ORISSA WORKS DEPARTMENT
Government of Orissa

ORISSA ROAD ASSET MANAGEMENT SYSTEM
O-RAMS

INCEPTION REPORT

Consultancy Services for Providing Technical Assistance to Establish an Asset Managemment System on the Core State Road Network of Orissa Works Department

July 2011

LEA Associates South Asia Pvt. Ltd. (LASA), India
in Joint Venture with
LEA International Ltd. (LEA), Canada
in Association with
Geo InfoSpace Private Ltd. (GIPL), India

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1. INTRODUCTION

1.1. PROJECT BACKGROUND

Government of Orissa (GoO) has embarked upon several major initiatives and projects. Orissa State Road Project (OSRP) with assistance from the World Bank is one of the important amongst them.[1] OSRP is a major project and has several important components in it. Development of Asset Management System (AMS) for the state core road network is one of the important mandates of OSRP. The AMS is envisioned to assist the Orissa Works Department (OWD) to rationalize decision making in planning, programming, funding, and in allocation of resources in the road sector. It is essentially to make the best use of public funds and to preserve the road network at an acceptable level of serviceability.

In view of the scope of the present system under development for the state of Orissa, it is appropriate to call it as Orissa Road Asset Management System and hence referred to as **O-RAMS**[2] instead of O-AMS. The present effort of developing the O-RAMS could be referred to as a part of the total institutional strengthening plan of the OWD, which it undertook as part of OSRP. OWD has retained LEA Associates South Asia Pvt. Ltd. (LASA), India in Joint Venture with LEA International Limited (LEA), Canada in association with Geo InfoSpace Private Limited (GIPL), India for this purpose.

1.2. PURPOSE OF THIS REPORT

Inception Report is the first milestone among the agreed deliverables of the project. As per the Contract Agreement, the Inception Report is expected to cover the following:

- Project appreciation;
- Revised work plan, methodology, task assignment and manning schedule, if required; and
- Proforma for data collection;

All the above are addressed in this report. Apart from this, the following, which are believed to be important and essential for any Inception Report, are also dealt with:

i) To confirm the scope of work as stated in the Description of Services,

ii) To suggest any changes in methodology to achieve the desired results more efficiently and effectively, taking into account the findings from a preliminary review of data available with the OWD, field visits and information gained from the workings of the OWD,

[1] The State Government of Orissa (GoO) through the Government of India (GOI) has received a loan from the International Bank for Reconstruction and Development (IBRD) for implementation of Orissa State Roads Project and intends to apply a portion of this loan to finance consultancy services for establishing an Asset Management System (AMS) for the state road network.

[2] **O-RAMS,** is expected to improve the technical capacities, skills and management capabilities of the OWD and other road agencies associated with road management and maintenance, thus improving the ability of the GoO and its subordinate agencies to manage efficiently and cost-effectively road maintenance and improvement activities. The system will be set up to reflect the best of international practices, in a way that suits the local needs and conditions.

iii) To bring the OWD up-to-date on the progress so far, and

iv) To further expand and explain the issues for early actions and decisions.

Although contractually there is no obligation for the Consultant to submit a Draft Inception Report, the Consultant did submit Draft Inception Report on 6th June, 2011. The Inception Report went through the review of the World Bank and OWD officials. In the meantime, the first Review Committee meeting was also held on 14th July, 2011 which was chaired by the Secretary, OWD to consider and advise the Consultant on the Inception Report. This Inception Report is now submitted by duly incorporating all the suggestions of the World Bank and the OWD officials. It may be noted that some suggestions had to do with the next stages of work, therefore, they have not been covered as part of this submission. However, the Consultant remains committed to incorporate all such advise appropriately during the various stages of the present assignment.

1.3. MOBILISATION

As agreed, the Project commenced on May 5, 2011. The following staff was mobilized on the first day of the Project:

1. Mr. Anand Prakash, Team Leader
2. Mr. G. P. Sahoo, Group Leader-cum-Highway/ Pavement Engineer
3. Mr. Satyakam Sahu, Transport Planner
4. Mr. Ahmed Asif, Highway/ Pavement Engineer
5. Mr. Parag Sawant, Software Engineer/ DBMS Specialist
6. Mr. Swapneswar Dey, Office Manager
7. Mr. Ramakant Mangaraj, Accounts Manager

Subsequently, the following staff has also joined the team:

8. Dr. M. P. Raju, M.D., LASA; Network Planning and Road Classification Expert
9. Dr. S. S. Seehra, Highway Engineer-cum-Pavement Management System Specialist
10. Mr. Andy Kim, Systems (IT) Specialist
11. Mr. Nirmal Kumar Yadamani, GIS Specialist
12. Mr. Sagar Prabhakar Deshmukh, Data Acquisition Specialist
13. Mr. Pradeep Kumar, Group Leader-cum-Transport Planner
14. Mr. Bhupesh Gupta, Group Leader-cum-GIS Specialist
15. Mr. P. Rama Raju, Bridge Engineer
16. Mr. Ravi Ranjan, Software Engineer
17. Mr. Satya Sapath Roy, Data Collection Supervisor
18. Mr. Atanu Purkait, Data Collection Supervisor
19. Mr. Rajesh Sahoo, Data Collection Supervisor
20. Mr. Rahul Bhatt, Data Collection Supervisor
21. Mr. Gautam Patnaik, Data Collection Supervisor
22. Mr. Sashikanta Panigrahi, Road Surveyor

23. Mr. Naresh Thakor, GPS Data Analyst
24. Mrs. P. Karuna Priya, DTP Operator
25. Mr. Anek Kumar Thakur, Accounts Assistant

1.4. MEETING WITH OWD / WORLD BANK / OTHER AGENCIES

The project team met the PMU staff and other agencies on several occasions since inception. These meetings were helpful to the team to familiarize itself with the basic workings of OWD. The broader objective of such meetings/interactions was:

- to obtain any data available with OWD which could be made use of,
- to obtain letters to interact with the Orissa's IT Department and Orissa Space Application Centre (ORSAC),
- to disseminate information regarding the software to be used and its configuration at the headquarter, circles and divisional offices, and
- to regularly inform the OWD about O-RAMS.

The Systems (IT) Specialist interacted with PMU staff regarding the needs analysis pertaining to IT aspect.

Based on the above reference letters, the Consultant visited the IT Department of Orissa Government to gain knowledge about its set-up, facilities and capabilities.

Similarly, the Consultant visited ORSAC to explore the type of imagery or digitized information that is available with the Centre and the procedure to acquire the same for the GIS component of O-RAMS. A formal letter from the Chief Engineer (World Bank Projects) was also forwarded to the Chief Executive of ORSAC to render the necessary assistance to the Consultant.

May 5th: Collected books containing road and bridge inventory and condition data collected in five divisions for Project Vision-2015, now called Vision-2020. These include inventory of cross drainage works also.

May 7th: Meeting with the IT Department and Orissa Computer Application Centre (OCAC): Meeting was held with two Deputy General Managers in charge of the implementation of State e-Governance programme, and computerization of various departments within the Orissa State Government. A summary of the discussion that took place is as follows:

The Orissa State Wide Area Network (OSWAN) is currently implemented using infrastructure of BSNL (either OFC / copper wire) providing 10 mbps bandwidth of connectivity from the State Secretariat to the District Collectorate offices. This is maintained by the private vendors on contract basis. Further, it is planned to connect other district offices with the District Collectorate office in their respective districts.

The State Data Centre (SDC), which is to house the servers of all State departments at one place, is being readied and will be operational soon. This is going to be the one point solution to maintenance, periodic backup and security needs of servers and the databases. The specifications of the servers can be obtained from the State Data Centre.

May 9th and May 17th: Meeting with ORSAC: Meeting was held with the Chief Executive, Mr. A. K. Mohapatra, IFS. A summary of the discussion is as follows:

The available satellite images with ORSAC are of different ages for different regions with variation in accuracy / scale. The complete dataset for Orissa for a singular period in a single scale/ accuracy is not available. However, it is planning to acquire 5.8m resolution LISS-4 images for the entire State shortly. The Chief Executive asked the Consultant to provide a list of what is needed from ORSAC. Subsequently, the following data was requested from ORSAC:

1. Satellite data of 5.8 m resolution or better for the State of Orissa (indicate the sensor, resolution and date of acquisition of the data)
2. Vector data for the State of Orissa. (mention the source of the vectorised data, scale and accuracy)
   - Base map
   - Roads layer (NH, SH, MDR, ODR, other roads)
   - State boundary
   - Tehsil boundary
   - Village boundary
   - Forest boundary
   - Water bodies / rivers / streams
   - Settlements
   - Habitation layer
3. Ground control points for the State of Orissa

May 21st: A Project Review Meeting was held in the Data Room, Nirman Soudha, Works Department chaired by the Chief Engineer, World Bank Projects. The minutes of the meeting are included in **Annexure-I** of the Report.

May 23rd: An interaction was held between the PMU staff and the Systems (IT) Specialist. The following brief summarizes the discussion:

1. Filling up the questionnaire on IT preparedness of the Department at all levels of OWD. Refer to the **Annexure-II** for the sample format that was used to interact with the PMU officials.
2. Assessment of IT infrastructure of the Department
3. Assessment of the use of computers and office productivity tools
4. Use of Internet and internet enabled services
5. IT-related staffing and their skill-sets.

May 28th: An interaction was held between the PMU staff and the Consultant. In brief, the following was discussed:

1. Planning and funding process for road development and maintenance
2. Funding for roads under various schemes of Central and State Government agencies
3. Use of funds for improvement, rehabilitation, widening, and periodic and routine maintenance

June 4th: A Project Review Meeting was held in the Data Room, Nirman Soudha, Works Department chaired by the Chief Engineer, World Bank Projects. The minutes of the meeting are included in **Annexure-III** of the Report.

Apart from the above, the Consultant had interacted with and benefitted from the World Bank advice on the assignment.

1.5. STRUCTURE OF THIS REPORT

The Report, in addition to restating the basic objectives, the scope of services and the key elements involved in establishing O-RAMS, intends to highlight the issues that need to be addressed and the necessary advance actions desirable for the success of the Project. These pre-requisites are crucial; otherwise further progress of the Project could be impeded. Report is structured into six sections as under to be fully compliant with the Contract Agreement:

1. **Project Appreciation**[3]
2. **Approach and Methodology**[4]
3. **Task Assignment and Manning Schedule**[5]
4. **Work Programme**[6]
5. **Proforma for Data Collection**[7]
6. **Project Dependencies and Facilitation**[8]

[3] This section starts with various definitions of Asset Management System (AMS), its key components and the scope of the Project. Review of OWD is presented in terms of its institutional setup, jurisdiction, planning and funding pattern. A broad summary of road network characteristics is also provided.

[4] This section intends to explain in detail various tasks and sub-tasks in response to the requirement of ToR including scheduling of sub-tasks for various stages of work. A preliminary review of the data / information available with OWD and other related department(s) has been presented. A description of the data collection formats and methodology to be tested in the Pilot Project forms an important part of this section. The deficiencies and gaps to bridge during the course of the Project, or a change in methodology to achieve the original objectives, and the recommended approach to overcome shortcomings or anticipated bottlenecks are included in various chapters.

[5] The inputs required from the key / sub-professionals for each of the identified tasks and sub-tasks has been clearly stated. A tentative manning schedule is also provided in response to scheduling of various deliverables and tasks.

[6] A detailed work programme addressing each of the task and sub-task to undertake the assignment is provided in this section.

[7] Draft data collection formats for undertaking data collection at site is provided in this section. It is anticipated that the data collection formats and the methodology may be refined based on the data collection experience on the Pilot Project. It is to be further discussed in a workshop during the 4th month of the Project.

[8] Normally, the Description of Services provides the framework of the Project, however, where a deviation from the previously proposed approach or methodology is deemed to be beneficial for the Project, it has been elucidated highlighting the dependencies. And finally, the decisions and actions required during the implementation of the Project have been described in this section.

2. PROJECT DOMAIN

2.1. INTRODUCTION

Of the many definitions, the most acceptable definition of 'asset management' that is most appropriate for the road agency/sector is:

"A systematic process of maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing tools to facilitate a more organized and flexible approach to making the decisions necessary to achieve the public's expectation" – OECD

The Federal Highway Administration (FHWA) of the United States and the American Association of State Highway and Transportation Officials (AASHTO) define 'asset management' in the same vein, but slightly different as below:

"Asset Management is a strategic approach to manage transportation infrastructure"

Or, in an elucidated form;

"Asset management is a systematic process of maintaining, upgrading and operating physical assets cost–effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision making. Thus asset management provides a framework for handling both short- and long-range planning".

The term 'asset management system' (AMS) encompasses all the processes, tools, data and policies necessary to achieve the goal of managing assets in the most effective, efficient and economical manner for the asset it relates to, which in the present context is "Roads". A typical flow of data into and out of a generic road asset management system is shown in Figure 2-1.

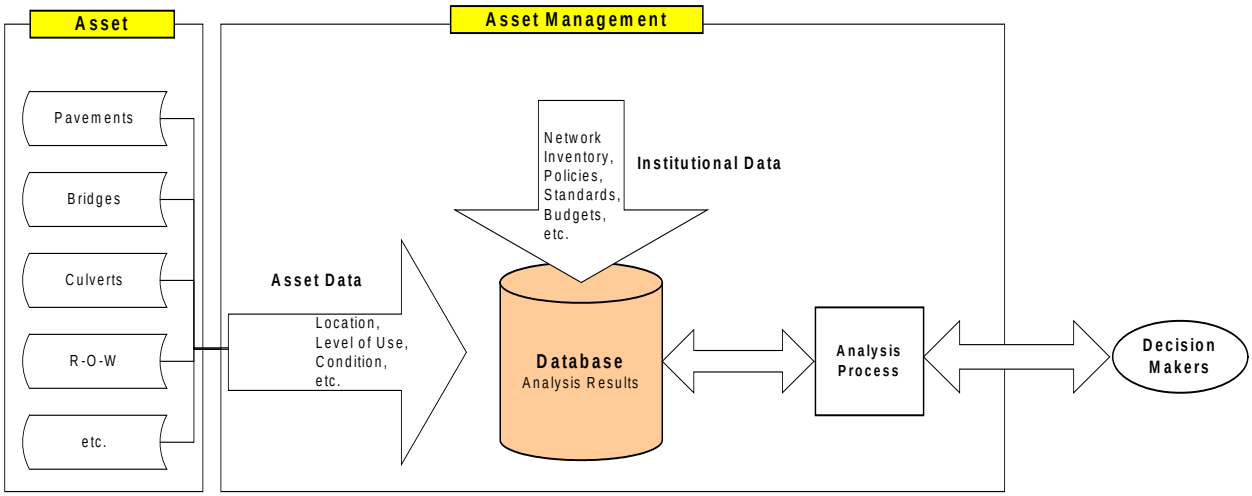

Figure 2-1: Flow of Data in an Asset Management System

2.2. PROJECT OBJECTIVES

The goal of the Technical Assistance is to ensure that the Works Department is able to effectively prioritize works on its road network, as well as report on its condition using a computerized RAMS suitable for operating on a GIS platform. This will, in turn, help to improve the quality and delivery of OWD services in the management of the state road network. The O-RAMS will enhance the capabilities of the OWD 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 analytical tools.[9] The aim of this effort is to create RAMS suitable for a sustainable implementation in Orissa, taking into account that the collection, storage and processing of road condition data for a network of thousands of kilometers on annual basis is difficult and expensive. The task of data collection, keeping in view the limitations of road agencies, may have to be simplified as much as possible.[10] The operation of the road database and the evaluation tools will be easy and logical, so that O-RAMS outputs are useful to decision-makers and the O-RAMS begins to produce outputs, even if approximate, after the first year of its development.

The specific objectives of the services are, to:

1. Develop and establish in use an electronic Road Asset Management System at the headquarters,
2. Prepare a multi-year rolling maintenance program and two annual updates for implementation in subsequent years on the state road network, and
3. Transfer skills and procedures to an adequate number of staff in the OWD to sustain the use of the RAMS during, as well as after the end of these services.

2.3. SCOPE OF SERVICES

The scope of services of the O-RAMS is given below:

1. Evaluate and assess current international practices related to road asset management.
2. Study the existing system of maintenance management, current decision-making process, organizational structure, and technical and managerial capabilities of the Roads and Bridges wing of the OWD, and propose changes aimed at providing adequate support for the AMS ensuring that any system so developed will be sustainable.

[9] The O-RAMS will store data regarding the state road network and will evaluate these roads for planning and programming purposes. The O-RAMS will also store basic network data of National Highways. The O-RAMS will also have options to add new road systems to the database and analysis tool.

[10] The structure of the database will contain such parameters that the RAMS can function with a set of default parameters at the outset. Data collection for the parameters listed in Table 2 of the Contract for Consultant's Services (page 36) will be carried out with a realistic approach, so that data of a large network can be loaded into the database in a few months to make O-RAMS operational. It will have open options for incorporating further parameters, if required, along with its analysis as a separate add-on module.

3. Based on the needs analysis and gaps of the current systems, establish and implement a web-based computerized network level asset management system and to provide training to selected department staff in the use and maintenance of the System.
4. Undertake a road and bridge condition survey and collect the required inventory data for input into O-RAMS.
5. Define the required human resources and organization structure required to manage the System and plans for training programs required to use the System.
6. Develop a road asset management strategy and a maintenance management program for the State of Orissa.
7. Assist in procurement of necessary data collection equipment for collection of the road and bridge inventory / condition data, creation of a GIS base map including supply and installation of latest and updated software and hardware needed to run the O-RAMS from the head office of OWD.

The O-RAMS will include the following components:

1. Road Information System (RIS)
2. Bridge Information System (BIS)
3. Pavement Management System (PMS)
4. Routine Maintenance Management System (RMMS)
5. Right-of-Way Features Information Management System (RWFIMS)
6. Traffic Information System (TIS)

GIS will be the basic platform for all spatial features for road assets and it will link to O-RAMS for non-spatial attributes. Furthermore, the components shall be accessible via an internet browser for reporting purposes. In addition to views of various outputs, it will also be possible to extract information from O-RAMS through an internet browser. It will also be possible to interface with other Geographic Information System (GIS) layers of GoO like revenue maps and forest maps, in future to facilitate easy access to tabular data residing within O-RAMS.

2.4. KEY ELEMENTS

The three essential elements of the proposed Road Asset Management System are:

(i) Asset Management System – hardware and software

(ii) Geographic Information System (GIS) – hardware and software

(iii) Data for the above – existing data and future data collection, equipment for data collection and storage

2.4.1. Road Asset Management System

The proposed Orissa Road Asset Management System (O-RAMS), like most road management systems, is a computer-based system. Since it will be implemented Department-wide at the headquarters, circles and divisional offices, it needs to have computer facilities at all these locations and connectivity between them. For a web-based system, dedicated bandwidth is a mandatory requirement. Normally, a server(s) on which the parent database resides will be required at the headquarters, and only work stations will be required at the circle and divisional offices. The exact hardware configuration of the server / client, operating system, database management software, other software (if any) and the networking needs will depend upon the Commercial-Off-The-Shelf (COTS) Software required to customize and develop road asset management system specific to the present ToR. This software is to be selected and procured in this project.

2.4.2. Geographic Information System (GIS)

As already stated, GIS will be the basic platform for all spatial features for road assets and it will link to O-RAMS for non-spatial attributes. The GIS will require digitized maps of acceptable resolution and age for the entire State. The primary source of spatial data is the Government of India's National Remote Sensing Centre (NRSC) in Hyderabad and Survey of India topographical map sheets. ORSAC, being the nodal agency for spatial requirement for all State departments, is being contacted for such data. Therefore, use of this option will be further explored and exploited if found to be more efficient and effective in the interest of this project. GPS referencing data for all OWD road assets will be collected during the assignment. These will be spatially corrected to align with the GIS base map to be prepared using the satellite image, as explained earlier.

Irrespective of the types and sources of maps/imagery and data, it will be necessary to procure software to analyze, map, manage, share and publish geographic information. ESRI's ArcGIS is one such option in GIS software. It is learnt from ORSAC (the nodal agency for State Government's geo-spatial requirements) that, they are using ESRI's ArcGIS products for their regular works for all the State departments. Therefore it is prudent to use the same platform for O-RAMS so that, there is software compatibility. The Consultant recommends use of ESRI's ArcGIS for use in O-RAMS.

2.4.3. Data Collection

Data is the most important component and forms the very foundation of a road asset management system. At the same time, data collection is the most expensive and time consuming part of any system. But, correct, complete and timely data is absolutely essential for meaningful analysis and results. Therefore, a very careful review of the data available with the OWD against those required for the system is necessary. The inventory data requirement for O-RAMS has been discussed based on the review of data available in OWD and a format has been devised, explained and communicated to all the field offices (divisions). A methodology and format to collect various data in the field has been developed and included in this Report. It will be first tried on a Pilot Project before further refining and finalizing it for adoption State-wide.

2.5. ROLE OF ASSET MANAGEMENT SYSTEM

In general, the sequence of asset management begins with the identification of goals and policies of a road agency / department and the available budget. From this starting position, the sequence proceeds through data collection, performance monitoring, analysis of maintenance options and programme/plan optimization, through to project selection and implementation. Finally, monitoring and review procedures provide feedback, which in turn influence the goals, policies and available budget.

Asset management generally examines such factors as investment levels, maintenance standards and economic importance. In terms of infrastructure management, these factors may be translated into various measures of performance of the asset, including level of use, safety and environmental impact. Asset management will therefore, be influenced by geographical and socio-economic circumstances in the organization and the business processes adopted.

The needs of a senior management in a road agency/department from an asset management system, are:

1. Sound design, construction, maintenance and rehabilitation policies:
    - are the state-of-the-art concepts being used?
    - are the alternatives cost-effective and how much?
    - are the treatments optimal?
2. Asset conditions:
    - What are the trends with the resources/budgets committed in the past few years?
    - What is the present condition of assets and how it has changed in the past few years?
    - What are the predicted conditions under certain scenarios?
    - What is a desirable condition level and why?
3. Rational basis for allocating funds:
    - Where are the priorities of actions?
    - What are the funding/budget needs, now and in future?
    - Where and when should the funds be allotted for maximum public benefits/returns?
    - How should the funds be distributed across the organization?
    - What would be the impact of funding levels on the overall health of the asset?
    - What would be the consequences of external/political exigencies?

Data analysis in an asset management system can be of a technical, financial or general nature and not every type of analysis will be used equally in all levels of an organization. In general, different parts of an organization will carry out data analyses at different levels of detail. Table below shows examples of the types of data analyses carried out by a road administration and which may benefit from the use of an asset management system.

Type of Analysis	*Analysis*
Technical	Condition of the asset Causes of maintenance Age and deterioration of the asset Use of the network
Economic	Budget required Budget allocations (e.g. budget breakdown) Variations in unit prices Deviations between outputs and estimated costs Maintenance costs of assets Total costs and budget
General	Comparison of prioritization with political preferences Comparison of detailed and summary technical plans Changes in performance monitoring statistics Comparison of performance monitoring statistics between divisions/circles

3. ORISSA ROAD NETWORK & MANAGEMENT

3.1. ROAD NETWORK

The total length of road network in Orissa state is about 237,000 km comprising National Highways, State Highways, Major District Roads, Other District Roads, Rural Roads, Panchayat Samiti Roads, Gram Panchayat Roads, Forest Roads and Municipal Roads. The development and maintenance of these roads is carried out by eight different agencies. The total length of roads under various agencies is given in Table 3-1 below.

Table 3-1: Orissa Road Length

Road Category	Agency	Length (km)
National Highways	NHAI	521*
National Highways	Works Department	3,594*
State Highways		3,687*
Major District Roads		4,057*
Other District Roads		6,813*
Rural Roads	Rural Development Department	27,882#
Panchayat Samiti Roads	Panchayati Raj Department	20,314#
Gram Panchayat Roads		1,39,942#
Forest Roads	Forest Department	7,298#
Urban Roads	Urban Development Department	17,282#
Irrigation Roads	Irrigation Department	6,277#
GRIDCO Roads	Electricity Department	88#

** As on 30 March 2010*
 # 2004-2005
Source: NHAI, OWD, Economic Survey 2005-06, GoO

A part of National Highways network in Orissa has been developed by NHAI under the two schemes, i.e., NHDP (Golden Quadrilateral) and Port Connectivity. The details of these corridors are presented in Table 3-2.

Table 3-2: NHAI Road Length

Sl. No.	Section	Length (km)
NHDP (GQ Programme)		
1	Laxmanath-Baleshwar (Northern Corridor)	53.41
2	Baleshwar-Bhadrakh	62.64
3	Baleshwar-Bhadrakh (Bridge Section)	11.58
4	Bhadrakh-Chandikhole	75.50
5	Chandikhole-Bhubaneswar	55.80
6	Bhubaneswar-Khurda	26.30
7	Khurda-Icchapuram	158.57
Port Connectivity		
1	Chandikhole-Paradip	77.00

The above-mentioned sections in Table 3-2 are all four-lane, and most part of the northern corridor is concrete road (rigid pavement).

The responsibility for development and maintenance of National Highways, other than those owned by NHAI, in the State rests with the Ministry of Shipping, Road Transport and Highways (MOSRTH) of the Government of India. The OWD acts only as an agency to undertake construction and maintenance works on these National Highways as required by the MOSRTH. A substantial part of the network belongs to the Rural Development and Panchayati Raj Departments and provides vital linkage to the hinterland.

The Orissa Works Department (OWD) looks after the construction and maintenance of National Highways (NHs), State Highways (SHs), Major District Roads (MDRs) and Other District Roads (ODRs) totaling 18,069 km, which is about 7 % of the total road length in the State. These carry the bulk of traffic and are the principal routes of economic activities.

3.1.1. ROW Characteristics

From the initial discussions with the OWD, it is understood that the right-of-way of the SHs and MDRs in the State varies between 15 m and 30 m, with formation width not more than 12 m in most cases; whereas the ODRs have a right-of-way that varies between 10 m and 20 m.

3.1.2. Distribution of Roads by Category and Surface Type

The distribution of surface type on various categories of roads under the jurisdiction of OWD is shown in Figure 3-1. On the whole, 94% of roads (SH/MDR/ODR) have black top (BT) surface, accounting for 90% of ODRs to 99% of SHs; water bound macadam (WBM) and earthen roads constitute 9.2% of ODRs.

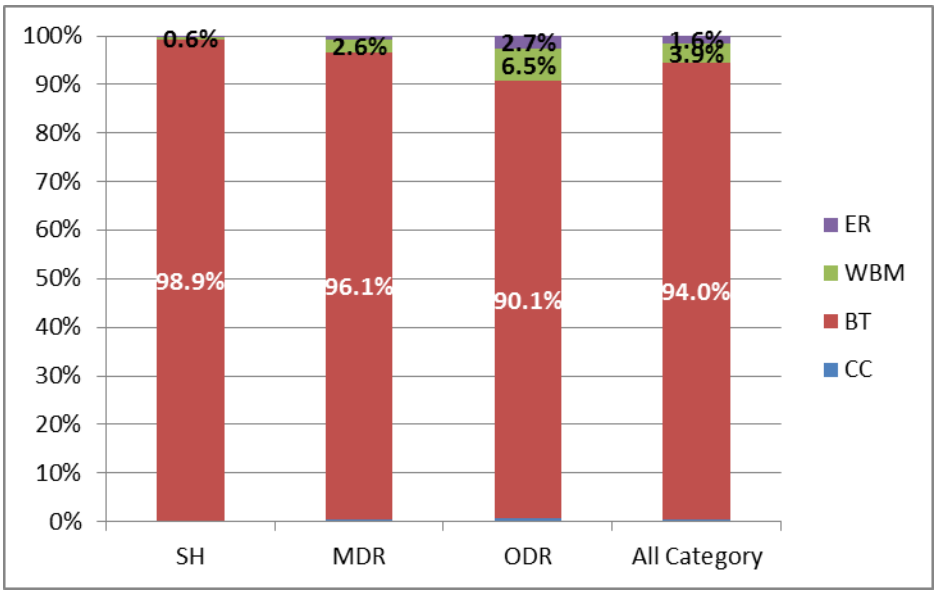

Figure 3-1: Distribution of Roads by Surface Type

The distribution of surface type across various regions (OWD circle offices) is shown in Figure 3-2. Among all circles, Cuttack has the lowest percentage (88%) and the Southern has the highest percentage (99%) of BT roads.

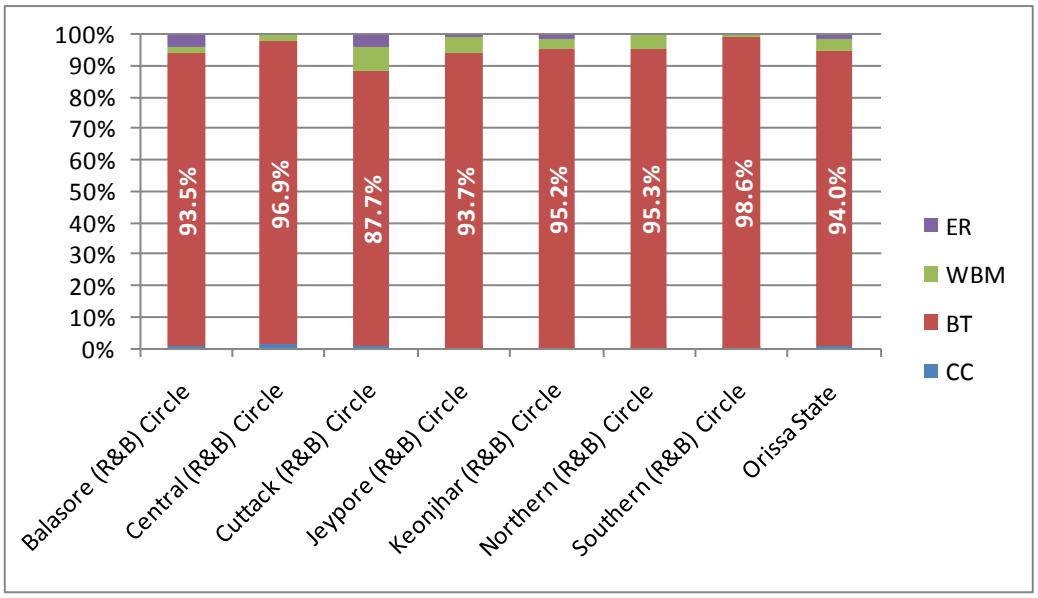

Figure 3-2: Distribution of Roads Surface Type Across R&B Circles

3.1.3. Distribution of Roads by Category and Carriageway Width

The carriageway (as on 2010) of most roads is standard single lane (SSL) or intermediate lane (IL) across all categories (See Figure 3-3). The share of standard double lane (SDL) roads varies from 3% on ODR to 15% on SH category, the overall being just 7 percent, which is insignificant.

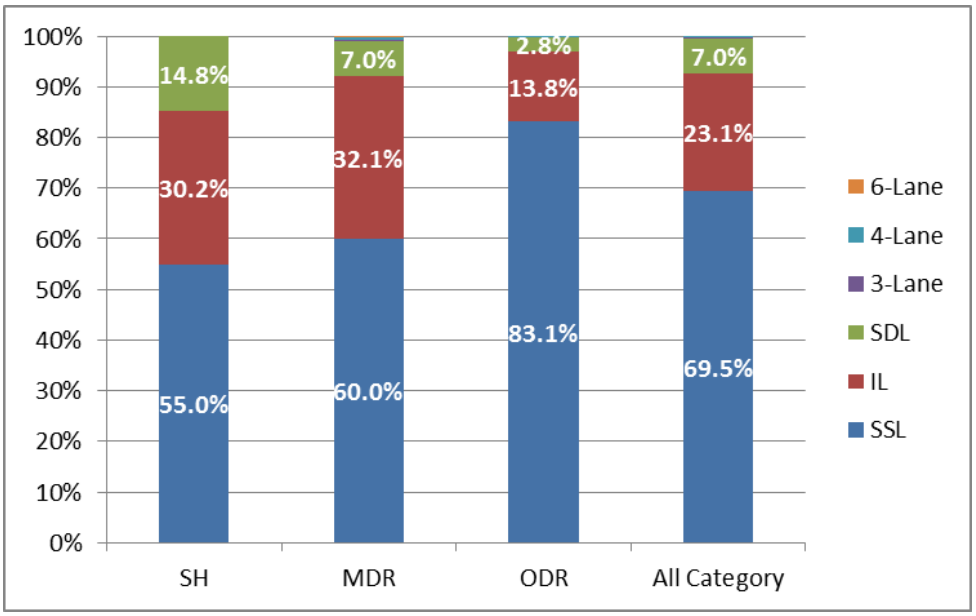

Figure 3-3: Distribution of Roads by Road Width

A further distribution of the carriageway width of roads by the regions (R&B circles) is shown in Figure 3-4. There are no standard double lane (SDL) State Highways in Jeypore and Central Circle, even though MDRs & ODR in the same circles are double lane. This illustrates the imbalance in road classification (provided the road widths are based on the actual traffic). Overall, Keonjhar R&B Circle has the most (272 km, 27%) and Jeypore R&B Circle the least (26 km, 3.5%) of double lane roads.

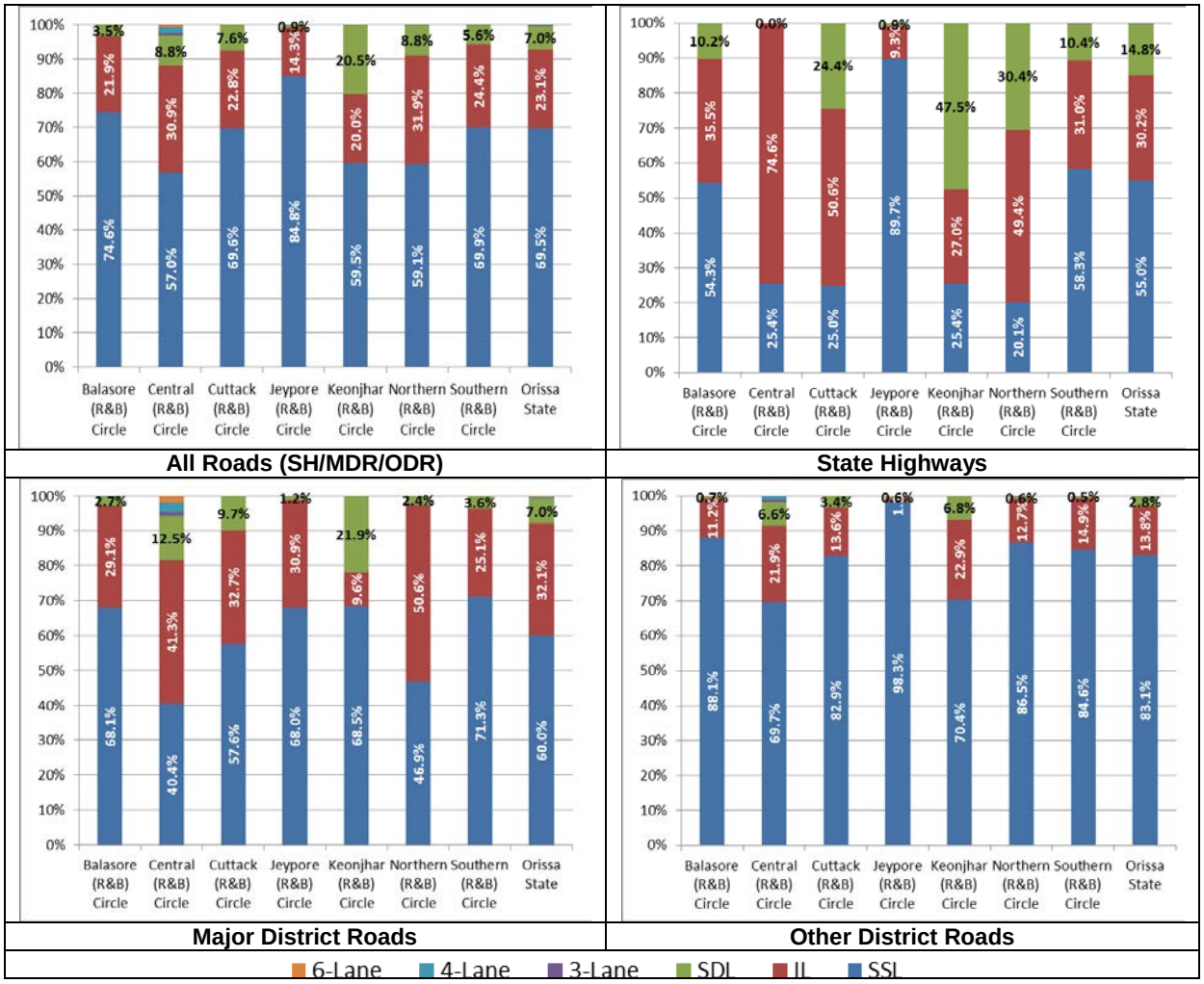

Figure 3-4: Distribution of Roads by Road Width and R&B Circles

3.1.4. Road Condition

Several important sections of the network under the jurisdiction of OWD were visited and an initial assessment of the road condition was made. One of the important state highways, SH-13 (Khurda-Jatni-Pipili Road), MDRs (Pipili-Konark Road, Nimapada-Astaranga Road) and (Phulnakhara-Niali-Charichhak-Gop Road) were visited. Their carriageway width varies from standard single lane (SSL) to intermediate lane (IL). Photographs of the roads (given next page) illustrate their condition.


Photo 1: Pipili-Konark Road (MDR)

Pipili-Konark Road was recently resurfaced. Although this Road is an MDR according to OWD records, new kilometer stones in the field show it to be SH-13. Earthen shoulders were absent on most of the stretches (Photo 1).

On Khurda-Jatni-Pipili Road, cracking and raveling of pavement was observed and earthen shoulders were absent (Photo 2).


Photo 2: Khurda – Jatni – Pipili Road (SH-12)

3.1.5. Status of Traffic Census on State Road Network

The OWD conducts 24-hour (1-day) traffic census on selected traffic stations on SHs and NHs twice a year, but the Consultant has not yet reviewed all the data. A road network study and DPR conducted in 2006-07 on the selected SH / MDR Network of 4,725 km (Phase-1: 825, Phase-2: 3,900 km) included traffic volume count data on 125 (Phase-1: 20 and Phase-2: 105) survey stations. A summary of the traffic is shown in Figure-3.5. The traffic level (AADT) on about 45% of the selected network is below 2,500 PCU, about 38% between 2,500 and 5,000 PCU and about 68% between 1,000-5,000 PCU.

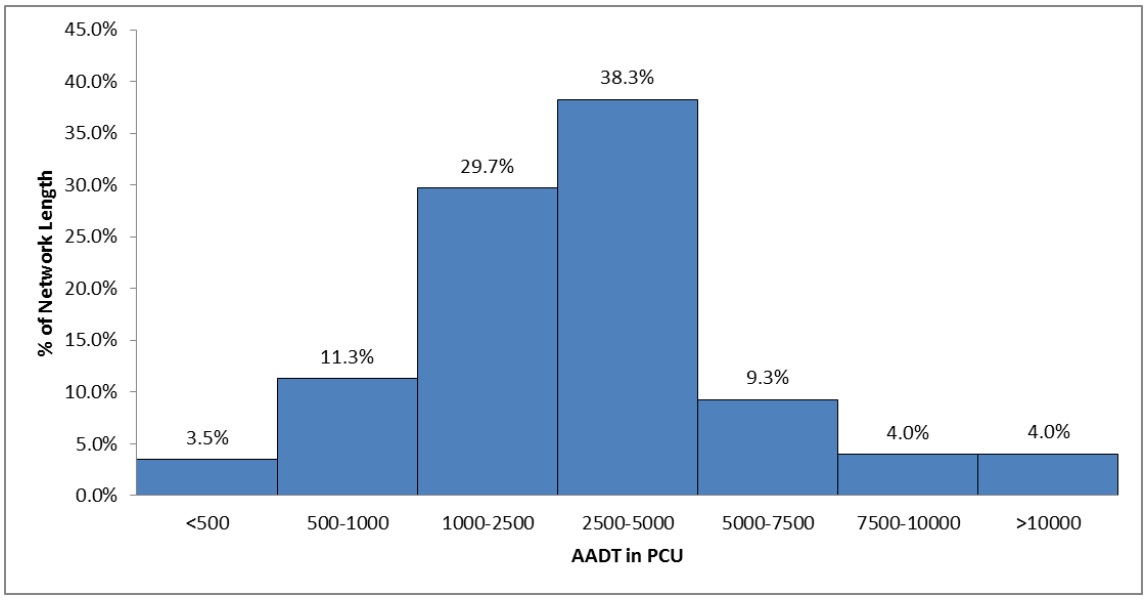

Figure 3-5: Traffic Level in Year 2007 on Selected SH Network

3.1.6. Major and Minor Bridges

Since Orissa is a coastal state, hundreds of small and big rivers criss-cross the State. Consequently, the numbers of cross drainage structures are substantially large on the road network. Following are the number of major and minor bridges on various categories of OWD roads.

Table 3-3: No. of Bridges

Sl. No.	Category of Road	No. of Major Bridges	No. of Minor Bridges
1	National Highway	239	451
2	State Highway	300	1350
3	Major District Road		

Source: OWD

3.2. INSTITUTIONAL SET-UP OF ORISSA OWD: STAFFING, MANDATE AND RESPONSIBILITIES

3.2.1. Functions and Responsibilities

The functions and responsibilities of OWD, as given in the OPWD Code are as follows:

- Construction, repair and maintenance of buildings, roads, bridges and other related structures financed from the state and capital budget allocations in Orissa.
- Execution of original, renewal and repair works on the NH network financed through MOSRTH after levying agency charges at the rates agreed between GOI and the GoO. Construction of buildings, roads and bridges as relief works in the event of floods, cyclones or other natural disasters.
- Ensuring that no encroachment or structure, whether temporary or permanent is erected on the land and property under the control of OWD. It is also responsible for removal of such encroachments as per GoO rules.
- Maintaining a register of land, buildings and properties belonging to the GoO and under the administration of OWD.

3.2.2. Institutional Setup

The OWD is headed by an Engineer-in-Chief (EIC)-cum-Secretary to the Government of Orissa, Works Department. As "Engineer-in-Chief"; this position carries technical responsibility for the OWD and as 'Secretary' exercises administrative control of the OWD. The EIC-cum-Secretary operates as the senior liaison between the Government and the OWD.

In the OWD, there are six Chief Engineers (CEs), and one Managing Director (MD), Bridge & Construction Corporation who report to the EIC-cum-Secretary and EIC-Civil. Each Chief Engineer is responsible for a functional unit called a 'wing'. The senior most CE holds the title of EIC (Civil) and, is responsible for all the administrative functions of the OWD. This includes financial reporting and personnel functions. A brief description of each wing is given below.

The three wings, i.e., the Roads, National Highways, and Buildings have field offices called circles, which are headed by Superintending Engineers (SE). Each circle in turn is subdivided into a number of divisions, each headed by an Executive Engineer (EE). The head office is responsible for overall coordination and monitoring activities, while execution of works is carried out by the EE at divisional level. Divisions manage a number of sub-divisions located at taluka level, each headed by an Assistant Executive Engineer (AEE) / Assistant Engineer (AE); further lower level is 'sections', managed by Junior Engineers. The organisation chart of Orissa Works Department is shown in Figure 3-6.

Roads Wing

The Roads Wing is headed by a Chief Engineer (Roads), reporting to the EIC-cum-Secretary. It is responsible for the maintenance and upgrading of 14,557 km of existing SHs, MDRs and ODRs and construction of new roads at the State and district level. The Wing is responsible for routine and periodic maintenance together with supervision of contracts for works on roads and bridges.

The Wing comprises seven geographically based circles and a specialist Mechanical Circle, each headed by an SE reporting to the CE. The SEs in turn, supervises the activities of 40 divisions (36 R&B, 4 Mechanical) which execute the works. Each of these divisions is managed by an EE. There are 224 sub-divisions in the OWD under the charge of AEE or AE.

Design Planning and Investigation Wing

The design and planning activity in the organization, is provided through a separate Design, Planning and Investigation (DPI) Wing in the OWD. The Chief Engineer (Design Planning and Investigation) heads the Wing and has a reporting responsibility to the EIC-cum-Secretary, but at present Roads and DPI Wing heads, i.e. CE positions are combined together; where a Chief Engineer (Roads and DPI) takes care of both the functions.

Research, Development and Quality Promotion Wing

R&D and quality promotion activity is under the control of Chief Engineer (Research, Development and Quality Promotion). A laboratory was established in 1965 to cater to the need for testing of materials involved in road and building construction. The function expanded in 1982 to include a research development and quality promotion cell.

The bulk of the investigative and reporting work of the unit is related to the work undertaken in the Roads Wing. The unit is also responsible for monitoring and reporting on the quality of work undertaken in other operational wings, including National Highways, and Buildings Wings.

Buildings Wing

In addition to its responsibilities for roads, OWD has the task of supervising the construction and maintenance of public buildings on behalf of a wide range of State Government organizations. For this purpose, the organization of OWD includes a specific wing devoted to this activity. It is headed by a Chief Engineer (Buildings) reporting to the EIC-cum-Secretary.

The divisions, sub-divisions and sections in the field, which look after the roads, are also responsible for maintenance and construction supervision of public buildings within their jurisdiction but report to CE (Buildings) in building matters.

This Wing has a dedicated SE who is responsible for electrical works including installation, repairs and maintenance of electrical works in Government buildings. Four EE's (Electrical) are also part of this Wing. Similarly, there is an SE and two EEs responsible for Public Health, i.e. water supply and sanitation.

National Highways Wing

The responsibility for improvement and maintenance works on NHs is under the jurisdiction of Chief Engineer (National Highways). There are three NH circles and 15 NH divisions.

This Wing was set up to comply with the requirements of MOSRTH to:

- Reduce the line of communication between the GOI and the State authorities.
- Achieve efficiencies in implementation by avoiding the cumbersome and outdated delegations for administrative and technical sanction which limit the ability of the OWD to respond quickly.
- Achieve uniform maintenance and construction standards on NHs.

World Bank Projects Wing

It is a newly created Wing headed by Chief Engineer (World Bank Projects). This Wing is responsible for upgradation and maintenance of priority corridors of State Highways funded by the World Bank and other external funding agencies/financial institutions.

The Government of Orissa (GoO) is undertaking a World Bank assisted project to upgrade part of the Core Road Network under Orissa State Roads Project (OSRP). The high priority state roads identified for upgradation and improvement under the above project amount to 825 km (461 km in Phase-I and balance in Phase-II) of State Highways.

Orissa Bridge & Construction Corporation Ltd.

It is headed by a Managing Director of the rank of Chief Engineer. The Engineer-in-Chief-cum-Secretary is the Chairman of this organisation. This Wing is responsible for construction and maintenance of bridge works allotted to it by the Works Department and other government agencies in the State.

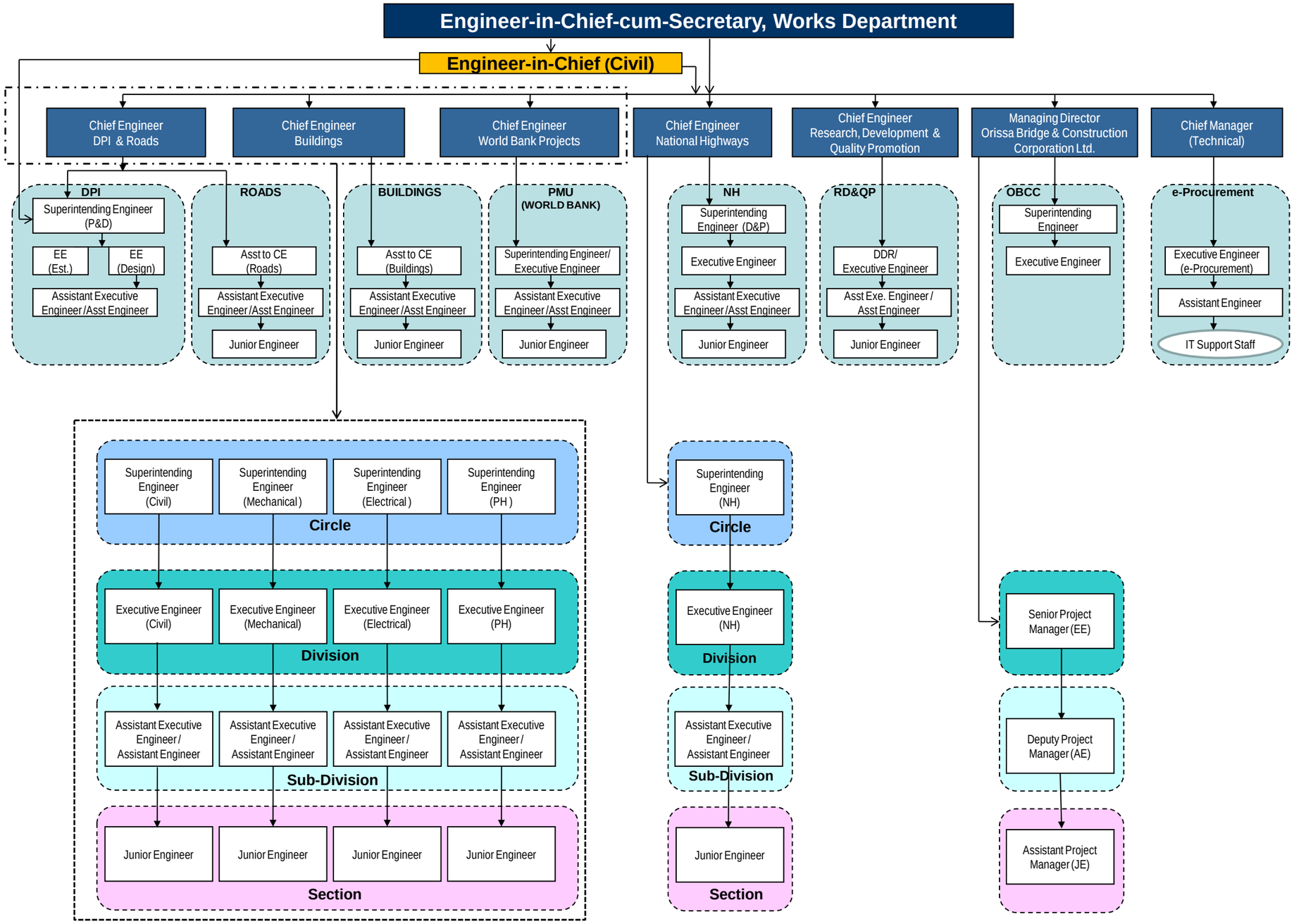

Figure 3-6: Organisation Chart of Orissa Works Department

3.3. FUNDING & BUDGETING OF OWD

3.3.1. Annual Budget of Orissa Works Department

The annual budget of Works Department is executed under two heads; planned (Under Five Year Plan) and non-planned works (refer to Table 3-6).

Eleventh Five Year Plan

The Works Department's targets for Eleventh Five Year Plan (2007-12) are: improvement of 4500 km of road stretches and construction of 52 bridges for a financial outlay of Rs.1945 crore. The financial and physical achievement upto December, 2010 are shown in Table 3-4 below.

Table 3-4: 11th Five Year Plan Achievements

Year	Financial Achievement (Rs. in crore)	Physical Target		Physical Achievement	
		Bridge (no.)	Road (km)	Bridges Completed (no.)	Roads Completed (km)
2007-08	356.29	19	617.69	16	605.39
2008-09	727.95	16	458.00	15	534.694
2009-10	644.15	12	467.00	13	569.519
2010-11 (Up to Dec 2010)	543.98	14	730.00	0	448.27

Achievements made by OWD under other schemes are as follows;

1. NABARD Loan Assistance:

This loan assistance is given by the GOI for improving rural infrastructure. Only MDRs and ODRs are included in this scheme. By the end of December 2010, 2160 km of roads were improved and 115 new bridge projects were completed. There is a further budget provision of Rs. 330 crore for the year 2011-12.

2. Revised Long Term Action Plan for KBK Districts:

In order to boost the socio-economic conditions of KBK (Undivided Koraput, Balangir & Kalahandi) districts, the Works Department was entrusted to take up road connectivity under this programme from year 2001-02. The achievement from 2001 to 2010 is shown in Table 3-5 below.

Table 3-5: RLTAP Achievement

Financial Allocation (Rs. in crore)	Physical Achievement	
	Bridges Completed (no.)	Roads Completed (km)
105.23	23	493.59

3. Central Road Fund:

Under this scheme, roads and bridges are improved using funds available from GOI as Central Grants. Since 2001-02, Rs. 345.92 crore has been spent against an allocation of Rs. 558.07 crore for construction / rehabilitation of 19 bridges and 125 roads. Out of a budget proposal of Rs. 75.62 crore for 2010-11, 28.42 crore was spent till December 2010 on 49.30 km of road. Some of the important roads partly funded under this scheme are Cuttack-Paradip Road (SH-12) and Jaganathpur- Berhampur-Phulbani (State Highways).

4. One Time ACA for Tourist Importance Roads:

In order to provide better connectivity to places of tourist importance/cultural heritage, GOI allocated Rs. 292.96 crore till 2009-10 for 53 road projects. During 2010-11, the Planning Commission of GOI sanctioned 21 projects at a cost of Rs.56.53 crore, out of which an amount of Rs. 28.40 crore was spent till December 2010 on 49.39 km of roads.

5. Roads of Economic Importance under E&I Scheme:

GOI sanctioned 9 road projects on 50:50 share with GoO. An estimated Rs. 333.69 crore was spent by 2008-09 on 14 road projects. One of the important roads, partly funded under this scheme, is Naranpur-Pandapara-Harichandanpur-Bharhmanipal-Duburi Road. The proposal for improvement of 69.80 km road at a cost of Rs. 135.70 crore for 4 projects has been sent to MOSRTH, GOI for sanction during 2010-11.

6. Interstate Connectivity:

GOI sanctioned Rs. 57.21 crore for 7 road projects for this scheme. A total of 108.64 km of road were improved upto December 2010 incurring an expenditure of Rs. 54.35 crore. A proposal for the improvement of 97.15 km of road at a cost of Rs. 190.63 crore has been sent to MOSRTH, GOI for sanction during 2010-11.

7. Road Development Programme (State Plan Normal):

Under this scheme, the State Government provides funds for the construction of ROBs, flyovers, bridges, improvement of important roads; land acquisition, capacity building etc. For this purpose a budget provision of Rs. 184.72 crore was made during 2010-11. By the end of December, 2010, Rs.135.55 crore was spent on the improvement of 49.61 km and on renewal coat on 25 km of Core Road Network.

Some Important Road Stretches and Their Funding Sources:

- Cuttack-Paradip Road (SH-12) with two-lane rigid pavement for a length of 82 km is under progress at a cost of Rs. 224.80 crore. The work is consists of 2 packages i.e. Package No.-I (0/0 to 43/00 km) at a cost of Rs. 112 crore and Package No.-II (43/00 to 82/00 km) at a cost of Rs. 112.11 crore. The funding has been obtained from various sources, e.g., MOSRTH, GOI have sanctioned Rs.26.46 crore under Central Road Grant and Fund, and Paradip Port Trust and Orissa Mining Corporation Ltd have funded Rs.30 crore.
- Vijayawada-Ranchi corridor which passes through several districts in Orissa has been taken up by the State Government for improvement. This is essentially done to facilitate development in Naxal-prone areas, to bring the inhabitants, who are mainly poor tribals to join the main stream society. Development of this corridor is anticipated to reduce Left Wing Extremism (LWE) activities. Under this corridor 979.70 km of state road has been considered, out of which 320 km has already been taken up for implementation at a cost of Rs. 598.90 crore. In addition, the GOI has approved a project proposal for 578 km of road at a cost of Rs. 1200 crore.

8. Left Wing Extremism (LWE) Scheme:

At the request of GoO, the GOI has agreed to provide funds for the improvement of road network in 5 Naxal affected districts (Malkangiri, Rayagada, Deogarh, Sambalpur and Gajapati) in Orissa. By the end of December 2010, GOI had sanctioned 14 projects for improvement of 614.82 km of road at a cost of Rs.945.02 crore, of which 7 projects are in progress.

9. 12th Finance Commission Grant:

Since 2006-07 an amount of Rs. 649.08 crore has been allocated for repair and maintenance of roads under this scheme. During 2008-09, Rs. 177.02 crore was provided for improvement of 176 projects which were completed. In 2009-10, the target was 144 road projects for a budgetary provision of Rs. 177.02 crore.

Non-Plan

In the year 2010-11, a sum of Rs. 555.26 crore (for roads and bridges) was spent, mostly for routine repair of about 14,500 km of roads (refer to Table 3-6)

Table 3-6: Financial & Physical Achievement of Roads and Bridges (Plan and Non-Plan)

Sl. No.	Scheme	2007-08			2008-09			2009-10	2010-11	Total (Rs.crore)
		Expenditure (Rs.crore)	Bridges (no.)	Roads (km)	Expenditure (Rs.crore)	Bridges (no.)	Roads (km)	Expenditure (Rs.crore)	Expenditure (Rs.crore)	
1	Rural Infrastructure Development Fund (NABARD)	166.03	10	351.23	194.83	12	265.13	281.32	355.88	998.07
2	General State Fund (Incl. ROB)	13.58	2		256.18	1		127.36	242.29	639.41
3	Central Road Fund (CRF)	66.56	1	118.11	151.85	0	102.06	73.91	52.18	344.50
4	ONE TIME Additional Central Assistance (ACA)	34.24		48.96	48.53		72.20	48.19	66.31	197.27
5	KBK	8.40	3	28.40	14.44	2	55.60	1.42	10.03	34.30
6	State Share of Central Sponsored Plan (E&I)	6.70			13.57			33.31	52.46	106.04
7	Central Share of Central Sponsored Plan (E&I)	31.60		58.69	19.57		39.70	22.00	26.61	99.78
8	Central Plan-Inter-state Connectivity (ISC)	16.96			14.52			7.01	7.81	46.30
9	Externally Aided Projects	14.06			50.01			33.70	93.99	191.76
TOTAL OF PLAN		358.14	16	605.39	763.51	15	534.69	628.22	907.56	2657.43
1	Non Plan (State)	437.92		NA	265.96		NA	268.39	555.26	1527.53
2	12th Finance Commission Grant	147.52		895.00	176.67		940.00	177.02	0.00	501.21
TOTAL OF NON-PLAN		585.44			442.63			445.41	555.26	2028.75
GRAND TOTAL		943.58			1206.15			1073.63	1462.83	4686.18

3.3.2. External Funding : Orissa State Roads Project (OSRP)

This is a World Bank (WB) funded project being implemented by Orissa Works Department (OWD) of GoO. The Project Development Objective (PDO) is to remove transport bottlenecks in targeted transport corridors for greater investment and economic and social development activities in the State of Orissa. The World Bank completed the loan negotiation for the Orissa State Roads Project (ORSP) in July, 2008 for an amount of US$ 250 million. The loan has a funding ratio of 80: 20 between the World Bank and the State Government. The loan agreement was signed in January 2009 and the loan became effective from April 15, 2009. It was agreed to take up 461 km of busy corridors of the State in the 1st phase at an estimated cost of Rs.1431.19 crore. The period of implementation of these projects is 5 years. Bids were finalized for implementation of 204 km out of the 461 km of Phase-I roads, which include the following roads in three contracts.

- Berhampur-Taptapani (41 km)
- Bhawanipatana-Khariar (68 km)
- Chandbali-Bhadrak-Anandpur (95 km)

A supervision consultant has been engaged for the supervision of the above three contract, where civil works have already started. Furthermore, the World Bank has funded the engagement of a consultant for taking up the task of preparation of DPR and bid documents for another 3 busy corridors i.e. Sambalpur-Rourkela, Joda-Bamebari and Koira-Rajamunda comprising 229 km under PPP. The consultant has submitted the required project documents for two roads and the third one is under preparation. A toll policy for the State is also under preparation which will be essential for road projects developed under PPP.

3.4. ACTIONS ON INSTITUTIONAL DEVELOPMENT: E-GOVERNANCE

In light of recent initiative by OWD regarding development of a web-based Orissa Road Asset Management System (O-RAMS), the Consultant explored other similar IT initiatives by GoO, the IT infrastructure available and the environment at the State level. This is important because the development and implementation of O-RAMS to some extent will be guided by the existing level of infrastructure in the State, and the usage and parallel initiatives of similar nature.

E-Governance

E-Governance is the application of **Information and Communication Technology** (ICT) for delivering government services, exchange of information, communication transactions, and integration of various stand-alone systems and services between Government and Citizens (G2C), Government and Business (G2B), as well as back office processes and interactions within the entire Government frame-work.

Vision

“Establishing a Networked Government for greater transparency and accountability in delivery of public services to facilitate moral & material progress of all citizens”.

Environment

The State has drafted the IT Policy 2004 which aims at establishing a robust and futuristic IT architecture in the State to bring about:

- Ease & convenience in transactions between the Government and the citizens
- Increased employment opportunities for the educated youth
- Higher economic growth in a definite time frame.

A number of critical core ICT projects have been or are being implemented in the State to establish the basic technological infrastructure.

Future Plan

GramSATs (a VSAT based 128 kbps network) under ORSAC, are installed at each DRDA and Block levels of Orissa. The OSWAN project is coming up as a better alternative solution to facilitate ICT in Orissa. The e-Governance related projects are running in isolation, but are expected to be integrated soon. Human Resource Development & Training has been started for Government staff (6000 employees) and public entrepreneurs. A state level Centralized Data Centre will also be developed soon.

3.5. INTEGRATION OF ASSET MANAGEMENT IN OWD

Having studied the OWD from various perspectives, it is evident that it has established organization set-up with clear responsibilities and decision making on its engineering, planning and management functions. Following key issues needs to be addressed through O-RAMS:

- Absence of scientific basis and rationale on which various decisions are taken at headquarters, circles and division offices.
- Lack of proper mechanism of data collection, record keeping, updation and retrieval
- Lack of training

3.6. BENEFITS OF ASSET MANAGEMENT SYSTEM

The many benefits and expected outcomes available to a road agency/department upon implementation of an asset management system may be put into the following categories:

- Communications (both internal and external)
- Asset inventory, condition and level of use
- Road network performance
- Asset management tools
- Budget process
- Staff development

The benefits as reported and realized by the developed countries, where an asset management system has been implemented, in each of the above six categories are listed below:

Benefits Relating to Communications:

Common benchmarks:

- Enable comparisons of funding levels to be made between individual assets (e.g. pavements and bridges).

Improved internal and external communications:

- Provide better communication of strategies and promotion of more effective management within the department.
- Enable more effective communication to stakeholders and improved understanding of stakeholder needs.
- Implement benchmarks to allow the identification and adoption of best practice.

Adoption of accounting practices:

- Leads to improved communication with budget holders and other decision makers
- Provides the value of assets to support the allocation of budgets.

Outcomes:

- *Better budget analysis and decision making provides an improved service to the community.*

Benefits Relating to Asset Inventory, Condition and Level of Use:

Integrated, harmonised database:

- Improves data quality and consistency, due to use of minimum quality standards.
- Allows comparison of information and standardized evaluation of condition.
- Improves data display and reporting facilities.
- Increases in access and use of new technologies for data collection and management provide a major benefit to the management of road assets.

Upgrade skills and technology:

- Provides opportunities to upgrade existing technologies improving the efficiency of data collection, storage, management, analysis and reporting.
- Provides opportunities to upgrade staff skills and ensure staff acceptance of a new business framework.
- Improves dissemination of information using new technologies.

Outcomes:

- *Provides operational efficiencies due to easier interpretation of data and better analysis tools.*

Benefits Relating to Road Network Performance:

Performance monitoring reports:

- Enables asset inventory and performance to be related to the needs and priorities of the users/public.
- Enables the improved use of inventory and condition data in planning, maintenance and budgeting.
- Provides an increased focus on public benefits.
- Provides information that can be understood by non-engineers to focus multi-programme strategies.
- Allows the impact of policy decisions on the infrastructure and on transport costs to be assessed.

Outcomes:

- *Enables the development of strategies that provide an appropriate level of service appropriate to specific budgets.*

Benefits Relating to Asset Management Tools:

Management systems for individual assets:

- Provides up-to-date, accurate information on the condition of the individual assets.
- Contains the tools to assist in the determination of appropriate rehabilitation and maintenance programmes and strategies for a given budget.

Common definitions and standards for rehabilitation and maintenance:

- Permits benchmarking with other road departments both locally and nationally.
- Enable the determination of design standards and levels of service together with the required budget to maintain these levels.

Economic modeling:

- Provides an estimate of the economic effect of spending scenarios.
- Enables the management of the asset on an economic basis.
- Allows prioritization of maintenance needs on the basis of future costs rather than current condition.

Outcomes:

- *Enables more effective use to be made of available resources.*
- *Facilitates improved programming for asset rehabilitation and maintenance.*
- *Enables asset management to perform as a planning and investment strategy tool and not just a traditional, engineering-based management system.*

Benefits Relating to the Budget Process:

Assessment of investment choices:

- Improves the process of allocation within a programme area (such as pavements).
- Enables the use of standard accounting concepts and terms to provide understandable information to decision makers.
- Enables an enhanced analysis of budgetary need.
- Allows the identification of the potential impact on assets if budgets are reduced or performance standards are lowered.
- Improves the process of allocation of the management of maintenance and rehabilitation budgets.
- Provides enhanced budget reporting information for financial managers and decision makers.
- Provides a negotiation tool to justify budgets to government and decision makers based on sound technical and economic criteria.
- Enhances the credibility of the decision-making process.
- Enables the assessment of the implications of using specific network level performance measures.

Outcomes:

- *Enables the determination of the funding levels required to maintain an asset at a specified level of service.*
- *Enables the prioritization of work requirements and funding allocations to achieve the goals and objectives of the administration.*
- *Enables the allocation of expenditure between individual assets to give the best value for the overall asset.*

Benefits Relating to Staff Development:

Staff development opportunities:

- Broadens the multi-disciplinary knowledge base.
- Indirect benefits can be realized by departments' staff, resulting from implementation of an asset management system.
- Provides access to accurate data and state-of-the-art information technology.
- Provides access to the analysis tools needed for cost effective management.
- Provides the opportunity to make the right decisions on programme spending at the right time.
- Improves the credibility of the decision-making process.
- Improves the ability to defer lobbying pressures from special interest groups.
- Provides the ability to query databases to a wide range of staff.

- Enables front line staff to become more involved in the decision making process.
- Provides opportunities to improve the technical and business knowledge of staff.

Outcomes:

- *Increases productivity due to reduced information fragmentation and increased ease of access.*

The actual benefits that can be realized by a road agency/department, however, will depend to a large extent upon its organizational structure and culture, and most importantly upon its keenness to change, and its ability to adopt and adapt to change.

4. APPROACH, METHODOLOGY & WORK PLAN

4.1. APPROACH

The system to be implemented at the OWD will be a full-featured system, allowing for large scale usage, full configurability and controlled accessibility. A 'commercial-off-the-shelf' (COTS) software product implemented world-wide is proposed[1] to be used as the core O-RAMS software solution. This will be configured upon its selection for implementing RIS, BIS, PMS, RMMS, TIS and RWFIMS.

There are basically three activities/components of the Project that needs to be undertaken simultaneously with a fair degree of integration between them. These are:

1. System development / integration
2. Data collection, and
3. Spatial data / mapping or GIS.

The above three are intertwined with each other. It is not appropriate/possible to undertake any one of them independently. Therefore, the approach will have to have synergy in the tasks of all three components. A layout of the approach is presented below in Table 4-1.

Table 4-1: Approach

System Development	Data Collection	GIS
Needs Analysis		
1. Review of international / national best practices 2. Assessment of maintenance practices and system in OWD 3. Gap analysis 4. Functional/ business / system requirements	1. Review of international / national best practices 2. Review of data available with OWD 3. Gap analysis 4. Firming up data collection procedure and formats	1. Review of international / national best practices 2. Review of data available with OWD / ORSAC 3. Identification of base mapping & procurement 4. Procedures for base mapping, scheme and integration
Conceptual Model		
1. System architecture 2. System design and integration 3. Database design and integration 4. Deployment architecture	1. Location referencing system design 2. Survey organisation 3. GPS survey 4. Data verification at site (inventory)	1. Strategic base mapping (for data collection) 2. Detailed base mapping procedure 3. GPS data integration and validation
Development		
1. Business logic 2. User interface 3. Master data tables 4. Report design 5. Release of beta version for testing	1. Condition survey (both visual / actual) 2. Building condition relationship model 3. Traffic surveys 4. Pavement strength & bridge Condition survey 5. Data coding and validation	1. Spatial / attribute data updation 2. Segmentation of linear attribute

[1] .dTIMS CT was considered as option at the proposal stage and also is part of the Contract. However, now based on the discussions with OWD we will be recommending COTS after the needs analysis and with the consent of OWD.

System Development	Data Collection	GIS
Training and Implementation		
1. Procurement of database / application / web server 2. Bug fixing and release of O-RAMS 3. Networking and Installation of O-RAMS at HQ & pilot offices 4. Testing, evaluation and refinement 5. Full scale roll out 6. User training	1. Data collection training 2. Data entry to O-RAMS and testing 3. Refinement and full scale Entry	1. Data integration and testing

4.1.1. Needs Analysis

The approach to needs analysis will involve the following three steps:

1. What are the international and national best practices relevant to the Project?
2. What is the organizational structure, function, decision making process, capabilities, IT environment etc. in the OWD?
3. Gap analysis and assessment of what is further required

The resolution of the above will invariably involve a series of consultation with the OWD in order to firm up the functional, business and system requirements. All PWDs in India are similar in nature so far as functions and mandate are concerned, but unique in other aspects, such as, organizational set-up, delegation of roles and authority, capability, motivation, internal procedures, and maintenance practices. Drawing upon the Consultant's experience and expertise in implementing similar projects in developed and developing countries, it will identify the best international practices and solutions available which are appropriate for OWD. The Consultant will also review various asset management systems in India and elsewhere to draw upon their experiences and learning.

Following a review of the existing OWD systems, IT environment and requirements, a conceptualization of the system architecture and of the functions of key components (data collection, GIS and system selection / development) will be undertaken in accordance with the scope as given in the Terms of Reference. Thereafter, respective domain and technology specialists will finalize the system requirements along with appropriate data collection and business processes, taking into account the findings from the review of previous relevant studies conducted by OWD, the existing OWD practices and the feedback from OWD. With the system requirements in place, the gaps between the existing system/business processes/practices and the O-RAMS system/business processes will be identified and a need-based plan to address these gaps in the system design, data collection and GIS shall be firmed up. The data collection requirements and their procedure will also be firmed up during this stage.

One of the principal requirements of the project is the integration of GIS with the road data. Establishment of a procedure at the onset of the Project would facilitate data collection and further detail level mapping of various road infrastructure. A mapping framework that provides the basic platform from which all the GIS layer are referenced, and preparation of a base map from the available and authentic sources shall be the primary task in this phase. A preliminary base

map from the available sources of reliable information from OWD will be combined with a recent satellite image with the most updated information on a relevant scale. This preliminary base map shall be updated using adequate ground reference points using GPS. The ground reference points shall be distributed across the State to ensure higher transformation accuracies during rectification. This is further dealt with in more detail in ensuing sub-sections of this chapter.

One of the important tasks of the consulting services is to establish an asset management system, by identifying and acquiring the most appropriate software, which meets the requirements of OWD. An asset management system (AMS) for roads must include and meet specifications and requirements specified in the Terms of Reference. Therefore, the evaluation and selection of COTS is an important event in the assignment that will determine the course of the project, as the assignment revolves around the configuration and use of this software for performing future activities.

The output of a needs analysis will be the following:

1. Data collection procedure and formats
2. GIS methodology and mapping framework
3. Evaluation / selection of COTS
4. Conceptual system architecture
5. Hardware and software requirement

4.1.2. Conceptual Model

This stage will follow the outcome of needs analysis and build on the following tasks:

1. Confirmation of COTS that will be configured for this project
2. Data to be collected, procedure and its use in O-RAMS
3. Integration framework of O-RAMS in OWD business process

A conceptual model covering the following aspects shall be established:

- System architecture
- System design
- Database design and integration
- Deployment

The approach to establish a conceptual model has to be need-based. Taking the requirement from the Terms of Reference on various components / tools, and the outcome of the needs analysis, an assessment of the appropriateness of the component and the level of complexity of the feature that could be successfully incorporated within the OWD will be undertaken. Conceptual system architecture (as firmed up during the needs analysis) will identify the relationship of various tools / models that will be integrated into O-RAMS. The flow of data from various modules ensuring the integrity of data will be established at this stage including preliminary database design. A system for exchanging information from O-RAMS, including via internet in a secure manner, will be established.

A location reference and a data reference system will be devised such that all modules talk to each other on the same platform using the same reference. This is a most important part of the Project which will determine the way data is attached to the asset. It is intended to introduce modern referencing method in addition to traditional linear referencing. Data collection formats will be designed in such a way that it responds to the adopted method and thereafter seamlessly imports it to O-RAMS.

4.1.3. System Development

Once the conceptual model is established and is approved by the OWD, a systematic system development shall follow. This will be integrated in the overall framework of O-RAMS and configured. Therefore, the system development will be essentially a configuration of COTS and new development limited to tools that do not feature in the COTS. We intend to approach the system development in the following manner:

1. Setting up the business logic
2. Setting up the master data tables
3. Design of user interface (for tools / modules not addressed in COTS)
4. Design of reports / report output
5. Module integration
6. Release of beta version for testing

Setting up the business logic into the COTS (system configuration) is the major task as part of system development. This includes setting up various models, their parameters, formulas and tools, based on the findings of the needs analysis of OWD and its maintenance practices. These will be based on design documents prepared by various domain experts. Various master data tables such as jurisdictions, codes for various parameters have to be standardized for use in different modules. These need to be carefully documented and kept aside for future reference of OWD.

User interfaces would be designed for the new modules and interfaces provided by COTS would be customized to suit OWD requirements. This will be based on the feedback from OWD to provide a user-friendly and simple interface for ease of handling.

Reports are the key to visualize the outputs from the models in the form of graphs, simple charts, GIS maps, pivot tables or summary reports. Established reporting formats of OWD would be replicated, where necessary and possible, and value addition would be undertaken by providing additional information useful for decision-making at various levels. Emphasis will be given to graphical and map-based outputs, rather than data reports. The report content would be carefully chosen for various levels of reporting in OWD.

At the end of the integration and development a beta-version would be released for testing with actual data. Test cases would be developed for each of the functions / tools and tested with results documented at every stage. After fixing of any identified deficiencies / bugs, the version for acceptance testing will be released.

4.1.4. Training and Implementation

The training program is not only a tool to make an improvement in the level of service of infrastructure, but also, more importantly it makes sure that such improvements are made on a sustainable basis. The process of technology / skill transfer, training and manpower development is one of the critical areas of this assignment. Our effort shall, therefore, be to ensure, through the mandate given and the degree of participation of OWD engineers, this becoming an integral part of new thinking, and in the implementation of the new system and the commitment they have in the longer term to the State and the community in prioritizing investments and providing better level of service. This is not just one technical task. It is much more. Internalizing asset management system is important. And, this is not possible unless engineers know, accept and own the system.

Our experience in skill transfer suggests that this process can be inculcated in all aspects of the assignment without unduly affecting the daily work flow. But a true transfer can only be achieved when all stakeholders in the project are fully aware and committed to the project training objectives even if it is informal. It is to be understood that the skill/knowledge cannot be transferred overnight.

The approach that training and implementation should go hand in hand enhances the chances of successful implementation of O-RAMS at every level. Training will be need-based geared to each level of OWD officers. For example, workshop for high level administrators and on-the-job training at site for lower level officers.

The ToR describes the mandate of skill and knowledge transfer at the following levels:

- Level 1: Training to approximately 210 OWD Engineers / IT staff (approx. 700 staff-days) on various aspects of O-RAMS within Orissa at site.
- Level 2: Field exposure within the country but outside Orissa; training to 40 OWD Engineers in 10 batches (10 x 4 OWD Engineers) for one week each.
- Level 3: Overseas training, field exposure to 12 selected OWD Engineers in three batches (4 Engineers in each batch) in Canada for 2 weeks each batch.

The most effective techniques are proposed to be adopted by us to provide the individuals with ample opportunities to integrate skills through practice in a work environment. The extent and coverage of training will be based on a clear assessment we proposed to make under Training Needs Assessment (TNA). The following is a suggested approach, which can be tailored up or down, to meet the needs of the OWD during implementation of the same.

- Establish how much project time is to be designated for training activities.
- Establish objectives of the training by the focus areas
- Propose a tentative calendar
- Review the home-office orientation course and the techniques for two-way transfer of the knowledge/skills between the Consultant and OWD staff.
- Reach an agreement on the involvement of the counterpart staff in the various tasks of the project.
- Finalization of training modules, form, duration and level of trainees.

In order to ensure high impact of the training effort, the Consultant propose to follow a phased process that focuses on providing effective targeted training and make the training results last.

Focus area of training / skill transfer will be on:

- Data collection procedure/technique, and entry of data into O-RAMS
- Maintenance planning and budgeting
- System use - various levels
- Performance monitoring and decision-making using O-RAMS and RIS software
- System maintenance / improvement

The following photographs illustrate some of our training exercises undertaken in the field and in office environment.

Training on Data Acquisition Related to Asset Management System in the Field

Training on Data Entry and System Use at Various Level in Classroom Environment

Focused Group Discussion in Office / Workshop

4.2. METHODOLOGY AND WORK PLAN

In response to the mandate in the ToR, an indicative methodology in the Description of Services covered the entire process to be followed under 10 Tasks and 83 Sub-Tasks. These tasks and sub-tasks are further elaborated at this stage. This will be further fine-tuned from the experience with the Pilot Project in selected divisions.

4.2.1. Task-1: Assessment of Current Maintenance Management System

Sub-Task 1: Mobilization and Interaction with OWD Officers

Mobilization of the key and support professionals was undertaken since the commencement of the Project on May 5, 2011. Interaction with various OWD officers and agencies has been initiated. A date-wise activities on the interaction are presented in Chapter 1: 1.3.

Sub-Task 2: Project Appreciation

Key and support professionals of the team have been deliberating since the inception, on various aspects of the project related to software procurement, data collection and GIS. The methodologies for these three aspects have been evolving based on the availability of the basic data/information from OWD and other agencies, and are elucidated in Section 1 of this Report.

Sub-Task 3: Review of Data Available with OWD

Inventory data of roads, culverts and bridges collected by OWD in 2007 for Vision-2015 (now Vision-2020) Project was discussed and shared with the Consultant. The Consultant reviewed the data and found the data to be old but useful, and that every effort should be made to make the maximum use of it. The Consultant offered to examine the Vision-2020 data and indicate the deficiencies and the gaps therein, and prepare a detailed list. It was suggested by the Consultant that only if the divisions could: i) collect the missing data, ii) update the 2007 information wherever it has changed, and iii) correct any erroneous information; this would considerably reduce the tedious work of the Department in collecting data in the field as compared to using a new format.

A detailed review of the inventory data from a survey in 2007 is underway on a division by division basis. The OWD is retrieving more such data. Action for updation and filling in of missing data is already planned. The formats were discussed with OWD and circulated to all circles and divisions offices for updation of inventory data. The data formats are listed below while the formats with detailed explanation on the items therein are provided in Section-V, Chapter 8:

1. Road Inventory Data Sheet
2. Pavement Composition
3. Inventory for Culverts
4. Bridge Inventory Data Sheet

Sub-Task 4: Conduct Site Visit

Some sections of the network, e.g., SH-13 (Khurda-Jatni-Pipili Road) and MDRs (Pipili-Konark Road, Nimapada-Astaranga Road, PhulnakharaNialiCharichhak-Gop Road) were visited for an initial assessment of the road conditions and verification of OWD data. Details of the site visit and their findings are given in Chapter 3: 3.1. This task will continue in the Pilot Divisions in Cuttack Circle.

Sub-Task 5: Finalize Approach and Methodology (for Data Collection, GIS / GPS Mapping)

The data collection will be undertaken as outlined in Table 2 of the Description of Services (page 36) of the Contract Agreement on the defined network over a period of two (2) years. Based on the experience from the Pilot Project, any modification to the data collection may be proposed to make it more effective. A summary of field survey that will be undertaken in the Project is outlined in Table 4-2.

Table 4-2: Field Survey Summary

Items	Unit	Survey Quantity (By Consultant)				Survey Quantity (By Client)				Remarks
		Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Total	
GPS Referencing	km	18069			**18069**					All roads (NH, SH, MDR / ODR)
Inventory of Pavements	km	3614			**3614**					20% verification
Inventory CD Works	km	3614			**3614**					20% verification
Roughness on Paved Road Using ROMDAS	km	8163			**8163**			8163	**8163**	1. Data on NH will be made available by the Client for Year 1 & 3 2. Client may ask the Consultant to validate on 20% of NH length 3. Data on SH/MDR will be collected by the Client in Year 3
Surface Distress Indicators (Visual)	km	8163			**8163**			8163	**8163**	1. Data on NH will be made available by the Client for Year 1 & 3 2. Client may ask the Consultant to validate on 20% of NH length 3. Data on SH/MDR will be collected by the Client in Year 3
Surface Distress (Mechanical)*	km	800			**800**					Demonstration Project for assessing the possibility of its use in future data collection by the Client.
Pavement Strength (BBD /FWD/ CBR)	km	6122			**6122**		2041	2041#	**4082**	1. 75% on SH/MDR in Year 1 by the Consultant. 2. 25% on SH/MDR in Year 2 by the Client. 3. 25% on SH/MDR in Year 3 by the Client.
Bridge Condition (Major)	No.	300			**300**			300	**300**	
Bridge Condition (Minor)	No.	1350			**1350**			1350	**1350**	
Traffic Survey (Classified Volume Count 3-day on SH/MDR)	No.	200	200		**400**			200	**200**	1. Data on NH will be made available by the Client for Year 1, 2 & 3. 2. Client may ask the Consultant to validate on 20% of locations.
Traffic Axle Load (One Day)	No.	30			**30**			30	**30**	1. Data on NH will be made available by the Client for Year 1 & 3. 2. Client may ask the Consultant to validate on 20% of locations.

it is not necessary to conduct structural strength survey on 25% of the network by OWD (during Year-3), rather, it should be limited to the roads on which this survey was not possible during Year 1 or Year 2 because of the on-Going works. Repeating Year 1 or Year 2 measurement serves no purpose.

Pavement condition survey will be undertaken using a simplified, visual rating method of road condition. This will be first undertaken through a Pilot Project. A demonstration project for surface distress using mechanized / automated equipment will be undertaken on 800 km. The stretches will be selected with the help of OWD. The Consultant is in touch with the agencies who provide such equipment. This will be finalized in August/September 2011, to enable the survey to start by December 2011.

All logistic arrangements, data format, permission letters from the Client etc. will be initiated before the commencement of field activities. Actual survey locations, particularly for traffic, and axle-load surveys, will be finalized in consultation with OWD.

The first task will be to review the available skills and resources of the OWD for the purpose of sustainability of the data collection. This will be ascertained during interaction with the OWD staff, both at the headquarters and at the divisional offices. An indicative methodology is proposed in Table 4-3, which will be modified (if required), to suit the project objective and the practical limitations. Assessment of the data requirements, data collection methodology and proforma for data collection will be finalized during the Pilot Project.

Table 4-3: Data Collection Methodology

Data Type	Methodology
GPS Referencing	The Global Positioning System (GPS) survey is being undertaken on entire 18,000 km network of NH, SH, MDR and ODR using Garmin GPSMAP 78s which is a handheld mapping instrument. This instrument has a positional accuracy of 2-5 m and has a facility to record a maximum of 2000 points. This feature is being used to record location of various roadway attributes such as km stone, cross road / junction, culvert, bridge, village, change of pavement width / type etc. while travelling along. It also has feature (record track) to automatically record location of points at a regular interval (distance or time). This is being used to record the center-line of the road at every 10m interval. The points captured will be further processed and rectified using a satellite base map. The data collection formats are provided in the Chapter 8.
Inventory of Pavements, CD Works	OWD will provide the Consultant with the inventory data of pavements and CD works. The Consultant will verify about 20% of the field data to ensure its suitability for use in the proposed O-RAMS. In case of the discrepancies in the field, the Client shall provide the updated data to the Consultant within 60 days. The verification of location of roads, surface type, width, CD structures including bridges etc. is being undertaken during the GPS referencing survey, while taking along the divisional staff. Rest of the features of road, CD structures and bridges will be verified during the condition survey in October. The data collection formats are provided in the Chapter 8.
Roughness on Paved Roads Using ROMDAS	Road roughness, expressed in IRI will be measured, using the ROMDAS fitted with Bump Integrator (BI) and Odometer on over 8,200 km of State Highways and MDRs during the first year. The BI fitted to the floor of the vehicle mechanically measures the vertical displacement of the rear axle relative to the vehicle body. It is to be calibrated for a vehicle type, speed. The BI is also calibrated using a MERLIN developed by TRL. The odometer is also to be calibrated for distance / speed. From the calibration, regression equations are developed and fed into the software for further analysis to get standard IRI from the collected raw count of bumps for every 100m of the surveyed sections.

Data Type	Methodology
Surface Distress Indicators	Four distress types, i.e. cracking, pothole, raveling and rutting will be used to visually describe surface distresses of flexible pavement. A system of describing severity and extent (density) has been devised for calculating the surface distress index, and possibly Pavement Condition Index in combination with the roughness. Rating of surface distress on concrete and gravel pavement is also are being considered as it is found that the OWD road network has substantial network of above surface types. The data collection formats are provided in the Chapter 8. A mechanized system to capture surface distresses will be used on a demonstration basis to assess the feasibility of its use in the future by OWD. At this stage potential survey vehicles that could be used for this purpose are being explored. Information on Hawkeye and ARAN, automatic survey vehicles from two vendors in use worldwide is attached in Annexure-IV as reference only. A decision to use one of these or similar vehicles for a demonstration project will be made at a later date.
Pavement Strength (BBD / FWD / CBR)	Structural strength testing of the pavement will be carried out by means of Benkelman Beam / FWD at an interval of 500 m. A data collection manual is being prepared that will explain the procedure in detail. The data collection format is provided in the Chapter 8. The in-situ CBR of the sub-grade will be back-calculated from a modified BBD testing method and relationship equation(s) to be developed specifically for this purpose, taking into account the existing pavement structure(s). The representative structure(s) of the existing pavement will be established at the edge of the pavement as required for validation/calibration of equation(s) for back-calculation of subgrade CBR from the BBD deflection basin. Routine soil testing will be carried out on the samples, including the lab CBR test on the subgrade soil and field moisture content as per IS: 2720 in order to correct the deflection measurements using the charts of IRC:81-1997.
Bridge Condition	Bridge inventory details shall be provided by the Client, following which a condition survey of bridges will be undertaken by the Consultant through visual inspection, in the first year. In year 3, the data shall be collected by OWD with the assistance of Consultants through its core Asset Management Group as a part of Technology Transfer. Condition Survey will include four critical attributes like Cracking, Spalling, Corrosion of reinforcement and Condition of Bearings which are the major defects for condition rating.
Traffic: AADT	The Consultant will carry out 3-day classified traffic volume count survey by manual counting for 16 vehicle types at 200 selected locations on SHs, MDRs and a few ODRs. The Consultant has identified 115 locations on which traffic volume count was undertaken in 2007 on various SHs and MDRs. While these locations are being reviewed, 85 new locations have been identified on rest SHs, MDRs and selected ODRs. These locations will be finalized in discussion with OWD. The format for data collection is provided in Chapter 8. The Consultant is also exploring a method to count the vehicles by analyzing frames from video recording. It will be tested as a pilot project and put to use at selected locations in place of manual count.
Traffic: Axle-Load	The Consultant will carry out axle-load surveys at 30 selected locations on State Highways and MDRs, and if necessary at some ODR(s). The locations will be finalized in discussion with OWD. Axle-load study was undertaken in 2007 on 9 locations on selected SHs and MDRs. Adequacy of location of these locations will be studied and further 21 new locations will be identified. The format for data collection is provided in Chapter 8.

More details on the methodology for GIS / GPS mapping is provided in Sub-Task 15 through the following pages.

Sub-Task 6: Finalize Task Assignment and Scheduling

The task assignments and scheduling has been reviewed and a work plan against actual time line is provided later in Section-IV, Chapter 7. The tasks related to data collection have been rescheduled to accommodate monsoon season in Orissa during which field activities are not feasible.

Sub-Task 7: Prepare Draft Data Collection Formats

As already discussed, OWD will update the inventory data in the format that they have used for the project Vision-2015 in 2007, for:

1. Road Inventory
2. Pavement Composition
3. Culvert Inventory
4. Bridge Inventory

A format with description and instructions to assist in the task is included in Section-V, Chapter-8. Further, data collection formats have been designed, but at this stage they are in a draft nature. A fine-tuning based on further deliberations and testing in the pilot divisions is planned for the future.

Sub-Task 8: Prepare and Submit Inception Report

The Draft Report was submitted to PMU on June 6, 2011. Based on the comments received from the World Bank and the OWD, it is now revised and resubmitted.

Sub-Task 9: IDS Report Study and Review of ISAP

The preparation for ISAP project is still under process, therefore, review is not possible at this stage. The objective of review of ISAP was to know if there is any reference in it to; standardization of specification / practices for maintenance management, or policies and strategies related to road sector, or / and any other such matter that may have impact on the design of maintenance / up-gradation strategies for PMS. Since the assignment is yet to start, a review is not possible. The Consultant for “IT-ICT-MIS” assignment and O-RAMS will need to liaise together as facilitated by the OWD from time to time.

Sub-Task 10: Review Current Maintenance Management Practices of the OWD and MIS

A discussion was held with the PMU staff on the planning process of OWD and maintenance management methods. Funding sources for the maintenance and development of the network were also discussed at the same meeting. Details of OWD roads, institutional setup, maintenance and funding are elaborated in Chapter 3. This task, however, is not complete; this aspect will be further deliberated during the next few weeks and a comprehensive review of various aspects related to current maintenance and management practices of the OWD will be done. The review of current practices will encompass various aspects of budgeting and planning, project development, programme delivery and monitoring within OWD. The specific areas which will be reviewed are:

- Current referencing system
- Data collection
- Planning and budgeting
- Design and specification of maintenance works
- Procurement and supervision
- Quality control and/or assurance
- Current level of computer/software use
- Institutional setup
- Expenditure patterns of the road sector for the last 5 years, method of current resource allocations and the coverage of the maintenance programs at the current level of funding.

Each of the above aspect will be compared with the industry's best practices. Recommendation for improvement in each area will be provided in line with asset management principles.

Costs of works for standard design and specification for improvement and maintenance options will be estimated from historical data and/or engineering estimates in consultation with and collaboration of OWD. Strategies for road maintenance will be formulated for planning and budgeting studies. Standard reporting undertaken internally within the Department for asset information, maintenance / improvement will be reviewed and documented for accommodating within O-RAMS. The institutional setup and decision-making process will be reviewed. The Consultant will review the involvement of other wings and norms/guidelines adopted in budget both for capital and maintenance works. This sub-task would involve a series of discussions with various levels of officials within OWD, in head office and those in the field as well.

Sub-Task 11: Needs Analysis and Outline of O-RAMS System Architecture

Needs analysis with respect to IT infrastructure, O-RAMS architecture, COTS and maintenance practices are currently ongoing based on the defined approach. This will be further firmed up during the course of the Project and presented in the needs analysis report. Essentially, the following tasks will be performed:

- This task would involve a full review of any relevant existing systems and tools related to the O-RAMS at every level of OWD. This will include computerized and non-computerized practice followed within the department.
- The early establishment of the O-RAMS 'system architecture' is critical to the success of the subsequent implementation. It is important that the implementation of the O-RAMS conforms to the overall IT strategy of Govt. of Orissa.
- The Consultant to employ a method developed by the World Bank[2] that allows the assessment of the current level of IT infrastructure in OWD, and recommends the appropriate set of features of the RMS software commensurate with the level of sophistication and complexity that could be supported. A format for the same is attached in Annexure-II.

[2] Generic Terms of Reference for Supply and Installation of Road Management Systems, Version 1.0 – 31 January, 2007, East Asia Pacific Transport Unit, The World Bank, Washington, D.C."

- Similarly, with respect to the O-RAMS-related data, the data collection processes and procedures and the use of associated equipment/tools will be assessed so that they are compatible with the capacity of the OWD.
- The Consultant envisages COTS playing a pivotal role in providing source of road and bridge related data as well as a link with other modules within (e.g. inventory, condition, and road network definition). It also links to the GIS which mean that virtually anything in the proposed O-RAMS that is referenced against the network could be displayed visually. Furthermore, the O-RAMS will be accessible securely over the Internet, giving users rich map-based reports that help them see impacts of decisions immediately. Therefore, early selection of COTS is an important milestone of the project. The needs analysis report will cover a review of various COTS and enable selection of it for adoption in O-RAMS.

The proposed system architecture will be discussed in a workshop with participation of OWD engineers and other experts.

Sub-Task 12: Prepare and Submit Needs Analysis and Overall System Architecture Report

All works related to Sub-Task 11 will be finalized during the next few weeks and a report will be submitted at the end of the 3rd month.

Sub-Task 13: Review the Road Classification System

It is proposed to introduce an addition to the existing classification in the identified core road network of the State. The core network needs to be identified with macro level perspective using Multi-Criteria Analysis (MCA) approach and parameters such as:

- Physical status
- Traffic level
- Connectivity (between major urban centers)
- Connectivity to ports and other economic centers such as industries, SEZs etc.
- Missing link between two important corridors.
- Spatial coverage

In addition to the traffic volume data to be collected at 200 locations by the Consultant, data/information available within OWD or from other sources will be utilized in this exercise. Functional hierarchy established through this process and endorsed by the Government may be further fine-tuned after a year, once more information and better database is available. Since this activity depends upon the availability of road inventory and traffic survey results, the task may only be completed by the 10th month when the data is available. A report on same will be submitted at the end of 11th month as a part of Task 5.

Sub-Task 14: Assess Current Road Reference System, Propose Refinement and Data Model for O-RAMS

The current road reference system is linear. Under each road category roads have a linear chainage system in place. The Consultant has reviewed the system, and a similar linear system will be adopted for O-RAMS.

As part of data collection, the GPS co-ordinates of the road centerline of the NH, SH, MDR and ODR road network within Orissa will be recorded. Any data related to the road may then be referenced and shown by utilizing a linear offset along this shape in the GIS. Geographic locations (i.e. GPS coordinates) of important point assets such as km stones, culverts, bridges, level crossings, major road junctions will also be recorded separately and will be made available as an added layer. As this task is important and pre-requisite for any data collection and system design, it has been initiated on a pilot basis. This aspect is further deliberated in subsequent Sub-Task 22.

Sub-Task 15: Deliberate on GIS/GPS Requirement, Recommend Necessary Data/Maps/ Images to be Procured and Outline Methodology for GIS Development

The following is the methodology for the GIS / GPS development.

1. Base Map Preparation and Satellite Data:

High resolution satellite data must be procured for preparation of GIS base map for O-RAMS. This data will also be useful in regional planning and undertaking road developmental works, planning & identifying new roads/ missing links etc., width enhancements, routing of way during road / bridge / culverts maintenance works and other emergency situations.

There are various satellites providing high resolution satellite data like IRS, Quick Bird, etc. A resolution of about 1m is considered as high resolution these days although 5.8m MSS is also used as a cost effective technology. High resolution satellite data with resolution ranging from 0.6m to 5.8m obtained from various satellites are listed in Table 4-4.

Table 4-4: Cost of Satellite Data

Sl. No	Satellite / Sensor	Resolution	MSS/ PAN	Cost / km^2	Scale / Cost	Usage
1	IRS LISS IV MSS	5.8m	MSS	Rs.14	1:25,000, **Total Cost Rs.22 lakh**	Thematic mapping – watershed mapping, land use etc & road mapping.
2	IRS Carto 1	2.5m	PAN	Rs.13	1:10,000 **Total Cost Rs.21 lakh**	Roads mapping , low level urban mapping
3	IRS Carto 2	1m	PAN	Rs.70	1:8,000 **Total Cost Rs.1.2 crore**	Urban mapping
4	Quick bird *(selected data along the road)*	2 m	MSS	Rs.850 for archive data and Rs.1,150 for new acquisition	1:10,000	Urban mapping
5		0.6 m	PAN		1: 4000 Urban application including right-of-way **Total Cost Rs. 5 crore**	Urban mapping

MSS – Multi Spectral Scanner
PAN – Panchromatic

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High resolution satellite data is required only for a width of 100m along the road, but the satellite data is available only in scenes (9.6 km x 9.6 km). Since the costing is done per sq km the total cost of the data will be about Rs.5 crore assuming selective ordering of scenes (refer to items 4 & 5 of Table 4-4). Furthermore, most of the data procured will not be put to use for our purpose. Hence, it is not advisable to buy 1m or better satellite image purely from the cost perspective. Therefore, it is suggested that OWD should explore acquiring the available satellite image of 1m or better data existing with ORSAC or other departments. The OWD may even consider procuring 5.8m MSS data as a cost-effective technology, but this will compromise the accuracy.

It is apparent that ORSAC is unable to provide the required data / images, therefore, an alternative source, NRSA, for satellite data is proposed. The delivery of the data by NRSC takes 3 weeks from the date of order confirmation with 100% advance payment.

2. Survey of India Topo Sheets:

Survey of India (SOI) provides OSM series topo sheets on the scale of 1:25,000, 1:50,000 and 1:250,000 in hard copies and soft copies. Each scale of maps provides various level of information, with 1:25,000 scale providing information at a higher level (more information). The copyrights of the hard copy topo sheets lies with the Survey of India and the user can only use it without scanning or photocopying.

Information from the Survey of India cannot be used alone as a base map in replacement of satellite images as extracting features along the road is not possible, thereby limiting its capability for use in O-RAMS. The available information such as village / tehsil / district / settlement / forest boundaries, water bodies, rivers can only be superimposed on a satellite image for area level analysis.

For O-RAMS Project, we can use available vector map on 1:250,000 scale as reference for boundaries to be superimposed on the base map (being created through satellite image). Assembly and Parliament constituency maps should be acquired from the Census of India, digitized and superimposed.

ORSAC may have access to the Survey of India vector layers as they are the nodal agency for spatial data creation in the State. OWD may consider procuring vector layers from them.

The details of cost of the SOI vector maps, in case it is to be procured directly from SOI are provided in Table 4-5.

Table 4-5: Survey of India Vector Layers

Sl. No	Description	Cost per Sheet	Scale	Approximate Cost
1	OVLMF/250K/15 All layers	Rs.16,500	1:250,000	Rs.6,00,000
2	OVLMF / 42 Village boundary	Rs.4,950	Unverified	Rs.2,00,000

If no satellite map could be procured, the GPS data will have to be corrected using SOI vector layers. If both, i.e. the satellite map and the SOI layers could not be procured, then GPS referencing will have to be used as the base layer. Google Earth maps may then be used as background image to view spatial layers on web interface.

3. Mapping of 18,069 km of Road Network:

Mapping of 18,069 km of road network will be taken up using Garmin 78s GPS handsets which have an accuracy of 2-5 m. Using the GPS, the following features will be captured:

- Road centre line
- Culverts
- Bridges
- Traffic count stations
- Pavement surface type change
- Pavement width change
- Land marks, including kilometer stones, road junctions, villages etc.

The reading will be corrected by using high-resolution satellite data supplied by OWD / SOI topographical maps.

4. Spatial Layer Preparation:

- The spatial road layer will be projected to UTM, Datum - WGS 84. All other spatial layers provided by OWD / other departments will be projected to the above projection, edited and superimposed on the road layer.
- The spatial layers generated will be corrected topologically and codification of all the roads will be undertaken. The direction of the measure of all the roads will be corrected as per available chainages. Features captured through GPS will be included as point layer and will be used for calibration of the roads for the distances.

5. Reference System

Once the road spatial data layer is prepared, a road referencing system will be developed by creating routes and dynamic segmentation. The existing road reference system will be modified to suit GIS requirements keeping in view the OWD's needs and compatibility.

Dynamic segmentation is the process of computing the map locations of events stored and managed in an event table using a linear referencing measurement system and displaying them on a map. The term dynamic segmentation is derived from the concept that line features need not be split (i.e., segmented) each time an attribute value changes-you can dynamically locate the segment.

Using dynamic segmentation, multiple sets of attributes can be associated with any portion of an existing linear feature independently of where it begins or ends. These attributes can be displayed, queried, edited, and analyzed without affecting the underlying linear feature's geometry.

The following steps will ensure a proper linear referencing system:

- Create the centre-line of road
- Calibrate it with points along it
- Locate point features along the centre-line
- Dissolve the events
- Intersect the events

Other reference layers are:

- All CD works, bridges and other structures over the road formation will be stored in the database with reference to the LRS and superimposed on the referenced road layer.
- All such features will be stored in the database with reference to the LRS, superimposed and will be attached with attribute data collected.
- Traffic count stations will be incorporated as point features using the LRS system

6. Deliverables in Arcinfo's Geodatabase Format and Shape Files

- Vector line layer of 18,069 km of roads
- Point layer of culverts/CD works
- Point layer of bridges
- Point layer of traffic count stations
- GIS base map with above layers

All spatial data will be uniquely identified and linked to the attribute data in COTS. A schematic flow chart of development of GPS / GIS maps and database is provided in

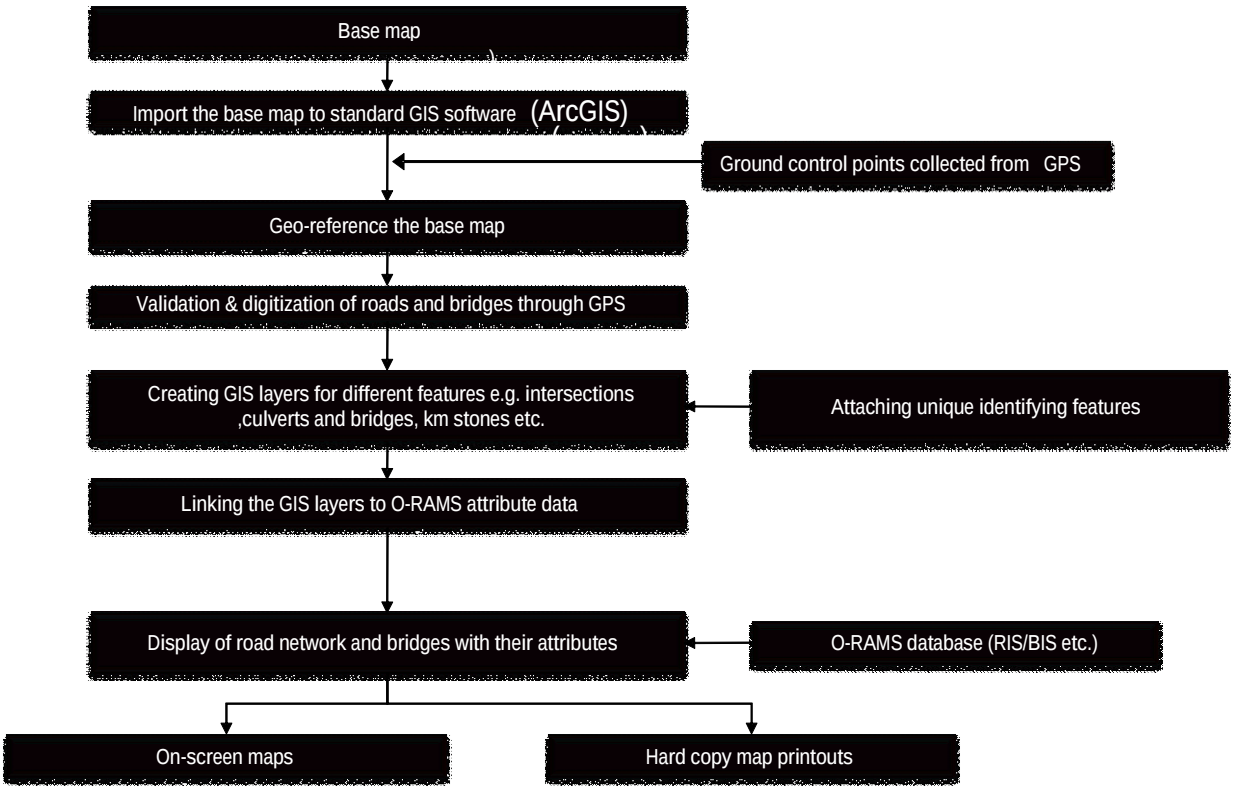


Figure 4-1: GIS/ GPS Data Collection / Development Methodology

Sub-Task 16: Prepare and Submit GPS Referencing Report

This will be the first among the surveys to be initiated during the 2nd month of the Project, by following the methodology defined earlier. As the monsoon season has already begun in Orissa, it is likely that the work may get delayed because of the inaccessibility due to road submergence and local weather conditions. Survey will be initiated first in the Pilot Circle (Cuttack) starting with Charbatia Division (refer Table 4-3). Rest of the circles / divisions will follow, based on the tentative schedule. It is, however, subject to modification based on the actual weather and site conditions. The actual schedule will be intimated before the survey commencement.

Table 4-6 : Work Schedule (Task -1)

Task No.	Task / Activities	2011-12 (Year-1)											
		1	2	3	4	5	6	7	8	9	10	11	12
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12
TASK-1:	**ASSESSMENT OF CURRENT MAINTENANCE MANAGEMENT SYSTEM**												
Sub-Task 1	Mobilisation and Interaction with OWD officers												
Sub-Task 2	Project Appreciation												
Sub-Task 3	Review of data available with OWD												
Sub-Task 4	Conduct Site Visit												
Sub-Task 5	Finalise Approach and Methodology (for Data Collection, GIS / GPS Mapping)												
Sub-Task 6	Finalise Task Assignment and Scheduling												
Sub-Task 7	Prepare Draft Data Collection Formats												
Sub-Task 8	Prepare and Submit Inception Report												
Sub-Task 9	IDS Report Study and Review of ISAP												
Sub-Task 10	Review Current Maintenance Management Practices of the OWD and MIS												
Sub-Task 11	Needs Analysis and Outline of AMS-System Architecture												
Sub-Task 12	Prepare and Submit Needs Analysis and overall System Architecture Report												
Sub-Task 13	Review the Road Classification System												
Sub-Task 14	Assess Current Road Reference System, Propose refinement and Data Model for O-AMS												
Sub-Task 15	Deliberate on GIS/GPS Requirement, Recommend Necessary Data/Maps/Images to be procured and outline methodology for GIS Development												
Sub-Task 16	Prepare and Submit GPS Referencing Report												
16 (a)	Collection of GPS Points (pilot circle)												
16 (b)	Collection of GPS Points (rest circles)												

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

Table 4-7 : Work Schedule (GPS Survey)

Task No.	Task Activities	Jun-11	Jul-11				Aug-11				Sep-11				Oct-11			
		4 Wk	1 Wk	2 Wk	3 Wk	4 Wk	1 Wk	2 Wk	3 Wk	4 Wk	1 Wk	2 Wk	3 Wk	4 Wk	1 Wk	2 Wk	3 Wk	4 Wk
TASK-1:	**ASSESSMENT OF CURRENT MAINTENANCE MANAGEMENT SYSTEM**																	
Sub-Task 16	Prepare and Submit GPS Referencing Report																	
16 a	Collection of GPS Points (Pilot Circle)																	
1	Charbatia Division																	
2	Jagatsinghpur Division																	
3	Kendrapara Division																	
4	Panikoili Division																	
5	Cuttack Division																	
6	Dhenkanal Division																	
7	Angul Division																	
16 b	Collection of GPS Points (Rest Circles)																	

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.2. Task-2: Data Collection and Road Information System (RIS) Development

Task-2 has been broadly divided into 13 sub-tasks, 17 to 29 as detailed below:

Sub-Task 17: Agreements on Data Requirement, Collection Methodology and Format

The activities under this sub task are already explained in detail under Sub-task 5. Further, the detailed data collection methodology will be explained in the "Data Collection Manual" to be ready at the end of the 3rd month.

Under this sub-task, the data requirements will be assessed, and data collection methodology and proforma for data collection will be proposed. This will be discussed in a workshop where the following will also be deliberated on:

- Information on the major initiative of OWD to establish O-RAMS
- Goals and objectives of O-RAMS
- Consultant's scope of work and time line
- System architecture of O-RAMS
- Data requirement for O-RAMS, collection methodology, and proforma
- Expectation of the Consultant from various levels of officers in HQ and in the field
- Feedback

This workshop, proposed during the 3rd month, will be an important event not only in taking certain critical decisions but also in successful implementation of the proposed O-RAMS.

Sub-Task 18: Prepare and Submit Road Data Collection Manual

Documentation and manual for the following will be prepared:

- Data requirement for GPS referencing
- Pavement inventory
- Culverts and CD works inventory
- Bridge inventory
- Pavement condition survey
- Pavement roughness survey
- Pavement structural strength survey
- Bridge condition survey
- Traffic survey
- Axle-load survey
- Methodology for data collection including the use of field equipment, standard formats, procedure of coding in field data sheet

This sub-task will be finalized after the completion of the workshop.

Sub-Task 19: Agreement on System Architecture

Consultant's recommendations regarding the system architecture will be discussed at the workshop and a decision will be taken since this is very critical for any further work on system development.

Sub-Task 20: Computerization of Available Data in the Required Format

The data provided by the OWD for the inventory of pavement / culverts / bridges, pavement condition, pavement roughness, and traffic and axle-loads for NHs will be compiled in an agreed database format for linking to the GIS. Further, the Consultant will convert the information into a format suitable for data entry into the proposed system. This sub-task will commence after the receipt of data from OWD, in the data collection format, starting from 3rd month onwards to the end of the 4th month.

Sub-Task 21: Gap Analysis and Assessment of Additional Data Requirement

- Extensive review of existing data collection procedures and the additional data requirement will be undertaken based on the needs arising out of the systems developed and to be implemented.
- OWD will provide the Consultant with pavement and CD inventory, right-of-way features for the entire 18,000 km; and roughness and pavement distress indicators for the national highway (3,592 km).
- Initial validation/consistency checks (limited to 20%) in data will be done on random basis in consultation with OWD. In case of discrepancy found at the ground level, this will be transmitted to the OWD for re-submission of correct/updated data.
- This sub-task will commence after the receipt of data from OWD immediately after inception.

Sub-Task 22: Prepare Data Collection/Verification Programme and Conduct Surveys

Under this sub-task, the Consultant proposes to carry out the surveys in the field, as defined in Table 2, page 36 of the Contract, during the first year. Survey for the subsequent year, i.e. traffic survey will be finalized in consultation with OWD at the end of Year-1. A tentative survey schedule is shown in Table 4-5. All surveys will be initiated first in the Pilot Circle (Cuttack) before they are undertaken in rest of the divisions.

- The Consultant will initiate all logistic arrangements, data format and permission letters from the Client etc. before commencement of field activities.
- Actual locations of traffic and axle-load surveys will be finalized in consultation with OWD before commencement.

Pavement, Culvert/CD Works and Bridge Inventory

The Consultant will verify 20% of the pavement, culvert/CD works and bridge inventory data supplied by OWD for the entire NH, SH, MDR & ODR network. It is proposed to undertake this task in two stages. In Stage-1, the centre-line of the pavement/CD works, pavement width, and shoulder type, land use, location of villages, and cross road details will be verified during the GPS survey. The pavement composition will be verified during Stage-2 along with the pavement structural strength survey starting from December 2011. Further, the inventory of culverts/CD works and bridges will be verified at the tune of the bridge condition survey after the monsoon season during October 2011 – February 2012. Refer to Table 4-5 for the tentative schedule of the surveys.

At the Review Committee meeting, suggestions were made to include information on the soil type, and any ongoing construction work including its progress. Soil type is an important information and should be part of pavement inventory data just as pavement composition data is. The most appropriate means to collect soil type may be to mark the alignment of roads on the Soil Map of Orissa. The soil description therein then needs to be converted to engineering soil classification with the information from Soil Series of Orissa (Technical Bulletin, NBSS publication 119). The actual soil type in the field could then be verified at the time of collecting pavement inventory or condition data, and added as an attribute in pavement inventory.

Similarly, room could be made for an additional attribute in pavement/culvert/bridge inventory for construction activity and its progress. This, however, will need to be updated periodically by the divisional office to keep the information on the progress of works current.

Pavement Roughness Survey

Pavement roughness survey, using ROMDAS equipment, will be undertaken on SHs & MDRs after the monsoon, but separate from the GPS survey, from October 2011 and is expected to continue till February 2012 (Refer 22 [e] of Sub-task 22 of Table 4-5).

Pavement Condition Survey

Pavement condition survey will be undertaken using a simplified, visual rating method. This will be first undertaken through a Pilot Project. Four distress types, i.e. cracking, pothole, raveling and rutting will be used to visually describe surface distresses of flexible pavement. A system of

describing severity and extent (density) will be devised for calculating the surface distress index, and possibly Pavement Condition Index in combination with the roughness. This will be initiated after the monsoon in October 2011 and is expected to continue until February 2012 (Refer 22 [f & g] of Sub-task 22 of Table 4-5). A similar system of important distresses will be used for rigid/concrete (cracking, pothole, faulting(stepping), joint deficiencies) and gravel (loose gravel, pothole, rutting) pavement surface type respectively.

A mechanized system to capture surface distresses will be used on a "Demonstration Project" of about 800 km, to assess the feasibility of its use in the future. The actual road sections for survey will be finalized in discussion with OWD. This will be undertaken sometime between December 2011 and February 2012.

Benkelman Beam Deflection (BBD) Survey

Structural strength testing of the pavement will be carried out by means of Benkelman Beam at an interval of 500 m. The in-situ CBR of the sub-grade will be back-calculated from a modified BBD testing method and a relationship equation(s) will be developed specifically for this purpose, taking into account the existing pavement structure(s).

At each test location, deflections will be measured at four positions to simulate the shape of deflection basin. This can be accomplished by recording the rebound deflections directly under the wheel load and at 0.5m, 1.0m and a final reading when the wheel has advanced 9.0m. The elastic modulus of subgrade may be calculated using Boussinesq equation for a homogeneous half-space,

$$d_r = \frac{P\,(1-v)^2}{\pi r E}$$

where dr = surface deflection at a distance r from the load

P = load

v = Poisson's ratio

r = radial distance from the load

E = elastic modulus

The detailed methodology to conduct the test and the derivation of equations, as well as the data collection, and output sheets showing the computation and plotting of results are described in Data Collection Manual. This procedure, though unfamiliar in India, is quite common elsewhere in the world. The consultant has extensive experience in its use. In order to ensure that the resulting subgrade modulus or CBR values are valid and applicable to Orissa, these will be related to CBR tests carried out on samples of the subgrade material from selected Benkelman Beam Deflection test locations. The test should also be able to provide an estimate of the composite modulus of the pavement, which could in turn be used to estimate the effective structural number of the pavement and the overlay requirements.

The representative structure(s) of the existing pavement will be established at the edge of the pavement as required for validation/calibration of equation(s) for back-calculation of subgrade CBR from the BBD deflection basin. Routine soil testing will be carried out on the samples, including the lab CBR test on the subgrade soil and field moisture content as per IS: 2720 in order to correct the deflection measurements using the charts of IRC:81-1997. This will be initiated after the monsoon in November 2011 and expected to continue until February 2012 (Refer 22 [h] of Sub-task 22 of Table 4-8).

Bridge Condition Survey

Bridge inventory details will be provided by the Client, following which a condition survey of bridges will be undertaken by the Consultant through visual inspection, in the first year. This will be initiated after the monsoon in September 2011 and is expected to continue till February 2012 (Refer 22 [i] of Sub-task 22 of **Table 4-8**). Four critical attributes thought at this stage are Cracking, Spalling, Corrosion of reinforcement and Condition of Bearings for visual inspection and condition rating. These attributes and there rating system will be deliberated within a workshop towards finalization of Data Collection Manual with OWD.

Traffic Survey

The Consultant will carry out 3-day classified traffic volume count survey at 200 selected locations on SH and MDRs, and may be at selected few ODRs. The locations are being finalized in discussion with OWD. The Consultant is exploring the possibility of using video based technology in those places where it is more practical than the manual method. As an added benefit, this will give exposure to the OWD staff to the emerging technology. Although the use of video technology is more expensive than the conventional manual method of traffic survey, the Consultant will bear all such additional costs in the interest of the Project. The Department will benefit from this at absolutely no cost to itself. It should be noted that software developed for counting vehicles based on video images is Intellectual Property (IP) of another company which provides services, and the Consultant has no control over their availability or timing. Worst come worst, the Consultant will do all classified traffic volume survey by manual method employing trained enumerators in the field.

This will be initiated after the monsoon in October 2011 and is expected to continue till December 2011 (Refer 23 [j] of Sub -task 22 of Table 4-8).

Axle-Load Survey

Axle-load surveys at 30 selected locations will be conducted by the Consultant on State Highways and MDRs, and may be on a few ODR(s). The locations will be finalized in discussion with OWD. This will be initiated after the monsoon in October 2011 and is expected to continue till December 2011 (Refer 23 [k] of Sub-task 22 of Table 4-8).

This sub-task will commence after the finalization of Data Collection Manual at the end of 3rd month and will continue to the 10th month in the first year. This task will be performed by OWD during 28-30 months in the 3rd year.

Survey for the Right-of-Way Features

A demonstration project will be done by the Consultant for capturing features within the right-of-way through GPS survey, and by extracting features from high resolution satellite images. The 10 km stretch for this purpose will be finalized in discussion with the OWD officers.

Sub-Task 23: Survey Data Verification (from Test Data Collection)

- The Consultant will undertake pavement condition survey through a simplified, visual rating method of road condition except for a Demonstration Project where mechanized process will be used. The actual extent of the coverage of the road for mechanized survey will be finalized in consultation with OWD.
- It is proposed to undertake condition survey on 10% of length (800 km approximately) by both visual as well as by mechanical means on the Demonstration Project to compare with the visual ratings.

Sub-Task 24: Prepare and Submit Draft System Design Document of O-RAMS

- After performing various sub-tasks, including a review of the existing system, O-RAMS requirements and gap analysis, the Consultant will develop “System Design of AMS” which will take into account user needs and sustainability of the system.
- The conceptual model will include system architecture, user interface design including user interface prototype, in some cases business logic layer design, and more importantly conceptual database design.
- Based on the comments at the workshop and deliberations and discussions with OWD, the draft system design document will be submitted to the Client. Further modification may be made as and when required and before final submission of overall system design report.
- This sub-task will be undertaken in the 4th month of the assignment, and the final version will be ready in the 11th month.

Table 4-8: Work Schedule – Task 2

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-2:	**DATA COLLECTION AND ROAD INFORMATION SYSTEM (RIS) DEVELOPMENT**																																				
Sub-Task 17	Agreement on Data Requirement, Collection Methodology and Format for Two Years																																				
Sub-Task 18	Prepare and Submit Road Data Collection Manual																																				
Sub-Task 19	Agreement on System Architecture																																				
Sub-Task 20	Computerization of Available Data in the required Format for AMS																																				
20 (a)	Referencing data of the road network & CD structures																																				
20 (b)	Inventory data of road network & CD structures																																				
20 [c]	Other data lfrom the Grant book regarding sanctioned and executed works and others (if any)]																																				
Sub-Task 21	Gap Analysis and Assessment of Additional Data Requirement																																				
Sub-Task 22	Prepare Data Collection/Verification Programme and Conduct Surveys																																				
22 (a)	Inventory of Pavements (20% verification in pilot circle)																																				
22 (b)	Inventory of Pavements (20% verification in rest circles)																																				
22 [c]	Inventory of CD Works (20% verification in pilot circle)																																				
22 (d)	Inventory of CD Works (20% verification in rest circles)																																				
22 [e]	Roughness Survey on Paved Road using ROMDAS																																				
23 (f)	Condition Survey of Pavements-Visual (Surface Distress Indicators)																																				
23 (g)	Condition Survey of Pavements-Mechanical																																				
23 (h)	BBD Survey + CBR																																				
23 (i)	Bridge Condition (Major + Minor)																																				
23 (j)	Traffic Survey (Classified Volume Count-200 locations)																																				
23 (k)	Axle-load Survey (30 locations)																																				
Sub-Task 23	Survey data Verification (from Test Data Collection)																																				
Sub-Task 24	Prepare and Submit Draft System Design Document of AMS																																				
Sub-Task 25	Develop GIS based RIS, RWFIMS, BIS and TIS																																				
Sub-Task 26	Prepare and Submit Data Acquisition on Road Inventory, Condition, Roughness, Pavement Strength, Traffic Volume, Axle Load etc.																																				
Sub-Task 27	Populate GIS based RIS, BIS & TIS with Actual Data and Testing with Test Cases																																				
Sub-Task 28	Prepare and Submit System Operation Manual																																				
Sub-Task 29	Install RIS, BIS and TIS Live in OWD																																				

Sub-Task 25: Develop GIS-Based RIS, RWFIMS, BIS and TIS

- The development of O-RAMS (RIS, BIS, RWFIMS and TIS) can only be initiated after COTS is finalised.
- Development and configuration will be done in the following three steps:
  - Build first level design – The conceptual system models will be elaborated for programming / configuration and integration.
  - Coding - Programs (coding) / design of database will then be developed, based on the first level design and 'unit tested'.
  - Testing - Elaborate test cases will be developed along with the necessary test (data) beds to be used for testing the system.

Testing is further proposed to be undertaken at three levels:

- Component testing,
- Integration testing, and
- System testing

Key requirements….

- Compatibility with current system in use within OWD
- Uniform and user friendly interface
- Menus and reports in English
- International practices (e.g. Common user interface, data import/export, truth-in-data etc.)
- Inbuilt alert system to flag most recent data
- Ability to average out data and export to Excel format by kilometer/road homogeneous sections.
- Sub database for CD structures, bridges, road furniture, routine maintenance management, traffic.
- RIS is capable of handling data of different spatial attributes ranging from point data to continuous or interval data.
- RIS is allowing for the graphical representation and presentation of information and shall interface with a Geographic Information System (GIS) for **mapping purposes**.
- GIS software to be defined by the Client. This will be discussed and finalized in consultation with OWD.
- Technology: SQL, RDBMS, Microsoft Excel environment….

Road Information System (RIS) and Right-of-Way Features Information Management System (RWFIMS)

- The proposed COTS database will form the basis of the RIS/RWFIMS which will contain all road-related data referenced against the network entities. COTS will act as the definitive source of Orissa's network-level data.

- The data contained in the O-RAMS database will be available to external applications via SQL. For example, the Traffic Information System (TIS) will be a separate application, but it will be linked to the O-RAMS database for purposes of location referencing and the former will also supply the AADT data to be used in planning analysis.
- COTS, in effect the RIS and RWFIMS, will meet the basic requirements as listed in Section 4.8 of the "Detailed Scope of Work" [of Appendix A "Description of Services] and as well the detailed functional and technical requirements as specified in Annexure 1 of Appendix A.

Location Referencing

- In COTS the location can be referred by multiple means such as kilometer stones, linear reference system and geo coordinates. The linear reference system will be adopted for O-RAMS.

Bridge Information System

- The O-RAMS will be configured to accommodate information on bridges and will be populated with approximately 1,650 bridges on SHs and MDRs.
- It will contain bridge inventory (supplied by OWD) and visual condition data from inspections (done by the Consultant), any available history of bridge repairs and expenditures, (source-OWD) and data collected by the Consultant.
- A demonstration project would be undertaken, with the agreement of the Client, where alternative / NDT technologies could be used on a major bridge for programming of maintenance / rehabilitation / reconstruction activity.

Traffic Information System

- The Consultant, in consultation with OWD, will determine the requirements for the Traffic Information System (TIS) and software will be developed as a separate application (module).
- It will, as a minimum, be capable of storing, processing and reporting on the types of data given in Sections 4.12 and 4.13 of the Detailed Scope of Work in Appendix A.
- This task will be undertaken during the 4th to the 9th month of the assignment.

Sub-Task 26: Prepare and Submit Data Acquisition Report on Road Inventory, Condition, Roughness, Pavement Strength, Traffic Volume, Axle Load etc.

- The above data duly verified and validated, will be entered in O-RAMS and linked to the location referencing of the road network and summarized will be reported at the end of the 11th month.
- This sub-task will be carried out in stages, as and when data is collected, on the network.

Sub-Task 27: Populate GIS-Based RIS, BIS & TIS with Actual Data and Testing with Test Cases

- Mostly, data collected on the Pilot Project will be used for testing of GIS-based RIS, BIS and TIS.
- This sub-task will be undertaken during the 7th to the 9th month of the assignment.

Sub-Task 28: Prepare and Submit System Operation Manual

- A system operation manual (User Manual) for RIS, BIS and TIS will be prepared after testing of the system.
- Once prepared, a draft version will be issued in advance to OWD for comments and necessary improvement.
- This sub-task will be undertaken at the end of 9th month of the assignment after completion of Sub-task 29.

Sub-Task 29: Install RIS, BIS and TIS Live in OWD

- The integrated and tested RIS / BIS and TIS, including the traffic and bridge information system, will be installed in OWD at the end of 10 month, subject to timely procurement of the necessary software etc.

4.2.3. Task-3: Development of Planning Tools

Sub-Task 30: Develop Analytical Tools for an HDM-4 Based Pavement Management System (PMS)

- The Consultant will develop economic evaluation models, capable of performing the following types of analyses using HDM-4 and / or in-built analytical tools of proposed COTS:
  - Strategic budgeting studies;
  - Project-level technical analyses;
  - Multi-year road-works programming and optimization under budget constraints; and
  - Projection of network condition under various budget scenarios.
- This task will be undertaken during 7^{th} -12^{th} month of the assignment after the end of surveys.
- A simplified flow chart of PMS development within overall framework of AMS development is shown in the following figure.

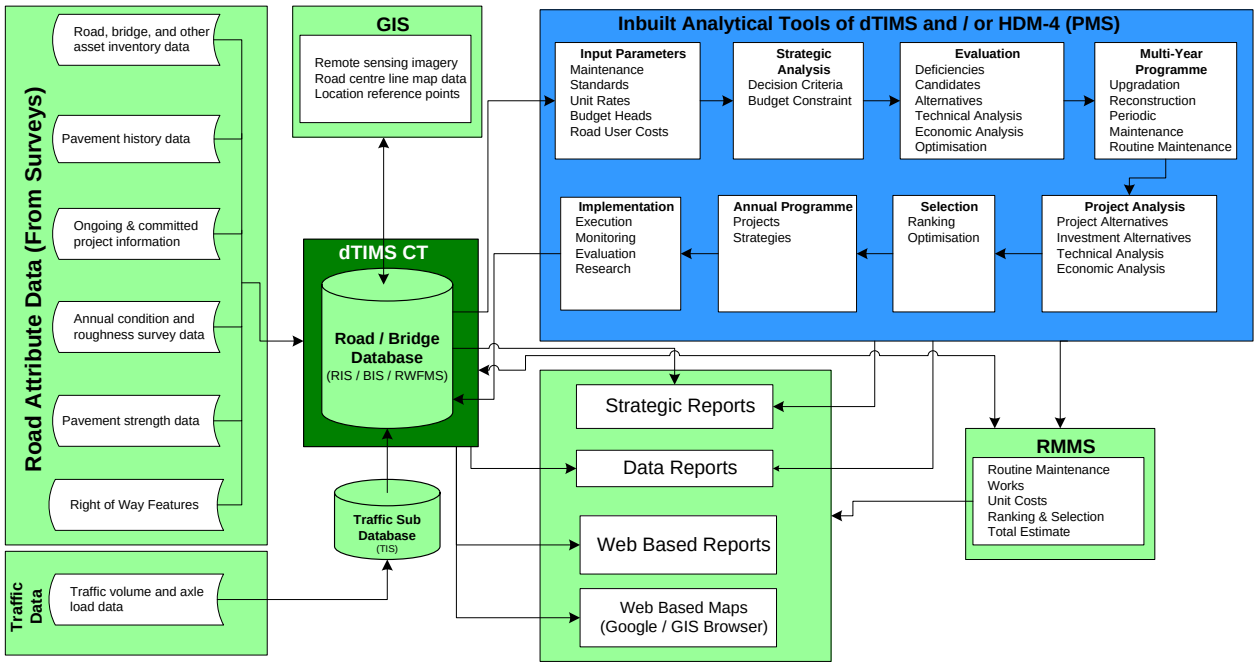


Figure 4-2: Simplified Flow Chart of PMS Development within Overall Framework of O-RAMS Development

Sub-Task 31: Develop Analytical Tools for Strategic Budgeting Studies

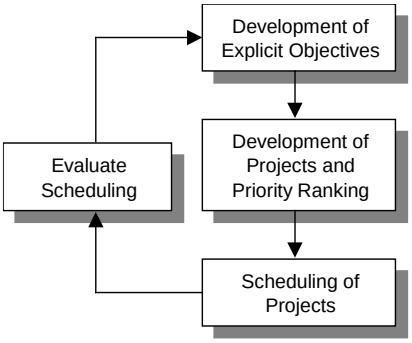
- The PMS (HDM4/COTS) module develops short-, medium- and long-term plans for various budgetary levels and priorities.
- This sub-task will be undertaken during 11th -12th month of the assignment.

Sub-Task 32: Develop Analytical Tools for Project Level Analysis

- The PMS module will have analytical tools for project level analysis. The same data as used in the strategic studies will be used here.
- This task will be undertaken during 11th -12th month of the assignment after the end of surveys

Sub-Task 33: Develop Analytical Tools for Multi-year Programming

- A multi-year programming module, would optimize the selection and timing of pavement works under different budget constraints to achieve various performance indicators.
- As a pilot test run, both HDM-4/COTS will be used as analytical tools. A series of projects will be identified and placed into three categories, namely:



- Development – new projects including the proposed reconstruction of existing roads;
- Maintenance – ongoing construction and rehabilitation of existing roads;
- Operations – routine maintenance of roads.

- Once the prioritisation of road upgrading is complete, the Consultant will prepare a series of costs for the prioritised roads. The costs will be added together to prepare an annual budget envelope.
- This task will be undertaken during the 12th month of the assignment.

Sub-Task 34: Calibrate HDM-4/COTS - based PMS

- In order to achieve reliable results, it is necessary to adjust the parameters to calibrate the model for the local condition.
- For the O-RAMS, the Consultant will perform a 'Level-2' calibration and adaptation on the following sub-models.
  - **Road Deterioration** – Predicts pavement deterioration for bituminous, concrete and unsealed roads.
  - **Works Effects** – Simulates the effects of road works on pavement condition and determines the corresponding costs.
  - **Road User Effects** – Determines costs of vehicle operation, road accidents and travel time.
  - **Social and Environmental Effects** – Determines the effects of vehicle emissions and energy consumption.
- Where available information is lacking in sufficient detail and/or is difficult to compile, the Consultant may need to resort on some items to the less onerous Level-1 calibration in consultation with the Client.
- This will be an initial stage of calibration which will, however, need to be carried out subsequently as well, as better data/info and more experience is acquired in future.
- This task will be undertaken during the 13th month of the assignment on the 1st year data and, subsequently after the 2nd and 3rd year data collection.

Sub-Task 35: Estimate Unit Costs for Maintenance Activities (for PMS & RMMS)

- The Consultant will establish a list of treatments to be tested in the analysis, and each will be associated with both financial and economic average unit costs.
- The Consultant will estimate these from historical data and/or engineering estimates, and they may as well come from the recently completed road projects or those being prepared for bidding based on latest Schedule of Rates published by the GoO.
- Works for periodic maintenance, strengthening, reconstruction, improvement shall be based on sound accepted practices.
- The steps followed under this sub-task are;
  - Review basic treatments for various works such as periodic maintenance, strengthening, reconstruction, widening etc.

- Input basic costs of staff and equipment
- Input basic costs of materials
- Input speeds, load/unload times/transport leads for haulage of various materials to the site

- This task shall be undertaken during 9th -11th month of the assignment.

Sub-Task 36: Develop Analytical Tools of Routine Maintenance Management System (RMMS)

- The Routine Maintenance Management System (RMMS) application will be developed / configured to determine routine maintenance investments for sections not receiving periodic maintenance or improvements in that year; and to prepare reports and charts for a business plan.
- Further, RMMS application will include other important elements like standards of maintenance activities both in terms of quality and performance, unit costs, schedule of rates, etc.
- It will also have functions to estimate the cost of routine maintenance works, allocation of budget among activities/scheduling of works etc.
- This sub-task will be undertaken during 11th -12th month of the assignment.

Sub-Task 37: Develop the Right-of-Way Features Information Management System (RWFIMS)

- The Right-of-Way Features Information Management System will be developed in conjunction with RIS, initially with the data available from the OWD.
- The data collected from a demonstration project of 10 km will be used for testing.
- Further details are already explained as part of Sub-task-25.
- This sub-task will be undertaken during 8th -9th month of the assignment

Sub-Task 38: GIS Development and Integration

- The integration of GIS maps (already digitized) with the O-RAMS database server will enable the user to navigate seamlessly from map to the O-RAMS database and vice versa.
- This will enable the user to access any feature either from GIS interface and access its attributes in O-RAMS database or from O-RAMS database, locate the same on the GIS interface automatically. This will be a two-way integration.
- Following are the other important features:
  - After the completion of mapping the features (digitize using any industry standard GIS software in different layers) with unique identification (IDs), a link to the O-RAMS database will be established automatically.
  - Import / link the layers to the O-RAMS database or integrate the map server containing all the map files to the O-RAMS database server. The later will be a central repository of all maps and Client GIS system.

- OWD presently doesn't have a GIS system (software + base map) in place. As part of the current service, a GIS system will be procured by the OWD which will be used to store, manage and develop the GIS maps already developed and linked to O-RAMS. The Consultant will use its own license to develop GIS base map. The license procured by the Client can then be used to modify or add maps when required and then import / link the layers to O-RAMS by the Client in future.
- A utility will be inbuilt in GIS-ORAMS interface to import the modified map objects into the O-RAMS database seamlessly.
- This sub-task will be undertaken starting from the 2nd month of the assignment and will go on till the 12th month.

Sub-Task 39: Overall System Integration

- O-RAMS is envisaged to be an integration of the following:
  - Off-the-shelf third party product like dTIMS, HDM-4
  - Externally prepared GIS maps
  - New applications such as TIS / RMMS
- The end product would work as an integrated system with following characteristics:
  - Seamless data flow from an application to other
  - Software compatibility
  - Uniform Graphical User Interface (GUI) to enhance user friendliness and acceptability.
  - User authentication and role based access control.
  - Externalities like web application and security.
  - Master data like location referencing and other fixed features.
- Various sub-modules, as they are being developed, will be integrated and tested before they are installed for use.
- This task shall be undertaken during 11th -12th month of the assignment after development of all the modules.

Sub-Task 40: Prepare and Submit Overall System Design Report

- The draft system design document of O-RAMS already prepared as part of Sub-task-24 will be finalized, based on system development undertaken, including all the modules and will be submitted as final copy.
- This task shall be undertaken before the end of the 12th month of the assignment after development of all the modules and system integration.

Sub-Task 41: Overall System Testing

- Overall system testing will begin at the end of the 9th month of the assignment. Training versions of integrated O-RAMS will be deployed at select locations at head quarters, PIU etc. to obtain 'hands-on' comments from the end users for its acceptability.
- In parallel, testing of the system by the Consultant's team and further enhancement will continue. During the compliance testing process, suggestions made by the officers of OWD will be noted, reviewed and incorporated appropriately.
- This sub-task will be continued upto12/13th month of the assignment after over-all system integration.

Sub-Task 42: Install O-RAMS Live in OWD

- The integrated and tested version of O-RAMS will be installed in OWD by the end of 14 months. This installation will supersede the earlier installation comprising RIS/BIS/TIS.
- However, some amount of testing, enhancement, bug-fixing will continue in parallel both by Consultants' team and end users. Upgrades will be issued to the end users accordingly.

Sub-Task 43: Prepare and Submit Operation Manual(s) for PMS, RMMS

- The operations manual for PMS, RMMS will be prepared and submitted for training and hands-on practice for OWD officers.
- The Consultant would incorporate all the comments on value addition of the report and submit a final version after that along with complete O-RAMS operation manual.
- This sub-task will be undertaken after the 12th month of the assignment and a draft report will be submitted followed by a final report at the end of 14th month.

Sub-Task 44: Prepare and Submit Operation Manual of O-RAMS (Overall)

- The operations manual for RIS, RWFIMS, BIS and TIS will be prepared as part of Task 28 and PMS, RMMS under Sub-task-43 will be integrated and a draft operation manual for O-RAMS will be submitted.
- This task will be initiated in the 18th month of the assignment after successful testing of overall O-RAMS and a draft manual shall be submitted followed by a final one in the 23rd month.

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-3:	**DEVELOPMENT OF PLANNING TOOLS**																																				
Sub-Task 30	Develop Analytical Tools for HDM-4 based Pavement Management System (PMS)																																				
Sub-Task 31	Develop Analytical Tools for Strategic Budgeting Studies																																				
Sub-Task 32	Develop Analytical Tools for Project Level Analysis																																				
Sub-Task 33	Develop Analytical Tools for Multi-year Programming																																				
Sub-Task 34	Calibrate HDM-4 based PMS																																				
Sub-Task 35	Estimate Unit Costs for Maintenance Activities (for PMS & RMMS)																																				
Sub-Task 36	Develop Analytical Tools of Routine Maintenance Management System (RMMS)																																				
Sub-Task 37	Develop Right of Way Features Management System (RWFMS)																																				
Sub-Task 38	GIS Development and Integration																																				
Sub-Task 39	Overall System Integration																																				
Sub-Task 40	Prepare and Submit overall System Design Report																																				
Sub-Task 41	Overall System Testing																																				
Sub-Task 42	Install O-AMS Live in OWD																																				
Sub-Task 43	Prepare and Submit Operation Manual(s) for PMS, RMMS and RWFMS																																				
Sub-Task 44	Prepare and Submit Operation Manual of AMS (Overall)																																				

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.4. Task-4: Preparation of Annual Road Condition Reports and Rolling Maintenance Plan

Task-4 has been broadly divided into nine sub-tasks (45-53) as detailed below:

Sub-Task 45: Prepare Annual Road Condition and Traffic Report - Year 1 (i.e. 2011)

- Once data collection in the first year is complete with preliminary analysis, the Consultant proposes to prepare a report on "Annual Road Condition and Traffic".
- The coverage of this report will be limited to the roads under the jurisdiction of OWD. The following information is expected to be available:
  - An inventory of road & bridge asset for 18,069 km
  - Roughness level on road asset for 8,163 km of SH & MDR
  - Pavement condition for 11,755 km of NH, SH & MDR
  - Bridge condition for 1,650 bridges on SH & MDR
  - Information on pavement strength for 6,122 km of SH & MDR
  - Traffic characteristics on SH & MDR at 200 locations
  - Vehicle loading characteristics on SH & MDR at 30 locations
- The analysis of data/information would typically result in the following:
  - Road network characteristics – condition (limited to OWD network)
  - Distribution of OWD network by classification (NH, SH…) and roughness class.
  - Overall weighted roughness on OWD network. This could be one component of the PCIs
  - Distribution of OWD network by classification (NH, SH…) and surface distress indicators
  - Distribution of OWD network by classification (NH, SH…) and deflection
  - Road network characteristics – traffic (limited to OWD network)
  - Summary results in terms of average daily traffic, traffic composition, hourly variation etc.
  - Vehicle loading characteristics – (limited to OWD network)
  - Average axle-loads, VDF, ESAL etc.
- Maximum use of O-RAMS is expected in preparing such reports. The format for reporting results which should be suitable for public dissemination and hosting on the web will be finalized in consultation with OWD.
- This task will be initiated in the 9th month of the assignment and a draft report will be submitted followed by a final one at the end of 14th month. The Consultant will, however, explore possibilities of proposing sub-deliverable comprising part of the analysis/area etc. well before the actual submission to obtain early response of the Client on the same.

Sub-Task 46: OWD Annual Report - Year 1 (i.e. 2011)

- The preparation of "Annual Report" will take the State perspective into consideration and would propose key performance indicators for evaluation every year. Key results of "Annual Road Condition and Traffic" report would also be utilized appropriately. An "Annual Report" will be a performance report of the OWD.
- For this purpose, information related to Year-1 on the following will be obtained from the OWD:
  - Mandate of the OWD
  - Human resource at various levels.
  - Physical achievement: maintenance and improvement works as regards roads and bridges i.e. roads/bridge work completed and in progress.
  - Annual outlay by various heads and sub-heads.
  - Financial achievement: expenditure incurred on maintenance work, improvement (new road/bridge, widening, rehabilitation etc.)
  - Expenditure on establishment.
  - Expenditure on R&D, ICT, PPP etc.
- The results on the following would be utilized appropriately:
  - Road network and traffic characteristics-physical
  - Road network in the State by various class (NH, SH, MDR, ODR etc.)
  - Distribution of network by ownership and responsibility
  - Road network density by area and population
  - Distribution of road network by surface type (concrete, BT, unsealed)
  - Distribution of road network by road class and width standard (ML, SDLPS, SDL, IL, SL etc.)
  - Total lane-km in the State
  - Vehicular growth trend in the State
  - Accident trend in the State (based on secondary information)
  - Establish key performance indicators which are measurable and quantifiable every year for comparison.
  - Current road network condition (limited to NH, SH&MDR network).
  - Distribution of OWD network by classification (NH, SH…) and roughness class.
  - Overall weighted roughness on OWD network. This could be one of the PCI component
  - Distribution of OWD network by classification (NH, SH…) and surface distress indicators
  - Distribution of OWD network by classification (NH, SH…) and deflection class
  - Road network characteristics – traffic (limited to NH, SH&MDR network)
  - Distribution of OWD network by classification (NH, SH…) and Traffic class

- Road network utilization – vehicle-km and tonne-km (based on assumed pay load or extrapolated data as obtained from axle load survey).
- Distribution of OWD network by classification (NH, SH…) and LOS
- Vehicle loading characteristics – traffic (limited to OWD network)
- Average axle-loads, VDF, ESAL etc.

- This report is also proposed to include projected network condition, planned road/bridge works in subsequent year(s) along with the outlay.
- The format for reporting results in annual report will be finalized in consultation with OWD.
- This task will be initiated in the 12th month of the assignment and a draft report will be submitted followed by a final one in the 14th month. However, depending on the actual take-off month of this Project and in view of covering the complete financial year for reporting through Year-1 annual report, timing of such submission from the start of the Project may vary somewhat from the above.

Sub-Task 47: Prepare Rolling Three-Year Maintenance Plan

- The Description of Services suggests preparing three-year rolling maintenance program, which means preparation of plan while considering the budgets available in the three years, maintenance needs and most importantly prioritization of maintenance work. The Consultant will consider preparing the multi-year programme for medium- to long-term.
- However, in each subsequent year the rolling maintenance program is revised considering the actual budget available, works accomplished in the previous year and a budget forecast for a further year.
- The plan will focus on prioritizing periodic maintenance, rehabilitation and improvement works. The plan will be produced to a time-frame that meets the government's budgeting cycle. However, production of first three year rolling maintenance programme will depend on actual start month of the assignment, availability of data and status of system development.
- The economic evaluation model, PMS and RMMS will be ready by the 14th month of the assignment. Therefore, generation of multi-year programme using the tools will take at least 2 months, hence, it is expected to have the report ready in the 17th month.

Sub-Task 48: Prepare Annual Road Condition and Traffic Report - Year 2 (i.e. 2012)

- Under this sub-task, second year Annual Road Condition and Traffic Report is proposed to be prepared and submitted. In addition to the items discussed in Sub-task 45, a comparison is possible at this stage with the second round data (traffic).
- This report is expected to utilize the full potential of the O-RAMS. Hence, most of the reports/charts included in this will be a direct output of the O-RAMS. The Consultant has proposed to incorporate feedback of OWD on report for Year-1 and modify this report accordingly.
- This sub-task will be initiated in the 19th month of the assignment and a draft report will be submitted followed by a final one at the end of the 24th month.

Sub-Task 49: OWD Annual Report - Year 2 (i.e. 2012)

- Information obtained from the OWD (as mentioned in Sub-Task 46) is proposed to be updated for Year-2. A review of the performance indicators established is proposed to be included based on the new data available during Year-2. Feedback from OWD on Annual Report 1 will also be incorporated in this Annual Report 2.
- The Consultant will customize some of the standard reports in O-RAMS in consultation with OWD so that it could be included in subsequent Annual Report.
- This sub-task will be initiated in the 22nd month of the assignment and a draft report will be submitted followed by a final one in the 24th month.

Sub-Task 50: Prepare Rolling Three-Year Maintenance Plan - Revision 1

- The plan prepared under Sub-task 47 is proposed to be revised in an iterative process as more accurate forecasts of the next financial year budget become known. The revised report will include a further year and indicative budget for that financial year in prioritizing maintenance program.
- This task will be initiated in the 22nd month of the assignment and a draft report will be submitted followed by a final one in the 24th month.

Sub-Task 51: Prepare Annual Road Condition and Traffic Report - Year 3 (i.e. 2013)

- The sub-task as discussed under heading “Sub-Task 45 & 48” is proposed to be repeated to prepare a third year “Annual Road Condition and Traffic Report”. This report will utilize results of surveys conducted during the third year.
- This sub-task will be initiated in the 30th month of the assignment and a draft report will be submitted followed by a final one at the end of 36th month.

Sub-Task 52: OWD Annual Report - Year 3 (i.e. 2013)

- The sub-task as discussed under hearing “Sub-Task 49” is proposed to be repeated to prepare an Annual Report-3 for OWD.
- This sub-task will be initiated in the 33rd month of the assignment and a draft report will be submitted followed by a final one at the end of 36th month.

Sub-Task 53: Prepare Rolling Three-Year Maintenance Plan - Revision 2

- The sub-task as discussed under Sub-task 50 is proposed to be repeated as second revision of “three year rolling maintenance plan – Revision 2”. This plan would, hence, incorporate work accomplished in the previous two years, performance of the maintenance strategy adopted, and actual budget available for the following financial year and indicative budget for a further one year.
- The maintenance plan will accordingly be adjusted and proposed.
- The precise month of these deliverables will depend on actual start of the assignment, and will also consider a time-frame that meets the Government’s budget period.
- This task will be initiated in the 33rd month of the assignment and a draft report will be submitted followed by a final one in the 36th month.

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-4:	**PREPARATION OF ANNUAL ROAD CONDITION REPORTS AND ROLLING MAINTENANCE PLAN**																																				
Sub-Task 45	Prepare Annual Road Condition and Traffic Report- Year 1																																				
Sub-Task 46	OWD Annual Report- Year 1																																				
Sub-Task 47	Prepare Rolling Three Year Maintenance Plan																																				
Sub-Task 48	Prepare Annual Road Condition and Traffic Report- Year 2																																				
Sub-Task 49	OWD Annual Report- Year 2																																				
Sub-Task 50	Prepare Rolling Three Year Maintenance Plan - Revision 1																																				
Sub-Task 51	Prepare Annual Road Condition and Traffic Report- Year 3																																				
Sub-Task 52	OWD Annual Report- Year 3																																				
Sub-Task 53	Prepare Rolling Three Year Maintenance Plan - Revision 2																																				

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.5. Task-5: Road Classification

Task–5 has been broadly divided into four sub-tasks as detailed below:

Sub-Task 54: Establish and Deliberate on New Classification System

- Under this sub-task together with Sub-Task 13, criteria for defining a functional classification system will be proposed based on analysis of the collected road inventory and traffic data. Further to the data collected, socio-economic and demographic parameter will also be considered based on a multi-criteria analysis.
- The Consultant will superimpose the new classification of the roads over the existing one to develop a matrix of classification for discussion with OWD.
- This sub-task will be initiated in the 3rd but may go on till the 10th month, as it would be dependent on some of the data to be collected by the Consultant from field.

Sub-Task 55: Prepare and Submit New Classification System

- Based on the comments from OWD, the classification systems will be further revised.
- The final road classification system along with a list of roads for each classification will be submitted to OWD.
- This task will be initiated in the 10th month of the assignment and completed at the end of 11th month along with a report submission on same.
- The agreed new classification system of the state road network (limited to the coverage under this project) will be one of the additional attribute of road in RIS.

Sub-Task 56: Prepare Standards for Various Classification

- Roads classified under the new classification system may require different maintenance standards and facilities because of variation in traffic and importance. These will be defined accordingly.
- This sub-task will be initiated in the 10th month of the assignment and completed at the end of 12th month.

Sub-Task 57: Prepare Homogeneous Sections

- Homogeneous sections would have been already created as a part of Sub-Task 30.
- They will be reviewed based on new functional classification again and adjusted, if necessary.
- This sub-task will be performed in the 12th month of the assignment.

Task No.	Task / Activities	2011-12 (Year-1)											
		1	2	3	4	5	6	7	8	9	10	11	12
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12
TASK-5:	ROAD CLASSIFICATION												
Sub-Task 54	Establish and Deliberate on New Classification System												
Sub-Task 55	Prepare and Submit New Classification System												
Sub-Task 56	Prepare Standards for various Classification												
Sub-Task 57	Prepare Homogeneous Sections												

Legend
- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

*4.2.6. **Task-6: Skill/Knowledge Transfer***

Task–6 has been broadly divided into eight sub-tasks as detailed below:

Sub-Task 58: Finalize Methodology to Assess Training Needs

The training will be conducted at the following three levels:

1. **Training in Orissa**: for approximately 700 engineers/IT staff days from various levels using various techniques such as on-the-job, class rooms, field visits, system use, seminars, round table discussion etc.
2. **Training outside Orissa (in a state having RMS/AMS):** for approximately one week for ten batches comprising of four engineers in each batch.
3. **Overseas Training (in Canada):** for approximately two weeks tour, for three such batches, each batch comprising four engineers from OWD in Year 2 of the assignment.

- Out of these three levels, Level-1 is proposed to be carried out after having training needs assessment done. The Consultant will finalize methodology for training needs assessment covering the OWD after interactions with OWD. The actual sample size is to be decided in consultation with OWD for including the level of offices of OWD.
- Once the methodology for TNA is agreed, surveys/interactions will be undertaken under the following sub-tasks.
- For the purpose, the key professionals in the team would provide required guidelines for assessing training needs as regards implementation of the asset management system.
- The Consultant has kept a separate position as Training Expert/Facilitator. The person proposed as Training Expert/Facilitator has been extensively involved imparting to its Clients innovative techniques and methodologies through the technology transfer programs. The entire task related to “Training Needs Assessment” will be undertaken by this position.
- This sub-task will be carried out during the 4th month of the assignment.

Sub-Task 59: Conduct Consultations and/or Survey

- As per the agreed methodology under Sub-Task 58, this sub-task is to implement the same. For doing this, it is proposed to develop structured formats for interactions with senior management; to prepare a list of information required from the OWD, and to develop “self assessment form”. The form is proposed to be circulated to select staff on pilot basis first.
- In parallel, sampling of staff for this will be undertaken once feedback from field/site staff on the format is received, the same will be updated and final forms will be circulated to the sampled staff.
- Though the Training Experts will be responsible for coordinating the task and getting responses back from OWD staff, cooperation from PIU/OWD is highly solicited at this stage.
- This sub-task will be performed during the 4th month of the assignment.

Sub-Task 60: Assess Training Needs of OWD Staff

- Generally, the self-assessment form will reveal "Self-Assessment of Competency Level" on various areas such as :
  - Policy and planning
  - Design
  - Procurement, contract arrangement and project management
  - Safety aspects
  - Systems/software use
  - Computer literacy
  - Maintenance
  - Working with people etc.
- It will also reveal perceived areas of training needs. This will lead to training needs identification at various levels with focus to use O-RAMS once implemented in the State.
- The Consultant will develop/identify levels of training needs in those subject areas.
- This task will be performed during the 5th month of the assignment.

Sub-Task 61: Prepare and Submit Training Needs Assessment Report

A draft report on "Training Needs Assessment" will be submitted to the OWD by the end of the 6th month from the start of the assignment. This will be further refined based on the comments from OWD and a final revision will be submitted.

Sub-Task 62: Evolve Training Program

- While OWD will finalize list of the OWD staff from various offices including HQ to be trained on O-RAMS by the Consultant, the Consultant will develop a training program for them.
- Members of the Consultant's team will impart on-the-job-training to the identified OWD staff in addition to the training sessions comprising:
  - Seminars
  - Class rooms instructions
  - Field visits
  - Discussions/R&A

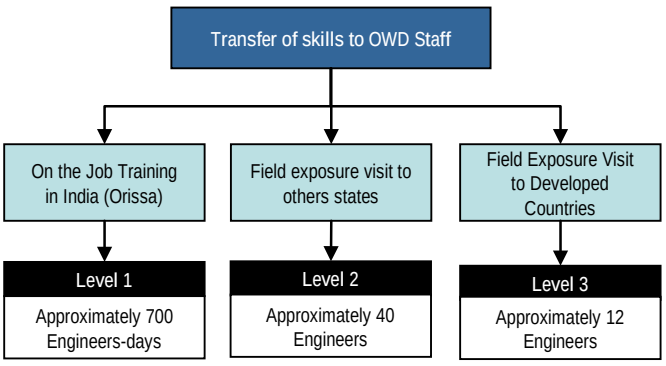


Table 4-9: Training

LEVEL-1					LEVEL-2	LEVEL-3
Trainee Type	**No.**	**Likely Skill Needs**	**Forms of training**	**Skills**	**(For selected 40 Engineers)**	**(for selected 12 OWD engineers)**
JE/AE	105	Data Acquisition, interpretation, collection including data entry	Field Visit	Data Collection Procedure	Visit to States of India where Asset Management Systems have been in use, benefits, problems found and solutions used etc. Each batch comprising four engineers from OWD One Week each batch Visit to Maharashtra and or Gujrat or Kerala or any other mutually agreed State	Visit to Canada to experience how developed countries uses such system, benefits, problems found and solutions used etc. Each batch comprising four engineers from OWD Two weeks each to Toronto, Canada.
			Seminar	Data Collection Techniques and data collection		
			Class Room	System use including data entry		
JE/AE	105	Maintenance planning and budgeting and procurement including data analysing and evolving the software applications to be developed for O-RAMS.	Field Visits	Data Collection Procedure		
			Seminar	Data verification & Analysis Maintenance planning and budgeting		
			Class Room	System application		
EE	35	Maintenance planning and budgeting including use of software applications, performance monitoring and reporting including through use of software applications,	Class Room	Maintenance planning and budgeting using system application		
			Discussion/Q&A	Performance monitoring and reporting using O-RAMS		
SE/CE	40	Performance monitoring and decision making using O-RAMS and RIS	Class Rooms	Performance monitoring and decision making using AMS and RIS		
			Discussion/Q&A	Queries		
J T Staff	30	Software maintenance, modifications and improvements	On-the-job	Software maintenance, modification and improvement		

- In overall training process, a group of engineers will be identified to be trained as "Trainers" for the other OWD staff. Most probably, any training related to system (O-RAMS) would start after a year from the start of the assignment.
- This task will be initiated in the 7th month of the assignment and completed by the 8th month.

Sub-Task 63: Develop Training Materials

Training material is proposed to be developed under the following focus area:

Table 4-10: Training Material

Data collection & entry into O-RAMS	• Overall requirement of data in O-RAMS • Collection proceedings such as manual and or through equipments • Data collection format • Data coding • Data entry (O-RAMS: User Manual) • Feedback form
Maintenance planning & budgeting	• Explanation of decision tree being used in PMS/RMMS of the proposed O-RAMS • Work item/specification • Rate estimate and revision • Optimisation using HDM-4 (and/ or dTIMS)
System use including data entry – Level I	• User Manual • Feedback form
System use Level-II	• Performance monitoring and reporting • Decision making process • Feedback form
System use including data entry – Level I	• User Manual • Feedback form
System use Level-II	• Performance monitoring and reporting • Decision making process • Feedback form
HDM-4	• Data flow between O-RAMS and HDM-4 • Strategic budgeting • Project level analyses • Multi-year works preparing and optimisation • Projection of network condition and … budget scenario
System Maintenance	• System administration • Installation, etc.

- The Consultant will develop such materials in consultation with OWD before its use. However, important feedback is expected on the user manual during its use in training which will be incorporated appropriately.
- This sub-task will be initiated in the 7th month of the assignment and completed by 14th month.

Sub-Task 64: Conduct Training Courses

- Once training program and material are mutually agreed, conduct of training courses are relatively straight forward.
- In addition to key professionals, the Consultant proposes to utilize our professionals proposed under support professional category to impart training at appropriate level on related aspects.
- This sub-task will be initiated in the 10/11th month of the assignment and repeated during 15/16th month.

Sub-Task 65: Conduct Exposure Visit

- A field exposure visit to Canada will be undertaken to gain experience on how such countries use Asset Management System, their benefits and problems found and solutions used etc.
- Since our key professionals have their working experience in Ministry of Transportation, Ontario, Canada, the Consultants propose the exposure visit be conducted in Canada. This will be finalized after discussion with senior OWD officials. This visit will be conducted for two weeks in three batches each comprising of four OWD officers.
- This sub-task will be initiated in consultation with OWD.

All cost relating to training and exposure visit shall be borne by the Consultant as detailed in Sl.4.32 and Appendix F.

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13
TASK-6:	**SKILL/KNOWLEDGE TRANSFER**																								
Sub-Task 58	Finalise Methodology to Assess Training Needs																								
Sub-Task 59	Conduct Consultations and/or Survey																								
Sub-Task 60	Assess Training Needs of OWD Staff																								
Sub-Task 61	Prepare and Submit Training Needs Assessment Report																								
Sub-Task 62	Evolve Training Program																								
Sub-Task 63	Develop Training Materials																								
Sub-Task 64	Conduct Training Courses																								
Sub-Task 65	Conduct Exposure Visits																								

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.7. Task-7: On-Going Support

Task–7 has been broadly divided into five sub-tasks as detailed below:

As per detailed Scope of Work given in Appendix A, the Consultant is expected to provide support to OWD with ongoing application of the system during third year of assignment. The Consultant will provide approximately 20 man-months of one or more technical and key staff for the support on assistance in field data acquisition / updation / integration / report. This would also ensure support to prepare subsequent road condition reports and rolling maintenance plans, to a schedule to be agreed with the Client.

Sub-Task 66: Assist in Functioning of Application of the System and Data Collection

- The Consultant will designate a person from the working team to co-ordinate with any such needs of OWD. Based on the support required in data collection by OWD staff in field /queries raised, Consultant's designated person will co-ordinate with suitable specialist and get back to OWD. Local technical support staff shall be mobilized for the required period to provide technical support to OWD staff during the data collection period.
- Key persons / specialists (if required) will be mobilized in the field for an agreed duration. In addition to 2 month input of key specialists, the Consultant has kept a provision for input from technical support professionals. Depending upon the actual requirement, suitable support staff could be mobilized for the purpose.
- Under this sub-task, intermittent input from professional will be available in the 25th to the 36th month of the assignment.

Sub-Task 67: Assist in Modifying or Developing Investment Plans & Budget Allocation

- This sub-task will require support from HDM-4 specialist. The Consultant will mobilize this person along with PMS specialist (if required) to support OWD during updating/modifying/developing investment plan/three-year rolling maintenance plan and budget allocation.
- This sub-task will be initiated in the 35th month of the assignment and completed by the 36th month.

Sub-Task 68: Assist in On-Golng Training

- It is expected that the "trainers", trained for this purpose, will be able to carry forward training program further for OWD engineers.
- Consultant may mobilize IT professionals for short period(s) for training in this area.
- However, database administrator, system programmer and GIS specialists will be provided to support OWD as per the committed manpower requirements.
- This sub-task will be performed between the 27th and the 36th month of the assignment.

Sub-Task 69: Technical Support of the System

- Beyond the initial 24 months and upto 36 months from start of the assignment, the Consultant will continue to provide technical support with “bug” fixing, clarification etc. This sub-task will primarily be done on a combination of online and offline support.
- For any fixes to the custom-developed part, the technical support staff will be available at Bhubaneswar to fix any identified bugs.
- For clarification on COTS, the Consultant will setup one email_ID to receive any queries by email or by phone. Our technology experts will respond to these queries by email or by phone and send paths/updates (if required) for trouble shooting as early as possible.
- The Consultant will develop a format for any `bugs’ or error to be recorded by OWD engineers.
- Under this sub-task intermittent input from professionals will be available in the 25th and the 36th month of the assignment as needed.

Sub-Task 70: O-RAMS Performance Report (Year 3)

- With the help of technical specialists/support professionals during the last two years of the assignments, the Consultant will develop Annual Performance Report comprising performance of developed O-RAMS, data collection activities, training aspects etc.
- The reports will be submitted as per the schedule.

Task No.	Task / Activities	2013-14 (Year-3)											
		25	26	27	28	29	30	31	32	33	34	35	36
		May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-7:	**ONGOING SUPPORT**												
Sub-Task 66	Assist in Ongoing Application of the System and Data Collection	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Sub-Task 67	Assist in modifying or developing Investment Plans & Budget Allocation											▪	▪
Sub-Task 68	Assist in Ongoing Training			▪			▪			▪			▪
Sub-Task 69	Technical Support of the System	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Sub-Task 70	AMS Performance Report (Year 3)										▪	▪	●

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.8. Task-8: Manuals, Technical Guidelines, and Completion Report

Task-8 has been broadly divided into five sub-tasks as detailed below:

To this end, it is vitally important that the users have a "Who, What, Where, When, Why, and How" guide to the O-RAMS. Accordingly, the Consultants will prepare the following documents/ materials to be made readily available to its users:

- O-RAMS user guide
- O-RAMS system administration manual
- O-RAMS data collection and update manual
- Training materials

Soft copies of all above material will be submitted to the Client.

Sub-Task 71: Finalize O-RAMS Technical Manuals (User Manual, System Administration Manual)

- A User Manual will describe the functions in the O-RAMS, how to use the software and data collection equipment, how to collect data and update database etc. Although, training will be provided to select officers, it is not possible to train all the officers at same level at the same time. In this regard, User Manual will be useful to the officers who could not be trained under this project.
- A Draft Manual will be submitted at the end of 12th month.
- System Administration Manual is a guide to administering O-RAMS (e.g. software installation, configuration and upgrade procedures; administration of users and data/program security). This will contain all the technical procedure for installation, configuration and troubleshooting procedure. This will be submitted during on-going support period.
- This sub-task will be initiated in the 10th month of the assignment and completed at the end of 12th month, but additions / modifications will continue till the 18th month, with final submission of manual.

Sub-Task 72: Finalize Data Collection Procedure Manual

- Data Collection Procedure Manual will be submitted at the end of the 3rd month as draft, and will contain data collection forms and procedures. Subsequent suggestions/additions will lead to finalization of Data Collection Procedure Manual for O-RAMS.

Sub-Task 73: Finalize Training Material /Manual

- Any training material (e.g. slide presentations, notes, and training exercises) that could be used to assist in training of new users on various components will be prepared. The Consultant will develop such material in consultation with OWD.

Sub-Task 74: Finalize Completion Report

- On completion of the services, the Consultants will prepare a Completion Report including any lessons learnt, and institutional and business procedures changes that may be required to further enhance the use and sustainability of the O-RAMS.
- This sub-task will be initiated during the 35th month of the assignment and completed at the end of 36th month.

Sub-Task 75: Quarterly Progress Report

- Progress on each task during the quarter shall be detailed out in the Quarterly Progress Report. Tasks/Sub-tasks which are planned for the next quarter will also be included.
- The report will flag any issues pending for decision from OWD.
- This sub-task will be performed at the end of every three months, in the week to follow.

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-8:	**MANUALS, TECHNICAL GUIDELINES, AND COMPLETION REPORT**																																				
Sub-Task 71	Finalise AMS Technical Manuals (User Manual, System Administration Manual)																																				
Sub-Task 72	Finalise Data Collection Procedure Manual																																				
Sub-Task 73	Finalise Training Manual																																				
Sub-Task 74	Finalise Completion Report																																				
Sub-Task 75	Quality Progress Report																																				

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.9. Task-9: Procurement of Hardware, Software and Data Collection Equipment

Task-9 has been broadly divided into five sub-tasks as detailed below:

The Consultant is mandated to develop O-RAMS satisfying the requirements mentioned in the Detailed Scope of Work in Appendix A, which encourages procurement and use of the Commercial-Off-The-Shelf (COTS) software to optimize the resource in development. Hence, procurement requirements can be classified into three categories as follows:

- Software
- Hardware
- Data collection equipment

Sub-Task 76: Recommend Software (COTS /Database / Front End Application, Report Designer, GIS, HDM4 etc)

- The Consultant has proposed to use dTIMS as "Commercial-Off-the-Shelf Software" around which O-RAMS will be developed. If necessary, during the development stage, the Consultant will use its own legally acquired licenses to develop new forms, tables etc.. At the completion of the project, any software required for further development and or maintenance will have to be acquired by the Client at its own cost, e.g. Deighton Associates (COTS provider for dTIMS) will provide necessary license for as many users as required by OWD at the Client's cost.
- The Consultant will assist OWD in the procurement of software license of front-end application, Microsoft SQL Server, GIS Application and HDM-4 and or Report Designer application at OWD's cost. In case there is a need for other software licenses, the Consultant will also assist OWD for procuring of the same.
- This sub-task will be performed soon after the Needs Analysis for the COTS, and for the rest of this task will be done during the 8th month, or as required.

Sub-Task 77: Recommend Hardware for O-RAMS (Servers, Work Stations, Networking, Web hosting)

- Depending on an agreed system architecture, the Consultant will propose to OWD the requirement of hardware. Once agreed, OWD will procure the same at their own cost with assistance from the Consultant. The proposal will include but not be limited to the following:
  - Servers: database/application/FTP
  - Client PCs with operating system
  - Printers
  - Plotters
  - Scanners
  - Peripherals (including LAN/WAN requirement)
- This sub-task will be performed by the 7th/8th month.

Sub-Task 78: Recommend Data Collection Equipments

- Depending on the agreed procedure for data collection, the Consultants will propose to OWD the requirement for data collection equipment. Once agreed, OWD will procure the same at their own cost with assistance from the Consultant. This will include but not be limited to ROMDAS, Benkelman Deflection Beam, GPS handsets etc.
- This task will be performed in the 4th and the 5th month.

Sub-Task 79: Report on Procurement of Hardware, Software and Data Collection Equipment

- A report (recommendations) detailing out the specification of the software, hardware and data collection equipments will be arranged from the providers and submitted to the Client. Approximate quantity of requirement of such will also be worked out for entire OWD in association with the Client and submitted along with approximate budget required.
- This task will be performed in the 8th month.

Sub-Task 80: Assist Procurement

- The Consultant will provide all necessary assistance in procurement of hardware, software and data collection equipment.
- Under this sub-task support will be given in 6th to 12th month, for procurement.

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-9:	**PROCUREMENT OF HARDWARE, SOFTWARE AND DATA COLLECTION EQUIPMENT**																																				
Sub-Task 76	Recommend Software (Database / Front End Application, Report Designer, GIS, HDM-4 etc)																																				
Sub-Task 77	Recommend Hardware for AMS(Servers, Work Stations, Networking, Webhosting)																																				
Sub-Task 78	Recommend Data Collection Equipments																																				
Sub-Task 79	Report on Procurement of Hardware, Software and Data Collection Equipment																																				
Sub-Task 80	Assist Procurement																																				

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

4.2.10. Task-10: Implementation and Maintenance Support

Task-10 has been broadly divided into three sub-tasks as detailed below:

After the implementation of O-RAMS, support on implementation and maintenance as well as regarding the training, data collection and system shall be provided from month 24 to 36. Adequate technical staff to take care of any bugs and troubleshooting will be deployed at Bhubaneswar for such purpose. As already mentioned in Task 7, around 20 man months have been proposed by the Consultant for this purpose during one year of support period.

Sub-Task 81: Assistance / Support in System Use

- It is expected that the "trainers", so trained for the purpose will be able to carry forward training program for other OWD Engineers. However, the Consultant will provide assistance on training during 3rd year regarding use of software (O-RAMS).
- Under this sub-task intermittent input from professionals will be available during 25th-36th month of the assignment.

Sub-Task 82: Assistance / Support in Data Collection

- OWD is expected to undertake data collection on its own using its own equipment. Although training on data collection would have been imparted to OWD staff, the Consultant will provide further assistance during the 3rd year regarding the use of data collection equipment, if necessary.
- Under this sub-task intermittent input from professionals will be available during 25th-36th month of the assignment.

Sub-Task 83: Maintenance Support of the System

- Beyond the initial 24 months and upto 36 months from start of the assignment, the Consultant will continue to provide technical support with "bug" fixing, clarification etc. This sub-task will primarily be done as a combination of online and offline support.
- For any fixes to the custom-developed part, the technical support staff will be available at Bhubaneswar to fix any identified bugs.
- For clarification on COTS, the Consultant will setup one email_ID to receive any queries by email or by phone. Our technology experts will respond to these queries by email or by phone and send paths/updates (if required) for trouble shooting as early as possible.
- The Consultant will develop a format for any `bugs' or error to be recorded by OWD Engineers.
- Under this sub-task intermittent input from professionals will be available during the 25th and 36th month of the assignment as needed.

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-10:	**IMPLEMENTATION AND MAINTENANCE SUPPORT**																																				
Sub-Task 81	Assistance / Support in System Use																																				
Sub-Task 82	Assistance / Support in Data Collection																																				
Sub-Task 83	Maintenance Support of the System																																				

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

5. TASK ASSIGNMENT

The tasks and sub tasks as explained in the chapter 4 are assigned to key and sub professionals based on their domain expertise. These are given in Table 5-1 and Table 5-2.

Table 5-1: Task Assigned by Professionals

Sl. No.	Name of Staff	Firm	Area of Expertise	Position Assigned	Task Assigned
A. PROFESSIONAL STAFF					
1	**Anand Prakash**	LEA	Civil Engineering, Road Maintenance Management System Quality System	Team Leader – cum - Road Asset Management Specialist	• Mobilization and Interaction with OWD officers • Project Appreciation • Finalize Task Assignment and Scheduling • Prepare and Submit Inception Report • IDS Report Study and Review of ISAP • Prepare and Submit Needs Analysis and overall System Architecture Report • Prepare and Submit Operation Manual of AMS (Overall) • Prepare Annual Road Condition and Traffic Report- Year 1 • OWD Annual Report- Year 1 • Prepare Annual Road Condition and Traffic Report- Year 2 • OWD Annual Report- Year 2 • Prepare Annual Road Condition and Traffic Report- Year 3 • OWD Annual Report- Year 3 • Conduct Exposure Visits • AMS Performance Report (Year 3) • Finalize AMS Technical Manuals (User Manual, System Administration Manual) • Finalize Completion Report • Quarterly Progress Report
2	**Dr. S. S. Seehra**	LASA	Highway Engineering, Pavement investigation works, pavement condition surveys, distress analysis / evaluation	Highway Engineer-cum-Pavement Management System Specialist	• Mobilization and Interaction with OWD officers • Project Appreciation • Review of data available with OWD • Conduct Site Visit • Review Current Maintenance Management

Sl. No.	Name of Staff	Firm	Area of Expertise	Position Assigned	Task Assigned
					Practices of the OWD and MIS • Needs Analysis and Outline of AMS-System Architecture • Agreement on Data Requirement, Collection Methodology and Format for Two Years • Prepare and Submit Road Data Collection Manual • Survey data Verification and Relationship establishment (from Test Data Collection) • Develop Analytical Tools for HDM-4 based Pavement Management System (PMS) • Develop Analytical Tools for Strategic Budgeting Studies • Develop Analytical Tools for Project Level Analysis • Develop Analytical Tools for Multi-year Programming • Calibrate HDM-4 based PMS • Estimate Unit Costs for Maintenance Activities (for PMS & RMMS) • Develop Analytical Tools of Routine Maintenance Management System (RMMS) • Develop Right of Way Features Management System (RWFMS) • Prepare and Submit Operation Manual(s) for PMS, RMMS and RWFMS • Prepare Rolling Three Year Maintenance Plan • Prepare Rolling Three Year Maintenance Plan - Revision 1 • Prepare Rolling Three Year Maintenance Plan - Revision 2 • Prepare Standards for various Classification • Prepare Homogeneous Sections • Develop Training Materials • Conduct Training Courses • Recommend Data Collection Equipments

Sl. No.	Name of Staff	Firm	Area of Expertise	Position Assigned	Task Assigned
					• Report on Procurement of Hardware, Software and Data Collection Equipment
3	**Sagar Prabhakar Deshmukh**	LASA	Highway Engineering Road Data Acquisition & Data Interpretation	Road Data Acquisition & Data Interpretation Specialist	• Mobilization and Interaction with OWD officers • Project Appreciation • Review of data available with OWD • Conduct Site Visit • Needs Analysis and Outline of AMS-System Architecture • Assess Current Road Reference System, Propose refinement and Data Model for O-AMS • Agreement on Data Requirement, Collection Methodology and Format for Two Years • Prepare and Submit Road Data Collection Manual • Gap Analysis and Assessment of Additional Data Requirement • Prepare Data Collection/Verification Programme and Conduct Surveys • Prepare and Submit Data Acquisition on Road Inventory, Condition, Roughness, Pavement Strength, Traffic Volume, Axle Load etc. • Develop Training Materials • Conduct Training Courses • Assist in Ongoing Application of the System and Data Collection • Finalize Data Collection Procedure Manual • Recommend Data Collection Equipments • Report on Procurement of Hardware, Software and Data Collection Equipment
4	**Nirmal Kumar Yadamani**	Geo Infospace	Road Management System, integration and implementation of GIS	GIS Specialist	• Mobilization and Interaction with OWD officers • Project Appreciation • Finalize Approach and Methodology (for Data

Sl. No.	Name of Staff	Firm	Area of Expertise	Position Assigned	Task Assigned
					Collection, GIS / GPS Mapping) • Assess Current Road Reference System, Propose refinement and Data Model for O-AMS • Deliberate on GIS/GPS Requirement, Recommend Necessary Data/Maps/Images to be procured and outline methodology for GIS Development • Prepare and Submit GPS Referencing Report • GIS Development and Integration • Overall System Integration • Develop Training Materials • Conduct Training Courses
5	**Andy Kim**	LEA	Road Maintenance Management System, HDM-4 Analysis and Data collection procedures, Information Systems and Data Analysis	Systems (IT) Specialist	• Mobilization and Interaction with OWD officers • Project Appreciation • Needs Analysis and Outline of AMS-System Architecture • Assess Current Road Reference System, Propose refinement and Data Model for O-AMS • Agreement on System Architecture • Prepare and Submit Draft System Design Document of AMS • Develop GIS based RIS, RWFIMS, BIS and TIS • Populate GIS based RIS, BIS & TIS with Actual Data and Testing with Test Cases • Prepare and Submit System Operation Manual • Install RIS, BIS and TIS Live in OWD • GIS Development and Integration • Overall System Integration • Prepare and Submit overall System Design Report • Overall System Testing • Install O-AMS Live in OWD • Prepare and Submit Operation Manual of AMS (Overall) • Finalize AMS Technical Manuals (User Manual,

Sl. No.	Name of Staff	Firm	Area of Expertise	Position Assigned	Task Assigned
					System Administration Manual) • Recommend Hardware for AMS(Servers, Work Stations, Networking, Webhosting) • Recommend Software (Database / Front End Application, Report Designer, GIS, HDM-4 etc) • Report on Procurement of Hardware, Software and Data Collection Equipment
B. OTHER EXPERTS					
1	S.K. Pancholy	LASA	Quality Control / Quality System	Quality Management System Specialist	• Advise on ongoing asset maintenance practices, benchmarking, improvement
2	AthavanAndavar	LASA	System Design / Architecture / Database	System Engineer	• Advise on system architecture, DB design etc.
3	Dr. M.P. Raju	LASA	Traffic & Transport/ Network Planning / Institutional Development / Capacity Building	Network Planning & Road Classification Expert	• Advise on Network Planning / Road Clarification
4	M.K. Saxena	LASA	Training Coordination and Human Resource Development	Overseas Training Coordinator	• Co-ordinate overseas training programme in consultation with Client / TL

Table 5-2: Task Assignment Matrix

Task No.	Task / Activities	Anand Prakash Team Leader cum Road Asset Management Specialist	Dr. Sohan Singh Seehre Highway Engineer-cum-Pavement Management System Specialist	Sagar Deshmukh Road Data Acquisition & Data Interpretation Specialist	Nirmal Kumar Yadamani GIS Specialist	Andy Kim Systems (IT) Specialist	Highway Engineering Group	Transport Planner / Economist / HDM-4 Specialist Group	GIS / GPS Engineering Group	System (IT) / Database Specialist Group	Data Collection / Survey Group	Training Facilitator Group
TASK-1:	**ASSESSMENT OF CURRENT MAINTENANCE MANAGEMENT SYSTEM**											
Sub-Task 1	Mobilisation and Interaction with OWD officers	●	●	●	●	●						
Sub-Task 2	Project Appreciation	●	●	●	●	●	●	●	●	●	●	●
Sub-Task 3	Review of data available with OWD	○	●	●			●	●			●	
Sub-Task 4	Conduct Site Visit		●	●			●	●			●	
Sub-Task 5	Finalise Approach and Methodology (for Data Collection, GIS / GPS Mapping)	○			●	○			●			
Sub-Task 6	Finalise Task Assignment and Scheduling	●	○	○	○	○						
Sub-Task 7	Prepare Draft Data Collection Formats	○										
Sub-Task 8	Prepare and Submit Inception Report	●										
Sub-Task 9	IDS Report Study and Review of ISAP	●						○				
Sub-Task 10	Review Current Maintenance Management Practices of the OWD and MIS	○	●				●					
Sub-Task 11	Needs Analysis and Outline of AMS-System Architecture	○	●	●		●						
Sub-Task 12	Prepare and Submit Needs Analysis and overall System Architecture Report	●	○	○	○	○						
Sub-Task 13	Review the Road Classification System	○						●				
Sub-Task 14	Assess Current Road Reference System, Propose refinement and Data Model for O-AMS	○		●	●	●				●		
Sub-Task 15	Deliberate on GIS/GPS Requirement, Recommend Necessary Data/Maps/Images to be procured and outline methodology for GIS Development				●				●			
Sub-Task 16	Prepare and Submit GPS Referencing Report				●				●			
TASK-2:	**DATA COLLECTION AND ROAD INFORMATION SYSTEM (RIS) DEVELOPMENT**											
Sub-Task 17	Agreement on Data Requirement, Collection Methodology and Format for Two Years	○	●	●								
Sub-Task 18	Prepare and Submit Road Data Collection Manual	○	●	●								
Sub-Task 19	Agreement on System Architecture	○				●				●		
Sub-Task 20	Computerization of Available Data in the required Format			○			●				●	
Sub-Task 21	Gap Analysis and Assessment of Additional Data Requirement		○	●								
Sub-Task 22	Prepare Data Collection/Verification Programme and Conduct Surveys		○	●			●	●	●		●	
Sub-Task 23	Survey data Verification and Relationship establishment (from Test Data Collection)		●	○			○					
Sub-Task 24	Prepare and Submit Draft System Design Document of AMS	○				●				●		
Sub-Task 25	Develop GIS based RIS, RWFIMS, BIS and TIS					●			●	●		
Sub-Task 26	Prepare and Submit Data Acquisition on Road Inventory, Condition, Roughness, Pavement Strength, Traffic Volume, Axle Load etc.	○		●			●	●	●		●	
Sub-Task 27	Populate GIS based RIS, BIS & TIS with Actual Data and Testing with Test Cases					●	○	○	●			
Sub-Task 28	Prepare and Submit System Operation Manual	○				●	○	○	○	●	○	
Sub-Task 29	Install RIS, BIS and TIS Live in OWD					●				●		

Task No.	Task / Activities	Anand Prakash Team Leader cum Road Asset Management Specialist	Dr. Sohan Singh Seehre Highway Engineer-cum-Pavement Management System Specialist	Sagar Deshmukh Road Data Acquisition & Data Interpretation Specialist	Nirmal Kumar Yadamani GIS Specialist	Andy Kim Systems (IT) Specialist	Highway Engineering Group	Transport Planner / Economist / HDM-4 Specialist Group	GIS / GPS Engineering Group	System (IT) / Database Specialist Group	Data Collection / Survey Group	Training Facilitator Group
TASK-3:	**DEVELOPMENT OF PLANNING TOOLS**											
Sub-Task 30	Develop Analytical Tools for HDM-4 based Pavement Management System (PMS)	○	●	○		○	●	●		○		
Sub-Task 31	Develop Analytical Tools for Strategic Budgeting Studies		●			○	○	●		○		
Sub-Task 32	Develop Analytical Tools for Project Level Analysis		●			○	○	●		○		
Sub-Task 33	Develop Analytical Tools for Multi-year Programming		●			○	○	●		○		
Sub-Task 34	Calibrate HDM-4 based PMS		●			○	○	●		○		
Sub-Task 35	Estimate Unit Costs for Maintenance Activities (for PMS & RMMS)	○	●			○	●	○		○		
Sub-Task 36	Develop Analytical Tools of Routine Maintenance Management System (RMMS)		●			○	●	○		○		
Sub-Task 37	Develop Right of Way Features Management System (RWFMS)		●	○			●			●		
Sub-Task 38	GIS Development and Integration				●	●			●	●		
Sub-Task 39	Overall System Integration	○			●	●				●		
Sub-Task 40	Prepare and Submit overall System Design Report	○			○	●			○	●		
Sub-Task 41	Overall System Testing					●	○	○	○	●	○	
Sub-Task 42	Install O-AMS Live in OWD					●				●		
Sub-Task 43	Prepare and Submit Operation Manual(s) for PMS, RMMS and RWFMS		●			○	●	●		○	○	
Sub-Task 44	Prepare and Submit Operation Manual of AMS (Overall)	●	○		○	●	●	●	●	●		
TASK-4:	**PREPARATION OF ANNUAL ROAD CONDITION REPORTS AND ROLLING MAINTENANCE PLAN**											
Sub-Task 45	Prepare Annual Road Condition and Traffic Report- Year 1	●	○	○			●	●				
Sub-Task 46	OWD Annual Report- Year 1	●					○	●				
Sub-Task 47	Prepare Rolling Three Year Maintenance Plan	○	●				○	●				
Sub-Task 48	Prepare Annual Road Condition and Traffic Report- Year 2	●	○	○			●	●				
Sub-Task 49	OWD Annual Report- Year 2	●					○	●				
Sub-Task 50	Prepare Rolling Three Year Maintenance Plan - Revision 1	○	●				○	●				
Sub-Task 51	Prepare Annual Road Condition and Traffic Report- Year 3	●	○	○			●	●				
Sub-Task 52	OWD Annual Report- Year 3	●					○	●				
Sub-Task 53	Prepare Rolling Three Year Maintenance Plan - Revision 2	○	●				○	●				
TASK-5:	**ROAD CLASSIFICATION**											
Sub-Task 54	Establish and Deliberate on New Classification System	○					○	●				
Sub-Task 55	Prepare and Submit New Classification System	○					○	●				
Sub-Task 56	Prepare Standards for various Classification	○	●				●	●				
Sub-Task 57	Prepare Homogeneous Sections		●				●	●				

Task No.	Task / Activities	Anand Prakash Team Leader cum Road Asset Management Specialist	Dr. Sohan Singh Seehre Highway Engineer-cum-Pavement Management System Specialist	Sagar Deshmukh Road Data Acquisition & Data Interpretation Specialist	Nirmal Kumar Yadamani GIS Specialist	Andy Kim Systems (IT) Specialist	Highway Engineering Group	Transport Planner / Economist / HDM-4 Specialist Group	GIS / GPS Engineering Group	System (IT) / Database Specialist Group	Data Collection / Survey Group	Training Facilitator Group
TASK-6:	**SKILL/KNOWLEDGE TRANSFER**											
Sub-Task 58	Finalise Methodology to Assess Training Needs	○										●
Sub-Task 59	Conduct Consultations and/or Survey										●	●
Sub-Task 60	Assess Training Needs of OWD Staff	○	○	○	○	○						●
Sub-Task 61	Prepare and Submit Training Needs Assessment Report	○										●
Sub-Task 62	Evolve Training Program	○	○	○	○	○						●
Sub-Task 63	Develop Training Materials		●	●	●	○	●	●	●	○	●	●
Sub-Task 64	Conduct Training Courses	○	●	●	●	○	●	●	●	●	●	●
Sub-Task 65	Conduct Exposure Visits	●										●
TASK-7:	**ONGOING SUPPORT**											
Sub-Task 66	Assist in Ongoing Application of the System and Data Collection			●		○	●	●		●	●	
Sub-Task 67	Assist in modifying or developing Investment Plans & Budget Allocation	○	○				○	●				
Sub-Task 68	Assist in Ongoing Training						●	●	●	●	●	●
Sub-Task 69	Technical Support of the System								●			
Sub-Task 70	AMS Performance Report (Year 3)	●					●		●			
TASK-8:	**MANUALS, TECHNICAL GUIDELINES, AND COMPLETION REPORT**											
Sub-Task 71	Finalise AMS Technical Manuals (User Manual, System Administration Manual)	●	○	○	○	●	●	●	●	●	●	
Sub-Task 72	Finalise Data Collection Procedure Manual	○	○	●			●	●			○	
Sub-Task 73	Finalise Training Manual	○	○	○	○	○						●
Sub-Task 74	Finalise Completion Report	●						●				
Sub-Task 75	Quarterly Progress Report	●										
TASK-9:	**PROCUREMENT OF HARDWARE, SOFTWARE AND DATA COLLECTION EQUIPMENT**											
Sub-Task 76	Recommend Hardware for AMS(Servers, Work Stations, Networking, Webhosting)	○				●				●		
Sub-Task 77	Recommed Software (Database / Front End Application, Report Designer, GIS, HDM-4 etc)	○				●				●		
Sub-Task 78	Recommend Data Collection Equipments	○	●	●								
Sub-Task 79	Report on Procurement of Hardware, Software and Data Collection Equipment	○	●	●		●						
Sub-Task 80	Assist Procurement											
TASK-10:	**IMPLEMENTATION AND MAINTENANCE SUPPORT**									●		

6. MANNING SCHEDULE

There has been no change in the key personnel originally proposed and included in the contract agreement. All the key professionals have been mobilized and have contributed to the assignment progress till date.

As per the contract, key professionals' person-month input is to be 70, support technical professionals person-months to be 410, and 460 person-months for other support staff. Based on the requirement, as discussed in the earlier section, we have introduced four expert positions and have allocated 16 person months out of 410 person-month of support technical staff. This is as shown in Contract Agreement too.

An input of overall 20 person-months is envisaged during the one year "ongoing support" beyond 24 months of initial assignment. Manning or Staffing Schedule is given in Table 6-1. At this stage this is what is considered to be appropriate. If there are any changes that are required to meet the changing needs of the Project, these will be made at the appropriate time and the OWD will be kept fully informed.

Table 6-1: Staffing Schedule

Sl. No.	Name of Staff	Position	Home/ Field	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)												Total Staff-month input		
				May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14			
				Quarter-1			Quarter-2			Quarter-3			Quarter-4			Quarter-1			Quarter-2			Quarter-3			Quarter-4			Quarter-1			Quarter-2			Quarter-3			Quarter-4			Home	Field	Total
KEY PROFESSIONALS																																									
Foreign																																									
1	Anand Prakash	Team Leader cum Road Asset Management Specialist	*Home*																																				0		0
			Field																																					18	18
2	Andy Kim	Systems (IT) Specialist	*Home*																																						0
			Field																																					16	16
Local																																									
1	Dr. Sohan Singh Seehra	Highway Engineer-cum-Pavement Management System Specialist	*Home*																																				0		0
			Field																																					18	18
2	Sagar Prabhakar Deshmukh	Road Data Acquisition & Data Interpretation Specialist	*Home*																																				0		0
			Field																																					12	12
3	Nirmal Kumar Yadamani	GIS Specialist	*Home*																																				0		0
			Field																																					6	6
OTHER EXPERTS																																									
1	S.K. Pancholy	Quality Management System Specialist	*Home*																																				0		0
			Field																																					5	5
2	Athavan Andavar	System Engineer	*Home*																																				0.5		0.5
			Field																																					0.5	0.5
3	Dr. M.P. Raju	Network Planning / Road Classification Expert	*Home*																																				0		0
			Field																																					5	5
4	M.K. Saxena	Overseas Training Coordinator	*Home*																																				1		1
			Field																																					4	4
SUPPORT STAFF																																									
1	Group 1: Highway Engineer/ Pavement Engineer/ Bridge Engineer		*Home*																																				0		0
			Field																																					62	62
2	Group 2: Transport Economist/ Transport Planner/ HDM Specialist		*Home*																																				0		0
			Field																																					38	38
3	Group 3: GIS/ RIS/ GPS Data Analysis		*Home*																																				0		0
			Field																																					28	28
4	Group 4: System Architect/ Sr. System Administrator/Software Engineers/ DBMS Specialist		*Home*																																				0		0
			Field																																					80	80
5	Group 5: Road Surveyor / Data Collection Supervisors / Quantity Surveyors		*Home*																																				0		0
			Field																																					164	164
6	Group 6: Training Experts / Facilitator		*Home*																																				0		0
			Field																																					22	22
																																					TOTAL			480

Legend
Full Time input
Part Time input

7. WORK PROGRAMME

7.1. BACKGROUND

This is a major assignment. As described in Chapter 4, it involves various tasks and sub-tasks. To have a better clarity and to be of use to monitor the progress, both by the Team and the OWD, Work Programme for individual tasks and sub tasks is already presented under the respective sub-tasks in Chapter 4.

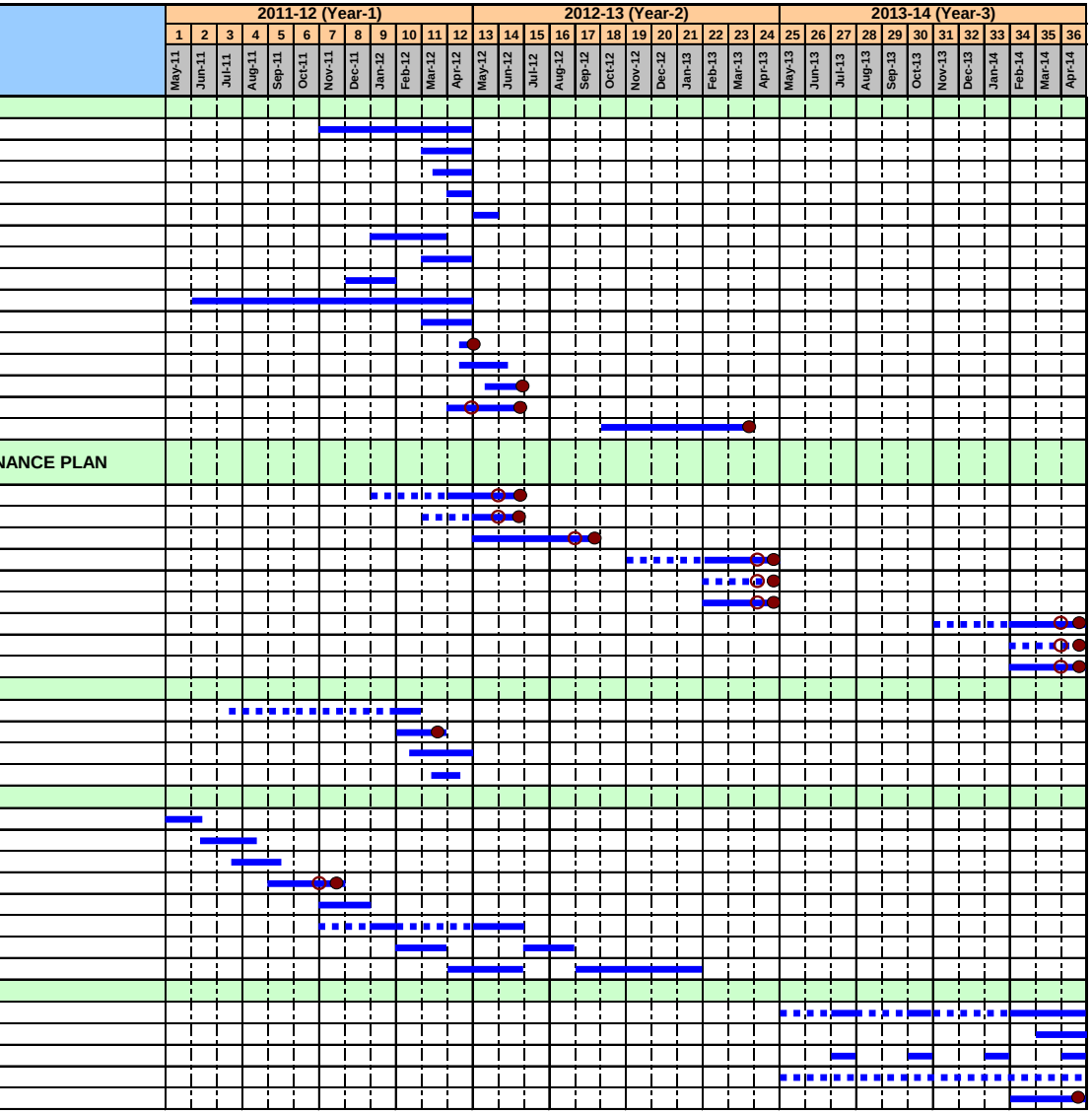
7.2. WORK PROGRAMME

To be compliant of the Contract, and to give a broader picture for high-level decision-makers, a consolidated Work Programme for the entire three-year period is presented in Table 7-1.

Table 7-1: Work Programme : O-RAMS

Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-1:	**ASSESSMENT OF CURRENT MAINTENANCE MANAGEMENT SYSTEM**																																				
Sub-Task 1	Mobilisation and Interaction with OWD officers																																				
Sub-Task 2	Project Appreciation																																				
Sub-Task 3	Review of data available with OWD																																				
Sub-Task 4	Conduct Site Visit																																				
Sub-Task 5	Finalise Approach and Methodology (for Data Collection, GIS / GPS Mapping)																																				
Sub-Task 6	Finalise Task Assignment and Scheduling																																				
Sub-Task 7	Prepare Draft Data Collection Formats																																				
Sub-Task 8	Prepare and Submit Inception Report																																				
Sub-Task 9	IDS Report Study and Review of ISAP																																				
Sub-Task 10	Review Current Maintenance Management Practices of the OWD and MIS																																				
Sub-Task 11	Needs Analysis and Outline of AMS-System Architecture																																				
Sub-Task 12	Prepare and Submit Needs Analysis and overall System Architecture Report																																				
Sub-Task 13	Review the Road Classification System																																				
Sub-Task 14	Assess Current Road Reference System, Propose refinement and Data Model for O-AMS																																				
Sub-Task 15	Deliberate on GIS/GPS Requirement, Recommend Necessary Data/Maps/Images to be procured and outline methodology for GIS Development																																				
Sub-Task 16	Prepare and Submit GPS Referencing Report																																				
16 (a)	Collection of GPS Points (pilot circle)																																				
16 (b)	Collection of GPS Points (rest circles)																																				
TASK-2:	**DATA COLLECTION AND ROAD INFORMATION SYSTEM (RIS) DEVELOPMENT**																																				
Sub-Task 17	Agreement on Data Requirement, Collection Methodology and Format for Two Years																																				
Sub-Task 18	Prepare and Submit Road Data Collection Manual																																				
Sub-Task 19	Agreement on System Architecture																																				
Sub-Task 20	Computerization of Available Data in the required Format for AMS																																				
20 (a)	Referencing data of the road network & CD structures																																				
20 (b)	Inventory data of road network & CD structures																																				
20 [c]	Other data lfrom the Grant book regarding sanctioned and executed works and others (if any)]																																				
Sub-Task 21	Gap Analysis and Assessment of Additional Data Requirement																																				
Sub-Task 22	Prepare Data Collection/Verification Programme and Conduct Surveys																																				
22 (a)	Inventory of Pavements (20% verification in pilot circle)																																				
22 (b)	Inventory of Pavements (20% verification in rest circles)																																				
22 [c]	Inventory of CD Works (20% verification in pilot circle)																																				
22 (d)	Inventory of CD Works (20% verification in rest circles)																																				
22 [e]	Roughness Survey on Paved Road using ROMDAS																																				
23 (f)	Condition Survey of Pavements-Visual (Surface Distress Indicators)																																				
23 (g)	Condition Survey of Pavements-Mechanical																																				
23 (h)	BBD Survey + CBR																																				
23 (i)	Bridge Condition (Major + Minor)																																				
23 (j)	Traffic Survey (Classified Volume Count-200 locations)																																				
23 (k)	Axle-load Survey (30 locations)																																				
Sub-Task 23	Survey data Verification (from Test Data Collection)																																				
Sub-Task 24	Prepare and Submit Draft System Design Document of AMS																																				
Sub-Task 25	Develop GIS based RIS, RWFIMS, BIS and TIS																																				
Sub-Task 26	Prepare and Submit Data Acquisition on Road Inventory, Condition, Roughness, Pavement Strength, Traffic Volume, Axle Load etc.																																				
Sub-Task 27	Populate GIS based RIS, BIS & TIS with Actual Data and Testing with Test Cases																																				
Sub-Task 28	Prepare and Submit System Operation Manual																																				
Sub-Task 29	Install RIS, BIS and TIS Live in OWD																																				

Task No.	Task / Activities
TASK-3:	DEVELOPMENT OF PLANNING TOOLS
Sub-Task 30	Develop Analytical Tools for HDM-4 based Pavement Management System (PMS)
Sub-Task 31	Develop Analytical Tools for Strategic Budgeting Studies
Sub-Task 32	Develop Analytical Tools for Project Level Analysis
Sub-Task 33	Develop Analytical Tools for Multi-year Programming
Sub-Task 34	Calibrate HDM-4 based PMS
Sub-Task 35	Estimate Unit Costs for Maintenance Activities (for PMS & RMMS)
Sub-Task 36	Develop Analytical Tools of Routine Maintenance Management System (RMMS)
Sub-Task 37	Develop Right of Way Features Management System (RWFMS)
Sub-Task 38	GIS Development and Integration
Sub-Task 39	Overall System Integration
Sub-Task 40	Prepare and Submit overall System Design Report
Sub-Task 41	Overall System Testing
Sub-Task 42	Install O-AMS Live in OWD
Sub-Task 43	Prepare and Submit Operation Manual(s) for PMS, RMMS and RWFMS
Sub-Task 44	Prepare and Submit Operation Manual of AMS (Overall)
TASK-4:	PREPARATION OF ANNUAL ROAD CONDITION REPORTS AND ROLLING MAINTENANCE PLAN
Sub-Task 45	Prepare Annual Road Condition and Traffic Report- Year 1
Sub-Task 46	OWD Annual Report- Year 1
Sub-Task 47	Prepare Rolling Three Year Maintenance Plan
Sub-Task 48	Prepare Annual Road Condition and Traffic Report- Year 2
Sub-Task 49	OWD Annual Report- Year 2
Sub-Task 50	Prepare Rolling Three Year Maintenance Plan - Revision 1
Sub-Task 51	Prepare Annual Road Condition and Traffic Report- Year 3
Sub-Task 52	OWD Annual Report- Year 3
Sub-Task 53	Prepare Rolling Three Year Maintenance Plan - Revision 2
TASK-5:	ROAD CLASSIFICATION
Sub-Task 54	Establish and Deliberate on New Classification System
Sub-Task 55	Prepare and Submit New Classification System
Sub-Task 56	Prepare Standards for various Classification
Sub-Task 57	Prepare Homogeneous Sections
TASK-6:	SKILL/KNOWLEDGE TRANSFER
Sub-Task 58	Finalise Methodology to Assess Training Needs
Sub-Task 59	Conduct Consultations and/or Survey
Sub-Task 60	Assess Training Needs of OWD Staff
Sub-Task 61	Prepare and Submit Training Needs Assessment Report
Sub-Task 62	Evolve Training Program
Sub-Task 63	Develop Training Materials
Sub-Task 64	Conduct Training Courses
Sub-Task 65	Conduct Exposure Visits
TASK-7:	ONGOING SUPPORT
Sub-Task 66	Assist in Ongoing Application of the System and Data Collection
Sub-Task 67	Assist in modifying or developing Investment Plans & Budget Allocation
Sub-Task 68	Assist in Ongoing Training
Sub-Task 69	Technical Support of the System
Sub-Task 70	AMS Performance Report (Year 3)



Task No.	Task / Activities	2011-12 (Year-1)												2012-13 (Year-2)												2013-14 (Year-3)											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
TASK-8:	**MANUALS, TECHNICAL GUIDELINES, AND COMPLETION REPORT**																																				
Sub-Task 71	Finalise AMS Technical Manuals (User Manual, System Administration Manual)																																				
Sub-Task 72	Finalise Data Collection Procedure Manual																																				
Sub-Task 73	Finalise Training Manual																																				
Sub-Task 74	Finalise Completion Report																																				
Sub-Task 75	Quality Progress Report																																				
TASK-9:	**PROCUREMENT OF HARDWARE, SOFTWARE AND DATA COLLECTION EQUIPMENT**																																				
Sub-Task 76	Recommend Software (Database / Front End Application, Report Designer, GIS, HDM-4 etc)																																				
Sub-Task 77	Recommend Hardware for AMS(Servers, Work Stations, Networking, Webhosting)																																				
Sub-Task 78	Recommend Data Collection Equipments																																				
Sub-Task 79	Report on Procurement of Hardware, Software and Data Collection Equipment																																				
Sub-Task 80	Assist Procurement																																				
TASK-10:	**IMPLEMENTATION AND MAINTENANCE SUPPORT**																																				
Sub-Task 81	Assistance / Support in System Use																																				
Sub-Task 82	Assistance / Support in Data Collection																																				
Sub-Task 83	Maintenance Support of the System																																				

Legend

- Continuous
- Intermittent
- Draft Report (Original Schedule)
- Final Report (Original Schedule)
- Draft Report (Proposed Schedule)
- Final Report (Proposed Schedule)

8. PROFORMA FOR DATA COLLECTION

8.1. INTRODUCTION

Collection of data is one of the major efforts of this assignment. It is to be accomplished both by Consultant's team and OWD collectively during the course of assignment. While, the Consultant will take the lead in Year 1, OWD with necessary training in phased manner will take over in the next couple of years.

Rightly so the authors of the Terms of Reference, given the importance of it and have included the **Road Data Collection Manual** as a separate deliverable. The Consultant commends the thought and wisdom behind this.

To be compliant of the process and the Contract the Consultant has developed Draft Survey formats, addressing various areas of concern. These should be seen as draft and will be further refined and finalized to be part of Road Data Collection Manual (Draft and Final).

8.2. PAVEMENT, CULVERT AND BRIDGE INVENTORY

Pavement, culvert and bridge inventory data will be collected by OWD. List of data formats are the following:

1. Road Inventory Data Sheet
2. Pavement Composition Data Sheet
3. Culvert Inventory Data Sheet
4. Bridge Inventory Data Sheet

The formats along with explanation on the items are provided in Figure 8-1.to Figure 8-4.

8.3. PAVEMENT CONDITION EVALUATION

Three formats have been developed for evaluating flexible, rigid and gravel pavements (refer Figure 8-5 to Figure 8-7)

1. Flexible Pavement Condition Evaluation Form (PC-1)
2. Rigid Pavement Condition Evaluation Form (PC-2)
3. Gravel Pavement Condition Evaluation Form(PC-3)

8.4. GPS REFERENCING

A format for capturing GPS points along the road has been devised (refer Figure 8-8)

8.5. PAVEMENT STRUCTURAL STRENGTH

Formats for recording BBD deflection measurement and output are provided at Figure 8-9 and Figure 8-10.

8.6. CLASSIFIED TRAFFIC VOLUME COUNT

A format for recording classified traffic volume count is provided at Figure 8-11.

8.7. AXLE-LOAD SURVEY

A format for axle-load survey is provided at Figure 8-12.

8.8. BRIDGE CONDITION SURVEY

Draft format for recording condition of bridge is provided at Figure 8-13.

Figure 8-1 : Road Inventory Format

ROAD INVENTORY DATA SHEET																	
Road Name				**Division**								**Road No.** *SH ___, MDR _____, ODR_____*					
Section				**From** *km* _____ **To** *km* _____								**Date of Survey** (dd/mm/yy)	**Engineer**				
From	**To**	**Terrain** Plain P Rolling R Hilly H Swamp S	**Land Use** Builtup Bu Agri A Forest F Ind I Res R Barren Ba Water W **+** **L / R**	**Name of Village/ Town**	**Formation Width**	CARRIAGEWAY **Type** CC BT GR ER	CARRIAGEWAY **Width**	CARRIAGEWAY Cond	SHOULDER **Type** CC BT GR ER	SHOULDER **Width**	SHOULDER Cond	**Embankment Height**	**Submergence** **Y / N**	CROSS ROAD **Location + L / R / X**	CROSS ROAD **Road No. / Name**	CROSS ROAD **Carriageway Type & Width**	**Remarks**
km	km				m		m			m		m		km/m		m	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Col. No	Explanation
1,2	Data for every 1 km, or less if significant change in column 3-12
3	Plain(P) or rolling (R) or hilly(H) or swamp(S)
4	Built Up (Bu) or agriculture (A) or forest area (F) or industrial (I) or residential (R) or barren land (Ba) or Water (W); state whether on the left (L) or the right side (R)
5	Name of each village separately, wherever present (**No grouping**), state the beginning and end wherever possible
6	The width of carriageway or pavements + shoulders
7	CC - Cement concrete, BT- Bituminous, GR- Gravel, ER - Earthen
8	Report in metres to one decimal place
9	**Not required**
10	CC - Cement concrete, BT-Bituminous, GR- Gravel, ER - Earthen
11	Report in metres to one decimal place. If both shoulders are of different width, record accordingly.If no shoulders available, report as Nil
12	**Not required**
13	Report in metres to a minimum of one decimal place. If less than a metre, to the nearest 5cm
14	submergence in Yes (Y) / No (N) [if yes, state the chainage from / to in remarks column]
15	Report the chainage km/m of the above road where it crosses another road; state whether on the left **(L)** or the right side **(R)** or crossing **(X)**
16	Name of the cross road and No. if available
17	**Not required**

Figure 8-2 : Pavement Composition

PAVEMENT COMPOSITION													
Road Name:				**Division**				**Road No.** : SH _____, MDR _____, ODR_____					
Section:				**From** *km* _____ **to** *km* _____				**Date of Survey** (dd/mm/yyyy) :		**Engineer**			
Chainage		Pavement Composition										Shoulder Type	Right of Way (m)
		Surface course		Binder course		Base course		Subbase course		Subgrade			
From km	To km	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)		
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Data Type	Col. No.	Sub Data Type	Explanation
Chainage	1,2		Mention chainage in Km/m wherever there is any change of data in any of the columns 3 to 14.
Pavement type	3	Surface	Cement concrete- CC, Bituminous concrete- BC, Semi dense bituminous concrete- SDBC, Premix carpet-PC, Built up spray grout- BUSG, Mix seal surfacing- MSS
	4,6,8,10	Thickness	Mention thickness of each layer in mm
	5	Binder	Dense bituminous macadam- DBM, Bituminous macadam- BM, Built-up spray grout- BUSG
	7	Base	Dry lean concrete- DLC, Wet mix macadam- WMM, Water bound macadam- WBM
	9	Sub-base	Granular- GSB, Moorum, Crushed stone, stone soling
	11	Subgrade	Sandy, Silty, Clayey, Stablized soil, any other
Shoulder type	13		Paved- P, Gravel- Gr, Earthen- ER
Right of way	14		Right of way (Reserved width of land for roads) in m

Figure 8-3 : Culvert Inventory

INVENTORY SURVEY FOR CULVERTS											
Road Name: **Division**						**Road No.** : *SH* _____, *MDR* _____, *ODR*_____					
Section: ***From*** *km* _____ ***to*** *km* _____						**Date of Survey** (dd/mm/yyyy) : **Engineer**					
Sl. No.	Location (km/m)	Type of Structures (Pipe, Slab, Box, Arch)	Thickness of Slab (m)	Span Arrangement and Pipe Diameter (No.x Length) (m)	Carriageway Width (m)	Length of Culvert (m)	Height above Bed Level		Scour High-H, Medium-M, Low-L, Nil	Adequacy of Waterway (Yes / No)	Indication and Condition
							U/S side (m)	D/S side (m)			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Column reference	Description
2	Report location in km/m
3	RCC slab, box, hume pipe, brick arch, stone
4	Thickness of Slab has to be given for stone slab, RCC slab
5	Span arrangement has to be mentioned. In case of hume pipe, internal diamter of the pipe has to be mentioned.
6	Record width of carriage way in metres to one decimal place
7	Record width of culvert in metres to one decimal place
8	**Not Required**
9	depth from the bed level (downstream side) to the soffit of the culvert (Soffit :- the highest internal level of pipe / slab)
10	H -high, M-medium, L- low, N-Nil
11	Yes or No
12	**Not Required**

Figure 8-4 : Bridge Inventory

BRIDGE INVENTORY DATA SHEET

Road Name : **Division :** **Road No.** *SH_____, MDR _____, ODR____*

Section : **From** *km_____* **To** *km_____* **Date of Survey** (dd/mm/yy) : **Engineer :**

Sl. No.	Bridge no.	Location (km)	Name of river bridge	Year of construction	Number of spans	Span arrangements (no. X span length in m)	Clear span (m)	Length of bridge (m) (between inner face of dirt wall)	High level or submersible	Clear road way width between kerbs (m)	Outer width of bridge (m)	Width of footpath (m)	**Super structure**					**Wearing coat**		**Sub-structure**								
													Girder	Type	Type of bearing (elastomeric/pot-cum-PTFE/roller-rocker)	Thickness of slab (m)	Material of slab (RCC/PSC)	Handrail / parapet thickness & height (m)	Type (CC / flexible)	Thickness (mm)	**Type**			Thickness of pier (m)		Height of pier & abutment (m)	Material		
																					Abutment	Pier	Wing wall	Top	Bottom		Abutment **(Masonry/PCC/RCC)**	Pier **(Masonry/PCC/RCC)**	Wing wall **(Masonry/PCC/RCC)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22A	22B	22C	23	24	25	26	27A	27B

Pier foundation		**Abutment foundation**		**Protection work**		Skew angle (degree)	Vertical clearance (m)	Road formation level (m)	Direction of flow	**Present Condition of Bridge**					Clear waterway (m)	Design loading	High flood level (HFL) (m)	Lowest water level (m)	Design discharge (cumecs)	Maximum design velocity (m/sec)	**Remarks**
Type	Material	Type	Material	Bed	Approach					Abutments	Piers	Slab	Carriageway	Parapet							
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	**49**

Description of Bridge Inventory Data Sheet

Column No.	Description
1	Sl. No. (Serial Number)
2	Bridge no. as assigned by OWD
3	Chainage at center point of Bridge
4	Name of the river Bridge
5	Year of Completion of construction of the bridge
6	Total number of spans
7	Number and length of each span measured from centre to centre of expansion joints in sequence
8	Length between the inside faces of piers at pier cap level
9	Length of bridge measured from inner faces of dirtwalls
10	**High Level** : The bridge, which carries the roadway above H.F.L. of the channel **Submersible** : The Bridge which is designed to be over topped during flood
11	Minimum clear width measured at right angles to the longitudinal centreline of bridge between inside faces of roadway kerb
12	Width measured from outer to outer face of railing / crash barrier / parapet.
13	Width of footpath measured between inner face of Railing / Crash barrier / parapet and kerb.
14	Not required to be filled
15	RCC solid slab / t-beam / Girder & deck slab(RCC / PSC) / I Girder & Slab (Rcc / Psc) / Box girder(RCC & PSC),
16	Elastomeric,Pot cum PTFE,Roller & rocker, Steel plate type
17	Thickness of deck slab at the central line of the bridge
18	RCC / PSC
19	Thickness and height of handrail / parapet
20	CC / Flexible
21	Thickness from top surface of the deck slab to Finished Road Level.
22A	Abutment - Solid wall type / spill through type
22B	Pier - solid wall / Coulmn / Coulmn with web / Frame
22C	Wing Wall - Splayed Wall / Box Return Wall / Butterfly / Gravity Return Wall
23 & 24	Thickness of pier near Pier cap and foundation
25	This is measured from the top of foundation to the bottom of pier cap.
26, 27A, 27B	Masonary / PCC / RCC etc.
28 & 30	Open foundation / Well Foundation / Raft foundation / Pile foundation
29 & 31	Masonary / PCC / RCC etc.
32 & 33	Stone Rip Rap / Gabions / Concrete block / mat
34	It is the angle between the perpendicular to the flow of traffic direction and the flow direction of river.
35	The height from the design highest flood level with afflux of the channel to the lowest point of the bridge superstructure at the position along the bridge. (IRC : 5 - 1998)
36	The reduced level of top surface of road.
37	If skew angle is Zero, then the flow is perpendicular
38-42	**Not required to be filled**
43	Clear water way is the total width of the water way at HFL minus the effective width of the obstruction. (IRC : 5 - 1998)
44	70R / Class AA / Class A / Class B etc.
45	Highest Flood Level is the level of the Highest Flood ever recorded or calculated level for the design discharge. (IRC : 5 - 1998)
46	Lower water level is the level of the water surface ever recorded during the dry season . (IRC : 5 - 1998)
47	The discharge for which the water way of the bridge has been designed. (IRC : 5 - 1998)
48	The maximum velocity for which the bridge has been designed.

Figure 8-5 : Flexible Pavement Condition Evaluation Form

O-RAMS	PC1: FLEXIBLE PAVEMENT CONDITION EVALUATION FORM				District:
HIGHWAY ID:		Location	From	To	
DATE OF SURVEY:			Name :	Name:	
TIME OF SURVEY:			Km :	Km:	

Sub-Section No./ Sl. No.	Chainage		CRACKING						POTHOLES						RAVELLING						RUTTING						Remarks, if any
			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			
	From	To	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	

Figure 8-6 : Rigid Pavement Evaluation Form

O-RAMS	PC2: CEMENT CONCRETE (RIGID) PAVEMENT CONDITION EVALUATION FORM	District:

HIGHWAY ID:		Location	From		To	
DATE OF SURVEY:			Name :		Name:	
TIME OF SURVEY:			Km :		Km:	

Sub-Section No./ Sl. No.	Chainage		CRACKING						POTHOLES						JOINT DEFICIENCY						FAULTING(STEPPING)						Remarks, if any
			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			
	From	To	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	

Figure 8-7: Gravel Pavement Surface Condition Evaluation Form

O-RAMS	PC3: GRAVEL PAVEMENT SURFACE CONDITION EVALUATION FORM	District:

HIGHWAY ID:		Location		From						To																
DATE OF SURVEY:				Name :						Name:																
TIME OF SURVEY:				Km :						Km:																
Sub-Section No./ Sl. No.	Chainage		LOOSE GRAVEL						POTHOLES						RUTTING						Remarks, if any					
			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT								
	From	To	Slight	Moderate	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	slight	moderate	high	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	slight	moderate	high	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)						

Figure 8-8 : GPS Data Recording Format

ORISSA ASSET MANAGEMENT SYSTEM (O-AMS)

GPS REFERENCING SURVEY SHEET													
Road Name:												Road No. : SH_____, MDR_____,ODR_____	
Section name:					Chainage: Km_____ to Km_____							Date of Survey :	
Division:												Surveyors :	
Waypoint	Features							Village		Inventory		Odometer Reading	Remarks
	Km Stone	Cross Road/Junction		Culvert	Bridge					Surface Change	Width Change		
		L	R		Start	End	Center	Start	End				

LEA Associates South Asia Pvt. Ltd.

Description

- *Road Name: Name of the road as per OWD records*
- *Section name: Name of the road section within the road*
- *Chainage: Chainage from the start of road section (from km) to at the end of road section (to km).*
- *Division: Name of division under whose jurisdiction the road falls.*
- *Road No. Number of SH, MDR or ODR as per OWD records*
- *Date Survey: DD/MM/YY*
- *Surveyors: Names of the persons carrying out the survey.*
- *Waypoint: Number of waypoint*
- *Odometer Reading: Reading of vehicle odometer at the waypoint. Odometer reading should be set to '0' at the start point of every new road.*
- *Remarks: Details of features like name of village, irrigation culvert etc.*
- *For all other columns (Features, Village and inventory) tick marks to be put in the relevant boxes.*

Note: If cross road/junction has four arms the tick mark should be put in the both the boxes L and R. In case of minor bridge tick mark should be put in the box 'Center' and if bridge is major then tick marks should be put in the boxes 'Start' and 'End' against the relevant waypoint numbers

Figure 8-9: BBD Data Collection Format

BENKELMAN BEAM TEST **DATA COLLECTION**							
Road Name & No.: Date : Engineer:							
Station	Edge/Lane L/R	Dial Readings				Temp.	Remarks
		D_0	D_{500}	D_{1000}	Final		

Figure 8-10: Output

BENKELMAN BEAM TEST
DEFLECTIONS AND CALCULATIONS

Road Name & No.:

Date : Engineer:

Station	Deflection (mm)			M_R	CBR	AREA
	d_0	d_{500}	d_{1000}			

Figure 8-11 : Format for Recording Classified Volume Count

Traffic Volume Survey: FIELD DATA SHEET

Orissa Works Department, Government of Orissa

Division: **Circle:**

Name of Road with No.: Day:

Survey Station Name with Chainage: **Direction:** **from** **To** Date: / /2011

Time Period	PASSENGER MOTORIZED VEHICLE					GOODS MOTORIZED VEHICLE						NON-MOTORIZED VEHICLE			Others (Pl. specify)
	Sc/Mc	Auto Rickshaw	Car / Jeep / Van	Buses		Tempo/ LCV	2-Axle Trucks	3-Axle Trucks	Multi-axle Trucks	Tractor with trailor	Tractor without trailor	Cycle	Cycle Rickshaw	Animal drawn	
				Mini Bus	Std. Bus										
: 00 TO : 15															
Sub Total															
: 15 TO : 30															
Sub Total															
: 30 TO :45															
Sub Total															
: 45 TO : 00															
Sub Total															
Total															

Name and Signature of Enumerators:

Name and Signature of Supervisor:

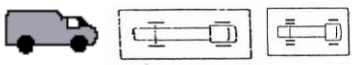
Figure 8-12 : Format for Axle-Load Survey

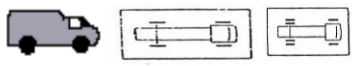
Name of Road: Survey Station with Km:

Direction: From To Date: / 0 / 2011

S.No.	Vehicle Type	Commodity Type	Wheel Weight (Tones)					Time (hh:mm)	Regn. No.	Remarks
			Front-1	Rear-1	Rear-2	Rear-3	Rear-4			
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Vehicle Type:


1 - Two axles single/twin tyred Mini Bus


2 - Two axles single/twin tyred LCV


3 - Two axles twin tyred Std. Bus


4 - Two axles twin tyred Truck


5 - Tandem axle twin tyred Truck


6 - 3 axle twin tyred Truck


7 - Multi axle twin tyred Truck


8 - Multi axle twin tyred Truck


9 - Multi axle twin tyred Truck

Commodity Code:

1. Food Grains	2. Fruits and Vegetables	3. Textiles & Clothing	4. Petroleum Products
5. Minerals & Ores	6. Building Materials	7. Wood and Wood Product	8. Machines / Parts
9. Fertilizers / Chemicals	10. Iron & Steel	11. Coal / Coke	12. Others (pl.specify)
13. Empty	14. Not Applicable (in case of passenger vehicle)		

Name & Signature of Person In-charge

Figure 8-13 : Bridge Condition Format

BRIDGE CONDITION

Road name : Road no. : Division :

Bridge no: Bridge location : Date of survey :

Sl. No.	Description	Problem Seen		Severity			Extent			Location
		Yes	No	Slight	Moderate	Severe	Low	Medium	High	
I	**CONCRETE** in Deck, beams, abutments, wing walls, retaining walls, piers, culvert barrel etc									
1	Cracking									
2	Spalling									
3	Corrosion of reinforcement									
II	**CONDITION OF BEARINGS**									
	Bearing seated properly									
	Span seated properly on bearing									
	Damage of bearing (splitting, tearing, cracking, corrosion)									
	Free to move									
III	**OVERALL CONDITION** (Check one box)	Good (No action required)		Fair (Minor repairs only)		Poor (Major repairs required)	Very Poor (High urgency /replacement)			
IV	**ADDITIONAL COMMENTS**									

9. PROJECT DEPENDENCIES

9.1 BACKGROUND

Any major project consists of a number of components and steps necessary for its execution. Orissa's proposed Road Asset Management System is no exception. The components and steps could be interdependent or sequential. In either case, it is important that these components or steps are available in a timely fashion. Failing this, it is quite conceivable that the entire project may be put into jeopardy. Certain component or steps are, however, critical and any slippage will certainly adversely and seriously affect the Project. Such issues, because of their importance, are highlighted below.

9.2 DATA

The OWD is to provide inventory data of all roads, culverts and bridges on NH/SH/MDR/ODR to the Consultant. The Consultant will verify 20% of the data and report discrepancies, if any to the OWD. The observations of the Consultant are communicated to the concerned divisions to rectify the discrepancies and recompile the data. The Consultant will then collect condition data on all roads, culverts and bridges as stipulated by contract.

We also expect updated road map from head of division offices (The Executive Engineers) / to be provided with. It is important that the above data is collected and provided in a timely manner, so that it could be verified.

Further, the following additional information will also be required from OWD:

1. Traffic volume, axle-load, roughness, and condition data on National Highways
2. On-going and completed road, CD and bridge project details in the last five year, including the associated costs
3. Schedule of Rates for different items for different regions

9.3 MAP

The satellite imagery to be used for extracting the road network for the State requires that the raw satellite imagery be processed involving colour-balancing, histogram matching, mosaicking, ortho-rectifying and geo-referencing. A resolution of 1.0 m would be ideal for use on this Project, therefore, it would be prudent to acquire these satellite images so that the road network for the entire State can then be extracted by screen or heads-up digitization of the visible roads.

The National Remote Sensing Center (NRSC), Hyderabad is the most commonly used source of satellite imagery in India. However, ORSAC being the nodal agency for spatial requirements for the State Departments; is being contacted for availability and supply of such product to OWD for use in O-RAMS. The Consultant has explored such options till this stage and details are already

furnished in this report. The OWD may initiate further needful with ORSAC/NRSC towards the process of acquisition, which is an important milestone. The collection of GPS coordinates along all roads is being initiated and they will be spatially adjusted after the map/ images are available.

9.4 COTS

For the timely and successful implementation of O-RAMS it is imperative that proposed COTS should be procured as soon as possible, so that the data being collected in the field could be entered into the database. The evaluation of COTS has been undertaken and will be presented in the Needs Analysis Report. The Consultant recognizes the fact that OWD has to follow a certain procedure laid down for acquisition, which is likely to take its own time. It is precisely for this reason that the Consultant strongly recommends an early, rather immediate, initiation of the procurement process. Any delay in this regard will have serious, adverse impact on all future activities and ultimately on the progress and success of the Project. Similarly, it will be necessary to acquire ArcGIS software for handling and managing GIS data after the Consultant completes and delivers GIS database. It would be prudent to initiate the process for this procurement at the same time at which COTS is being procured. It could possibly save some duplication in effort and may be some time also.

9.5 WORK FLOW (INTER-LINKAGES)

Road asset management system is a complex undertaking, more so when it involves 18,000 km of roads. The undertaking involves several sub-systems and a large database for which data has to be collected. Some data like inventory data is collected only once or when a change occurs, others like condition survey and traffic survey is required at defined intervals. There is software involved in data storage, handling and analysis, while hardware is involved in data collection.

Generally, the types of assets to be included in an asset management system (AMS) are dependent upon the road agency and its administration. As per the present scope of work, this system will begin with its major assets like roads and bridges, and later be expanded to include other assets; as data, or system capabilities become available to the agency. Major elements of an asset management system are shown in Figure 9-1:

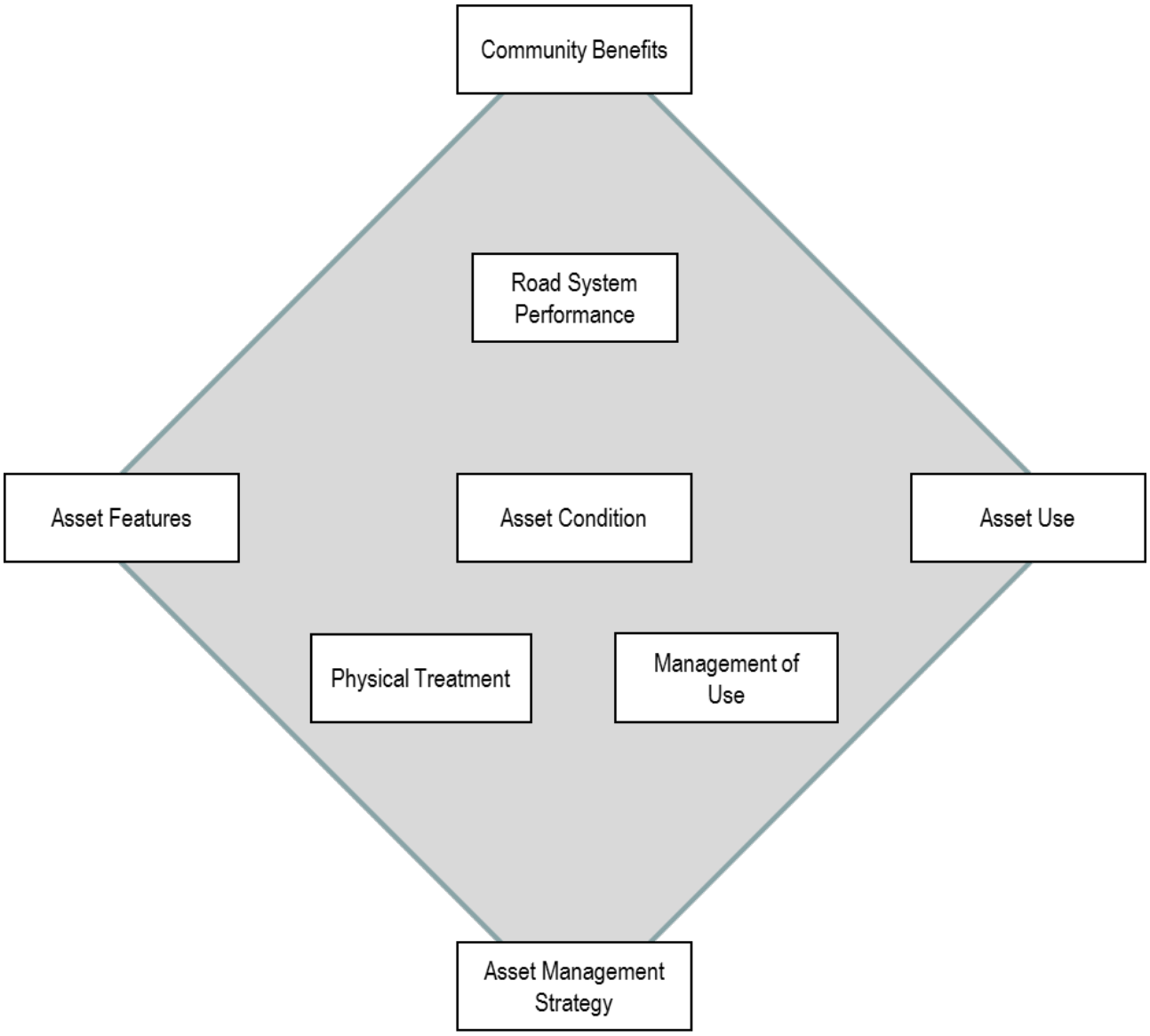


Figure 9-1: Elements of Asset Management

Figure 9-2 shows a summary of the implementation steps involved in a typical asset management system for the road sector.

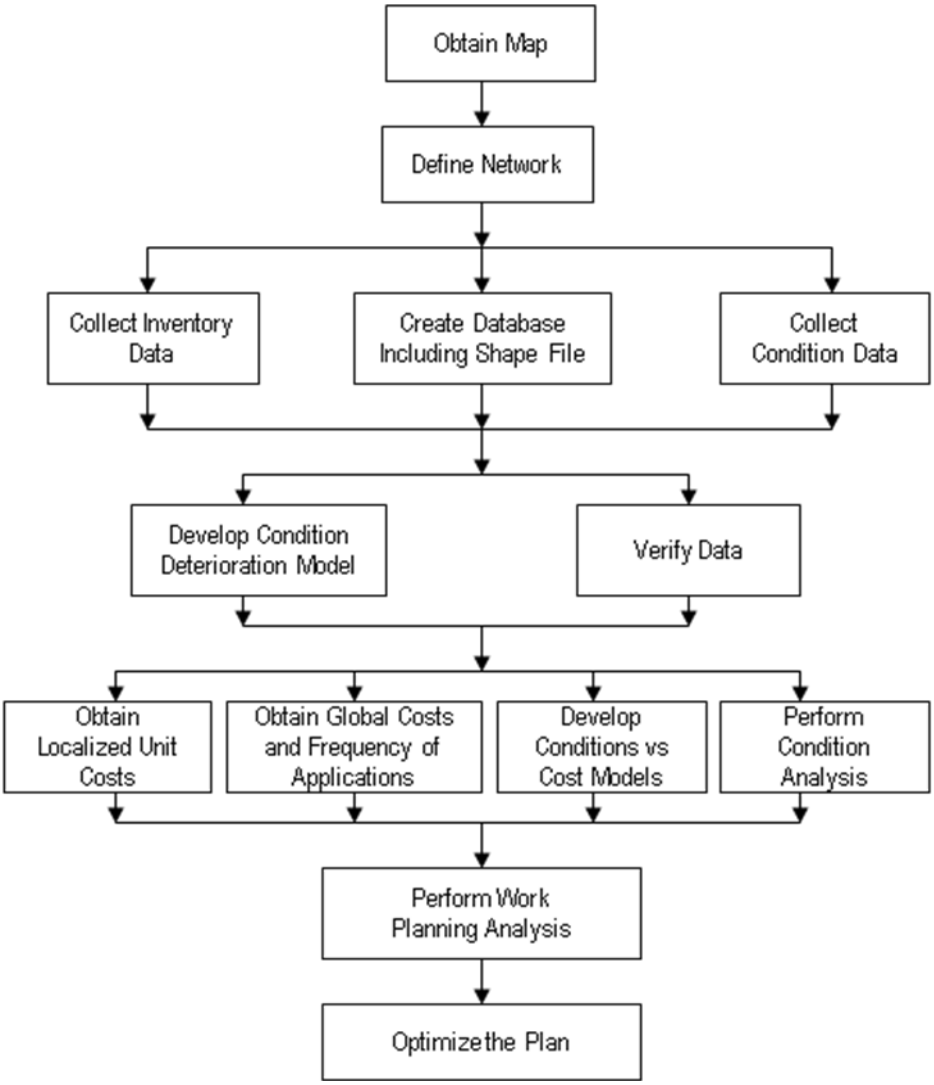


Figure 9-2: Generic Steps for Implementation of AMS

9.6 DECISIONS

At every step of the above figure in the previous section, decisions will be required, some by the Consultant alone and others jointly with OWD. For example, while the road and bridge asset data to be collected and performance modeling would be carried out by the Consultant, others such as, costs and prioritizing will be done only with the help of OWD so that it conforms to the goals, policies and budget of OWD. Therefore, it will be necessary to have a clear understanding of intangibles like goals and policies and about tangibles such as unit costs and lives of treatment. Decisions will be arrived at after weighing all available options and alternative interpretations, and by choosing the ones which are most appropriate for O-RAMS. Of course, all decisions have to be arrived at with the consensus between the Consultant and OWD. Other major decisions which will be required in the course of development and implementation of O-RAMS are dealt with in the following sections.

Following is a summary of data / maps are to be supplied by the OWD. This has been already addressed.

- Inventory data as per Contract
- GIS satellite images and data as per Contract
- Decision on COTS[1]

The OWD has already initiated action with regards to above by contacting the concerned agencies/offices. This process needs to be expedited to ensure that the development and data collection schedule of O-RAMS is not affected.

9.7 PROCUREMENT OF HARDWARE AND SOFTWARE

The following is only a preliminary indication of the hardware and software needs of the O-RAMS. While only general descriptions can be given at this stage, these requirements will be updated with more detailed specifications and pricing information as we take on Tasks 76 and 77 in the Work Plan.

The hardware and software will be procured in two stages:

1. Development and testing, during which only users from the OWD head office will be involved;
2. Full implementation, when users in the circle and division offices will be added.

Table 9-1 and **Table 9-2** list the hardware and software (in addition to the COTS software), respectively, which is expected to be either procured or made available from the existing resources, during each of the two stages in the event dTIMS is selected by GoO as the preferred COTS for the development and implementation of O-RAMS. Otherwise, the requirement may be revised as per the licensing practice of the chosen COTS.

Table 9-1: Hardware Procurement List

i) Development & Pilot Testing Phase (Month 3 to 9)

Location	Item	Description	No.
OWD Head Office	Desktop Computer	Computer installed with dTIMS CT, md, wf, mm, plus office tools (e.g. Excel, Access)	3
	Printer	A3 paper size colour printer.	1
Division Office	Desktop Computer	Computer installed with dTIMS md, wf, mm, plus office tools (e.g. Excel, Access)	3
	Printer	A3 paper size colour printer.	3

[1] Mr. Rob Piane, P.Eng. and Mr. Gary Ruck, P.Eng., Vice President and Engineering Manager respectively of Deighton Associates Ltd (DAL), Whitby, Canada visited Bhubaneswar during the week of May 16, 2011. Deighton Associates are the developer and vendor of the Asset Management system dTIMS, which is the one of the software for transportation asset management system in the world and forms the basis of the proposal and contract regarding O-AMS. Mr. Piane and Mr. Ruck made a presentation to OWD on May 17th explaining various components of dTIMS, their functions and capabilities / working. As a result of their interaction with OWD engineers, Mr. Piane and Mr. Ruck recommended a systems configuration at headquarters, circles and divisions, which was presented to OWD engineers on May 18th and further discussed.

During this time consultant will arrange for server and other PCs to develop / configure, test and run O-RAMS at his own office.

ii) Full Implementation Phase (Beyond Month 9)

Location	Item	Description	No.
Department of Information Technology	Server Computer	Server computer to run SQL Server, web server, etc. (Additional server may be necessary if performance is found to be an issue.)	1
OWD Head Office	Desktop Computer	Computer installed with dTIMS CT, md, wf, mm, plus office tools (e.g. Excel, Access)	3
	Printer	A3 paper size colour printer.	1
	Plotter	Colour plotter.	1
Circle Office	Desktop Computer	Computer installed with dTIMS md, wf, mm, plus office tools (e.g. Excel, Access)	7
	Printer	A3 paper size colour printer.	7
Division Office	Desktop Computer	Computer installed with dTIMS md, wf, mm, plus office tools (e.g. Excel, Access)	36
	Printer	A3 paper size colour printer.	36

Table 9-2: Software Procurement List

i) Development & Pilot Testing Phase (Month 3 to 9)

Location	Item	Description	No.
OWD Head Office	GIS	Tool such as ArcGIS to process spatial data (e.g. road network definition from GPS surveys).	1
	Office Productivity	Tools for data processing, writing reports, etc. (e.g. Microsoft Excel, Access, Word)	3
	HDM-4	HDM-4 software (should it be used instead of analysis capability of dTIMS CT)	1
Division Office	Office Productivity	Tools for data processing, writing reports, etc. (e.g. Microsoft Excel, Access, Word)	3

During this time consultant will arrange for SQL Server, Web Server, ArcGIS and other software required to develop / configure, test and run O-RAMS at his own office.

ii) Full Implementation Phase (Beyond Month 9)

Location	Item	Description	No.
Department of Information Technology	SQL Server 2008	Serving the dTIMS CT database in client-server configuration.	1
	Web Server	Such as Microsoft Internet Information Server to allow for dTIMS mm, wf and mm portals.	1
OWD Head Office	GIS	Tool such as ArcGIS to process spatial data (e.g. road network definition from GPS surveys).	1
	Office Productivity	Tools for data processing, writing reports, etc. (e.g. Microsoft Excel, Access, Word)	3
	HDM-4	HDM-4 software (should it be used instead of analysis capability of dTIMS CT)	1
Circle Office	Office Productivity	Tools for data processing, writing reports, etc. (e.g. Microsoft Excel, Access, Word)	7
Division Office	Office Productivity	Tools for data processing, writing reports, etc. (e.g. Microsoft Excel, Access, Word)	36

During the development and testing phase, it is proposed to house the O-RAMS server at the Consultant's office (which will be arranged by the Consultant), in effect emulating the facilitation that would ultimately be provided by the Department of IT. Subscription to a leased line service will be required to establish connectivity between OWD - PMU and Consultant's office. This is also being arranged by the Consultant on its own cost.

By the time of full implementation, it is understood that the OWD Head Office will be connected to the Department of Information Technology through a 10 mbps OSWAN connection. Should there be delays in achieving this connectivity, it would be necessary for the OWD to subscribe to a leased line though a service provider, similar to the connection between the Consultant's office and OWD head office during development phase.

The circle and division offices will need access to the internet to access the O-RAMS using the browser-based applications. These offices presently have relatively narrow bandwidth internet connections through copper wire (e.g. 256/512 kbps) which may become a performance issue particularly due to using map-based reports. It is recommended that the OWD discuss, with the Department of IT, the feasibility of connecting these offices to the wide area network as well.

The Project O-RAMS has a complex set of linkages and dependencies with respect to data from OWD and other agencies, as mentioned earlier. In addition to the above, pro-active measures by the Consultant and the decisions by OWD & other agencies will be required to facilitate development, data collection, testing and deployment of O-RAMS successfully in a timely manner. The following (**Table 9-3)** is a summary of the facilitation required along with the Agency responsible for it.

Table 9-3: Data Facilitation

Sl. No.	Description	Agency Responsible	Time When Required	Status
Data				
1	Inventory Data (NH/SH/MDR/ODR) a. Roads b. Bridges & Culverts	OWD	Jun-11	Letter from OWD issued to division offices. Consultants are in touch with various division offices as required.
2	History of Works undertaken	OWD	Aug-11	Budget books received from the ACE (Planning & DPI)
3	Funding Sources	OWD	Aug-11	Annual reports received from the ACE (Planning & DPI)
4	Roughness Data (NH)	OWD / NHAI	Oct-11	Initiated
5	Surface Distress Data (NH)	OWD / NHAI	Oct-11	Initiated
6	Traffic Volume Count (NH)	OWD / NHAI	Oct-11	Initiated
7	Traffic Axle Load (NH)	OWD / NHAI	Oct-11	Initiated
GIS Data				
1	Satellite Images / Vector Data (Spatial Layers)	OWD / ORSAC	Jun-11	Letter from OWD issued to ORSAC and discussed. Decisions awaited
Decisions				
1	Purchase of COTS	OWD	Jul-11	Based on needs analysis, recommendation to OWD will be submitted for decision.

Authorization letters to undertake various surveys will be required from the competent authorities during survey execution.

10. INITIATIVES

10.1 EXPOSURE TRAINING

10.1.1 World Bank Counsel

The World Bank visited Orissa during the 1st week of April 2011 and met the PMU officials including the staff of newly created Asset Management Unit (AMU) on 6th April 2011. The Bank advised that the staff of the AMU should visit other states in India (Gujarat and / or Karnataka) where the Asset Management System has been put in place.

10.1.2 Visit to Gujarat

Consequently, a visit to the Gujarat Roads and Building Department by, the staff of Asset Management Unit of the PMU was organized from 9th to 14th of May 2011. The visit focused on following aspects:

1. The challenges faced by the road agencies during 80's and 90's, before the advent of multilateral funding agencies, and how the departments tackled them,
2. How the departments used to function / make decisions then, and how this has changed in the last decade,
3. How the WB projects, such as Gujarat State Highway Project was conceived, planned and effectively implemented.
4. The role of road management system in the departments post-WB project implementation
5. The impact of road management system in shaping the department's business decisions, e.g.,
    a. Preparation of annual budgets,
    b. Identification of deficiencies (design, capacity, maintenance, service life) of the asset,
    c. Assistance in preparatory works (planning & pre-feasibility studies)
    d. Easy availability of current and relevant data/ information, and
    e. Benefits to other government departments, initiatives and programmes
6. The institutional framework in which the road management system functions;
    a. Detail dedicated resources and their skills
    b. Need of external support from consultants
    c. Annual budgetary requirements for the system (maintenance, manpower, data collection etc.)
7. Framework of the road management system, and its functional areas (modules);
    a. Modules & their description (input, output)
    b. Data requirement (collection formats) and frequency of collection
    c. Technology and architecture

d. GIS Interface
e. Data collection methods
f. Data validation and calibration
g. Road management department's business
h. Incorporation of road development policy into asset management
i. Output formats useful for decision

8. Implementation of Road Management system
   a. Servers and facilities
   b. Connectivity to circle and division offices
   c. Interaction between division staff and planning unit staff
9. Issues and challenges today;
   a. Sustenance of road management system
   b. Up-gradation of technology
   c. Up-gradation of skills of manpower
   d. Dedicated staff and attrition rates

Programme / Schedule:

The following schedule was prepared for Gujarat visits,

- Meeting With Mr. P. P. Vakharia, Chief Engineer (PPU)
- GRMS overview
- GRMS module presentation: bridge management system (BMS)
- GRMS detailed presentation
- Demonstration of bridge data collection
- Demonstration of data collection for GRMS modules

Summary of Meetings and Discussions:

Date: 13th May 2011

1. Meeting with Mr. P.P. Vakharia, Chief Engineer (World Bank), R&B Department, Govt. of Gujarat

- Involvement of both project and field office are essential during the development & data collection and during implementation. The needs of the field staff must be addressed by the system as they will be the users.
- The changes in the regular data collection formats (of the department) must be finalized during the system development in line with the requirements and must be regularized by institutional arrangement.
- The pilot project must include all categories of road.
- In addition to technical, social factors must also be considered (and built into the system) for prioritization of works.

- The system must have capability to store and use past work done on the assets to enable better decision-making.
- All CD structures present on a road must be automatically selected for upgradation when the same road is selected for any widening work.
- Use of automatic data collection equipment should be preferred, if it is sustainable
- IT staff (database administrator) must be recruited from within the department to coordinate with the IT department and for support to planning unit.
- Continuity must be maintained with the staff in-charge of asset management system
- The asset management team must include professionals with IT background, transport planning, economist, engineering and knowledgeable enough to run prioritization process using HDM-4.
- The system must be as simple as possible to gain popularity among the field users and to integrate in their regular work process. This is vital for system sustainability.
- Dedicated budget must be allocated to operate and maintain the system including periodic data collection / updation.
- The periodic update of the software / patches must be done in collaboration with the software vendor to shield the system from any technology / technical obsolescence.

2. Meeting with Mr. Sailesh Bhai Shah, Deputy Executive Engineer (Policy & Planning Unit) & Unit Staff, R&B Department, Govt. of Gujarat

- Web-based solution is preferable and more practical than client server application.
- Involvement of division offices is critical in the development and execution.
- Need to identify one nodal person in every division office to update and keep a track of all data.
- The nodal person at each division office must coordinate with the consultant or vice-versa for any information / clarification during data collection.
- Need for regular training of the staff and induction of professionals with experience in road management aspects.

3. Meeting with Mr. K.M. Dholakiya, Executive Engineer, Under Secretary, R&B Department, Govt. of Gujarat

- Advantage of GRMS is wide-ranging in all planning areas and project formulation.

ANNEXURES

Annexure-I: Minutes of Meeting held on 21st May 2011

MINUTES OF MEETING

Orissa State Roads Project-Orissa Asset Management System

Date : Saturday, 21st May 2011, 12.30 pm

Place : Data Room, Ground Floor, Nirman Soudha

Present : OWD

1. Mr. Nalini Kanta Pradhan, Chief Engineer, World Bank Projects, Orissa
2. Mr. Gati Krushna Prasad, E.E., Asset Management Cell
3. Mr. Fakir Mohan Panigrahi, E.E., PMU-IV & A.C.E (DP&I)
4. Mr. Jaydev Mishra, Sr. D.A.O., PMU
5. Mr. Amiya Ranjan Nayak, A.E., Asset Management Cell
6. Mr. Narayan Behera, J.E., Asset Management Cell

Consultant

7. Mr. Anand Prakash, Team Leader
8. Mr. G.P. Sahoo, Group Leader cum Highway/Pavement Engineer
9. Mr. Andy Kim, IT Specialist
10. Mr. Satyakam Sahu, Transport Planner
11. Mr. Ahmed Asif, Highway / Pavement Engineer

Chief Engineer, World Bank Projects, who chaired the meeting, welcomed the participants and stated that today's discussion would cover a review of work done by the Consultant so far and issues needing attention.

The Chief Engineer stated that weekly meeting will be held every Saturday to review, plan and monitor the work. In case Saturday is a holiday, the meeting will be rescheduled.

		Action by
1	**Update on Deighton Associates' Proposal**	
	• Mr. Rob Piane and Mr. Gary Ruck of Deighton Asssociates Ltd. gave a presentation on dTIMS (Deighton's Total Infrastructure Management System) software solution to engineers of Project Management Unit on 17th May 2011 followed by a presentation on proposed dTIMS software configuration at Head-office, Circle and Division offices and License procurement programme for Orissa Asset Management System on 18th May 2011 in presence of the consultant team.	
	• Cost figures for the suggested configuration along with different alternatives in view of proposed restructuring of Works Department will be provided by Deighton Associates next week and the same will be communicated by the Consultant to OWD after reviewing it.	Consultant
2	**Data Collection and Review of OWD data**	
	• The Consultant addressed the issue of supply of inventory data by OWD and designing a format for collecting the same. The Consultant suggested an alternative to collecting data in the field from scratch by OWD. It has reviewed the data collected in 2007 under the Vision-2020 Project and found the data to be old but useful. Based on the review of data collected by the Works Department in 2007 for Vision 2020 document, Consultant suggested that the inventory data of roads, bridges and culverts can be optimally utilised if the R&B divisions could: i) collect the missing data, ii) update the 2007 information, wherever it has changed, and iii) correct any erroneous information as per site verification; this would considerably reduce the tedious work of collecting data in the field using a new format.	

- It was agreed that the suggested procedure will be followed and a detail list of deficiencies and gaps will be provided by the Consultant after scrutiny of Vision-2020 data, as and when ready even on a daily basis, if necessary. Asset Management Cell will forward the list to the concerned Division offices for compliance within a week. — Consultant OWD

3 **Pilot Divisions**

- The Consultant proposed Jagatsinghpur, Kendrapara and Panikoili Divisions for the Pilot Project in which the inventory / condition survey data will be verified / collected. Chief Engineer suggested that Cuttack Circle be chosen for the Pilot Project with active involvement of concerned Superintending Engineer. It was agreed that Cuttack will be used as a Pilot Circle beginning with the above three Divisions, where data are already available, as Pilot Divisions. OWD assured that data for the remaining four Divisions in the Circle will be made available to the Consultant. The S.E., Cuttack Circle will be kept fully apprised of the progress and consulted, when and where necessary. — Consultant OWD

4 **Data Requirement from OWD**

- The Consultant requested the OWD to provide the following reports / documents:
  - Prioritisation for OSRP (Strategic Option Study) (2000-02) [RITES & SMEC]
  - DPR on Prioritised Corridors (Core Network) – 2005-07 by Consulting Engineers Group (CEG)
  - Vision-2020 document for remaining Divisions
- The Chairperson instructed the members to provide the above reports to the Consultant. — OWD
- The Consultant also requested the traffic data for all OWD traffic census locations for last 5 years.
- The Chairperson suggested the Consultant to review the CEG report and then recommend the need for OWD traffic data — Consultant

5 **Funding and Planning Process**

- The Consultant wanted to know the roles of Divisions, Circles and Head-office in the planning process as well as funding schemes for different categories of roads and work types etc.
- Chief Engineer gave an overview of the budget process and suggested the Consultant team to interact with the PMU including Finance / Accounts officers for further details and supplement by visit to Division / Circle offices, if necessary. — Consultant OWD

6 **Operational Details at the Division / Circle Office**

- The Consultant stated that it would like to visit a Division and a Circle office to familiarize itself with the operational details thereof.
- Chief Engineer suggested that the Consultant team should interact with the Pilot Division / Circle in consultation with PMU. — Consultant

7 **On-going Tasks: Meeting with the IT Department**

- The Consultant apprised the members about the meeting, they had with the officers of the IT Department on implementation of OSWAN / networking, State Data Centre and Standardisation with respect to hardware / software / security. Although OSWAN has been implemented up to District Collector offices and connected to State capital, it has not yet been extended to R&B Division offices.

- The Chairperson informed that the Divisions are having their own internet connectivity through various service providers and appreciated that there is a need for higher bandwidth for OAMS. He asked the Consultant to provide details of the networking needs for implementation of the system and various options. — Consultant

8 **On-going Tasks: Meeting with the Orissa Space Application Centre (ORSAC) officers**

- The Consultant briefed the team about the meeting with officers of ORSAC. It further informed that based on the interaction of Consultant with officers of ORSAC, a letter requesting data from ORSAC has already been forwarded.
- The Consultant apprised that the satellite image available with ORSAC is of different ages for different regions with variation in accuracy / scale. The complete dataset for Orissa for a singular period in a single scale/ accuracy is not available. However, it was indicated that ORSAC is planning to acquire LISS-4 image shortly and they will respond to the letter forwarded by the OWD in this regard..

9 **On-going Tasks: Base Mapping**

- The Consultant informed that as an interim measure, it intends to use Google images for their base mapping till the satellite images are available from ORSAC.

10 **On-going Tasks: Others**

- The Consultant informed that it had undertaken a site visit to Khordha – Jatani – Nimapara – Charichhak – Niali – Phulnakhara with a view to get an appreciation of field conditions.
- The Consultant indicated that it will undertake needs analysis for IT Infrastructure / IT proficiency and preparedness at all levels of OWD. — Consultant

The meeting adjourned at 1:30 p.m.

May 23, 2011

Team Leader

Chief Engineer,
World Bank Projects, Orissa

Annexure-II: Assessment Sheet for Information Technology Infrastructure

Consultancy Services for providing "Technical Assistance to Establish an Asset Management System on the Core State Road Network of Orissa Works Department"

Assessment Sheet for Information Technology Infrastructure

Organisation/Location: _____ Date: _____

Completed by: _____

A1.3 Client Assessment Sheet for Information Technology Infrastructure				
The AMS implementation should fit within the overall IT strategy of the agency, and should be properly supported from an IT perspective, with appropriate IT policies and procedures. The more sophisticated asset management systems demand a strong IT infrastructure that is well planned, managed and monitored. This Client Assessment Sheet is designed to assess the existing IT capabilities of the Client, and recommend a particular type of AMS to fit into that environment.				
A1.3.1 Organization				Check all that apply
a.	Is there a separate IT Division?			
b.	How many staff in the organization whose primary function is IT-related?			
c.	IT Staff Turnover	Low	Med	High
d.	Are any IT services outsourced?			
(i)	Network Administration			
(ii)	Systems Administration			
(iii)	External Hosting			
(iv)	Application Development			
(v)	Other (please specify):			
A1.3.2 Policy				Check all that apply
a.	IT Security			
b.	Computer User Policies			
c.	Software Licensing			
d.	Hardware Warranty and Maintenance			
e.	Software Warranty and Maintenance			
f.	Virus Protection			
g.	Hardware and Software Replacement			
A1.3.3 Functions				Check all that apply
a.	IT Procurement			
b.	IT Budgeting			
c.	IT Security			
d.	IT Auditing			
e.	Network Administration			
f.	Systems Administration			
g.	Application Support			
h.	IT Help Desk			

i.	Application Monitoring			
j.	Database Management			
k.	Data Administration			
l.	Application Acceptance Testing			
m.	Application Development			
n.	Intranet Development			
o.	IT Training			
p.	Other (please specify):			
A1.3.4 Strategies / Directions		Check all that apply		
a.	Technology Architecture			
b.	Data Architecture			
c.	Application Architecture			
A1.3.5 Infrastructure		Check all that apply		
a.	Extent of Wide Area Network / Local Area Network implementation:			
(i)	Offices Connected			
(ii)	Staff Connected			
b.	Total No of Servers in the Network			
c.	Total No of PCs			
d.	Virtual Private Network (VPN) capability			
e.	Remote dial-up capability			
A1.3.6 Applications				
a.	Type of Applications Implemented or Planned:	**Implemented**	**Off-the Shelf**	**Developed**
(i)	Financial Management System			
(ii)	Contract Management System			
(iii)	Road Management System			
(iv)	Pavement Management System			
(v)	Bridge Management System			
(vi)	GIS			
A1.3.7 General IT Skill Levels		Check all that apply		
It is difficult to make generalizations, but a feeling for IT proficiency in the Client office can be obtained by observing staff and their use of common PC tools.				
(i)	Little if any exposure to common PC tools			
(ii)	Entry-level use of word processors, simple spreadsheets			
(ii)	Proficient with word processors, spreadsheets			
(iv)	Advanced use of word processors, spreadsheets			
(v)	Exposure to / use of single-PC databases			
(vi)	Exposure to / use of Client-server applications			

DO NOT COMPLETE THIS SECTION (TO BE FILLED BY CONSULTANT)		
A1.3.8 Overall Assessment of IT Infrastructure		Check one only
On the basis of the above assessments, identify if the AMS should be entry level (EL), mid-level (ML), high level (HL) or based on Application Programming Interface (API)		
A	Client has little IT infrastructure, with no communications network, with little ability to plan and manage IT. Infrastructure and organizational assistance required. Recommend entry-level database AMS.	EL
B	Client has some IT infrastructure, limited LAN, and little organizational capacity to plan and manage IT. Infrastructure and organizational assistance required. Recommend entry-level database AMS.	EL
C	Client has significant IT infrastructure, including LANs, and has multiple users in Central Office that would benefit from AMS. Recommend mid-level database AMS. Some IT organizational assistance may be necessary for policies and procedures.	ML
D	Client has significant IT infrastructure, including LANs and WAN, strong policies and procedures, and has multiple users in many locations and job functions that would benefit from AMS. Recommend high-level AMS.	HL
E	Client has significant IT infrastructure, including WAN, strong policies and procedures, and multiple applications that need to be integrated to AMS. Recommend high-level AMS with Application Programming Interface.	HL API

Note: This assessment form was extracted from a document titled “Generic Terms of Reference for Supply and Installation of Road Management Systems” Version 1.0 – 31 January, 2007. East Asia Pacific Transport Unit, The World Bank, Washington, D.C.

Annexure-III: Minutes of Meeting held on 04th June 2011

MINUTES OF MEETING

Orissa State Roads Project-Orissa Asset Management System

Date : **Saturday, June 04, 2011, 05.00 p.m.**

Place : Data Room, Ground Floor, Nirman Soudha

Present: **OWD**

1. Mr. Nalini Kanta Pradhan, Chief Engineer (World Bank Projects), Orissa
2. Mr. Gati Krushna Prasad, E.E., Asset Management Cell
3. Mr. Fakir Mohan Panigrahi, E.E., PMU-IV & A.C.E. (DP&I)
4. Mr. Sameer Hota, A.E., PMU
5. Mr. Amiya Ranjan Nayak, A.E., Asset Management Cell
6. Mr. R.C. Panda, A.E., Asset Management Cell
7. Mr. Narayan Behera, J.E., Asset Management Cell

Consultant

8. Mr. Anand Prakash, Team Leader
9. Mr. G.P. Sahoo, Group Leader-cum-Highway/Pavement Engineer
10. Mr. Pradeep Kumar, Group Leader-cum-Transport Planner
11. Mr. Satyakam Sahu, Transport Planner
12. Mr. Ahmed Asif, Highway / Pavement Engineer

Chief Engineer chaired the meeting convened to review the work done by the Consultant and discuss issues needing attention.

		Action by
1	**Update on Deighton Associates Proposal**	
	• The Consultant apprised the members that it is looking at alternative options to reduce the costs involved in licensing of software. The Consultant has requested financial estimates for these options, which will be submitted to OWD after the information is received from Deighton Associates.	Consultant
2	**Data Collection and Review of OWD Data**	
	• The Consultant has reviewed Vision-2020 document of for 10 Divisions and has submitted a list of observations to the Asset Management Unit and requested it to issue necessary instructions to the respective Divisions.	OWD
3	**Pilot Divisions**	
	• The Consultant plans to visit some pilot Divisions next week after submission of the Inception Report to verify the road and bridge data.	Consultant
4	**Data Requirement from OWD**	
	• The Consultant has received the following reports / documents from OWD and are reviewing these: - DPR on Prioritised Corridors (Core Network) – 2005-2007 prepared by Consulting Engineers Group. - Vision-2020 document for seven more Divisions.	Consultant
5	**Funding and Planning Process**	
	• The Consultant interacted with the staff of PMU on planning and funding process for road development and maintenance, and was informed about funding for roads under various schemes of Central and State Government. Use of funds for improvement, rehabilitation, widening and periodic and routine maintenance were also discussed. • The Consultant is currently reviewing the Demand for Grants for the past several years.	

6 **Inception Report**

- The Consultant stated that the work towards preparation of Inception Report is progressing well and plans to submit the Report on time for views of the Review Committee as stipulated in the Contract.

Consultant

7 **On-going Tasks: Traffic Survey Locations**

- The Consultant apprised the members regarding its work on traffic survey locations on the OWD network. It further stated that the 105 traffic survey locations in the DPR Survey undertaken during 2005-2007 will be used and additional 95 locations will be identified on the SH and MDR network.
- It was indicated by PMU that there are many ODRs, which are carrying traffic to important mines and other important locations, and it was suggested that the Consultant should study if any such ODR should be included in the survey. The Consultant should also examine if some locations out of 105 locations used for traffic survey during 2005-07 need not be included in traffic survey by Consultant (LASA). Chairperson suggested the Consultant to prepare final list of 200 traffic survey locations considering all parameters in consultation with PMU, especially Planning unit.
- The Consultant informed the meeting that it is exploring a video recording method for traffic count for use at many locations as a substitute for manual method, whence it was suggested that the method can be demonstrated in an urban location also.

Consultant
OWD

8 **On-going Tasks: Needs Analysis**

- The Consultant briefed the members about needs analysis on IT infrastructure, it has carried out at Headquarters, Circle and Division levels. The findings will be included in the Inception Report.

9 **On-going Tasks: Base Mapping**

- The Consultant informed that it is temporarily using Google images for mapping until appropriate satellite images become available, and that it has made substantial progress in digitisation of NH, SH and MDR. However, it has to be verified against the CAD map supplied by the Department.
- The members of OWD informed that Division-wise CAD map is also available, which can be referred to.
- The Chief Engineer suggested that the Asset Management cell be involved in understanding the process by interaction with the consultants.

The meeting adjourned at 6:30 p.m.

June 6, 2011

Team Leader

Chief Engineer,
World Bank Projects, Orissa

Annexure IV:

Hawkeye System, ARRB Group, Australia

HAWKEYE
SCALEABLE SURVEY SOLUTIONS

Introduction to the Hawkeye 2000 series

Professional Survey Solutions

The 2000 series is a professional, highly featured and highly specified range of survey products designed to meet the most demanding of survey applications.

Typically fitted to a dedicated survey vehicle, the modular, yet integrated design allows for complete scaleability and growth.

Once your requirements are established, simply customise the Hawkeye 2000 to meet your needs.

Should your requirements grow in the future, just upgrade your existing Hawkeye by plugging in new modules. Now that's true flexibility and future proofing!

Hawkeye 2000 series

Professional Survey Solutions

Features and Benefits

- Modular design allows for:
  - product expansion to meet growing needs
  - the adoption of new technologies
- Fully integrated system with common data and survey control referencing
- Common user interface enables single or multiple operator consoles
- Safe and efficient data collection for both urban and highway surveys
- Can acquire all condition data and images in a single pass
- Fully networked system allows for remote monitoring, diagnostics and support
- Uses standard interfaces and protocols to take advantage of future devices to protect your investment

Applications

- Network and project level road and asset collection surveys
- Routine pavement monitoring surveys
- Road-side inventory and asset management
- Road geometry and mapping surveys
- Contractor quality control

Output parameters

Longitudinal and transverse profiles, roughness, rutting, texture, crack detection, cross-fall, slope, grade, advisory speed, asset and inventory images.

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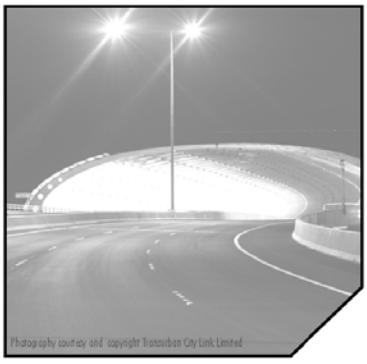

HAWKEYE
SCALEABLE SURVEY SOLUTIONS

Hawkeye 2000 series

Professional Survey Solutions

Hawkeye Packages

The 2000 series consists of a suite of individual packages designed to provide seamless options.

This enables you to choose the exact product mix to suit your immediate budget and need, with the comfort of knowing that you can upgrade.

Video Packages

The Asset View Package is a sophisticated video acquisition system for visually identifying and locating roadside features accurately. The system utilises the latest digital camera technology to achieve resolutions of up to 1280 x 960 pixels.

The Pavement View Package is designed for visually identifying and locating pavement deterioration and cracking accurately at highway speeds. Using the latest digital camera technology it produces crisp high resolution frames.

Digital Profiler Package (DP)

The DP package can be configured with a variety of sensor systems to enable the collection and reporting of data for Longitudinal Road Profile, Road Roughness, Slab Faulting, Macrotexture, Transverse Profile and Rutting.

GPS & DGPS Packages

The GPS & DGPS Packages enable the referencing of data against GPS coordinates. The DGPS system is capable of delivering real-time sub-metre accuracy.

GIPSI Geometry Packages

The GIPSI Geometry Package uses dead reckoning sensors and GPS data to collect road geometry information and continuous highway 3D maps.

Acquisition Package

The Acquisition Package is the central hub of the Hawkeye 2000 series where all the packages are brought together into a fully integrated system.

Software Packages

There are two categories of software for the Hawkeye range of products. Live real-time data acquisition software and office-based data reviewing and analysis software.

Onlooker Live is an interactive and real-time acquisition control interface.

Image Analyser is a fully-featured office-based data reviewing tool for the Hawkeye video packages.

Further Information

Further details for each of these 2000 series packages are found in separate individual data sheets.

Note: ARRB Group Ltd reserves the right to change these specifications without notice. Whilst every care is taken in preparing these specifications, ARRB recognises that there may be classes of surface and applications for which the device has not been tested, and for which the device may not meet the stated specifications.

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HAWKEYE
SCALEABLE SURVEY SOLUTIONS

Hawkeye 2000 series

network and project level road / asset surveys

professional survey solutions

Professional Survey Solutions

The 2000 series is a professional, highly featured and highly specified range of survey products designed to meet the most demanding of survey applications.

Typically fitted to a dedicated survey vehicle, the modular, yet integrated design allows for complete scaleability and growth.

Once your requirements are established, simply customise the Hawkeye 2000 to meet your needs.

Should your requirements grow in the future, just upgrade your existing Hawkeye by plugging in new modules. Now that's true flexibility and future proofing!

Features and Benefits

- Modular design allows for:
  - product expansion to meet growing needs
  - the adoption of new technologies
- Fully integrated system with common data and survey control referencing
- Common user interface enables single or multiple operator consoles
- Safe and efficient data collection for both urban and highway surveys
- Can acquire all condition data and images in a single pass
- Fully networked system allows for remote monitoring, diagnostics and support
- Uses standard interfaces and protocols to take advantage of future devices to protect your investment

Applications

- Network and project level road and asset collection surveys
- Routine pavement monitoring surveys
- Road-side inventory and asset management
- Road geometry and mapping surveys
- Contractor quality control

Output parameters

Longitudinal and transverse profiles, roughness, rutting, texture, crack detection, cross-fall, slope, grade, advisory speed, asset and inventory images.

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HAWKEYE
SCALEABLE SURVEY SOLUTIONS

Hawkeye 2000 series

Hawkeye Packages

The Hawkeye 2000 series consists of a suite of individual packages designed to provide seamless options. This allows you to choose the exact product mix to suit your immediate budget and needs with the comfort of knowing that you can upgrade at any time in the future.

Digital Cameras - Asset View & Pavement View Packages

The AssetView Package is a sophisticated video acquisition system for visually identifying and locating roadside features accurately.
The PavementView Package is designed for visually identifying and locating pavement deterioration and cracking accurately at highway speeds.
- Resolutions of 1280 x 960 pixels. Max. 16 cameras
- Latest digital camera technology produces crisp high resolution images.

GPS or DGPS Packages

The GPS & DGPS Packages enable the referencing of data against GPS coordinates.
The DGPS system is capable of delivering real-time sub-metre accuracy.

Data Acquisition Package

The Acquisition Package is the central hub of the system which provides a fully integrated solution.
- Compact PC system with operator LCD/kb
- No dedicated equipment rack required
- Real-time data processing
- Unified database correlates all data

Software Packages

Live real-time data acquisition software:
- Onlooker Live is an interactive and real-time acquisition control interface.

Office-based data reviewing and analysis software:
- Processing Toolkit is a fully-featured office-based data reviewing tool for the Hawkeye packages.

GIPSI-Trac Geometry

The GIPSI Geometry Package uses dead reckoning sensors and GPS data to collect road geometry information and continuous highway 3D maps.

Rotorpulser

High resolution Distance Measurement Instrument for accurate chainage.

Digital Profiler Package

The DP package can be configured with a variety of sensor systems to enable the collection and reporting of data for: Longitudinal Road Profile, Road Roughness, Slab Faulting, Macrotexture, Transverse Profile and Rutting.
- Supports 21 + lasers/ accelerometers / gyros
- Inter-changeable lasers (16 kHz, 32 kHz, 64 kHz or 78 kHz)
- Configured to meet international standards and client requirements

Side Projection Lasers

Full lane width (typically 3.5 m)
Enables full transverse profile

network and project level road / asset surveys

professional survey solutions

Further Information

Further details for each of these 2000 series packages are found in separate individual data sheets.

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ARAN 9000

The Evolution of Data Collection

Fugro Roadware has re-introduced the ARAN and has unveiled the ARAN 9000! The ARAN has been retooled to meet the rigorous data collection requirements of the road infrastructure data collection community. The ARANs' robust platform has been expanded to deliver:

- 50% reduction in computing hardware over the previous platform with the same functionality
- Database driven systems
- Robust, fault tolerant systems
- Plug and play system integration
- Microsoft.net platform
- Real-time sub-cm data synchronization
- Advanced mission management software
- Increased portability of subsystem components
- Global solution with interfaces in several languages
- User friendly operating system to minimize training costs and operator error
- Industry-defining warranty
- Dynamic architecture supporting future upgrades

Mission Management Software

On-vehicle and office software for data collection, calibration, and simulation.

DIGITAL VIDEO

HDTC Digital Video

Right of Way Perspective Images

Fugro Roadware's ARAN (Automatic Road Analyzer) may be outfitted with up to six HDTV (1920 x 1080 pixel) cameras, with options varying from 90 degree down to 47 degree horizontal field of view. Images are captured at user-definable intervals, based on 'pulses' received from the ARAN Distance Measuring Instrument (DMI). Distance based image capture eliminates the capturing of repetitive information when the vehicle is stopped at intersections or in heavy traffic conditions, thereby efficiently utilizing available image storage space.

Image quality may be monitored in real-time during data collection. ARAN operators may then make common adjustments to the image as required including contrast, brightness, and white balance using a graphical user interface onboard the ARAN.

As images are captured on the Digital Video Storage (DVS) system, adjustments are made automatically for current lighting conditions thus minimizing the negative impact on image quality that transitions from light to dark areas normally impose (such as

traveling through tunnels, underpasses, and tree-canopied areas).

Compression ratios are also adjustable during collection through the DVS graphical user interface (GUI).

Cameras are typically mounted in a turret type enclosure above the vehicle cabin, but angled to emulate a windshield view. This affords maximum visibility without restricting driver movements, and also allows for more camera angles than in-cab mounting alternatives. Where the turret is not available or camera type/configurations preclude this option, in-cab windshield mounting is available.

The collected imagery may serve as a stand-alone video inventory of surveyed areas, or may be used in conjunction with additional Fugro Roadware software applications. Additional functionality may be found through:

VisiData®

Fugro Roadware's image viewing software. Display all collected views concurrently. 'Visit' sections on demand through a section inventory list, map interface, or graphs of pertinent associated data.

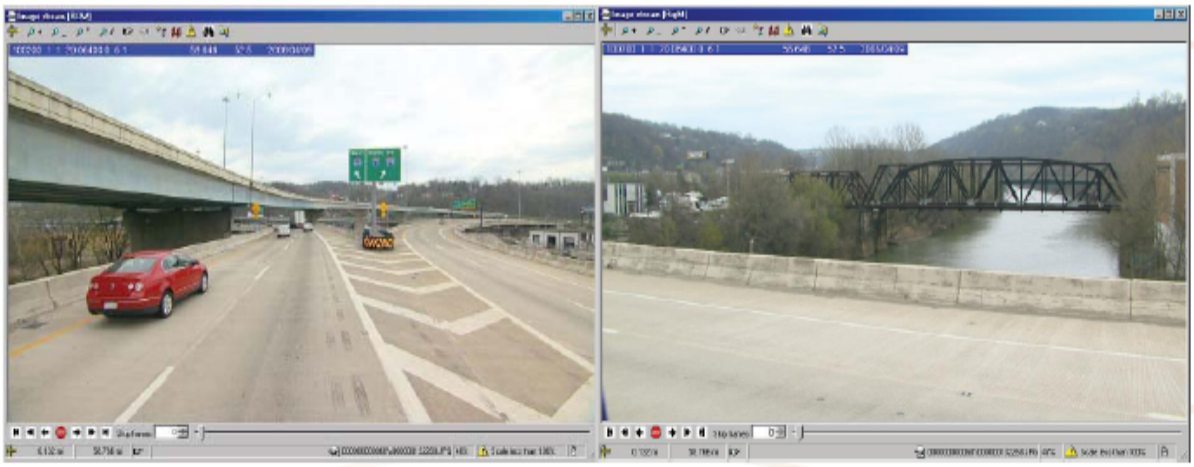
Surveyor®

Use calibrated digital images to perform asset and geometric feature inventories.

D/VRate®

Perform windshield distress rating surveys from the office.

Pictured here: 1920 x 1080 pixel resolution (HDTV) Right-of-Way video image, with 90 degree horizontal field of view



Pictured here: Two HDTV Right-of-Way video images. Each camera has a resolution of 1920 x 1080 pixels. The forward view has a horizontal field of view of 90 degrees and the right side view has a horizontal field of view of 53 degrees.

SYSTEM COMPONENTS

HDTV Digital Camera(s)

All HDTV cameras produce 1920 x 1080 pixel resolution, with horizontal fields of view varying from 90 to 47 degrees. Specific cameras will be considered for system integration where preferred.

System Control

Cameras and captured images are controlled by the DVS. Through the DVS GUI, adjustments may be made to images prior to or during collection.

Distance Measuring Instrument (DMI)

The ARAN DMI is able to measure distances accurate to within +/- two-thousandth (0.002) mile per mile, (or +/- 0.2%) and displays the distance in miles/kilometers to three decimal places.

The DMI is a non-contact optical encoder that divides each wheel revolution into 2,000 pulses. Using this methodology, distance measurement is not speed dependent so all linear measurements rretain accuracy through the reality of fluctuating traffic conditions.

ACCURACIES

Using Fugro Roadware's ARAN DMI, image location is reported to within 10 cm (3.94") of actual linear position.

ADDITIONAL SYSTEM INTEGRATION

Digital images will be linked to data from other available ARAN subsystems, including Roughness, Rutting, Faulting, Texture, Vertical Clearance and GPS position.

OUTPUT

All images are written into an intuitive directory structure organized by the collected file name and linear reference point at which each image is collected. The JPEG images are named according to the lineal distance point where they were captured.

PAVEMENT VIDEO

Pavement View Digital Images

The ARAN can be equipped with a variety of production-proven and reliable pavement imaging subsystems according to the user's application and budget.

With the ARAN's pavement imaging subsystem, planer-view digital pavement images (JPEG format) are recorded directly to disk for 100% of the driven lane (up to 14 feet or 4.3 meters). Digital storage is configured to create a complete back-up of every collected image to guard against data loss and the avoid time consuming rework.

All pavement imaging subsystems offered by Roadware incorporate artificial lighting in order to provide better consistency and resolvability of pavement images which in turn results in more accurate distress determination. Through the ARAN architecture, pavement-view images are specially-encoded to allow for subsequent distress analysis using either semi-automated or fully-automated distress analysis software.

Available system configurations include:

2mm Resolution with Strobe Lighting

Optimally angled and camera-synchronized strobe lights provide intense artificial lighting even in the presence of natural sunlight. The quality and intensity of light provided by strobe systems is superior to that provided by standard incandescent systems which tend to require filming during low-light periods of the day to ensure optimal image quality. High-intensity strobe systems permit pavement imaging throughout all hours of the day and under all lighting conditions (e.g. overcast, full sun, etc.).

Left and right cameras are synchronized and real-time software properly overlaps and "stitches" left and right frames to provide an uninterrupted view of the full lane width (~4.3 m maximum width). The resultant images each represent a continuous 1/100th mile of road.

1mm Resolution with Infrared Lighting

Roadware's 1 mm Pavement Imaging System provides high resolution imagery of the pavement surface. Cracks down to 1 mm in width can typically be seen in images of hot mix asphalt roadways (JPEG format) and may be rated visually or through Roadware's automated crack detection software (WiseCrax®).
Left and right cameras are synchronized and real-time software

Pictured here: 1mm resolution pavement video image

Features

- *Available in resolutions for 2mm and 1mm crack detection*
- *Real-time monitoring of image quality during collection*
- *Adjustable compression for optimizing image quality and storage efficiency*
- *Intuitive directory structure*
- *Easily accessible through image viewing software*
- *Calibrated images for performing distress extraction with Roadware's D/VRate and WiseCrax software*

properly overlaps and "stitches" left and right frames to provide an uninterrupted view of the full lane width (~3.9 m maximum width). The resultant images each represent a continuous 1/100th mile of road.

Illumination of the pavement surface is provided through laser lighting which is not discernable to the naked eye. The incident illumination angle of the laser causes cracks to project shadows which improve visibility and contrast. The laser illumination is immune to shadows and variations in ambient lighting, allowing consistent collection of quality images in all light conditions.

The collected imagery may serve as a stand-alone video inventory of collected sections, or may be used in conjunction with additional Roadware software applications. Additional functionality may be found through:

VisiData®

Roadware's image viewing software. Display all collected views concurrently. 'Visit' sections on demand through a section inventory list, map interface, or graphs of pertinent associated data.

D/V-Rate®

Perform windshield distress rating surveys from the office.

WiseCrax®

Using pavement images and advanced image recognition algorithms, WiseCrax automatically detects, classifies, and rates visually apparent cracking at widths as low as 1 millimeter (0.03 inches).

Pictured below: 1mm resolution pavement system

Pictured above: 2mm resolution pavement system

SYSTEM COMPONENTS

Digital Camera(s)

Cameras are available in resolutions capable of capturing fine cracks from widths of 2 millimeters (0.07 inches) down to 1 millimeter (0.03 inches) in width on hot mix asphalt surfaces.

System Control

Cameras and captured images are controlled by the Digital Video Storage (DVS) system. Through the DVS graphical user interface (GUI) image adjustments may be made prior to or during collection.

Distance Measuring Instrument

The ARAN DMI is able to measure distances accurate to within +/- two-thousandth (0.002) mile per mile (or +/- 0.2%) and displays the distance in miles/kilometers to three decimal places. The DMI is a non-contact optical encoder that divides each wheel revolution into 2,000 pulses. Using this methodology, distance measurement is not speed dependent so all linear measurements retain accuracy through the reality of fluctuating traffic conditions.

ACCURACY

Using Roadware's ARAN DMI, image location is reported to within 10 cm (3.94 inches) of actual linear position.

ADDITIONAL SYSTEM INTEGRATION

Digital images will be linked to data from other available ARAN subsystems, including Roughness, Rutting, Faulting, Texture, Vertical Clearance and GPS position.

OUTPUT

All images are written into an intuitive directory structure organized by the collected file name and linear reference point at which each image is collected. The JPEG images are named according to the lineal distance point where they were captured.

WiseCrax

Automatic, accurate, repeatable crack detection

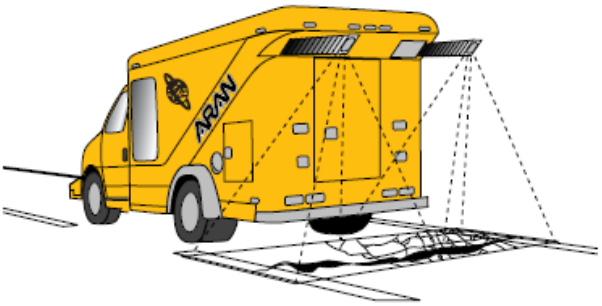
WiseCrax is a crack detection system developed by Roadware. Cracks as small as one millimeter are detected and analyzed automatically.

High speed cameras on retractable booms record sharp, clear Images at variable highway speeds up to 80 km/h (50 mph). Video is recorded as a continuous series of non-overlapping, high contrast images 1.5 m by 4 m (4.9 ft by 13 ft).

Synchronized strobe lights eliminate shadows from trees, bridges, tunnels, and other overhead objects even in bright sunlight.

Images are processed off-line overnight at the office workstation by a unique open architecture process using advanced image recognition software.

Reports are produced describing crack type, severity, extent and location. Crack maps are easily produced and printed on a laser printer for hard copy output.



A unique symbiotic design enables the pavement engineer to interact with the computerized analysis process, to apply sound engineering judgment and experience to the automated outputs.

WiseCrax helps to remove the subjectivity and drudgery from pavement evaluation and ensures more accurate, repeatable comparisons of road deterioration from year to year.

The open-architecture software design makes it possible to adjust WiseCrax to suit local conditions and distress criteria.

Features

- ***Totally automated***
- ***Reports crack type, severity, extent and location***
- ***Detects and analyzes cracks as small as 1 mm (0.03 in.)***
- ***Prepares crack maps automatically***
- ***Dual video cameras record 1.5 m by 4 m sections of pavement***
- ***High intensity strobe lights produce consistent illumination of pavement images***
- ***Eliminates hazardous and expensive walking of pavements***
- ***Crack mapping can be done without disrupting traffic flow***
- ***Interactive, symbiotic and open architecture design***
- ***Helps agencies meet mandates for PMS data collection***
- ***Compliant with AASHTO and LTPP (SHRP) Protocols***