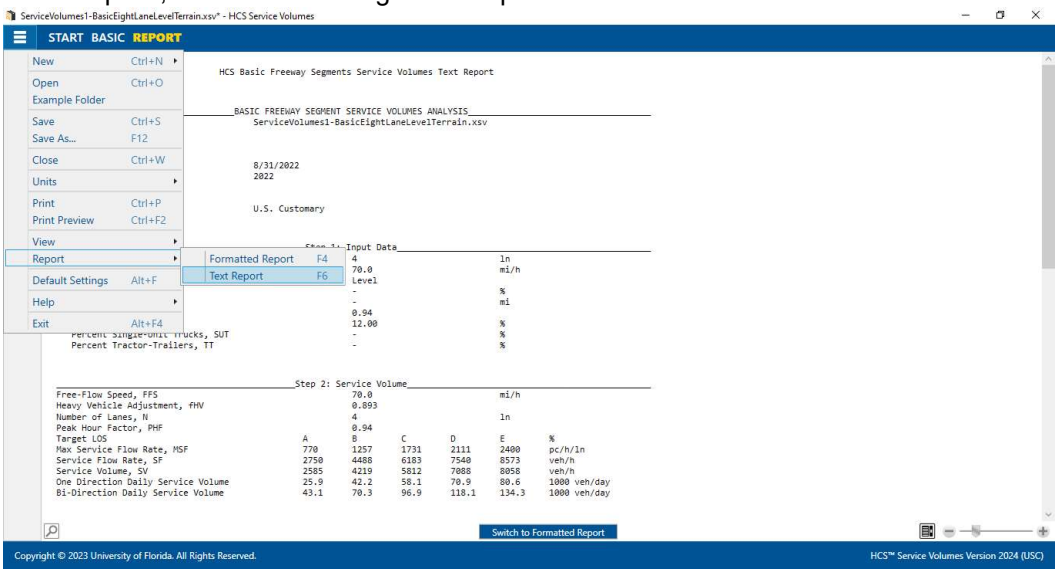
3. The type of report displayed can be changed by using the main menu items, keyboard shortcuts, or toggle buttons found under the report

    a. Main Menu Items

        i. To switch to the Formatted Report, select *File* > *Report* > *Formatted Report* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen; hovering over “Report”, and then selecting “Formatted Report”.



        ii. To switch to the Text Report, select *File* > *Report* > *Text Report* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen, hovering over “Report”, and then selecting “Text Report”.



    b. Keyboard Shortcuts

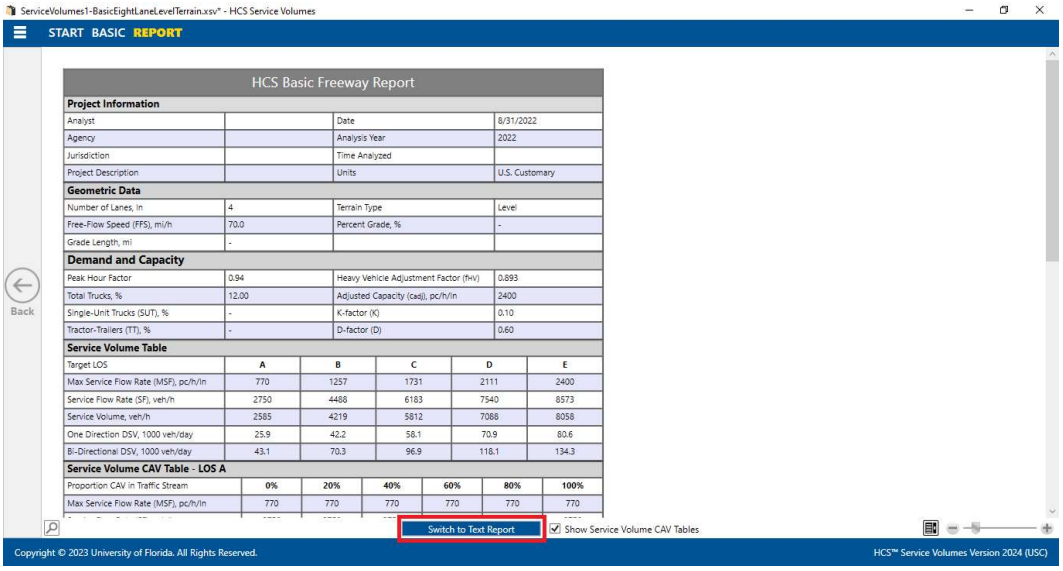
        i. Formatted Report: keyboard shortcut is “F4”

        ii. Text Report: keyboard shortcut is “F6”

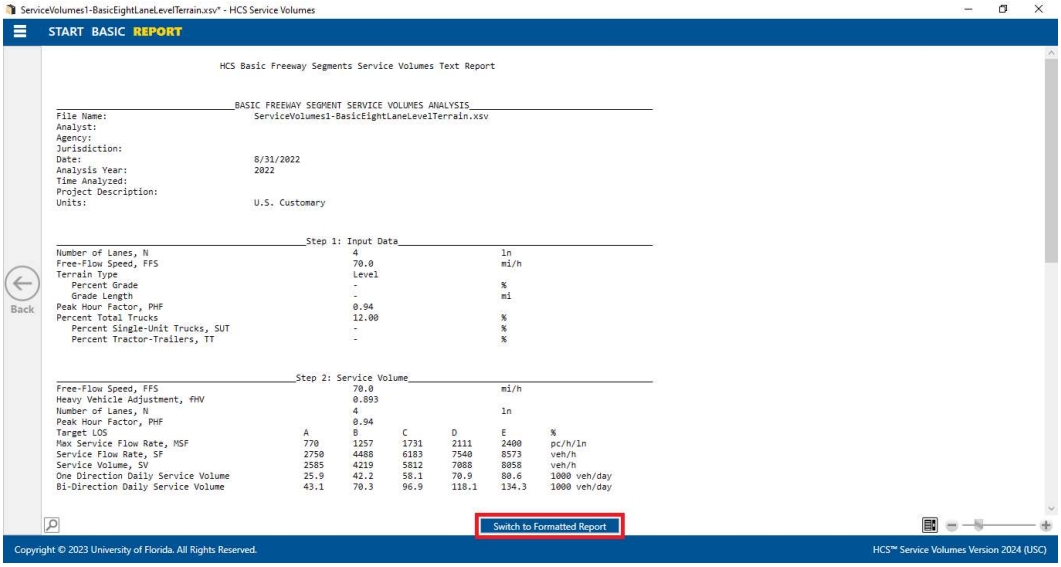
    c. Report Toggle Buttons

        i. Whether viewing the report in Page View or Full View; a toggle button will be available at the bottom of the screen underneath the report.

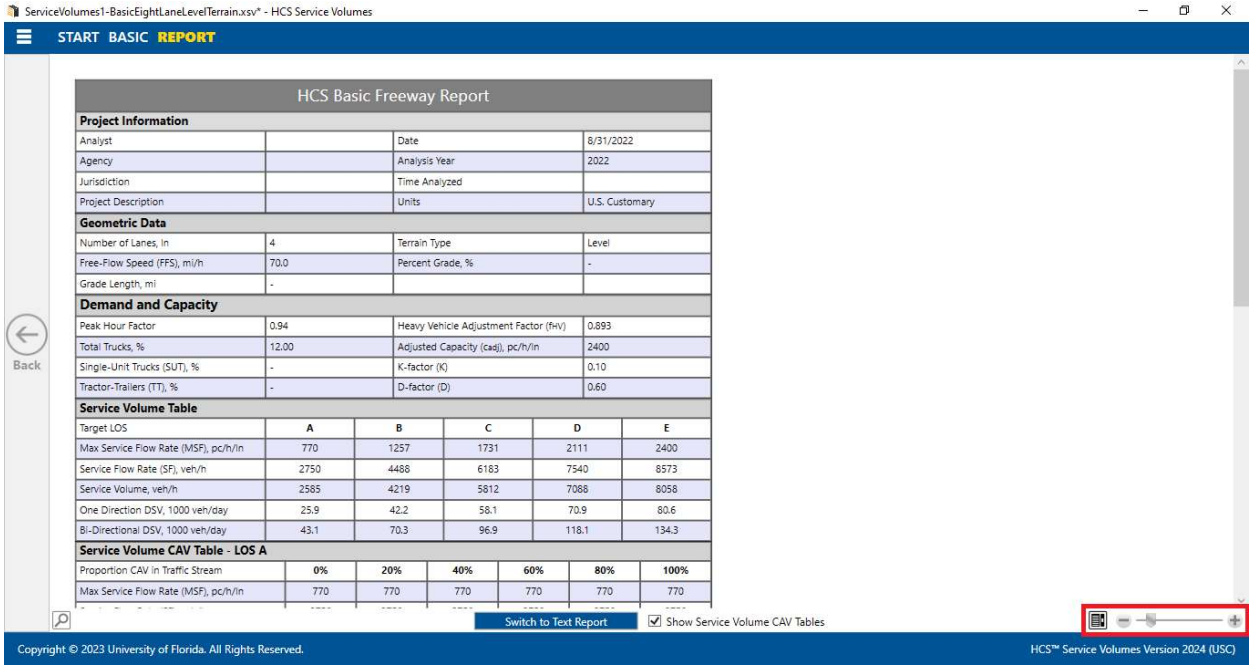
ii. If the formatted report is currently being displayed, the toggle button will say “Switch to Text Report” which will allow you to display the text report if clicked. There is also a checkbox next to the toggle button that will allow you to show the Service Volume CAV tables; this is only available for the formatted report.



iii. If the text report is currently being displayed, the toggle button will say “Switch to Formatted Report” which will allow you to display the formatted report if clicked.



4. The magnification of the report currently being displayed can be changed using the zoom slider found at the bottom right-hand corner of the screen.



   a. To zoom in, drag the slider to the right; to zoom out, drag the slider to the left

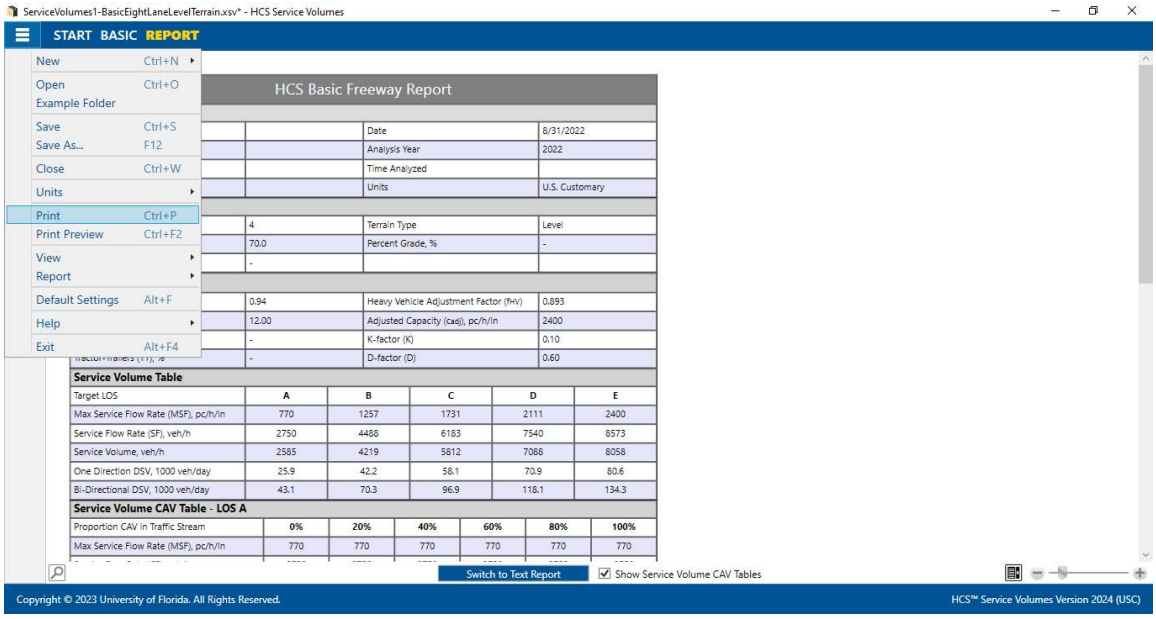
   b. Clicking the plus (+) button will zoom in; clicking the minus (-) button will zoom out

   c. Holding down “ctrl” on the keyboard and scrolling up on the mouse wheel will zoom in; holding down “ctrl” on the keyboard and scrolling down on the mouse wheel will zoom out

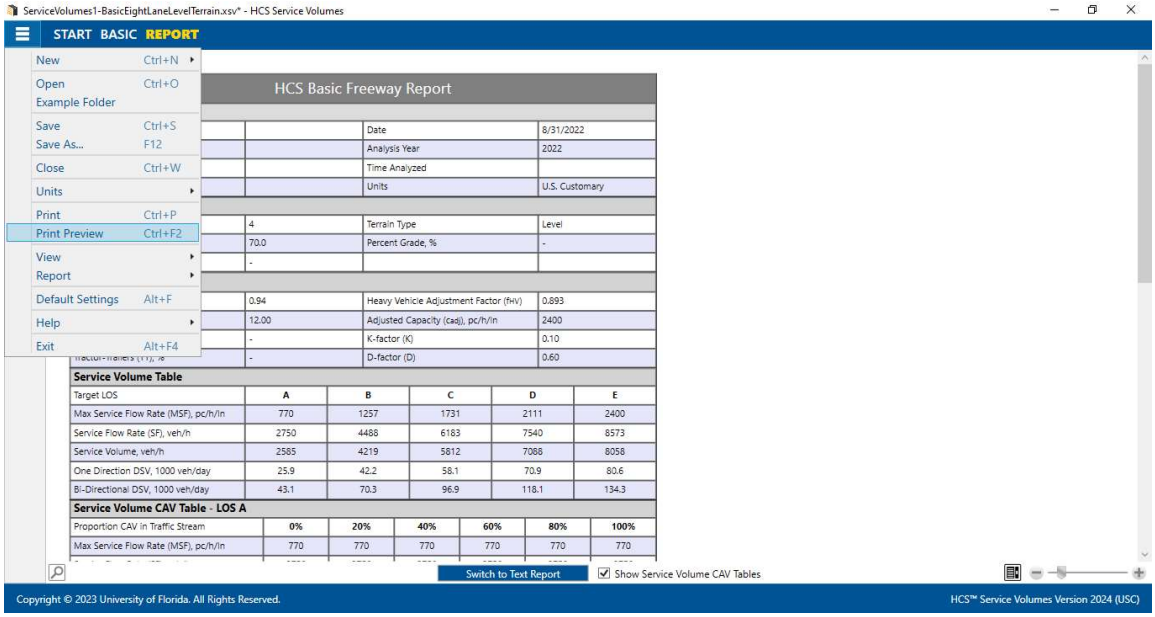
Print a Report

1. There are four options for printing a report:

   a. Selecting *File* > *Print* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Print”



b. Selecting *File* > *Print Preview* from the main menu; this can be found by selecting the three lines in the top left-hand corner of the screen and then selecting “Print Preview”

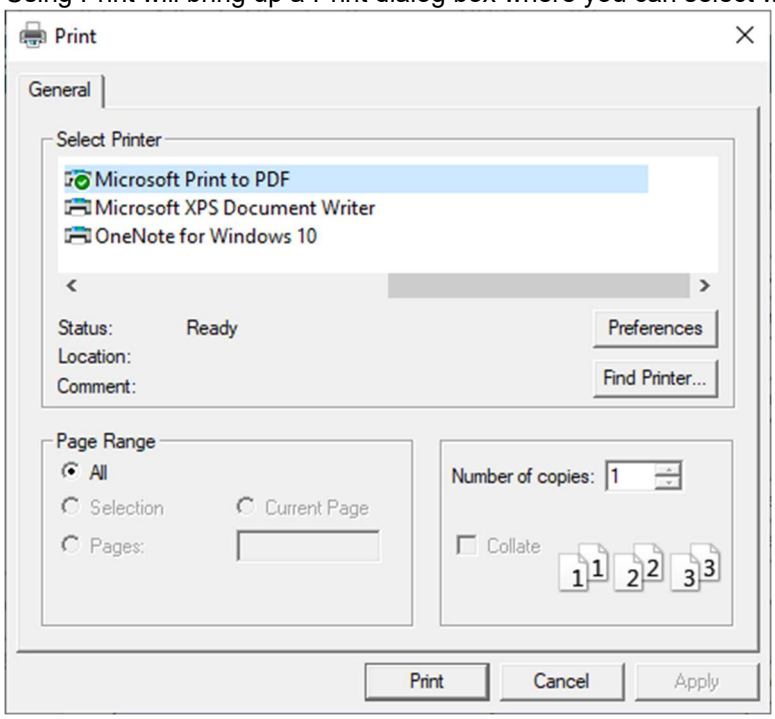


c. Using keyboard shortcut “Ctrl+P” for Print

d. Using keyboard shortcut “Ctrl+F2” for Print Preview

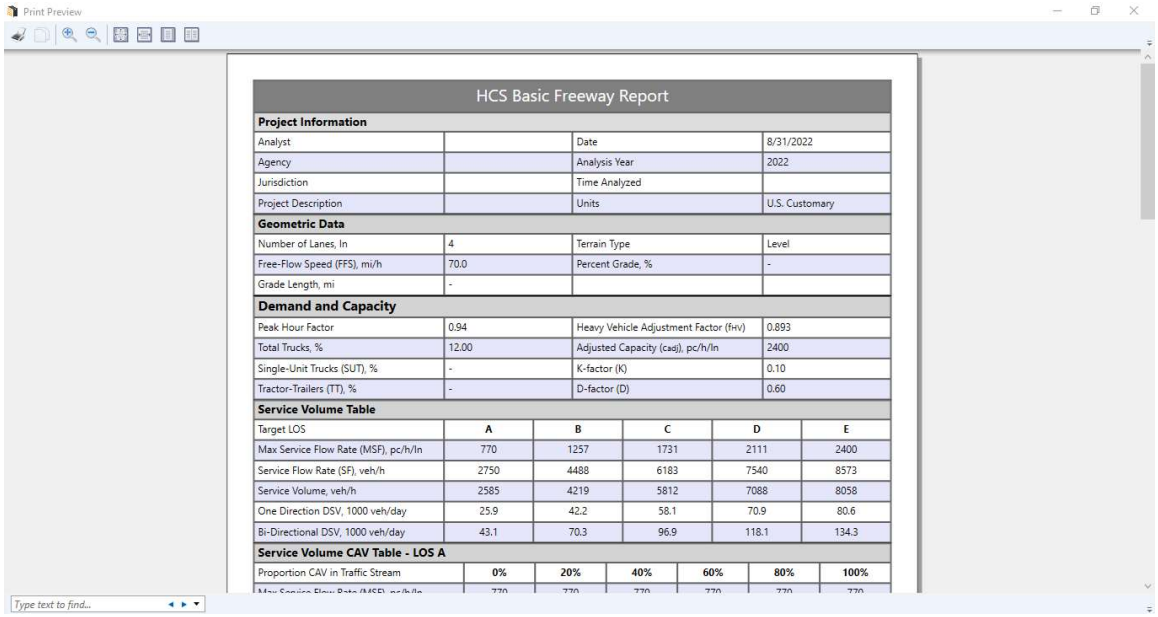
2. Print

a. Using Print will bring up a Print dialog box where you can select which printer to print to



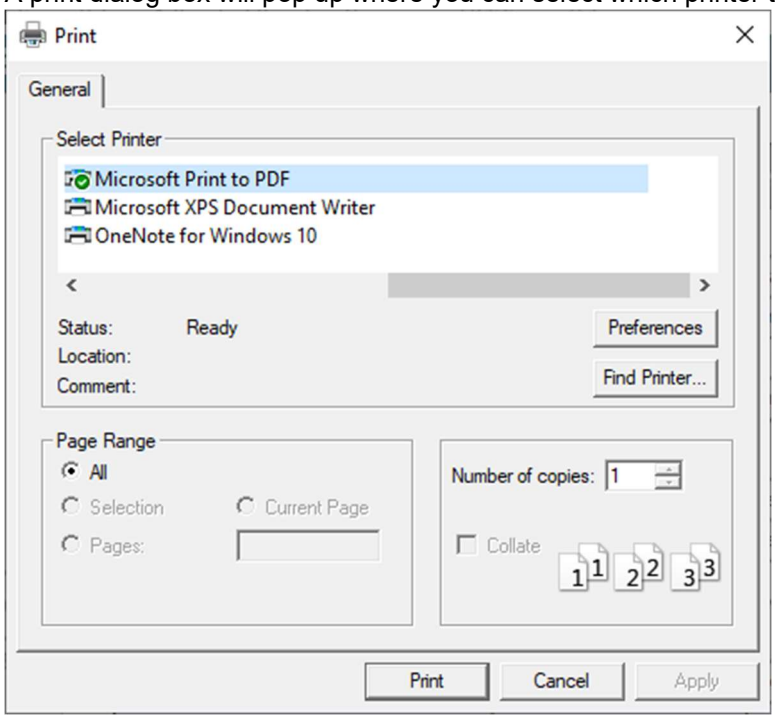
3. Print Preview

   a. Using Print Preview will bring up a window where you can view how the report will look on paper before sending it to the printer



   b. The print icon in the toolbar found in the top left-hand corner can then be selected

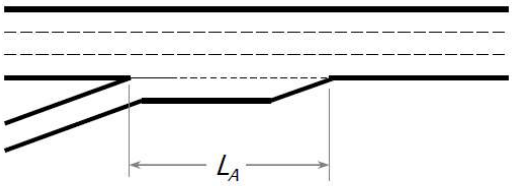
   c. A print dialog box will pop up where you can select which printer to print to



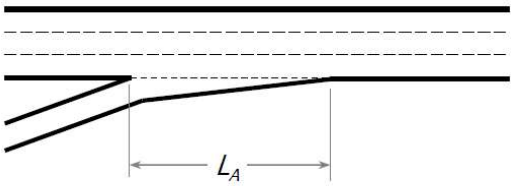
Glossary of Terms

Acceleration Lane Length

This value defines the length for on-ramp acceleration lanes. The typical length of acceleration lanes for ramps should be obtained from the design standards used by the highway operation agency. It is measured from the intersection of the edge of the travel way for the freeway and the ramp (the first point) and the downstream merge point of the freeway and ramp edges of the travel way (the second point).

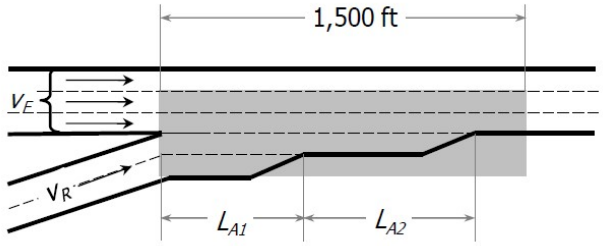


(a) Parallel Acceleration Lane



(b) Tapered Acceleration Lane

The exhibit below illustrates the geometry of a typical two-lane ramp-freeway junction. It is characterized by two separate acceleration lanes, each successively forcing merging maneuvers to the left.



For two-lane ramps, the effective acceleration length must be calculated by the user based on the lengths of the two lanes. In all equations using the length of the acceleration lane L_A, this value is replaced by the effective length of both acceleration lanes L_{Aeff}. The formula for calculating effective acceleration length is:

$L_{Aeff} = 2*L_{A1} + L_{A2}$

where

L_{Aeff} = Effective acceleration length,

L_{A1} = Length of the shorter acceleration lane, and

L_{A2} = Difference in length between the longer acceleration lane and the shorter acceleration lane

In merge and diverge areas, the capacity of the two outer lanes is reduced by 100 and 200 veh/h/ln, respectively. When the user sets the acceleration lanes to 1500 feet (or 457.2 meters in metric), only the outer lane of the merge experiences a capacity reduction, as opposed to normally both the outer two lanes.

Agency

This field is provided to document the agency or company associated with this analysis or project.

Analysis Year

This field is provided to document the year for which the analysis is being performed.

Analyst

This field is provided to document the name of the analyst.

Calculation Approaches

There are two approaches available for service flow rates and service volumes calculations. These include: *Fixed Proportion of Ramp Flow* and *Fixed Freeway Demand*.

1. The Ramp demand flow rate will be stated as a fixed percentage of the arriving freeway flow rate. The service flow rates and service volumes are expressed as arriving freeway flow rates that result in the threshold densities within the ramp influence area that define the limits of the various levels of service.
2. A fixed freeway demand flow rate will be stated, with service flow rates and service volumes expressed as ramp demand flow rates that result in the threshold densities within the ramp influence area that define the limits of the various levels of service.

CAVs

Connected and automated vehicles, or CAVs, integrate two separate types of technology, communications and automation. The combination of these technologies is required to achieve roadway capacity increases, as described below:

- *Connected vehicles* transmit data about their status to their surroundings (e.g., roadside infrastructure, other road users). They also receive information about their surroundings (e.g., traffic conditions, weather conditions, presence of potential conflicting vehicles, traffic signal timing) that motorists can use to adjust their driving behavior in response to conditions present at a given time and location. This exchange of information offers potential safety, fuel economy, and environmental benefits. However, because a human is still driving the vehicle, car-following and other behavior that influences freeway capacity is not expected to fundamentally change.
- *Automated vehicles* take over all or a portion of the driving task. Depending on the level of automation, a human may still need to take over under certain conditions. In the absence of connectivity, the information available to automated vehicles is limited to that which can be gathered by on-board sensors, which is typically constrained by a sensor's line of sight and the rate at which the sensor takes measurements (e.g., 10 time per second). As a result, for both safety and passenger comfort reasons, current adaptive cruise control systems offer minimum time gaps that are similar to, or longer than, the gaps used by human drivers, and thus may decrease roadway capacity when in widespread use.
- *Connected and automated vehicles* communicate with each other and with roadside infrastructure. The connectivity element provides automated driving systems with more complete information about a vehicle's surroundings and enables cooperative vehicle maneuvers that improve roadway operations. The vehicles' enhanced detection capabilities, as well as redundancy in detection, enable an automated driving system to operate more efficiently and more safely than with only an on-board system.

Daily Service Volume

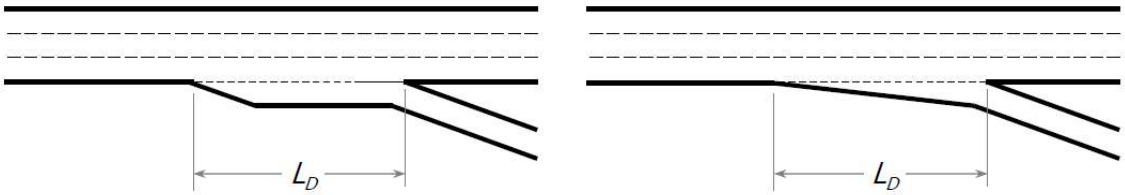
A daily service volume DSV_i is the maximum AADT that can be accommodated by the facility under prevailing conditions while LOS *i* is maintained during the worst 15-min period of the analysis day.

Date

This field is provided to document the date when the analysis is performed.

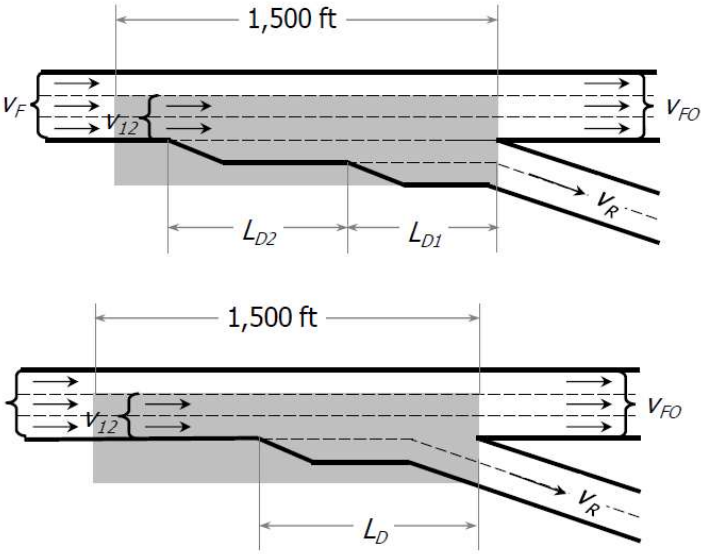
Deceleration Lane Length

This value defines the length for off-ramp deceleration lanes. The typical length of deceleration lanes for ramps should be obtained from the design standards used by the highway operation agency. It is measured from the departing point between the edge of the travel way for the freeway and the outer edge of the ramp (the first point) and the downstream intersection point of the freeway and inner ramp edge of the travel way (the second point).



(c) Parallel Deceleration Lane (d) Tapered Deceleration Lane

Two common types of diverge geometries are in use with two-lane off-ramps, as shown in the exhibit below. In the first, two successive deceleration lanes are introduced. In the second, a single deceleration lane is used. The left-hand ramp lane splits from Lane 1 of the freeway at the gore area, without a deceleration lane.



Where a single deceleration lane is used, there is no modification to the length of the deceleration lane L_D; where two deceleration lanes exist, the length is replaced by the effective length L_{Deff} in all equations.

For two-lane ramps in the Freeways module, the effective deceleration length must be calculated by the user based on the lengths of the two lanes. Where two deceleration lanes exist, the length of the deceleration lane L_D is replaced by the effective length L_{Deff} in all equations. The formula for calculating effective deceleration length is:

$L_{Deff} = 2*L_{D1} + L_{D2}$

where

L_{Deff} = Effective deceleration length,

L_{D1} = Length of the shorter deceleration lane, and

L_{D2} = Difference in length between the longer deceleration lane and the shorter deceleration lane

In merge and diverge areas, the capacity of the two outer lanes is reduced by 100 and 200 veh/h/ln, respectively. When the user sets the deceleration lanes to 1500 feet (or 457.2 meters in metric), only the outer lanes of the diverge experiences a capacity reduction, as opposed to normally both of the outer two lanes.

D-factor

D is the proportion of traffic moving in the peak direction of travel on a given roadway during the peak hour. It is used, along with AADT (annual average daily traffic) and the *K*-factor (proportion of AADT occurring during the peak hour), in the following equation to determine the demand volume (*V*) or directional peak-hour volume (*DDHV*) in a planning and preliminary engineering analysis:

$V = DDHV = AADT \times K \times D$

Directional distribution vary, but a typical value for both urban and rural freeways is 0.55. As with all default values, locally or regionally calibrated values are preferred and yield more accurate results. Both the *K*-factor and the *D*-factor have a significant impact on the estimated hourly demand volume.

Driver Population

Driver population describes the level of driver familiarity in the traffic stream and is used in adjustments for speed and capacity. The base traffic stream characteristics for basic freeway segments are representative of traffic streams composed primarily of commuters or drivers who are familiar with the facility.

Free-Flow Speed

1. The average speed of vehicles on a given segment, measured under low-volume conditions, when drivers are free to drive at their desired speed and are not constrained by the presence of other vehicles or downstream traffic control devices.
2. The theoretical speed when both density and flow rate are zero.

Freeway Demand

The number of vehicles, per hour, using the freeway mainline.

Grade Length

The length of the segment, in miles (or kilometers in metric), to represent the percent grade

Interchange Density

The average number of interchanges per mile (or per kilometer in metric), measured over 3 miles upstream and 3 miles downstream (or over 4.8 kilometers upstream and 4.8 kilometers downstream in metric) from the midpoint of the weaving segment

Jurisdiction

This field is provided to document any jurisdiction convention or project related information.

K-factor

K is the proportion of AADT (annual average daily traffic) that occurs during the peak hour. It is used, along with AADT and the *D*-factor (the proportion of peak-hour volume traveling in the peak direction), in the following equation to determine the demand volume (*V*) or directional peak-hour demand volume (*DDHV*) in a planning and preliminary engineering analysis:

$V = DDHV = AADT \times K \times D$

On urban freeways, the typical range of *K*-factors is from 0.08 to 0.10. On rural freeways, values typically range between 0.09 and 0.13. As with all default values, locally or regionally calibrated values are preferred and yield more accurate results.

For many rural and urban highways, this factor falls between 0.09 and 0.10. For highway sections with high peak periods and relatively low off-peak flows, the *K*-factor may exceed 0.10. Conversely, for highways that demonstrate consistent and heavy flows for many hours of the day, the *K*-factor is likely to be lower than 0.09. In general,

- The *K*-factor decreases as the AADT on a highway increases;
- The *K*-factor decreases as development density increases; and
- The highest *K*-factors occur on recreational facilities, followed by rural, suburban, and urban facilities, in descending order.

The *K*-factor should be determined, if possible, from local data for similar facilities with similar demand characteristics.

Level of Service (LOS)

A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A-F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst.

LOS on basic freeway and multilane highway segments is defined by density. Although speed is a major concern of drivers related to service quality, it would be difficult to describe LOS by using speed, as it remains constant up to high flow rates, i.e., 1,000 to 1,800 pc/h/ln for basic freeway segment (depending on FFS) and 1,400 pc/h/ln for multilane highway segments. Density describes a motorist's proximity to other vehicles and is related to motorist's freedom to maneuver within the traffic stream. Unlike speed, however, density is sensitive to flow rates throughout the range of flows.

Units: USC

The criteria for LOS is shown in the exhibit below:

LOS	Density (pc/mi/ln)
A	≤11
B	>11–18
C	>18–26
D	>26–35
E	>35–45
F	Demand exceeds capacity OR density >45

Units: Metric

Density is measured in passenger cars per kilometer per lane. The criteria for LOS is based on the following:

LOS	Density (pc/km/ln)
A	≤ 6.8
B	> 6.8–11.2
C	> 11.2–16.2
D	> 16.2–21.7
E	> 21.7–28.0
F	Demand exceeds capacity OR density > 28.0

Level Terrain

Any combination of grades and horizontal or vertical alignment that permits heavy vehicles to maintain the same speed as passenger cars. This type of terrain typically contains short grades of no more than 2%.

Minimum Freeway-to-Ramp Lane Changes

Minimum number of lane changes that a freeway-to-ramp weaving vehicle must make to complete the freeway-to-ramp movement successfully. This is only applicable for one-sided weaving segments. This is denoted as LC_{FR}.

Minimum Ramp-to-Freeway Lane Changes

Minimum number of lane changes that a ramp-to-freeway weaving vehicle must make to complete the ramp-to-freeway movement successfully. This is only applicable for one-sided weaving segments. This is denoted as LC_{RF}.

Minimum Ramp-to-Ramp Lane Changes

Minimum number of lane changes that must be made by one ramp-to-ramp vehicle to execute the desired maneuver successfully. This is only applicable for two-sided weaving segments. This is denoted as LC_{RR}.

Number of Lanes

This specifies the number of lanes on the freeway in the analysis direction. If there is a weaving segment, the number of auxiliary lanes is also included.

Number of Lanes on Ramp

This specifies the number of lanes on the ramp roadway (on- or off-ramp). There can be 1 or 2 lanes.

Number of Maneuver Lanes

Number of lanes from which weaving maneuvers may be made with either one or no lane changes; denoted as N_{WL}.

For one-sided weaving segments, the value of N_{WL} is either 2 or 3. The determination is made by a review of the geometric design and the configuration of the segment.

For two-sided weaving segments, the value of N_{WL} is always 0 by definition.

Peak Hour Factor (PHF)

The hourly volume during the analysis hour divided by the peak 15-min flow rate within the analysis hour; a measure of traffic demand fluctuation within the analysis hour.

Percent Grade

The longitudinal slope of a roadway; provided by the user as a percentage

Percent of Freeway-to-Ramp Flow

The flow rate of the freeway-to-ramp movement set as a percentage of the total flow rate.

Percent of Ramp-to-Freeway Flow

The flow rate of the ramp-to-freeway movement set as a percentage of the total flow rate.

Percent of Ramp-to-Ramp Flow

The flow rate of the ramp-to-ramp movement set as a percentage of the total flow rate.

Project Description

This field is provided for the user to document the analysis with any information for identification purposes.

Proportion of CAVs

This is the proportion of CAVs in the traffic stream. CAV is a connected automated vehicle, defined here as a vehicle with an operating cooperative adaptive cruise control system. The range of proportion of CAVs in the traffic stream is from 0 to 100.

The proportion of CAVs is used in determining a Capacity Adjustment Factor where CAVs are present in the traffic stream (CAF_{CAV}).

Proportion of Flow in Lanes 1 and 2

The flow rate in freeway lanes 1 and 2 immediately upstream of the ramp influence area is set at a percentage—converted from a proportion—of the approaching freeway flow rate.

Proportion of Ramp Demand

The ramp flow is set at a percentage—converted from a proportion--of the approaching freeway flow rate.

Roadway Type

Roadway types include Multilane Highways or Collector-Distributor (C-D) Roadways and Freeways. For Weaving segments, the LOS criteria changes based on the roadway type. For Merge and Diverge segments, the FFS range is somewhat lower (45-60 mi/h in USC or 72.4-96.6 km/h in metric) and can be estimated by using the methodology in HCM Chapter 12 if no field measurements are available. The capacity checks and the maximum desirable flow rates of the ramp influence areas also change based on the roadway type.

Rolling Terrain

Any combination of grades and horizontal or vertical alignment that causes heavy vehicles to reduce their speed substantially below that of passenger cars but that does not cause heavy vehicles to operate at crawl speeds for any significant length of time or at frequent intervals.

Segment Length

This is the distance in feet (or meters in metric) of each segment.

Default Segment Lengths

- Basic: 5280 ft (or 1609.3 m in metric)
- Merge: 1500 ft (or 457.2 m in metric)
- Diverge: 1500 ft (or 457.2 m in metric)
- Weaving: 3000 ft (or 914.4 m in metric)

Service Flow Rate

Service flow rates are the maximum rates of flow (within a 15-min period) that can be accommodated without exceeding the limits of the various levels of service. As is the case for service volumes, service flow rates can be found for LOS A-E, but none is defined for LOS F.

Service Volume

Service volume is the maximum hourly volume that can be accommodated without exceeding the limits of the various levels of service during the worst 15 min of the analysis hour. Service volumes can be found for LOS A-E. LOS F, which represents unstable flow, does not have a service volume.

Short Length

Short length is a measure of weaving segment length, which is the distance between the merge and diverge that form the weaving segment. Short length is the distance in feet (or meters in metric) between the end points of any barrier markings (solid white lines) that prohibit or discourage lane changing.

Side of Junction

This refers to the ramp side or location of the ramp relative to the freeway. There are two types: *right-hand* and *left-hand*.

Single-Unit Trucks (SUT)

Single-Unit Trucks are defined as one of two categories of heavy vehicles. Buses and RVs are treated as SUTs in the HCM. SUTs include the following:

- Other Two-Axle, Four-Tire Single-Unit Vehicles: Two-axle, four-tire vehicles, other than passenger cars. Generally pickup trucks, sports utility vehicles, and vans.
- Buses: All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. Excludes modified buses no longer capable of mass passenger transport.
- Two-Axle, Six-Tire, Single-Unit Trucks: All vehicles on a single frame with two axles and dual rear wheels. Includes some trucks, camping and recreational vehicles, and motor homes.
- Three-Axle Single-Unit Trucks: All vehicles on a single frame with three axles. Includes some trucks, camping and recreational vehicles, and motor homes.
- Four or More Axle Single-Unit Trucks. All trucks on a single frame with four or more axles.

Specific Grade

A single grade of a roadway segment or extended roadway segment expressed as a percentage

Target LOS

Target LOS is used in a planning and/or preliminary engineering analysis. This is the Level of Service (LOS) the analyst wishes to achieve based on other parameters, such as Number of Lanes and FFS.

See also *Level of Service (LOS)*.

Terrain Type

An extended length of highway containing a number of upgrades or downgrades where no single grade is long enough or steep enough to have a significant impact on the operation of the overall segment. There are three types of terrain: Level, Rolling, and Specific Grade.

See also *Level Terrain*, *Rolling Terrain*, and *Specific Grade*.

Time Analyzed

This field is provided to document the time frame of the analysis as morning peak, afternoon peak, existing conditions, future projection, etc.

Total Trucks

The percentage of trucks in the traffic stream. Trucks are heavy vehicles engaged primarily in the transport of goods and materials or in the delivery of services other than public transportation. All heavy vehicles are classified as single-unit trucks (SUTs) or tractor-trailers (TTs).

Tractor-Trailers (TT)

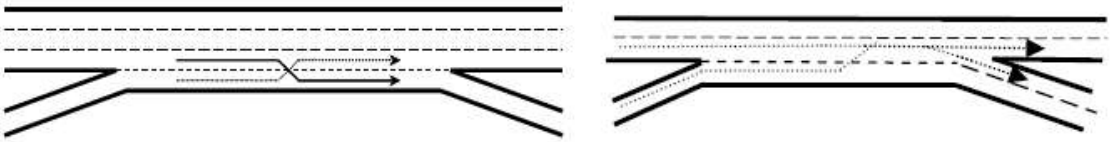
Tractor-Trailers are defined as one of two categories of heavy vehicles. TTs include the following:

- Four or Fewer Axle Single-Trailer Trucks: All vehicles with four or fewer axles consisting of two units, one of which is a tractor or straight truck power unit.
- Five-Axle Single-Trailer Trucks: All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.
- Six or More Axle Single-Trailer Trucks: All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.
- Five or Fewer Axle Multi-Trailer Trucks: All vehicles with five or fewer axles consisting of three or more units, one of which is a tractor or straight truck power unit.
- Six-Axle Multi-Trailer Trucks: All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.
- Seven or More Axle Multi-Trailer Trucks: All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit. Includes triple-trailer combinations.

Weaving Configuration

Configuration of a weaving segment refers to the way that entry and exit lanes are linked. The configuration determines how many lane changes a weaving driver must make to complete the weaving maneuver successfully. There are two types of weaving configurations: *one-sided* and *two-sided*.

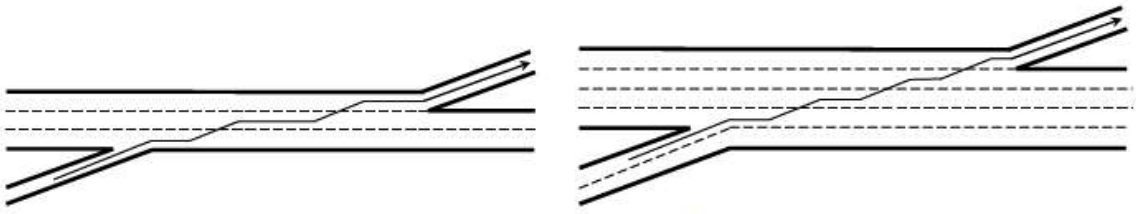
- A *one-sided weaving segment* is one in which no weaving maneuvers require more than two lane changes to be completed successfully. The following illustrates two examples of one-sided weaving segments:



(a) One-Sided Ramp Weave

(b) One-Sided Major Weave

- A *two-sided weaving segment* is one in which at least one weaving maneuver requires three or more lane changes to be completed successfully or in which a single-lane on-ramp is closely followed by a single-lane off-ramp on the opposite side of the freeway. The following illustrates two examples of two-sided weaving segments:



(a) Two-Sided Weaving Section with Single-Lane Ramps

(b) Two-Sided Weaving Section with Three Lane Changes

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