

**Report No: CR-2004/40**

Report CR-2004/40  
**Heavy Vehicle Simulator (HVS)**

**Programme  
Summary**

**Authors:**

**AC Brink  
HL Theyse  
WJvdM Steyn**

**PREPARED BY:**

CSIR Transportek  
PO Box 395  
PRETORIA, 0001  
Tel.: +27 12 841 2905  
Fax: +27 12 841 3232

Programme:  
Programme Manager:

Transport Infrastructure  
B Verhaeghe

**PREPARED FOR:**

Department of Transport  
and Public Works: Gauteng  
Directorate: Design  
Private Bag X3  
Lynn East, 0039



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<b>Author:</b> AC Brink and H L Theyse				
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<p><b>Abstract:</b></p> <p>This report contains a summary of the Gautrans HVS test programme since 1994. It contains tables indicating the basic test site information, a summary of the test descriptions, objectives and results, as well as HVS test reports and HVS-related publications.</p> <p>The objective of this report is to serve as a summary of the strategic plan as well as the outcomes of various tests, and the way the strategic plan and the APT projects are interlinked.</p> <p>Detailed project descriptions, conclusions and recommendations are available in the reports for each of the projects.</p>				
<b>Proposals for implementation:</b> Report to be published on the Gautrans HVS website.				
<p><b>Related documents</b> (e.g. software, interim or other reports, working drawings etc):</p> <p>Refer to reports in Section 5.</p>				
<b>Signatures:</b>				
A McKay Language review	Gautrans review panel Technical Review	B Verhaeghe Programme Manager	P Hendricks Division Director	E van Heerden Info Centre

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# **1. INTRODUCTION**

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## **1.1. Introduction**

This report provides a summary of the Accelerated Pavement Testing (APT) programme of the Gauteng Department of Public Transport, Roads and Works for the period 1994 to 2004. It covers three periods of strategic objectives and places the information in the context of the focus areas emanating from these strategic objectives.

It provides the strategic context for the APT programme, as well as a summary of the history, impact and reports originating from the APT work.

## **1.2. Context and APT Strategic plan**

### **1.2.1 Introduction**

The HVS programme in Gautrans is being guided through the Accelerated Pavement Testing (APT) Strategic Plan (Sampson, 2004). The Strategic Plan outlines a 3-year strategy for Accelerated Pavement Testing (APT), in an effort to identify and prioritise strategic areas for HVS testing which will provide the primary, but not exclusive, testing support to the overall APT plan. The plan is developed to be in line with the key strategic areas of the overall strategy for the Gautrans Department of Public Transport, Roads and Works in terms of:

- Cooperative Governance;
- Integrated Infrastructure Planning and Development;
- Public Freight Transport Systems and Logistics;
- Finance and Funding Strategies;
- Expanded Public Works Programme;
- Asset Management and Maintenance; and
- Capacity Building for enhanced service delivery.

The plan also takes note of national needs and priorities along with the optimization of alternative APT facilities that could be utilised to meet the various needs and is prepared with inputs from, and on behalf of the APT Steering Committee for approval by Gautrans.

Gautrans has been operating a Heavy Vehicle Simulator (HVS) since 1978. The Department's HVS-associated technology development programme (HVS Programme) as part of a broader Accelerated Pavement Testing (APT) programme, coordinated by

the Department, has had a major technological and economic impact on the design, construction and maintenance of roads not only in Gauteng but nationally, regionally and internationally. It has impacted on, for example:

- The development of pavement design standards and guidelines;
- The development of material specifications and guidelines;
- The development of human resources;
- Capacity building in the road construction industry;
- Implementation of labour-intensive technologies;
- The development of innovative products and designs; and
- The provision of cost-effective, fit-for-purpose road infrastructure engineering solutions.

The future programme will inter alia address cost-effective and efficient means of rehabilitating the Gauteng road network, where over 70 per cent of its roads have reached the end of their design life span, and will further investigate means by which labour can be maximised in road construction and maintenance without compromising quality and, hence, performance. The Strategic Plan provides a strategic approach to achieving the vision, mission and goals of the HVS programme as part of the overarching APT programme for South Africa as agreed at the APT Steering Committee meeting of 27 November 2003.

## **1.2.2 Previous APT Strategic Plans**

### **1995 to 2000**

In October 1995 a strategic document for the Gautrans HVS projects was prepared by Sadzik et al. At that time, the following **strategic objectives** were identified in that the Gautrans HVS programme would aim to develop, improve understanding of, verify or evaluate:

- The design and performance of pavement structures suitable for basic access roads and collectors for rural road networks;
- Labour intensive construction (LIC) friendly pavement composition and LIC techniques;
- Techniques for upgrading and maintenance of existing gravel (and other) low volume pavement structures;
- The use of innovative, cost-effective materials and methods, optimising the use of in-situ materials (treated and untreated);
- Technologies for the preservation of the existing road network in order to extend its service life;

- Technologies for optimisation of the use of scarce building materials (e.g. gravel roads); and
- Pavement deterioration models for use in Pavement Management Systems.

In line with the strategic objectives for the 5-year period to 2000, HVS testing focused on the following four **focus areas** with specific emphasis on the upgrading of low volume, generally unsurfaced roads to provide all-weather access with an emphasis on LIC (the designation in brackets / bold indicate the generic focus area description for comparison with the other strategic periods):

- Completion of the HVS testing on a relatively strong in-situ gravel upgraded by sealing with a gravel bonding agent (road S702) to evaluate the ability of inexpensive upgrading measures to provide an all-weather riding surface for moderate to low traffic (**Low volume roads**);
- Evaluation of the performance of very light gravel pavements (G4 to G10 base material) upgraded by sealing with a gravel bonding agent (road D327) to evaluate the ability of inexpensive upgrading methodologies to provide roads suitable for basic access and to provide a basis for the work on LIC methods (**Labour intensive construction**);
- Investigation of the performance of various upgrading options constructed with LIC methods on very light existing gravel roads to evaluate their suitability for providing basic access roads, collectors and rural, lightly trafficked roads (**Labour intensive construction**);
- Maximisation of the use of the historic HVS data base in association with future HVS results to develop pavement deterioration models suitable for pavement Management Systems (**Pavement Management Systems**).

### **2000 to 2003**

The period from 2000 to 2003 saw a shift in **focus areas**. The increase in traffic volumes and the need to rehabilitate heavily trafficked roads quickly to reduce delays, allied to the decline in availability of non-renewable aggregate sources lead to an increased popularity in cold in-situ recycling of the existing base and wearing course material. Stabilisation of the recycled material was generally carried out with foamed bitumen and cement or bitumen emulsion and cement. The new **focus areas** included (the designation in brackets / bold indicate the generic focus area description for comparison with the other strategic periods):

- Laboratory testing on both the foamed bitumen and emulsion treated materials (an effort to provide a better understanding of how to design and use these material to obtain optimum performance from the roads) (**DISR foam and emulsion**);

- Additional work on Low Volume Roads in the Western Cape (**Low volume roads**);
- Investigation of concrete and composite pavements for highly trafficked roads (**Concrete pavements**).

### 1.2.3 Current (2004 to 2007) Strategic Plan

The **vision** for the APT research in Gauteng has been evaluated during 2004 and updated to indicate that APT will contribute to:

- Minimising premature pavement distress;
- Improving design procedures and models;
- Optimising material type, use and performance;
- Evaluating appropriate construction techniques;
- Quantifying pavement performance;
- Integrating APT, LTPP, laboratory testing and existing pavement knowledge; and
- Optimising use of resources.

To achieve the vision, mission and goals for APT, the **strategic objectives** were defined as:

- Optimisation of the various APT options with particular reference to the Gautrans HVS testing programme;
- The development of a coordinated approach to APT through strategic alliances and partnerships;
- The development of technologies in line with industry needs and ensuring appropriate transfer back to industry;
- Consultation with relevant stakeholders;
- Effective communication; and
- Efficient dissemination of information.

Five strategic **focus areas** have been identified for APT (2004 to 2007) (the designation in brackets / bold indicate the generic focus area description for comparison with the other strategic periods):

- Cold In-Place Recycling (**DISR foam and emulsion**);
- Asphalt Performance (**HMA**);
- Provision of Low Volume Roads (including upgrading of unpaved roads) (**Low volume roads**);
- Vehicle Pavement Interaction (including dynamic loads and contact stresses) (**Vehicle-Pavement Interaction**), and
- Concrete pavements (**Concrete pavements**)

### 1.3. Objectives

The objectives of this report are in line with the deliverables in the original work proposal (Appendix A):

- A table summarising the history of tests that were conducted, indicating start and end dates, the subject of the test programme, and the location of the test.
- A table summarising the objectives, results obtained and reports/papers generated through each test setup.

Apart from these two original deliverables, the following has been added since:

- The document should be broadened to incorporate a section where the context of the APT-related research is provided.

In line with these deliverables the objectives of this report are to provide:

- A summary of HVS test history;
- A summary of HVS focus area activities;
- A summary of the impact of the HVS, and
- A list of various reports, papers and other publications.

The objective is **not** to provide detailed information on any of these specific topics, but rather to summarise it in such a way that the reader can obtain a quick and clear perception of the work that was done, the impact and available outputs from the work and the strategic context in which it has been done. All detailed analyses related to the success of various efforts and the impact on the industry are covered in other references.

### 1.4. Report outline

The information in the report is mainly presented in tables that are grouped in line with the three strategic periods covered (1995 to 2000, 2000 to 2003 and 2004 onwards). The main link between the information in the various tables is therefore the strategic objectives and focus areas for the various periods.

## 2. HVS HISTORY.

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The HVS history provides a summary of the various tests performed as part of the Gautrans APT programme for the period 1994 to 2004. It consists of two tables (one each for the two strategic plan periods (1994 to 2000 and 2000 to 2003). There are currently (November 2004) no new APT tests that form part of the 2004 to 2007 strategy that can as yet be added to this list. The following information is provided:

- Start and end dates of the tests;
- Focus area of the specific study;
- Location of the project (site and road number), and
- HVS test numbers for the specific period.

In the focus area column the generic focus area designation is provided, together with more detail on the specific programme where required.

**Table 1: HVS history summary (1994 to 2000).**

Start date	End date	Focus Area	Location (Site and Road no)	Test no.
12/08/94	05/09/94	Low volume roads	Bultfontein, S702	385A4
08/09/94	18/11/94			386A4
22/12/94	25/08/95			387A4
11/09/95	02/01/96			388A4
13/02/97	06/05/97			389A4
31/01/96	17/05/96			390A4
18/07/96	25/09/96			391A4
30/09/96	29/10/96			392A4
30/10/96	02/02/97			393A4
03/07/97	25/08/97	Labour intensive construction	Cullinan / Brandbach R2388	394A4
25/08/97	13/10/97			395A4
16/10/97	21/01/97			396A4
27/11/97	12/10/98			397A4
14/01/98	02/03/98			398A4
04/03/98	14/04/98			399A4
16/04/98	27/05/98			400A4
29/05/98	29/06/98			401A4
02/07/98	31/07/98			402A4
07/08/98	05/10/98	403A4		
18/02/99	25/03/99	Labour intensive construction (waterbound macadam)	Louis Trichardt N1	404A4
08/04/99	18/06/99			405A4
07/06/99	18/06/99	Dynamic testing of HVS <sup>x</sup>	CSIR SITE Parking area	406A5
18/10/99	22/11/99	Labour intensive construction	Cullinan / Brandbach R2388	407A4
23/11/99	24/01/00			407B4
27/01/00	13/04/00			408A4
03/08/00	03/09/00	DISR foam and emulsion	Vereeninging P243/1	409A4
04/09/00	23/09/00			409B4
26/09/00	27/10/00			410A4
28/10/00	24/11/00			410B4
14/03/01	03/07/01			411A4
04/07/01	06/11/01			412A4
14/06/02	08/08/02	Comparative testing <sup>x</sup>	Cullinan / Brandbach R2388	413A4
05/07/02	04/08/02			414A5

\* These two areas are not specific focus areas, but underpin the research in the focus areas by providing supportive information regarding various aspects of the HVS performance.

**Table 2: HVS history summary (2000 to 2004).**

<b>Start date</b>	<b>End date</b>	<b>Focus Area</b>	<b>Location (Site and Road no)</b>	<b>Test no.</b>
18/09/02	31/10/02	DISR foam and emulsion (Evaluate foam treated base)	Cape Town N7 slow lane south bound	415A5
01/11/02	23/02/03			416A5
24/02/03	04/04/03	DISR foam and emulsion (Evaluate original base)	Cape Town N7 fast lane south bound	417A5
05/04/03	06/07/03			418A5
13/07/03	30/07/03	Low volume roads (Evaluate low volume roads)	Lamberts Bay R365	419A5
31/07/03	03/10/03			420A5
29/10/03	15/01/04	Concrete pavements (Evaluate aggregate interlock and steel dowels in concrete)	Hilton Interchange Off N3 concrete trial sections	421A5
17/01/04	17/03/04			422A5
02/04/04	26/05/04			423A5
28/05/04	28/06/04	Concrete pavements (Determine remaining life of continuously reinforced concrete inlays)	Pietermaritzburg N3/3, km 16.5 slow lane north bound	424A5

### 3. FOCUS AREA ACTIVITIES

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The focus area activities provide information on the specific activities performed under each of the two strategic periods for which information is available at the time of compiling this report. The information is summarised into five tables. The first four tables cover focus areas as designated in the strategic objectives, while the last table covers an area that is not a specific focus areas, but underpins the research in the focus areas by providing supportive information regarding various aspects of the HVS performance. As there is some overlap between the focus areas for the two periods concerned, the information for similar focus areas is provided in the same table, with an indication of the strategic period for which the focus area was relevant. The five tables provide:

- Information on the focus area concerned;
- A short description of the work done;
- Information on the objectives of the project, and
- A summary of the main results.

**Table 3: Focus area activities (Low Volume Roads).**

Focus Area	Description	Objectives	Results
<p>Low volume roads (Periods 1995 to 2000 and 2000 to 2003)</p>	<p>Two LVR options investigated:                      1. Surface treatment of existing gravel road near Bultfontein.                      2. Imported natural gravel base with surface seal at Lamberts Bay.                      Testing included HVS and comprehensive laboratory testing.</p>	<ol style="list-style-type: none"> <li>1. Assess structural bearing capacity of light pavement structures compared to estimated bearing capacity in TRH4.</li> <li>2. Assess appropriateness of HVS testing on these pavements – structural vs. functional performance.</li> <li>3. Establish minimum strength requirements for marginal base layer materials.</li> </ol>	<ol style="list-style-type: none"> <li>1. Large difference between structural performance under HVS and functional performance under real-life conditions.</li> <li>2. Structural capacity of LVR design seems adequate from early results.</li> </ol>

**Table 4: Focus area activities (Labour intensive construction).**

Focus Area	Description	Objectives	Results
<p>Labour intensive construction (Periods 1995 to 2000 and 2000 to 2003)</p>	<p>Various LIC options for the construction of bases were evaluated:</p> <ol style="list-style-type: none"> <li>1. Clinker ash.</li> <li>2. Waterbound macadam.</li> <li>3. Composite macadam.</li> <li>4. Emulsion treated gravel.</li> <li>5. Emulsion treated clinker ash.</li> <li>6. Conventionally constructed crushed stone base control section.</li> </ol> <p>Testing included construction monitoring HVS testing and comprehensive laboratory testing.</p>	<ol style="list-style-type: none"> <li>1. Evaluate outstanding process in terms of ease of construction and quality control.</li> <li>2. Test bearing capacity of various options relative to each other.</li> <li>3. Cost/benefit evaluation.</li> </ol>	<ol style="list-style-type: none"> <li>1. None of the LIC options performed as well as CSB control section.</li> <li>2. Highest bearing capacity: ETB gravel and high density waterbound macadam.</li> <li>3. Intermediate bearing capacity: Below density specification waterbound macadam and composite macadam.</li> <li>4. Low bearing capacity: Clinker ash and emulsion treated clinker ash.</li> <li>5. Cost/benefit results calibrated for effect of density.</li> <li>6. Mechanistic – empirical guideline document for waterbound macadam material.</li> </ol>

**Table 5: Focus area activities (DISR with foam and emulsion).**

<b>Focus Area</b>	<b>Description</b>	<b>Objectives</b>	<b>Results</b>
DISR with foam and emulsion (Periods 1995 to 2000 and 2000 to 2003)	DISR construction technique applied to previously cement treated base in Gauteng and crushed stone base in Western Cape.  Treatment options: 1. Gauteng – foamed + emulsified bitumen. 2. Western Cape – foamed bitumen.	1. Establish appropriate material “strength” criteria resulting in a material classification system.  2. Determine mechanical properties and structural performance of stabilized construction materials.	1. An initial material classification system. 2. Calibration of an initial set of mechanistic empirical design models for foamed and emulsion treated material. 3. Site specific bearing capacity estimates. 4. A comprehensive set of engineering, mechanical and durability properties of specific materials investigated.

**Table 6: Focus area activities (Concrete pavement testing).**

<b>Focus Area</b>	<b>Description</b>	<b>Objectives</b>	<b>Results</b>
Concrete pavement testing (Hilton)	Apply uni-directional traffic across joints in concrete pavement trial sections.	1. Evaluate aggregate interlock load transfer efficiency and erosion of subbase 2. Evaluate steel dowel and aggregate interlock load transfer efficiency and erosion of subbase 3. Evaluate performance of dolerite and quartzite aggregates	1. Environmental conditions had a major effect on the concrete slab behaviour. 2. Severe erosion occurred during trafficking combined with moisture tests. 3. Moisture Accelerated Distress caused formation of a void underneath the slabs, which affected the pavement behaviour.
Concrete pavement testing (Hilton)	Apply HVS loading to a concrete inlay on the N3 to determine remaining life of a conventionally trafficked section.	1. Determine the remaining life of a concrete inlay to estimate need for rehabilitation.	1. The concrete inlay still has a substantial remaining life – no discernable damage was done to the section during the test that was equal to approximately 6 years of typical traffic for the section.

**Table 7: Focus area activities (Comparative testing of equipment).**

Focus Area	Description	Objectives	Results
Comparative testing of equipment	Equipment testing involved: 1. Dynamic testing 2. Comparative tests	1. Evaluate forced dynamic loading of HVS MK IV+. 2. Compare results from HVS MK III to MK IV+.	1. Differences in the induced pavement response under the two HVS machines are small and of the magnitude of the variation normally associated with HVS testing 2. Differences in pavement response may be attributed to differences in load application frequency, actual applied load, tyre contact stress distributions. 3. Increased productivity of the HVS Mk IV+ compared to the HVS Mk III could result in a 50% increase in productivity.

## 4. IMPACT OF HVS TESTING

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In this section the impact of the various HVS projects are summarised in terms of the following five impact areas:

- Design;
- Materials;
- Construction;
- Maintenance, and
- Guidelines.

The objective of this summary is to provide a more generic indication of the area in which the impact of the outputs of a specific focus area can be located. The benefit of this summary is that it indicates the direct practical impact that the HVS tests have on road infrastructure provision, maintenance and management.

The information is summarised in three tables, one for each of the focus areas in which the impacts are identified.

**Table 8: Summary of HVS testing impacts (Low volume roads).**

Study	Design	Materials	Construction	Maintenance	Guidelines	Reports
Low volume roads	In process.	In process.	In process.			TR-96/049
						CR-96/086
						CR-96/087
						CR-97/076
						CR-98/013
						CR-2004/01

**Table 9: Summary of HVS testing impacts (Labour intensive construction).**

Study	Design	Materials	Construction	Maintenance	Guidelines	Reports
Labour intensive construction	<ol style="list-style-type: none"> <li>1. Mechanistic – empirical design methods for waterbound macadam including effect of density.</li> <li>2. Mechanistic – empirical design models for all other materials.</li> </ol>	<ol style="list-style-type: none"> <li>1. Rating of LIC materials.</li> <li>2. Material properties for LIC options:                             <ol style="list-style-type: none"> <li>a) Engineering</li> <li>b) Mechanical</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Importance of tight control during construction.</li> <li>2. Effect of density on performance (waterbound macadam).</li> </ol>		Waterbound macadam application guidelines	TR-96/048
						TR-97/071
						CR-97/004
						CR-97/082
						CR-97/082
						CR-97/048
						CR-97/074
						CR-98/071
						Presentation
						Presentation
						CR-99/011
						CR-99/012
						CR-99/038
						CR-99/065
						CR-2000/47
CR-2002/81						
DP-2000/05						

**Table 10: Summary of HVS testing impacts (DISR with foam and emulsion).**

Study	Design	Materials	Construction	Maintenance	Guidelines	Reports
DISR with foam and emulsion	<ol style="list-style-type: none"> <li>1. Mechanistic – empirical design for EBTM.</li> <li>2. Mechanistic – empirical design for FBTM</li> </ol>	<ol style="list-style-type: none"> <li>1. Material classification.</li> <li>2. Appropriate selection criteria.</li> </ol>		DISR applied on rehabilitation projects	TG2	CR-2001/06
						TN-2001/01
						CR-2001/05
						CR-2001/14
						CR-2001/24
						LR-
						2000/1/JR3879
						CR-2001/32
						CR-2001/69
						CR-2001/81
						CR-2002/23
						TN-2001/01
						CR-2001/76
						CR-2001/77
						CR-2001/53
						CR-2002/09
CR-2002/22						
DRAFT CR-						
2003/44						
CR-2003/22						
CR-2003/23						
CR-2003/60						
CR-2004/12						

**NOTE:** A detailed list of all HVS-related publications, including STEP projects is listed below.

## 5. HVS-RELATED PUBLICATIONS

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The tables in this section contain a summary of the reports that were written on the Gautrans APT programme activities. It includes all the reports, from the Level 1 reports on specific tests up the strategic plan for the programme. It is divided into five tables, again with the focus areas as starting point for the first three tables. The last two tables provide information on reports that are not necessarily linked to the strategic objectives of Gautrans, as their specific focus areas are either STEP investments (CSIR parliamentary grant funding) or related HVS reports that cover various issues that are investigated to support the strategy.

In each of the tables the following information is provided:

- Title;
- Report number;
- Authors, and
- Date of issue.

The reports summarised are available through the Gautrans HVS website ([www.gautrans-hvs.co.za](http://www.gautrans-hvs.co.za)).

**Table 11: Reports for Focus area - Low volume roads.**

<b>Title</b>	<b>Report No.</b>	<b>Authors</b>	<b>Date of issue</b>
Progress report for HVS testing on Road S702	TR-96/049	WJ Steyn	1996
HVS4 impact study report	CR-96/086	E Kleyn	1996
HVS4 impact study - executive summary	CR-96/087	E Kleyn	1996
Level 1 data analysis for HVS tests on road S702	CR-97/076	WJ Steyn	1998
S702 level 2 analysis	CR-98/013	WJ Steyn	1998
1 <sup>st</sup> Level Analysis Report: LVR Western Cape	CR-2004/01	HL Theyse	2004

**Table 12: Reports for Focus area - Labour intensive construction.**

<b>Title</b>	<b>Report No.</b>	<b>Authors</b>	<b>Date of issue</b>
Planning report for HVS testing on Road 2388	TR-96/048	WJ Steyn	1997
The Construction of the HVS experimental section on Road 2388 near Cullinan	TR-97/071	HL Theyse	1998
Permanent deformation and in-depth deflection records for selected HVS tests	CR-97/004	HL Theyse	1999
Laboratory report, MMLS/Road 2388	CR-97/082	C Semmelink	1998
Laboratory report, G1/Road 2388	CR-97/082	C Semmelink	1998
P157/1 report	CR-97/048	F Jooste	1997
Overview of the strategy for the HVS testing of LIC bases on Road 2388 near Cullinan	CR-97/074	C Rust	1998
Progress report on performance of the asphalt surfacing on Road 2388	CR-98/071	CM MacCarron JL du Plessis EJ van Assen	1998
Permanent deformation model evaluation (Gustav Rohde)	Presentation	HL Theyse	1998
Asphalt testing on Road 2388	Presentation	B Verhaeghe	1999
1 <sup>st</sup> level analysis report: HVS testing of the experimental section on Road 2388 near Cullinan	CR-99/011	W Mancotywa	2001
Contact stresses of the 11.00 - R22.5 pneumatic radial tyres on the Gautrans Heavy Vehicle Simulator (HVS) measured with the Vehicle Road Surface Pressure Transducer Array (VRSPTA) system	CR-99/012	M de Beer	2000
Laboratory design models for materials suited to labour-intensive construction	CR-99/038	HL Theyse	2000
First level report for HVS testing on the N1/28 near Louis Trichardt	CR-99/065	HL Theyse	2000
1 <sup>st</sup> level report for HVS test sections (407A4/407A4A & 408A4) on Road 2388 near Cullinan	CR-2000/47	W Mancotywa HL Theyse	2000
Waterbound Macadam Guidelines	DP-2000/05	HL Theyse	2000
1 <sup>st</sup> Level Analysis Report: Comparative Testing of HVS Mk IV+ and HVS Mk III on Road D2388 near Cullinan	CR-2002/81	B Morton HL Theyse	2003

**Table 13: Reports for Focus area - Deep in situ recycling with foam and emulsion.**

<b>Title</b>	<b>Report No.</b>	<b>Authors</b>	<b>Date of issue</b>
The foaming characteristics of selected bitumens	CR-2001/06	WJ Steyn	2001
Notes on Tyre, Pavement and Ambient Temperatures on HVS Test Section 411A4	TN-2001/01	WJ Steyn	2001
First level data analysis of HVS tests on foam treated gravel and emulsion treated gravel on road P243-1: 80 kN and 100 kN test sections	CR-2001/05	WJ Steyn	2001
Strength of foamed bitumen-cement and emulsion-cement stabilised ferricrete base material from HVS test site at Heidelberg as measured with K-mould	CR-2001/14	CJ Semmelink PB Botha	2001
Strength of cement stabilised ferricrete material from HVS test site as measured with K-mould	CR-2001/24	CJ Semmelink PB Botha	2001
Interim Guidelines on the Design and Use of Foamed Asphalt Bases and Subbases: Phase I	Issued as a draft, not finalized.	FM Long	2002
Evaluation of treated ferricrete material on the new HVS site in the initial stage	LR-2000/1/JR3879	CJ Semmelink PB Botha	2001
Dynamic laboratory test programme, Road 243/1 Phase I: Field mix design (foamed asphalt/ETB)	CR-2001/32	FM Long	2002
Dynamic laboratory test programme, Road 243/1 Phase II: Optimised mix design (foamed asphalt/ETB)			
The influence of different cement and foamed bitumen contents on the compressive, tensile and flexural strength of Foam Treated Materials	CR-2001/69	S Robroch	2002
Durability aspects of the ferricrete from the HVS sections on Road P243/1	CR-2001/81	D Ventura	2002
Second level analysis of the HVS data from Road P243/1	CR-2002/23	FM Long HL Theyse	2002
Notes on tyre, pavement and ambient temperatures on HVS Test Section 411A4	TN-2001/01	WJ Steyn	2001
The development of structural design models for foamed bitumen treated pavement layers	CR-2001/76	F Long	2001
The influence of different cement and bituminous emulsion contents on the compressive, tensile and flexural strength of Emulsion Treated Materials	CR-2001/77	JJE Liebenberg	2002
1 <sup>st</sup> Level report, 2 <sup>nd</sup> phase Road 243/1	CR-2001/53	HL Theyse W Mancotywa	2003
The development of a pavement design catalogue for foamed bitumen treated bases.	CR-2002/09	F Long	Draft 2002
HVS operations : protocol for instrumentation, data collection and data storage - 2 <sup>nd</sup> draft	CR-2002/22	DJ Jones B Morton	2002
Interim Guidelines: The design and use of foamed bitumen treated material	Asphalt Academy document, TG2	F Long	2002
Phase I Emulsified-bitumen-treated material project: Inception report	Unpublished report	F Long	2003
Phase II Emulsified-bitumen-treated material project: Structural design model	DRAFT CR-2003/44	F Long	2003
Phase III Emulsified-bitumen-treated material project: Interim Guideline Document	DRAFT CR-2003/44	F Long	2003
The use of HVS depth deflection data to back-calculate typical subgrade resilient modulus values	CR-2003/22	HL Theyse	2003
1 <sup>st</sup> Level Analysis Report: HVS testing of the foamed bitumen treated crushed stone base on the slow lane of the southbound carriageway on the N7 near Cape Town	CR-2003/23	HL Theyse	2003
MMLS testing of the slow lane on TR11/1 (N7)		L Ebels	2003
1 <sup>st</sup> Level Analysis Report: HVS Testing of crushed stone base on the fast lane of the southbound carriageway of the N7 near Cape Town	CR-2003/60	HL Theyse	2004
2 <sup>nd</sup> Level Analysis of the HVS Data for the Southbound Carriageway of the N7 (TR11/1)	CR-2004/12	FM Long AC Brink	2004

**Table 14: CSIR STEP reports.**

<b>Title</b>	<b>Report No.</b>	<b>Authors</b>	<b>Date of issue</b>
HVS data base	STEP-TBG01	WBA Ringwood	2000
HVS database (Permanent MDD displacement module)	STEP-TIJ03/020	HL Theyse	2001
Subgrade Design Models	STEP-TIJ68	HL Theyse	2002
Training of HVS technician L Gamoo	STEP-TIJ77	HL Theyse C Fisher L Swele	2003
Cordless MDD feasibility study	STEP-TIN32	F Vogel	2002
Triaxial protocol	TR-2002/21	HL Theyse	2003

**Table 15: Reports on other HVS-related projects.**

<b>Title</b>	<b>Report No.</b>	<b>Authors</b>	<b>Date of issue</b>
The HVS Text Database (First draft)	I/PA/18/95	B Gass	1995
A Method for evaluating structures using the HVS and some considerations of the assumptions used	TC/19/75	PC Curtayne	1996
Prediction of pavement performance using HVS - Instron and Experimental Pavement structures	TC/18/75	CP Marais	1996
GAUTRANS HVS interim report for 95/96	TN-96/001	WJ Steyn	1996
Strategy for the Gautrans HVS	DP-96/007	FC Rust ES Sadzik EG Kleyn	1996
A HVS diagnostic system	TR-96/028	WBA Ringwood	1996
HVS data acquisition system manual	TR-97/030	B Gass	1997
Use of HVS test data for prediction of long term pavement performance pilot study	CR-97/086	FJ Jooste	1997
Gautrans heavy vehicle simulator operation	TR-98/029	S Kekwick	1998
HVS – an instrumentation manual for WES - draft	CR98/072	WJ Steyn W Du Preez C Coetzee	1998
Simulation of dynamic traffic loading for use in accelerated pavement testing (APT) – draft	DP-99/006	WJ Steyn M De Beer	1999
Bridging the gap between APT results and practice - draft	DP-99/007	EG Kleyn ES Sadzik FC Rust	1999
Permanent deformation and in-depth deflection records for selected HVS tests	TR-97/004	HL Theyse	1999
The development and commissioning of HVS05	TR-99/058	WJ Steyn	1999
Simulation of dynamic traffic loading for use in accelerated pavement testing (APT)	TR-99/057	WJ Steyn M De Beer W Du Preez	1999
Report of tour of duty to the USA: 14 October 1999 to 26 October 1999	TR-99/062	WJ Steyn	1999
Heavy vehicle simulator operation: FY99/00 onwards	TR-99/055	S Kekwick	1999
Presentations on invitation from the NRA by Transportek, CSIR	DP-053	HL Theyse M De Beer	2000
Evaluation of pavement response instrumentation	CR-2000/17	F Vogel WJ Steyn	2000
Intelligent sensors and improved signal conditioning	TR-2001/26	F Vogel	2001
Tire contact stress measurements with the Stress-In-Motion (SIM) Mk IV System for the Texas Transportation Institute (TTI). The Texas A&M University System, Texas, USA: [Part of TxDOT Project O-4361]	CR2002/82	M De Beer C Fisher	2002
Acceptance test results and report for HVS Mk IV+; Chassis number: T763532467203	CR2002/84	B Morton WJ Steyn JL du Plessis	2002
Initial investigation into development of accelerated pavement evaluation (APE) vehicle	TR-2003/09	WJ Steyn M De Beer	2002
Accelerated Pavement testing – Strategic Plan 2004 - 2007	--	L Sampson	2004

## 6. REFERENCES

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Sampson, L. 2004. **Accelerated Pavement testing – Strategic Plan 2004 – 2007.**  
Gauteng Department of Public Works, Transport and Roads, Pretoria.

**APPENDIX A: ORIGINAL WORK PROPOSAL**

COST ESTIMATE  
25 November 2003

Version 1

SUMMARY OF HVS TESTS DONE SINCE  
1995

**Contact persons**

Name	Affiliation	Telephone Nr	Facsimile Nr	E-mail address
Mr H L Theyse	Transportek	(012) 841-2269	(012) 841-2690	<a href="mailto:htheyse@csir.co.za">htheyse@csir.co.za</a>
Dr A C Brink	Transportek	(012) 841-2933	(012) 841-2690	<a href="mailto:abrink@csir.co.za">abrink@csir.co.za</a>
Mr C Fisher	Transportek	(012) 841-3960	(012) 841-2690	<a href="mailto:cfisher@csir.co.za">cfisher@csir.co.za</a>

The content of this document is confidential

**1. BACKGROUND**

The need to compile a complete database of all Heavy Vehicle Simulator (HVS) tests that have been conducted in South Africa, since 1995, has been identified by the HVS Steering Committee.

**2. PROBLEM STATEMENT AND MOTIVATION**

HVS testing is a time-consuming and costly operation. It is therefore necessary that a system be in place by which relevant information concerning these tests can be located without difficulty. Furthermore, the objectives of the various studies, the impact of the results, as well as the reports or papers that were generated for each test setup, need to be summarised.

**3. METHODOLOGY**

Although HVS testing has been conducted in South Africa since the late 1970's, it has been decided that the initial summary will only include HVS tests that were conducted since the beginning of 1995.

The summary of HVS testing conducted since 1995 will be acquired by searching current records and personal interviews. The summary will be structured according to the system used by the Pavement Research Centre for the CALAPT project.

**4. PROJECT DELIVERABLES**

The project deliverables will be in the form of a two tables with the following components:

- A table summarising the history of tests that were conducted, indicating start and end dates, the subject of the test programme, and the location of the test.
- A table summarising the objectives, results obtained and reports/papers generated through each test setup.

## 5. PROJECT COST

The cost estimate for the project is set out in the table below.

Project component	Resource	Rate	Units	Cost		Sub-totals
				Time	Running	
Collect historical data	ACB	R 475.00	8	3800		5128.00
	CF	R 332.00	4	1328		
Compile summary report of HVS testing since 1995	ACB	R 475.00	8	3800		3800.00
<b>Sub-total</b>						8928.00
<b>VAT (14%)</b>						1249.92
<b>Total</b>						10177.92

## 6. PROJECT SCHEDULE

The draft summary tables will be available for the Steering Committee meeting on 27 November 2003. These tables will be finalised after comments from the steering committee.

**PROJECT Approval:**

I ..... hereby accept the content of the proposal

**SUMMARY OF HVS TESTS DONE SINCE 1995**

and the conditions of contract on behalf of  
Gautrans (CLIENT)

Signed at ..... on this ..... day of ..... 2004.

.....

As witness:

- 1.
- 2.

I ..... hereby undertake on behalf of CSIR  
Transportek (CONTRACTOR) to complete the work set out in the proposal

**SUMMARY OF HVS TESTS DONE SINCE 1995**

under the conditions of contract.

Signed at ..... on this ..... day of ..... 2004.

.....

As witness:

- 1.
- 2.