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**A protocol for the  
establishment and  
operation of LTPP  
sections -  
Inception report**

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<p><b>Abstract:</b></p> <p>This Inception Report assesses local and international experience on the development of a protocol for the establishment and operation of Long Term Pavement Performance (LTPP) sections in conjunction with Accelerated Pavement Testing (APT). Discussions and a review of the literature indicated that some work in this regard has been initiated in South Africa and despite a draft general protocol (not specifically related to APT/HVS tests) being proposed this has not been implemented. Various ad hoc project specific LPTT projects have been carried out.</p> <p>A detailed protocol for LTPP work was devised in the USA for the SHRP programme (not related to APT) and this has been related where possible to the Australian APT programme. No other protocols were located.</p> <p>Based on the review, a detailed framework for the local specific problem areas has been identified and various problem areas highlighted. These include:</p> <ul style="list-style-type: none"> <li>• Standardisation of deflection measurement</li> <li>• Standardisation of transverse and longitudinal profile</li> <li>• Non destructive moisture content determination</li> </ul> <p>No significant deviations from the proposed work programme or budget were considered necessary.</p>				
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## TERMS OF REFERENCE

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CSIR Transportek was requested by Gautrans to develop a protocol for the establishment and operation of LTPP sections. The terms of reference for the study were to:

- Undertake a literature review on other LTPP studies
- Develop an appropriate protocol linking to the protocol already developed for HVS testing
- Develop appropriate data specifications for monitoring
- Prepare a report detailing the study and the recommended protocol.

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# 1. INTRODUCTION

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Long-term pavement performance (LTPP) programmes are established to support a broad range of pavement performance analyses leading to improved engineering tools to design, construct and manage pavements. Most current programmes focus on the calibration of pavement performance models used in pavement management systems. It is recognized that the link between accelerated pavement testing (APT) and in-service pavement performance is through LTPP studies. While APT can, and does, provide significant data for analysing and predicting the effects of traffic loading on the performance of various materials, it is not always capable of capturing environmental and other long-term effects. It is only when comparisons of APT and LTPP are available that there will be greater confidence in the interpretation and use of APT results.

Hence the need has long been recognised for establishing LTPP test sections linked to existing and future HVS test sections, so that the long-term performance of the test pavements can be linked to their performance under HVS testing. However, in South Africa, sustained long-term funding for this type of program has not been forthcoming and the programs have thus never been fully initiated, with LTPP studies being undertaken on an ad hoc basis only. LTPP sections have, however, been identified for calibrating pavement deterioration models for local pavement management systems and are being monitored at routine intervals.

There is renewed interest in linking APT to LTPP worldwide, given the increase in the number of APT facilities and the need for accelerating the implementation of new technologies that will reduce the cost of infrastructure provision and rehabilitation, withstand increasing numbers of axles, axle weights and tyre pressures and minimise traffic disruptions.

In order to ensure that models and pavement design specifications determined from the data collected from LTPP and APT programmes are reliable, it is imperative that the data is collected in a systematic, consistent and correlatable manner. A protocol is therefore necessary to ensure that this is achieved.

In this report, LTPP protocols are reviewed and a framework for developing a local protocol for the establishment and operation of LTPP sites in general and in conjunction with HVS tests is discussed.

## 2. REVIEW OF LTPP PROTOCOLS

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### 2.1. South Africa

Sources of information:

- Department of Transport reports by Bofinger and Shackelton
- Department of Transport reports by Paige-Green
- ISAP paper by Jooste
- Discussions with E Sadzik (Gauteng), M Henderson (Western Cape), R Lindsay (KwaZulu-Natal), D Rossman and M Yorke-Hart (Sanral), G van Zyl (Consultant), I Wolmarans (Consultant).

#### 2.1.1 Previous Studies

Despite HVS tests being carried out in South Africa since 1976, an LTPP study was first initiated in South Africa in 1991, part of which entailed an investigation of the relationships between LTPP and HVS results<sup>Error! Reference source not found.</sup>. The terms of reference for the study were later amended to establish LTPP sites for data collection for pavement management systems. However, in the initial part of the study rut depth, cracking and peak deflection measurements recorded on HVS sections were compared with those measured a number of years later on adjacent LTPP sites. The following experiments were monitored:

- Road between Laudium and Erasmia (Pretoria)
- Road between Pretoria and Johannesburg International Airport (P157/1 and P157/2)
- Koeberg (TR77/1)
- Stellenbosch (MR8)

Another comparison was made between HVS results and actual performance on P157/1 by Jooste et al in 1996<sup>2</sup>. Measurements included Dynamic Cone Penetrometer, (DCP), moisture and density, peak deflection and rutting.

#### Cracking

Bofinger made no reference to the method of assessing cracks, although it is assumed that TRH6<sup>3</sup> was used (TMH9<sup>Error! Reference source not found.</sup> was not published at the time of the study). During HVS tests, two types of cracking were noted, namely the existence of edge cracks and the appearance of cracks within the section. Under HVS loading conditions, the loaded wheel covers a section exactly 8.0 m by 1.0 m and the adjacent pavement carries no load of any type. On a normal road, there is no such distinct

demarcation between parts of the road surface that carry no wheel loads and a strip 1.0 m in width that carries all the applied loads. It is common, therefore, for edge cracks to occur in the HVS tests and, while these are noted, they have no comparable occurrence in normal road pavements<sup>Error! Reference source not found.</sup>.

At the time of writing the report<sup>Error! Reference source not found.</sup> (1992), it was standard practice on HVS test sections to note the appearance of the first crack at each of the 16 equally spaced measuring points in each 8.0 m length. No other measurements such as the change in the width of the crack or the appearance of other cracks were noted subsequent to the first crack appearing. (The method of measuring cracks on HVS sections has since changed<sup>5</sup> with daily monitoring and recording of crack development.)

On specific HVS sections, measurements of the horizontal and vertical movements were made across specific cracks with a Crack Activity Meter (CAM), but these have no corresponding measurements on sections of the road network. It was therefore concluded that the appearance of cracks or the relative movement across the faces of the cracks could not be used to compare the performance of pavements during HVS tests with their performance under the longer term conditions when a pavement is subjected to the loading of normal commercial traffic.

Jooste et al did not assess cracks as they considered it a difficult measure to compare in a quantitative manner because of the often-subjective nature of measurement and definition of cracks. This problem has largely been overcome with the use of digital photography.

#### Peak Deflection

In the earlier study, concerns were raised about data acquired from the adjacent pavements in that test results were not adequately documented or the location of the precise position of the deflection tests was not known (the substantial variations of the peak deflection within 1.0 m had been noted from the HVS tests and the exact locations of the points at which deflection values were measured were considered essential if peak deflections were to be used to denote the changes in condition of the pavement). Inspections of the deflection tests carried out during the selection of the exact site for an HVS test showed that none of the test points could be relocated precisely and repeat tests could not, therefore, be carried out at the same points. The variation in pavement response would introduce unacceptable errors in repeat deflection tests carried out in a similar area. Peak deflection values were therefore excluded from the study as a system for monitoring changes in the pavement structures with traffic.

In Jooste et al's study, Road Surface Deflectometer (RSD) and Falling Weight Deflectometer (FWD) measurements were taken and compared with the deflection

measurements taken during HVS testing. No mention is made of the concerns raised above. Furthermore, it was found that the HVS-predicted deflections compared well with the deflections measured after the road had been trafficked for 16 years.

### Rutting

Bofinger believed that changes in the rut depth provided the best comparison of the condition of pavements loaded by the HVS and the road network adjacent to HVS test sections, where normal traffic loaded the pavement, although some problems were still encountered in quantifying the traffic loads that the pavement had carried in terms of standard axles. A relative damage coefficient of four was ultimately used. Substantial differences were noted between the rut ratios obtained in Gauteng (underestimated) and those in the Western Cape (overestimated). This was attributed to the different subbase types (cement in Gauteng, granular in the Cape).

Jooste et al found that the HVS rut curve compared well with the rut depth measured after actual traffic and 16 years of changes in environmental conditions. However, since the rut depths were in all cases very low, the strength of the conclusions that could be drawn was considered to be somewhat limited. However, it was concluded that environmental influences that were not included in the HVS testing did not cause significant changes in rut depth formation and that the rut depths that developed during HVS testing were very similar in magnitude and variation to those measured after a significant period of trafficking and seasonal changes in environmental conditions.

### Other Studies

Paige-Green<sup>6</sup> reported on the long-term pavement performance of 24 sections of low-volume road constructed with marginal base course materials. No standard protocols were followed with ongoing collection of specific data over a period of more than nine years in order to relate performance to pavement material properties and structure. A number of problems including the accurate assessment of traffic in terms of standard axles, significant fluctuations in moisture content (variance from predicted values), poor correlations between deflection and performance, and generally high variability in properties over short sections of road were noted.

A number of other LTPP studies have been carried out, mostly of an ad hoc nature to monitor various parameters. Most of these have been for pavement management purposes, rather than pavement design. In the past nine years, a number of sections in the Gauteng and Western Cape provinces have been identified and routinely monitored to calibrate pavement deterioration models (HDMIII) for pavement management systems. No attempt has been made to link HVS performance data and monitoring protocols (visual assessment, deflection (FWD) and riding quality (IRI)) and the database population is based on the data input requirements for HDMIII and HDMIV. A visual



assessment guide was developed for monitoring the sections<sup>7</sup>. LTPP sections have been purposely built adjacent to HVS sections since 1997 (Road 2388), although no official LTPP monitoring programme is being followed for these roads.

## 2.1.2 Site Establishment and Data Collection Protocols

### Department of Transport - 1991

A draft protocol for LTPP section identification and monitoring was established as part of the 1991 South African LTPP study<sup>8</sup> and included details on the following:

- **Selection of test sections** - Guidelines, rather than a protocol, were provided on the criteria to be used for selecting sections and primarily focussed on the development of pavement deterioration models. These included level of traffic, age of the road, type of pavement, section layout and inventory data. Emphasis appeared to be on selecting sections that had not been tested with the HVS. The development of a detailed populated experimental design was not initiated as it was considered outside the scope of the study.
- **Types and methods of test** - The following parameters were considered essential for the monitoring programme:
  - Extent, degree and type of cracking
  - Riding quality/road roughness
  - Extent of patching
  - Extent of bleeding/stone loss
  - Rut depth
  - Deflection characteristics
  - Moduli/strengths (usually back-calculated from deflection data or from DCP)
  - Surface characteristics (penetration, texture)

In addition to the above routine assessments, detail on diagnostic testing for auditing purposes or in the event of ultimate failure of the pavement sections was provided. A number of material tests were proposed.

Details on the methods to assess the above parameters were provided. No visual assessment manual is prescribed. The recommended methods for assessing roughness (Linear Displacement Integrator, rod-and-level survey, rolling profilometer) are outdated. There was also some debate around deflection measurements, with an assumption that it would not be possible to get parties to agree on one testing method. It was therefore proposed that, as an absolute minimum requirement, deflection tests be carried out with the device that is normally used by the road authority in the region in which a particular road section is located and that every second survey be completed using both an FWD and a Benkelman Beam.

- **Frequency of the monitoring operations** - Guidelines, instead of a protocol, were provided for frequency of testing, with intervals between tests largely left to the discretion of the road authority.
- **Traffic loading data** - The following essential traffic parameters were identified:
  - Axle load spectrum of the vehicles travelling on the section
  - Axle configuration
  - Speeds of the various categories of vehicle
  - Range of tyre pressures used by each category
 Guidelines on the method and frequency of collection are given.
- **Data storage and management** - Broad recommendations on general structure of the information management system, process of database population, database structure and software and access rights were made.
- **Data analysis** - Data analysis is described as formal and informal. Formal analyses are those that must be carried out to achieve the ultimate goals of the LTPP programme. Informal analyses are typically those associated with research studies and usually investigate specific problems or phenomena. The following requisite formal analyses were identified:
  - Variation with parameters over time
  - Correlation between any two parameters (eg rut depth vs deflection)
  - Correlation between wheel paths for any parameter
  - Correlation between performance of different pavements or pavement types
  - Adequacy of data for the above tasks

Gautrans Visual Assessment Manual - 2001

In 1996, Gautrans commissioned a study on calibration of HDM-III models for local conditions. Thirty-six sections were identified and a Visual Assessment Manual written. The manual, which is used in conjunction with TMH-9<sup>Error! Reference source not found.</sup>, includes the following chapters as well as an example of the data collection form:

- Location and length of sections
- Section width
- Surface defects (cracks, ravelling, mechanical damage, shoving/slippage of the surfacing, binder condition and bleeding/flushing)
- Structural defects (cracks, pumping, patching and potholing)
- Functional evaluation (assessed using TMH-9)
- Rutting

No detail is given on the selection of new sections, traffic counts or the measurement of deflections (two deflection measurements (FWD) have been taken during the course of the study). Destructive testing (density, DCP, moisture measurements) is not discussed.

### **2.1.3 Protocol for HVS Instrumentation, Data Collection and Data Storage**

The CSIR has managed Heavy Vehicle Simulator (HVS) operations in South Africa for the past 25 years. During this period, experience in the collection and storage of pavement performance data under accelerated pavement testing has been gained. Current norms relating to quality management of processes and products necessitated the consolidation of these processes into a protocol for use in future HVS projects. A protocol<sup>5</sup> was therefore recently prepared and is currently under review. The protocol covers three key aspects of HVS operations, namely:

- Instrumentation used for pavement performance monitoring and protocols related to installation
- Data collection protocol
- Storage of collected pavement performance data

Site selection criteria, test section identification, calibration methods and operational instructions are also described in the document.

Any protocol document prepared for the comparison of HVS and LTPP sections in South Africa would need to take the HVS protocol into consideration to ensure that similar parameters are measured in a similar way.

## **2.2. United States**

Sources of information:

- Federal Highways Administration Website and reports

### **2.2.1 Background to SHRP LTPP Program**

The United States Strategic Highway Research Program (SHRP) was a five-year, US\$150M undertaking. It was the largest single highway research program ever conducted in the United States and represented the most concentrated investigation of highway problems undertaken anywhere in the world. SHRP research addressed four technical areas of investigation:

- Asphalt
- Concrete and Structures

- Highway Operations
- Long-Term Pavement Performance (LTPP)

The LTPP component of the program embraced the total range of pavement information needs. It drew on knowledge of pavements currently available and sought to develop models that would better explain how pavements perform. It also sought to gain knowledge of the specific effects on pavement performance of various design features, traffic and environment, use of various materials, construction quality and maintenance practices.

Despite SHRP's five-year program being formally completed in 1993, the nature of LTPP is such that this aspect of the program will have a duration of about 20 years. To facilitate this, the management of the LTPP study was taken over by the US Federal Highway Administration (FHWA).

More than 2 400 sections representing a diverse range of physical, environmental and traffic conditions are being investigated in the program. The scope of the program allowed other countries, including Canada and Australia, to participate in the program.

The United States LTPP program has the following specific objectives<sup>9</sup>:

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

Monitoring of the more than 2 400 sections started in 1989. The program was initially set up with three subsections, namely:

- General pavement studies (GPS) monitoring a 160 m section selected from a full factorial experimental design incorporating the following primary and secondary factors:

<b>Primary</b>	<b>Secondary</b>
Subgrade (fine/coarse)	Asphalt concrete (AC) thickness
Traffic (medium/heavy)	AC stiffness
Temperature (freeze/non-freeze)	Structural number of base and subgrade
Moisture (wet/dry)	Portland cement concrete (PCC) thickness
	Joint spacing

- Specific pavement studies (SPS) monitoring multiple 160 m sections selected from a half factorial experimental design incorporating the following primary and secondary factors:

<b>Primary</b>	<b>Secondary</b>
Subgrade (fine/coarse)	AC drainage (yes/no)
Traffic (medium/heavy)	AC thickness
Temperature (freeze/non-freeze)	AC base type and thickness
Moisture (wet/dry)	Structural number of base and subgrade
	PCC drainage (yes/no)
	PCC strength and thickness
	Lane width
	Base type

- Accelerated pavement testing (APT) including road tests or accelerated loading facilities. Neither has been considered for implementation to date.

The GP and SP studies are further divided as follows:

- GPS-1 Asphalt concrete (AC) on granular base
- GPS-2 AC on bound base
- GPS-3 Jointed plain Portland cement concrete (PCC) pavement
- GPS-4 Jointed reinforced PCC pavement
- GPS-5 Continuously reinforced PCC pavement
- GPS-6A Existing AC overlay on AC pavements
- GPS-6B New AC overlay on AC pavements
- GPS-7A Existing AC overlay on PCC pavements
- GPS-7B New AC overlay on PCC pavements
- GPS-9 Unbounded PCC overlays on PCC pavements
- SPS-1 Strategic study of structural factors for flexible pavements
- SPS-2 Strategic study of structural factors for rigid pavements
- SPS-3 Preventative maintenance effective for flexible pavements

- SPS-4 Preventative maintenance effective for rigid pavements
- SPS-5 Rehabilitation of AC pavements
- SPS-6 Rehabilitation of jointed PCC pavements
- SPS-7 Bonded PCC overlays on concrete pavements
- SPS-8 Study of environmental effects in the absence of heavy loads
- SPS-9 Validation of SHRP AC specification and mix design (Superpave)

It appears that most of the sections have a thick asphalt or concrete surfacing contributing significantly to the structural capacity of the road.

The APT component has not been initiated to date, although the matter is being discussed at length in a number of fora<sup>11</sup>. No formalised program of linking LTPP to APT at national level has been initiated, although this is being done to a limited extent in a number of states that have APT facilities.

### 2.2.2 Data Collection

A data collection guide<sup>9</sup>, supported by 22 detailed sub-documents, have been prepared as part of the LTPP project. The detailed guides include the following:

- Distress identification manual
- Falling Weight Deflectometer relative calibration analysis
- Guidance for rehabilitation
- Traffic data collection and processing
- FWD calibration protocol
- Calibrating traffic data collection equipment
- Operational field guidelines for FWD measurements
- Operational field guidelines for profile measurements
- Test method for determining resilient modulus of unbound materials - laboratory start-up and quality control procedure
- Test method for determining the creep compliance, resilient modulus and strength of asphalt materials using the indirect tensile test device
- Test method for determining the resilient modulus of unbound granular base/subbase materials and subgrade soils
- Seasonal monitoring program: Instrumentation installation and data collection guidelines
- Guide for field materials sampling, handling and testing
- Guide for laboratory material handling and testing
- Traffic monitoring guide
- SPS traffic site evaluation
- IMS reference material

- Climatic database revision and expansion
- IMS quality control checks
- Traffic quality control software

When compiling the documents, it was realised that the primary difficulties in utilisation of data collected in the past was the lack of uniformity of that data and the omission of data that was significant to the performance of the pavement. The data collection guides were therefore developed to support the experimental designs and provide a uniform basis for data collection. The approach taken identified those data items that were considered to be of high priority for achieving the goals of the LTPP studies. It also provided for a comprehensive set of other data items that may be desirable in the LTPP Information Management System for other purposes such as pavement management, detailed studies of pavement components, construction techniques and design features.

The following categories of data are collected:

- Inventory data
- Monitoring data
- Traffic data
- Climatic data
- Maintenance data
- Rehabilitation data
- Materials sampling and testing data

In addition to the above categories, a “minimum data set” considered to be the most desirable data set for fulfilling the requirements of the LTPP objectives was defined. This includes the dependent variables representing performance of pavements and those independent variables expected to significantly affect pavement performance.

Data collection and equipment used in each category is comprehensively described in the data collection manuals.

### **2.3. Australia and New Zealand**

Sources of information:

- K Sharp and R Yeo, ARRB Transport Research
- R Douglas (University of Canterbury), D Alabaster and C Parkman (Transit NZ)
- Austroads reports

### **2.3.1 Background to ALF-LTPP**

The objective of the Accelerated Load Facility - Long-Term Pavement Performance (ALF-LTPP) study is to compare the relative performance of full-scale in-service test sections under real traffic loading conditions with that determined under ALF loading. Verification of the relevance of accelerated pavement testing trials to observed in-service performance would result in an increased level of confidence in the use of these types of accelerated trials. Twelve sites are currently being monitored, although not all of the LTPP studies were initiated at the same time as the associated ALF program<sup>11</sup>.

A comparative analysis conducted by Koniditsiotis (1999) suggested that there were clear benefits associated with conducting LTPP studies of pavement types already tested under accelerated loading conditions. In addition, the long-term monitoring of these sites would allow issues that cannot be addressed with accelerated loading, such as the effects of mixed traffic loading, environment and aging, to be evaluated.

### **2.3.2 Data Collection Protocols**

Guidelines for site establishment and data collection have been prepared<sup>12</sup>. Since a number of the sites are official SHRP-LTPP sites, they are monitored according to the US standard described above.

New Zealand does not have a formal LTPP program. They have calibration sections for HDM models, but no links to their CAPTIF APT program. However, they are considering instrumenting one of the test sections in a similar manner to CAPTIF sections with a view to comparing performance predictions.

## **2.4. United Kingdom and Europe**

Sources of information

- M Nunn and T Greening, TRL
- COST-347 Website

### **2.4.1 United Kingdom**

The UK has a validation monitoring programme to assess the long-term performance of a number of designs on a number of pavements in the road network. However, since the UK APT programme is confined to a building where short specially constructed pavement sections are compared with control pavements, it is difficult to compare APT with LTPP, given the differences in construction technique. Where possible, TRL attempts to relate results from the APT programme to in-service performance, but this is done on a project-by-project basis and is dependent on funding.



## 2.4.2 Europe

There are some 17 APT facilities in Europe, mostly fixed in one location (ie cannot be moved between sites). No detail on comparison of the APT findings with that of LTPP findings has been located to date. However, the European Cooperation in the Field of Scientific and Technical Research (COST) programme is currently investigating the role of APT in pavement engineering. One of the tasks currently being carried out is a comparison between APT and LTPP research results. The study is concentrating on the following issues:

- Economics of APT vs LTPP
- Construction techniques
- Physical and environmental conditions
- Loading conditions
- Pavement deterioration

No results have been published to date. Another task will be to look at developing a common code of good practice. This entails two items:

- Guidelines for existing facilities
- Guidelines for new facilities

No reference to a protocol for comparing APT and LTPP sections could be located.

### 3. PROTOCOL DEVELOPMENT

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Although numerous countries have an LTPP monitoring programme in place, it is clear from the literature review and interviews that only Australia has embarked on a dedicated comparison of APT results with those obtained from adjacent LTPP sections.

Since there is very little published information on the development of protocols to standardise the monitoring of LTPP sections in conjunction with APT sections, a workshop was held to brainstorm a framework for essential and desirable items that need to be monitored. The data that is currently being collected from HVS testing was used as a basis for this framework.

The framework will be developed into a detailed protocol for the establishment and operation of LTPP sections in conjunction with HVS tests. The requirements for calibration of performance models used in local pavement management systems will also be considered. The proposed chapters and subsections in the protocol include:

- Introduction
  - Background
  - Scope
- Linkage of HVS and LTPP
  - Justification of instrumentation
  - Justification of testing requirements
- Management and responsibilities
  - Staffing
  - Management structure and responsibility matrix
  - Funding
  - Data management
- Site location and establishment
  - Location and marking
  - Setting up
  - Instrument installation
- Data collection
  - Monitoring standards
  - Monitoring procedures
  - Sampling frequency
  - Laboratory testing
- Reporting criteria

Where appropriate, use will be made of relevant techniques developed for the SHRP program.

### **3.1. Problem Areas**

In discussions on the development of a framework for the protocol, considerable debate arose around a number of issues. These included the minimum requirements for measurement and monitoring of deflection, transverse and longitudinal profile, moisture content and destructive vs non-destructive testing.

After considerable deliberation it was proposed that the following minimum standards should be included in the protocol, with the option of including additional measurements with other equipment resting with the road authority:

- Deflection - On HVS sections, multi-depth deflectometers installed in the pavement at the same time as the HVS section. Periodic measurements with an RSD and FWD to determine maximum deflection and radius of curvature. On other LTPP sections, deflection measurements should be limited FWD.
- Transverse profile - maximum depression under a 2.0 m straight edge using a 1.0 cm wedge.
- Longitudinal profile - International Roughness Index (IRI) determined with any appropriate calibrated equipment meeting the specification for measuring HDM-III/IV sections. The equipment used must be specified in the database.
- Moisture - twin probe nuclear density gauge with gravimetric calibration until a calibration curve is obtained for each LTPP section.
- Destructive testing will be confined to identified areas of the section such that they will not influence later monitoring.

It is also clear that there are ongoing developments in pavement monitoring techniques and equipment and laboratory testing. It is therefore suggested that the protocol is given a version number and that a statement to the effect that the document content will be reviewed periodically is included.

### **3.2. Linkage to Gautrans Database Project**

The data outputs will be developed in the protocol and these will form the fields for the materials database currently being developed for Gautrans.

## **4. PROJECT PROGRAM**

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During preparation of this Inception Report, the overall project program and budget was reassessed. No significant changes in the program are envisaged and the budget will remain as quoted in the original proposal.

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