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16. Abstract

Comprehensive and reliable databases are essential for the development, validation, and calibration of any pavement design and rehabilitation system. These databases should include material properties, pavement structural characteristics, highway traffic characteristics, environmental conditions, and performance data. In general, performance data consists of the development of rutting, roughness, and cracking.

It is true that these databases are currently available in Texas; however, they were originally designed and are currently being maintained with specific objectives in mind, which are not necessarily their potential uses for pavement design. Specifically, some of these databases have been designed for network level applications, not compatible with the calibration of data intensive performance models such as those typical of mechanistic-empirical design systems.

The goal of this research project is the development of the Texas Flexible Pavement Database. In order to achieve this goal, a plan for the development of a sustainable database was conceived, followed by the development of interim database structures in MS Access for uploading the required data and for data sharing. The initial population of the database has been initiated with the objective of performing local calibration. This integrated database approach has been designed as a project-level application with the purpose of developing, validating and calibrating empirical or mechanistic flexible pavement design models. It will interact with and complement the Pavement Management Information System (PMIS) and other existing databases such as the Design and Construction Information System (DCIS). This report summarizes the research progress during the first year of the research project.

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Chapter 1. Introduction

1.1 Background

For more than 30 years, in a quasi-continuous effort that began in 1972, the Texas Transportation Institute (TTI) has maintained a Texas Flexible Pavement Database. Originally, the database comprised 350 pavement sections that were selected following a stratified random sampling approach. The number of sections selected in each Texas Department of Transportation (TxDOT) district was proportional to the total number of miles in each district for each type of facility (e.g., Interstate, U.S. and State Highways, Farm-to-Market and Ranch-to-Market roads, etc.). This process resulted in the sampling of a large number of FM roads. Therefore, because of the strategic and economic importance of the interstate system, these facilities were sampled at a higher rate. The data collected and contained in this database have been the basis for developing the performance equations and pavement condition prediction capabilities that were incorporated into various optimization routines, which eventually became part of the Flexible Pavement System (FPS) software for flexible pavement design.

In addition to structural and basic condition information, deflection measurements were performed and complete condition surveys were carried out to determine the serviceability index of the various sections contained in the database. Weather data were also taken from the records of weather stations in the counties where the sections were located. In the process, a backup system of weather stations was also installed. With the advent of mechanistically-based pavement design approaches, the popularization of the Falling Weight Deflectometer (FWD) and backcalculation techniques, and the increased need for designing overlays, data needs became more demanding and maintaining such a large database for design purposes became unrealistic and unfeasible. Thus, in 1988, TxDOT Project 0-187-6, "Preserving the Texas Pavement Database," was initiated to:

- Preserve, update and improve the Texas Flexible Pavement Database,
- Store all condition and deflection data that are collected by TxDOT personnel on the pavement sections in the database, and
- Revise, using the new data, the pavement distress and performance equations for each type of pavement represented in the database.

Once Project 0-187-6 concluded, a period of time followed during which data were not collected and the database was not maintained. This was reverted in 2001, when another project modification was put in place to re-establish the Texas Flexible Pavement Database and to facilitate its full implementation. The objective of this modification was to fill in the experimental cells that were lacking, primarily covering pavement structures in different environmental regions. The full experimental design included the following variables: type of pavement structure, environmental conditions, traffic loads, layer thickness, and material types. The experimental design necessary to take into account possible levels for all these variables was not economically feasible, so the project focused on a partial experiment that was more realistic.

The implementation plan established that the database was "to be used to validate and verify design data being generated by District Pavement Engineers." In addition, the database was to be applied for calibrating the performance curves used in FPS-19W and other design algorithms used by TxDOT. The database was also to be used to validate modulus values used in FPS-19W and to monitor the changes in material stiffness during the life of the pavement.

The experimental design considered in this project consisted of almost 500 sections that included:

1) Six pavement types,
2) Two subgrade types (weak and strong),
3) Five traffic levels, and
4) Five environmental regions (dry-cold, dry-warm, wet-cold, wet-warm, and mixed).

Although logical, this goal turned out to be challenging due to the gigantic effort that it implied. Thus, in 2003, another project modification contemplated the incorporation of the data corresponding to the Long Term Pavement Performance (LTPP) studies contained in the DataPave database (http://www.ltpp-products.com/). Sections from the General Pavement Studies (GPS) and Specific Pavement Studies (SPS) were incorporated into the scope of the project. These data were to be used to perform a sensitivity analysis to the design variables using the mechanistic design guide.

The belief of the research team for the current research project (0-5513) is that the resources required to maintain and manage a project-level database containing information of several hundred sections are very significant and may not be sustainable. The database generated as a result of the LTPP studies, DataPave (FHWA, 2004), is the largest and most comprehensive pavement performance database generated to date. The database contains a large number of fields, which makes data collection and maintenance a task that is economically and practically challenging. The database is rich in data that can easily be collected and processed, such as FWD deflection data and backcalculated moduli. However, it often lacks accurate essential information such as well-characterized highway traffic loads (counts, classification, axle load spectra) (Prozzi and Hong, 2006; Prozzi, Hong and Leidy, 2006).

As discussed earlier, to some extent, the same applies to local efforts with similar objectives. Work on the development of a Texas Flexible Pavement Database has been ongoing for more than 30 years. The research set logical objectives; however those objectives were too wide-ranging and almost exhaustive and became unachievable and unrealistic within reasonable budget and time constraints.

1.2 Other Research Projects

In recent years the Transportation Research Board (TRB), through their National Cooperative Highway Research Program (NCHRP), invested more than 6 years and $6.5 million putting together the recommended “Mechanistic-Empirical Guide for the Design of New and Rehabilitated Pavement Structures,” or simply the MEPDG (NCHRP, 2006). More than 20 years of pavement research and experience were compiled into a comprehensive document, and corresponding software was developed for designing new and rehabilitated flexible and rigid pavement structures. The software and relevant information is available at http://www.trb.org/mepdg/. The performance models contained in the software have been calibrated for national standards and, therefore, their applicability to specific regional conditions is questionable (Prozzi and Hong, 2005).

In particular, two recent research projects, 0-4510, "Evaluate Equipment, Methods, and Pavement Design Implications for Texas Conditions of the AASHTO 2002 Axle Load Spectra Traffic Methodology," and 0-4714, "Development of a Strategic Plan for the Implementation of the AASHTO 2002 Design Guide for TxDOT Operations," sponsored by TxDOT indicated that, in numerous instances, the MEPDG produced unreasonable results for typical Texas structures and environmental conditions (Prozzi, Hong and Leidy, 2006). Similar conclusions have been observed in other states. There are a number of potential reasons for these discrepancies, including:

1) Lack of calibration to local environmental conditions in Texas;
2) Inaccurate pavement response models (e.g., multi-layer linear elasticity);
3) Inadequate transfer functions or pavement performance models to capture Texas pavement design technology; and
4) Problems inherent to the functionality of the software itself.

The lack of accuracy in the performance predictions can partially be attributed to the lack of an accurate local pavement database to calibrate the models. Interestingly, the following observation is relevant: the original intent of NCHRP 1-37A was to use data from LTPP for development, validation, and calibration of the performance models. This task proved to be extremely laborious due to the reduced number of LTPP sections containing complete information. It should be noted that some of the Texas LTPP sections provided some of the best data available.

Other data sources were also utilized, including the results of the American Association of State Highway Officials (AASHO) Road Test, which took place in the late 1950s and early 1960s (probably the better designed and most accurate pavement performance database available to date). The AASHO Road Test database, however, has other limitations related to the change in technology over the past 50 years. These changes affect material technology, construction techniques, and traffic characteristics. Furthermore, the subgrade conditions and environmental effects from the AASHO Road Test are drastically different from those found in Texas.

Given the above-mentioned shortcomings, it should be emphasized that, in its current format, the MEPDG and associated software can be considered the most powerful and comprehensive pavement performance analysis tool ever put together. For this reason, it is recommended that TxDOT incorporate the correct and accurate components and ignore or discard those that are not realistic or relevant to local conditions.

It is important to note that the MEPDG cannot currently be considered a design tool but a potentially powerful analysis tool. Furthermore, the specific data that are required by the MEPDG are not necessarily the most practical or the best type of data for design or for TxDOT's needs. A typical example is the use of dynamic modulus (E*) to estimate pavement response and fatigue and rutting performance. National and local experimental work has already indicated that dynamic modulus is a relatively complex test that does not correlate well to performance. This research includes projects at Texas A&M University and The University of Texas at Austin and El Paso (Bhasin et al, 2004; Sungandh et al, 2007). Hence, before embarking on populating a database, some essential planning is necessary to determine the type, quality, and level of reliability of the data to be incorporated into the database. For instance, the MEPDG characterizes axle loads by means of more than 10,000 parameters, while only one parameter is used for tire inflation pressure, and only one parameter is used to characterize traffic speed

(Prozzi and Luo, 2005; Prozzi and Hong, 2007b). A decision should be made as to the data that need to be collected before collecting everything the MEPDG recommends.

1.3 Design Reliability and Risk Analysis

With the incorporation of design reliability in the 1986 version of the AASHTO Guide for the Design of Pavement Structures, an important advancement was achieved. However, when designing pavement, it should be kept in mind that what is being designed is probably the most complex civil engineering structure due to the high variability of road building materials and the typical dimensions of the pavement structures: "miles long, feet wide but only inches deep." These highly variable materials are exposed to the action of the environment and traffic, both elements that are very difficult to predict with a high degree of confidence (Prozzi, Gossain, and Manuel, 2005). Hence, we should rethink what levels of reliability are reasonable and economically achievable with current technologies: What is the purpose of aiming at 95 percent design reliability if environmental conditions cannot be predicted but merely estimated based on historical data? Are levels of 95 percent, 90 percent, or even 80 percent reliability actually achievable with a reasonable pavement structure?

TxDOT should establish appropriate and realistic standards to guide the level of effort. The selection of an appropriate level of reliability of a particular facility depends on the project level of usage and the economic and socio-political consequences associated with early failures. Suggested levels of reliability range from 99.9 percent for interstate highways to 50 percent for some local roads. The higher recommended levels are only achievable if all data are collected (at least) at the selected level of reliability. Bearing in mind (i) the inability to accurately estimate traffic loads far into the future and to predict the environmental conditions and (ii) the high variability typical of any road construction process, it is questionable whether those high levels are reasonable and can actually be achieved within current economic constraints.

Another strategic decision to be made relates to the length of historical data that need to be collected to develop realistic performance trends. As traffic volumes increase, highways are growing more and more congested, maintenance and rehabilitation budgets are shrinking in real terms, and there is a national drive toward long-lasting or perpetual types of pavement structures. These structures are designed to last more than 25 years and up to 50 years or more. By the time performance information is available, design and construction technology would have changed, as would vehicle technology. To this effect, and in order to deliver some historical data for calibration purposes, the incorporation of some section of the LTPP database has been recommended.

The final discussion point is related to the appropriate design level consistent with the research objectives (Prozzi and Hong, 2007). The MEPDG proposes the following design levels:

1) Level 1, the highest level of accuracy and reliability, implies specific data collection and material testing,
2) Level 2, the intermediate level or regional level, proposes limited data collection efforts and the use of surrogate laboratory tests, and
3) Level 3, lowest accuracy and reliability, makes use of default data or state defaults.

Current thinking at the national level is that Level 1 will probably never be implemented by the states, except for individual high-dollar projects that warrant the extensive and costly data collection and testing effort. Thus, Level 1 falls outside the scope of this research. Besides, Level 1 calibration lacks general applicability. For the results of this project to be useful, Level 3 and Level 2 should be the focus.

1.4 Components

To develop and calibrate any pavement design and rehabilitation method, a number of reliable databases are required. This concept applies to both empirical design methods, such as the AASHTO Guide for the Design of Pavement Structures (AASHTO, 1993), as well as mechanistic-empirical design methods, such as the NCHRP 1-37A Mechanistic-Empirical Design of New and Rehabilitated Pavements (NCHRP, 2006). To address these objectives, the databases should include:

1) Material properties,
2) Pavement structural characteristics,
3) Traffic information,
4) Environmental conditions, and
5) Pavement performance data.

To some extent these databases are currently available at TxDOT. They have, however, been designed and are maintained with specific objectives not necessarily compatible with their potential use for pavement design. A recent joint effort between TxDOT and the Center for Transportation Research (CTR) (Smit and Cleveland, 2004) produced a very successful tool for linking some of the existing databases [Design and Construction Information System (DCIS) and Pavement Management Information System (PMIS)] and "mining" them to extract the desired data. This effort, however limited in scope, demonstrated the feasibility and benefits of the approach. Building on the success of this effort and the lessons learned, a similar approach is being followed for the development of the Texas Flexible Pavement Database that is to be used for the development and calibration of a Texas Mechanistic-Empirical Pavement Design Method.

In summary, the ultimate deliverable of this project is simple: a database for development, validation, and calibration of a flexible pavement design method. The goal was conceived to not be too ambitious, and the scope is limited to address a reduced number of designs and expected trends by limiting the number of sections to be monitored. For this reason, the initial database will consist of sixty-four sections, including sections containing asphalt surface on top of asphalt bases, asphalt surface on top of untreated granular bases (flexbase), and surface treated pavements.

From a handful of Accelerated Pavement Test (APT) sections available worldwide 20 years ago, there are close to ninety facilities today. It is interesting to note that the most active facilities (California, Florida, France, South Africa and Australia) that have been sustainable and are still very active have been key to supporting the development of pavement and material performance models for aiding in the design and performance analysis of pavements. The advantage of APT is that results can be obtained in a few weeks or months rather than years. Thus, information on new materials and designs could be available before the materials become obsolete, or their source depleted. Thus, APT has the potential to bridge the gap between design and LTPP; therefore, potential contribution and synergies between APT, LTPP, and the development of the Texas Flexible Pavement Database will also be considered. It is foreseen that an APT facility in Texas could play an important role, and a long-term APT program could be developed for supporting the development of the Texas Flexible Pavement Database, if TxDOT is interested. This is especially important for the development of performance functions of new structures and new materials. Other sources of APT data in the public domain include those from Westrack (http://www.westrack.com) in Reno and the National Center for Asphalt Technology's (NCAT) test track in Opelika, Alabama (http://www.pavetrack.com).

1.5 Considerations for Implementation

A central objective of RTI's research program is applied research that can be implemented to address concerns identified by TxDOT. The products and reports of this study will empower TxDOT to make informed decisions about the future of the flexible pavement database. This project has been conceived as a three-phase approach; the first two phases are an integral part of this research project, while the third phase relates to the implementation of research findings and reporting. The following three research phases were contemplated:

Phase 1 – Planning: Assess the status-quo, current research efforts, and expected trends; identify potentially useful existing databases; and determine the role of LTPP studies with respect to this project.

Phase 2 – Data Collection: The current scenario and trends were analyzed and discussed with local and out-of-state experts who helped in determining data needs, appropriate standards, and database architecture to be adopted by TxDOT. These recommendations have been used to develop an interim Texas Flexible Pavement Database, which has been populated with the relevant Texas LTPP sections.

Phase 3 – Initial Implementation: This phase covers the implementation of the research findings. As such, this phase is not part of the proposed research, per se. An Implementation Plan will be developed, which will include a Plan for the Management and Maintenance of the FPDB.

Chapter 2. Pavement Management Information System

2.1 Introduction to PMIS

Pavement Management Systems (PMS) are network level applications that facilitate the budget planning and resource allocation in a highway agency. Thus, data collected is typically aggregated into indexes or scores that represent overall condition and make possible comparisons among facilities. The condition of pavement surfaces is an indicator of the overall condition of the pavement infrastructure. It can serve as a means of indicating which pavements require or are in need of some type of maintenance or rehabilitation. The condition of pavement surfaces can be determined using several types of equipment that measure ride quality, structural adequacy, and skid resistance; however, visual assessment is also required so that the level of distress can be recorded in an orderly and consistent manner. According to TxDOT, the evaluations of the condition of the pavement should be consistent and detailed enough that the pavement can be described across the following geographical areas:

1) Maintenance section
2) County
3) District
4) Statewide

Additionally, the information recorded should help in determining which pavement sections require some sort of intervention or which sections are in greater need of rehabilitation, as well as aiding in the estimation of the funding that will be required to perform the rehabilitations. The annual TxDOT Pavement Management Information System (PMIS) survey consists of three separate surveys:

1) Visual evaluation survey,
2) Ride quality survey, and
3) Skid resistance.

Additional data, such as structural strength, may be collected; however, it is currently not included in the PMIS analysis procedures. For the purposes of the sections contained in the Texas Flexible Pavement Database, Falling Weight Deflectometer (FWD) data will be collected on an annual basis. If budget and time constraints allow, some of the section's semiannual data collection will be considered in the winter and in the summer.

TxDOT PMIS contains approximately 190,000 data collection sections, which are usually 0.5 mile in length. Reference marker (RM) numbers are used to identity the different sections in the PMIS data collection. RM's are highway route signs with numbers placed below the sign spaced at approximately every 2 miles (every 1 mile for Interstate highways). Each reference marker can be identified and located by its highway number and its distance from origin (DFO).

On an annual basis, one lane from each section is rated, corresponding to the lane that shows the most distress on each roadbed. Consequently, the lane that is being rated can change from section to section, and for a given section, from year to year. However, it most often corresponds to the outside lane. Safety considerations are also taken into account for the selection of the lane being monitored.

Although the TxDOT PMIS is currently being used as a network level application, the data collected (before being processed into the various scores) is detailed enough to meet the requirements of the Texas Flexible Pavement Database. The various scores used by TxDOT are briefly described in the following section.

2.2 PMIS Scores

2.2.1 PMIS Condition Score

The PMIS Condition Score combines ride quality measurements (Ride Score) and pavement distress ratings (Distress Score) into a single description of overall pavement condition. PMIS Condition Score values are generally grouped into descriptive classes as follows:

Table 2.1: PMIS Condition Scores

Condition Score	Description
90 – 100	Very Good
70 – 89	Good
50 – 69	Fair
35 – 49	Poor
1 – 34	Very Poor

2.2.2 PMIS Distress Score

The PMIS Distress Score describes visible surface deterioration (pavement distress). PMIS Distress Scores are generally grouped into descriptive classes as follows:

Table 2.2: PMIS Distress Scores

Distress Score	Description
90 – 100	Very Good
70 – 89	Good
50 – 69	Fair
35 – 49	Poor
1 – 34	Very Poor

2.2.3 PMIS Ride Score

The PMIS Ride Score describes pavement ride quality. Ride Score is calculated from pavement roughness measured by calibrated electronic equipment. PMIS Ride Scores are generally grouped into descriptive classes as follows:

Table 2.3: PMIS Ride Scores

Ride Score	Description
4.0 – 5.0	Very Good
3.0 – 3.9	Good
2.0 – 2.9	Fair
1.0 – 1.9	Poor
0.1 – 0.9	Very Poor

Ride information currently collected is very detailed and can be used to determine average pavement roughness and variability for each PMIS section. Ride information will be collected on an annual basis for all sections contained in the Texas Flexible Pavement Database.

2.2.4 PMIS IRI Score

The PMIS IRI Score describes pavement ride quality. The units are in. (of roughness) per mi. IRI Score is the average of the IRI values measured in the left and right wheelpaths. Although IRI Score is a description of ride quality, it is not one of the factors used when determining the PMIS Condition Score. PMIS IRI Scores are generally grouped into descriptive classes as follows:

Table 2.4: PMIS Condition Scores

IRI Score	Description
1 – 59	Very Good
60 – 95	Good
96 – 130	Fair
131 – 169	Poor
170 – 950	Very Poor

For the purposes of the Texas Flexible Pavement Database, continuous information will be preferred to discrete (or range) information: this is very important for calibration purposes.

2.3 Visual Evaluation

There are two methods in which the data may be collected: using a laptop (using the VISTARE software), or through automated rating forms (which require that the data be entered afterward on the PMIS Database). On flexible pavements, the following types of distress are identified and rated during the visual inspections:

1) Rutting—Shallow (measured by automated rut-measuring device)
2) Rutting—Deep (measured by automated rut-measuring device)
3) Patching
4) Failures
5) Block cracking
6) Alligator cracking
7) Longitudinal cracking
8) Transverse cracking
9) Raveling
10) Flushing

The rating consists of entering a one-, two- or three-digit number for each of these ten distress types. The ratings indicate either the area or the amount of the distress observed. The definitions and methods of measurement for the different types of distress are described in TxDOT's Pavement Management Information System Rater's Manual (TxDOT, 2005).

2.3.1 Rutting—Shallow

Rutting consists of a longitudinal surface depression in the wheelpath, caused by consolidation or lateral displacement of the pavement materials when loaded. That is, rutting could be associated with volumetric change or shape change, both of which are dictated by the shear resistance of the material. Typically, rutting indicates a structural problem within one or more of the pavement layers.

Shallow Rutting is defined by a rut depth of 0.25 in. to 0.49 in. Rutting measured from 0.5 in. to 0.99 in. is referred to as Deep Rutting. Severe Rutting is measured from 1.0 in. to 1.99 in., and Failure Rutting is higher than 2 in.

Rutting is measured along the wheelpaths. Each wheelpath is measured separately and added together to determine the total feet of rutting. Based on the total feet of rutting and the length of the PMIS section, the percentage of area that presents rutting is reported. For the purposes of the Texas Flexible Pavement Database, average surface rutting will be stored in the database, as well as its variability in terms of the standard deviation of the rutting in each wheel path.

2.3.2 Rutting—Deep

As was the case with Shallow Rutting, Deep Rutting is measured along the wheelpaths. Each wheelpath is measured separately, and added together to determine the total ft of rutting. Based on the total ft of rutting, and the length of the PMIS section, the percentage of area that presents rutting is reported. It should be noted that for the objectives of the database, the actual measured surface rutting will be stored. Rut and Ride are collected as part of PMIS on an annual basis. In addition, Rut and Ride will be collected on the pavement sections corresponding to the Texas Flexible Pavement Database on an annual basis, typically after TxDOT PMIS data collection season concludes (typically in the March-April-May timeframe). This operation is necessary to ensure that the Texas Flexible Pavement Database lane is actually being monitored.

When duplication exists (which will be often), both surveys can be compared as a quality control measure.

2.3.3 Patching

Patches are repairs made to correct pavement distress. The presence of patches indicates previous maintenance activities. Patching is rated according to the percentage of the rated lane's total surface area. It is measured throughout the PMIS section and converted to full lane width patching. After determining the total feet of patching, and based on the length of the PMIS section, the percentage of area that presents patching is reported.

2.3.4 Failures

Failures are localized sections of pavement where the surface has been severely eroded, badly cracked, depressed, or severely shoved. These localized sections of pavement identify specific structural deficiencies that may generate safety hazards. Failures are measured in lengths of 40 ft. Only unrepaired areas are rated. If a failed area has been adequately patched, then it is rated a patch.

2.3.5 Block Cracking

Block cracking consists of interconnecting cracks that divide the pavement surface into approximately rectangular pieces, varying in size from 1 ft by 1 ft up to 10 ft by 10 ft. Block cracks are larger than alligator cracks and are not load-associated. Block cracks are commonly caused by shrinkage of the asphalt concrete, or shrinkage of the cement- or lime-stabilized base courses.

Block cracking is measured throughout the PMIS section (and converted to full lane width block cracking). With the measurement of full lane width block cracking and the total length of the section, the percentage of area that presents block cracking is reported.

2.3.6 Alligator Cracking

Alligator cracking consists of interconnecting cracks which form small, irregularly shaped blocks that resemble the patterns found on alligator skin. Blocks formed by alligator cracking are smaller than 1 ft by 1 ft. Alligator cracking is the result of repeated flexural stresses caused by traffic loading. Consequently, they may indicate improper design or weak structural layers.

Alligator cracking is rated on the wheelpath throughout the PMIS section. After determining the total feet of alligator cracking, and based on the length of the PMIS section, the percentage of area that presents alligator cracking is reported.

2.3.7 Longitudinal Cracking

Longitudinal cracking consists of cracks or breaks that run approximately parallel to the pavement centerline. Edge cracks, joint or slab cracks, and reflective cracking on composite pavement may all be rated as longitudinal cracking. Longitudinal cracking is measured in terms of linear ft per station (i.e., average ft of cracking in 100 ft of surface). The longitudinal cracks are measured throughout the length of the PMIS section, and based on the total section length, longitudinal cracking in ft per station is determined.

2.3.8 Transverse Cracking

Transverse cracking consists of cracks or breaks which travel perpendicular to the pavement centerline. Joint cracks and reflective cracks may also be rated as transverse cracking. Transverse cracking may be caused by surface shrinkage due to extreme temperature variations or differential movement beneath the pavement surface.

Transverse cracking is measured in terms of number per station (i.e., average number of cracks in each 100 ft of surface). The transverse cracks are counted throughout the length of the PMIS section, and based on the total section length, transverse cracking in number of cracks per station is determined.

It should be noted that cracking data is currently being collected by means of visual inspection, and consequently all types of cracking are subjected to significant human error and rater subjectivity. This problem is also aggravated by the fact that daylight and moisture conditions affect crack visibility and therefore its rating. As a preliminary measure, crack information contained in PMIS will be assessed to determine its suitability to meet the research objective. In the longer term, however, it is expected that TxDOT will implement an automated crack data collection system, which is currently being debugged and calibrated.

2.3.9 Raveling

Raveling is the progressive disintegration of the surface due to dislodgment of aggregate particles. Raveling is rated according to the following table. The rating code is reported. The rating code indicates the percent of the rated lane's total surface area.

Table 2.5: Rating Codes

Rating Code		Amount (Percent Area)
0	None	0
1	Low	1 – 10
2	Medium	11 – 50
3	High	> 50

2.3.10 Flushing

Flushing is the presence of asphalt on the pavement surface. Flushing is rated according to the previous table. The rating code is reported. The rating code indicates the percent of the rated lane's total surface area that is flushed.

2.3.11 Automated Data Collection

Preliminary analysis of PMIS indicated that data collected by mean of visual evaluations are too variable to be used for pavement design purposes. For this reason, data collected with TxDOT automated systems will be used in the development of the database. These data include roughness (in IRI), surface rutting (based on 5-point data collection and the wire-line method), and surface cracking (collected with the V-crack equipment). Automatically collected data will be processed consistently with LTPP protocols to be included into the Texas Flexible Pavement Database.

Chapter 3. Database Development Process

3.1 Data Elements

To effectively manage and organize data within a relational database structure, it was first necessary to identify the essential data elements required for successful implementation. Consequently, considerable effort was required to identify those specific data fields necessary to effectively analyze pavement performance and for calibration purposes. The importance of this aspect cannot be over-emphasized. Once data fields have been established and the database has been populated, it is not always possible to modify or add additional fields without disrupting the integrity of the existing data structure. Too many data fields can lead to slow-response bulky databases, but too few data fields can result in calibration models that are not well correlated.

In the development of any database system, the definition of data fields, primary keys, and indexes are undoubtedly the most time-consuming effort. Only once these elements have been defined can the database be populated and used for analysis purposes. Fortunately, the researchers did not have to identify many of these data fields but could lean heavily on the structures of well-defined successful models such as LTPP, MEPDG, and TxDOT's PMIS.

The following is an overview of some data fields identified within LTPP, used for calibration of the AASHTO MEPDG software:

1) Administration fields: Location, Project Type, Pavement Type, Base/Subgrade Construction Completion Date, Asphalt Construction Completion Date, Traffic Opening Date, Design Period.
2) Pavement Lane Properties: Lane Width, Pavement Slope, Initial IRI, Thermal Conductivity, Heat Capacity, Surface Short Wave Absorptivity.
3) Environmental/Climatic: Latitude, Longitude, Elevation, and Groundwater Table Depth.
4) Pavement Structure: Number of Layers, Layer Number, Layer Type, Representative Thickness.
5) Aggregate Gradation for Asphalt Mix: Layer Number, Layer Type, Percentage Retained ¾-in. Sieve, Percentage Retained 3/8-in. Sieve, Percentage Retained #4 Sieve, Percentage Passing #200 Sieve.
6) Effective Binder Content by Volume at Time of Construction: Layer Number, Layer Construction Date, Binder Content by Weight, Specific Gravity of the Binder, Bulk Specific Gravity of the Mix, Maximum Theoretical Specific Gravity of the Mix, Bulk Specific Gravity of the Aggregate, Effective Specific Gravity of the Aggregate, Effective Binder Content by Volume at Time of Construction.
7) Original Air Voids (at Time of Construction) and Total Unit Weight: Layer Number, Layer Type, Air Voids at Age = t, Age = t, Mean Annual Air Temperature, Original Viscosity at 77°F, Original Air Voids, Total Unit Weight.
8) Asphalt Binder Data: Layer Number, Layer Type, Viscosity Grade, Penetration Grade, Penetration at 77°F, Viscosity at 140°F, Viscosity at 275°F.

9) Unbound Materials Data: Layer Number, Layer Type, Dry Thermal Conductivity, Dry Heat Capacity, Liquid Limit, Plastic Limit, Plasticity Index, Percent Passing #200 Sieve, Percent Passing #4 Sieve, Diameter D60, Optimum Moisture Content, Estimated Optimum Moisture Content for Level 3 Analysis, Maximum Dry Unit Weight, Estimated Maximum Dry Unit Weight for Level 3 Analysis, Specific Gravity of Solids, Saturated Hydraulic Conductivity, AASHTO Soil Classification, Unified Soil Classification System (USCS) Classification, Estimated Resilient Modulus based on AASHTO Soil Classification

During the 1-day workshop conducted in June 2007, a list of agreed data elements was established. It should be noted that it was also agreed that the list was dynamic and new elements could be incorporated and some elements could be removed in the future. A list of the data elements incorporated to date can be found in Appendix A, Definitions of Data Elements. The database can be accessed at http://pavements.ce.utexas.edu/TxFlex3/TxFlex/TxFlex/Register.asp

3.2 Pavement Types

The Texas Flexible Pavement Database will contain pavement sections that will enable addressing the following variables:

1) Type of pavements. A number of typical pavement designs have been identified and proposed as part of the database. Although pavement type and facility type (e.g., Interstate Highway, U.S Highway, Farm-to-Market road) are highly correlated, consideration will be given to sampling diverse pavement types within each facility type. The database will contain pavement sections with (i) an asphalt surface on top of an asphalt base, (ii) an asphalt surface layer of top of a granular base, and (iii) surface treated pavements (typically one-, two- or three-course surface treatments on top of a flexbase).

2) Current and “future” materials. It is important that not only the most common current materials be selected but a number of “future” materials or “recent” materials that are expected to become popular in Texas also be included. Thus, the sections include conventional dense graded asphalt layers as well as “newer” mixes, such as the so-called performance mixes. Consideration has been given to the inclusion of sections containing geomaterials (such as geotextiles, geogrids, and geomembranes).

3) Traffic characterization. Currently state default traffic data has been incorporated into the database; however, recommendations will be provided with respect to minimum requirements for traffic data, including recommended survey frequencies and data type (traffic/axle counts, classification, wheel/axle loads, and tire pressures). These recommendations will be based on the findings of TxDOT Project 0-4510 and will consider the use of continuous axle load distribution rather than the discrete distribution proposed by the MEPDG. This was done because of the practical advantages and the reduction of the number of input parameters required to characterize the traffic stream.

4) Performance Monitoring. The types of distresses to be collected and the minimum data collection frequencies, as well as desired accuracies, are recommended. At

the very minimum, performance data for calibrating rutting and roughness models will be collected on an annual basis for all sections. Cracking data from visual inspection will be evaluated for its suitability; however, it is expected that cracking data will be eventually collected using an automated data collection system, currently being finalized under a concurrent research project.

5) Environmental Conditions. From a pavement performance point of view, five environmental regions have been identified in Texas that are consistent with the LTPP Program. These are wet-warm, wet-cold, dry-warm, dry-cold and mix. Pavement sections in each area will be identified and recommended for monitoring. Pavement sections have been identified in the following Districts: Austin, Beaumont, Bryan, El Paso, Lubbock, and Waco. The Lufkin District will be contacted to provide additional candidate sections.

Four types of pavements are considered within the design domain of the M-E Pavement Design Guide: (i) full-depth, (ii) deep strength (asphalt base), (iii) conventional (granular base) and (iv) semi-rigid (treated bases). Current research projects are focusing on full-depth pavements, so this study will address the other three types. Emphasis will be placed on pavement structural sections that are built with materials that are currently used or likely to be used more extensively in the near future.

Aging of the pavement structure is another design variable to be considered. Two levels of pavement age will be addressed: relatively new, and older existing pavements. In the case of existing pavements, the selection will be limited to those LTPP sections for which the relevant data are available or can be accurately estimated. It should be noted that the Interim Database (http://pavements.ce.utexas.edu/TxFlex3/TxFlex/TxFlex/Register.asp) contains only the LTPP sections, which will represent the "old" sections. Therefore, the so-called old sections are sections contained in the Texas LTPP that are at least 15 years old. These sections can be found in the online database under LTPP 0-5513.

The selection of the remaining sections has been done such that they will represent the "new" sections. These sections have been proposed by TxDOT personnel and in general are sections which are less than five years old. These sections can be found in the online database under TxFlex 0-5513.

Another important design variable is traffic which, for many, is the most important variable. It is the researchers' opinion that traffic may not be the most important variable but it is, traditionally, the most neglected. In order to make optimum use of available data and resources, several pavement sections have been selected on multilane highways. Thus, each pavement section will provide several experimental sections. Most importantly, the outer lanes will be highly trafficked, compared with the inner lanes.

3.3 Interim Database

TxDOT has well-established protocols in place for the development and use of databases as part of their relational database management system (RDBMS) (TxDOT, 2005). These protocols ultimately determine the type and structure of applications accessing databases on TxDOT computer servers and infrastructure. Besides existing databases, efforts are underway to develop new information systems and even web-based applications for reporting information using geographic information systems under the GIS Architecture and Infrastructure Project (GAIP). Developments undertaken as part of this study have to consider the broader TxDOT vision. It is necessary that the developments conform to RDBMS protocols and are flexible enough to allow interaction with other TxDOT developments.

Ideally, the design and development of pavement-related databases should be coordinated with a common database framework and user interfaces to improve the efficiency, enhance the accessibility, and ensure the long-term maintainability of these databases. To take advantage of state-of-the-art information technologies, these databases should be web-based, global information system (GIS)-oriented, and application-integrated (Zhang, 1996; 1999). Therefore, the following are the key features contemplated for the final database architecture:

1) Web-Based. The advancement in Internet technologies has made web-based applications a viable choice for pavement-related databases. Major advantages include: (i) databases that can be accessed conveniently not only from TxDOT, but also by TxDOT-authorized personnel from any place, domestically or internationally, where internet services are available; (ii) because the databases are maintained and updated in a central location, every TxDOT-authorized user is able to access the same data that is kept up-to-date; and (iii) problems and data errors that could be introduced with traditional means of data-sharing (such as file transfer and CD distribution) will be eliminated. Examples of web-based applications that can be used as models for implementation include LTTP (http://www.ltpp-products.com/). An interim web-based version of the database is available at http://pavements.ce.utexas.edu/TxFlex3/TxFlex/TxFlex/Register.asp. It should be emphasized that this version is only for demonstration purposes and for testing the concepts. The final web-based version of the Texas Flexible Pavement Database is expected to incorporate some user-friendly querying capabilities. Data input capabilities will also be programmed into it.

2) GIS-Oriented. The maturity of GIS technology provides a solid basis for the Texas Flexible Pavement Database to be enhanced in a GIS environment where information can be managed, queried, analyzed, and visualized graphically. In particular, when GIS-related technology is combined with the web-based design as discussed earlier, it will significantly enhance the user interfaces and improve the user-friendliness.

3) Integrated. Even though current (and future) TxDOT pavement-related databases are maintained and updated independently, it is important to recognize and take advantage of any similarities between datasets through integration. This is a long-term vision but must be addressed in the development of the Flexible Pavements Database to ensure future compatibility.

The initial database development follows TxDOT recommendation, but it is taking place outside the TxDOT environment. For the development stage, the database will reside in a server at The University of Texas at Austin, thus avoiding security and protocols that may delay the project. At the conclusion of the project and at the discretion of TxDOT, the application could be moved to a TxDOT Division server as part of the research implementation.

Chapter 4. Long-Term Pavement Performance: Texas Sections

4.1 Reasons for LTPP

As discussed in the previous chapter, the Long-term Pavement Performance (LTPP) study will provide the initial set of sections. Approximately half of the 50 Texas LTPP sections that are currently under consideration will be added to the database. These sections are very important for capturing longer time series. LTPP was initiated as a part of Strategic Highway Research Program (SHRP), which was established by the Transportation Research Board (TRB) of the National Research Council in the early 1980s. The program is sponsored by the Federal Highway Administration (FHWA) and with the cooperation of the American Association of State Highway and Transportation Officials (AASHTO).

As is suggested by a TRB Special Report 202, *"America's Highways, Accelerating the Search for Innovation,"* there is a need to carry out the LTPP program based on monitoring long-term pavement performance throughout the nation. In detail, the motivation for carrying out LTPP-like studies is to better understand pavement performance under the effects of various relevant parameters involving design features, construction quality, material properties, traffic loads, environment, and maintenance activities. Thus, sound performance models can be developed to well capture pavement deterioration processes and accurately forecast their future conditions, which play a central role in both pavement design and system management.

4.2 Objectives and Scope

The overall objective of LTPP is to monitor and evaluate long-term pavement performance under a variety of affecting factors over a pavement's service life, usually over 20 years. To account for the effect of those critical factors on pavement performance, the specific objectives are listed as follows:

1) Evaluate existing design methods,
2) Develop improved design methodologies and strategies for the rehabilitation of existing pavements,
3) Develop improved design equations for new and reconstructed pavements,
4) Determine the effects of loading, environment, material properties and variability, construction quality, and maintenance levels on pavement distress and performance,
5) Determine the effects of specific design features on pavement performance, and
6) Establish a national long-term pavement database to support SHRP objectives and future needs.

4.3 Test Section Designation and Layout

The LTPP pavement test sections are classified into two categories: General Pavement Studies (GPS) and Specific Pavement Studies (SPS). The two types of studies are involved with different purposes and have different focuses. The details of GPS and SPS sections are discussed next.

4.3.1 General Pavement Studies (GPS)

GPS test sections consists of around 800 sites across U.S. and Canada. These sections are located on existing pavement structures with up to 15 years of service prior to the start of the LTPP program. In more detail, GPS sections are further divided into eighteen experiments in conjunction with different research purposes. These experiments are listed in Table 4.1.

Table 4.1: List of GPS Experiments

Experiment	Experiment Title
GPS-1	Asphalt Concrete (AC) pavement on granular base
GPS-2	AC Pavement on bound base
GPS-3	Jointed plain concrete pavement (JPCP)
GPS-4	Jointed reinforced concrete pavement (JRCP)
GPS-5	Continuously reinforced concrete pavement (CRCP)
GPS-6A	Existing AC overlay of AC pavement (existing at the start of the program)
GPS-6B	AC overlay using conventional asphalt of AC pavement – no milling
GPS-6C	AC overlay using modified asphalt of AC pavement – no milling
GPS-6D	AC overlay on previously overlaid AC pavement using conventional asphalt
GPS-6S	AC overlay of milled AC pavement using conventional or modified asphalt
GPS-7A	Existing AC overlay on PCC pavement
GPS-7B	AC overlay using conventional asphalt on PCC pavement
GPS-7C	AC overlay using modified asphalt on PCC pavement
GPS-7D	AC overlay on previously overlaid PCC pavement using conventional asphalt
GPS-7F	AC overlay using conventional or modified asphalt on fractured PCC pavement
GPS-7R	Concrete pavement restoration treatments with no overlay
GPS-7S	Second AC overlay, which includes milling or geo-textile application, on PCC pavement with previous AC overlay
GPS-9	Unbounded PCC overlay on PCC pavement

4.3.2 Specific Pavement Studies (SPS)

SPS test sections involve the pavement sites with specially constructed, maintained, or rehabilitated conditions under a controlled set of experiment design and construction features. The objective of SPS is to provide a more concrete data set to extend and refine the results obtained from GPS sites. The SPS sections are classified into five categories with ten experiment designs, as is shown in Table 4.2. Usually multiple test sections at each test site are involved. The number of sections may vary from two for SPS-8 to twelve for SPS-1 and 2.

Table 4.2: List of SPS Experiments by Category

Category	Experiment	Title
Pavement Structural Factors	SPS-1	Strategic study of structural factors for flexible pavements
	SPS-2	Strategic study of structural factors for rigid pavement
Pavement Maintenance	SPS-3	Preventative maintenance effectiveness of flexible pavements
	SPS-4	Preventative maintenance effectiveness of rigid pavements
Pavement Rehabilitation	SPS-5	Rehabilitation of AC pavements
	SPS-6	Rehabilitation of jointed Portland cement concrete (JPCC) pavements
	SPS-7	Bonded PCC overlays of concrete pavements
Environmental Effects	SPS-8	Study of environmental effects in the absence of heavy loads
Asphalt Aggregate Mixture Specifications	SPS-9P	Validation and refinements of Superpave asphalt specifications and mix design process
	SPS-9A	Superpave asphalt binder study

Because particular research studies associated with LTPP may usually get involved with a particular data requirement, it is important to differentiate the two basic types of studies, GPS and SPS. The Texas Flexible Pavement Database will contain sections from both experiments. The specific sections will be determined as a function of the data available. The major differences between GPS and SPS test sections are presented as follows:

1) A fundamental difference comes from the fact that GPS sections were existing pavement sections at the start of the LTPP program and different experiment treatments begin when or after LTPP's implementation time.
2) Compared with GPS, SPS sections are involved with more controlled experimental designs and usually involve more information. Thus, they are richer in data.
3) After rehabilitation, SPS sections are converted into GPS sections, although the SHRP_ID remains the same.

4.3.3 Test Section Layout

Generally, for both GPS and SPS test sections, the length is around 500 ft (152 m). Figure 4.1 illustrates the overall layout for a typical GPS test section. There are two maintenance control zones before and after the test section, with their lengths of 500 ft (152 m) and 250 ft (76 m), respectively. Figure 4.2 presents the overall layout for a typical SPS test project, which consists of several test sections with their individual lengths of 500 ft (152 m). In addition to maintenance control zones, there are transition zones between each two test sections.

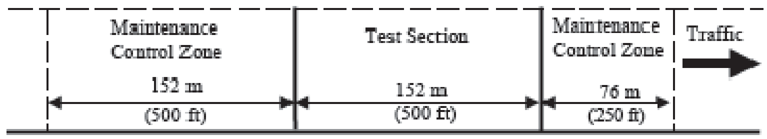

Figure 4.1: Layout of a Generic GPS Test Section

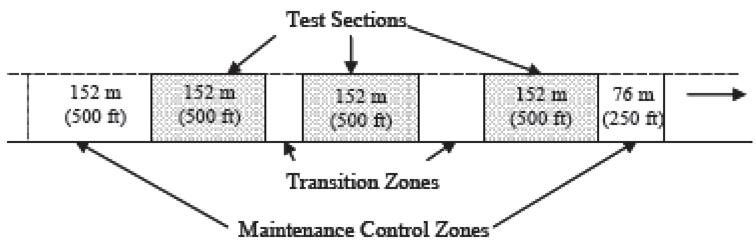

Figure 4.2: Layout of a Generic SPS Test Project

4.4 Detailed Explanation of GPS and SPS Flexible Pavement Sites

Because the current research project focuses on flexible pavement, a detailed explanation for those experiments only involving asphalt pavements is presented next. Among GPS experiments, GPS-1, GPS-2, GPS-6A, GPS-6B, GPS-6C, GPS-6D, and GPS-6S are of particular interest for our research purposes. Their main characteristics are as follows:

1) GPS-1: asphalt concrete on granular base. The typical pavement structure consists of a dense-graded hot-mix asphalt concrete (HMAC) surface layer, with or without other supporting HMAC layers, which are then followed by an untreated granular base or no base. Some sections have one or more sub-base layers. A treated subgrade is regarded as a sub-base layer. Full-depth AC pavements (with a total HMAC of 152 mm / 6 in.) are also included in this experiment.
2) GPS-2: asphalt concrete on bound base. The typical pavement structure consists of a dense-graded HMAC surface layer, with or without other underlying HMAC layers, which are then followed by a bound base layer. There can be one or more sub-base layers, but they are not required.
3) GPS-6: asphalt concrete overlay of asphalt concrete pavement. Typical pavement structures consist of a dense-graded HMAC surface layer, followed with or without other HMAC layers, then followed by an existing older HMAC pavement. The designation 6A refers to the situation that the overlay was in prior to acceptance of the LTPP program. The rest refers to those sections with overlays after they were accepted into the LTPP program. In addition, it is required that the overall AC overlay thickness be at least 25.4 mm (1 in.)

Among SPS experiments, SPS-1, SPS-3, SPS-5, and SPS-9 involve asphalt pavements. The following definitions apply only to the core sections within each experiment. The situation for supplemental sections may vary among different highway agencies.

1) SPS-1: structural factors for flexible pavements. Sections within this category start as newly constructed pavements or reconstructed pavements after removal of previously existing pavements. The purpose of this experiment is to examine the performance of pavement structural factors, mainly including in-pavement drainage layer, surface thickness, base type, and base thickness, under different environments. The combination of those factors, through fractional factorial design, leads to twenty-four different pavement structures, which include twelve sections at one site and a complementary twelve sections at another site in the same climatic region on a similar subgrade type.
2) SPS-3: preventive maintenance effectiveness of flexible pavements. The purpose of this experiment is to examine the effectiveness of four treatments: crack seal, chip seal, slurry seal, and thin overlay on AC pavements. These four types of treatments are evaluated independently. In addition, a control (or "do nothing") section is used as comparison. The control section is, however, classified as a GPS experiment.
3) SPS-5: rehabilitation of asphalt concrete pavements. The purpose of this experiment is to examine the performance of eight combinations of AC overlays on existing AC-surfaced pavements. Four rehabilitation treatment factors are involved: intensity of surface preparation, recycled versus virgin AC overlay mixture, and overlay thickness.
4) SPS-9: validation of SHRP asphalt specifications and mix design. The SPS-9A experiment focuses on Superpave asphalt binder study. It aims at evaluating and improving the practical aspects of implementing the Superpave mix design. The second SPS-9 type experiment is SPS-9P. As a pilot effort, SPS-9P was established to document some experience in implementing the Superpave specifications. The specifications were subject to change during the test period.

4.5 Texas LTPP Sites

Based on the latest online LTPP database, the DataPave Release 20, a total number of 218 sections are identified in Texas. Figure 4.3 indicates the locations of those LTPP sections in Texas. The majority of those sections are located in the central and east part of Texas as well as in Panhandle area.

Among the 218 LTPP sections in Texas, 91 sections are GPS, while the remaining 127 sections are SPS. Furthermore, according to the definition of the different experiments, there are 58 GPS sections and 127 SPS sections involving flexible pavements. By querying the LTPP database, the general information for the GPS and SPS sections in Texas is presented Appendix B Tables B1 and B2, respectively. It is indicated that the beginning time attached to the individual section varies.

After reviewing the data corresponding to the 218 sections, 66 of these sections were considered of the highest quality and deemed appropriate for incorporation in the Texas Flexible Pavement Database. Most of these sections contain the data necessary for meeting the project objectives. After further consideration and taking into account the experimental design proposed in the project, these 66 sections were further categorized into the following 3 groups:

1) LTPP 0-5513 (31 sections). This subset of LTPP sections is part of the experimental design proposed in this project.
2) LTPP Calibration (18 sections). This subset of sections provided the data used for the interim calibration of the pavement design models.
3) LTPP Miscellaneous (17 sections). This subset consists of sections that did not fit in the original experimental design but could provide additional calibration data at a later stage.

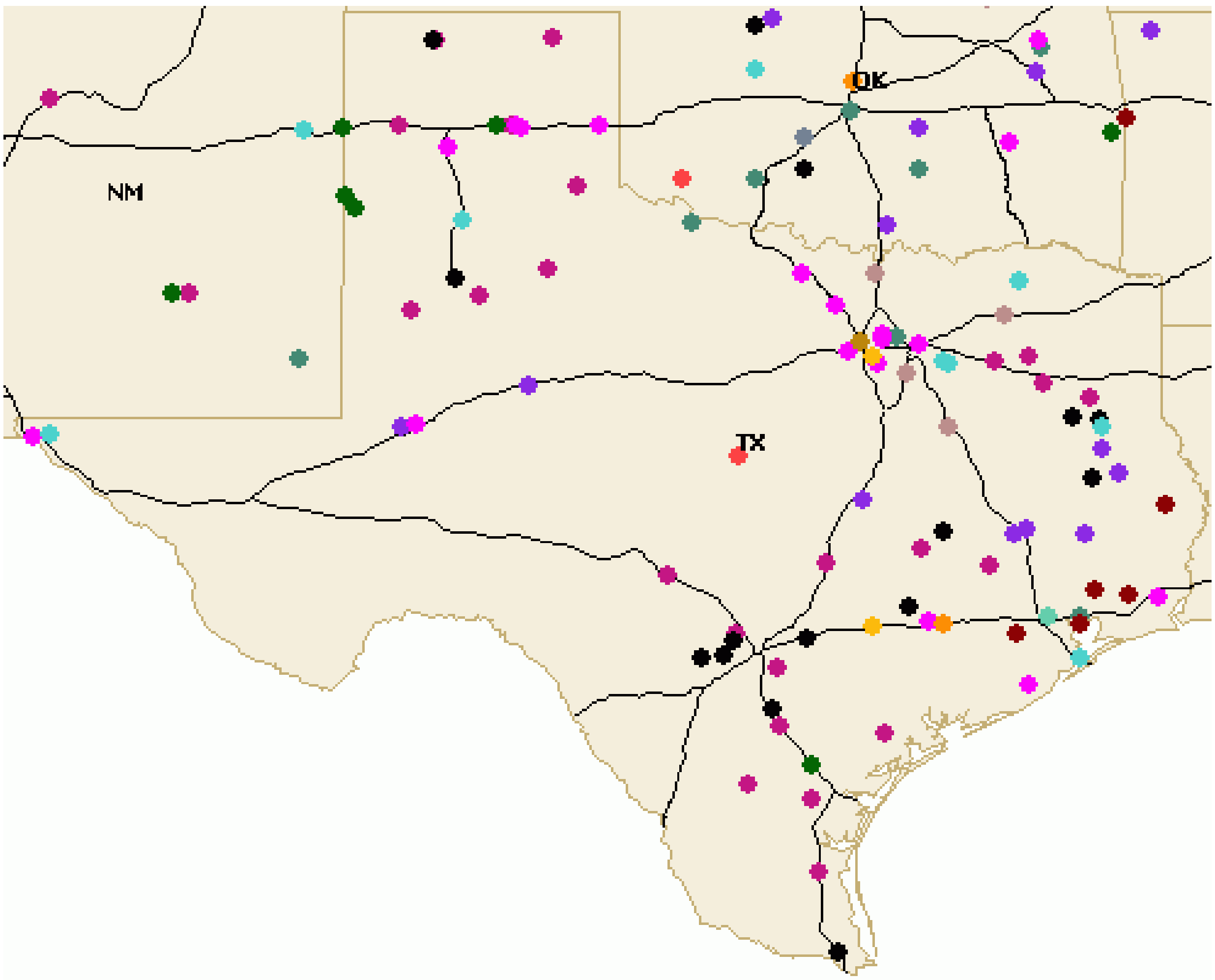

Figure 4.3: LTPP Test Sections across Texas

4.6 LTPP Data Source for Texas Flexible Pavement Database

The data that will be contained in the final version of the Texas Flexible Pavement Database will be collected from several sources, one of the major sources being LTPP. As described in the previous section, of the 218 LTPP sections available in Texas, 66 were selected for incorporation in the Texas Flexible Pavement Database. Three primary aspects were considered: (1) quality of data, (2) data completeness, and (3) fitness into the experimental design. The FHWA updates LTPP information periodically through its Standard Data Release (SDR) and delivers the data through Microsoft Access. The most recent SDR Version 20.0, published in October 2005, was used in this study. SDR Version 21 is expected in early 2007 and will be used to update the current version. Four volumes are included in the V20.0 SDR: (i) Reference Document, (ii) Primary Dataset, (iii) FWD Measurements, and (iv) Profile Data. Furthermore, the database is organized in different modules. Each individual module contains tables with information relevant to that module. In the V20 SDR, there are a total of twenty-two modules with 458 tables involved. Those modules in the SDR V20.0 contain the following information:

1) Administration (ADM) contains tables describing the structure of database and master test section control table.
2) Automated Weather Station (AWS) contains weather information for some SPS projects.
3) Climate (CLM) contains climate data from off-site weather conditions used to derive a simulated virtual weather station for LTPP sections.
4) Dynamic Load Response (DLR) contains dynamic load response instrumentation data from SPS sections in North Carolina and Ohio.
5) Ground Penetrating Radar (GPR) contains thickness estimates for SPS-1, SPS-2, and SPS-6 projects based on GPR measurements. This module was started in 2003.
6) Inventory (INV) contains inventory information (as defined by LTPP) for all GPS sections and those of SPS sections originally classified in maintenance and rehabilitation experiments. It is important to note that information in this module is primarily provided by the agency and may not reflect the actual condition.
7) Maintenance (MNT) contains information on maintenance-type treatments reported by highway agencies.
8) Monitoring (MON) contains pavement performance monitoring data such as deflection, distress, friction, profile, rut, and transverse profile.
9) Rehabilitation (RHB) contains information on rehabilitation treatments.
10) Seasonal Monitoring Program (SMP): contains SMP-specific data, e.g., air temperature, precipitation, subsurface temperature, moisture, and frost information.
11) Specific Pavement Studies (SPS): contains SPS-specific general and construction information.
12) Specific Pavement Studies (SPS1): contains SPS-1 related information.
13) Specific Pavement Studies (SPS2): contains SPS-2 related information.
14) Specific Pavement Studies (SPS3): contains SPS-3 related information.
15) Specific Pavement Studies (SPS4): contains SPS-4 related information.
16) Specific Pavement Studies (SPS5): contains SPS-5 related information.

17) Specific Pavement Studies (SPS6): contains SPS-6 related information.

18) Specific Pavement Studies (SPS7): contains SPS-7 related information.

19) Specific Pavement Studies (SPS8): contains SPS-8 related information.

20) Specific Pavement Studies (SPS9): contains SPS-9 related information.

21) Traffic (TRF): contains traffic load, classification, and volume information.

22) Test (TST): contains field and laboratory test data.

The Texas Flexible Pavement Database is customized to accommodate Texas conditions and needs. A relational database has been developed to meet this particular need (details at http://pavements.ce.utexas.edu/TxFlex3/TxFlex/TxFlex/Register.asp). The database includes numerous tables:

1) CODE
2) COUNTY
3) DISTRICT
4) ENV_CONDITIONS
5) ENV_PRECIP_VAR
6) ENV_WATER_TABLE
7) PAV_ADMIX
8) PAV_BINDER
9) PAV_CONSTR
10) PAV_FIELD_PERF
11) PAV_FIELD_PERF_IRI
12) PAV_FIELD_PERF_CRACK
13) PAV_FIELD_PERF_RUT
14) PAV_LAYER
15) PAV_LAYER_BASE
16) PAV_LAYER_HMA
17) PAV_LAYER_HMA_CREEP
18) PAV_LAYER_HMA_MOD
19) PAV_LAYER_SOIL
20) PAV_LAYER_SS_US_MOD
21) PAV_LAYER_STSC
22) PAV_MIX
23) PAV_MIX_JMF

24) PAV_SECTION
25) TST_FATIGUE
26) TST_HWTD
27) TST_MMLS3
28) TRAFFIC
29) TRAFFIC_AXLE_LOAD_VAR

The data elements are not listed here for succinctness but are provided in Appendix A. It should be noted that the dictionary contained in Appendix A is constantly updated and the version contained in this report has been superseded by a later one. In addition, all available updated information is available by visiting the provided internet address.

During the process of retrieving information from the LTPP for filling in the Texas Flexible Pavement Database, the available information in the LTPP database was thoroughly investigated. As a result, the location of information from the LTPP database corresponding to Texas Flexible Database is identified, as is shown in Table 4.3:

Table 4.3: Data Source for Texas Flexible Pavement Database from LTPP Database

TXFLEX Table	Description	LTPP Modules
CODE	Code for filed explanation	ADM
COUNTY	County number	
DISTRICT	District number	
ENV_CONDITIONS	Environmental condition	
ENV_PRECIP_VAR	Precipitation	
ENV_WATER_TABLE	Water table depth	
PAV_ADMIX	Asphalt additive	TST
PAV_BINDER	Asphalt binder	INV,TST
PAV_CONSTR	Construction information	INV
PAV_FIELD_PERF	Field performance summary	MON
PAV_FIELD_PERF_IRI	IRI information	MON
PAV_FIELD_PERF_CRACK	Crack information	MON
PAV_FIELD_PERF_RUT	Rut information	MON
PAV_LAYER	Layer information	INV,TST
PAV_LAYER_BASE	Base information	TST
PAV_LAYER_HMA	HMA information	
PAV_LAYER_HMA_CREEP	HMA creep test results	TST
PAV_LAYER_HMA_MOD	HMA resilient modulus	TST
PAV_LAYER_SOIL	Soil information	TST
PAV_LAYER_SS_US_MOD	Granular material modulus	TST
PAV_LAYER_STSC	Surface treatment information	
PAV_MIX	Asphalt mix information	INV
PAV_MIX_JMF	Asphalt mix job mixture formula	
PAV_SECTION	Pavement section general information	INV
TST_FATIGUE	Fatigue test results	
TST_HWTD	Hamburg wheel test results	
TST_MMLS3		
TRAFFIC	General traffic information	TRF
TRAFFIC_AXLE_LOAD_VAR	Axle load distribution	TRF

At the current stage, an effort to populate the Texas Flexible Pavement Database is made with focus on twenty-eight GPS sections and four SPS projects in Texas. The locations of those sites are illustrated in Figure 4.4. It should be noted that the yellow triangles in Figure 4.4 indicate the geographical location. In some cases, at each location there are several experimental sections, in particular at the SPS sections.

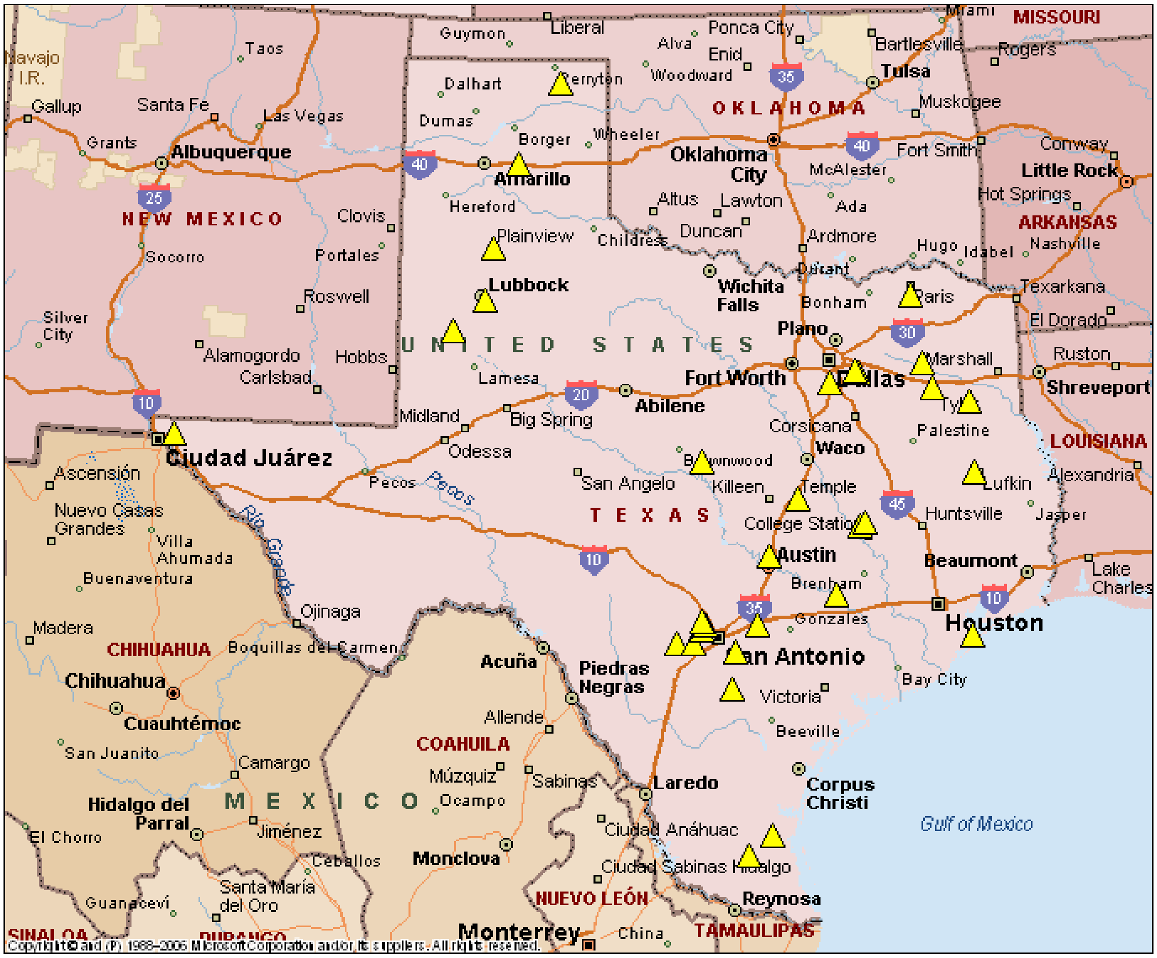

Figure 4.4: Location of LTPP Sections Incorporated into Texas Flexible Pavement Database

In addition to the LTPP Sections shown in Figure 4.4, numerous other Texas sections will be incorporated in to the database. The geographical locations of these potential sites are illustrated in Figure 4.5. It should be noted that the LTPP section will provide the data necessary to carry out the preliminary calibration of the design guide. The sections sown in Figure 4.5 will not provide adequate data for calibration because only one or two years or performance data will be available at the time of the termination of the research project. It is expected, however, that data collection at these sites will continue in the future to facilitate the calibration of the available pavement design models (transfer functions). In most cases, at each of the locations indicated in Figure 4.5 there are two or more experimental sections.

Figure 4.5: Texas Sections Potentially Incorporated into Texas Flexible Pavement Database

4.7 Experimental Design

As suggested in Chapter 1, the long-term success of the Texas Flexible Pavement Database will be determined by the balance achieved between the cost allocated for the development and maintenance of the system and the benefits in terms of improved pavement design and performance. It is the development and maintenance cost that constrains the number of sections to included into the database. To optimize the use of the resources allocated to this project, the following main experimental variables (experimental design) were considered:

Pavement type (3 levels)

Hot-mix asphalt surface on top of hot-mix asphalt base
Hot-mix asphalt surface on top of untreated granular base (flexbase)
Two course surface treatment on top of untreated granular base (flexbase)

Traffic levels (2 levels)

Heavier traffic (typical of outside lanes)
Lighter traffic (typical of passing lanes)

Environmental conditions (5 levels)

Wet-warm
Wet-cold
Dry-warm
Dry-cold
Mixed

Section replicates (2 levels)

Whenever available replicates will be included

Thus, the complete main factorial would consist of 60 sections (3x2x5x2). Additional sections will be considered to account for aging (old and new sections). Data collection has been initiated on a much larger number of sections (currently above 100 sections). Of this larger set of sections, some will be discarded based on considerations such as safety of data collection, section homogeneity and condition, etc.

4.8 Final Comments

This report presents a summary of some of the work carried out during the first year of a 3-year research project for the development of the Texas Flexible Pavement Database (TFPD). Many aspects of the TFPD have changed since then and will be updated in the final comprehensive research report in fall 2008. In particular, the data entities and elements reported in Appendix A have been significantly to fit TxDOT Standards.

Much has been learned from FHWA's LTPP Program; as a matter of fact, the LTPP data structures formed the basis and starting point for the current development. This initial framework was later significantly modified and updated based on interaction with TxDOT personnel and a number of national experts that met in Austin for a 1-day workshop. Further modifications were incorporated to accommodate unique TxDOT conditions such as the availability of data from the Hamburg Wheel Tracking Device and the PathFinder study (TxDOT Project 0-5496).

The Texas Flexible Pavement Database will contain new and old sections. The so-called old sections have been obtained based on the remaining sections of the LTPP study in Texas. Those sections have already been incorporated into the web-based database. The so-called new sections will correspond to some thirty pavements sections selected among almost 100 candidates submitted by the following TxDOT districts: Austin, Beaumont, Bryan, El Paso, Lubbock, Lufkin, Tyler, and Waco. These newer sections are, in turn, subdivided into the following three groups: (i) asphalt surface on top of asphalt bases, (ii) asphalt surface on top of untreated granular bases (flexbase) and (iii) surface treated pavements.

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Appendix A: Definitions of Data Element

(as of February 2007)

(Note that this table has been significantly updated since February 2007. An updated table is included in the final Project Report.)

COUNTY	The COUNTY table contains all the counties of Texas, and to what district to they belong.
COUNTY_ID	Unique identifier to represent every County in the State of Texas
COUNTY_NAME	County Name
DISTRICT_ID	Unique identifier to represent every State in Texas
DISTRICT	The DISTRICT table contains all the districts of Texas, and a general climatic classification per district.
CLIMATE	PMIS Climate Classification for each (Wet warm, wet cold, dry warm, dry cold, mixed)
DISTRICT_ID	Unique identifier to represent every State in Texas
DISTRICT_NAME	District Name
ENV_CONDITIONS	The ENV_CONDITIONS table contains specific environmental information for the different pavement sections included in the database.
1_DAY_MIN_TEMP_MEAN	Minimum 1-day Annual Air temperature, °F
1_DAY_MIN_TEMP_SDV	Standard Deviation of Minimum 1-day Annual Air temperature, °F
3_DAY_MAX_TEMP_MEAN	Average 3 days maximum air temperature, °F
3_DAY_MAX_TEMP_SDV	Standard Deviation of 3-days maximum air temperature, °F
5_DAY_MAX_TEMP_MEAN	Average 5 days maximum air temperature, °F
5_DAY_MAX_TEMP_SDV	Standard Deviation of 5-days maximum air temperature, °F
7_DAY_MAX_TEMP_MEAN	Average 7 days maximum air temperature, °F
7_DAY_MAX_TEMP_SDV	Standard Deviation of 7-days maximum air temperature, °F
ADJ_LEFT_LANE_COND	Adjacent left lane condition
ADJ_LEFT_LANE_DEPTH	Adjacent left lane depth
ADJ_LEFT_LANE_TYPE	Adjacent left lane type
ADJ_LEFT_LANE_WIDTH	Adjacent left lane width
ADJ_RIGHT_LANE_COND	Adjacent right lane condition
ADJ_RIGHT_LANE_DEPTH	Adjacent right lane depth
ADJ_RIGHT_LANE_TYPE	Adjacent right lane type
ADJ_RIGHT_LANE_WIDTH	Adjacent right lane width
ALTITUDE	Altitude, ft
ANN_PRECIPITATION	Annual precipitation, in

AVG_MAX_MONTHLY_TEMP	Average maximum monthly temperature, °F
AVG_MIN_MONTHLY_TEMP	Average minimum monthly temperature, °F
CROSS_SLOPE	Cross Slope, %
DRAINAGE_CONDITION	Description of drainage conditions
DRAINAGE_TYPE	Drainage type
FROST_DEPTH	Frost Depth, in
FROST_DURATION	Frost Duration, days
FROST_INDEX	Frost Index
LATITUDE	Latitude, decimals
LOCATION_ID	Unique identifier for location of weather station
LONGITUDE	Longitude, decimals
NO_FREEZE_THAW_CYCLE	Number of freeze/thaw cycles
SEASONS	Number of seasons that take place in specified location
SOLAR_RADIATION	Solar Radiation, kWhr/m^2-day
WEATHER_STATION	Type and number of weather station

ENV_PRECIP_VAR	The ENV_PRECIP_VAR table contains specific information on the seasonal/monthly variation of precipitation on the different pavement sections included in the database.
LOCATION_ID	Unique identifier for location of weather station
PERIOD	Defined as season or month
PRECIPITATION	Precipitation for the specified period, in
TYPE	Type: Seasonal/Monthly

ENV_WATER_TABLE	The ENV_WATER_TABLE table contains information on the monthly depth of the water table for the different pavement sections included in the database.
DEPTH_APR	Depth of water table in April, in
DEPTH_AUG	Depth of water table in August, in
DEPTH_DEC	Depth of water table in December, in
DEPTH_FEB	Depth of water table in February, in
DEPTH_JAN	Depth of water table in January, in
DEPTH_JUL	Depth of water table in July, in
DEPTH_JUN	Depth of water table in June, in
DEPTH_MAR	Depth of water table in March, in
DEPTH_MAY	Depth of water table in May, in

DEPTH_NOV	Depth of water table in November, in
DEPTH_OCT	Depth of water table in October, in
DEPTH_SEP	Depth of water table in September, in
LOCATION_ID	Unique identifier for location of weather station
PAV_ADMIX	The PAV_ADMIX table contains information on the additives, modifiers, and admixtures included in the asphalt mixtures used on the different pavement sections included in the database.
ADDITIVE_ID	Unique Identifier for additive used in the mix
CONTENT	Additive Content, %
HMA_ID	Unique identifier for each pavement layer included in the database
TYPE	Additive Type: Additive/Modifier/Admixture
PAV_BINDER	The PAV_BINDER table contains specific rheological and physical information on the asphalt binders used on the different asphalt layers of the different pavement sections included in the database,
BINDER_CONTENT_VOL	Binder Content in percentage by volume, field extracted samples
BINDER_CONTENT_VOL_TST	Binder Content in percentage by volume, laboratory molded samples
BINDER_CONTENT_WT	Binder Content in percentage by weight, field extracted samples
BINDER_CONTENT_WT_TST	Binder Content in percentage by weight, laboratory molded samples
BINDER_ID	Unique identifier for each binder type included in the database
BINDER_MANUF	Binder manufacturer
BINDER_MOD	Is the binder modified?
BINDER_MOD_CONT	Binder Modifier Content, %
BINDER_MOD_TYPE	Binder Modification Type: SBS, SBR, latex, etc
BINDER_SOURCE	Binder Source
BINDER_TYPE	Binder Type. A general classification of the binder (PG Grade, AC Grade, PEN Grade, or similar)
CREEP_STIFF_64_PAV	Creep Stiffness @ 64°C on PAV binder
CREEP_STIFF_70_PAV	Creep Stiffness @ 70°C on PAV binder
CREEP_STIFF_76_PAV	Creep Stiffness @ 76°C on PAV binder
DUCTILITY	Ductility @ 5cm\min, cm
ELASTIC_RECOVERY	Elastic Recovery (100 mm elongation and cut immediately at 25°C), %
FAIL_STRAIN_64_PAV	Failure strain in direct tension @ 64°C on PAV binder
FAIL_STRAIN_70_PAV	Failure strain in direct tension @ 70°C on PAV binder
FAIL_STRAIN_76_PAV	Failure strain in direct tension @ 76°C on PAV binder

FIBER_CONT	Fiber Content, by weight of mix
FIBER_TYPE	Fiber Type
G_64_ORG_BINDER	G*/sin δ @ 64°C on original binder, kPa
G_64_PAV	G*/sin δ @ 64°C on PAV binder, kPa
G_64_RTFO	G*/sin δ @ 64°C on RTFO binder, kPa
G_70_ORG_BINDER	G*/sin δ @ 70°C on original binder, kPa
G_70_PAV	G* sin δ @ 70°C on PAV binder, kPa
G_70_RTFO	G*/sin δ @ 70°C on RTFO binder, kPa
G_76_ORG_BINDER	G*/sin δ @ 76°C on original binder, kPa
G_76_PAV	G* sin δ @ 76°C on PAV binder, kPa
G_76_RTFO	G*/sin δ @ 76°C on RTFO binder, kPa
HMA_ID	Unique identifier for each HMA layer included in the database
M_VAL_64_PAV	m-value @ 64°C on PAV binder
M_VAL_70_PAV	m-value @ 70°C on PAV binder
M_VAL_76_PAV	m-value @ 76°C on PAV binder
MIN_FILLER_CONT	Mineral Filler Content
MIN_FILLER_TYPE	Mineral Filler Type
PENETRATION_25	Penetration @ 25°C, mm
SOFTENING_PT	Softening point: R&B or T800
TST_DATE	Test date for binder content
VISCOSITY_135, Pa s	Viscosity @ 135°C
VISCOSITY_60, Pa s	Viscosity @ 60°C

PAV_CONSTR	The PAV_CONSTR table contains information on the initial construction and maintenance and rehabilitation activities that have been performed on the pavement sections included in the database.
ANALYSIS_PERIOD	Analysis period for pavement construction
CN_CHANGE_REASON	Construction change reason, e.g., cracking seal, overlay, etc. Please refer to CODE table for description of each activity.
CONST_ID	Construction ID accounts for different construction activities involving a specific pavement section. The lowest construction ID represents the initial construction of the pavement section, and subsequent constructions represent additional activities
CSJ	Control Section Job Number
DATE_OPEN_TRAFFIC	Date pavement section was originally opened to traffic.
NO_OF_LAYERS_AC	Number of layers after current construction. If the number of layer before and after the current construction are the same, maintenance work was performed, but no layer was necessarily added.

NO_OF_LAYERS_BC	Number of existing layers before current construction.
NO_OF_LAYERS_NEW	Number of new layers added during current construction.
NO_OF_LAYERS_REMOVE	Number of removed layers that were removed during current construction. It has to be observed that an equal number of layer before and after the current construction might indicate that some layers were removed, but an equal number of layers were lifted.
PER_PERIOD	Performance design period for pavement
PROJECT_TYPE	Project Type pavement section belongs to. Can be classified as: new, rehab, reconstruction
SECTION_ID	Unique identifier for each pavement section included in the database

PAV_FIELD_PERF_CRACK	The PAV_FIELD_PERF_CRACK table includes information on cracking initiation and development of the pavement sections included in the database.
ANALYSIS_DATE	Date of PADIAS film analysis.
BLK_CRACK_A_H	Area of high severity block cracking. (mean crack width greater than 19 mm or under 19 mm with moderate to high severity random cracking.)
BLK_CRACK_A_L	Area of low severity block cracking. (cracks of unknown width well sealed or with mean width of 6 mm or less.)
BLK_CRACK_A_M	Area of moderate severity block cracking. (mean crack width from 6 to 19 mm or under 19 mm with adjacent low severity random cracking.)
CRACK_ID	Crack ID is a system assigned variable to keep track of cracking surveys performed on the different pavement sections included in the database.
GATOR_CRACK_A_H	Area of alligator (fatigue) cracking of high severity. (moderately or severely spalled interconnected cracks, may be sealed, pumping may be evident.)
GATOR_CRACK_A_L	Area of alligator (fatigue) cracking of low severity. (no or few connecting cracks, not spalled or sealed, no pumping evident.)
GATOR_CRACK_A_M	Area of alligator (fatigue) cracking of high severity. (moderately or severely spalled interconnected cracks, may be sealed, pumping may be evident.)
LONG_CRACK_NWP_L_H	Length of high severity, well sealed non-wheel path longitudinal cracking. (mean crack width greater than 19 mm or under 19 mm with adjacent moderate to high severity random cracking.)
LONG_CRACK_NWP_L_L	Length of low severity, non-wheel path longitudinal cracking. (cracks of unknown width well sealed or with mean width of 6 mm or less.)
LONG_CRACK_NWP_L_M	Length of moderate severity, non-wheel path longitudinal cracking. (mean crack width from 6 to 19 mm or under 19 mm with adjacent low severity random cracking.)
LONG_CRACK_WP_L_H	Length of high severity, well sealed wheel path longitudinal cracking. (mean crack width greater than 19 mm or under 19 mm with adjacent moderate to high severity random cracking.)
LONG_CRACK_WP_L_L	Length of low severity, wheel path longitudinal cracking. (cracks of unknown width well sealed or with mean width of 6 mm or less.)
LONG_CRACK_WP_L_M	Length of moderate severity, wheel path longitudinal cracking. (mean crack width from 6 to 19 mm or under 19 mm with adjacent low severity random cracking.)

SECTION_ID	Unique identifier of each pavement section entered into the database.
SURVEY_DATE	Date survey was performed.
TRANS_CRACK_L_H	Length of high severity transverse cracking. (crack mean width greater than 19 mm or under 19 mm with adjacent moderate to high severity random cracking.)
TRANS_CRACK_L_L	Length of low severity transverse cracking. (cracks of unknown width well sealed or with mean width of 6 mm or less.)
TRANS_CRACK_L_M	Length of moderate severity transverse cracking.
TRANS_CRACK_NO_H	Number of high severity transverse cracks. (mean crack width greater than 19 mm or under 19 mm with adjacent moderate to high severity random cracking.)
TRANS_CRACK_NO_L	Number of low severity transverse cracks. (cracks of unknown width well sealed or with mean width of 6 mm or less.)
TRANS_CRACK_NO_M	Number of moderate severity transverse cracks. (mean crack width from 6 to 19 mm or under 19 mm with adjacent low severity random cracking.)

PAV_FIELD_PERF_IRI	The PAV_FIELD_PERF_IRI table includes IRI roughness information for the pavement sections included in the database.
AVERAGE_SPEED	Average speed of the profilometer during the test, mph
BEGINNING_DESCRIPTION	Beginning description of the run location.
DIRECTION_MEASURED	Run location direction measured.
ENDING_DESCRIPTION	Ending description of run location.
IRI_AVERAGE	Average International Roughness Index (IRI) value, in/mi.
IRI_ID	Inspection ID for IRI. It is a system assigned variable to keep track of IRI measurements performed on the different pavement sections included in the database.
IRI_LEFT_WHEEL_PATH	IRI value for left wheel path, in/mi.
IRI_RIGHT_WHEEL_PATH	IRI value for right wheel path, in/mi.
LANE_MEASURED	Identification of the lane measured.
LOAD_DATE	Date of load
OTHER_WEATHER_INFO	A description of other weather information at the time and location specified
PROFILE_DATE	Date of profile
PROFILE_TIME	Time of profile
RUN_NUMBER	Run number
SECTION_ID	Unique identifier of each pavement section entered into the database.
SLOPE_VARIANCE	Approximation of slope variance as computed by PROFCHK software.
START_METHOD	Code designating the start method.
STOP_DISTANCE	Length of profile run as measured by profilometer DMI.
STOP_METHOD	Code indicating the method for determining stop.

SURFACE_CONDITION	Description of the surface condition.
TEMPERATURE	Ambient air temperature.
WAVE_LENGTH_INIT	Code indicating if the wave length initialization was disabled or enabled.
PAV_FIELD_PERF_RUT	The PAV_FIELD_PERF_RUT table contains rutting information for the pavement sections included in the database.
LLH_DEPTH_1_8_MAX	Maximum left lane half straight edge 1.8 m (6 ft) depth, in.
LLH_DEPTH_1_8_MEAN	Mean left lane half straight edge 1.8 m (6 ft) depth, in.
LLH_DEPTH_1_8_MIN	Minimum left lane half straight edge 1.8 m (6 ft) depth, in.
LLH_DEPTH_1_8_STD	Left lane half straight edge 1.8 m (6 ft) depth standard deviation, in.
MAX_MEAN_DEPTH_1_8	Maximum value of left or right lane half straight edge 1.8 m (6 ft) depth mean, in.
RLH_DEPTH_1_8_MAX	Maximum right lane half straight edge 1.8 m (6 ft) depth, in.
RLH_DEPTH_1_8_MEAN	Mean right lane half straight edge 1.8 m (6 ft) depth, in.
RLH_DEPTH_1_8_MIN	Minimum right lane half straight edge 1.8 m (6 ft) depth, in.
RLH_DEPTH_1_8_STD	Right lane half straight edge 1.8 m (6 ft) depth standard deviation, in.
RUT_ID	Unique Identifier of Rutting Information. It is a system assigned variable to keep track of rutting measurements performed on the different pavement sections included in the database.
SECTION_ID	Unique identifier of each pavement section entered into the database.
SURVEY_DATE	Date survey was performed.
PAV_LAYER	The PAV_LAYER table includes specific layer information for the different pavement sections that are included in the database. It also includes the aggregate gradation that was used on the different layers.
AGG_GRADATION	Aggregate Gradation according to TxDOT Specifications. Can be one of the following: A, B, C, D, E
AGG_SOURCE	Aggregate Source of material from current layer
AGG_TYPE	Aggregate Type for current layer. Can be classified as: Limestone, granite, gravel, blend
CONST_ID	Construction ID accounts for different construction activities involving a specific pavement section. The lowest construction ID represents the initial construction of the pavement section, and subsequent constructions represent additional activities
L_CONST_DATE	Date on which the current layer was constructed
L_OPEN_TRAFFIC_DATE	Date on which the current layer was opened to traffic
L_REMOVAL_DATE	Date on which the current layer was removed. If a layer were to be removed, no new layer is to re-use the layer number corresponding to the removed layer.
LAYER_ID	Unique identifier for each pavement layer entered into the database
LAYER_NO	Layer number. Layers are identified from 1 on, where 1 corresponds to subgrade (or bottommost

	layer), 2 corresponds to subbase/base (layer on top of layer 1), an so forth.
LAYER_THICKNESS_MEAN	Layer Thickness Mean, in.
LAYER_THICKNESS_SDV	Layer Thickness Standard Deviation, in.
LAYER_TYPE	Type of material that makes up current layer: Can be one of the following: HMA layer=1, Base/subbase layer=B (includes treated/untreated materials), Subgrade=G (includes treated/untreated materials), Other=O
NO_10_PASSING	Sieve analysis of aggregate from current layer. Percent passing the #10 sieve.
NO_16_PASSING	Sieve analysis of aggregate from current layer. Percent passing the #16 sieve.
NO_200_PASSING	Sieve analysis of aggregate from current layer. Percent passing the #200 sieve.
NO_4_PASSING	Sieve analysis of aggregate from current layer. Percent passing the #4 sieve.
NO_40_PASSING	Sieve analysis of aggregate from current layer. Percent passing the #40 sieve.
NO_80_PASSING	Sieve analysis of aggregate from current layer. Percent passing the #80 sieve.
NO_OF_LIFTS	Number of lifts to place current layer.
ONE_AND_HALF_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 1 1/2 sieve.
ONE_AND_QUATER_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 1 1/4 sieve.
FIVE_EIGHTHS_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 5/8 sieve.
ONE_HALF_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 1/2 sieve.
ONE_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 1 sieve.
ONE_QUATER_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 1/4 sieve.
SEVEN_EIGHTHS_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 7/8 sieve.
THREE_EIGHTHS_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 3/8 sieve.
THREE_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 3 sieve.
THREE_QUATER_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 3/4 sieve.
TWO_PASSING	Sieve analysis of aggregate from current layer. Percent passing the 2 sieve.
PAV_LAYER_BASE	The PAV_LAYER_BASE contains general and material subbase/base information on the different pavement sections included in the database.
AASHTO_CLASSIFICATION	AASHTO Soils Classification
COMP_STRENGTH	Compressive Strength
COMP_STRENGTH_103KPA	Compressive Strength at 103 kPa
COMP_STRENGTH_OKPA	Compressive Strength at 0 kPa
CON_DENSITY_MEAN	Construction density: Mean, %
CON_DENSITY_SDV	Construction density: Standard Deviation, %.
CON_MC_MEAN	Construction moisture content: Mean, %
CON_MC_SDV	Construction moisture content: Standard Deviation, %

CON_SEISMIC_MOD_MEAN	Construction seismic modulus: Mean, ksi.
CON_SEISMIC_MOD_SDV	Construction seismic modulus: Standard Deviation, ksi
GRANULAR_ID	Granular Layer ID (Includes Base, Subbase, treated materials, etc.)
INTRFACE_COND	Type of interface conditions present in the field
LAB_COMPACTION_EFFORT	Laboratory Compaction Effort
LAB_SEISMIC_MOD_MEAN	Laboratory seismic modulus: Mean, ksi
LAB_SEISMIC_MOD_SDV	Laboratory seismic modulus: Standard Deviation, ksi
LAYER_ID	Unique identifier for each pavement layer entered into the database
LIQUID_LIMIT	Atterberg limits: Liquid Limit
MC_SINE_APPX_A	Moisture Content Sinusoidal approximation: Constant A
MC_SINE_APPX_B	Moisture Content Sinusoidal approximation: Constant B
MC_SINE_APPX_C	Moisture Content Sinusoidal approximation: Constant C
MDD	Maximum Dry Density (MDD), pcf
OMC	Optimum Moisture Content (OMC), %
PLASTIC_INDEX	Atterberg limits: Plastic Index, 0=NP
PLASTIC_LIMIT	Atterberg limits: Plastic Limit
POISONS_RATIO	Poisson's Ratio
PRIME_COAT_APP_RATE	Application rate of prime coat
PRIME_COAT_TYPE	Type of prime coat
SHRINKAGE_LIMIT	Atterberg limits: Shrinkage Limit
TREATMENT_AMOUNT	Amount of treatment in percentage
TREATMENT_TYPE	Treatment Type
TX_TRIAXIAL_CLASSIFICATION	Texas Triaxial Classification
USC_CLASSIFICATION	Unified Soil Classification
WET_BALL_MILL	Wet Ball Mill

PAV_LAYER_HMA

The PAV_LAYER_HMA table is a link table between the different asphalt layers, and the additives, binder, HMA, and mix information for the layers.

ADDITIVE_ID	Unique identifier for the different additive types entered into the database
BINDER_ID	Unique identifier for each asphalt binder entered into the database
HMA_ID	Unique identifier for each HMA layer included in the database
LAYER_ID	Unique identifier for each pavement layer entered into the database
MIX_ID	Unique identifier for each individual asphalt mixture entered into the database

PAV_LAYER_HMA_CREEP

The PAV_LAYER_HMA_CREEP table contains creep results on samples from the different asphalt

	layers.

CREEP_COMP_1_SEC	Creep compliance value at 1 second.
CREEP_COMP_10_SEC	Creep compliance value at 10 seconds.
CREEP_COMP_100_SEC	Creep compliance value at 100 seconds.
CREEP_COMP_2_SEC	Creep compliance value at 2 seconds.
CREEP_COMP_20_SEC	Creep compliance value at 20 seconds.
CREEP_COMP_5_SEC	Creep compliance value at 5 seconds.
CREEP_COMP_50_SEC	Creep compliance value at 50 seconds.
CREEP_ID	Unique identifier for creep compliance results for each specific test specimen
CREEP_POISSON_CALC	Poisson's ratio calculated from load/deformation time histories.
CREEP_POISSON_USED	Poisson's ratio used for subsequent calculations.
HMA_ID	Unique identifier for each pavement layer entered into the database
TEST_NO	Code number indicating sample number
TEST_TEMPERATURE	Temperature at which test was performed.

PAV_LAYER_HMA_MOD

HMA_ID	Test section identification number assigned by LTPP program. Must be combined with STATE_CODE to be unique.
INST_MR_AVG	Average instantaneous resilient modulus determined by averaging results from cycles 1, 2, and 3.
INST_MR_CYCLE_1	Instantaneous resilient modulus for load cycle 1, ksi.
INST_MR_CYCLE_2	Instantaneous resilient modulus for load cycle 2, ksi.
INST_MR_CYCLE_3	Instantaneous resilient modulus for load cycle 3, ksi.
INST_MR_POISSON_CALC_AVG	Average instantaneous calculated Poisson's ratio determined by averaging results from cycles 1, 2 and 3.
INST_MR_POISSON_CALC_CYCLE_1	Instantaneous Poisson's ratio for load cycle 1. Calculated from raw load/deformation time histories.
INST_MR_POISSON_CALC_CYCLE_2	Instantaneous Poisson's ratio for load cycle 2. Calculated from raw load/deformation time histories.
INST_MR_POISSON_CALC_CYCLE_3	Instantaneous Poisson's ratio for load cycle 3. Calculated from raw load/deformation time histories.
MOD_ID	Numerical code for state or province. U.S. codes are consistent with Federal Information Processing Standards.
MR_DATA_FILE_SPECIMEN_1	Name of file that contains load/deformation time histories used in calculation of resilient modulus for a given test temperature for specimen 1.
TEST_NO	Code number indicating sample number
TEST_TEMPERATURE	Temperature at which test was performed, °F
TOTAL_MR_AVG	Average total resilient modulus, ksi.

TOTAL_MR_CYCLE_1	Total resilient modulus for load cycle 1, ksi.
TOTAL_MR_CYCLE_2	Total resilient modulus for load cycle 2, ksi.
TOTAL_MR_CYCLE_3	Total resilient modulus for load cycle 3, ksi.
TOTAL_MR_POISSON_CALC_AVG	Average total calculated Poisson's ratio.
TOTAL_MR_POISSON_CALC_CYCLE_1	Total calculated Poisson's ratio for load cycle 1.
TOTAL_MR_POISSON_CALC_CYCLE_2	Total calculated Poisson's ratio for load cycle 2.
TOTAL_MR_POISSON_CALC_CYCLE_3	Total calculated Poisson's ratio for load cycle 3.

PAV_LAYER_SOIL

The PAV_LAYER_SOIL table contains soil properties of the subgrade of the different pavement sections included in the database.

AASHTO_CLASSIFICATION	AASHTO Soil Classification
BAR_LINEAR_SHRINKAGE	Bar Linear Shrinkage
CBR	California Bearing Ratio
COMP_STRENGTH_103KPA	Compressive Strength at 103 kPa
COMP_STRENGTH_OKPA	Compressive Strength at 0 kPa
CON_DENSITY_MEAN	Construction density: Mean, %
CON_DENSITY_SDV	Construction density: Standard Deviation, %
CON_MC_MEAN	Construction moisture content: Mean, %.
CON_MC_SDV	Construction moisture content: Standard Deviation, %.
CON_SEISMIC_MOD_MEAN	Construction seismic modulus: Mean, ksi.
CON_SEISMIC_MOD_SDV	Construction seismic modulus: Standard Deviation, ksi.
DCP	Dynamic Cone Penetrometer
GROUP_INDEX	Group Index
INTRFACE_COND	Type of interface conditions present in the field
LAB_COMPACTION_EFFORT	Laboratory Compaction Effort
LAB_SEISMIC_MOD_MEAN	Laboratory seismic modulus: Mean, ksi
LAB_SEISMIC_MOD_SDV	Laboratory seismic modulus: Standard Deviation, ksi
LAYER_ID	Unique identifier for each layer entered into the database
LIQUID_LIMIT	Atterberg limits: Liquid Limit
MC_SINE_APPX_A	Moisture Content Sinusoidal approximation: Constant A
MC_SINE_APPX_B	Moisture Content Sinusoidal approximation: Constant B
MC_SINE_APPX_C	Moisture Content Sinusoidal approximation: Constant C
MDD	Maximum Dry Density (MDD), pcf
MOD_SUBGRADE_REACTION	Modulus of Subgrade Reaction, ksi
OMC	Optimum Moisture Content (OMC), %.

ORG_CONTENT	Organic Content, %.
PLASTIC_INDEX	Atterberg limits: Plastic Index
PLASTIC_LIMIT	Atterberg limits: Plastic Limit
POISONS_RATIO	Poisson's Ratio
RESILIENT_MOD_CONST_K1	Resilient Modulus Function: Constant k1
RESILIENT_MOD_CONST_K2	Resilient Modulus Function: Constant k2
RESILIENT_MOD_CONST_K3	Resilient Modulus Function: Constant k3
SHRINKAGE_LIMIT	Atterberg limits: Shrinkage Limit
SOIL_ID	Unique identifier for each subgrade soil layer entered into the database
SULPHATE_POT	Sulfate potential
SWELL_POT	Swell potential
TX_TRIAXIAL_CLASSIFICATION	Texas Triaxial Classification
USC_CLASSIFICATION	Unified Soil Classification

PAV_LAYER_STSC	The PAV_LAYER_STSC table contains information on the surface treatments and surface seals used on the different pavement sections included in the database.
BINDER_RATE	Binder application rate used on surface treatment/seal coat
BINDER_TYPE	Binder type used on surface treatment/seal coat
LAYER_ID	Layer ID
STSC_ID	Surface treatment and surface curing ID

PAV_MIX	The PAV_MIX table contains asphalt mixture information for the different asphalt layers of the pavement sections included in the database.
AIR_VOID_CONTENT_MEAN	Air Void Content: Mean, %.
AIR_VOID_CONTENT_SDV	Air Void Content : Standard Deviation, %.
DENSITY_MEAN	In-situ Density: Mean, %
DENSITY_SDV	In-situ Density : Standard Deviation, %.
DYNAMIC_MOD	Dynamic Modulus, ksi
DYNAMIC_STIFF	Dynamic Stiffness, ksi
FATIGUE_ID	Unique identifier for each bending beam sample entered into the database
FLOW_NUMBER	Flow Number
FLOW_TIME	Flow Time
HMA_ID	Unique identifier for each HMA layer included in the database.
HWTD_ID	Unique identifier for each Hamburg Wheel Tracking Device (HWTD) sample included in the

	database.
IND_TENSILE_STRENGTH	Indirect Tensile Strength, ksi.
INTERFACE_COND	Interface Condition: bounded, unbounded
JMF	Job Mix Formula
MASTER_CURVE	Master Curve or Estimate
MIX_DESIGN_PROCEDURE	Mix Design Procedure: Marshall, Hveem, SGC, TGC
MIX_ID	Unique identifier for each asphalt mixture entered into the database.
MIX_TYPE	TxDOT Item number(340[DENSE],341[DENSE QCQA],342[PFC],344[SUPERPAVE&CMHB],346[SMA],OTHER,UNKNOWN)
MMLS3_ID	Unique identifier for each MMLS3 test result included into the database
OVERLAY_TESTER	Number of repetitions to reach failure in the overlay tester.
POISSONS_RATIO	Poisson's Ratio
RESILIENT_MOD_25	Resilient Modulus(25°C)
RESILIENT_MOD_40	Resilient Modulus(40°C)
RESILIENT_MOD_5	Resilient Modulus(5°C)
RICE_DENSITY	Rice Density: Maximum theoretical density, pcf.
TACK_COAT_RATE	Tack coat application rate
TACK_COAT_TYPE	Tack coat type
VMA	Voids in the Mineral Aggregate, %.

PAV_MIX_JMF	The PAV_MIX_JMF table contains information on the job mix formula used for the asphalt mix used on the pavement sections included in the database.
JMF_ID	Unique identifier for each Job Mix Formula
MIX_DETAIL	Mixture Design Details
MIX_ID	Unique identifier for each asphalt mixture included in the database.

PAV_SECTION	The PAV_SECTION table is the main table in the database, and contains specific location, climate, and geographical information for the pavement sections included in the database.
BEG_PT_ELEV	Elevation of pavement section beginning point, as measured using GPS equipment.
BEG_PT_LAT	Latitude of pavement section beginning point, as measured using GPS equipment.
BEG_PT_LONG	Longitude of pavement section beginning point, as measured using GPS equipment.
BEG_TRM	Pavement section beginning reference marker number
BEG_TRM_DISP	Pavement section beginning reference marker displacement
COUNTY_ID	Unique identifier to represent every County in the State of Texas

DEPTH_BEDR	Depth to bedrock from pavement section surface
DIRECTION	Traffic travel direction. Can be classified as one of the following: East=1, West=2, North=3, South=4
END_PT_ELEV	Elevation of pavement section end point, as measured using GPS equipment.
END_PT_LAT	Latitude of pavement section end point, as measured using GPS equipment.
END_PT_LONG	Longitude of pavement section end point, as measured using GPS equipment.
END_TRM	Pavement section ending reference marker number
END_TRM_DISP	Pavement section ending reference marker displacement
FACILITY_TYPE	PMIS facility ranking. Can be ranked as: IH, US, SH, BI, BU, BS, FM, BF, PR
FOUNDATION_TYPE	Type of foundation to support roadway structure. Can be classified as one of the following: cut, fill, level
LANE_NUMBER	Lane number on pavement roadway that corresponds to pavement section
LANE_WIDTH	Lane width that corresponds to pavement section
NO_OF_LANES	Number of lanes on pavement section
ORIGINAL_DB	Database from which data was originally acquired from (LTPP, Successful, Research, Surface, TFDB)
ORIGINAL_ID	ID of pavement section on the original database
ROADBED	PMIS roadbed type. Can be classified as one of the following: K, R, L, A, X
ROADWAY_NO	Texas Roadway number, which correspond to the TxDOT highway number or route number from PMIS
ROADWAY_TYPE	Roadway Type Classification. Can be classified as one of the following: IH=1, US=2, SH=3, Loop=4, FM=5
SECTION_ID	Section ID is a unique identifier of each pavement section entered into the database. This is a system assigned variable.
TERRAIN_GRADE	Terrain grade/slope. Can be classified as one of the following: flat=1, downhill=2, uphill=3l

PAV_SS_US_MOD	The PAV_SS_US_MOD table contains modulus information for the granular materials and soils used on the different layers of the sections included in the database.
APPLIED_CONTACT_LOAD_AVG	Applied contact load average.
APPLIED_CONTACT_LOAD_STD	Applied contact load standard deviation.
APPLIED_CONTACT_STRESS_AVG	Applied contact stress average.
APPLIED_CONTACT_STRESS_STD	Applied contact stress standard deviation.
APPLIED_CYCLIC_LOAD_AVG	Actual applied cyclic load average.
APPLIED_CYCLIC_LOAD_STD	Applied cyclic load standard deviation.
APPLIED_CYCLIC_STRESS_AVG	Applied cyclic stress average.
APPLIED_CYCLIC_STRESS_STD	Applied cyclic stress standard deviation.
APPLIED_MAX_AXIAL_LOAD_AVG	Applied maximum axial load average.

APPLIED_MAX_AXIAL_LOAD_STD	Applied maximum axial load standard deviation.
APPLIED_MAX_AXIAL_STRESS_AVG	Applied maximum axial stress average.
APPLIED_MAX_AXIAL_STRESS_STD	Applied maximum axial stress standard deviation.
CON_PRESSURE	Chamber confining pressure.
DEF_LVDT_1_2_AVG	Average across cycles of the average recoverable axial deformations.
DEF_LVDT_1_2_STD	Standard deviation across cycles of the average recoverable axial deformation.
DEF_LVDT_1_AVG	Average across cycles of the recoverable axial deformation of the sample for each LVDT.
DEF_LVDT_1_STD	Standard deviation across cycles of the recoverable axial deformation.
DEF_LVDT_2_AVG	Average across cycles of the recoverable axial deformation of the sample for each LVDT.
DEF_LVDT_2_STD	Standard deviation across cycles of the recoverable axial deformation.
FIELD_SET	Sequential number indicating the field sampling event. Assigned 1 for first sample event and incremented by 1 for subsequent events.
LAYER_ID	Unique sequential number assigned to pavement layers, starting with the deepest layer (subgrade).
LOC_NO	Unique code number assigned to each sampling location indicating the sample type. The single character prefix indicates the sample type. The numeric suffix is the unique project location for the sample type.
MOD_ID	Unique identifier of modulus information for granular layers in a specific pavement section in the database.
MR_MATL_TYPE	Code designating whether the material was coarse
NOM_MAX_AXIAL_STRESS	Nominal maximum axial stress.
RES_MOD_AVG	Average resilient modulus across cycles.
RES_MOD_STD	Standard deviation of the resilient modulus across cycles.
RES_STRAIN_AVG	Average resilient strain across cycles.
RES_STRAIN_STD	Standard deviation of resilient strain across cycles.
SAMPLE_NO	Unique code number assigned to each material sample indicating the sample type and material type. The fist character indicates the sample type. The second character indicates the material type. The numeric suffix is the unique sample number for the sample
TEST_DATE	Date the test was performed.
TEST_NO	Code number indicating test.

TEST_FATIGUE	The TEST_FATIGUE table contains four-point bending beam results for the asphalt mixtures included in the database.
CYCLE	Applied load cycle
FATIGUE_ID	Unique identifier for each individual fatigue test sample included in the database
MIX_ID	Unique identifier for each asphalt mixture included into the database
STIFFNESS	Stiffness at given cycle, ksi

STRAIN	Applied strain at given cycle, µs
TEMPERATURE	Testing temperature, °F
TEST_HWTD	The TEST_HWTD table contains Hamburg Wheel Tracking Device (HWTD) measurements for the asphalt mixtures included in the database.
CYCLE	HWTD Wheel Pass
DEFORMATION	HWTD Deformation at given cycle, mm.
HWTD_ID	Unique identifier for each HWTD sample test results.
MIX_ID	Unique identifier for each asphalt mixture included into the database
TEMPERATURE	HWTD Testing temperature, °F.
TEST_MMLS3	The TEST_MMLS3 table contains Model Mobile Load Simulator (MMLS) measurements for the asphalt mixtures included in the database.
CYCLE	MMLS3 Wheel Pass
DEFORMATION	MMLS3 Deformation at given cycle
MIX_ID	Unique identifier for each asphalt mixture included into the database
MMLS3_ID	Unique identifier for each MMLS3 sample test results.
TEMPERATURE	MMLS3 Testing temperature, °F.
TRAFFIC	The Traffic table contains general traffic information regarding the pavement sections included in the database.
AADT_PER_LANE	Average Annual Daily Traffic (AADT) per lane for the indicated year
AVG_OVERLOADING	Average Overloading
DIR_DIST_FACTOR	Direction distribution factors
FUTURE_ESAL	Future Equivalent Single Axle Loads (ESAL)
FUTURE_ESAL_YEAR	Year of Future ESAL
GROWTH_FACTOR	Growth factor, number of trucks.
GROWTH_RATE	Growth rate in percentage
INITIAL_AADT	Initial AADT
INITIAL_ESAL	Initial ESAL
INITIAL_PER_TRUCKS	Percentage trucks, %
LANE_DIST_FACTOR	Lane distribution factor
PER_OVERLOADING	Percentage Overloading, %

SECTION_ID	Unique identifier for each pavement section included into the database.
TIRE_INFLAT_SDV	Tire inflation pressure: Standard Deviation, psi
TIRE_INFLATION_DIST	Tire Inflation Distribution type
TIRE_INFLATION_MEAN	Tire inflation pressure: Mean, psi
TRAFFIC_WANDER	Traffic wander
YEAR_INITIAL_AADT	Year initial AADT
YEAR_RECORD	Year at which traffic data is reported

TRAFFIC_AXLE_LOAD_VAR	The TRAFFIC_AXLE_LOAD_VAR table contains load variability information due to time seasonal and hourly variations.
CLASS	Vehicle and axle class type
CLASS_PER	Percentage of class type, %
DISTR_MNTH_APR	Distribution for April, %
DISTR_MNTH_AUG	Distribution for August, %
DISTR_MNTH_DEC	Distribution for December, %.
DISTR_MNTH_FEB	Distribution for February, %.
DISTR_MNTH_JAN	Distribution for January, %.
DISTR_MNTH_JUL	Distribution for July, %.
DISTR_MNTH_JUN	Distribution for June, %.
DISTR_MNTH_MAR	Distribution for March, %.
DISTR_MNTH_MAY	Distribution for May, %.
DISTR_MNTH_NOV	Distribution for November, %.
DISTR_MNTH_OCT	Distribution for October, %.
DISTR_MNTH_SEP	Distribution for September, %.
HRLY_DISTR_00	Percentage of daily traffic from 12:00 AM to 12:59 AM
HRLY_DISTR_01	Percentage of daily traffic from 01:00 AM to 01:59 AM
HRLY_DISTR_02	Percentage of daily traffic from 02:00 AM to 02:59 AM
HRLY_DISTR_03	Percentage of daily traffic from 03:00 AM to 03:59 AM
HRLY_DISTR_04	Percentage of daily traffic from 04:00 AM to 04:59 AM
HRLY_DISTR_05	Percentage of daily traffic from 05:00 AM to 05:59 AM
HRLY_DISTR_06	Percentage of daily traffic from 06:00 AM to 06:59 AM
HRLY_DISTR_07	Percentage of daily traffic from 07:00 AM to 07:59 AM
HRLY_DISTR_08	Percentage of daily traffic from 08:00 AM to 08:59 AM
HRLY_DISTR_09	Percentage of daily traffic from 09:00 AM to 09:59 AM
HRLY_DISTR_10	Percentage of daily traffic from 10:00 AM to 10:59 AM

HRLY_DISTR_11	Percentage of daily traffic from 11:00 AM to 11:59 AM
HRLY_DISTR_12	Percentage of daily traffic from 12:00 PM to 12:59 PM
HRLY_DISTR_13	Percentage of daily traffic from 01:00 PM to 01:59 PM
HRLY_DISTR_14	Percentage of daily traffic from 02:00 PM to 02:59 PM
HRLY_DISTR_15	Percentage of daily traffic from 03:00 PM to 03:59 PM
HRLY_DISTR_16	Percentage of daily traffic from 04:00 PM to 04:59 PM
HRLY_DISTR_17	Percentage of daily traffic from 05:00 PM to 05:59 PM
HRLY_DISTR_18	Percentage of daily traffic from 06:00 PM to 06:59 PM
HRLY_DISTR_19	Percentage of daily traffic from 07:00 PM to 07:59 PM
HRLY_DISTR_20	Percentage of daily traffic from 08:00 PM to 08:59 PM
HRLY_DISTR_21	Percentage of daily traffic from 09:00 PM to 09:59 PM
HRLY_DISTR_22	Percentage of daily traffic from 10:00 PM to 10:59 PM
HRLY_DISTR_23	Percentage of daily traffic from 11:00 PM to 11:59 PM
HRLY_DISTR_24	Percentage of daily traffic from 12:00 AM to 12:59 AM
QUAD_AXLE	Axial load for quad axles
SECTION_ID	Unique identifier for each pavement section included into the database.
SIN_CONST_A	Parameter A for sinusoidal model for hourly variability
SIN_CONST_B	Parameter B for sinusoidal model for hourly variability
SIN_CONST_C	Parameter C for sinusoidal model for hourly variability
SINGLE_AXLE_DUAL_WHEEL	Axial load for single axles w/double wheels
SINGLE_AXLE_SINGLE_WHEEL	Axial load for single axles w/single wheels
TANDEM_AXLE	Axial load for tandem axles
TRIDEM_AXLE	Axial load for tridem axles

TRAFFIC_LOAD_SPECTRA	The TRAFFIC_LOAD_SPECTRA table contains information on the axle load spectra for different axle types, as well as default axle load spectra.
Axle_ID	Unique Identifier for different axle types. Axle load spectrum (or distribution) for a given type of axle (such as single axle, single axle with dual wheels, tandem, and tridem…) is composed of two elements: axle load bins and frequency for each interval.
Axle_Type	Steering =1, Single axle with wheels =2, tandem=3, tridem=4.
Bin_1	Normalized Frequency for distribution bin 1 (in %)
Bin_10	Normalized Frequency for distribution bin 10 (in %)
Bin_11	Normalized Frequency for distribution bin 11 (in %)
Bin_12	Normalized Frequency for distribution bin 12 (in %)
Bin_13	Normalized Frequency for distribution bin 13 (in %)

Bin_14	Normalized Frequency for distribution bin 14 (in %)
Bin_15	Normalized Frequency for distribution bin 15 (in %)
Bin_16	Normalized Frequency for distribution bin 16 (in %)
Bin_17	Normalized Frequency for distribution bin 17 (in %)
Bin_18	Normalized Frequency for distribution bin 18 (in %)
Bin_19	Normalized Frequency for distribution bin 19 (in %)
Bin_2	Normalized Frequency for distribution bin 2 (in %)
Bin_20	Normalized Frequency for distribution bin 20 (in %)
Bin_21	Normalized Frequency for distribution bin 21 (in %)
Bin_22	Normalized Frequency for distribution bin 22 (in %)
Bin_23	Normalized Frequency for distribution bin 23 (in %)
Bin_24	Normalized Frequency for distribution bin 24 (in %)
Bin_25	Normalized Frequency for distribution bin 25 (in %)
Bin_26	Normalized Frequency for distribution bin 26 (in %)
Bin_27	Normalized Frequency for distribution bin 27 (in %)
Bin_28	Normalized Frequency for distribution bin 28 (in %)
Bin_29	Normalized Frequency for distribution bin 29 (in %)
Bin_3	Normalized Frequency for distribution bin 3 (in %)
Bin_30	Normalized Frequency for distribution bin 30 (in %)
Bin_31	Normalized Frequency for distribution bin 31 (in %)
Bin_32	Normalized Frequency for distribution bin 32 (in %)
Bin_33	Normalized Frequency for distribution bin 33 (in %)
Bin_34	Normalized Frequency for distribution bin 34 (in %)
Bin_35	Normalized Frequency for distribution bin 35 (in %)
Bin_36	Normalized Frequency for distribution bin 36 (in %)
Bin_37	Normalized Frequency for distribution bin 37 (in %)
Bin_38	Normalized Frequency for distribution bin 38 (in %)
Bin_39	Normalized Frequency for distribution bin 39 (in %)
Bin_4	Normalized Frequency for distribution bin 4 (in %)
Bin_40	Normalized Frequency for distribution bin 40 (in %)
Bin_41	Normalized Frequency for distribution bin 41 (in %)
Bin_42	Normalized Frequency for distribution bin 42 (in %)
Bin_43	Normalized Frequency for distribution bin 43 (in %)
Bin_5	Normalized Frequency for distribution bin 5 (in %)
Bin_6	Normalized Frequency for distribution bin 6 (in %)
Bin_7	Normalized Frequency for distribution bin 7 (in %)

Bin_8	Normalized Frequency for distribution bin 8 (in %)
Bin_9	Normalized Frequency for distribution bin 9 (in %)
Bin_Width	Bins represent the intervals of axle load weight. For steering axle and single axle with dual wheels the bins have an interval width of 1 kip; for tandem axle, 2 kip; and for tridem axle, 3 kip.
Sta_PK1_M	Peak 1 statistic, mean
Sta_PK1_S	Peak 1 statistic, standard deviation
Sta_PK1_W	Peak 1 statistic, weight
Sta_PK2_M	Peak 2 statistic, mean
Sta_PK2_S	Peak 2 statistic, standard deviation
Sta_PK2_W	Peak 2 statistic, weight
Sta_PK3_M	Peak 3 statistic, mean
Sta_PK3_S	Peak 3 statistic, standard deviation

Appendix B: GPS and SPS Sections Involving Asphalt Concrete Pavements

Table B1: GPS sections involving asphalt concrete pavements

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
0001	31-Jan-89		1	1		31-Jan-89			E	E	E	E
0001	05-Mar-97	1	2	1		31-Jan-89			E	E	E	E
0001	31-Aug-04	23	3	1		31-Jan-89			E	E	E	E
0113	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0114	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0115	29-Apr-02	51,10	3	6S		29-Apr-02			E	E	E	E
0116	29-Apr-02	51,10	3	6S		29-Apr-02			E	E	E	E
0117	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0118	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0119	29-Apr-02	51,10	3	6S		29-Apr-02			E	E	E	E
0120	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0121	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0122	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0123	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0124	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0160	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0161	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0162	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0163	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0164	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0165	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
0167	29-Apr-02	51,10	2	6S		29-Apr-02			E	E	E	E
1039	01-Jan-87		1	1		01-Jan-87	01-Aug-96		E	E	E	E
1039	18-Sep-89	26,33	2	1		01-Jan-87	01-Aug-96		E	E	E	E
1039	01-Aug-96	31,19	3	6B		01-Aug-96			E	E	E	E
1039	15-Jul-01	31	4	6B		01-Aug-96			E	E	E	E
1039	04-Nov-02	33	5	6B		01-Aug-96			E	E	E	E
1046	01-Jan-87		1	6A		01-Jan-87			E	E	E	E
1046	21-Dec-88	1	2	6A		01-Jan-87			E	E	E	E
1046	28-Jan-98	1	3	6A		01-Jan-87			E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
1047	01-Jan-87		1	1	O	01-Jan-87	01-Oct-00		E	E	E	E
1047	30-Nov-88	1	2	1	O	01-Jan-87	01-Oct-00		E	E	E	E
1047	21-Jan-98	1	3	1	O	01-Jan-87	01-Oct-00		E	E	E	E
1047	11-Feb-98	1	4	1	O	01-Jan-87	01-Oct-00		E	E	E	E
1048	01-Jan-87		1	2	O	01-Jan-87	01-Aug-96		E	E	E	E
1049	01-Jan-87		1	2	O	01-Jan-87	30-Apr-96		E	E	E	E
1050	01-Jan-87		1	1	O	01-Jan-87	30-Nov-96		E	E	E	E
1056	01-Jan-87		1	1		01-Jan-87			E	E	E	E
1056	01-Jul-88	31	2	1		01-Jan-87			E	E	E	E
1056	06-Jul-00	31	3	1		01-Jan-87			E	E	E	E
1060	01-Jan-87		1	1	O	01-Jan-87	01-Aug-00	F	E	E	E	E
1061	01-Jul-88		1	1	O	01-Jul-88	13-Feb-91		E	E	E	E
1065	01-Jan-87		1	1	O	01-Jan-87	01-Jun-97		E	E	E	E
1065	22-Aug-95	31	2	1	O	01-Jan-87	01-Jun-97		E	E	E	E
1068	01-Jan-87		1	1		01-Jan-87	01-Nov-00	B	E	E	E	E
1068	14-Oct-92	34	2	1		01-Jan-87	01-Nov-00	B	E	E	E	E
1068	14-Aug-93	36	3	1		01-Jan-87	01-Nov-00	B	E	E	E	E
1068	27-Jul-99	31	4	1		01-Jan-87	01-Nov-00	B	E	E	E	E
1068	01-Nov-00	31,51	5	6S		01-Nov-00			E	E	E	E
1069	01-Jan-87		1	2		01-Jan-87	15-Jul-03		E	E	E	E
1069	13-Sep-90	1	2	2		01-Jan-87	15-Jul-03		E	E	E	E
1069	15-Jul-03	51,33	3	6S		15-Jul-03			E	E	E	E
1070	01-Jan-87		1	2		01-Jan-87	15-Jul-03		E	E	E	E
1070	15-Jul-03	51,33	2	6S		15-Jul-03			E	E	E	E
1076	01-Jan-87		1	1		01-Jan-87			E	E	E	E
1076	13-Jun-99	31	2	1		01-Jan-87			E	E	E	E
1077	01-Jan-87		1	1	O	01-Jan-87	01-Oct-99	A	E	E	E	E
1077	16-Nov-92	34	2	1	O	01-Jan-87	01-Oct-99	A	E	E	E	E
1087	01-Jan-87		1	1		01-Jan-87			E	E	E	E
1087	26-Aug-97	33	2	1		01-Jan-87			E	E	E	E
1092	01-Jan-87		1	1		01-Jan-87	15-Sep-98		E	E	E	E
1092	01-Jan-88	21	2	1		01-Jan-87	15-Sep-98		E	E	E	E
1092	27-Aug-91	31	3	1		01-Jan-87	15-Sep-98		E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
1092	15-Jul-95	31	4	1		01-Jan-87	15-Sep-98		E	E	E	E
1092	15-Sep-98	19	5	6B		15-Sep-98			E	E	E	E
1093	01-Jan-87		1	1		01-Jan-87	14-Sep-88		E	E	E	E
1093	14-Sep-88	28,19	2	6B		14-Sep-88			E	E	E	E
1094	01-Jan-87		1	1		01-Jan-87			E	E	E	E
1094	14-Sep-98	31	2	1		01-Jan-87			E	E	E	E
1096	01-Jan-87		1	1		01-Jan-87	30-May-01		E	E	E	E
1096	01-Jul-96	31	2	1		01-Jan-87	30-May-01		E	E	E	E
1096	30-May-01	31,19	3	6B		30-May-01			E	E	E	E
1109	01-Jan-87		1	2	O	01-Jan-87	01-Jul-01		E	E	E	E
1109	04-Sep-96	31	2	2	O	01-Jan-87	01-Jul-01		E	E	E	E
1109	13-Aug-97	31	3	2	O	01-Jan-87	01-Jul-01		E	E	E	E
1111	01-Jan-87		1	1		01-Jan-87	15-Aug-99		E	E	E	E
1111	15-Aug-99	19	2	6B		15-Aug-99			E	E	E	E
1113	01-Jan-87		1	1	O	01-Jan-87	07-Jun-92		E	E	E	E
1113	07-Jun-92	31,19	2	6B	O	07-Jun-92	31-Jan-05		E	E	E	E
1116	30-Jun-87		1	1	O	30-Jun-87	17-Oct-90		E	E	E	E
1116	17-Oct-90	19	2	6B	O	17-Oct-90	02-Feb-92		E	E	E	E
1116	02-Feb-92	51	3	6S	O	02-Feb-92	01-Sep-99		E	E	E	E
1119	01-Jan-87		1	1	O	01-Jan-87	02-Aug-89		E	E	E	E
1119	02-Aug-89	19	2	6B	O	02-Aug-89	01-Dec-00		E	E	E	E
1122	01-Jan-87		1	1		01-Jan-87		E	E	E	E	E
1122	19-Jul-02	31	2	1		01-Jan-87			E	E	E	E
1123	01-Jan-87		1	1	O	01-Jan-87	26-Jul-93		E	E	E	E
1123	31-Aug-88	33	2	1	O	01-Jan-87	26-Jul-93		E	E	E	E
1130	01-Jan-87		1	1		01-Jan-87	21-Oct-92		E	E	E	E
1130	21-Oct-92	19	2	6B		21-Oct-92			E	E	E	E
1130	19-Apr-94	31	3	6B		21-Oct-92			E	E	E	E
1168	01-Jan-87		1	1		01-Jan-87			E	E	E	E
1168	15-Apr-02	31	2	1		01-Jan-87			E	E	E	E
1169	01-Jan-87		1	1		01-Jan-87			E	E	E	E
1169	15-May-00	33	2	1		01-Jan-87			E	E	E	E
1169	15-Aug-00	31	3	1		01-Jan-87			E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
1174	01-Jan-87		1	1	O	01-Jan-87	17-Apr-98		E	E	E	E
1174	14-Mar-95	12	2	1	O	01-Jan-87	17-Apr-98		E	E	E	E
1178	30-Jun-88		1	1	O	30-Jun-88	02-May-95		E	E	E	E
1178	31-Mar-91	1	2	1	O	30-Jun-88	02-May-95		E	E	E	E
1181	01-Jan-87		1	1	O	01-Jan-87	01-Aug-00		E	E	E	E
1183	01-Jan-87		1	1	O	01-Jan-87	10-Sep-94		E	E	E	E
1183	11-Dec-90	26	2	1	O	01-Jan-87	10-Sep-94		E	E	E	E
1183	19-Sep-91	26	3	1	O	01-Jan-87	10-Sep-94		E	E	E	E
1183	30-Jan-92	1,26	4	1	O	01-Jan-87	10-Sep-94		E	E	E	E
2108	01-Jan-87		1	2		01-Jan-87	15-Jun-03		E	E	E	E
2108	22-Jun-94	26	2	2		01-Jan-87	15-Jun-03		E	E	E	E
2108	01-Aug-95	25	3	2		01-Jan-87	15-Jun-03		E	E	E	E
2108	15-Jun-03	51	4	6S		15-Jun-03			E	E	E	E
2133	01-Jan-87		1	2		01-Jan-87			E	E	E	E
2133	03-Aug-00	31	2	2		01-Jan-87			E	E	E	E
2172	01-Jan-87		1	2	O	01-Jan-87	01-Aug-95		E	E	E	E
2172	08-Aug-90	1	2	2	O	01-Jan-87	01-Aug-95		E	E	E	E
2172	25-Feb-91	31	3	2	O	01-Jan-87	01-Aug-95		E	E	E	E
2172	11-Jul-94	31	4	2	O	01-Jan-87	01-Aug-95		E	E	E	E
2172	18-Jan-95	26	5	2	O	01-Jan-87	01-Aug-95		E	E	E	E
2176	01-Jan-87		1	2		01-Jan-87	22-Feb-01		E	E	E	E
2176	26-Jun-97	31	2	2		01-Jan-87	22-Feb-01		E	E	E	E
2176	22-Feb-01	19	3	6S		22-Feb-01			E	E	E	E
3559	01-Jan-87		1	2	O	01-Jan-87	01-Mar-99		E	E	E	E
3579	31-Oct-87		1	1	O	31-Oct-87	01-Sep-98		E	E	E	E
3609	01-Jan-87		1	1	O	01-Jan-87	27-Nov-91		E	E	E	E
3669	01-Jan-87		1	2		01-Jan-87	15-Sep-00		E	E	E	E
3669	22-Jan-95	23	2	2		01-Jan-87	15-Sep-00		E	E	E	E
3669	15-Sep-00	19	3	6B		15-Sep-00			E	E	E	E
3669	11-Jun-03	31	4	6B		15-Sep-00			E	E	E	E
3679	31-May-88		1	2	O	31-May-88	19-Jul-97		E	E	E	E
3679	23-Apr-95	26	2	2	O	31-May-88	19-Jul-97		E	E	E	E
3679	04-Jun-95	26	3	2	O	31-May-88	19-Jul-97		E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
3689	31-Mar-87		1	2	O	31-Mar-87	15-Jun-99		E	E	E	E
3689	10-May-94	26	2	2	O	31-Mar-87	15-Jun-99		E	E	E	E
3689	04-Jun-95	26	3	2	O	31-Mar-87	15-Jun-99		E	E	E	E
3689	28-May-98	26	4	2	O	31-Mar-87	15-Jun-99		E	E	E	E
3729	01-Jan-87		1	1		01-Jan-87	01-Sep-99		E	E	E	E
3729	09-Apr-99	31	2	1		01-Jan-87	01-Sep-99		E	E	E	E
3729	01-Sep-99	19	3	6B		01-Sep-99			E	E	E	E
3739	01-Jan-87		1	1		01-Jan-87		G	E	E	E	E
3739	26-Sep-94	31	2	1		01-Jan-87		G	E	E	E	E
3739	30-Jan-95	34	3	1		01-Jan-87		G	E	E	E	E
3739	02-Apr-01	12,28	4	1		01-Jan-87			E	E	E	E
3749	01-Jan-87		1	1	O	01-Jan-87	29-Mar-97		E	E	E	E
3749	26-Nov-95	24	2	1	O	01-Jan-87	29-Mar-97		E	E	E	E
3769	01-Jan-87		1	1		01-Jan-87	01-May-03		E	E	E	E
3769	01-May-03	51	2	6S		01-May-03			E	E	E	E
3835	01-Oct-91		1	1		01-Oct-91	31-Dec-99		E	E	E	E
3835	13-Sep-92	1	2	1		01-Oct-91	31-Dec-99		E	E	E	E
3835	31-Dec-99	19	3	6B		31-Dec-99			E	E	E	E
3855	01-Jan-87		1	1		01-Jan-87	14-Dec-98		E	E	E	E
3855	30-Jun-98	27	2	1		01-Jan-87	14-Dec-98		E	E	E	E
3855	14-Dec-98	19	3	6B		14-Dec-98			E	E	E	E
3865	01-Jan-87		1	1		01-Jan-87	18-May-01		E	E	E	E
3865	18-May-01	19	2	6C		18-May-01			E	E	E	E
3865	07-Jul-03	31	3	6C		18-May-01			E	E	E	E
3875	01-Jan-87		1	1	O	01-Jan-87	26-Jun-91		E	E	E	E
3875	26-Jun-91	19	2	6B	O	26-Jun-91	01-Jul-00		E	E	E	E
6079	01-Jan-87		1	6A	O	01-Jan-87	11-Nov-02		E	E	E	E
6079	14-Apr-91	25	2	6A	O	01-Jan-87	11-Nov-02		E	E	E	E
6079	15-Jun-92	25	3	6A	O	01-Jan-87	11-Nov-02		E	E	E	E
6079	15-Jun-94	25	4	6A	O	01-Jan-87	11-Nov-02		E	E	E	E
6079	15-Jun-96	25	5	6A	O	01-Jan-87	11-Nov-02		E	E	E	E
6079	15-Jun-98	25	6	6A	O	01-Jan-87	11-Nov-02		E	E	E	E
6086	01-Jan-87		1	6A	O	01-Jan-87	01-Sep-00		E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
6086	14-Nov-96	31	2	6A	O	01-Jan-87	01-Sep-00		E	E	E	E
6160	01-Jan-87		1	6A	O	01-Jan-87	10-Nov-93		E	E	E	E
6179	01-Jan-87		1	6A	O	01-Jan-87	08-Jul-04		E	E	E	E
6179	29-Aug-99	31	2	6A	O	01-Jan-87	08-Jul-04		E	E	E	E
9005	01-Jan-87		1	1		01-Jan-87	14-Sep-98		E	E	E	E
9005	14-Sep-98	19,31	2	6B		14-Sep-98			E	E	E	E

Note: “E” indicates the data has passed the fifth level of quality control as specified in the LTPP protocols.

Table B2: SPS sections involving asphalt concrete pavements

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
0100	01-Jan-95		1	1		01-Jan-95			E	E		E
0113	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0114	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0115	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0115	07-Jul-98	12	2	1		01-Jan-95	29-Apr-02		E	E	E	E
0116	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0116	07-Jul-98	12	2	1		01-Jan-95	29-Apr-02		E	E	E	E
0117	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0118	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0119	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0119	07-Jul-98	12	2	1		01-Jan-95	29-Apr-02		E	E	E	E
0120	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0121	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0122	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0123	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0124	01-Jan-95		1	1		01-Jan-95	29-Apr-02		E	E	E	E
0160	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
0161	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
0162	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
0163	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
0164	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
0165	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
0166	01-Jan-95		1	1		01-Jan-95		S	E	E	E	E
0167	01-Jan-95		1	1		01-Jan-95	29-Apr-02	S	E	E	E	E
A300	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E		E
A310	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
A310	04-Dec-89	19	2	3	O	01-Jan-87	14-Sep-98		E	E	E	E
A320	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
A320	04-Dec-89	33	2	3	O	01-Jan-87	14-Sep-98		E	E	E	E
A330	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E

SHRP_ID	CN_ASSIGN _DATE	CN_CHANG E_REASON	CONSTRUC TION_NO	EXPERIME NT_NO	STATUS	ASSIGN_D ATE	DEASSIGN_ DATE	SUPPLEME NTAL	EXP_SECT_ RS	BASIC_I NFO_RS	PAV_STR UCT_RS	CLIMATIC _RS
A340	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
A500	01-Jan-87		1	5		01-Jan-87			E	E		E
A502	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A502	25-Sep-91	43,10	2	5		01-Jan-87			E	E	E	E
A503	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A503	20-Sep-91	43,10	2	5		01-Jan-87			E	E	E	E
A504	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A504	16-Oct-91	19,10	2	5		01-Jan-87			E	E	E	E
A505	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A505	20-Oct-91	19,10	2	5		01-Jan-87			E	E	E	E
A506	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A506	28-Jul-91	51,10	2	5		01-Jan-87			E	E	E	E
A507	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A507	28-Jul-91	51,10	2	5		01-Jan-87			E	E	E	E
A508	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A508	24-Jul-91	55,10	2	5		01-Jan-87			E	E	E	E
A509	01-Jan-87		1	5		01-Jan-87			E	E	E	E
A509	24-Jul-91	55,10	2	5		01-Jan-87			E	E	E	E
B300	01-Jan-87		1	3		01-Jan-87			E	E		E
B310	01-Jan-87		1	3		01-Jan-87			E	E	E	E
B310	12-Sep-90	1,19	2	3		01-Jan-87			E	E	E	E
B320	01-Jan-87		1	3		01-Jan-87			E	E	E	E
B320	12-Sep-90	1,33	2	3		01-Jan-87			E	E	E	E
B330	01-Jan-87		1	3		01-Jan-87			E	E	E	E
B330	25-Sep-90	1	2	3		01-Jan-87			E	E	E	E
B340	01-Jan-87		1	3		01-Jan-87			E	E	E	E
B350	01-Jan-87		1	3		01-Jan-87			E	E	E	E
B350	12-Sep-90	1	2	3		01-Jan-87			E	E	E	E
B350	25-Sep-90	31	3	3		01-Jan-87			E	E	E	E
D300	01-Jan-87		1	3	O	01-Jan-87	01-Aug-95		E	E		E
D310	01-Jan-87		1	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D310	08-Aug-90	1	2	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D310	11-Oct-90	19	3	3	O	01-Jan-87	01-Aug-95		E	E	E	E

SHRP_ID	CN_ASSIGN _DATE	CN_CHANG E_REASON	CONSTRUC TION_NO	EXPERIME NT_NO	STATUS	ASSIGN_D ATE	DEASSIGN_ DATE	SUPPLEME NTAL	EXP_SECT_ RS	BASIC_I NFO_RS	PAV_STR UCT_RS	CLIMATIC _RS
D320	01-Jan-87		1	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D320	08-Aug-90	1	2	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D320	17-Sep-90	33	3	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D330	01-Jan-87		1	3	O	01-Jan-87	11-Jul-94		E	E	E	E
D330	08-Aug-90	1	2	3	O	01-Jan-87	11-Jul-94		E	E	E	E
D330	17-Sep-90	1	3	3	O	01-Jan-87	11-Jul-94		E	E	E	E
D330	25-Feb-91	34	4	3	O	01-Jan-87	11-Jul-94		E	E	E	E
D350	01-Jan-87		1	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D350	08-Aug-90	1	2	3	O	01-Jan-87	01-Aug-95		E	E	E	E
D350	17-Sep-90	31	3	3	O	01-Jan-87	01-Aug-95		E	E	E	E
E300	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94		E	E		E
E310	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E310	01-Aug-90	1,27	2	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E310	24-Sep-90	19	3	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E320	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E320	01-Aug-90	1,25	2	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E320	13-Sep-90	33	3	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E320	09-Apr-91	26	4	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E320	05-Mar-92	26	5	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E330	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E330	01-Aug-90	26	2	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E330	09-Apr-91	26,1	3	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E330	30-Jan-92	1,26	4	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E340	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E340	30-Jul-90	26	2	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E340	09-Apr-91	26	3	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E340	05-Mar-92	26	4	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E350	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E350	01-Aug-90	1,26	2	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E350	13-Sep-90	31	3	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E350	09-Apr-91	26	4	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E350	05-Mar-92	26	5	3	O	01-Jan-87	10-Sep-94		E	E	E	E
E351	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94	S	E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
E351	01-Aug-90	1	2	3	O	01-Jan-87	10-Sep-94	S	E	E	E	E
E352	01-Jan-87		1	3	O	01-Jan-87	10-Sep-94	S	E	E	E	E
E352	01-Aug-90	1	2	3	O	01-Jan-87	10-Sep-94	S	E	E	E	E
E352	18-Sep-90	29	3	3	O	01-Jan-87	10-Sep-94	S	E	E	E	E
F300	01-Jan-87		1	3	O	01-Jan-87	13-Jul-97		E	E		E
F310	01-Jan-87		1	3	O	01-Jan-87	20-Jul-97		E	E	E	E
F310	14-Oct-90	19	2	3	O	01-Jan-87	20-Jul-97		E	E	E	E
F320	01-Jan-87		1	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F320	03-Oct-90	33	2	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F320	06-Sep-94	22	3	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F330	01-Jan-87		1	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F330	03-Oct-90	1	2	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F330	06-Sep-94	25	3	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F330	11-Apr-95	22	4	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F340	01-Jan-87		1	3	O	01-Jan-87	13-Jul-97		E	E	E	E
F350	01-Jan-87		1	3	O	01-Jan-87	12-Apr-95		E	E	E	E
F350	03-Oct-90	31	2	3	O	01-Jan-87	12-Apr-95		E	E	E	E
F350	06-Sep-94	22	3	3	O	01-Jan-87	12-Apr-95		E	E	E	E
G300	01-Jan-87		1	3		01-Jan-87			E	E		E
G310	01-Jan-87		1	3		01-Jan-87			E	E	E	E
G310	14-Oct-90	19	2	3		01-Jan-87			E	E	E	E
G320	01-Jan-87		1	3		01-Jan-87			E	E	E	E
G320	04-Oct-90	33	2	3		01-Jan-87			E	E	E	E
G330	01-Jan-87		1	3		01-Jan-87			E	E	E	E
G350	01-Jan-87		1	3	O	01-Jan-87	20-Jul-97		E	E	E	E
G350	04-Oct-90	31	2	3	O	01-Jan-87	20-Jul-97		E	E	E	E
G350	15-Sep-91	24	3	3	O	01-Jan-87	20-Jul-97		E	E	E	E
G350	15-Mar-95	24	4	3	O	01-Jan-87	20-Jul-97		E	E	E	E
H300	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96		E	E		E
H310	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H310	14-Oct-90	19	2	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H320	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H320	24-Sep-90	1,33	2	3	O	01-Jan-87	30-Nov-96		E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
H330	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H330	24-Sep-90	1	2	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H330	03-Mar-93	1	3	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H340	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H350	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H350	10-Oct-90	31	2	3	O	01-Jan-87	30-Nov-96		E	E	E	E
H351	01-Jan-87		1	3	O	01-Jan-87	30-Nov-96	S	E	E	E	E
H351	16-Jul-90	31	2	3	O	01-Jan-87	30-Nov-96	S	E	E	E	E
I300	01-Jan-87		1	3		01-Jan-87			E	E		E
I310	01-Jan-87		1	3		01-Jan-87			E	E	E	E
I310	29-Nov-90	19	2	3		01-Jan-87			E	E	E	E
I320	01-Jan-87		1	3		01-Jan-87			E	E	E	E
I320	09-Oct-90	33	2	3		01-Jan-87			E	E	E	E
I330	01-Jan-87		1	3		01-Jan-87			E	E	E	E
I340	01-Jan-87		1	3		01-Jan-87			E	E	E	E
I350	01-Jan-87		1	3		01-Jan-87			E	E	E	E
I350	09-Oct-90	31	2	3		01-Jan-87			E	E	E	E
J300	01-Jan-87		1	3		01-Jan-87			E	E		E
J310	01-Jan-87		1	3		01-Jan-87			E	E	E	E
J310	30-Oct-90	19	2	3		01-Jan-87			E	E	E	E
J320	01-Jan-87		1	3		01-Jan-87			E	E	E	E
J320	15-Oct-90	33	2	3		01-Jan-87			E	E	E	E
J330	01-Jan-87		1	3		01-Jan-87			E	E	E	E
J340	01-Jan-87		1	3		01-Jan-87			E	E	E	E
J350	01-Jan-87		1	3		01-Jan-87			E	E	E	E
J350	15-Oct-90	31	2	3		01-Jan-87			E	E	E	E
J351	01-Jan-87		1	3		01-Jan-87		S	E	E	E	E
J351	11-Jul-90	31	2	3		01-Jan-87		S	E	E	E	E
K300	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E		E
K310	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K310	19-Jun-90	1	2	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K310	30-Oct-90	19	3	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K320	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E

SHRP_ID	CN_ASSIGN _DATE	CN_CHANG E_REASON	CONSTRUC TION_NO	EXPERIME NT_NO	STATUS	ASSIGN_D ATE	DEASSIGN_ DATE	SUPPLEME NTAL	EXP_SECT_ RS	BASIC_I NFO_RS	PAV_STR UCT_RS	CLIMATIC _RS
K320	19-Jun-90	1	2	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K320	15-Oct-90	33	3	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K330	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K340	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K350	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K350	19-Jun-90	1	2	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K350	15-Oct-90	31	3	3	O	01-Jan-87	14-Sep-98		E	E	E	E
K351	01-Jan-87		1	3	O	01-Jan-87	14-Sep-98	S	E	E	E	E
K351	19-Jun-90	1	2	3	O	01-Jan-87	14-Sep-98	S	E	E	E	E
K351	12-Jul-90	31	3	3	O	01-Jan-87	14-Sep-98	S	E	E	E	E
L300	01-Jan-87		1	3	O	01-Jan-87	30-Nov-01		E	E		E
L310	01-Jan-87		1	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L310	19-Aug-90	1	2	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L310	15-Apr-91	19	3	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L320	01-Jan-87		1	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L320	19-Aug-90	1	2	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L320	19-Sep-90	33	3	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L330	01-Jan-87		1	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L330	19-Sep-90	1	2	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L340	01-Jan-87		1	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L350	01-Jan-87		1	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L350	19-Aug-90	1	2	3	O	01-Jan-87	30-Nov-01		E	E	E	E
L350	19-Sep-90	31	3	3	O	01-Jan-87	30-Nov-01		E	E	E	E
M300	01-Jan-87		1	3	O	01-Jan-87	29-Mar-97		E	E		E
M310	01-Jan-87		1	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M310	14-Aug-90	19	2	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M310	27-Nov-95	24	3	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M320	01-Jan-87		1	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M320	18-Oct-90	33	2	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M320	27-Nov-95	24	3	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M330	01-Jan-87		1	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M330	27-Nov-95	24	2	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M340	01-Jan-87		1	3	O	01-Jan-87	29-Mar-97		E	E	E	E

SHRP_ID	CN_ASSIGN_DATE	CN_CHANGE_REASON	CONSTRUCTION_NO	EXPERIMENT_NO	STATUS	ASSIGN_DATE	DEASSIGN_DATE	SUPPLEMENTAL	EXP_SECT_RS	BASIC_INFO_RS	PAV_STRUCT_RS	CLIMATIC_RS
M340	22-Mar-94	24	2	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M340	28-Nov-95	24	3	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M350	01-Jan-87		1	3	O	01-Jan-87	29-Mar-97		E	E	E	E
M350	18-Oct-90	31	2	3	O	01-Jan-87	29-Mar-97		E	E	E	E
N300	01-Jan-87		1	3	O	01-Jan-87	28-Sep-94		E	E		E
N310	01-Jan-87		1	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N310	14-Aug-90	19	2	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N320	01-Jan-87		1	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N320	18-Oct-90	33	2	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N320	17-Dec-90	26	3	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N330	01-Jan-87		1	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N330	25-Sep-91	24	2	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N330	21-Jan-92	26	3	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N340	01-Jan-87		1	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N350	01-Jan-87		1	3	O	01-Jan-87	28-Sep-94		E	E	E	E
N350	18-Oct-90	31	2	3	O	01-Jan-87	28-Sep-94		E	E	E	E
Q300	01-Jan-87		1	3		01-Jan-87			E	E		E
Q310	01-Jan-87		1	3		01-Jan-87			E	E	E	E
Q310	25-Sep-90	19	2	3		01-Jan-87			E	E	E	E
Q320	01-Jan-87		1	3		01-Jan-87			E	E	E	E
Q320	24-Sep-90	33	2	3		01-Jan-87			E	E	E	E
Q330	01-Jan-87		1	3		01-Jan-87			E	E	E	E
Q340	01-Jan-87		1	3		01-Jan-87			E	E	E	E
Q350	01-Jan-87		1	3		01-Jan-87			E	E	E	E
Q350	24-Sep-90	31	2	3		01-Jan-87			E	E	E	E
Q350	19-Nov-90	34	3	3		01-Jan-87			E	E	E	E
Q353	01-Jan-87		1	3		01-Jan-87		S	E	E	E	E
Q353	24-Jun-91	31	2	3		01-Jan-87		S	E	E	E	E