Memorandum

U.S. Department
of Transportation

Federal Highway
Administration

6300 Georgetown Pike
McLean, Virginia 22101-2296

ACTION:LTPP Monitoring Directive P-9
Non-Automated Dipstick Longitudinal Measurement
Procedure

Date: December 16, 1996

Antonio Nieves Torres
Pavement Performance Division

Reply to
Attn. of: HNR-30

To: Mr. Ivan Pecnik, LTPP Regional Engineer (NA)
Mr. Morris Reinhardt, LTPP Regional Engineer (S)
Mr. Richard Ingberg, LTPP Regional Engineer (NC)
Mr. Cal Berge, LTPP Regional Engineer (W)

Attached is the Long-Term Pavement Performance (LTPP) Program Monitoring Directive P-9 that transmits Monitoring procedures Non-Automated Dipstick Longitudinal Measurement.

This directive should be transmitted to all Profilometer operators as soon as possible. These procedures should be used on all test sections requiring a manual measurement of the longitudinal profile.

If you have any questions concerning this transmittal, please do not hesitate to call me at 703-285-2526.

Antonio Nieves Torres

Attachment

FHWA:HNR-30:anieves:ant:285-2526:12/16/96
File: h:\data\anieves\wp\covdir2.doc
cc:
Gonzalo Rada (PCS/LAW)
Gary Elkins(PCS/LAW)
Antonio Nieves Torres
Monte Symons
Directive Binder
LTPP Team
Chron

LONG TERM PAVEMENT PERFORMANCE PROGRAM DIRECTIVE

For the Technical Direction of the LTPP Program

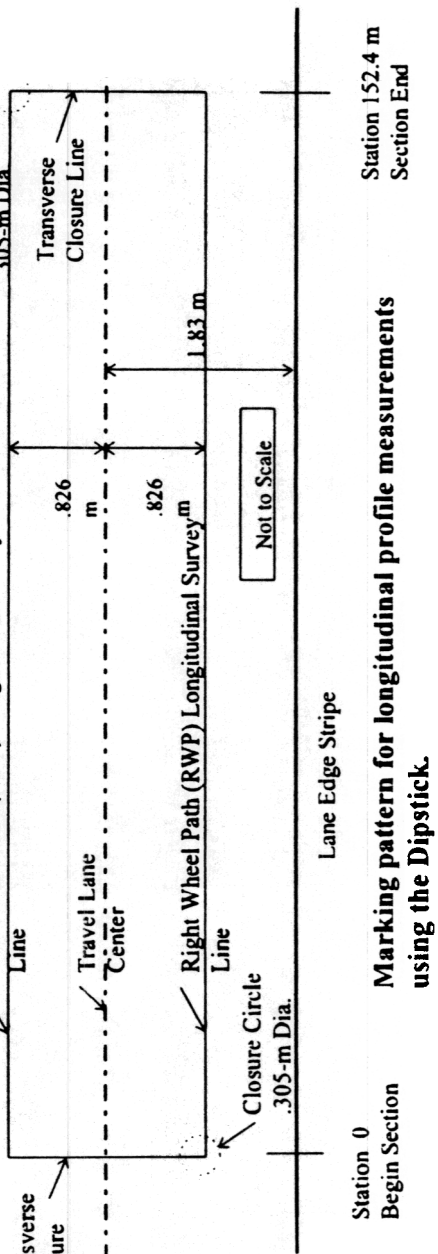
Program Area:	Monitoring	Directive Number:	P-9
Date:	November 25, 1996	Supersedes:	n/a
Subject:	Non-Automated Dipstick Longitudinal Measurement Procedure		

Introduction

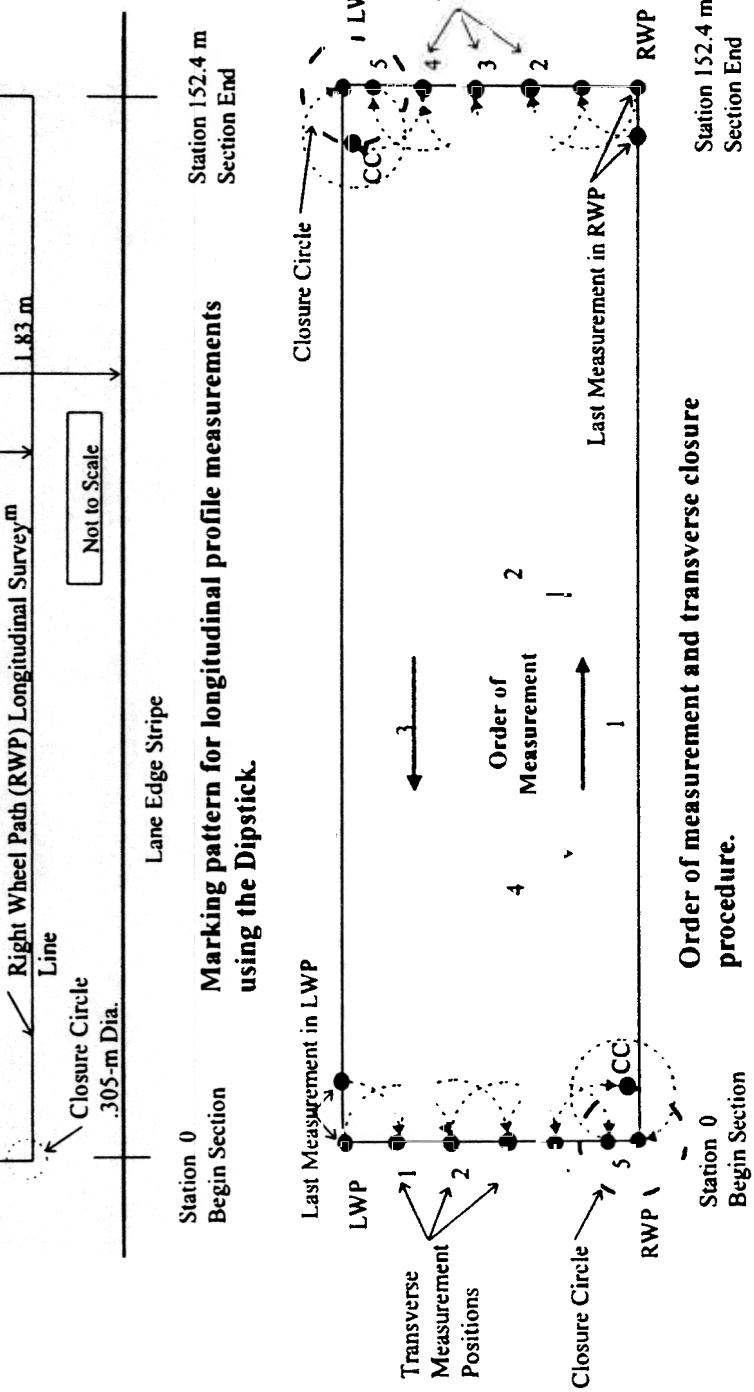
The following procedure for longitudinal profile measurements on LTPP test sections, using non-automated Dipsticks, should be used on all test sections requiring manual measurement of the longitudinal profile. This is a replacement for the procedures contained in sections 3.3.2, 3.3.3.2, 3.3.3.3 and 3.3.3.4 of the SHRP Profile Measurement Manual, "Manual for Profile Measurements: Operational Field Guidelines," SHRP-P-378, Strategic Highway Research Program, National Research Council, 1994. Other portions of the SHRP Manual are still applicable.

Overview

This procedure consists of performing an elevation survey in each wheel path and using transverse measurements at the ends of the section to form a closed loop. As illustrated in Figure 1, the measurement procedure starts at Station 0+00 (0 m) in the right wheel path and proceeds in the direction of traffic toward the end of the section. At the end of the section, transverse measurements are made to the end point of the survey line in the left wheel path. A 2-ft (0.610-m) diameter closure circle around this point is used to close the transverse measurements on this start location for measurements in the left wheel path. Longitudinal measurements are then performed in the left wheel path back to Station 0+00 (0 m). Transverse measurements and the closure circle are used to close the survey on the starting point. Forms DS-1 through DS-6 have been designed for use with this measurement procedure. This procedure is designed for a 500-ft (152.4-m) test section, although the concept can be applied to test sections of any length.



Marking pattern for longitudinal profile measurements using the Dipstick.



Order of measurement and transverse closure procedure.

Procedure

1. Site Marking

a. The marking pattern is illustrated in Figure 1

b. Clean both wheel paths of loose stones and other debris to prevent slippage of the footpads during measurements.

c. Locate the center of the travel lane.

1) Where the wheel paths are easily identified, the midway point between the two wheel paths should be used as the center of the lane.

2) If the wheel paths are not clearly identifiable, but the two lane edges are well defined, the center of the travel lane should be taken as the midpoint between the two lane edges.

3) Where the wheel paths are not apparent and only one lane edge can be clearly distinguished, the center of the lane should be established at 6 ft (1.83 m) from that edge.

d. Locate and mark longitudinal elevation survey lines in each wheel path. Establish the location of the two longitudinal elevation survey lines 2.710 ft (0.826 m) from the center of the lane. Mark these locations at intervals equal to the length of the chalk line used for marking. Use a chalk line to mark a straight line between the previously established points. The start location should be located so that back edge of the Dipstick footpad is located immediately adjacent to leave edge of the white stripe at the beginning of the monitoring portion of the test section. If this location is not marked with a stripe, the start location should be established at Station 0+00. Using a tape measure (measuring wheels are not acceptable), carefully measure the length of each longitudinal elevation survey line to establish the end points at 500-ft (152.4-m), or at the specified length for test sections not 500-ft (152.4-m) long, from the previously established start location. An accurate measurement of this length is required since it is used as a quality control check on the measurement process.

e. At Station 0+00 (0 m) use a chalk line to mark a transverse line connecting the endpoints of the two longitudinal elevation survey lines. In the Right Wheel Path (RWP), mark a 2-ft (0.610-m) diameter circle centered on the first measurement point. This closure circle will be used for completion of the elevation survey loop.

f. At the end point marks placed at Station 5+00 (152.4 m), or the end of the test section, use a chalk line to mark a transverse line connecting the endpoints of the longitudinal elevation survey lines. Mark a 2-ft (0.610-m) diameter circle centered on the measurement

point located in the Left Wheel Path (LWP) at this location. This closure circle will be used for completion of the elevation survey loop.

g. Note on the data collection sheet or field notebook, the method used to establish and the location of the lane center and the two longitudinal elevation measurement survey lines, and any discrepancies between the painted and measured section end locations.

2. Pre-Operational Checks on the Dipstick

a. The pre-operational checks should be performed as specified in section 3.3.3.1 of the **Manual for Profile Measurements: Operational Field Guidelines**. Form DS-7, included in this document, should be used to record this information.

3. Longitudinal Profile Measurement

a. To start the profile measurement, the Dipstick should be placed with one foot on the marked elevation survey line in the RWP at Station 0+00 (0 m) and the foot in the direction of the start arrow on the unit, positioned on the survey line. The start arrow on the Dipstick should point forward in the direction of traffic.

b. After the reading stabilizes, it should be recorded under the RWP column on Form DS-2 on the row corresponding to Station 0+01 (0.30 m). The Dipstick should then be rotated to the next measuring point using a clockwise rotation. After the reading has stabilized it should be recorded on the next row of Form DS-2 labeled 0+02 (0.62 m). This procedure should be repeated for the entire length of the test section. During the measurements, the following precautions and procedures should be used:

1 Always use a clockwise rotation.

The handle of the Dipstick should be held in a vertical position.

3. Lateral pressure should not be applied to the handle during a measurement.

4. The foot pads should be placed to avoid minor localized cracks, holes, open joints, the edge of open joints or wide cracks, and loose stones or debris.

5. If for any reason the measurements must be stopped, circles should be drawn around both foot pads with the start arrow in the direction of traffic at the last measurement position. When restarting the measurement process the Dipstick shall be returned to this position and adjusted so that the current measurement agrees with last measurement prior to stoppage.

6. If it is not possible to mark the leg positions prior to stoppage or to successfully reposition the Dipstick in the same position, then the data must be discarded and the measurement procedure restarted from the beginning.

c. After the last measurement in the right wheel path at Station 5+00 (152.4 m), the location of the front Dipstick foot should be compared to the pre-measured end point location. If the front foot is within 6-in (0.152-m) of the marked end point location, proceed with the transverse closure measurements as indicated below. If the front foot is not within this interval, perform the following:

1 Draw circles around each foot and note the direction of the start arrow.

2. Check the data sheets for skipped or missing measurements.

3 If no apparent anomalies are present in the data, remeasure the length of the longitudinal survey line to verify the position of the end point. If the re-measured location of the end point is within 6-in (0.152-m) of the front foot of the Dipstick, remark the transverse line at this location and proceed. If the end-point is not within 6-in (0.152-m) of the Dipstick front foot, discard the data as suspect and restart the survey measurement from Station 0+00 (0 m).

d. After the location of the last measurement in the right wheel path has been verified, the transverse closure measurements should be initiated by rotating the rear foot of the Dipstick toward the left wheel path and placing it on the pre-marked transverse closure line. Measurements along the transverse closure line should be recorded in the table labeled "Transverse Closure Measurements from Right Wheel Path to Left Wheel Path at Station 5+00 (152.4 m)" located at the bottom of form DS-6. When the Dipstick reaches the point in which the next measurement along the transverse survey line would pass the location of the Left Wheel Path, it should be rotated so that the foot pad rests at any point on the closure circle (CC). After recording this measurement in the column labeled 5-CC, rotate the device so that the foot pad rests on top of the intersection between the longitudinal survey line in the LWP and the transverse closure line. Record this measurement under CC-LWP. This procedure is illustrated in Figure 1.

e. Begin measurements down the longitudinal survey line in the LWP, recording them in the column labeled LWP on forms DS-2 through 6. These measurements will be entered in reverse order from those in the RWP.

f. When the last measurement in the LWP is made at Station 0+00 (0 m), verify that the position of front Dipstick foot is within 6-in (0.152 m) of the end point. If not, follow the procedures for end point verification previously discussed in Sections 3.c.1, 3.c.2 and 3.c.3 for the measurements in the right wheel path. If a problem is found with a missing or skipped measurement or the final location of Dipstick in the left wheel path, the

measurements in the left wheel path should be discarded as suspect and the survey restarted at the beginning point in the left wheel path.

g. After the location of the last measurement in the left wheel path has been verified, then closure measurements along the transverse closure line back toward the starting point in the RWP should be performed. As illustrated in Figure 1, use the closure circle made around the starting point to close the elevation survey on the start point. Record these measurements in the table located at the bottom of the form DS-2.

4. Post Data Collection Check

a. After completing the survey, the operator must conduct the zero and calibration checks. The results of these checks should be entered on Form DS-7.

1 If the Dipstick fails the zero check, but can successfully be adjusted and pass the calibration check, then the data should be discarded as suspect and another survey should be performed.

2. If the Dipstick passes the zero check, but fails the calibration check, the data should be discarded as suspect and the Face Technologies should be contacted for repair, as discussed under section 3.3.3.1 of the **SHRP Profile Measurement Manual**.

3 If the Dipstick passes both tests, the closure error computations should be performed.

5. Closure Error Computations

a. These closure error computations must be performed in the field prior to leaving the site.

b. The readings in each column on forms DS-2 through 6 should be summed and recorded in the last row of each column. The measurements in the transverse closure measurement tables on forms DS-2 and DS-6 should be summed across the row and entered in the last column.

c. The column summations should be entered onto form DS-1 in the locations corresponding to the labels shown in each summation cell.

d. On form DS-1, the elevation sums in the RWP and LWP should be added together and recorded in the indicated cells.

e. The transverse sums should then be added to each of these sums and the result recorded in the total row at the bottom of the closure calculation table.

f. The two totals should then be added together and the result entered into the cell labeled closure error.

g. If the closure error is greater than ± 3 in (76 mm), then the data should be discarded as suspect and the test section re-surveyed until the closure error is less than this amount.

Prepared by: Antonio Nieves

Approved by:

Monte Symons, Team Leader
LTPP Operations

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-1 Measurement Information and Closure Computation	State Code [__ __] LTPP Section [__ __ __ __] Date (dd/mmm/yy) __ __/__ __ __/__ __

Operator: _____ Employer: _____

Recorder: _____ Employer: _____

Dipstick Serial Number: _____

Start Time (military): __ __ . __ __ Stop Time (military): __ __ . __ __

Weather: _____

Closure Error Computation

Right Wheel Path		Left Wheel Path		
Nº	Elevation Sum	Nº	Elevation Sum	
O1		I1		
O2		I2		
O3		I3		
O4		I4		
O5		I5		
O6		I6		
O7		I7		
O8		I8		
O9		I9		
O10		I10		
O11		I11		
O12		I12		
O13		I13		
O14		I14		
O15		I15		
O16		I16		
O17		I17		
O18		I18		
O19		I19		
O20		I20		
Total O1 to O20	OA	Total I1 to I20	IA	
Transverse Sum T2	OB	Transverse Sum T1	IB	**Closure Error**
Total OA+OB	OC	Total IA + IB	IC	

Comments: _____

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-2 Station 0+00 to 1+00	State Code [_ _] LTPP Section ID [_ _ _ _] Date (dd/mmm/yy) [_ _ _ _ / _ _ _ _ / _ _ _ _]

Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)	
	RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑
0+00											
0+01			0+26			0+51			0+76		
0+02			0+27			0+52			0+77		
0+03			0+28			0+53			0+78		
0+04			0+29			0+54			0+79		
0+05			0+30			0+55			0+80		
0+06			0+31			0+56			0+81		
0+07			0+32			0+57			0+82		
0+08			0+33			0+58			0+83		
0+09			0+34			0+59			0+84		
0+10			0+35			0+60			0+85		
0+11			0+36			0+61			0+86		
0+12			0+37			0+62			0+87		
0+13			0+38			0+63			0+88		
0+14			0+39			0+64			0+89		
0+15			0+40			0+65			0+90		
0+16			0+41			0+66			0+91		
0+17			0+42			0+67			0+92		
0+18			0+43			0+68			0+93		
0+19			0+44			0+69			0+94		
0+20			0+45			0+70			0+95		
0+21			0+46			0+71			0+96		
0+22			0+47			0+72			0+97		
0+23			0+48			0+73			0+98		
0+24			0+49			0+74			0+99		
0+25			0+50			0+75			1+00		
Sum	01	11		02	12		03	13		04	14

Transverse Closure Measurements from Left Wheel Path to Right Wheel Path at Station 0+00 (0 m)

	Transverse Position							Sum
	LWP-1	1-2	2-3	3-4	4-5	5 - CC	CC - RWP	
Reading (in.)								T1

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-3 Station 1+00 to 2+00	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / ___ / __ __]

Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)	
	RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑
1+00											
1+01			1+26			1+51			1+76		
1+02			1+27			1+52			1+77		
1+03			1+28			1+53			1+78		
1+04			1+29			1+54			1+79		
1+05			1+30			1+55			1+80		
1+06			1+31			1+56			1+81		
1+07			1+32			1+57			1+82		
1+08			1+33			1+58			1+83		
1+09			1+34			1+59			1+84		
1+10			1+35			1+60			1+85		
1+11			1+36			1+61			1+86		
1+12			1+37			1+62			1+87		
1+13			1+38			1+63			1+88		
1+14			1+39			1+64			1+89		
1+15			1+40			1+65			1+90		
1+16			1+41			1+66			1+91		
1+17			1+42			1+67			1+92		
1+18			1+43			1+68			1+93		
1+19			1+44			1+69			1+94		
1+20			1+45			1+70			1+95		
1+21			1+46			1+71			1+96		
1+22			1+47			1+72			1+97		
1+23			1+48			1+73			1+98		
1+24			1+49			1+74			1+99		
1+25			1+50			1+75			2+00		
Sum	05	15		06	16		07	17		08	18

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-4 Station 2+00 to 3+00	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)	
	RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑
2+00											
2+01			2+26			2+51			2+76		
2+02			2+27			2+52			2+77		
2+03			2+28			2+53			2+78		
2+04			2+29			2+54			2+79		
2+05			2+30			2+55			2+80		
2+06			2+31			2+56			2+81		
2+07			2+32			2+57			2+82		
2+08			2+33			2+58			2+83		
2+09			2+34			2+59			2+84		
2+10			2+35			2+60			2+85		
2+11			2+36			2+61			2+86		
2+12			2+37			2+62			2+87		
2+13			2+38			2+63			2+88		
2+14			2+39			2+64			2+89		
2+15			2+40			2+65			2+90		
2+16			2+41			2+66			2+91		
2+17			2+42			2+67			2+92		
2+18			2+43			2+68			2+93		
2+19			2+44			2+69			2+94		
2+20			2+45			2+70			2+95		
2+21			2+46			2+71			2+96		
2+22			2+47			2+72			2+97		
2+23			2+48			2+73			2+98		
2+24			2+49			2+74			2+99		
2+25			2+50			2+75			3+00		
Sum											

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-5 Station 3+00 to 4+00	State Code [__ __] LTPP Section ID [__ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)	
	RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑
3+00											
3+01			3+26			3+51			3+76		
3+02			3+27			3+52			3+77		
3+03			3+28			3+53			3+78		
3+04			3+29			3+54			3+79		
3+05			3+30			3+55			3+80		
3+06			3+31			3+56			3+81		
3+07			3+32			3+57			3+82		
3+08			3+33			3+58			3+83		
3+09			3+34			3+59			3+84		
3+10			3+35			3+60			3+85		
3+11			3+36			3+61			3+86		
3+12			3+37			3+62			3+87		
3+13			3+38			3+63			3+88		
3+14			3+39			3+64			3+89		
3+15			3+40			3+65			3+90		
3+16			3+41			3+66			3+91		
3+17			3+42			3+67			3+92		
3+18			3+43			3+68			3+93		
3+19			3+44			3+69			3+94		
3+20			3+45			3+70			3+95		
3+21			3+46			3+71			3+96		
3+22			3+47			3+72			3+97		
3+23			3+48			3+73			3+98		
3+24			3+49			3+74			3+99		
3+25			3+50			3+75			4+00		
Sum	U13	T13		U14	T14		U15	T15		U16	T16

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-6 Station 4+00 to 5+00	State Code [__ __] LTPP Section ID [__ __ __ __] Date (dd/mmm/yy) [__ __ / __ __ __ / __ __]

Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)		Station (ft)	Reading (in.)	
	RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑		RWP ↓	LWP ↑
4+00											
4+01			4+26			4+51			4+76		
4+02			4+27			4+52			4+77		
4+03			4+28			4+53			4+78		
4+04			4+29			4+54			4+79		
4+05			4+30			4+55			4+80		
4+06			4+31			4+56			4+81		
4+07			4+32			4+57			4+82		
4+08			4+33			4+58			4+83		
4+09			4+34			4+59			4+84		
4+10			4+35			4+60			4+85		
4+11			4+36			4+61			4+86		
4+12			4+37			4+62			4+87		
4+13			4+38			4+63			4+88		
4+14			4+39			4+64			4+89		
4+15			4+40			4+65			4+90		
4+16			4+41			4+66			4+91		
4+17			4+42			4+67			4+92		
4+18			4+43			4+68			4+93		
4+19			4+44			4+69			4+94		
4+20			4+45			4+70			4+95		
4+21			4+46			4+71			4+96		
4+22			4+47			4+72			4+97		
4+23			4+48			4+73			4+98		
4+24			4+49			4+74			4+99		
4+25			4+50			4+75			5+00		
Sum	O17	I17		O18	I18		O19	I19		O20	I20

Transverse Closure Measurements from Right Wheel Path to Left Wheel Path at Station 5+00 (152.40 m)

	Transverse Position							Sum
	RWP-1	1-2	2-3	3-4	4-5	5 - CC	CC -LWP	
Reading (in.)								T2

LTPP Manual Dipstick Data Collection Form Longitudinal Profile Form DS-7 Pre/Post Measurement Zero and Calibration Checks	State Code [. .] LTPP Section ID [ ] Date (dd/mmm/yy) [/ /]

Operator: _____ Employer: _____

Dipstick Serial Number: _____

Diameter of Dipstick Foot Pad: in

Pre Measurement Checks

Time (military):

Zero Check		Calibration Check	
Measurement	Reading (inches)	Measurement	Reading (inches)
First Reading		First Reading	
Second Reading after 180° Rotation		Second Reading on Calibration Block	
First + Second Reading	[A]	Second Reading - 0.125 - First Reading	[B]

Notes:

A. First + Second Reading must be less than ± 0.001. If not, adjust the start pin as suggested in the LTPP Profile Measurement Manual and repeat zero check.

B. Second Reading - 0.125 - First Reading must be less than ± 0.003. If not, notify the RCOC office and contact Face Technologies for repair.

Post Measurement Checks

Time (military):

Zero Check		Calibration Check	
Measurement	Reading (inches)	Measurement	Reading (inches)
First Reading		First Reading	
Second Reading after 180° Rotation		Second Reading on Calibration Block	
First + Second Reading	[A]	Second Reading - 0.125 - First Reading	[B]

Notes:

A. First + Second Reading must be less than ± 0.001. If not, discard data as suspect, adjust the start pin as suggested in the LTPP Profile Measurement Manual, repeat zero check until it passes, perform calibration check and if it passes, resurvey section

B. Second Reading - 0.125 - First Reading must be less than ± 0.003. If not, notify the RCOC office and contact Face Technologies for repair.

Comments _____