

## **Terms of Reference**

### **Replacement/ upgradation of Web based Road Management System (RMS) application with RAMS along with data collection and engineering services.**

#### **1. INTRODUCTION & BACKGROUND**

- 1.1.** Himachal Pradesh has a road network of over 38,500 Km comprising of National Highways, State Highways, Major District Roads and Rural Roads. Himachal Pradesh Public Works Department (HPPWD) looks after the construction and maintenance of National Highways, State Highways, Major District Roads and Rural Roads.
- 1.2.** The responsibility for development and maintenance of National Highways in the state vests with MORTH. The HPPWD acts on an agency basis to undertake construction and maintenance works on this national network as required by the MORTH. However, the construction and maintenance of the State Highways, Major District Roads and Rural Roads are being looked after by the HPPWD. NHs, SHs and MDRs carry the bulk of the traffic and are the principal carrier of economic activities.
- 1.3.** Data on inventory of pavement, pavement condition (international roughness index using any NSV equipment and by visual inspection for Black Top Roads), road surface condition of Non-BT Roads, pavement strength using FWD, CD & Bridge Condition, traffic data for all roads is collected on standard forms, annually updated and entered into Road Management System (RMS) implemented under the World Bank funded HPSRP-I (2007-2017) to roll out annual maintenance plans and carry out periodic maintenance interventions on the priority roads.
- 1.4.** Using the RMS the HPPWD prepares an annual core road network condition report for the State roads. On the basis of an indicative budget, annual maintenance plans (AMPs) focusing on prioritizing periodic and rehabilitation works are prepared. The program is produced to a timeframe that meets the government's budgeting cycle and is revised in an iterative process as more accurate forecasts of the next FY budget become known.
- 1.5.** It has been observed that the RMS that has been implemented under HPSRP-I has not been used effectively by the HPPWD till date mainly due to the software having become obsolete and non-deployment of dedicated RMS units by the HPPWD. The intended rationalization of decision making in planning, programming, funding, procurement and in the allocation of resources in the road sector to make the best use of public funds and preserving the road networks at an acceptable level of serviceability is not being met due to the under performance of the RMS being used. The proposed project is expected to:
  - 1.5.1** Perform road network condition, strength, composition and traffic surveys;
  - 1.5.2** Migrate any available network condition data available in electronic form to the RAMS;
  - 1.5.3** Collection and digitization of different data as mentioned in scope of work document;
  - 1.5.4** identify the needs for road widening (based on traffic growth prediction), pavement strengthening, bridges, and maintenance using the RAMS;
  - 1.5.5** prioritize these needs using prioritization criteria, based on economic and other factors; and
  - 1.5.6** prepare a multiyear rolling program for network improvement and an Annual Maintenance Plan (AMP) each year containing the identified needs based on the budget allocation. All the available funds will be integrated to implement these plans. The RAMS is envisaged as a system which will eventually serve all levels in HPPWD, in planning and managing the State roads network (SRM) comprising of State Highways, MDRs and potential MDRs. The RAMS shall be user-friendly and adaptable enough to produce reliable outputs with an appropriate level of data inputs and with capabilities of increasing accuracy in outputs with

better data. The core of the system will be a Road Asset Management System (RAMS) around which several applications will be developed /configured to address the various requirements of road planning, management, and monitoring. The proposed RAMS should have a capability to integrate with other existing systems of HPPWD to increase the efficiency and avoid duplicate data repositories.

## 2. GOAL AND OBJECTIVES

The assignment has the following broad objectives:

- 2.1. Conduct comprehensive As-is assessment and gap analysis of the existing RMS and maintenance management practices to develop the strategic Asset Management Strategy roadmap and build scope for an upgraded RAMS for Himachal Pradesh
- 2.2. Provide and implement a COTS (Custom of the Shelf) Road Asset Management System (RAMS)
- 2.3. Deriving from the earlier As-is assessment and Gap analysis, customize the provided RAMS to suit the needs of HPRIDC and HPPWD.
- 2.4. Closely work with HPRIDC/ HPPWD to ensure all objectives of the data collection process and RAMS is achieved.
- 2.5. Improvement in adopting Data formats and Road Information System
- 2.6. Conduct complete Road Network Survey of the entire 30,000 km (approximate) State Road Network (SRN) mandated under the jurisdiction of restructured HPRIDCL/HPPWD.
- 2.7. Development and adoption of planning tools and asset management plan
- 2.8. Transfer of skills to HPRIDC/ HPPWD staff
- 2.9. Draft Asset Management Strategy for HPRIDC/ HPPWD
- 2.10. Maintenance support and Results monitoring

## 3. DETAILED SCOPE OF WORK

The service provider/Consultant will undertake the following tasks:

- a) **Conduct comprehensive As-is assessment and gap analysis to develop Asset Management Strategy and plan and build scope for an upgraded RAMS for Himachal Pradesh. The analysis should cover the following:**
  - i. General as-is assessment covering – Review of asset management related policies, Organization set up, Human Resource adequacy, Training needs, IT Policies/ initiatives and general e-governance practice in Himachal Pradesh.
  - ii. Assessment of IT infrastructure relevant to smooth functioning of RAMS.
  - iii. Review Best practices related to RAMS in India and Globally covering technical, management and institutional aspects. Undertake Gap analysis to bridge the needs of Himachal Pradesh's RAMS environment with global best practices.
  - iv. Undertake comprehensive analysis of previously developed RMS covering all modules, institutional sustainability measures and technical robustness. Develop detailed scope of the new RAMS incorporating old functionalities and data, wherever deemed relevant.
- b) **Develop the proposed RAMS system, deriving from the earlier As-is assessment and Gap analysis/needs assessment/provide and implement a COTS (Custom of the Shelf) Road Asset Management System (RAMS) with the following minimum functionalities / functional modules in the solution:**

- i. **System Administration and Security**  
System administration and security module should work as command and control unit of all other modules of RAMS application. This module may include: (a) User Management; (b) Password Management; (c) Role Management; (d) System Access rules and rights.
- ii. **Road Information System (RIS)**  
RIS module shall have facility to manage the road network like road creation on GIS platform, edit attribute and add and modify GIS alignment of road. In addition to road management the RIS module shall have functionalities to add, edit, delete road assets data like carriageway, pavement composition, pavement condition, road roughness etc.
- iii. **Bridge Information System (BIS)**  
Bridge Information System (BIS) module shall comprise of functions such as bridge registration and recording inventory of structures such as bridges, culverts, flyovers, RoBs, RuBs, etc. and their condition. Further BIS shall also allow storage of multi-media content and retrieval. This module will also comprise of parameters required for overall condition rating of bridge assets.
- iv. **Traffic Information System (TIS)**  
Traffic Information System (TIS) module shall comprise of functions such as traffic station creation, traffic volume count data validation, calculation of annual average daily traffic (AADT) and Million Standard Axle (MSA). Further TIS shall also allow assigning traffic data into road network.
- v. **Right of Way Feature Information System (RoWFIS)**  
The RoWIS supports the following core right-of-way business areas of appraisal (land valuation), acquisition, relocation, and property management for the Ministry or Road Authority. An integrated Right-of-Way Management System (RoWIS) primary functions must include the following capabilities:
  - Manage transportation project information relevant to the right-of-way (land) acquisition process;
  - Manage information on individual parcels that are candidates for acquisition
  - Support all aspects of the right-of-way acquisition lifecycle, including appraisal (land valuation), negotiation, and relocation (RAP);
  - Support land ownership management activities, including tracking of land parcels cataloguing, gazetting of land parcels, lease/rental for advertising or utilities, etc.
  - Capture the appraisal (land valuation), the review appraisal, and the finding of just compensation within the system
  - Support residential and business relocation services, including either calculations of relocation eligibility within the system or linkages to external tools/calculators;

Manage and track utility/facilities relocations, including managing the details of required agreements with utilities. This includes managing resettlement action plans (RAPs), community (affected persons) consultations, social impacts management, etc.

- vi. **Accident and Road Safety Information System (ARSIS)**  
Accident and Road Safety Information System (ARSIS) module shall have facility to fetch the key road accident data from HP Road Accident Data Management System (RADMS) and IRAD being implemented through MoRTH. This module should be able to analyse accident data and generate black spot location. It should allow to input more detailed data on safety collected from inspection regarding accident prone locations, road safety hazards such as sharp curves, narrow bridges, deficient road geometry, lack of sight distance, poor designed junctions etc. and suggest standard engineering safety

countermeasures for a defect already stored as a reference. It should also help in monitoring and reporting Road safety outcomes against the various Road Safety engineering and enforcement interventions undertaken on corridor level.

- vii. **Pavement Management System (PMS)**  
The Pavement Management System (PMS) to have tools to process the data for use in HDM-4. The consultant will design operating procedure to perform strategic and programme analysis for maintenance, preservation and upgradation of the road network and for prioritization and optimization of works for different funding levels, using tools in HDM-4. The consultant will identify procedure to indicate the necessary funding required to maintain the network at a given service level and the consequences of various funding levels on the health of the network. Further, the procedure to predict the future asset condition and value, agency/user costs for maintenance/improvement/upgrading treatment alternatives for various funding scenarios and evaluate them using measurable economic and engineering parameters is to be decided in discussion with PWD during the project. Using these parameters, RAMS will have the facility to prioritise a list of candidate sections for PWD to further undertake detail project evaluation and allocation of resources from the budget. The system will be able to prepare a short term (1-2 year) program and a long term (5 year) plan - detailed and summarized based on road, division and state.
- viii. **Simplified Maintenance Programming Tool (SMPT)**  
The tools in SMPT module shall comprise/ of simple user-friendly web-based form for performing analyses for short-term/routine maintenance work. The software tool will assign the treatment, quantity and cost based on road condition. Further the application will have facility to generate detailed and summarized report based on road, division and state.
- ix. **WEB-Geographic Information System:**  
Web-GIS module shall have functionalities to overlay all the assets on comprehensive GIS platform. This module shall have simple user-friendly web-based interface that should help user to monitor their asset by generating various georeferenced map-based and tabular reports.
- x. **Fund Allocation and Contract Packaging:**  
The tools in the module shall comprise of simple user-friendly interface to allow package of road works based on fund allocated.
- xi. **Rural Accessibility Index Module:**  
The tool shall aid in measuring proportion of the rural population who live within 1-2 km of an all-season (supported by sample field verification). For this purpose, an open RAI Toolkit may be referred to (<https://github.com/developmentseed/rai-toolkit>). The data should be represented in Web-GIS maps and integrated in RAMS.
- xii. **Economic Corridor Information System:**  
The module shall help to identify centres for economic growth; major national / regional investment initiatives; land use and key agricultural commodities within the influence area of the transport corridor; logistics facilities (cold storage, warehouses, truck stops/freight terminals, etc.) in GIS. Corridors shall be identified through the modules based on their economic importance and map various parameters.
- xiii. **Green and Climate Resilient RoW Module:**  
The module shall help identify disaster prone sections (landslide/ landslip, flood) etc. along RoW in the field. The module shall enable mapping bioengineering solutions for

protecting landslide, vegetated dumping areas, etc. as well as PWD owned rehabilitated quarry sites, etc. The module shall also identify and map (georeferenced) resilience enhancing features (protection structures, bioengineering solutions, resized drainage structures, etc.) within the RoW. The process shall include verification of existing right-of-way (RoW) by obtaining relevant revenue records for about 30,000 km of the state core roads network.

The data shall be appropriately geo-referenced and integrated in Web-GIS and strip-charts.

#### 4. DETAIL GOALS AND OBJECTIVES

The goal of adopting the RAMS is to ensure that HPRIDC/ HPPWD are able to effectively plan and prioritize their capital and maintenance works on the road network as well as report on the condition using a computerised web-based RAMS suitable for operating on a GIS platform and make efficient use of the resources. This will, in turn, help to improve the quality and delivery of HPRIDC/ HPPWD services in the management of the road network. The RAMS will enhance the capabilities of the HPRIDC/ HPPWD by providing a source of readily accessible, relevant and valid information on the road system as well as improved support for decision-making by providing web-based analytical and visual (photos & video) tools. The RAMS should be compatible with installation in the State data centre (Web-based) or on the cloud to scale with the growing demand of road condition data.

**The structure of the database:**

- i. should contain such parameters that the RAMS can function with a set of default parameters at the beginning.
- ii. should have open options for incorporating further parameters if required, along with its analysis as a separate add-on module.
- iii. The operation of the road database and the evaluation tools should be easy and logical;
- iv. the RAMS outputs should be useful for decision makers.
- v. should be also highly configurable to be able to accept any other off-pavement assets data (in the future) and to be able to be configured to manage these off-pavement assets in conjunction with the roads.
- vi. have the option to create additional tables in the database for use as part of reporting and data parameters should be available. This flexibility helps to have one central enterprise level asset management system oppose to many small satellite systems.
- vii. the RAMS data codebase shall allow migration of data to planning tools, like HDM4/RED.

**The specific objectives of the RAMS procurement are to obtain:**

- viii. Modern, web-based asset management system ideal for situations where every engineer should collaborate to maintain Road Assets. **This should include off-line mobile apps to capture the visual inspection data and automatic report back to the web-based server.**
- ix. Replace/ upgrade the existing RMS with latest state of art an electronic internet-based like COTS or bespoke, etc. software/solution on Road Asset Management System (RAMS) for HPRIDC/ HPPWD; While the bidder is encouraged to propose fully bespoke solutions, the Purchaser recognizes that the offered solution may contain a mix of bespoke and COTS modules or parts. The buyer will retain the IPR for only those modules, sub-systems, or applications that have been custom-

developed for this project. All the standard IPR clauses will apply to only these bespoke parts of the offered solution.

- x. A 100% customizable framework to meet all the asset management requirements which should be capable of not less than HPRIDC/ HPPWD 50,000 lane Km of the road;
- xi. Central web application and web-enabled data architecture;
- xii. Store network asset inventory and condition data referencing to the chainage;
- xiii. Centralised data processing, storage and streaming of digital content such as videos, photos & drone data.
- xiv. Provide HPRIDC/ HPPWD staff the ability to “remotely” inspect roads with all of the relevant condition data by using video and GIS technology in the RAMS;
- xv. Model optimization which required to integrate/run the latest version of Highway Development & Management Model (HDM-4) methodology. Any non-HDM-4 model methodology should also be able to be incorporated into the system and model outputs from several models should be able to be compared and the decision on model selection to be taken accordingly.
- xvi. Any models that includes Cost constrained, Quantity constrained, NPV optimised etc., like those based on Heuristics and Fuzzy logic analysis techniques, to analyse future network condition under different budget optimisation scenarios and work plans should also be configurable in case desired. These models must be easily configurable and run on demand for a period of at least 30 years.
- xvii. Statistical Data, Graphical analysis and reporting of network conditions and condition trends. Interrogate planned works with the help of data and visuals.
- xviii. Show trends with multiple time series information;
- xix. Time series linear strips to show aggregated data with chainage;
- xx. Analyse road condition with videos (streaming from the centralised server);
- xxi. Analyse work programs and budget requirements at State/District/Zone level as well as facilitate central management and auditing of work plans;
- xxii. Model and analyse future network conditions under different budget optimisation scenarios;
- xxiii. User definable benefit/ranking indexes and modelling parameters;
- xxiv. Flexible user-defined selection algorithm;
- xxv. Prepare Annual maintenance Plans, Multiyear rolling maintenance program and annual updates for implementation in subsequent years on the System;
- xxvi. Project the future trends and show time series data;
- xxvii. Batch export of pre-defined reports;
- xxviii. Quick aggregation of FWPs for multiple networks;
- xxix. GIS mapping engine showing the treatments and assets including the videos, photos, statistical analysis of the assets on the network;
- xxx. The RAMS application needs to be installable and configurable in a data centre or in a cloud environment.
- xxxi. Smartphone (or tablet) applications for recording visual inspections along with photos;
- xxxii. Smartphone (or tablet) applications for validating “Annual Work Programs” in the field before finalising the program.
- xxxiii. Visual analysis and GIS aided video streaming tools to validate works program in the office.
- xxxiv. Flexibility to add off-pavement inspection and reporting modules on the proposed RAMS and inspecting Road-off pavement assets at a later stage as part of additional

modules/project, which supports offline/online and having seamless sync-to-server technology and also facilitate GPS enabled data.

- xxxv. Ability to link external systems via web-APIs
- xxxvi. Transfer skills and procedures to the concerned staff in HPRIDC/ HPPWD and training of trainers to sustain the use of the Modelling modules and RAMS;
- xxxvii. Unlimited number of users and unlimited concurrent user access and security with different user permissions to the application;
- xxxviii. Providing implementation, operation & maintenance support (intermittent) to HPRIDC/ HPPWD for 12 months after all mandatory testing and validations and user acceptance test. Response time of not more than 24 business hours and rectification time, not more than 72 business hours (depending on the severity of the issue). That will include troubleshooting, resolving problems faced by the HPRIDC/ HPPWD, minor modifications and refinements required in the system to improve its effectiveness based on the feedback information collected from its use and removing bugs from the Software.

**c) Deriving from the earlier As-is assessment and Gap analysis, customize the provided RAMS to suit the needs of HPRIDC and HPPWD.**

- i. Analytical tools and reports on asset condition
- ii. Supply of mobile application to capture asset condition data (pavement and off-pavement)
- iii. Custom workflows for information based on location and conditions rating from mobile applications

**d) Closely work with HPRIDC/ HPPWD to ensure all objectives of the data collection process and RAMS is achieved:**

The Consultant shall prepare an inception report detailing the methodology for completing the services. The report shall cover the following major aspects:

- i. Data collection: The Consultant/ Sub Consultant will carry out data collection using the trained manpower and survey equipment of HPPWD and outsource only limited manpower to monitor and assist data collection through the departmental key personnel and to provide equipment not available with the department. The cost of using the Clients equipment will be borne by the Client.
- ii. Plans to integrate/import existing data and data from NSV vehicle including photos/videos;
- iii. Detailed methodology to meet the requirements of this TOR finalized in consultation with the HPRIDC/ HPPWD officers; including scheduling of various sub-activities to be carried out for completion of various stages of the work; stating out clearly their approach & methodology to integrate data collected from NSV, data interpretation & analysis tools development in conjunction with the nominated technical consultant by HPRIDC/ HPPWD.
- iv. Task assignment and Manning Schedule;

The Consultant shall undertake a “needs analysis” through discussion with HPRIDC/ HPPWD officers and the nominated technical consultant at different levels. It should be ensured that this system is in line with the overall IT and MIS policy of the State and the department.

The Consultant shall assess the road referencing system currently in place in HPRIDC/ HPPWD. The Consultant shall, if needed, recommend improvement in the method of referencing roads to be adopted in the RAMS, to be agreed with the client. This should reflect

the practical limitations that would arise by trying to make major changes to the existing system. The consultant should also make recommendations in other types of inspections that the Client should undertake so that asset furniture can be incorporated into future modifications that may be required.

**e) Improvement in adopting Data formats and Road Information System**

The Consultant shall study existing data collection forms and suggest a simple format for Roads and improvement of formats for SHs, MDRs & NHs on the overall network. The Consultant may propose improvements to the data compatibility methods and their calibrations for different category of roads.

The Consultant shall implement the Road Management System (RAMS) through customisation and enter appropriate additional fields for data on the core network. This RAMS shall be linked to data management applications required to meet the needs of the other systems and the management requirements of the HPRIDC/ HPPWD.

The RAMS should be able to:

- Operate on computer systems and software compatible with the other systems.
  - Accepted international practices (e.g. common user interface, data import/export standards, “single-source of truth” data standards)
  - Have an inbuilt alert system to ensure updating of road and pavement condition data by every year and flag the year of data collection while analysing for each parameter.
  - Have a reliable but flexible security system for access and data processing;
  - Be web-based to ensure operability and data updating using the internet;
  - Be capable of checking data accuracy, inconsistencies, and the data falling beyond acceptable ranges;
  - Be able to export to Excel and/or PDF all the road network data stored on the RAMS, being able to export to Excel and/or PDF all the average road attributes for each kilometer of the network and being able to export to Excel and/or PDF all the average road attributes for each homogeneous road section.
  - Be designed so that it needs to have query engine to process millions of data with less processing time for querying the database and extracting information should be satisfactory;
  - Compatibility and linear referencing with multimedia (photos & videos) data;
  - Include a centralised database for all the different types of data.
  - Includes GIS component and show work plans, condition data and hot-spots such as high roughness areas;
  - The model can operate on respective modules and produce results.
- i) The RAMS data model shall be capable of handling data different spatial attributes ranging from point data (e.g. km stones) to continuous or interval data (e.g. roughness) and should handle overlapping sections. The system shall be designed around a proper location referencing system with enough flexibility to cater for changes to the system over time. It should also allow for the graphical representation and presentation of information and shall interface with a Geographic Information System (GIS) for mapping purposes.
- ii) The software modules shall be evaluated based on technical and functional requirements.
- iii) The Consultant should share the RAMS full documentation and should provide full training to HPRIDC/ HPPWD staff on the process using RAMS.
- iv) The Consultant shall establish and implement a RAMS through customisation of their COTS software or by developing one for unlimited Users. While the bidder is encouraged to propose fully bespoke solutions, the Purchaser recognizes that the offered solution may contain a mix of bespoke and COTS modules or parts. The buyer will retain the IP for only those modules, sub-systems, or applications that have been custom-developed for this



project. All the standard IP clauses will apply to only these bespoke parts of the offered solution

- v) The services will include updates, troubleshooting, resolving any problems faced by the Client. A technical document mentioning the details of any software updates/patches and the type and extent of changes conducted on the software must be clearly mentioned.
- vi) An online and printed version of documentation and training manuals will be provided on the list of RAMS features;

The Consultant will be responsible for the following and providing:

- Supply preferably open source software with IP right to be vested with the client, and licenses for the COTS software, as required.
  - Supply licenses for the COTs software, as required.
  - Provide Training to Core Group of users.
  - Acceptance Testing for both COTs/Open Source Solution.
  - Provide Support during Services.
  - Provide Support through AMC up to 5 years after completion of Services.
  - Configure the Software (COTs/Open Source).
  - Configuring mobile application with:
    - Visual Inspection forms (Pavement)
    - Inspection forms (Bridge Information System)
  - Design Reports/Forms/Tables.
  - Populating with Data (Data collected by Consultant or nominated and approved consultant).
  - Develop GIS enabled Components (if required).
  - Overall System Acceptance Testing.
  - Provide Implementation Support.
  - Prepare Documentation (e.g User Manual online and offline)
  - Train HPRIDC/ HPPWD Users.
- vii) The Consultant shall provide the features to enter the data into the customised Road Management System (RAMS) on the core network. The Consultant shall write small programmes/ modules for uploading the data directly to RAMS as part of the data collection process.

**f) Conduct Road Network Survey**

- i. Data on selected network will be collected over a two (2) years period on this project to facilitate system testing and to finalize the procedures for data collection and work out treatment methodologies based on analysis of multiple time series data. The RAMS inventory should cover all roads (State Road Network) in the state, about 30,000 km and existing bridges, drainage structures and landslide protection structures and bioengineering solutions (landslide protection structures and bioengineering solutions). The road network inventory shall be geo referenced, and the code-set shall migrate/interface to the HDM4 location referencing and distance/road segment length code-sets. List of State Road Network for RAMS inventory shall be finalised with the client.  
The pavement condition data collection could be limited to the state core roads network (5,000 km) paved district roads in the pilot/demonstration horticultural supply chain districts /division/zones identified for the logistics system and strategy study, with remaining paved roads condition data collection to be outsourced. In this respect the

RAMS upgradation consultant shall prepare TOR for the outsourcing. The Consultant is required to conduct 24/7 traffic volume count once a year on locations to be decided with the client on the selected network; Direction, day, time and hourly count of vehicle types. The client will finalize the traffic count locations with the consultant/ sub consultants who will deploy a team for collection of traffic data as per the relevant codal provisions once every year during the three (3) years consultancy services period. The consultant shall note that data collection shall be completed within two (2) years).

- ii. Data collection is to be carried out with realistic approach so that the data of a large network can be loaded to the database quickly to make the RAMS operational. It should have options open for adding more data items, if required, including interfacing with GPS/DGPS, laser-based pavement surface profiler, FWD, R-o-W video images etc. Provision of hand-held mobile/digital system (Mobile Application) to assist with visual inspections of the road assets and provision to automatically upload data to the RAMS will also be made. Detail of surveys and data collection methodology is explained in detail in separate section C "Data Collection Requirements" of Annexure 1.
- iii. Before initiating the work, the Consultant shall prepare "Data Collection Procedural Manual" and submit to HPPWD for approval. Data collection, preparation, correction, validation shall be performed only after approval of the manual by HPPWD. Data collection and compilation formats shall be submitted as part of the procedure manual for approval by HPPWD. The number of formats may vary in order to fill requirement of scope of work.
- iv. The Consultant is allowed to subcontract survey work to a third-party expert agency but overall responsibility of survey, data quality, timelines and service levels shall remain with the Consultant only. Before employing such sub- Consultant, the Consultant shall update HPRIDC/ HPPWD with the qualification and experience and obtain acceptance/approval for same. Data Collection Procedural Manual submitted by the Consultant and approved by HPPWD, shall strictly be followed by the Consultant and sub-contracted vendor.
- v. The Consultant shall provide the following documentation at the appropriate times during the data collection exercise.
  - a) Project Plan: providing the task level detail with milestones and deadlines.
  - b) Resource loading plan: to identify which resources shall be working at what timelines
  - c) Details of Road/section wise division of the work.
  - d) Weekly project report showing progress against plan, and corrective action if required. These reports shall be shared with HPRIDC/ HPPWD.
  - e) Any other documents deemed necessary for implementation, operation and maintenance of the overall system.
  - f) A process document detailing the modus operandi in accordance with accepted international standards.
  - g) The Consultant shall ensure upkeep and update of all documentation.

**g) Development and adoption of planning tools**

For the RAMS application, the Consultant should use a widely accepted economic evaluation model (HDM – 4) based on sound engineering and economic priority principles, capable of undertaking both strategic and project level analyses at the appropriate organisational levels. This task should be performed in coordination with the HPRIDC/ HPPWD.

The following subtasks need to be performed by the consultant:

- o Strategic budgeting analysis;

- Network level technical analyses;
- Multi-year road work's programming and optimization under budget constraints; and
- Projection of network condition under various budget scenarios

To display optimized multi-year rolling programs, the RAMS must include a multiyear programming module Annual works program which shall optimise the selection and timing of pavement works under different budget constraints to achieve various performance indicators. This needs to be configurable with the inputs from the nominated consultant from HPRIDC/ HPPWD. The works under these plans should be prioritised using rational criteria for investment decisions to maximise the benefits of investment. The optimisation shall be done using a heuristic approach using advanced modelling techniques. The Consultant will use suitable pavement performance models for predicting the future pavement condition, which can be refined over the years the output for such Future Works program over the short and medium term.

The Consultant should provide a predictive modelling module with the capability of forecasting up to 30 years, and show the module online with multiyear program and ability to change the treatments on engineering judgment with a table-audit capability.

The software shall display a year-wise optimized work program covering different budget categories and work classes, such as periodic renewals (based on detailed data collected), routine maintenance (based on norms to be developed using age of surface, type of road and overall condition index), emergency maintenance (based on norms), and special repairs based on the indicative budget provided by HPRIDC/ HPPWD. The user should be able to refine these programs to obtain the most appropriate program given logistical and other considerations.

The unconstrained budget requirements for multi-year rolling Annual work plans should then be prioritized into two-year rolling plans for both road improvement and periodic maintenance considering the budget forecasts from the government and other sources. The above plans would be indicative of funds requirements of HPRIDC/ HPPWD using their plan and non-plan budget from various sources.

The database used by the RAMS will allow for automatic sectioning, so that road sections are created using factors such as condition, inventory and traffic as the criteria. The sectioning process shall be interactive with the user being able to adjust the resulting sections.

The reporting format shall allow for the presentation of historical and forecast data in a graphical format. The Consultant will provide views such as:

- i. Strip Map View
- ii. HI-Low graphs
- iii. Scatter plot graphs
- iv. Video analysis
- v. Geospatial views
- vi. Road deterioration forecast view
- vii. Allow customizable factor to define new analytical views

It shall include, but not be limited to, network utilisation, traffic volume and loadings, annual vehicle-km of travel, annual ton-km of freight by vehicle class and /or road class.

**h) Transfer of skills to HPRIDC/ HPPWD staff**

A training needs analysis shall be undertaken by the Consultant that identifies skills gaps in all levels of professional staff in all aspects of maintenance planning (including the use of the various software packages and the knowledge to modify or improve the systems developed under the contract) to be provided under these services.

- i. A set of the training program shall be prepared, agreed with the client and delivered on all components of the RAMS developed under the project. The training program will utilise several techniques and tools to transfer skills, including workshops, field training and practical experience. Consultant may include training materials for the management on applications/utilization of RAMS data for high-level decision-making – prioritization, institutional and sustainability measures, with real-life regional/global case studies.
- ii. The Consultant shall prepare or otherwise provide all operational and training materials, which will be the property of the HPRIDC/ HPPWD, for delivery of the program.
- iii. The following is an indicative list of training requirements.

**Table 1  
Tentative minimum Training Requirements**

<b>Indicative Training Programme</b>	<b>Duration of Training</b>	<b>No. of Batches</b>	<b>No. of Trainee in each batch</b>	<b>Type of Trainee</b>
Mandi Zone	4 Days	4	40 to 50	<u>Day 1:</u> Class Room Training, Data Acquisition for inventory and Road /Bridge condition survey with modern state of the art equipments like ROMDAS, Laser Profiler, Axle Weigh Pads, GPS/GIS Referencing, FWD, NDT tests etc. and through Mobile App etc. <u>Day 2:</u> Practical- On Site training for data acquisition with above survey equipments/ Mobile App operations/hands on training. <u>Day 3:</u> Class Room Lecture and Demonstration for Data Analysis through RAMS application for rolling out annual maintenance/upgradation plans to the dedicated RAMS key personnel deployed at RAMS Cell at the zonal office. <u>Day 4:</u> Assignments of tasks to the dedicated RAMS personal, evaluation of performance and clarifications etc.
Shimla Zone				As Above
Hamirpur Zone				As Above
Kangra Zone				As Above

The Consultant shall bear all cost of organising the training for on-the-job training, and should be clearly detailed in its financial proposal.

**i) Draft Asset Management Strategy for HPRIDC/ HPPWD:**

It is recommended that the asset management strategy be developed considering the following key elements to ensure it achieve the desired policy outcomes and effective corporate governance. Following strategies to implement the policy intent may also be considered:

- Use RAMS to Monitor asset performance using measurable and established parameters
- Collect periodic and regular field data with established methods using state-of-the-art technologies that provide reliable information for technical evaluation and decision making
- Use RAMS as universal database to store and disseminate information on assets
- Identify suitable maintenance and rehabilitation strategy using RAMS and prepare “*asset management plan*” – “*maintenance and investment plans*” by *interfacing with HDM4/RED* - every year with a long-term vision to preserve assets.
- Allocate funds using economic and social rationale for overall betterment of network performance
- Undertake regular preventive and emergency maintenance of assets with long-term contracts supported by independent regular inspection and monitoring.
- Adopt centralised institutional framework, dedicated funding, improved process monitoring and regulatory mechanism to support activities related to asset management. The Asset management strategy should clearly indicate the set-up and standard operating procedures of host unit within HPRIDC to ensure sustainable operation of the system.
- Generating short, medium and long-term maintenance and investment plan
- RAMS Administration Cell, including identifying/establishing the host unit, structure of the unit (duties, organizational structure and human resources), transition arrangement (considering outsourcing the admiration of the RAMS for the initial three years, whilst building the in house capacity through secondment and on the job-training.

**j) Ongoing Support**

For a period of 5 years after the initial assignment of 2 years, the Consultant shall arrange for approximately 1 month of one or more technical specialists (may not be key persons) to assist with the ongoing application of the system. The Consultant shall provide implementation and maintenance support to HPRIDC/ HPPWD in using the proposed system. That will include troubleshooting, resolving any problems faced by the HPRIDC/ HPPWD insofar as it relates to the RAMS application. The Consultant will also conduct a refresher training of the staff as is reasonably necessary. Several trainings & locations shall be mutually agreed during the currency of services. The timing and duration of the visit shall be discussed and agreed with the Client. The Consultant shall submit an annual Report comprising of the performance of RAMS, Training aspects etc. during this support period. include the requirements to set-up the host unit within HPRIDC to ensure sustainable operation of the system. If HPRIDC considers outsourcing the RAMS operation services for 3 to 5 years, the consultant shall develop ToR for the maintenance assignment.

**k) Manuals, Technical Guidelines, and Completion Report**

The Consultant shall provide comprehensive user manuals, in online and offline versions. Technical guidelines for the developed systems (software), generation of road condition and other reports, and performing various analyses using the RAMS. The Consultant shall provide soft copies of all the manuals, technical guidelines and other reports. On completion of the services the Consultant will provide a completion report including the lessons learnt further work, and institutional and business procedure changes that may be required to enhance the use of the RAMS further and sustain its use.

### 1) **Result Monitoring**

The Consultant/ Sub Consultant shall assess & identify performance parameters of the current maintenance system; establish baseline performance indicators, as well as in agreement with the Client, set after-project targets after the implementation of the new RAMS to measure improvements.

## 5. **SOFTWARE INPUTS AND METHODOLOGY**

- 5.1. The total duration of software replacement/ upgradation /customization/implementation is 9 months. The Consultant is free to provide his own mix of key persons to take care of the skill mix required and detail them out in his manning and work schedules. Skills which may be required for effective delivery of services as may be foreseen by the consultants shall be provided either as part of support person skills. The qualifications of the key staffs should be attached as part of the bid submission attached. Software implementation support will extend for 1 year after the 3 year project.
- 5.2. Introduction of the RAMS must recognise the capacity of HPRIDC/ HPPWD to implement the various components sustainably. The system design should be such that it can operate reliably both with a limited and a more expanded amount of data up to minimum 10 TB. On completion of the project this should be scalable provided at an additional cost for which additional hard ware will be provided by HPPWD. At the early stage of the project, the Consultant would be expected to recommend “a vision” of the system, i.e. an overall RAMS “system architecture” and an implementation plan for thoroughly testing the pilot system in selected offices preferably Head Office and zonal offices. before subsequent introduction to all Divisions.
- 5.3. Development of indicators for the assessment of the performance and impacts of the RAMS to enable the HPRIDC/ HPPWD to benchmark themselves in terms of timely and accurate reporting, data updating, improved network conditions and executing within budgets and time.
- 5.4. The Consultant will be expected to work collaboratively with staff at Head Office and Zonal levels. The Consultant shall conduct three workshops with wide participation of HPRIDC/ HPPWD professionals to share their views and goals for the GIS-based RAMS and thereby help ensure the effective usage and sustainability of the RAMS.

## 6. **FACILITIES AND SERVICES TO BE PROVIDED BY THE CLIENT**

**Server:** The client will assess the pricing of the cloud hosting, where the Consultant will supply all hardware, operating system and database licenses and backup services. Should the client elect to host the application in their own data centre, the client will provide the communication infrastructure, server, operating systems, backup services and data storage facilities.

**Smart Phones and Tablets:** Smartphones and tablets for the field staff are to be provided by the client;

**Information:** It is expected that **HPRIDC/ HPPWD**, both at HQ and at lower levels, will provide all-ready and available information as requested by the Consultant. The Consultant will be responsible for any translation of documents and processing of all data. The **HPRIDC/ HPPWD** shall provide available annual updates of inventory, condition and traffic data within a timeframe and format to be agreed with the Consultant for cross-checking.

## 7. **CONSULTANT DELIVERABLE / PAYMENT SCHEDULE**

The Consultant will be paid fee as a percentage of the contract value as per the schedule given below in Table 2 basing on satisfactory completion and approval of the deliverable items by the client HPRIDC.

**Table 2**  
**Consultant Deliverable / Payment Schedule**

<b>Sr. No.</b>	<b>Item</b>	<b>No. of Copies</b>	<b>Due date (Months from start)</b>	<b>Payment (Percentage of Contract Price)</b>
1.	Inception Report	5	T+1	5
2.	Need analysis and overall system architecture Draft Report.	5	T+1.5	-
3.	Need analysis and overall system architecture Final Report.	5	T+2	5
4.	Develop, customise & install RAMS system include hosting the application at State Data Centre and transfer of IP rights etc.	5 (User Manuals, SoPs etc.)	T+3	-
5.	Configuring mobile application with Visual Inspection forms (Pavement) and Inspection forms Bridge Information System include hand holding training at PIU office.	5 (User Manuals, SoPs etc.)	T+4	-
6.	Data Acquisition for inventory survey of roads with latest state as the art survey equipments for Kangra and Mandi Zones.	5	T+6	10
7.	Data Acquisition for inventory survey of roads with latest state of the art survey equipments for Shimla and Hamirpur Zones.	5	T+8	10
8.	Data Acquisition on road condition with latest state of the art survey equipments for 5,000 Kms.	5	T+10	10

<b>Sr. No.</b>	<b>Item</b>	<b>No. of Copies</b>	<b>Due date (Months from start)</b>	<b>Payment (Percentage of Contract Price)</b>
9.	Compliance testing begin with submission of System Design Document (SDD) alongwith operation manual.	5	T+10	-
10.	Acceptance on demonstration of the system with 1 <sup>st</sup> year data collection.	5	T+11	5
11.	Data Collection Manual Draft Report.	5	T+11	-
12.	Data Collection Manual Final Report.	5		-
13.	Economic evaluation Model PMS, RAMS, and RWFMS-Compliance testing begin with submission of System Design Document (SDD) alongwith operation manual.	5	T+12	-
14.	Acceptance on demonstration of the system with 1 <sup>st</sup> year data as complete.	5	T+12	5
15.	Annual Road Condition and Traffic Report (For 1 <sup>st</sup> and 2 <sup>nd</sup> year) - Draft Report.	10	T+10 & T+20	-
16.	Annual Road Condition and Traffic Report (For 1 <sup>st</sup> and 2 <sup>nd</sup> year) - Final Report.	10	T+10 & T+20	-
17.	Rolling two year Maintenance Plan (1 <sup>st</sup> and 2 <sup>nd</sup> year) Draft Report.	10	T+11 & T+22	10
18.	Rolling two year Maintenance Plan (1 <sup>st</sup> and 2 <sup>nd</sup> year) Final Report.	10	T+11 & T+22	10
19.	Training needs assessment report-Draft Report	5	T+12 (onwards)	-
20.	Training needs assessment	5	T+12	-



<b>Sr. No.</b>	<b>Item</b>	<b>No. of Copies</b>	<b>Due date (Months from start)</b>	<b>Payment (Percentage of Contract Price)</b>
	report-Final Report			
21.	RAMS and TIS user manuals-Draft Report	5	T+17	5
22.	RAMS and TIS user manuals-Final Report	5	T+18	5
23.	Various training events	(To be tabulated by the Consultant with client approval)	T+12 (onwards)	
24.	RAMS “Conceptual design” workshop (Two Numbers-One for Mandi and Kangra Zone and another for Shimla and Hamirpur Zone).		T+18	
25.	Acceptance of Data, Analysis Tool and accuracy thereof after rectification of errors/variations if any in the final form and Handing over of Assets to Client and other training manuals to be identified.	10	T+23	10
26.	Annual Performance Report at the end of 2 <sup>nd</sup> Year (24 month).	10	T+24	10

After 24<sup>th</sup> month deliverable, the consultant will provide maintenance support for 5 years. Final 24<sup>th</sup> month (Sl. No. 26) payment shall be released against a Bank Guarantee (BG) amounting to 10% of contract price pledged in favour of the client HPRIDC for the entire Maintenance Support Period (5 years) which Shall be released on pro-rata basis (2% per annum) after each year of maintenance support period.

#### **8. KEY STAFF REQUIREMENT, QUALIFICATION, AND EXPERIENCE**

The Consultant is expected to designate a team of key technical and professional personnel who between them have at least the following experience:

- (i) Handling of large road databases;
- (ii) Application of location referencing and road/traffic/pavement surveys;
- (iii) Experience in a similar projects and environment.

### 8.1. Proposed Team and Man-Months:

<b>Key Professionals</b>	<b>Input in person-month</b>
<b>A) For initial 24 months</b>	
a) Team Leader/ Roads Asset Management Expert	24
b) Data Collection Specialist	18
c) Maintenance Planning & Network Engineer	12
d) Data Management Engineer	12
e) GIS Specialist	12
f) Bridge Engineer	12
g) HDM-IV Expert	12
h) IT & Help Desk	18
<b>Total Staff Inputs</b>	<b>120</b>
<b>B) Ongoing Maintenance Support (5 Years)</b>	
a) Key Professional / Sub Professional	<b>1.5</b>
<b>Total Staff Inputs</b>	<b>1.5</b>

Note:

The above list of key professionals and estimated person month is for reference only. The Consultant is responsible to review the required services and may propose own requirements for the key professionals and other support staff (eg: Junior Programmers, Surveyors with helpers, CAD operators, traffic enumerators, Office Manager, IT Technicians, laborers with digging tools, etc.) required to complete the proposed services in a satisfactory manner. This is clarified that Support Staff and Non-Key staff CV's shall not be evaluated. Only Key Personnel CVs shall be evaluated.

Financial proposal should include rental of all the Professional GPS, geo-stabilized vehicle mountable video camera, Network Survey Vehicle (NSV), Falling Weight Deflectometer (FWD) Axle Load Pad and other survey equipment as well as laptops with necessary software to develop the system, transportation and other logistics, direct and indirect costs necessary to render the services and reporting.

The Financial proposal should also include organization of Training Workshops and AMPs Workshops at various locations within Himachal Pradesh and complete the required jobs as mentioned in the TOR.

#### Key Qualifications

- Team Leader/ Roads Asset Management Expert
  - (i) A graduate in Civil Engineering from a reputed institute, and preferably Masters in Highway / Transport / Pavement / Structures / Management;

- (ii) Have minimum 15 years of professional experience in infrastructure sector, preferably in roads and highways;
  - (iii) Have good knowledge on development and maintenance life cycle of highways;
  - (iv) Have adequate experience in developing and/or implementing computerised Road Asset management System or other similar infrastructure related IT systems in India;
  - (v) Have sound knowledge in data collection, data management and reporting;
  - (vi) Have good understanding on emerging and advanced technologies for data collection and data management;
  - (vii) Must have worked on two projects and in similar position or Deputy Team Leader on at least 1 similar project.
- Data Collection Specialist
    - (i) A graduate in Civil engineering with minimum 10 years of professional Experience in roads and highways;
    - (ii) Have sound knowledge in data collection, data management and reporting;
    - (iii) Have good understanding of different data collection technologies, including conventional systems and emerging technology such as LiDAR and Unmanned Aerial Vehicles (UAVs);
    - (iv) Have adequate experience in developing and/or implementing data collection and data management for large road networks;
    - (v) Have adequate experience in survey planning and coordinating and monitoring of network level data collection;
    - (vi) must have worked in similar position on at least 1 similar project.
- Maintenance Planning and Network Engineer
    - (i) A graduate in Civil engineering with minimum 10 years or diploma holder with 15 years of professional experience in roads and highways;
    - (ii) Have sound knowledge in maintenance planning and reporting;
    - (iii) Have good understanding of different methods and techniques used for maintenance need analysis;
    - (iv) Have adequate experience in preparing data inputs and interpretation of outputs of HDM-4 software;
    - (v) Have sound knowledge on relevant national and international codes and best practice guidelines in the area of maintenance needs analysis; Have adequate experience in preparing road maintenance budgets;
    - (vi) Have sound knowledge in development and maintenance of highways on Public Private Participation (PPP), EPC, OMT and Hybrid Annuity methods;
    - (vii) Have good understanding of different methods and techniques employed by MORTH, NHAI and NHIDCL practices for highways development and maintenance;
    - (ix) Have sound knowledge on Concessionaire / Contractors obligations in managing

## National Highways in India.

- **Data Management Engineer**

- (i) A graduate in Civil engineering / IT / Computer Science preferably masters in relevant field with minimum 7 years of professional experience;
- (ii) Have sound knowledge in data processing, analysis and reporting;
- (iii) Have good computer operation skills and hands on experience in MS office or equivalent.

In addition to the above, administration and secretarial support staff may be proposed for the duration of the services.

- **GIS SPECIALIST**

- (i) A graduate in any discipline with masters in GIS or Remote Sensing having minimum 7 years of professional experience;
- (ii) Have sound knowledge in modern GIS software platform including open source software;
- (iii) Have experience in analysis GPS data and preparation of highway base plans;
- (iv) Have good experience in operating ESRI ArcGIS software;
- (v) Have good computer operation skills and hands on experience in MS office or equivalent.

- **BRIDGE ENGINEER**

- (i) A graduate in Civil Engineering, preferably with masters in the relevant field with minimum 7 years of professional experience;
- (ii) Have sound knowledge in data collection, data management and reporting;
- (iii) Have good understanding of different data collection technologies including latest industry practices in the relevant sector;
- (iv) Have adequate experience in survey planning and coordinating and monitoring of network level data collection;
- (v) Have good computer operation skills and hands on experience in M office or equivalent.

- **HDM-IV EXPERT**

- (i) A graduate in Civil Engineering or masters in Transport Economics with minimum 7 years of professional experience in roads and highways;
- (ii) Have sound knowledge in maintenance planning and reporting;
- (iii) Have adequate experience in preparing data inputs and interpretation of outputs of HDM-4 software;
- (iv) Have adequate knowledge in HDM-4 deterioration models.

- **IT AND HELP DESK**

- (i) A graduate in IT or Computer Science with minimum 15 years of professional experience in infrastructure sector, preferably in roads and highways;
- (ii) Have sound knowledge in maintaining government offices' IT network;

- (iii) Have good understanding of software maintenance including installation, registration, user authentication and software security;
- (iv) Knowledge of IT infrastructure of MORTH, NHAI and NHIDCL is preferred;
- (v) Have sound knowledge In user training and providing software helpdesk;
- (vi) Have excellent proven past skills in managing and mentoring junior staff.

## ANNEXURE-1

### A. FUNCTIONAL AND TECHNICAL REQUIREMENTS OF THE SOFTWARE

The proposal of the Consultant for the replacement/ upgradation of the existing RMS software with RAMs will be evaluated against the criteria mentioned below. The following information will be used for evaluating the technical proposal of consultants. This applies to GIS, the database and the economic modules.

The following clarifications on the functional and technical requirements of the software are to be provided by the RAMS Software Provider:

#### 1. General Information

The Consultant shall supply the following general information on the proposed system.

- Software: The project is using commercial off-the-shelf (COTS) software, or Bespoke software. Consultants to submit the system developed and already customised in the past in a minimum of two countries other than India. While the bidder is encouraged to propose fully bespoke solutions, the Purchaser recognizes that the offered solution may contain a mix of bespoke and COTS modules or parts. The buyer will retain the IPR for only those modules, sub-systems, or applications that have been custom-developed for this project. All the standard IPR clauses will apply to only these bespoke parts of the offered solution.
- Demos: The system able to stream video data over the larger network and a live demonstration for this quantity of data in the web in the cloud as well as data centre environment needs to be demonstrated along with Video analysis functionality.
- Licensing: The platform can be licensed software or an open source.
- Visual/Field Inspections tools in RAMS: Apart from Mobile applications for visual inspections, tools to validate Work Programs before finalising these works programs and inspecting off-pavement assets using video and GPS technology
- Visual/Field Inspections Mobile apps: Mobile applications for visual inspections tools for Work Programs to validate before finalising the works program and inspecting off-pavement assets at a later stage as part of additional modules/project. The support for offline/online and having seamless sync-to-server technology. The Consultant should demonstrate a minimum 10 visual/field inspection apps, which include the off-pavement assets that can be configured at an additional cost if required.
- Configurable Software: The Consultant shall clearly indicate the level of customisation done.
- Regional experience with the application: The Consultant shall indicate in his proposal the regional and country presence of the application, listing within the last five (5) years:
  - a. all agencies to which the application was supplied;
  - b. the year that the system was implemented;
  - c. the current status of the implementation; and
  - d. the current contract details of the users.
  - e. the number of users currently using the platform.
- Country presence: The Consultant shall indicate whether or not any support offices in the region or country will provide on-going support after implementation.

- Support and maintenance services: The Consultant shall clearly describe future potential support and maintenance services for the application. This should include a sample Service Level Agreement.
- Hosting: Should the client elect not to follow the cloud hosting model, HPRIDC/ HPPWD will provide all hardware/data centre/cloud servers for hosting RAMS.
- Reference sites: The Consultant shall provide a minimum of three (3) reference sites, including contact details, for agencies that have implemented the application within the last five (5) years, and which would be suitable for the client to contact during any post- process exercise. The Consultant shall confirm with the reference sites before submitting the proposal that they are willing to provide comments on the implementation to the Client. There should be written references from a minimum of three existing clients and HPRIDC/ HPPWD to do the reference checks.

## 2. **Technical Requirements**

The Consultant shall indicate in their report on how the application will be developed and conforms to the following Technical Requirements. Note that some of these requirements are Mandatory. If the application being proposed does not conform to a mandatory requirement, then it will be rejected. If the mandatory features are not currently implemented in the system but will be as part of these services the Consultant shall clearly indicate this in their proposal, and confirm when the features will be available.

- Language: The language of the interface (all menus, screens, reports, and documentation) shall be English.
- Number of Users: It is anticipated that up to 100 concurrent users for online and offline systems will need access to the application at any one time. However, the system should have no limit on the number of users registered, nor the number of concurrent users at any one time.
- GIS: The Consultant is free to either use existing GIS with HPRIDC/ HPPWD or to use any open freely available platform like open street map/Google maps etc. and it shall be interfaced with RAMS as per ToR requirements.
- Field Data Collection Devices: The RAMS should support hand-held field data collection devices (smartphones and tablets) into which data can be downloaded from the RAMS, verified or updated in the field, and synchronized with the RAMS later through the Wifi or Data.
- Web Enabling: The RAMS should provide an interface to allow information from the RAMS to be made available to other applications, including a presentation on Client websites. This is expected to consist of, as a minimum, a map which is linked to summary data as pavement inventory, pavement condition, and traffic volumes.

## 3. **Functional Requirements**

The Consultant shall indicate in its findings how the application being proposed meets the following Functional Requirements. Note that some of these requirements are Mandatory. If the application being proposed does not conform to a mandatory requirement, then it will be rejected. If the mandatory features are not currently implemented in the system but will be as part of these services the Consultant shall clearly indicate this in their proposal, and confirm when the features will be available.

The Consultant must clearly indicate whether any customisation of source code in his application will be required for the project to meet these technical requirements.

- Terminology: All Screen Labels, Menu Items, and Reports should be configurable to the Client conventions in English.
- Network Referencing: The RAMS should support different network referencing schemes. These should include the linear distance from the start of the road section, linear distance from the start of a road, as well as distance from known location reference points.
- Cross-Sectional Positioning: The RAMS should support different cross-sectional positional models, to enable data to be referenced laterally to a location on a road section, in terms of lanes, shoulders, ditches, verges etc.
- Network Coding Rules: The RAMS should enforce the Client's Network Numbering rules, by performing data validation on entry or through some other form of the internal validation procedure.
- Network Editing: The RAMS should permit splitting and joining of road sections, and modification of road section lengths, while preserving the integrity of all current and historical data stored against the affected sections.
- Network Auditing: The RAMS should audit all changes to the road network definition, and allow the review of those changes. The audit should record the date and time of network change, the nature of the change, and the username of the person who made the change.
- User Defined Data Items, Functionality and Processes: The RAMS should be configurable to enable the user to define additional types of inventory and condition data to be stored, and to define what attributes are to be stored against each type of inventory. There should be no restriction on the number and type of items or their attributes, other than physical limitations of the database management system being used. The RAMS must have user-definable data entry forms, including labels in the local language so that the user does not need to use a table view for entering new types of data.
- Historical Data: The RAMS should allow the storage of data over different periods, to enable comparison of data over time. There should be the functionality to view/select the most current data.
- Multi-Media Data: The RAMS should enable management and display of multi-media objects (e.g. photographs, video etc.) as attributes of inventory items. For video, the RAMS should allow viewing of video data by chainage along the road section, based on frame/chainage lookup tables supplied. The GIS should display the multi-media objects in the correct spatial location, and the images should be accessible by selecting them in the GIS.
- Data Level Security: The RAMS should permit security setup so that the user may have different security privileges for sub-networks in different geographical or administrative areas. It should also permit setup so that different users have different levels of access for different types of data.
- Function Level Security: The RAMS should permit security setup so that different users may have access to different application modules and functions within these modules.
- Flexible Reporting: The RAMS should provide flexible reporting to enable Client staff to devise their own reports and to make those reports available to other users. Reporting of all items in the RAMS database must be permitted, including reporting on user-defined items and attributes, comparisons of current data with historical data, audit records etc. Export to a spreadsheet and/or comma-delimited text files should also be provided. The Consultant should also provide details of any interfaces to third-party reporting tools.
- Dynamic Sub-Sectioning: The RAMS should provide a dynamic sectioning capability that allows sections of homogenous characteristics to be generated and reported upon. This should allow a combination of all types of data stored in the RAMS. The RAMS should allow



parameters to be specified for a minimum length of the section, and also threshold changes in value at which new sections should be created.

- Schematic Line Diagrams/Strip Maps: The RAMS should enable the production of schematic line diagrams and/or strip-maps annotated with any data stored in the RAMS.
- Integration with GIS or any other open freely available platform: The RAMS should integrate with the Client's GIS, i.e. Google maps or any other open freely available platform. The following functions should be included:
  - i. From the RAMS, while reviewing a particular road section, the user should be able to view and highlight that road section in the GIS. The interface should highlight if there is any missing GIS representation for a given road section.
  - ii. Selected attributes of the road section, as stored in the RAMS, should be able to be viewed from the GIS, used as screen labels, and be available for thematic mapping. These attributes should include all section-wide attributes including section identifier, road identifier, the defined direction of the section, road classification, IRI, PCI etc.
  - iii. The GIS interface should be able to display dynamically segmented data from the RAMS. This means that any data stored in the RAMS that varies by length along the road section can be correctly displayed in the GIS.
  - iv. The GIS interface should be able to view all background GIS data held in the Client's GIS database.
- Model Interface: The RAMS should interface with type of models. The interface should include the following elements:
  - i. An automatic sectioning function to create 'homogeneous' sections for analysis based on inventory and condition data;
  - ii. A generic interface which allows the user to define the rules for the above- mentioned automatic sectioning. This can include specification of which data items to use, what transformations to apply to the individual data items (i.e. average, minimum, maximum, dominant, weighted average), minimum and maximum lengths of sections etc.;
  - iii. An interface to import the modelling segments if those were defined elsewhere;
  - iv. Fully configurable modelling parameters, treatment types, budgets and along with define rules of the treatment triggers;
  - v. Ability to configure advanced and modern modelling techniques by using Machine Learning (Artificial Intelligence) algorithms;
  - vi. Preparation of Input files for Work Standards, Traffic Classification and Growth Rates;
  - vii. Averaging and Preparation of data for Strategy Analysis (as opposed to Program Analysis);
  - viii. Import of the results of the works program generated by third-party modelling applications so that they can be related to the real road network and displayed in tabular or map-based reports. Depending on how complex the system is and what it is intended for, this may also require the RAMS retaining a copy of the road network definition passed to third party modelling applications, so that if any changes occur to that network between the time of passing the data and getting the results, then they do not prevent the results being imported.

## **B. DATA AND SOFTWARE TO BE DELIVERED TO THE CLIENT**

- a. Software: The Consultant shall also hand over to the Client pen drives/CDs/DVDs containing any general software /integrated/customised RAMS system/tool which has been specifically designed/developed for the project including its User Manual.
- b. The pen drives /CDs/DVDs should be properly indexed, and a catalogue is giving contents of all pen drives /CDs/DVDs, and print-outs of the contents(data from field studies topographic data and drawings) should be handed over to the Client at the time of submission of the Final Report.

## **C. DATA COLLECTION REQUIREMENTS**

For successful implementation of RAMS, the Consultant should collect the following key data by utilizing the trained manpower and equipment available with the HPPWD and outsourcing only the resources not available with the department:

### **a) Pavement Condition and Roughness**

Pavement condition survey is to be done through Automated Equipment using Romdas NSV. Visual inspection should only be done at places where the automated vehicle is not able to move due to operational reasons such as inaccessibility, poor condition of roads etc. The visual inspection shall be recorded using the mobile application integrated with the RAMS.

During this assignment, the Consultant shall collect the road condition data using equipment or through visual survey. The actual quantity of road network for conducting this survey will be arrived after deducting length of on-going or planned works. the Consultant will obtain all the necessary information from HPRIDC/ HPPWD or respective Executive Engineer of the division.

Roughness will be measured in conjunction with pavement condition survey. The roughness data will be measured using Bump Integrator. Single run in the outer lane will be performed to record Roughness at 100 m interval. The speed will be recorded during the survey and taken into account when calculating the IRI from the raw data. Factors that may influence the IRI will be recorded during the survey and the data will be corrected accordingly. These include, but are not limited to, traffic congestion, pavement construction activities, speed breakers, bridge abutments etc.

### **b) Pavement Deflection (Strength)**

The pavement strength data shall be collected using Falling Weight Deflectometer (FWD) equipment. The FWD equipment will be towed by a suitable SUV. The target stress of 566Kpa (corresponding to a load of 40KN) will be used. The sensors spacing will be kept at 0, 200, 300, 450, 600, 900 and 1500 mm measured from the centre of the applied load or as per the IRC 115- 2014 guidelines. The load pulse will be applied through a loading plate of diameter of 300 mm. The loading plate will have a rubber pad of at least 5 mm thickness.

The operator will follow the manufacturer's instructions for use of the equipment. Locations will be cleaned of loose stones and debris to ensure that the loading plate and deflection sensors are properly seated. The operator will –

- i. lower the loading plate and the sensors and ensure they are resting on a firm and stable surface.
- ii. raise the loading weights to the appropriate height to generate the target

- load level, and drop the weight. The software will record the peak load and resulting peak surface deflections.
- iii. Record three sets of deflection measurements.  
The peak load, temperature and deflection sensor readings resulting from the third drop load constitute the test results. The pavement surface, GPS coordinates and ambient temperature will be measured at each test location. The factors affecting the test results will be recorded in the field. These include but not limited to deviation from the test lane, surrounding structures (culvert/bridge) and localized surface contamination etc.

**c) Pavement Composition Data**

A typical flexible pavement consists of following four components i.e. Soil Subgrade, Sub-base course, Base course, and Surface. Base course consists of Granular base such as WBM/WMM and Bituminous Base such as BM, DBM etc. Similarly, rigid pavement consists of Subgrade Base course and Cement concrete slab. The pavement layers should be classified based on IRC-37 (2018) code. However, codes for materials are standardized and should be used for noting the layers.

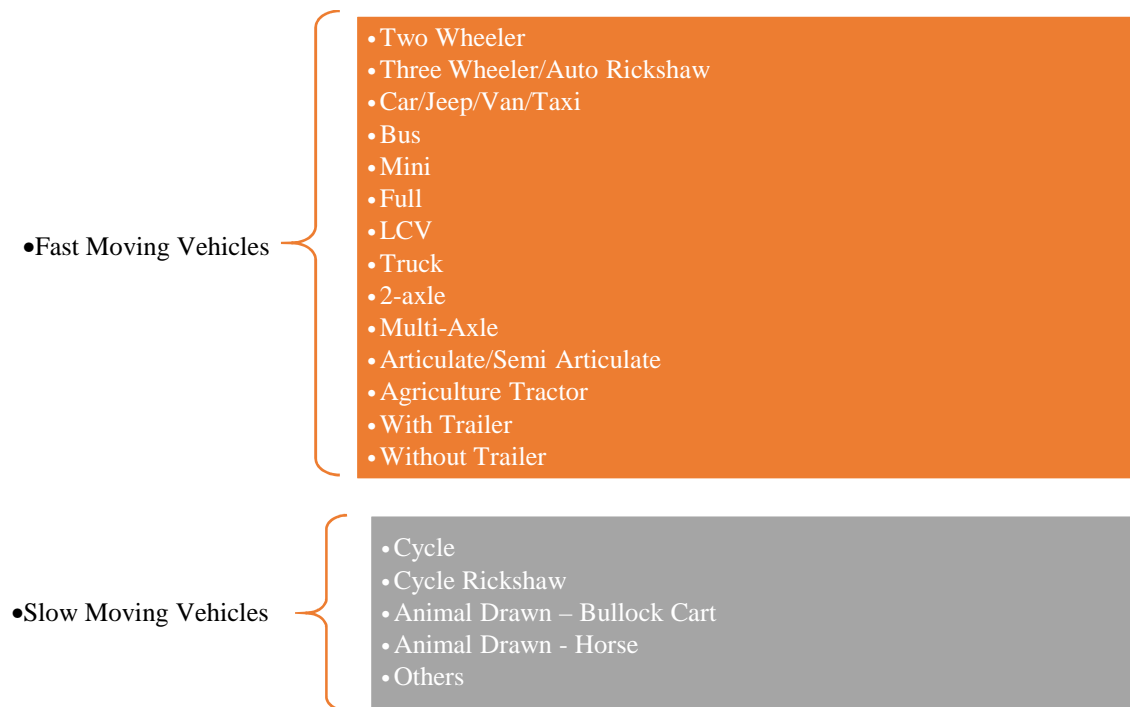
Pavement Composition Data collection contributes significantly to decision making on required maintenance and improvement. Test pits at each 2 km interval will be performed to ascertain the material and layer thickness. Alternatively, GPR (Ground Penetrating Radar) equipment can also be used to estimate the pavement composition.

A pit of size 600mm x 600mm is dug at the pavement edge in each 2km of road section and different layers of pavement are measured. Data is filled in the prescribed format as would be provided and agreed upon by HPRIDC/ HPPWD.

Soil samples must be collected from sub-grade to conduct laboratory investigation of soaked CBR or estimated using DCP. A detailed procedure for obtaining CBR is to be provided in the proposal with appropriate references. Pavement Composition and CBR data in the prescribed format, should be uploaded to RAMS based on the format agreed upon by HPRIDC/ HPPWD. For all new roads, HPRIDC/ HPPWD will provide the Road ID and composition data which needs to be incorporated in the RAMS.

**d) Classified Traffic Volume**

The purpose of this classified traffic volume count survey is to determine the current traffic volumes and type of traffic travelling on the project roads. The classified traffic volume count surveys will be carried out for 24-hours over Seven (7) continuous days, both bounds at the identified survey stations during normal period. A standard vehicle classification system based on IRC: SP19-2001 will be adopted for counting purposes. The vehicle classification break-down is defined below.



Survey will be undertaken using videography method. Manual counting or any automated method will be deployed from the videos recorded in the field. The enumerators will record each vehicle on a survey form according to the vehicle type. Each direction of the traffic will be recorded separately. Information in the daily traffic summary sheet will be compiled and analysed and the results will be presented in tabular and graphical form within the RAMS. Some of the outputs from the traffic count survey will be:

- Traffic Composition;
- Hourly and Daily Variation;
- Peak Hour Traffic;
- Directional Split;
- Temporal Variations;
- Average Daily Traffic (ADT) by vehicle type;
- Annual Average Daily Traffic (AADT) by vehicle type etc.

#### e) Axle Load Data

Axle load survey will be carried out to determine the axle load distribution of the commercial vehicles plying on project roads. Axle Load Surveys of 24 or 12 hours duration using static Axle weigh pads equipment will be carried out at given locations on representative basis i.e. loaded full, partial or empty.

The survey locations will be finalised based on commercial vehicle intensity / homogeneity in various sections. While selecting the location(s) of axle load survey station(s), the locations of existing bridges with load restrictions, if any, will be taken into account and such sites will be avoided.

**f) General Conditions for Data Collection**

The Consultant will ensure following at the time of data collection:

- i. The survey shall collect data strictly according to the requirements provided by HPRIDC/ HPPWD in this document.
- ii. The Consultant or approved sub Consultant shall use ONLY digital means to collect, record, store and deliver data. Any software or hardware other than that available with HPPWD used for this purpose shall be the ambit of the Consultant.
- iii. The collected data shall be posted on RAMS using specific interface designed to integrate third party road survey data.
- iv. The Consultant is expected to devise a scheme to uniquely identify each data point collected.
- v. The Consultant shall be responsible for citizen convenience at all times during the data collection activity. HPRIDC/ HPPWD reserves the right to take appropriate action against the Consultant in case of complaints of unreasonable behaviour on public roads on the part of the Consultant or its staff.
- vi. Any delay in the data collection work that is related to the tools used by the Consultant, shall be attributable to the Consultant. HPRIDC/ HPPWD reserves the right to levy penalties for incomplete, incorrect or missing data as a result of the Consultant's inappropriate usage of tools or techniques.
- vii. The Consultant can perform the survey activity on all days including public holidays from 8 AM to 5 PM except traffic surveys.
- viii. Uniforms as well as ID cards shall be provided to the data collection ground staff by the Consultant or approved Survey SubConsultant.
- ix. The Consultant shall be responsible for any damage to HPRIDC/ HPPWD roads or furniture thereof, sustained during the data collection as a result of negligence on the Consultants part.
- x. The data collected as part of this exercise shall become the property of the HPRIDC/ HPPWD for perpetuity, and shall not be used in any way, quoted or reproduced without the express written consent of HPRIDC/ HPPWD.
- xi. The stage shall be considered complete when and only when HPRIDC/ HPPWD provides written sign off on the data collected, after having duly examined its correctness and completeness, against the rules and specifications provided in the scope of work.

**g) Data Collection Technologies**

It is envisaged that the road data collection will use primarily an automated survey vehicle fitted with following equipment:

- Distance measuring instrument (DMI) attached to the wheel of the vehicle for accurate measurement of distance along the road.
- Differential GPS (DGPS) receiver installed on the top of the roof of the vehicle for capturing the GPS coordinates of the road and roadside assets corrected for sub meter accuracy using OMNISTAR's VBS subscription.
- Lasers mounted on a beam installed in wheel paths and accelerometers for longitudinal/transverse profile, roughness and surface texture.
- Digital cameras installed on the vehicle roof for high-resolution video imaging capable of capturing pavement & R-O-W features.
- Two high-resolution digital cameras for pavement surface imaging installed at the back facing downwards.

- Instrument with gyroscope and accelerometer installed inside the vehicle for measuring road geometry, such as grade cross slope and curvature.
- Automatic crack detection using line lasers at the back, and spread laser mounted at the back to capture rut depth and transverse profile.
- Data acquisition system (PC, data acquisition and processing software, hardware interface, UPS and other accessories) for data acquisition display, analysis and storage

Falling Weight Deflectometer (FWD) will be used to evaluate the pavement structural strength. Features would include the following:

- i. Trailer or truck-mounted powered by vehicle alternator or stand-alone generator sensors for measuring air temperature
- ii. Distance Measuring Instrument (DMI)
- iii. Integrated GPS
- iv. 4 segmented 300 mm loading plate
- v. 7 or 9 sensor geo-phones
- vi. Automatic loading lift/drop control facility generating pavement loading in range 6 to 150 kN with a loading pulse in the range of 20 to 60 milliseconds
- vii. Data acquisition system (PC, data acquisition and processing software, hardware interface, UPS and other accessories) for data acquisition display, analysis and storage.

### h) Survey Details

Sl. No	Data Item	Indicative Field Data	Road Category and Quantity	Responsibility of the Consultant and Methodology
1	GPS referencing	Start & end points of road, road name, road length, villages/towns, culverts, start points of bridges, intersections, district/ division/ sub-Division/ block boundaries	All Category (One Zone)	Consultant will use vehicle mounted DGPS (sub-meter accuracy) to collect this information
2	R-o-W imaging	High-resolution photographs, Chainage, Lat / Long	All Category (One Zone)	Collect every year at 10m or less interval Consultant will use vehicle mounted Camera, DGPS (sub-meter accuracy), and Distance Measuring Instrument (DMI) to collect this information.
3	Pavement condition/distress	Severity, and extent of distresses e.g., cracking, pothole, raveling, rutting (rut depth), edge break, failed sections and shoulder drop off.	All Category (One Zone)	SH and MDR – Survey using laser based systems, high-resolution images fitted in automated equipment ODR and VR – Visual interpretation of high-resolution images obtained from automated equipment or Visual inspection by trained surveyors
4	Pavement roughness	IRI in m/km	All Category (One Zone)	SH and MDR – Laser-based automated equipment (Class1 type) in both wheel tracks. ODR and VR – Response-type road roughness measuring systems (Class3) such as calibrated bump integrator or accelerometer
5	Pavement structural strength	Load, geophone readings at 305, 0, 305, 457, 610,914 and 1524 mm from the centre of the load plate	All Category (One Zone)	Collect deflection data every 0.5 km using falling weight deflectometer. the Consultant will analyses data using a recognized back-

Sl. No	Data Item	Indicative Field Data	Road Category and Quantity	Responsibility of the Consultant and Methodology
				calculation software, such as ELMOD, MODULUS, MODCOMP or WESDEF
6	Classified traffic volume	PWD collects the 7-day traffic volume count on 200 locations twice a year; Direction, day, time and hourly count of 10 vehicle types such as 2-wheeler, 3-wheeler/ vans/ cars/ jeeps, buses, LCV, 2-axle truck/tanker, multi-axle truck/trailers, tractors with/without trailers, cycle/cycle-rickshaw, animal drawn, Others	All Category (One Zone)	Consultant will review locations, and advise HPRIDC/ HPPWD to plan for additional locations on entire road network covering all categories of roads. 3-day traffic volume count, once a year on about 800 locations is proposed to be taken-up by HPRIDC/ HPPWD. 3-day count data on designated locations in 5,000 km will be supplied by HPRIDC/ HPPWD.
7	Axle-load	Time, registration number, vehicle type, commodity type, wheel weight on front and rear axle	30 locations	Manual with portable weigh pads at 30 representative locations with varying commercial traffic volume
8	R-o-W Features (including ITS installations)	Road features such a Traffic Sign, Poles, Km stone, guard posts, drainage etc. within R-o-W along the road with chainage, GPS location, feature type, offset from the carriageway edge	100 km demonstration on select NH, SH, MDR	Automated using high-resolution images (post processed from collected data) or LIDAR, installed on the survey vehicles
9	Maintenance History (Last 5 years)	Road start/end Chainage, Type of Work, Work description, Funding Source, Expenditure, Start Year, End Year, Status	All Category (One Zone)	Consultant will collect from all HPRIDC/ HPPWD and update in the database.