5-1924-01-P5

PRELIMINARY EXPERIMENTAL PLANS FOR THE TEXAS ACCELERATED PAVEMENT TEST CENTER (TXAPT)

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Project 5-1924-01: Implementation of a Fixed Site for the TxMLS

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Products

This report constitutes Product P5 to develop and document preliminary experimental plans for a shakedown test of the MLT device at Texas Mobile Load Simulation that is currently being refurbished.

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1. INTRODUCTION

This document defines a test plan for a Shakedown test of the newly refurbished Texas Mobile Load Simulator (TxMLS). The test will be performed at the Texas Accelerated Pavement Testing (TxAPT) Center, which is currently under construction at the J.J. Pickle Research Campus in Austin, Texas, with an expected completion date in August 2003.

Originally the Shakedown test was to be carried out by TxAPT staff in conjunction with the first research study, Project 0-4574. TxDOT decided to separate these two activities; therefore the Shakedown test will be the responsibility TxAPT Center staff, and the first research study, hereinafter referred to as the Pilot Study, will be performed under Project #0-4574 titled "Determination of the Impact of HB2060 Permits on Texas Load Zone Roads" at the University of Texas at Austin, Center for Transportation Research (CTR).

The purpose of the Shakedown test is to:

1. Evaluate and characterize operational characteristics of the refurbished mobile load simulator (MLS).
2. Evaluate existing instrumentation and software used to collect research data
3. Install and evaluate selected instrumentation that has not yet been field test for either primary or secondary data collection.
4. Establish and formalize the data handling, cleansing, processing, storage, backup, and distribution protocols.
5. Collect pavement performance data for the Pilot Study.

On June 15, 2003, construction began on the TxAPT test pavement at the J. J. Pickle Research Campus (PRC) in Austin, Texas. Ranger Excavating, Inc. is the prime contractor performing the site construction which includes, excavation, embankment construction, flexible base, asphalt installation, and utilities that include water/wastewater service; 110V - 100 amp and 480V - (3 phase) 400 amp electrical service, telephone and fiber optic Ethernet service. Expected completion date of construction is August 29, 2003.

The MLS device is currently located on a temporary site at PRC where it is undergoing the final stages of renovation. This site was prepared by TxAPT to accommodate the TxDOT Pavement group renovations.

Shakedown testing will commence shortly after the TxAPT test pavement construction is completed and the TxMLS renovations are complete and declared ready for testing (Figure 2.1). For the Shakedown, the MLS will be moved from it temporary site at PRC to the assigned test pad at the TxAPT Center (Figure 2.2).

2. PAVEMENT STRUCTURE AND LAYOUT

The TxAPT test facility is a specially constructed area 350 ft. x 75 ft. in size. The site was first excavated to a depth of 6-feet and a controlled construction of approximately 7.5 feet of selected compacted clay was reconstructed in the excavated area. As a result of the excavation, the TxAPT embankment is from 1 to 2 feet above the original ground surface, as shown in Figures 3a and b. This embankment is fully described in the report documentation of the construction (in press).

The initial pavement structure is being constructed to provide a test pad for a Shakedown test plus additional test pads for two research studies: Project #0-4574 "Determination of the Impact of HB2060 Permits on Texas Load Zone Roads" and "An Evaluation of High Performance Flexible Bases."

The initial pavement structure consists of 8-inches of three different flexible base materials and 1.5-inches of Type D hot mix asphalt concrete (HMAC). These materials will be installed according to the standard TxDOT highway construction specifications (1993). Figure 2.4 shows the plan view and profile of the initial pavement structure at the TxAPT Center.

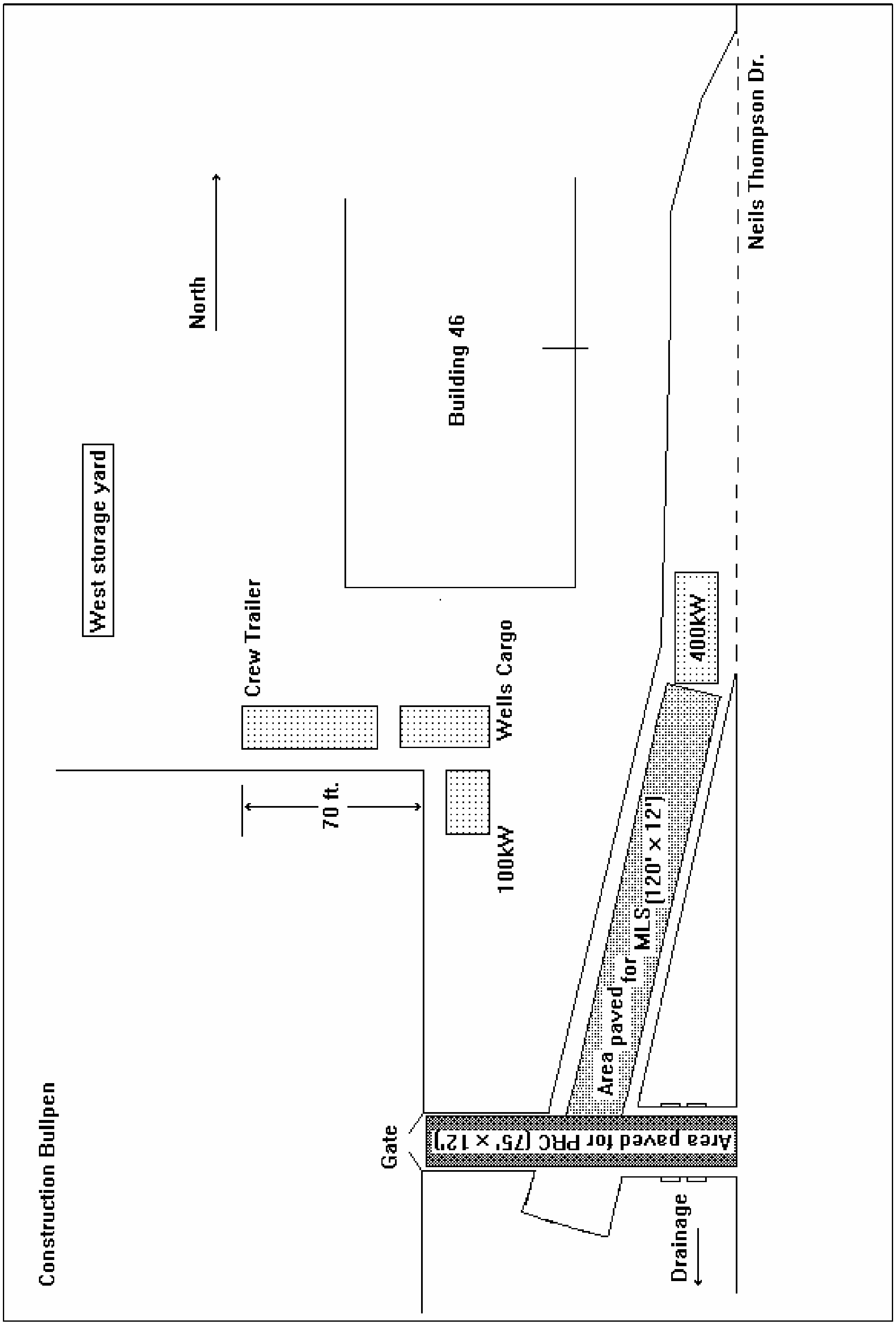


Figure 2.1 Temporary Site Layout
J. J. Pickle Research Campus
10100 Burnet Rd., Austin , TX

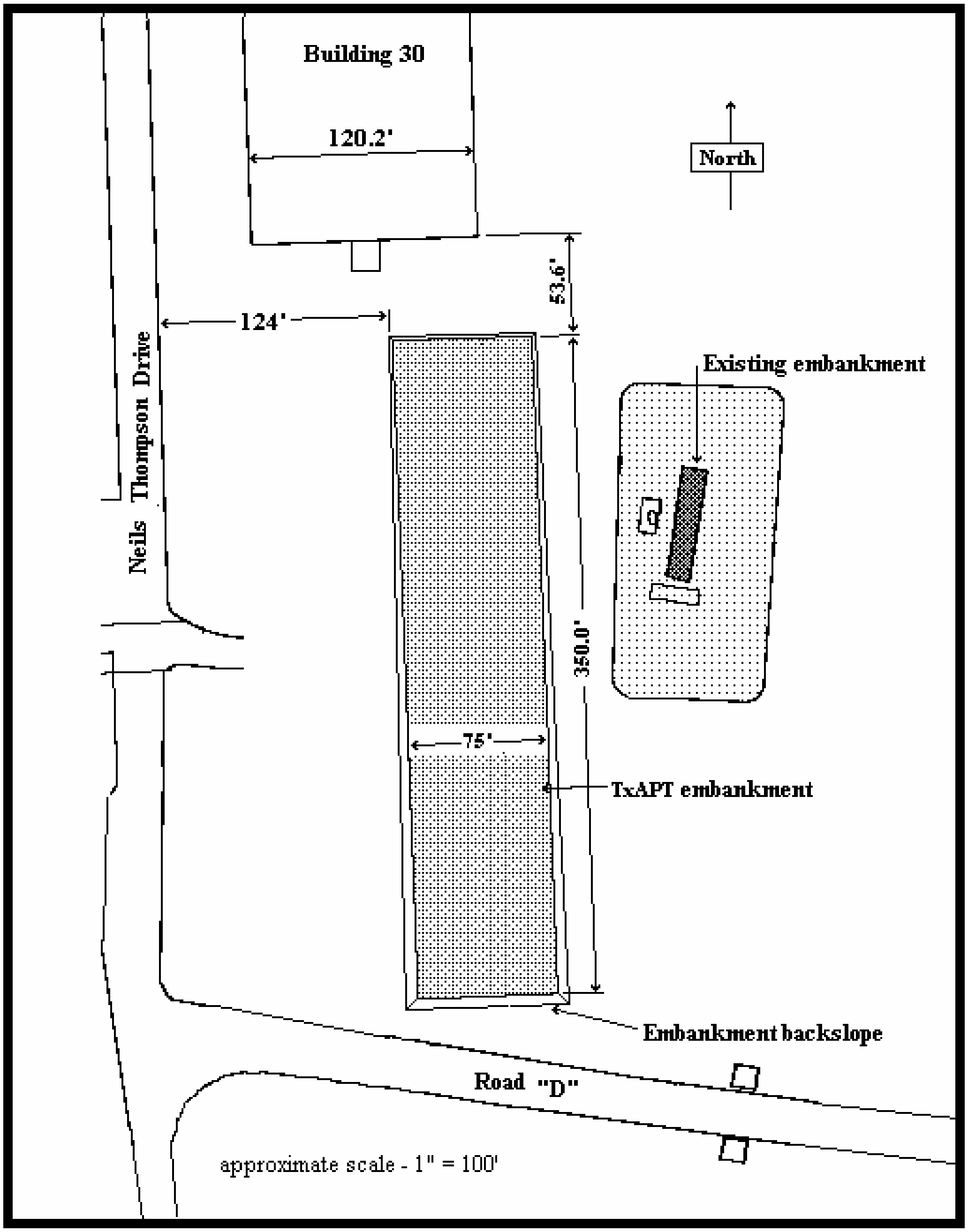


Figure 2.2 Permanent TxAPT Test Site Location and Layout.

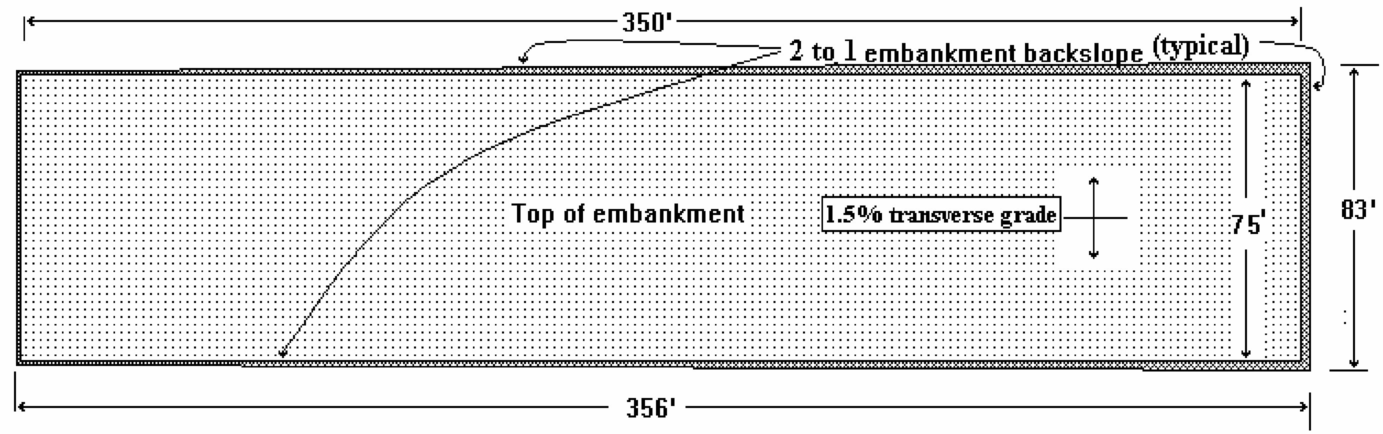


Figure 2.3 Plan view of TxAPT embankment.

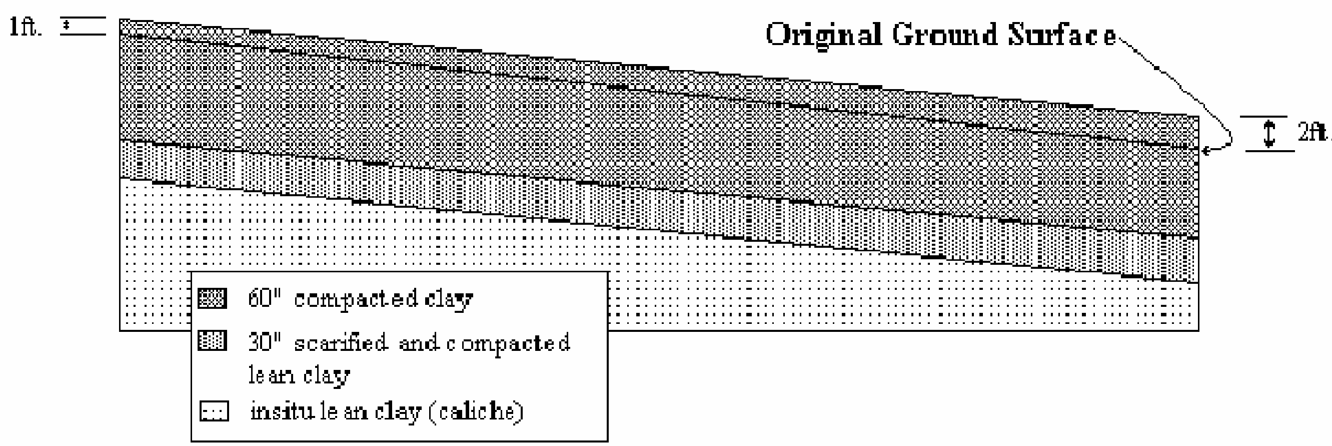


Figure 2.4 As constructed embankment profile.

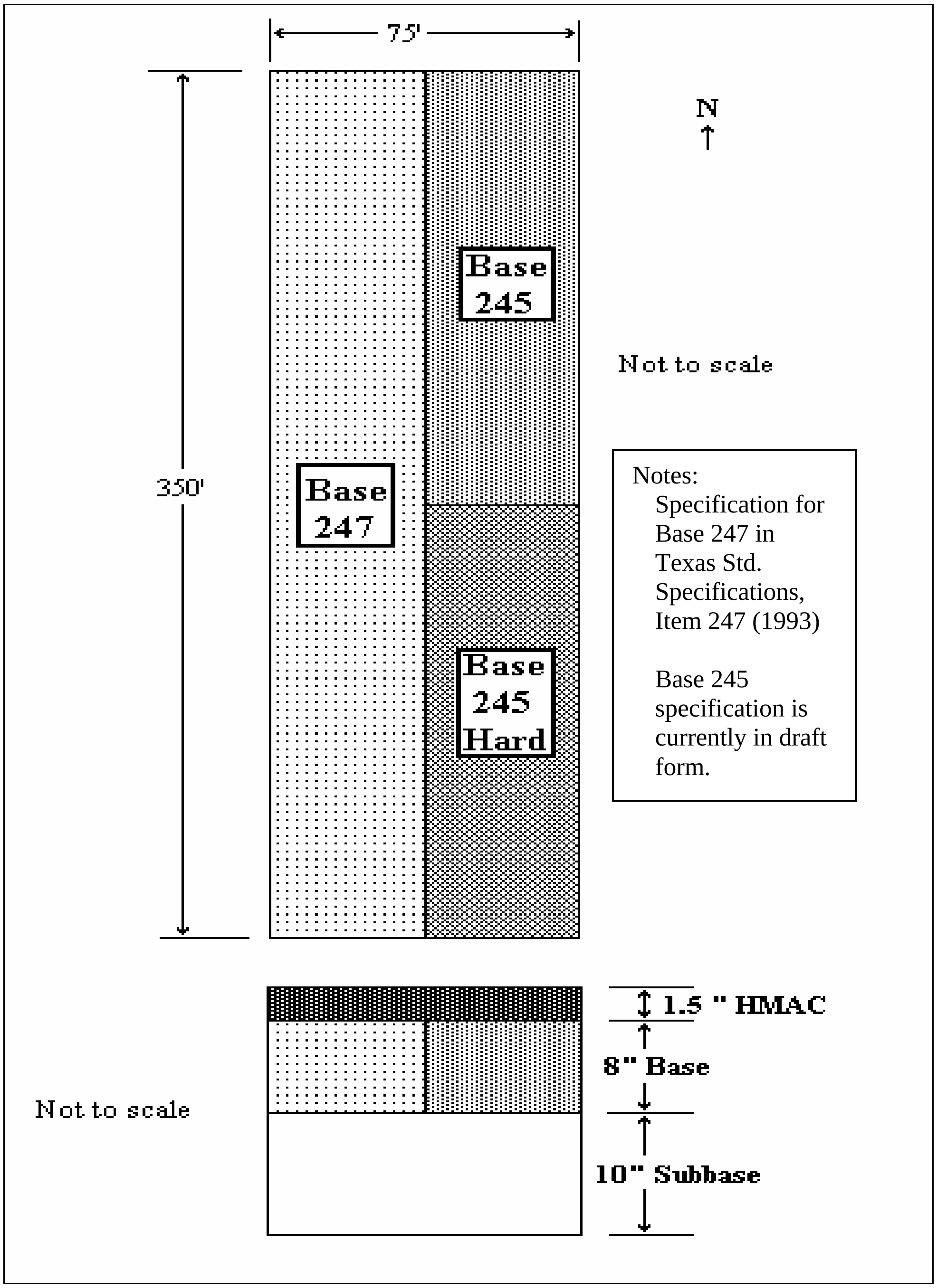


Figure 2.5 Plan/profile of initial pavement structure.

3. SHAKEDOWN TEST

When the Texas Accelerated Pavement Test Center (TxAPT) was founded, the need to have a substantial “Pilot” or “Shakedown” study of the site and the equipment was discussed. It was the original intention that the equipment would be thoroughly tested, problems sorted out, new test procedures evaluated and a methodology developed which might make it possible to trace pavement deterioration over the entire performance period. Thus, developing a model would make it possible to determine the projected life of pavements without wearing the loading equipment. In the past, each test section has been taken to an estimated “failure level.” This takes several million repetitions.

Historically, accelerated testing of pavements over the years has involved a prediction methodology which evaluates the performance curves which spots signals along the way that can be used as indicators of total life. Such indicators may be the number of applications to first crack, the rate of deterioration of serviceability or the rate of crack progression. No matter how good the renovation of the new equipment is, it will have a finite life in terms of load application, just as an automobile, caterpillar tractor, or any other mechanical device has a life of 200,000 miles or 10,000 hours, etc. It was our intention to investigate this type of predictive model as part of the Pilot Study, which was to involve 4 test sections. At the same time, we would have provided the information required on premature failure of thin load-zoned roads. However, in 2002, TxDOT decided to split the Shakedown activity from the Pilot Study and limit the shakedown work to a single test section.

There still remains a need to have an overview activity for TxAPT that will allow for an overall approach to maximize benefits from the MLS and TxAPT.

This report describes the testing plan for the single Shakedown test pad which is funded under Project 5-1924 and Project 0-9900.

3.1 TEST PAD SELECTION

During construction of the embankment and pavement structure, every effort has been made to construct the test pavement as uniformly as possible. For each pavement research study, test pads will be tested to obtain the greatest possible uniformity. This selection process will include the collection of pavement response data using non-destructive tools such as the Falling Weight Deflectometer (FWD), Seismic Pavement Analyzer (SPA), and Rolling Dynamic Deflectometer (RDD).

3.2 OBJECTIVES

The following objectives will be accomplished during the Shakedown test:

1. Evaluate the operation and performance of the refurbished MLS device and associated instrumentation, hardware, and software used to collect APT research data.
2. Evaluate instrumentation to be used in the MLS testing process.
3. Define and evaluate formal data handling, processing, cleansing, and storage methodologies to insure the accuracy and integrity of the stored research data.
4. Provide the results to all interested researchers.

Objective 1: Evaluate the operation and performance of the MLS.

For the past 2.5 years, the MLS has undergone extensive rehabilitation and refurbishments. Improvements to the original MLS have been designed and integrated into the machine. Located at a convenient temporary site on the Pickle Research Campus (PRC), the MLS is undergoing the final stages of the preliminary debugging process. Once the debugging process is complete, the MLS will be moved to the TxAPT facility and the Shakedown test will commence.

To satisfy this objective, the MLS will initially be run for an extended period of time with frequent stops so TxDOT operators can carefully inspect all critical MLS components for wear or damage. The information gathered during this process will enable the TxDOT and TxAPT teams to:

a. Establish standard maintenance procedures including daily, weekly, and monthly preventative maintenance activities.
b. Identify inventory requirements for "high-wear" parts and establish a replacement schedule.
c. Determine anticipated load applications rates (revolutions per day, per week, etc).
d. Identify optimal operating speeds.

Objective 2: Evaluate instrumentation.

The MLS has been under renovation and not operational for an extended period of time. The instrumentation used to monitor and record pavement research data also has not been used for about 3 years. The status of these instruments, such as use of iButtons to monitor pavement temperature and new sensors to monitor moisture in the base and subgrade, will be verified and we will work with the TxDOT to correct any deficiencies as needed. There is also new instrumentation being developed, which needs to be considered, includes a rut depth profiler, weather station, pavement temperature sensors, axle weighing systems (static and dynamic), longitudinal roughness measuring device (dipstick), and dynamic core penetrometer. For example, a new profiling device has been provided by the University of Houston, which is not working well. We would like to work with TxDOT to synchronize the movement of this device for automated profiling. The video camera condition survey system does not yet seem to have an adequate digital camera. We would like to get this corrected, if at all possible. Every attempt will be made to evaluate all of this equipment as part of the Shakedown; however, it may be necessary to do some additional fine tuning in the Pilot Study.

Objective 3: Evaluate data handling procedures.

Data handling procedures include data collection, processing, cleansing, storage, backup and distribution procedures and policies. These activities have already been drafted and they will be tested and refined during the Shakedown test. Again, unfortunately only one test section will be available but we will do the best we can within that framework and will revise the procedures prior to the beginning of the Pilot Study. These revised interim procedures will be adapted for use in the Pilot Study and we will continue during this fiscal year to examine those activities and to use the pilot test data itself to refine the procedures.

3.3 RESEARCH DATA TO BE COLLECTED

The original intention of this project was to collect data on four test sites in the Shakedown. As indicated above, that has been modified so we will conduct only one Shakedown test and then work with Project 0-4574 "Determination of the Impact of HB2060 Permits on Texas Load Zone Roads", which is the Pilot Study. In order to maintain close coordination, we will use the basic data collection plan, prepared by the Research Supervisor of Project 0-4574, and Dr. Dar-Hao Chen, the TxDOT MLS Supervisor, for each individual test site. That plan is not yet available but will serve as the primary guide for the data that we will collect. Changes will be made as necessary, for example to further validate load measurements and to evaluate the new profiler and other new instrumentation which may not be in the mainstream of the Pilot Study.

Objective 4: Provide the data results to all interested researchers.

The data collected during the Shakedown test cannot be considered to be normal test data since it may be contaminated by changes in procedure, adjustments and associated activities. We will do our best to document all of these activities and will store this data since it is part of the Shakedown process. We will then annotate the data in whatever way appropriate to make sure people understand the procedures that were used, for the data collected. That data will then be made available on the TxAPT 'read only' website for those who wish to peruse it. Particularly, we will work with the staff of Project 0-4574, the Pilot Study titled "Determination of the Impact of HB2060 Permits on Texas Load Zone Roads" to be sure that they are able to see the preliminary data from our tests which will point the way for kinds of data and activities they will be undertaking in their studies. We hope to maintain good interaction between these two projects for this purpose and, we believe that the data collection and handling procedures will have been completely debugged successfully by August 31, 2004.

Since the Shakedown test is, in effect a precursor to the Pilot Study, once the data is collected and all annotations of possible flaws are made, we will make sure the data is passed directly to the Research Supervisor of the Pilot Study, in order that they may it that to modify their test plan as needed. We will also hold discussions regularly during the Shakedown test so that both the MLS supervisor and the Research Supervisor of the Pilot Study will be aware of our findings and proposed changes in the procedures resulting from the Shakedown.

3.4 TEST PROGRAM

To satisfy these objectives of the Shakedown test, a sample test plan is shown in Table 1 which is similar to work planned for the Pilot Study. This is a draft and will be modified as required to fulfill the objectives of the Shakedown test. At this time a flexible approach must be maintained in the Shakedown test since this is the very first set of runs for the "new" MLS equipment.

Before the draft Pilot Study test plan is initiated, it will be necessary to undergo an evaluation of the operational characteristics of the load measuring instrumentation on the MLS. It will also be necessary to operate the MLS for several thousand repetitions at various load levels, to evaluate its operating characteristics, its power draw, the friction in the system and the accuracy of the load measuring system over a range of operational conditions and load levels. Once this basic checkout of each of the systems is carried out, particularly load measuring and the operation of the MLS itself, it will be possible to undertake various measurements and calculations associated with the sample plan in Appendix A.

3.5 INSTRUMENTATION TEST PLAN

The instrumentation test plan will focus on verifying the operation, accuracy, and durability of various instruments and transducers to be used in future TxAPT testing and to clarify and validate proposed methods for collection, cleansing and processing the APT database. Proposed new instrumentation will be evaluated for use on future research test sections as it becomes available.

Data collected with new instrumentation will be matched and compared with "ground truth" data collected with proven instrumentation, when available, to ascertain the accuracy of these new systems. The durability of the new systems can only be validated over time; therefore it will be important to load the Shakedown test to failure so that factors affecting durability can be properly evaluated.

<u>Load Monitoring</u>

During renovations of the MLS, a new strain gauge system is being installed that will estimate tire and axle loads. Each axle is equipped with two strain gauge devices (Each device will estimate the load of a dual-wheel set. The two strain gauges combined will estimate the axle load). Operational and calibration details are not yet available from RGB Company, the designer of this system, but verifying the accuracy and durability of this load monitoring system will be a high priority during the Shakedown test. Load data collected during the Shakedown test will be used to:

1. Verify the load setting procedure for Bogies.
2. Verify the calibration procedure for the Strain Gauge (SG) system.
3. Evaluate the wheel load and axle load accuracy of the SG system over a range of load levels and operational conditions.
4. Verify if the SG system is temperature sensitive.
5. Determine factors that can impact the accuracy of the SG system.

Since the new strain gauge system is still in the testing stages, the Captels load cell system will be installed for the Shakedown test.

The installation of the Captels load cells requires the removal of 1.5-inches of asphalt and 8-inches of base over an area of approximately 1.5' by 5'. A reinforced Portland Cement Concrete (PCC) sleeper slab is installed and allowed to cure before the load cell platforms are installed flush with the asphalt concrete surface. The installation process is labor intensive, requires frequent maintenance, and is intrusive and destructive to the test section.

For these reasons, TxAPT will install a second type of weigh-in-motion (WIM) sensor in the Shakedown section for testing purposes. This alternative WIM sensor is called the Lineas Quartz sensor and is manufactured by Kistler Instrument Corp.

To effectively evaluate the strain gauge sensors and the Quartz sensor, it will be important to apply enough load repetitions (500,000 axles) to properly evaluate the short and long-term accuracy of both systems as well as the durability (expected life).

Multi-Depth Deflectometer (MDD)

MDDs are specialized instruments installed in the pavement to measure elastic deflection and permanent deformation at different depths in the pavement structure. TxDOT installs three Linear Variable Displacement Transponder (LVDT) sensing elements in each hole and typically positions the elements at layer interfaces and other critical depths.

MDD measurements will be used to:

a. characterize the response of the pavement structure,
b. measure changes in layer stiffness,
c. back calculate effective elastic modulus of target layers,
d. detect non-linear elastic behavior in pavement layers, and
e. measure permanent deformation in pavement layers.

This device has been used on prior test sections and will continue to be used on future sections. Two MDD units, each with 3 LVDT sensor modules will be installed in the Shakedown section; one in each wheel path at the 4.5-meter line.

Temperature

In previous test sections, TxDOT installed thermocouples connected to a Campbell Scientific T25 interface mounted at the side of the road. The T25 interface was then connected to a weather station that stored the data. The T25 interface can be connected to 25 thermocouple inputs. The weather station electronics (part designation - 23X) queries the T25 at user programmable intervals to obtain the temperature data.

Thermocouple sensors have been installed in APT test section pavements to record temperature at selected depths in the pavement structure and inside the MLS to record ambient air temperature.

In the Shakedown section, four thermocouple sensors will be installed as follows:

- Left wheel path – One sensor is installed at the mid-point of HMAC
- Right wheel path – One sensor is installed at the mid-point of HMAC
- Between wheel paths – One sensor at surface and one sensor at mid-point of HMAC

Two additional thermocouples will also be installed in the asphalt pavement in an area not subjected to shade with one sensor at the surface and one more at the mid-point of the hot mix. One additional thermocouple will be mounted on a beam inside the MLS to measure air temperature. Outside ambient air temperature will be recorded by the weather station.

A new temperature sensor will be installed on a trial basis as a possible replacement for thermocouple sensors in future test sections. Dallas Semi-Conductor manufactures this sensor called the Thermochron temperature sensor (here-in-after called iButton). The TxAPT Center will coordinate with TxDOT and prepare the iButton temperature sensors for installation in the embankment and Shakedown test sections.

iButtons will be installed in conjunction with University of Houston moisture sensors. Plans call for thirty (30) iButton sensors to be installed in the TxAPT Center subgrade and base material (see the section on moisture sensors).

Ten groups of three (3) iButton temperature sensors will be prepared for installation with the moisture sensors. Each group of three (3) iButtons will be soldered in parallel so that all three sensors can be programmed and recorded from a single two-conductor lead.

In addition, iButton temperature sensors will be installed in conjunction with the thermocouples in the pavement sections and inside the MLS. Others may also be added at the discretion of TxDOT, TxAPT, or the Research team.

Part of the Shakedown test will evaluate the durability of the iButtons, particularly those located in the wheel paths of the MLS. The temperature output produced by the thermocouples and iButtons will be compared.

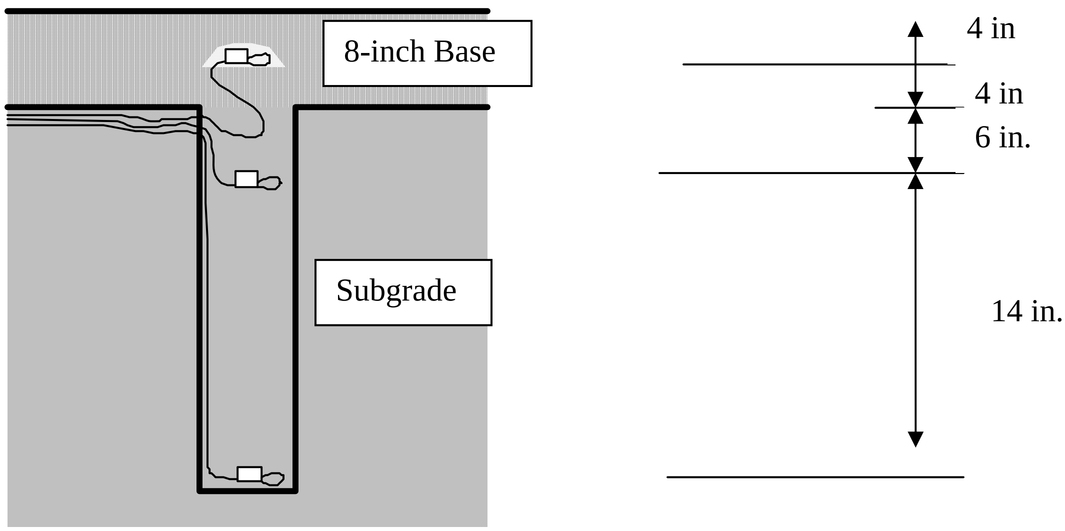
If the iButton technology proves accurate and durable, it may prove to be an acceptable low cost alternative to the thermocouple sensors in future test sections.

Moisture

On previous MLS test sections; TDR moisture sensors manufactured by Campbell Scientific were installed to monitor moisture levels in the pavement structure. TxDOT has elected not to install the TDR devices at the TxAPT Center at this time. Instead, a new moisture sensor developed by the University of Houston will replace the TDR sensors. TxDOT will calibrate these sensors prior to installation in the embankment. A total of thirty moisture sensors will be installed as shown in Figure 5. The output from these sensors will give researchers an indication of the moisture content in the clay embankment, subbase and base materials. TxAPT will use the information to try and control long-term changes in moisture levels in the embankment structure.

Weather Data

Weather data will be collected from the MLS weather station installed on site. Weather data will include wind speed and direction, humidity, rainfall amount, air temperature, and barometric pressure. The weather station is also the recording instrument for the thermocouple sensors.



Plan view of moisture sensors

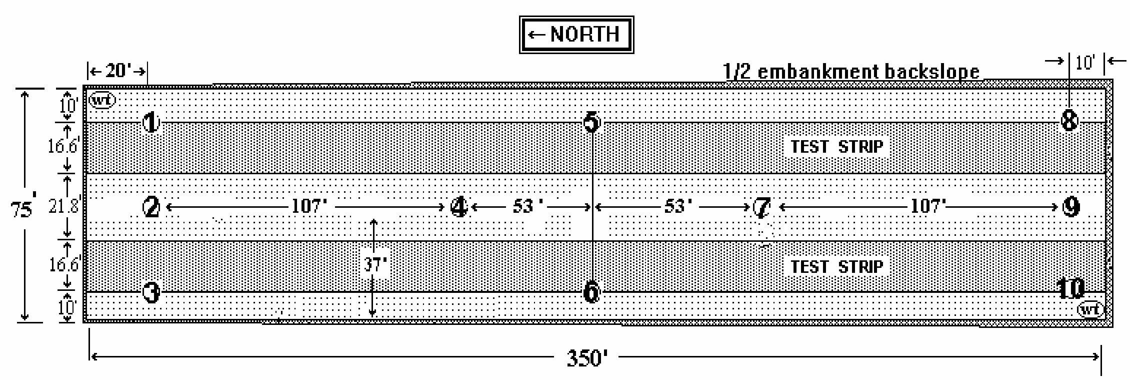


Figure 3.1 Moisture sensor installation plan.

Profiler

The Profiler is a device used to measure the longitudinal and transverse profiles of the test sections. A comparison of profiles over time gives the progression of wheel path rutting and longitudinal roughness. The profiler records the data from the same locations during each testing sequence so the same points are always measured. In the past, measuring points have been taken at transverse intervals of 1.5 meter and longitudinal intervals of 0.3 meter.

Profile data will be collected with the profiler instrument that has been used on previous test sections. A new profiler developed by the University of Houston will also be used to collect data at the point. The results from each device will be compared to validate the accuracy of the new profiler. If the new profiler produces acceptable results, the old profiler will be used as the backup unit on future test sections. The control motors on the new device still needs work.

3.6 CONDITION SURVEY

Visual condition surveys will be performed on the Shakedown section to monitor the progression of surface distresses including cracking, bleeding, raveling, etc. The presence and progression of cracking will be recorded to allow for easy quantification of crack growth and bleeding progression.

A new camera system will also be tested to take photographs of the pavement surface for crack detection. The results of the visual survey will be compared with the camera photographs to establish the effectiveness of the camera system as a crack detection/progression device.

Other Devices

Other devices include the Falling Weight Deflectometer (FWD), SPA (including DSPA, PSPA and SPA), and DCP. The principal use of these instruments is to estimate the insitu elastic properties of the pavement layers. The data collect by these devices will be recorded on a predefined intervals and locations.

Destructive (post-mortem) Testing

These tests include coring and trenching to evaluate and confirm changes in the pavement structure. These may or may not be collected on the Shakedown test at the discretion of TxDOT and the Pilot Study Research Supervisor.

3.7 MATERIALS TEST PROGRAM

TxAPT and TxDOT have worked closely to develop the materials testing program described in Figures 3.2 and 3.3. The plan incorporates testing of materials before, during and after construction and encompasses both laboratory and insitu testing for project control (quality assurance) and research testing.

In addition to the testing listed in these figures, nineteen borehole logs were drilled prior to construction to characterize the insitu soil strata and water table at the TxAPT Center construction site. Laboratory tests were performed with soil samples collected during the drilling operation to measure soil classification, Atterberg limits, insitu moisture content, and gradation. DCP data was also collected prior to construction to obtain an early estimate of the modulus of the different soil layers.

KEY

MATERIALS	
1	HMAC
2	BASE (247)
3	BASE (245)
4	GREY CLAY
5	MIXED CLAY
6	TAN CLAY

Technician	Name	Agency	Phone
JB	John Bilyeu	PAVE	465-3677
MA	Mike Arellano	CST M&P	506-5902
MM	Mark McDaniel	CST M&P	506-5949
MY	Mike Young	CST M&P	506-5912
CI	Claudia Izzo	CST M&P	506-5908
ZS	Zhiming Si	CST M&P	506-5901
LT	Lucio Trujillo	DIST 14	832-7185
SM	Summer Hire	CST M&P	506-5902
GSC	Gregory Cleveland	CST M&P	506-5830
TB	Tommy Blackmore	DIST 14	832-7271
RW	Ron White	UT-Austin	232-3115
AC	Arif Chowdhury	TTI	979-845-3350
TS	Tom Scullion	TTI	979-845-9913

RESEARCH TESTING

LABORATORY TESTING

	TEST	MATERIAL	TEST METHOD	SAMPLED BY	TEST BY	SECT.	TECH
EXCAVATION (STOCKPILES)	RESILIENT MODULUS	4	T 307	TXAPT	CST M&P	S&A	MM
		6	T 307	TXAPT	CST M&P	S&A	MM
	CBR SOAKED	4		TXAPT	TXAPT		
		6		TXAPT	TXAPT		
	FREE-FREE RES.COLUMN	4	TEX-145-E	TXAPT	CST M&P	S&A	MA
		6	TEX-145-E	TXAPT	CST M&P	S&A	MA
EMBANKMENT	RESILIENT MODULUS	4	T 307	TXAPT	CST M&P	S&A	MM
		6	T 307	TXAPT	CST M&P	S&A	MM
BASE	CONVENTIONAL TRIAXIAL	2	TEX-143-E	TXAPT	TXDOT	S&A	MY,MA
		3	TEX-143-E	TXAPT	TXDOT	S&A	MY,MA
	TUBE SUCTION TESTING	2	TEX-144-E	TXAPT	TTI		
		3	TEX-144-E	TXAPT	TTI		
	FREE-FREE RES.COLUMN	2	TEX-145-E	TXAPT	CST M&P	S&A	MA
		3	TEX-145-E	TXAPT	CST M&P	S&A	MA
	PERM. DEFORMATION	2		TXAPT	TTI		
		3		TXAPT	TTI		
	RESILIENT MODULUS	2		TXAPT	TTI		
		3		TXAPT	TTI		
Liquid Binder Tests	**Original Binder**						
	Flash Point	1	AASHTO T 48	TxAPT	UT	CTR	RW
	Viscosity	1	AASHTO TP 48	TxAPT	UT	CTR	RW
	Dynamic Shear	1	AASHTO TP 5	TxAPT	UT	CTR	RW
	Elastic Recovery	1	ASTM D 6084	TxAPT	UT	CTR	RW
	Rolling Thin Film Oven						
	Mass Loss	1	Tex-541-C	TxAPT	UT	CTR	RW
	Dynamic Shear	1	AASHTO TP 5	TxAPT	UT	CTR	RW
	PAV Aging	1	AASHTO PP 1	TxAPT	UT	CTR	RW
	Dynamic Shear	1	AASHTO TP 5	TxAPT	UT	CTR	RW
	Creep Stiffness	1	AASHTO TP 1	TxAPT	UT	CTR	RW
	Direct Tension	1	AASHTO TP 3	TxAPT	UT	CTR	RW
	MC-30 Prime Coat						
	Kinematic Viscosity	1	AASHTO T 201	TxAPT	UT	CTR	RW
	Percent Water	1	AASHTO T 55	TxAPT	UT	CTR	RW
	Flash Point	1	AASHTO T 79	TxAPT	UT	CTR	RW
	Distillation Tests	1	AASHTO T 78	TxAPT	UT	CTR	RW
	Tests on Distillation Residue	1	See Table 4e	TxAPT	UT	CTR	RW
Hot-Mix (Plant Mixture)	**Hamburg Wheel Tracking Test**	1	Tex-242-F	TxAPT	Texas A&M/UT	TTI/CTR	RW
	Fatigue tests	1	TTI Protocol	TxAPT	Texas A&M	TTI	AC
	Dynamic Modulus	1	TTI Protocol	TxAPT	Texas A&M	TTI	AC
	Flow Number	1	TTI Protocol	TxAPT	Texas A&M	TTI	AC
	Flow Time	1	TTI Protocol	TxAPT	Texas A&M	TTI	AC
	Surface Engergy Measurements	1	TTI Protocol	TxAPT	Texas A&M	TTI	AC
	Surface Aggregate Classification	1	AQMP	TxAPT	TxDOT	S&A	MA
	Coarse Aggregate Angularity	1	Tex-460-A	TxAPT	TxDOT	S&A	MA
	Micro-Deval Abrasion Loss	1	Tex-461-A	TxAPT	TxDOT	S&A	MA
	Flat and Elongated Particles @ 5:1	1	Tex-280-F	TxAPT	TxDOT	S&A	MA
	Coarse and Fine Aggregate Tests	1	as per Item 340	TxAPT	TxDOT	S&A	MA
	Mineral Filler Tests	1	as per Item 340	TxAPT	TxDOT	S&A	MA
	Aging Ratio	1	as per Item 340	TxAPT	UT	CTR	RW

FIELD TESTING

	TEST	MATERIAL	TEST METHOD	LOCATION	TEST BY	SECT.	TECH
EXCAVATION	DCP	2		TOP OF EXCAVATED BOTTOM	TXDOT	PAVE	JB
EMBANKMENT	DSPA	6	TEX-148-E	TOP OF COMPACTED TAN CLAY	TXDOT	PAVE	JB
		4	TEX-148-E	TOP OF COMPACTED GREY CLAY	TXDOT	PAVE	JB
	FWD	6		TOP OF COMPACTED TAN CLAY	TXDOT	PAVE	JB
		4		TOP OF COMPACTED GREY CLAY	TXDOT	PAVE	JB
	GEOGAUGE	6		TOP OF COMPACTED TAN CLAY	TXDOT	CST M&P	ZS
		4		TOP OF COMPACTED GREY CLAY	TXDOT	CST M&P	ZS
BASE	DSPA	2	TEX-148-E	TOP OF COMPACTED BASE	TXDOT	PAVE	JB
		3	TEX-148-E	TOP OF COMPACTED BASE	TXDOT	PAVE	JB
	FWD	2		TOP OF COMPACTED BASE	TXDOT	PAVE	JB
		3		TOP OF COMPACTED BASE	TXDOT	PAVE	JB
	GEOGAUGE	2		TOP OF COMPACTED BASE	TXDOT	CST M&P	ZS
		3		TOP OF COMPACTED BASE	TXDOT	CST M&P	ZS
	DCP	2		TOP OF COMPACTED BASE	TXDOT	PAVE	JB
		3		TOP OF COMPACTED BASE	TXDOT	PAVE	JB
	PORT. FWD	2		TOP OF COMPACTED BASE	TTI		
		3		TOP OF COMPACTED BASE	TTI		
Hot-Mix	**FWD**	1		HMA Surface	TxDOT	PAVE	JB
	RDD	1		HMA Surface	UT	CTR	RW
	SPA	1		HMA Surface	TxDOT	PAVE	JB
	Infrared Camera	1		HMA Surface	Texas A&M	TTI	TS
	PQI	1		HMA Surface	Texas A&M	TTI	TS
	PaveTracker	1		HMA Surface	Texas A&M	TTI	TS
	Rut Depth Measurements	1		HMA Surface	UT	CTR	RW
	Fatigue Cracking Measurements	1		HMA Surface	UT	CTR	RW

Figure 3.2

KEY

MATERIALS	
1	HMAC
2	BASE (247)
3	BASE (245)
4	GREY CLAY
5	MIXED CLAY
6	TAN CLAY

Technician	Name	Agency	Phone
JB	John Bilyeu	PAVE	465-3677
MA	Mike Arellano	CST M&P	506-5902
MM	Mark McDaniel	CST M&P	506-5949
MY	Mike Young	CST M&P	506-5912
CI	Claudia Izzo	CST M&P	506-5908
ZS	Zhiming Si	CST M&P	506-5901
LT	Lucio Trujillo	DIST 14	832-7185
SM	Summer Hire	CST M&P	506-5902
GSC	Gregory Cleveland	CST M&P	506-5830
TB	Tommy Blackmore	DIST 14	832-7271
RW	Ron White	UT-Austin	232-3115
AC	Arif Chowdhury	TTI	979-845-3350
TS	Tom Scullion	TTI	979-845-9913

PROJECT CONTROL TESTING

LABORATORY TESTING

	TEST	MATERIAL	TEST METHOD	SAMPLED BY	TEST BY	SECT.	TECH
EXCAVATION (STOCKPILES)	M/D CURVES	4	TEX-114	TXAPT	CST M&P	S&A	MY
		5	TEX-114	TXAPT	CST M&P	S&A	MY
		6	TEX-114	TXAPT	CST M&P	S&A	MY
	ATTERBERG LIMITS	4	TEX-104-106-E	TXAPT	CST M&P	S&A	MY,CI
		6	TEX-104-106-E	TXAPT	CST M&P	S&A	MY,CI
	GRADATIONS	4	TEX-110-E	TXAPT	CST M&P	S&A	MY,CI
		6	TEX-110-E	TXAPT	CST M&P	S&A	MY,CI
EMBANKMENT							
BASE	M/D CURVE	2	TEX-113-E	TXAPT	TXDOT	S&A	MY,ZS
		3	TEX-113-E	TXAPT	TXDOT	S&A	MY,ZS
	GRADATION	2	TEX-110-E	TXAPT	TXDOT	S&A	MY,CI,SM
		3	TEX-110-E	TXAPT	TXDOT	S&A	MY,CI,SM
	LIQUID LIMIT	2	TEX-104-E	TXAPT	TXDOT	S&A	MY,CI,SM
		3	TEX-104-E	TXAPT	TXDOT	S&A	MY,CI,SM
	PLASTICITY INDEX	2	TEX-106-E	TXAPT	TXDOT	S&A	MY,CI,SM
		3	TEX-106-E	TXAPT	TXDOT	S&A	MY,CI,SM
	TEXAS TRIAXIAL	2	TEX-117-E	TXAPT	TXDOT	S&A	MY,ZS
		3	TEX-117-E	TXAPT	TXDOT	S&A	MY,ZS
	WET BALL MILL	2	TEX-116-E	TXAPT	TXDOT	S&A	MY,CI,SM
		3	TEX-116-E	TXAPT	TXDOT	S&A	MY,CI,SM
Aggregate Testing for Hot-Mix	**COARSE AGGREGATE**						
	Unit weight	1	Tex-404-A	TxAPT	TxDOT	Flex. Pvmts	TB
	Pressure Slaking	1	Tex-431-A	TxAPT	TxDOT	Flex. Pvmts	TB
	Freeze Thaw Loss	1	Tex-432-A	TxAPT	TxDOT	Flex. Pvmts	TB
	24-hr Water Absorption	1	Tex-433-A	TxAPT	TxDOT	Flex. Pvmts	TB
	Deleterious Material	1	Tex-217-F, Part I	TxAPT	TxDOT	Flex. Pvmts	TB
	Decantation	1	Tex-217-F, Part II	TxAPT	TxDOT	Flex. Pvmts	TB
	L.A. Abrasion	1	Tex-410-A	TxAPT	TxDOT	Flex. Pvmts	TB
	MgSO4 Soundness Loss	1	Tex-411-A	TxAPT	TxDOT	Flex. Pvmts	TB
	FINE AGGREGATE						
	Linear Shrinkage	1	Tex-107-E, Part II	TxAPT	TxDOT	Flex. Pvmts	TB
	Sand Equivalent	1	Tex-203-F	TxAPT	TxDOT	Flex. Pvmts	TB
Verification Testing for Hot-Mix	Gradation	1	Tex-200-F, Part I or II	TxDOT	TxDOT	Flex. Pvmts	GSC
	Design VMA	1	Tex-207-F	TxDOT	TxDOT	Flex. Pvmts	GSC
	Lab Molded Density	1	Tex-207-F	TxDOT	TxDOT	Flex. Pvmts	GSC
	Asphalt Content	1	Tex-236-F	TxDOT	TxDOT	Flex. Pvmts	GSC
	Stability	1	Tex-208-F	TxDOT	TxDOT	Flex. Pvmts	GSC
	Moisture Susceptibility	1	Tex-531-C	TxDOT	TxDOT	Flex. Pvmts	GSC
	Stripping	1	Tex-530-C	TxDOT	TxDOT	Flex. Pvmts	GSC
	Mixing	1	Tex-205-F	TxDOT	TxDOT	Flex. Pvmts	GSC
	Rice Gravity	1	Tex-227-F	TxDOT	TxDOT	Flex. Pvmts	GSC
	Molding	1	Tex-241-F	TxDOT	TxDOT	Flex. Pvmts	GSC

FIELD TESTING

	TEST	MATERIAL	TEST METHOD	LOCATION	TEST BY	SECT.	TECH
EXCAVATION	ELEVATION	6	ROD/LEVEL	BOTTOM OF EXCAVATION	TXDOT	PAVE	JB
EMBANKMENT	DENSITY	6	TEX-115-E	8" Compacted Tan Clay	DIST 14	DIST 14	LT
		6	TEX-115-E	16"	DIST 14	DIST 14	LT
		6	TEX-115-E	24"	DIST 14	DIST 14	LT
		5	TEX-115-E	6" Compacted Mixed Clay	DIST 14	DIST 14	LT
		4	TEX-115-E	8" Compacted Tan Clay	DIST 14	DIST 14	LT
		4	TEX-115-E	16"	DIST 14	DIST 14	LT
		4	TEX-115-E	24"	DIST 14	DIST 14	LT
		4	TEX-115-E	32"	DIST 14	DIST 14	LT
		4	TEX-115-E	40"	DIST 14	DIST 14	LT
		4	TEX-115-E	48"	DIST 14	DIST 14	LT
	ELEVATION	6	ROD/LEVEL	TOP OF COMPACT TAN CLAY	TXDOT	PAVE	JB
		4	ROD/LEVEL	TOP OF COMPACT GREY CLAY	TXDOT	PAVE	JB
BASE	DENSITY	2	TEX-115-E	TOP OF THE COMPACTED BASE	TXDOT	DIST 14	LT
		3	TEX-115-E	TOP OF THE COMPACTED BASE	TXDOT	DIST 14	LT
	ELEVATION	2	ROD/LEVEL	TOP OF THE COMPACTED BASE	TXDOT	PAVE	JB
		3	ROD/LEVEL	TOP OF THE COMPACTED BASE	TXDOT	PAVE	JB
Aggregate Testing for Hot-Mix	Random Sampling	1	Tex-225-F	N/A	TxDOT	Flex. Pvmts	GSC
	In-Place Air Voids	1	Tex-207-F, Part III	HMA Surface	TxDOT	Flex. Pvmts	GSC
	Establish Rolling Patterns	1	Tex-207-F, Part IV	HMA Surface	TxDOT	Flex. Pvmts	Contractor
	Ride Quality	1	Tex-1001-S	HMA Surface	TxDOT	Flex. Pvmts	JB
	Segregation Profiles	1	Tex-207-F, Part V	HMA Surface	TxDOT	Flex. Pvmts	Contractor
	Joint Density	1	Tex-207-F, Part VII	HMA Surface	TxDOT	Flex. Pvmts	Contractor
	Elevation	1	Rod and Level	HMA Surface	TxDOT	Flex. Pvmts	RW
	Material Sampling	1	Tex-222-F	HMA Plant	TxDOT	Flex. Pvmts	RW

Figure 3.3

4. SUMMARY

This report presents a preliminary experimental plan for the single shakedown test section of the TxAPT facility. The activity will be coordinated with the Operating Advisory Group (OAG) and TxDOT personnel. While it is normal for an experimental plan to be followed faithfully, since this is the very first experiment to be done with the modified MLS and the new TxAPT facility, it will be necessary to use this preliminary plan flexibly as needed. We expect to have close coordination with both the TxDOT MLS operating crew and the Project Director. The activities carried out in the Shakedown test will be carefully documented and the final experimental plan as it is actually used will be recorded for possible use in modifying future experimental test plans.

APPENDIX A

Project 0-4574: Determine Impact of HB 2060 Permits on Texas Load Zone Roads

Technical Memorandum #01: Objectives, Testing and Instrumentation

FROM:	Jorge A Prozzi
DATE:	31 March 2003
TO:	K. Stokoe, A. Smit, Y. Yetkim, J. Bilyeu, G. Claros, D-H. Chen, M. Murphy, R. Hudson, R. White.

The *primary objective* of this project was to ***establish the actual capabilities*** of the newly rehabilitated TxMLS machine and associated technologies under actual testing conditions. In addition to this primary objective, this research project has objectives of a more technical and specific nature.

The *first technical objective* is to ***quantify the response and performance*** of a typical farm-to-market road pavement structure with increased traffic load applications under the TxMLS. This objective will be addressed by performing the following tasks:

i. Quantification of the engineering properties of the various pavement layers, based on in-situ and laboratory testing, and linear-elastic theory.
ii. Quantification of the stress dependence of the pavement layers, when appropriate.
iii. Determination of the fatigue life.
iv. Determination of the rutting life.
v. Determination of the reduction of the bearing capacity.

The ***second technical objective*** of the full series of tests is to ***compare the performance*** of the same pavement structure under ***different axle loads***. The following tasks will be carried out to address this objective:

i. Evaluation of the response and performance of one pavement structure to three or four different axle load levels.
ii. Performance modeling of the various tests sections and determination of the effects of loads and environment (when possible) on performance.
iii. Quantification of the effects of increased axle loads on pavement performance.

The *third technical objective* is to *develop a methodology* to estimate the reduction on pavement performance as a result of increased axle load.

It is recommended that **FOUR SECTIONS** should be tested at the following load levels (on a tandem axle): 20, 26, 32, and 40 kips. The exact load levels are subject to discussion and should be finally determined with input from the Project Monitoring Committee, Project Director, Project Coordinator, and the Research Team.

The MLS loads will be applied to the various test pads until failure. Failure will be primarily defined in terms of fatigue cracking and rutting. For this reason, it is imperative that fatigue cracking and surface rutting development should be accurately monitored at different stages of MLS trafficking. The loss of the bearing capacity of the pavement structure will also serve as an alternative failure criterion. The loss of bearing capacity will be determined by the increase in surface deflections as determined by the Falling Weight Deflectometer (FWD) or estimated from Multi-depth Deflectometer (MDD) measurements. The failure criteria should be consistent for all test sections.

General Testing Plan

i. Determine the bearing capacity of the foundation with FWD or seismic testing by means of SASW, SPA, P-SPA or similar technology.
ii. Evaluate the bearing capacity of the base as in (i).
iii. Evaluate the bearing capacity of the whole structure by means of FWD or RDD and determine the uniformity to specify the location of the test sections (pads).
iv. Test the first section to failure monitoring and recording its performance according to the detailed plan given in Table 1.
v. Test the remaining sections to failure applying accelerated testing to an equivalent final condition.

The final testing plan will then be turned over to the TxAPT Center, who will be responsible for carrying it out. No outside parties will be allowed to interrupt the testing or change the test plan without written approval of the Research Supervisor, Project Director, and Project Coordinator.

Multi-Depth Deflectometer will be evaluated during the shakedown test with the expectation that ***two MDD systems will be installed for each of the test pads*** by TxDOT. Some of the instrumentation is portable and does not require installation, e.g. SPA, FWD, etc. Such equipment will be provided by TxDOT and used as appropriate. Its use will be evaluated as part of the shakedown test.

The location of the test sections (pads) for MLS testing will be selected to ensure homogeneity *using the Falling Weight Deflectometer (FWD) or the Rolling Dynamic Deflectometer (RDD).* After determination of the test pads, these locations will be prepared by marking out of the test site and the instrumentation will be installed.

The following testing is recommended during the construction of the embankment and should be under the supervision of personnel of the TxAPT Center.

Subgrade: borehole logs and location of water table, classification tests and Atterberg limits, gradation, in-situ densities and water contents, Dynamic Cone Penetrometer (DCP), seismic testing, and Triaxial testing to determine the resilient modulus (M_R) of the material.

Base: classification test and Atterberg limits, gradation, in-situ densities and moisture contents, triaxial testing, FWD deflection and seismic testing on completed base layer.

Asphalt Surface: aggregate gradation, specific gravities, asphalt content, binder testing, air voids content, stiffness, fatigue resistance, rutting resistance under repetitive loading tests (HWTD or APA), frequency sweep tests.

The testing of the asphalt materials will be carried at the laboratories of the University of Texas at Austin. Where applicable, cooperation from TxDOT will be required to facilitate the use of their laboratories and laboratory equipment, particularly (but not exclusively) the use of the Hamburg Wheel Tracking Device (HWTD) or the Asphalt Pavement Analyzer (APA).

Provisional Test Plan

The ordering of the testing of the various pads (testing sequence) should be defined once the MLS is operational and an estimation of its production rate (e.g. repetitions per day) is available. This can only be done with some confidence after the shakedown test is completed. It is, however, recommended to start with one of the lighter load levels. With this information available, Research Team will ***develop and recommend a final test plan***. This test plan will be presented to the PC, PD, PMC, and TxAPT Center for its evaluation, modification (if required) and final approval.

In the following paragraphs all the relevant information to perform the actual MLS test of the first test pad of the series is detailed. This includes the traffic wheel load, tire pressures, instrumentation layout, measurement schedule, and any other relevant data to perform the test as planned. The conditions for testing and the taking of measurements are detailed below and they are summarized in Table 1.

Instrumentation and Performance Monitoring

The standard instrumentation available for use during MLS testing will be used and a number of variables and performance indicators will be monitored as follows:

i. Continuous axle and wheel load monitoring and recording by means of the instrumented MLS axle. Alternatively, the use of Captel equipment at regular intervals is recommended
ii. Tire pressure should be monitored and adjusted to the test level on a daily basis.
iii. Transverse and longitudinal profiles should be measured and recorded as per test plan by means of the Laser Profiler
iv. Dipstick or mechanical profiler as a backup system to the laser profiler
v. Falling Weight Deflectometer (FWD)
vi. Multi-depth Deflectometer (MDD)
vii. RDD Testing of four sections at the beginning of the testing of each test pad, and ideally after the testing of the sections.
viii. Spectral Analysis of Surface Waves (SASW), or SPA or P-SPA as per test plan
ix. Air Temperature on an hourly basis
x. Asphalt temperature through thermocouples
xi. Monitoring of moisture content of granular materials
xii. DCP testing of untreated granular materials (at subgrade and subbase level)
xiii. Visual inspections
xiv. Crack mapping and growth monitoring by digital camera
xv. Crack mapping and growth monitoring by alternative means (e.g. manual digital camera)

Tentative test frequencies are indicated in Table 1. The above list consists of most of the instrumentation currently available at TxDOT for use in conjunction with MLS testing. The available devices should be evaluated during the shakedown test but *only those that produce accurate, repeatable, and useful results (within impacting on the testing plan) should be used during the research study.*

The Multi-Depth Deflectometers (MDDs) are installed in a pavement to allow measurement of both elastic deflection and permanent deformation at various depths within the pavement structure. The MDD modules are usually placed at layer interfaces or at other critical depths in the pavement structure. *Two MDD systems will be installed in each pad, each of them capable of monitoring deflections and deformations at three different depths*. It is recommended to install the MDD sets at the 9.0 m transverse line at both wheel paths. The outputs from an MDD are influence lines of deflection at the selected depths within the pavement and the permanent deformation of the pavement with time. Recommended depths are: bottom of the surface layer (or closest possible depth), bottom of the base, and top of the subgrade. Alternatively, MDD should be placed at the bottom of the base and every 6 to 8 inches, depending of the thickness of the construction "lifts". MDD measurements could be used to: characterize the elastic and plastic properties of the various layers, monitor changes in the stiffness of the various layers with time, determine stress dependency of pavement layers, and determine the permanent deformation at various depths.

The laser profilometer developed at the University of Houston will be used to measure the profile of the surface of a test section. This output allows the determination of rut progression. The profilometer traverses the test section and the points of measurement are clearly marked to ensure the same point is always measured. An adequate number of data points should be taken to ensure that the behavior of the whole test section is monitored. The proposed points are consistent with the current practice, i.e. from 0 to 12 meters, every 1500 mm.

Thermocouples, or iButtons, will be installed in the pavement to measure temperature at selected depths. This allows the monitoring of temperature fluctuations within the test section. At a minimum, thermocouples should be located in the right and left wheel paths and in the centerline at two different depths within the asphalt surface layer.

The installation of 10 moisture probes is recommended. At each of these locations, instruments should be placed at 3 different levels: middle of the base, top of the subgrade and 12-24 inches into the subgrade.

Regular visual inspection of the test sections allows crack growth to be monitored and any other possible distress mode. Automatic measuring techniques by means of a digital camera will be available to quantify the crack growth and bleeding progression in terms of percentages of the test section area. These results could be compared to TxDOT specifications to determine the degree of cracking to warrant maintenance or rehabilitation.

Usually all the above factors are measured at selected load repetitions. The time taken for the readings is obviously dependant on the number of specified readings to be taken. In other words, the larger number of readings required, the longer the test will take. For this reason the number of instruments should be limited to the minimum necessary. However, it is important to ensure an adequate number of readings are taken to be able to draw representative conclusions. It is recommended to collect as much information as possible from the shakedown test and to modify the testing final plan accordingly.

After testing of each pad is completed a post-mortem study ***could*** be carried out. A trench across the center of the test pad is recommended. These post-mortem studies will not be carried out if TxDOT recommends the rehabilitation of the section and the accelerated testing of the corresponding overlaid structures. In this case, post-mortem studies will be conducted at the end of the testing of the rehabilitated pads.

TABLE 1: Tentative TxMLS Testing Program for Section PRCxxx

MLS Test Program

Start Date:

Wheel speed:

Tire:

Section:

Location: Pickle Research Centre

		Loading		Environment			CAPTEL		Profile		Cracking		MDD	FWD			Seismic		
Repetitions*	Date	Load	Stress	Surf. Temp.	Air Temp.	Moisture	Static	Dynamic	Profiler	Dipstick (a)	Camera	Manual (a)	MDD	Peaks	Full	MDDs	SASW	P-SPA (a)	SPA (a)
0		18	110	Y	Y	Y			Y	Y	Y	Y		Y	Y		Y	Y	Y
60		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5,000		18	110	Y	Y	Y			Y	Y	Y	Y	Y						
20,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
50,000		18	110	Y	Y	Y			Y	Y	Y	Y	Y						
100,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
150,000		18	110	Y	Y	Y			Y	Y	Y	Y	Y						
300,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
450,000		18	110	Y	Y	Y			Y	Y	Y	Y	Y						
600,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
800,000		18	110	Y	Y	Y			Y	Y	Y	Y	Y						
1,000,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1,250,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						
1,500,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1,750,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						
2,000,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2,500,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3,000,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3,500,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4,000,000		18	110	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

* These are suggested intervals. Actual intervals should be defined more precisely once the capabilities of the TxMLS are assessed.

** N = 0 (pre-test readings), indicates testing to be carried out as soon as the test pads are marked and before the TxMLS is mobilized.

*** N = 60 (initial readings), testing to be carried out as soon as the TxMLS has applied some minimum traffic to the section.

(a) Indicates alternative back-up testing.