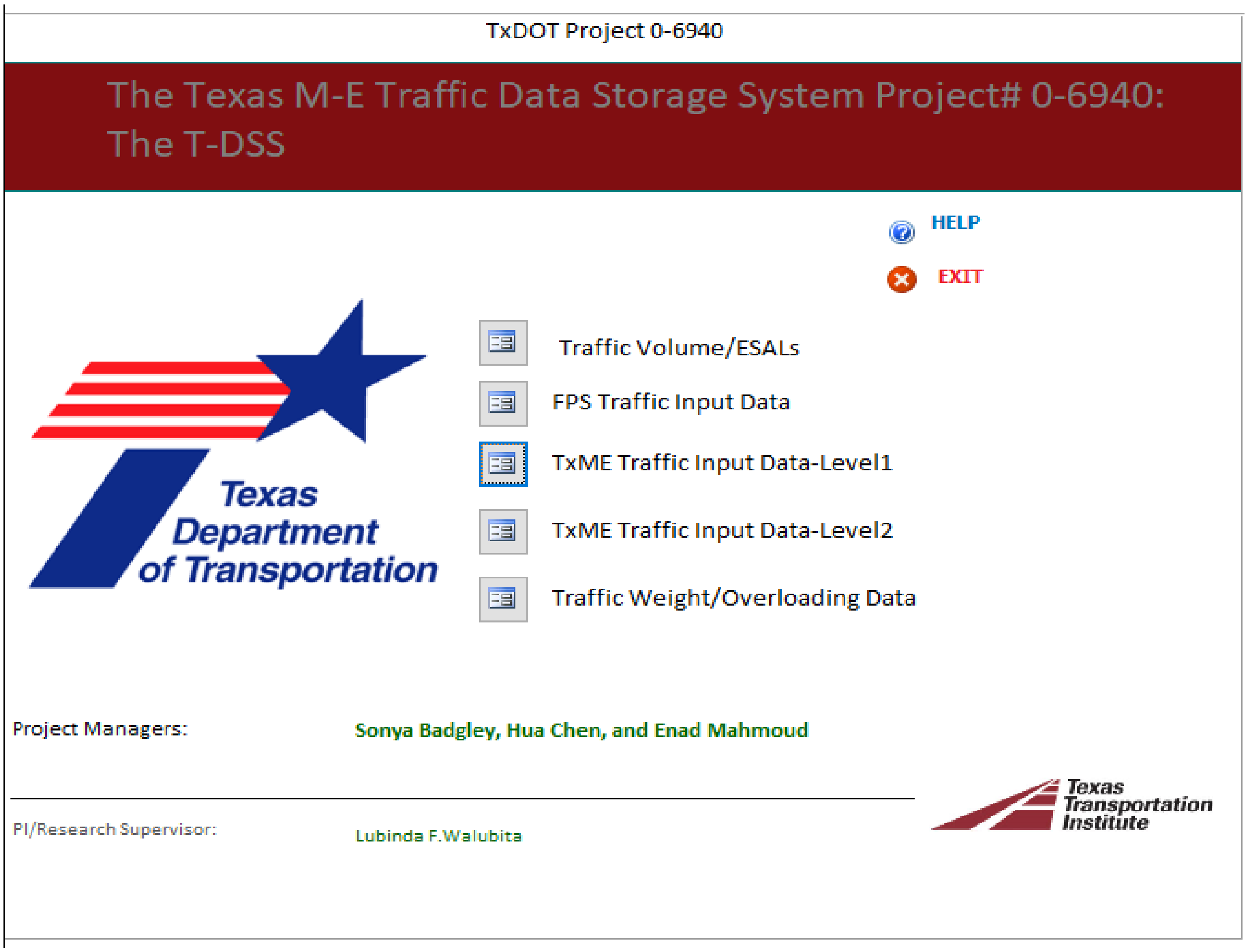
Project 0-6940: Develop System to Render Mechanistic-Empirical Traffic Data for Pavement Design

Product 0-6940-P2

Users' Manual and Guides for the M-E Traffic Database (T-DSS)



by

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TTI – The Texas A&M University System, College Station

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Users' Manual and Guides for the M-E Traffic Database (T-DSS)

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Lubinda F. Walubita.

The United States Government and State of Texas d not endorse products or manufactures. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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ADT	Average daily traffic
ADTT	Average daily truck traffic
ALD	Axle load distribution
ESAL	Equivalent single axle load
FHWA	Federal Highway Administration
FPS	Flexible pavement system
MAF	Monthly adjustment factor
M-E	Mechanistic-empirical
M-E PDG	Mechanistic-empirical pavement design guide
T-DSS	Traffic data storage system
TxACOL	Texas asphalt concrete overlay design
TxME	Texas mechanistic-empirical
WIM	Weigh-In-Motion

SECTION I. INTRODUCTION

SCOPE OF THE USER'S MANUAL

This user's manual aids users to understand and use the mechanistic-empirical (M-E) traffic data storage system (the T-DSS). The T-DSS is a Microsoft Access data storage system containing the essential outcomes of the project 0-6940 entitled "Develop System to Render Mechanistic-Empirical Traffic Data for Pavement Design." As a supporting material, this user's manual presents and describes the following points:

- Overall structure and data organization frame in the T-DSS.
- Data stored in the T-DSS, including units, values, and specific comments useful to users.
- The T-DSS interfaces including the layout formats.
- Tables under each interface to ease data retrieval from T-DSS. The data and attachment files in the T-DSS can also be exported or downloaded for use in M-E pavement design. Especially, the manual emphasizes the retrieval of inputs data needed for M-E models and the related software, including the flexible pavement design system (FPS), the Texas mechanistic-empirical (TxME), the Texas asphalt concrete overlay design and analysis system (TxACOL), the AASHTOWare Pavement M-E Design, and the mechanistic-empirical pavement design guide (M-E PDG).
- Guidance on Federal Highway Administration (FHWA) vehicle classification and the FHWA weight classification for different categories of axles including single, tandem, tridem, and quadrem.
- A map of the Texas weigh-in-motion (WIM) location and a summary of the geographic coordinates of the WIM sites as reported in the T-DSS.

THE MS ACCESS DATA STORAGE SYSTEM

In practice, the Microsoft Access is a platform, which enables the management and exploitation of large size databases. In project 0-6940, various traffic data were collected, processed, and analyzed to generate useful data inputs and parameters for pavement design. The outcomes were synthetized and stored as a MS Access database. The MS Access format developed for this traffic database grants access to data and files as it provides a relational database management interface. Furthermore, MS Access provides the option of exporting filtered or partial data as directly usable MS supported format (e.g., Microsoft Word®, Excel®, portable document format).

SECTION II. STRUCTURE OF THE T-DSS

MS Access is a user-friendly interface for database management and was selected as a platform for the T-DSS. MS Access is available on most computers as part the MS package. Hence, the T-DSS is a convenient data management system that will assist Texas Department of Transportation engineers and general stakeholders to easily access traffic data of highways across Texas. Figure 1 presents the main screen menu of the T-DSS.

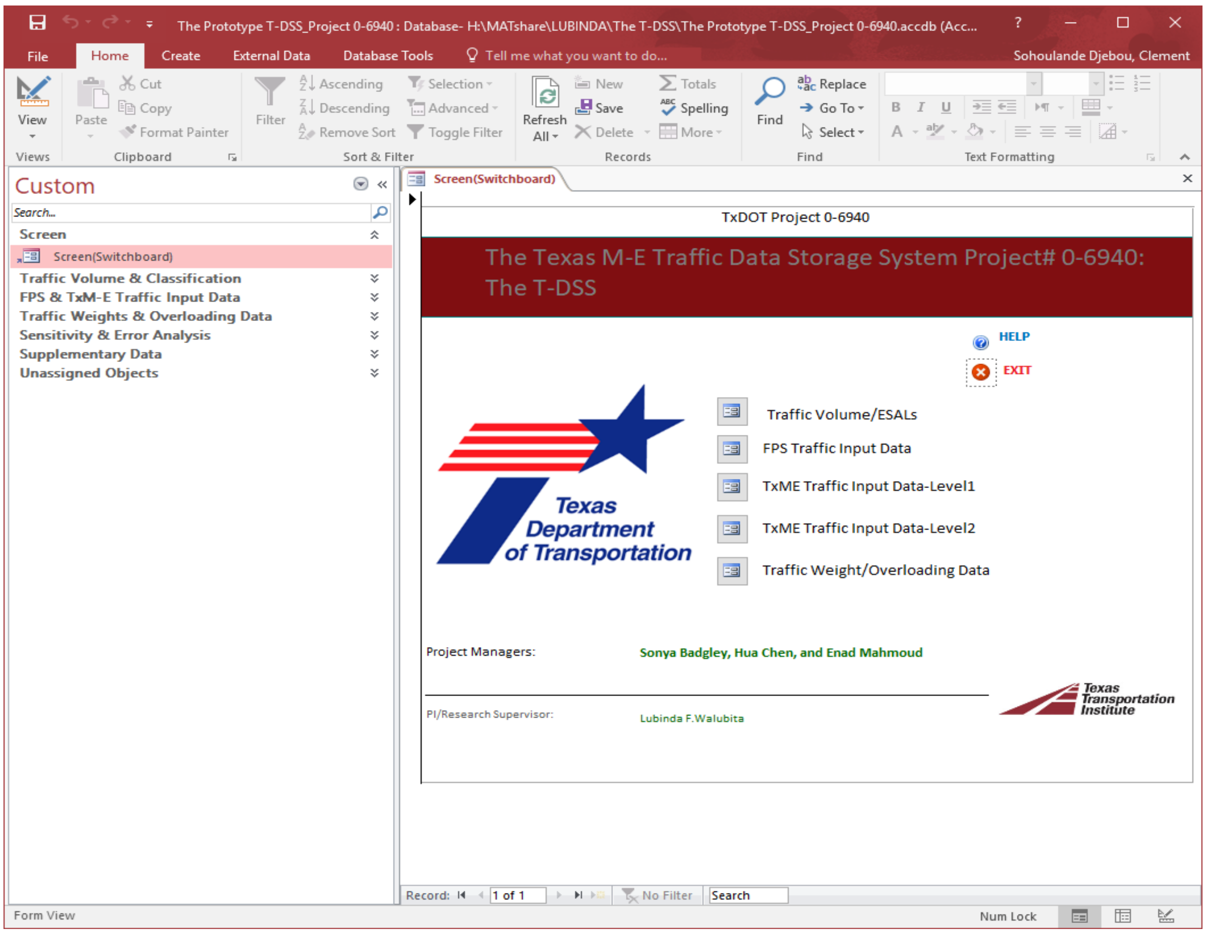


Figure 1. The T-DSS Main Screen.

The T-DSS is structured into six groups as showed in Figure 1. Results of the traffic data analyses are synthesized and organized under these groups. Each group is an interface containing several tables, and in total, 30 tables are set under these groups. The structure of the T-DSS enables interrelations between the groups under which data can be easily populated upon users' requests. The data constituting the T-DSS include the following:

- Traffic volume and vehicle classification parameters.
- FPS and M-E traffic inputs.
- Input parameters for TxME, M-E PDG, AASHTOWare, TxACOL, and TxCrackPro.
- Axle load distribution.

- Overweigh traffic statistics.
- Cumulative 20-year 18-kip equivalent single axle loads (ESALs) for flexible pavements and 30-year 18-kip ESALs for concrete pavements.

The T-DSS is a collection of traffic parameters, ready to use for pavement design and transportation planning.

SECTION III. INTERFACES AND SECTIONS OF THE T-DSS

As aforementioned, the T-DSS is organized into six groups, namely the following:

- Traffic Volume and Classification.
- FPS and TxME Traffic Input Data.
- Traffic Weights and Overloading Data.
- Sensitivity and Error Analysis.
- Supplementary Data.
- Unassigned Objects.

The computed traffic parameters are compiled as tables under each group.

TRAFFIC VOLUME AND CLASSIFICATION

As shown in Figure 2, the group of traffic volume and classification contains three tables, namely, Table 01, 02, and 03. The Table 01 contains traffic volume data, estimated ESALs, and statistics on vehicle speed. Table 02 contains the traffic volume parameters including average daily traffic (ADT), average daily truck traffic (ADTT), and vehicle classification (i.e., percentage of each class of vehicle/truck in the ADT and ADTT). Table 03 contains detailed data of hourly and daily traffic volume distribution. The hourly volume is reported as percentages of ADT corresponding to the different hours of the day (i.e., 00 am through 11 pm). The daily distribution is reported as the average absolute value of daily traffic corresponding to each day of the week (i.e., Monday through Sunday).

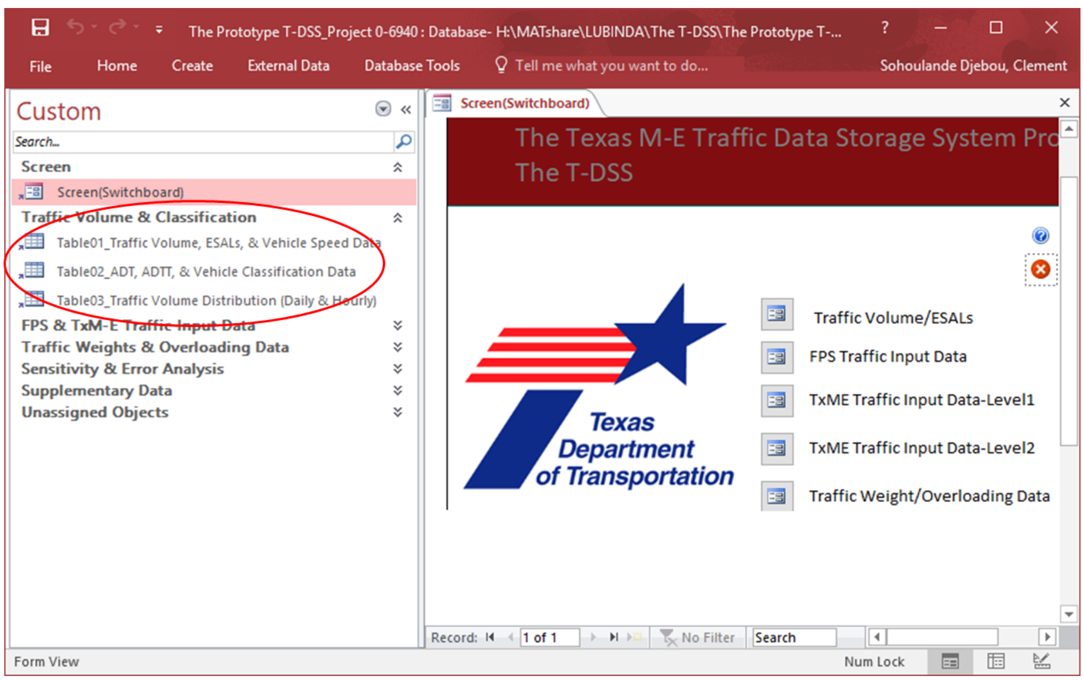


Figure 2. The Traffic Volume and Classification Interface.

FPS AND TXME TRAFFIC INPUT DATA

Figure 3 presents a screenshot of the FPS and TxME input data group. The interface is made of seven different tables, namely Table 04, 05a, 05b, 05c, 06, 07a, and 07b.

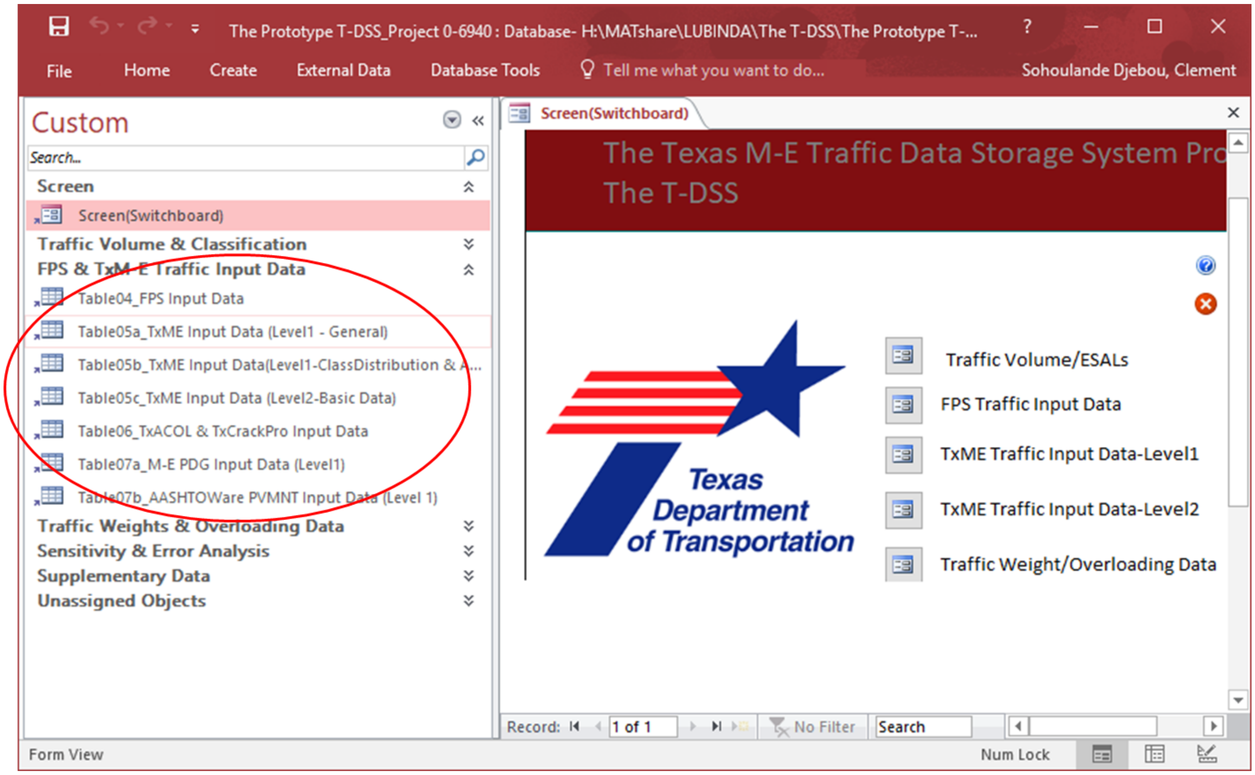


Figure 3. FPS and TxME Traffic Input Data Interface.

As shown in Figure 4, Table 04 recaps the FPS input data that include the computed ADT, the projected 20-year ADT, the 20-year cumulative 18 kips ESALs, the average speed, the percentage truck in ADT, the average tenth highest wheel load, and the percentage of tandem axles.

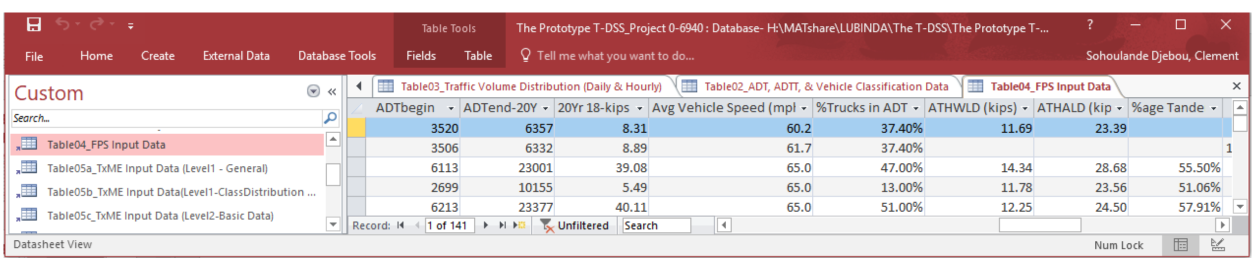


Figure 4. FPS Input Data in The T-DSS.

Table 05a summarizes the TxME input data (Level 1) and includes the computed two-way average annual daily truck traffic, the number of lanes in the design direction, the percentage of trucks in the design direction, and the percentage of trucks in the design lane. The remaining TxME input data (Level 1) are summarized in the Table 05b and contains data on vehicle class distribution, traffic growth rate, and average single, tandem, tridem, quad axles per truck. Figure 5 illustrates Table 05a and 05b including the traffic data required for the TxME.

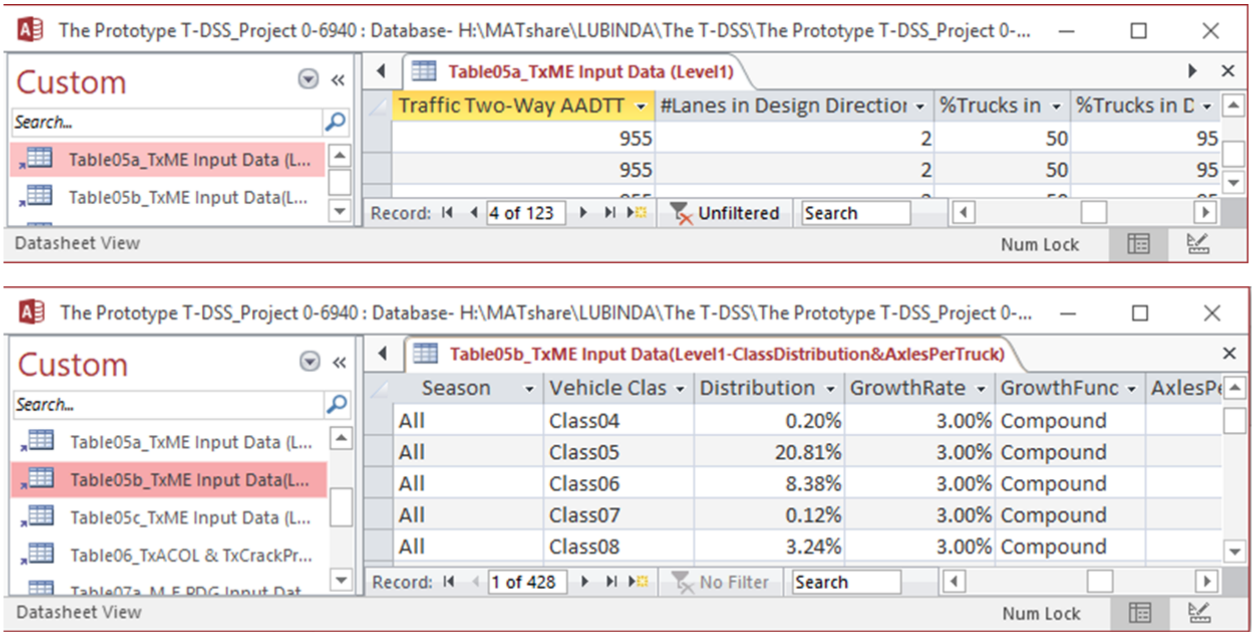


Figure 5. TxME Input Data (Level 1 Data) in the T-DSS.

As displayed in Figure 6, Table 05c is structured for compiling Level 2 TxME Input data computed for different highway sections. Each highway section corresponds to a location were a permanent or portable WIM system was installed for traffic data collection. These data include the standard tire pressure value, the ADT at beginning, the projected 20-year ADT, the 20-year cumulative 18 kips ESALs, and the operational speed for each highway section.

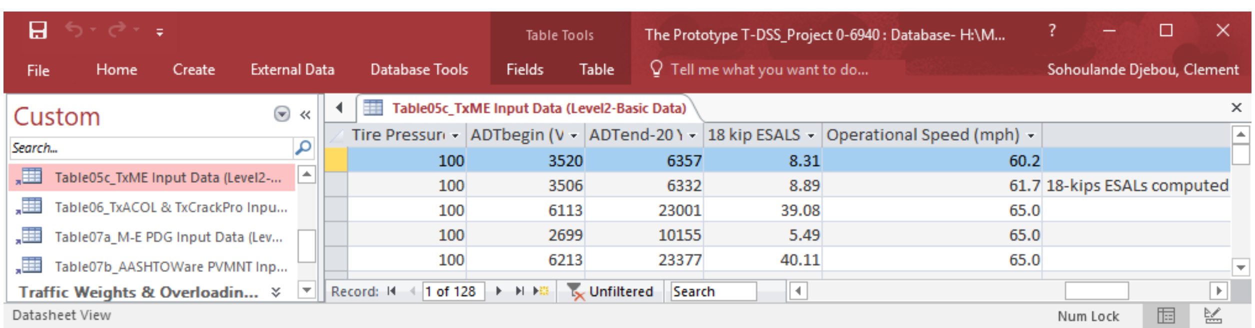


Figure 6. TxME Input Data (Level 2 Data) in the T-DSS.

Table 06 contains the input traffic parameters needed for TxACOL and TxCrackPro. As shown in Figure 7, these traffic parameters include the ADT at the beginning, the projected 20-year ADT, the 20-year cumulative 18 kips ESALs, and the operational speed associated with the highway.

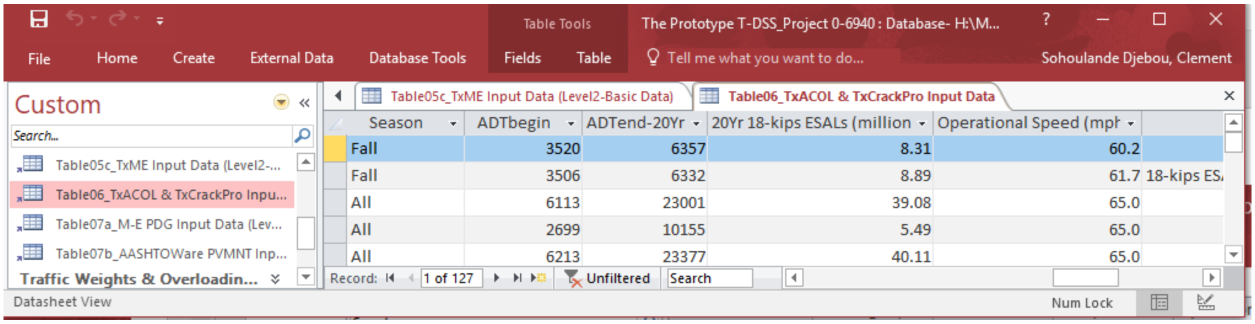


Figure 7. TxACOL and TxCrackPro Input Data in the T-DSS.

As indicated in Figure 8, Tables 07a and 07b report the traffic inputs needed for M-E PDG and AASHTOWare pavement design software, respectively. These inputs are essentially the monthly adjustment factors (MAF) and the axle load distribution (ALD) files. The MAF and ALD files are uploaded in the appropriate format in the corresponding tables.

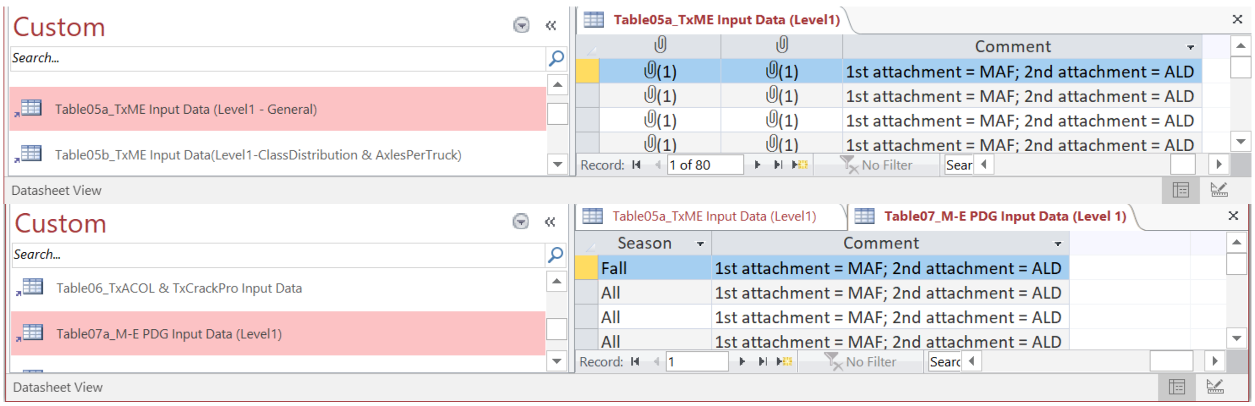


Figure 8. M-E PDG and AASHTOWare Input Data in the T-DSS.

TRAFFIC WEIGHTS AND OVERLOADING DATA

Figure 9 presents the traffic weights and overloading data interface as it is in the T-DSS. This interface contains eight different tables including Table 08, 09a, 09b, 09c, 09d, 09e, 09f, and 10. These tables summarize the different levels of vehicle weight data analysis.

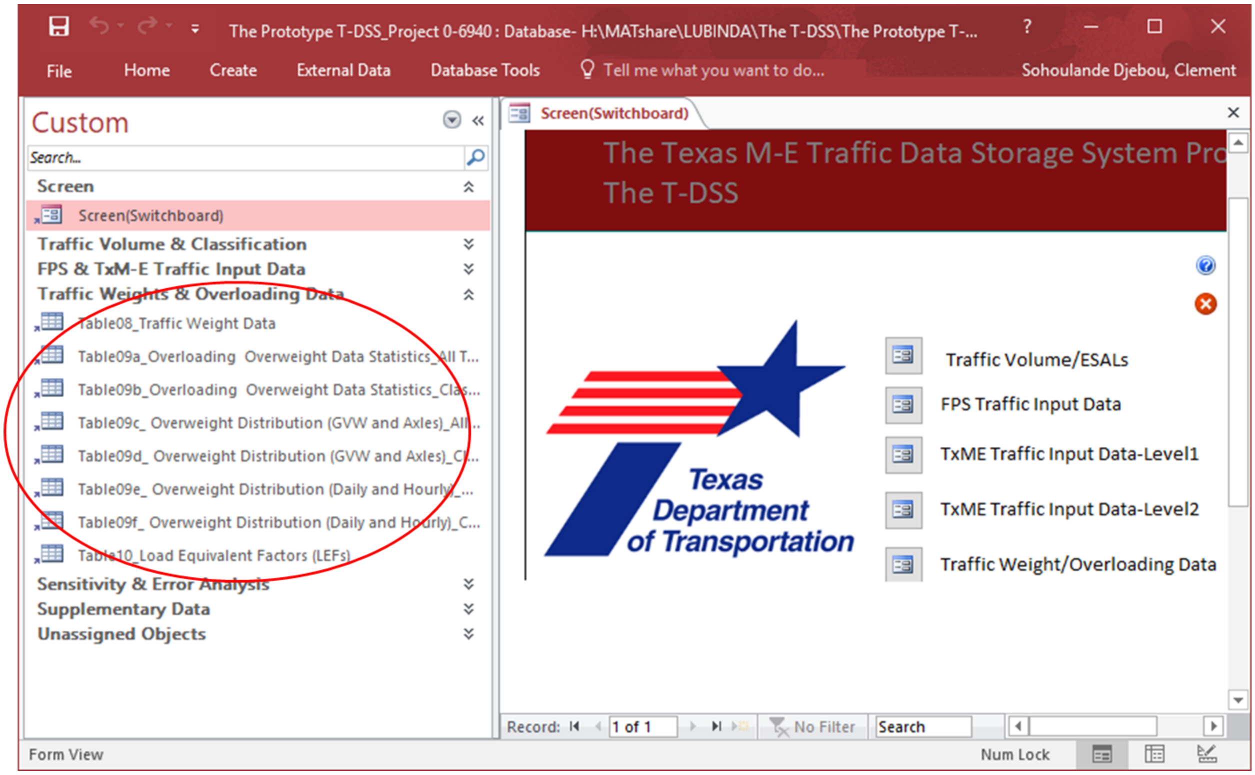


Figure 9. Traffic Weights and Overloading Data Interface.

In the T-DSS, Table 08 summarizes the general location of the highways sections. Table 9a, 9b, 9c, and 9d summarize different types of vehicle (truck) overloading statistics. As shown in Figure 10, these overloading statistics include the gross vehicles weight, daily overload count, single axle overload statistics, tandem overload statistics, tridem overload statistics, and quad overload statistics.

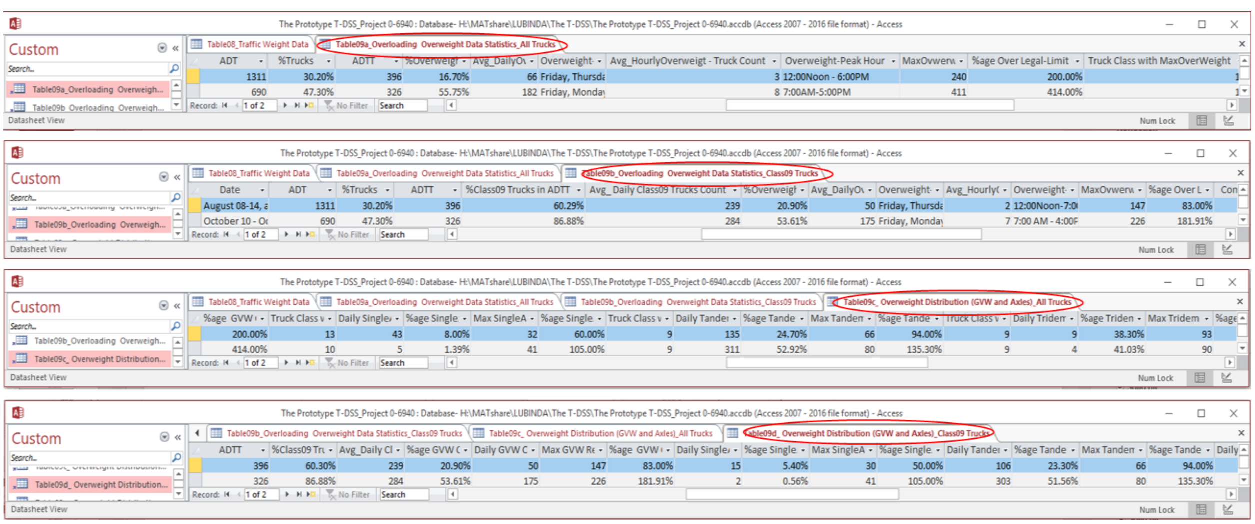


Figure 10. Interface of Overweight Analysis in the T-DSS

Figure 11 presents the interface for daily and hourly overloading statistics. Table 09e reports the daily and hourly overloading statistics for all trucks while Table 09f reports the statistics only for Class 9 trucks that is the most represented truck on all the highways analyzed.

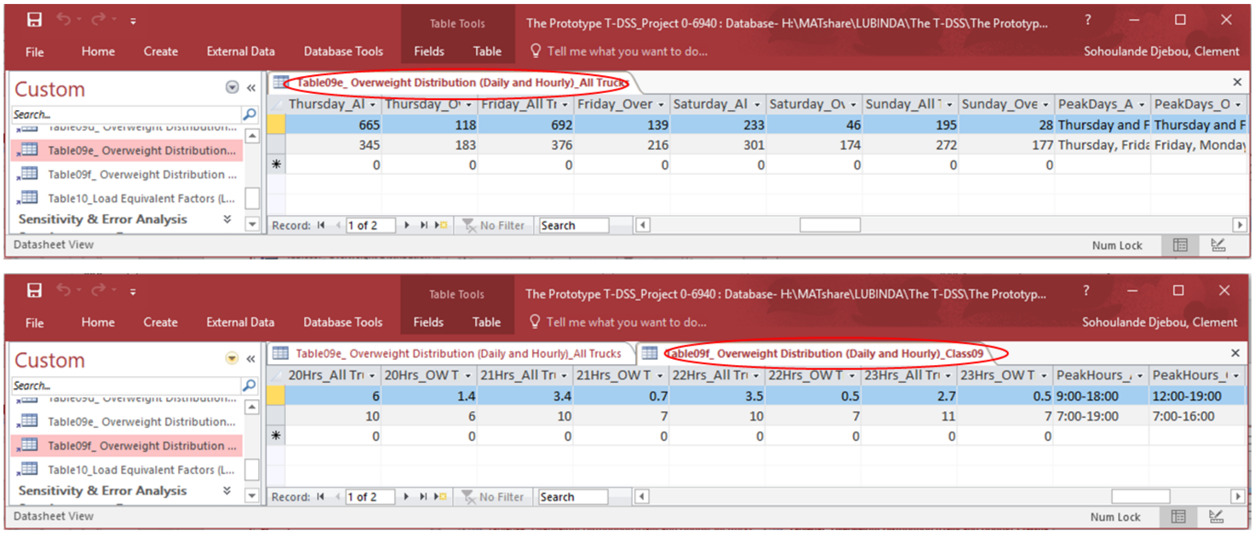


Figure 11. Interface of Daily and Hourly Overweight Analysis in the T-DSS.

SENSITIVITY AND ERROR ANALYSIS INTERFACE

Figure 12 shows the sensitivity and error analyses. These analyses were performed with the portable WIM data and the results indicate the accuracy of the portable WIM system. The outcomes of the sensitivity analyses include the estimates of standard deviation and covariance values based on the Class 9 truck data.

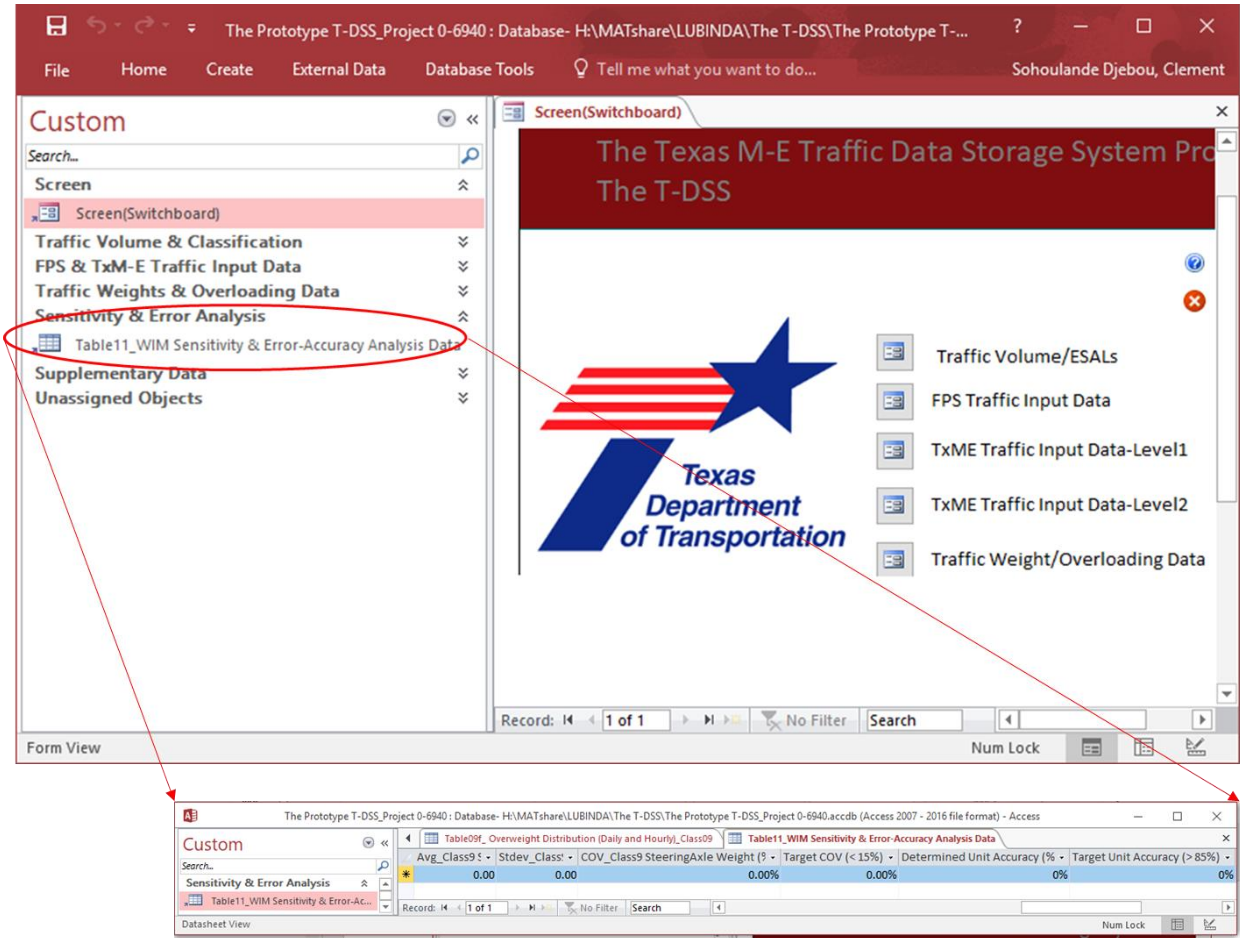


Figure 12. Sensitivity and Error Analysis Interface in the T-DSS.

SUPPLEMENTARY DATA INTERFACE

This component is designed to provide additional information to T-DSS users. As shown in Figure 13, the information reported under this interface is relevant to instruct users on the FHWA vehicle and weight classifications and the permanent WIM stations in Texas. This interface is made of four distinct tables including Tables 12, 13, 14, and 15.

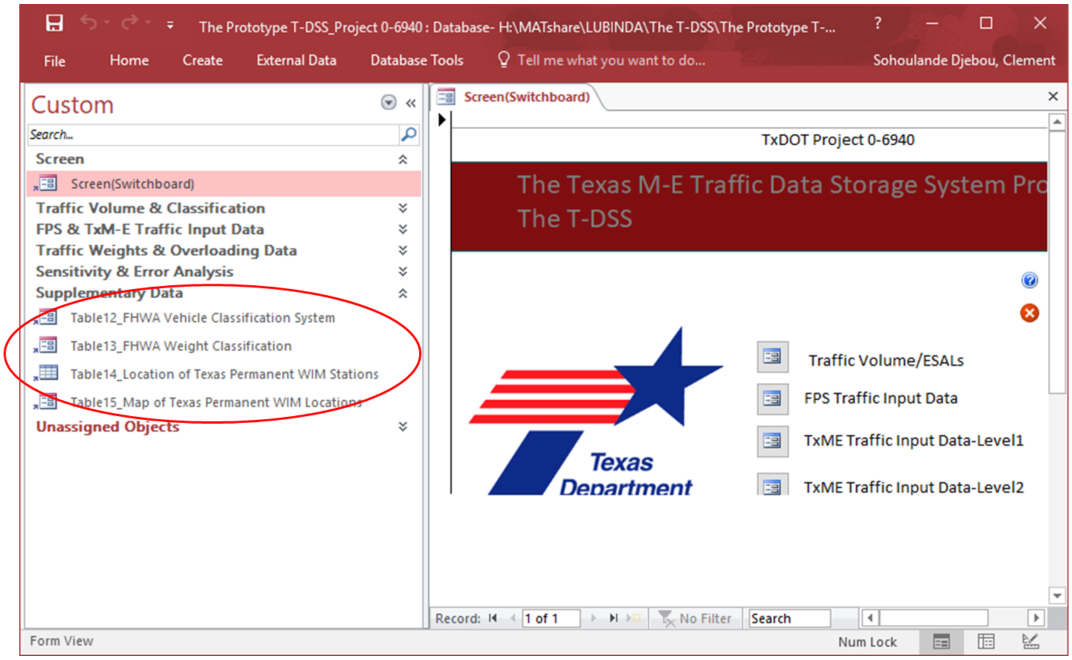


Figure 13. Sensitivity and Error Analysis Interface in the T-DSS

Table 12 as illustrated in Figure 14 presents the guidance on the FHWA classification that is used for the traffic data analysis. The description of each vehicle class can be used as a supporting tool by the T-DSS users.

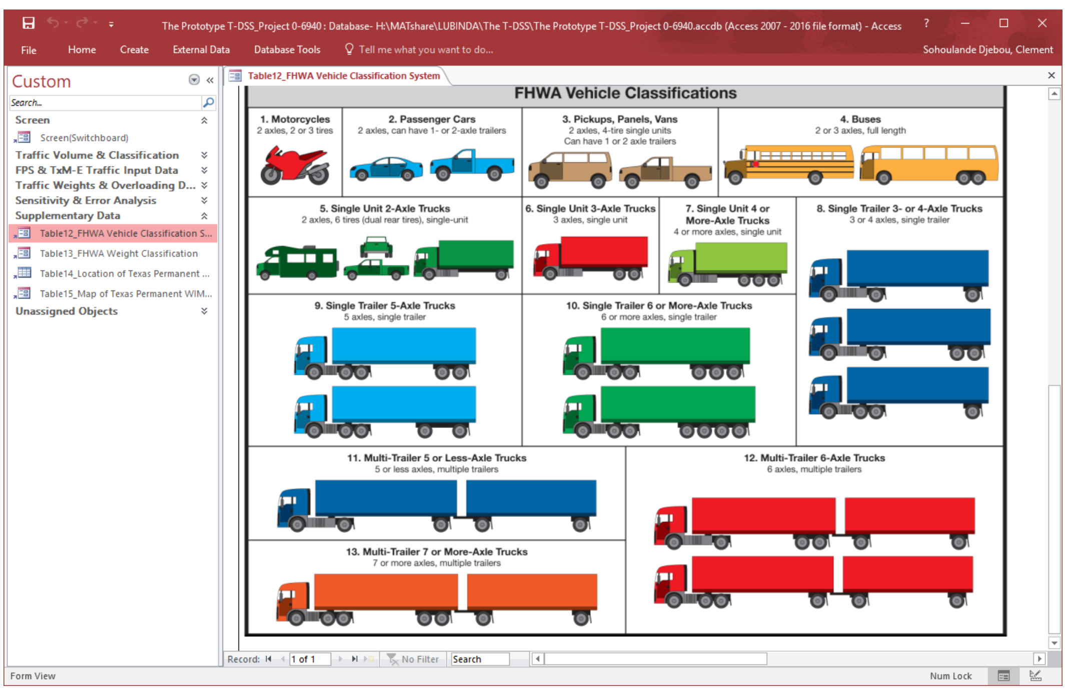
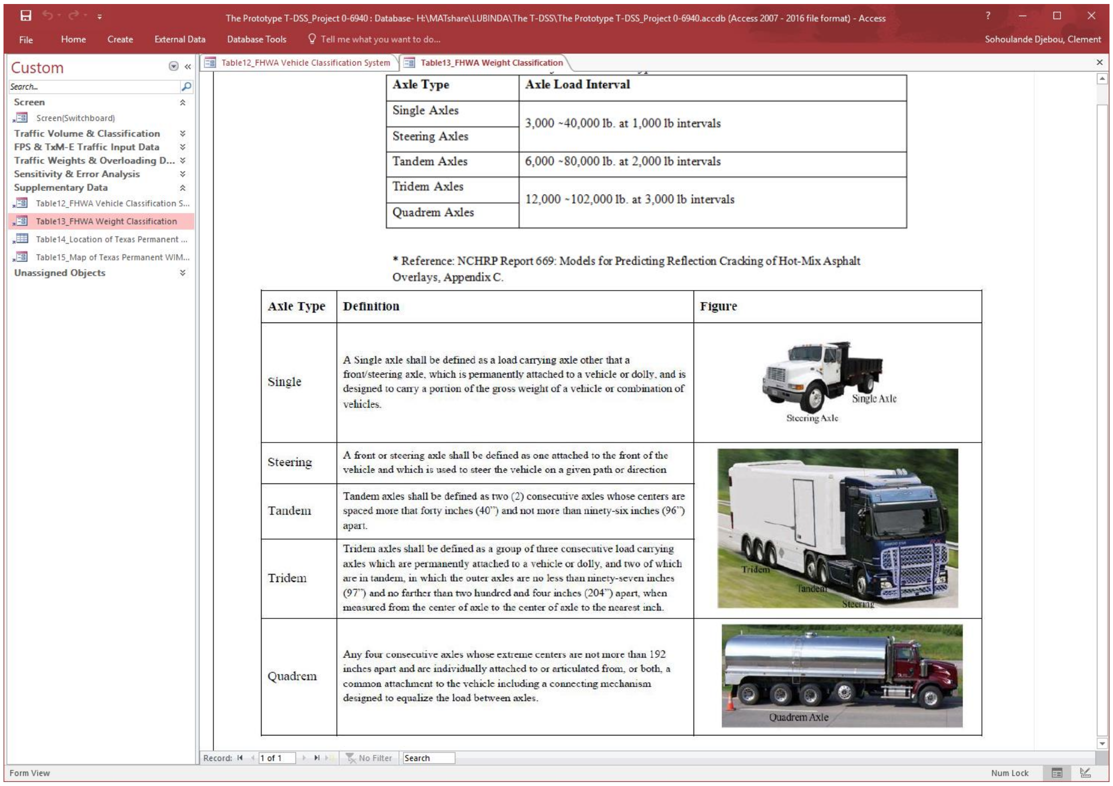


Figure 14. Guidance on FHWA Vehicle Classification in the T-DSS.

Table 13 provides a detailed guidance for FHWA weight classification. The definition and standard weight features are presented for individual axle type including single, steering, tandem, tridem, and quadrem axles (see Figure 15).



Axle Type	Axle Load Interval
Single Axles	3,000 ~40,000 lb. at 1,000 lb intervals
Steering Axles	
Tandem Axles	6,000 ~80,000 lb. at 2,000 lb intervals
Tridem Axles	12,000 ~102,000 lb. at 3,000 lb intervals
Quadrem Axles	

* Reference: NCHRP Report 669: Models for Predicting Reflection Cracking of Hot-Mix Asphalt Overlays, Appendix C.

Axle Type	Definition	Figure
Single	A Single axle shall be defined as a load carrying axle other that a front/steering axle, which is permanently attached to a vehicle or dolly, and is designed to carry a portion of the gross weight of a vehicle or combination of vehicles.	
Steering	A front or steering axle shall be defined as one attached to the front of the vehicle and which is used to steer the vehicle on a given path or direction	
Tandem	Tandem axles shall be defined as two (2) consecutive axles whose centers are spaced more that forty inches (40") and not more than ninety-six inches (96") apart.	
Tridem	Tridem axles shall be defined as a group of three consecutive load carrying axles which are permanently attached to a vehicle or dolly, and two of which are in tandem, in which the outer axles are no less than ninety-seven inches (97") and no farther than two hundred and four inches (204") apart, when measured from the center of axle to the center of axle to the nearest inch.	
Quadrem	Any four consecutive axles whose extreme centers are not more than 192 inches apart and are individually attached to or articulated from, or both, a common attachment to the vehicle including a connecting mechanism designed to equalize the load between axles.	

Figure 15. Guidance on FHWA Weight Classification in the T-DSS.

As shown in Figure 16, Table 14 reports the detailed location information of Texas permanent WIM stations addressed in the T-DSS. The information includes highway name, WIM site identification, and the geographic coordinate (latitude and longitude). Table 15 presents a map featuring the permanent WIM stations across Texas.

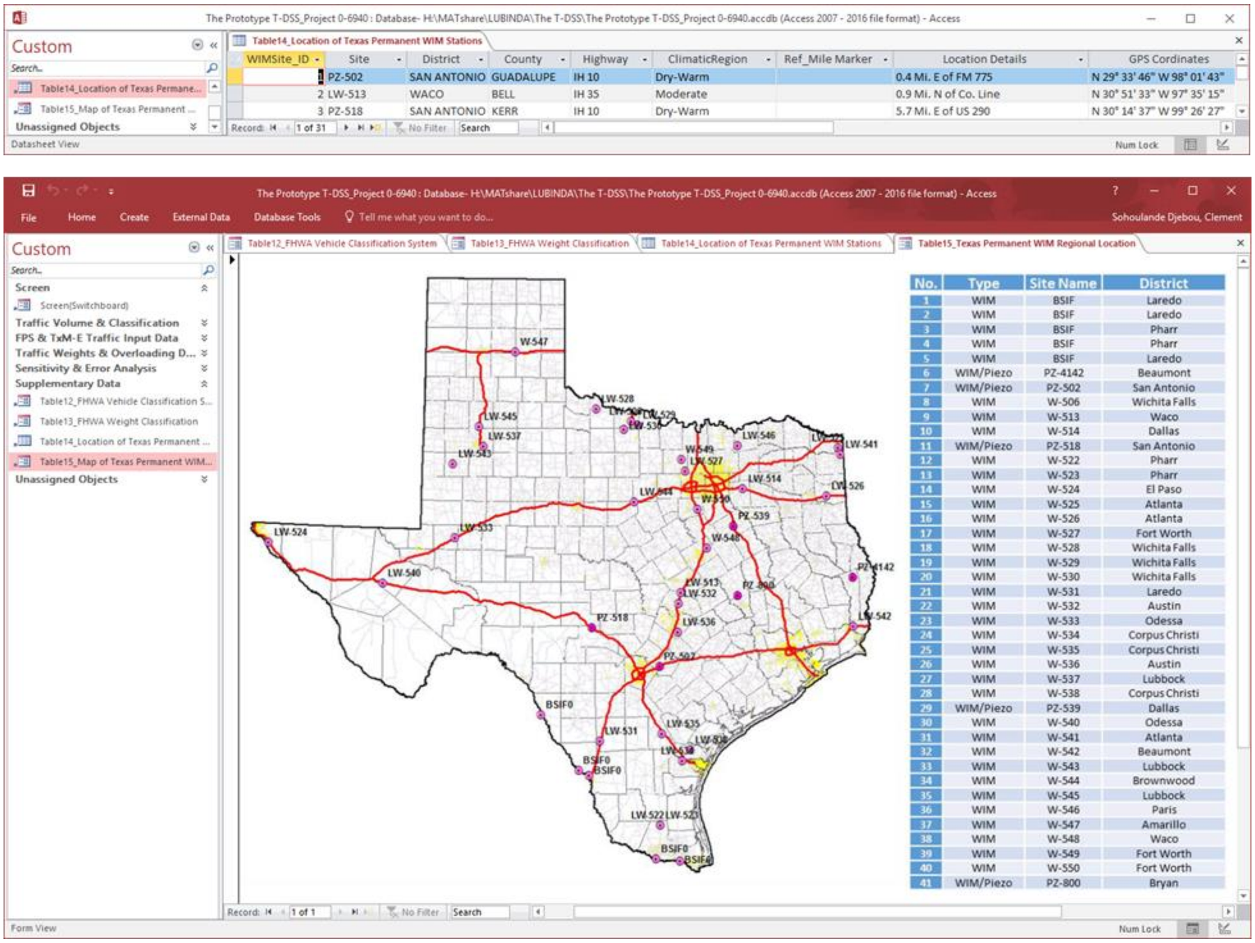


Figure 16. Location of Permanent WIM Stations in the T-DSS.

UNASSIGNED OBJECTS INTERFACE

The group of unassigned objects interface contains all the tables unassigned to any group because they are being processed. Table 16 includes the design parameters used for concrete pavements, which were collected and estimated using permanent and portable WIM and pneumatic traffic tube data, as presented in Figure 17.

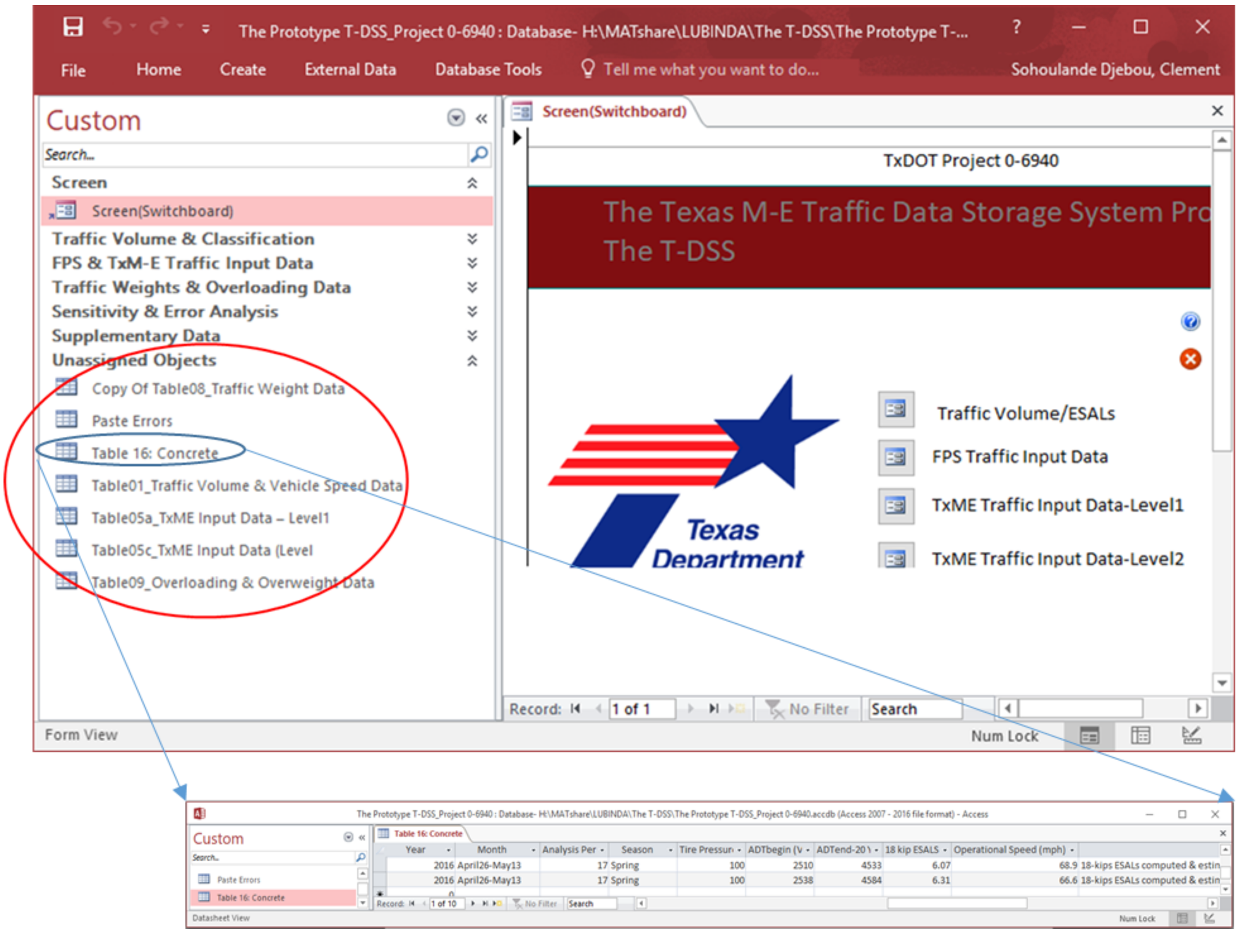


Figure 17. Interface for Unassigned Objects in the T-DSS.