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SOUTHERN SUDAN RURAL INFRASTRUCTURE PROJECT MUNDRI TO WAU ROAD

VOLUME XVII ASSESSMENT OF MAINTENANCE CAPABILITY AND RECOMMENDED TRAINING PROGRAM



THE
DEMOCRATIC REPUBLIC OF THE SUDAN
SOUTHERN REGIONAL GOVERNMENT,
REGIONAL MINISTRY OF
COMMUNICATIONS, TRANSPORT
AND ROADS, SRMCTR,
DIRECTORATE OF ROADS
AND BRIDGES, DRB.

In Cooperation with

UNITED STATES OF AMERICA
AGENCY FOR
INTERNATIONAL DEVELOPMENT

USAID/SUDAN

PROJECT NO. 650-0031



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1086-00

August, 1982
PRELIMINARY

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PLANS PREPARED BY:

Wilbur Smith and Associates

ARCHITECTS ENGINEERS

COLUMBIA, SOUTH CAROLINA,
U.S.A.

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1086-00 ASSESSMENT OF MAINTENANCE CAPABILITY

1. USAID HAS REVIEWED DRAFT OF ASSESSMENT AND MAINTENANCE
CAPABILITY AND RECOMMENDATIONS REPORT AND COMPARED WITH
SCOPE OF SERVICE AS DETAILED IN CONTRACT AMENDMENT 3
DATED JANUARY 3, 1983 ARTICLE IV, SECTION B. I. D, PAGE 4.

2. IF THE PROJECT WERE TO CONTINUE ALONG THE LINES
DESCRIBED IN THE WSA SCOPE OF WORK, THERE ARE CERTAIN
PORTIONS OF THE REPORT WHICH WE WOULD WANT CLARIFIED,
EXPANDED OR OTHERWISE REVISED. SINCE WE NOW PROPOSE A
SUBSTANTIALLY DIFFERENT APPROACH TO THE ROAD AND CONSE-
QUENTLY DIFFERENT MAINTENANCE STANDARDS, WE SEE NO NEED
FOR ADDITIONAL WORK BY WILBUR SMITH ON THE SUBJECT REPORT.

3. REQUEST THAT SER/COM SO ADVISE WSA. KONTOS.

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CHAPTER 1

SOUTHERN SUDAN RURAL INFRASTRUCTURE EVALUATION OF CURRENT MAINTENANCE CAPABILITY

INTRODUCTION

A field inspection to assess the current road and equipment maintenance capability of the Southern Regional Ministry of Transportation and Communication (SRMTC) was conducted from January 21, 1982 to February 22, 1982, during the height of the annual dry season. The condition of the existing roads, equipment and facilities were assessed to gauge the adequacy of the present maintenance system. All sections of the project route (Mundri-Mvolo-Rumbek-Tonj-Wau), as well as the Juba-Mundri-Maridi road and the Mvolo-Aluakluak-Rumbek road were driven by the project's maintenance team. The routes traveled are shown in Figure 1-1. SRMTC employees and other individuals were interviewed at the equipment work centers in Juba, Rumbek and Wau, at road maintenance camps along the project route, and at other locations in the Southern Region including Maridi and Mundri. A listing of individuals interviewed is given in Table 1-1.

It became readily apparent early during the field inspection process that the current road and equipment maintenance capabilities of the SRMTC are limited, and that inadequate levels of maintenance exist on the project roads.

The information presented in this maintenance evaluation report is organized into discussions of the following topics:

- Road System
- Road Maintenance
- Equipment maintenance
- Organization and Staffing
- Management Procedures

Figure 1-1

ROADS TRAVELED BY MAINTENANCE TEAM



Table 1-1
LIST OF PERSONS INTERVIEWED

Juba

Serafino Wani Saki, Director, Ministry of Transportation and Communications
Elisa Ismal, (Former) Director, Ministry of Transportation and Communications
Augustino Lado, Deputy Director, Mechanical Engineering SRMTC
Caesar Alexander, Assistant Director, Maintenance and Construction
Mohammed Julla, Acting Supervisor, Juba Work Center (Technician)
Michael Broadbent, Project Manager, T.P. O'Sullivan/IBRD Project
Helmet Schied, Master Mechanic, T.P. O'Sullivan/IBRD Project
Dennis Rowley, Storekeeper, T.P. O'Sullivan/IBRD Project
Mike Lennard, Mechanical Engineer, T.P. O'Sullivan/IBRD Project
John Smart, Senior Road Engineer, C.I.D.A. Project

Rumbek

Samuel Malet, Commissioner Lakes Province
John Kangatim, Assistant Commissioner of Roads and Bridges, Lakes Province
John Ater, Acting Supervisor, Rumbek Work Center (Technician)
Gordon Nhial, Road Foreman, Rumbek to Mvola Section
Father Valentino, German Leprosy Relief Mission (Construction Supervisor)
Father Itzio, Teacher, Rumbek Senior School
Caspar Wahlian, Teacher, Rumbek Senior School
Steve Jones, USAID, Rumbek Agricultural School

Wau

John Marier, Acting Supervisor, Wau Work Center (Technician)
Joseph Gotker, Technician, Wau Work Center
Joseph Oryem, Road Foreman, Wau-Tonj Section of Road (interviewed at Road Camp #5
50 km ± SE of Wau)

Mundri

Moses Baleiri, Road Supervisor, Jambo-Mundri-Mvola Road
Alison B. Jaba, Assistant Road Supervisor

Maridi

Hans Harder, Project Manager GITEC, Juba-Wau Road Construction Project

Nairobi

Yunus Mahmood Darr, Construction Equipment, Gailey & Roberts Ltd.
(Caterpillar Sales Representative)

- Environmental Factors
- Budgets
- Social/Political Factors

ROAD SYSTEM

Although a few kilometers of paved roads (Macadam) are present in the cities of Juba and Wau, the primary roads serving the project area are unpaved single lane roads, 3.5 meters (11.5 ft) wide, surfaced with lateritic stone and soil.

Classifications

The SRMTC utilizes three road classifications:

- Trunk - all season roads maintained by the SRMTC.
- Through - all season roads maintained by the Provinces.
- Feeder - dry season roads maintained by the Provinces.

The classifications may be somewhat misleading in that there is little difference in traffic volumes, widths or condition. Additionally the SRMTC is the only maintenance organization in the provinces. Manpower for the minimal amounts of maintenance performed on Through and Feeder roads is provided by SRMTC forces, with materials and supplies provided by the provincial commissioner.

Trunk and Through roads in the Southern Region are illustrated in Figure 1-2 and listed in Table 1-2. The trunk road mileage is subject to occasional revision by the Ministry. For example, the Rumbek, Yirol, Shambe road has changed from Ministry to Provincial jurisdiction and is apparently being currently considered for Ministry jurisdiction once more. Road mileage by province is presented in Table 1-3.

Foreign Assistance

In addition to the USAID sponsored improvements to the project route there are a number of road construction and maintenance projects underway that are being sponsored by other countries as illustrated in Figure 1-3, and briefly described below.

Figure 1-2

PRIMARY ROAD SYSTEM

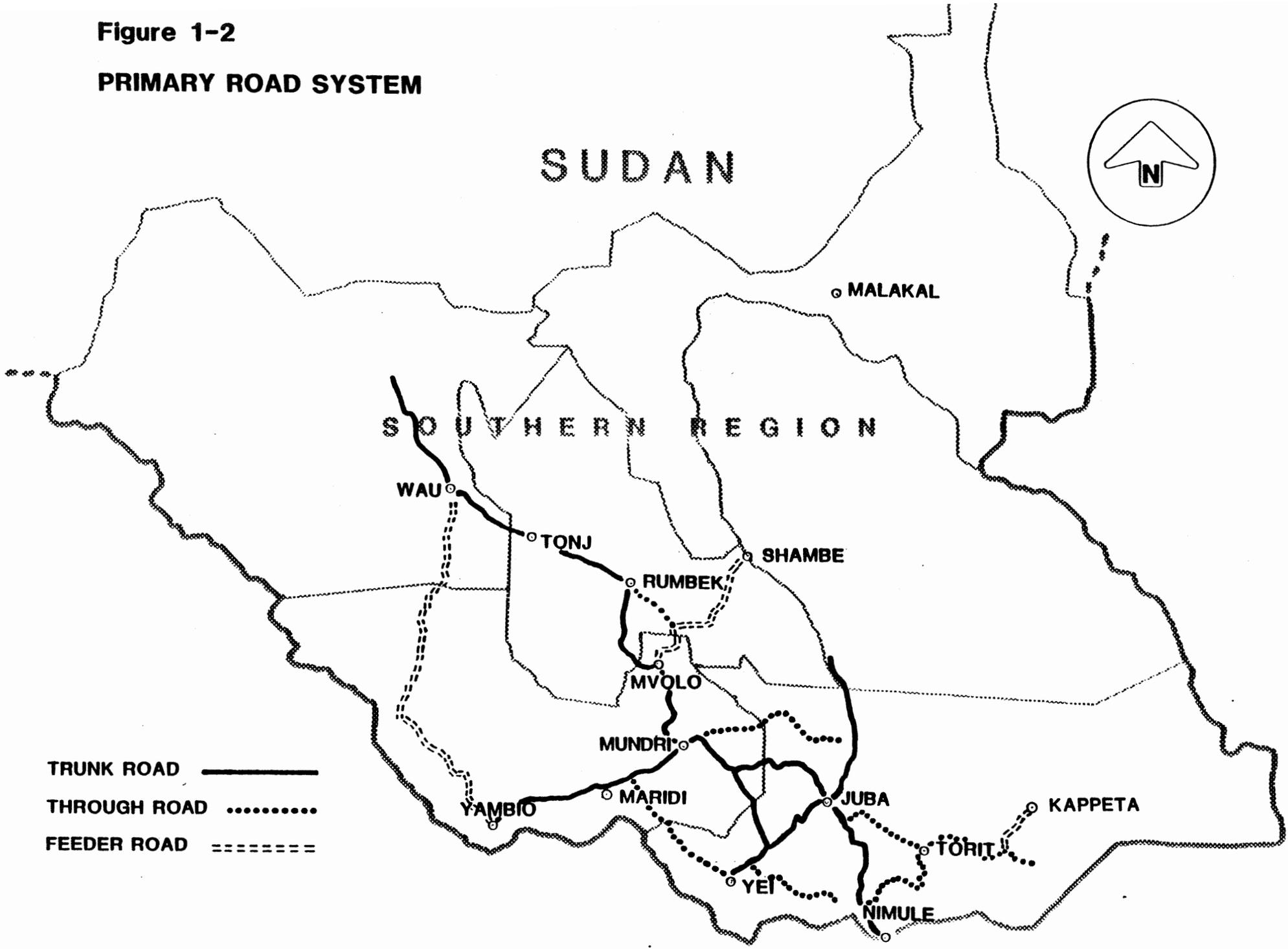


Table 1-2
PRIMARY ROAD SYSTEM

<u>TRUNK</u>	<u>THROUGH</u>	<u>FEEDER*</u>
Juba-Bor	Juba-Torit-Nagichot	
Juba-Nimule	Torit-Nimule	Aluaklauk-Yirol-Shambe
Juba-Rumbek-Wau	Yei-Kajo Kaji	Aluaklauk-Mvolo
Jub-Yei	Yei-Maridi	Mvola-Maridi
Mundri-Layo	Mundri-Terakeka	
Yambio-Mundri	Rumbek-Aluakluak	
Wau-Aweil	Wau-Deim Zubeir-Raga	

*Partial listing only of Feeder routes

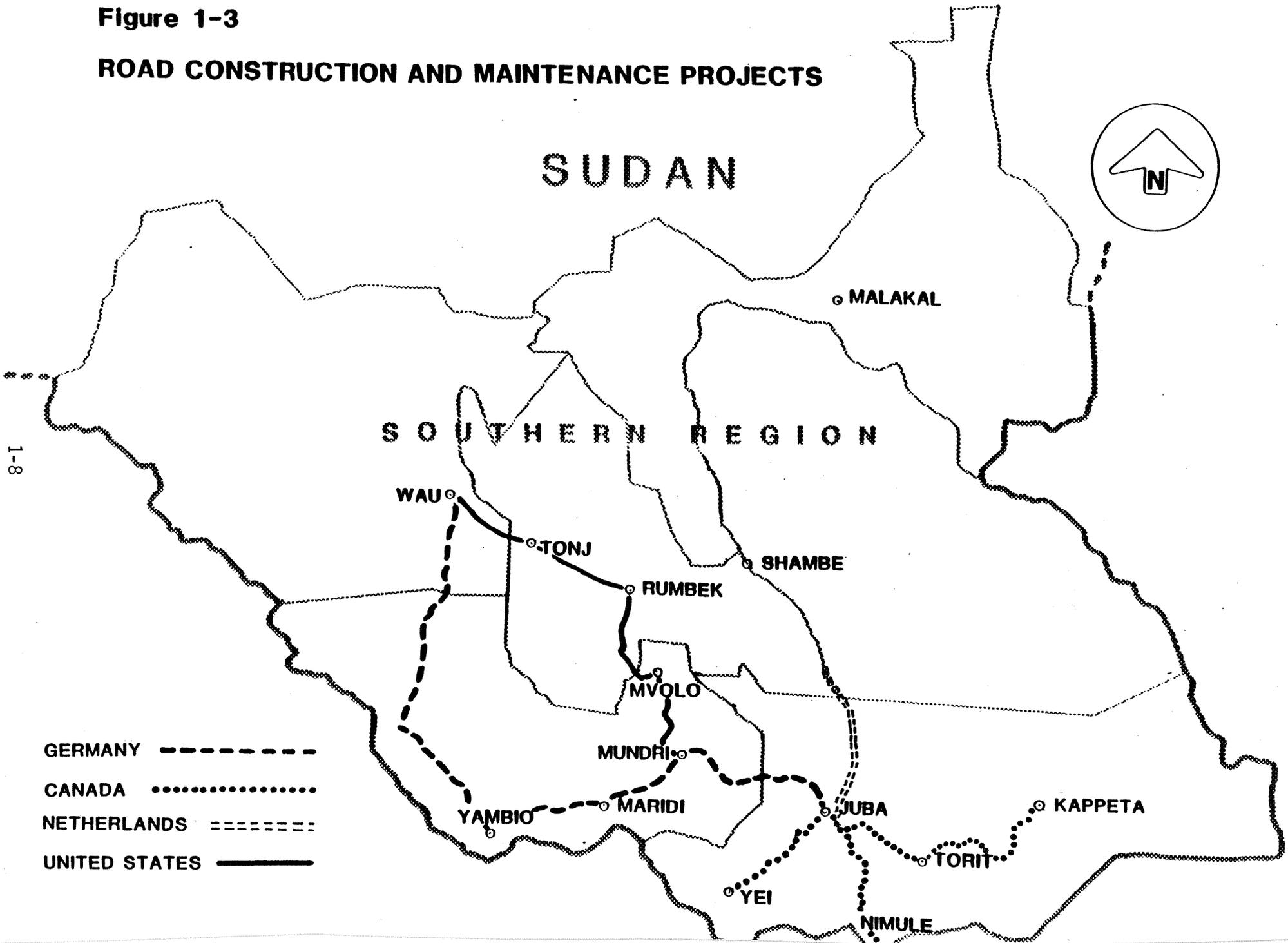
Source: Map at Rumbek Workcenter

Table 1-3
ROAD LENGTHS (KILOMETERS) BY PROVINCE

<u>PROVINCE</u>	<u>RURAL ACCESS ROAD</u>	<u>TRUNK ROADS</u>
Eastern Equatoria	1,250	1,363
Western Equatoria	135	1,429
Bahr El Ghazal	910	806
Lakes (El Buheyrat)	200	448
Junglei	675	382
Upper Nile	360	862
TOTAL	3,530	5,290

Figure 1-3

ROAD CONSTRUCTION AND MAINTENANCE PROJECTS



Germany - The Federal Republic of Germany has undertaken the reconstruction of the 1300 Kilometer Juba-Mundri-Maridi-Yambia-Wau route. The Juba-Mundri section was completed under the supervision of a consultant (GITEC) and turned over to the SRMTC in October 1981.

Canada - Originally envisioned as a technical assistance maintenance effort for the roads from Juba to Yei, Nimule and Torit, the project conducted by the Canadian International Development Agency (CIDA) has as its current emphasis the rehabilitation of the Juba - Torit - Kappeta road.

Netherlands - The project currently involves the rehabilitation of the Juba - Mongolla - Bor road.

World Bank - A 6.8 million dollar International Bank for Reconstruction and Development (IBRD) project is intended to provide technical assistance to the SRMTC in the areas of road construction, road maintenance, equipment maintenance, storekeeping, finance and other technical areas. The work of the IRBD consultant, T.P. O'SULLIVAN & PARTNERS, is concentrated primarily on the Juba area with a major portion of the funds and effort directed toward the design and construction of an equipment maintenance work center in Juba. The work center will conduct major equipment repairs, such as engine rebuilding, for the entire southern region.

Road Conditions

Although most of the roads in the Southern Region are unpaved single lane roads, roadway widths are somewhat deceiving during the dry season and typically appear to be two or more lanes wide. To avoid rough surface conditions vehicles travel on the shoulders or weave around defects as shown in Figures 1-4 through 1-6. These traffic patterns result in roadway widths that appear to be significantly wider than one lane. In river flood plains, narrow roadway embankments prevent weaving, causing vehicles to use parallel tracks, often over 100

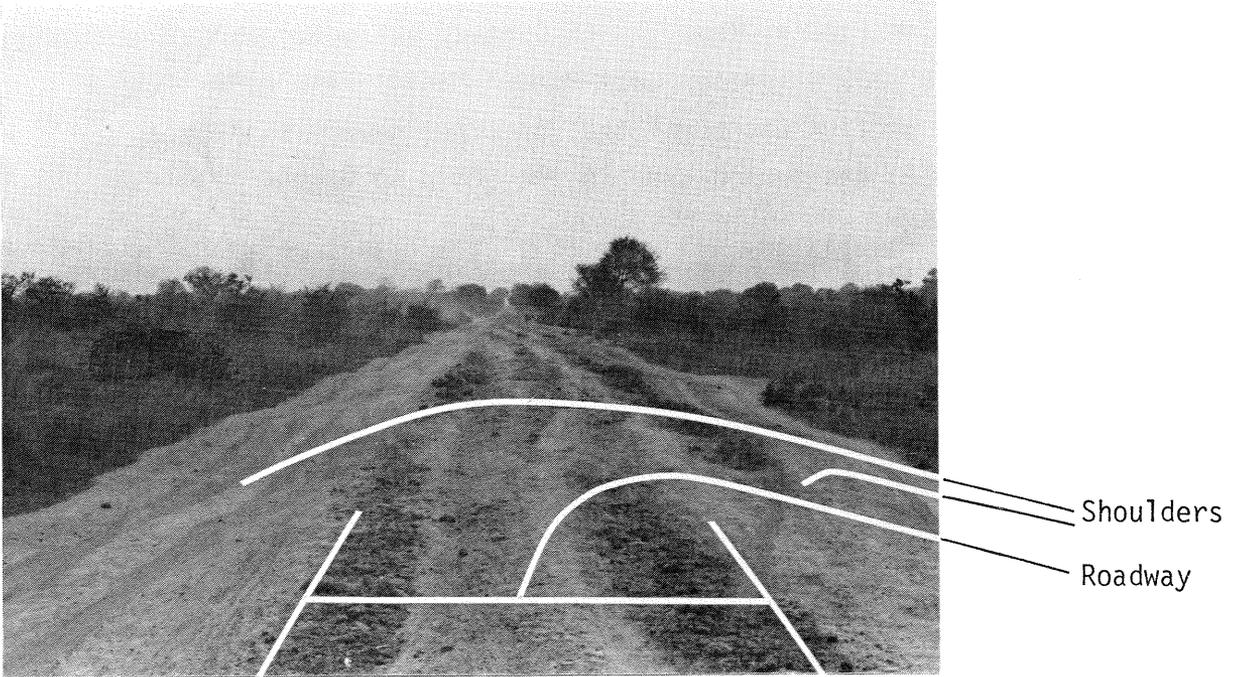


Figure 1-4: Use of shoulders during dry season
Rumbek-Mvolo Rd.

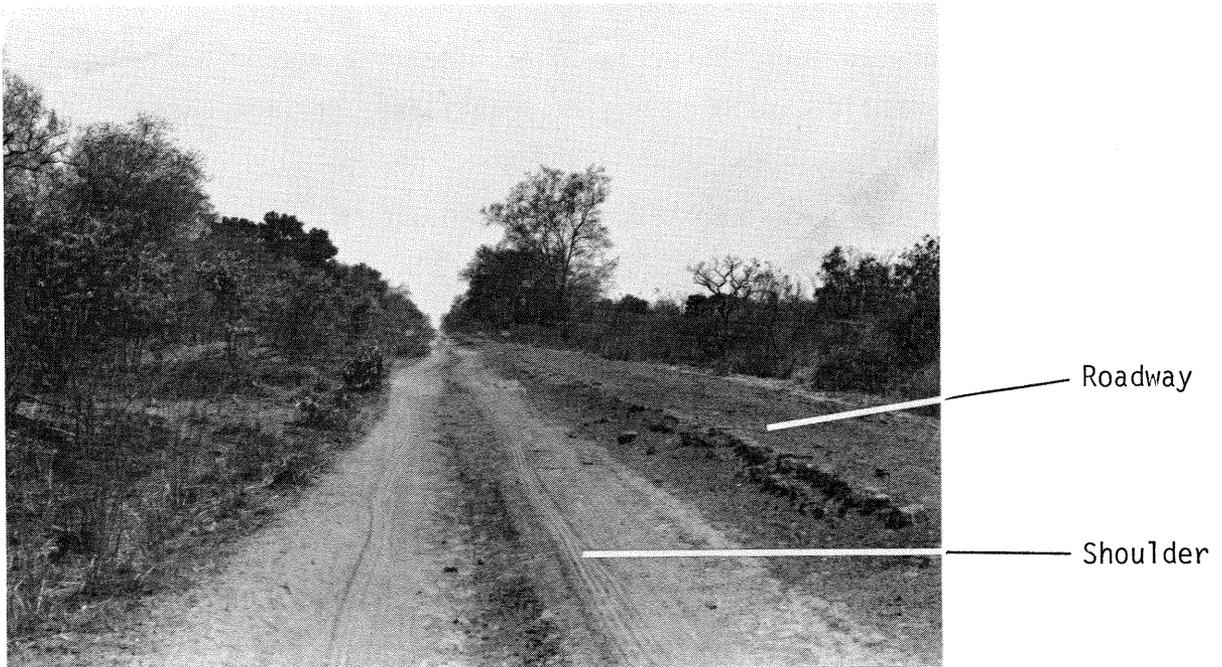


Figure 1-5: Use of shoulders during the dry season



Figure 1-6: Typical weaving pattern to avoid defects
Mundri-Mvolo Rd.

meters (330 feet) from the embankment, returning to the roadway at bridges and major culverts. However, during the rainy season shoulders and parallel tracks cannot be used due to the saturated ground conditions.

Roads traveled by the maintenance team were found to have a hard firm surface baked hard by the prevailing dry season and covered with fine or very fine granular material. However, surface defects were prevalent for virtually the entire length of the project route and most other roads traveled in the Southern Region. Common surface defects were distortion, rutting, potholes, corrugations and rock outcroppings, caused by instability during the rainy season, loss of surface material, and inadequate surface aggregate and maintenance. These defects occurred continuously throughout the project area. Significant features of various roadway segments are described briefly below.

Juba-Mundri - This section of roadway was recently constructed under the supervision of GITEC, a German consulting engineering firm. The roadway was completed and turned over to the SRMTC for maintenance in October 1981. The proposed project route begins at its intersection with this road six kilometers (3.6 miles) west of Mundri.

Of significance is the rapid appearance of moderate to severe corrugations, illustrated in Figure 1-7, which were present for the majority of this road.

Mundri-Mvolo - A clearing and grubbing operation has been recently performed by SRMTC forces from Juba on the project route from Mundri to Mvolo a distance of approximately 112 kilometers. According to a clerk at the Mvolo Police Station the work had been halted for two years prior to the SRMTC workers return to Juba in January 1982.

Vegetation and soil removed during the clearing and grubbing was windrowed along the sides of the right of way. The cleared width between windrows was approximately 12 meters (40 feet) except at several granite rock outcroppings. A light coating of lateritic gravel had been applied to the first 40 kilometers out of Mundri, the last five before Mvolo, and at other scattered locations. Corrugations were prevalent in



Figure 1-7: Light corrugations on Juba-Mundri Road
(recently completed by German project)

those areas with surface cover. The remaining 60 to 70 kilometers had experienced moderate to severe rutting, surface distortion, pot holes and rock outcroppings. Typical surface conditions are shown in Figures 1-8 and 1-9.

Population densities along the road were low and terrain was typically gently rolling or flat.

Mvolo-Rumbeck - During the dry season, vehicles traveling between Rumbek and Mvolo use the smoother but slightly longer Mvolo-Alouklouk-Rumbek route rather than the project route. Roadway widths vary considerably, ranging from 12 meters (40 feet) or more to as little as three to four meters (10 to 12 feet) including shoulders. Severe surface distortion, rutting and pot holes, as shown in Figures 1-10 and 1-11, occurred frequently although evidence of patching activities was observed at two or three locations approximately 18 kilometers (11 miles) south of Rumbek.

Population densities along the road are very low from Mvolo to a point 80 kilometers (50 miles) north; possibly due to Tsetse fly infestation. Population density and pedestrian traffic increased considerably over the remaining 42 kilometers (26 miles) to Rumbek.

Terrain was typically gently rolling, becoming very flat approaching Rumbek.

Rumbek-Tonj - The first 60 to 70 kilometers (35 to 40 miles) of this section have the highest population densities and heaviest pedestrian traffic found on the project route. Vehicular traffic was estimated to be less than 15 vehicles per day. Rutting, surface distortion and corrugations were the most common defects. Evidence of patching was observed at three or four locations approximately 20 kilometers (12 miles) north of Rumbek.

The northern half of this section of the project route passes through a sparsely populated forest area with severe surface distortions and rutting, as shown in Figure 1-12. During the rainy season these surface depressions, often over 50 centimeters (18 inches) deep, fill with water and the road becomes impassable.



Rutting

Figure 1-8: Typical rutting on Mundri-Mvolo Rd.



Figure 1-9: Granite outcropping Mundri-Mvolo Rd.



Rutting 1.0 meter deep

Figure 1-10: Rutting on shoulder of Mvolo-Rumbek Road



Figure 1-11: Potholes Mvolo-Rumbek Road



Figure 1-12: Surface Distortion and Rutting Rumbek-Tonj Road

Terrain for the 125 kilometer (78 miles) section of road between Rumbek and Tonj was very flat.

Tonj-Wau - Much of this section of roadway had a sparse covering of lateritic gravel. Typically, the wheel paths were severely corrugated in these areas with surface fines winrowed along the sides and between the wheel paths as shown in Figures and 1-13 and 1-14. Other defects such as rock outcroppings, potholes and rutting were present in areas with insufficient surface material. Population densities and pedestrian traffic were low to moderately heavy. Terrain was typically flat or gently rolling.

ROAD MAINTENANCE

Background

Roads in the Southern Region were constructed and maintained by labor intensive methods during the period when the Sudan was governed by the British - Egyptian Condominium. Credit for work in the tax structure was used to insure that tribes living along the roads performed road maintenance. Just prior to the Sudan's independence from both Egypt and Great Britain on January 1, 1956, a civil war began between northern and southern Sudan. During the civil war, which lasted from 1955 to 1972, more forceful methods were used to insure that the roads were maintained.

In 1972, road camps were established every 10 kilometers (six miles) along the primary (trunk roads) of the Southern Region. Each camp was responsible for maintaining a 10 kilometer (six mile) section of roadway by hand. Housing was provided for one headman, 11 laborers and their families. Camp staffs were appointed from local tribes, soldiers who had fought in the civil war, and repatriated refugees returning from Uganda and other nations.

Road camp locations along the project route are illustrated in Figure 1-15. As can be seen from the Figure 1-15, the number of road camps generally conforms with the one camp per 10 kilometers (six miles)



Figure 1-13: Typical corrugations Tonj-Wau Road.



Figure 1-14: Close up of corrugations Tonj-Wau Road

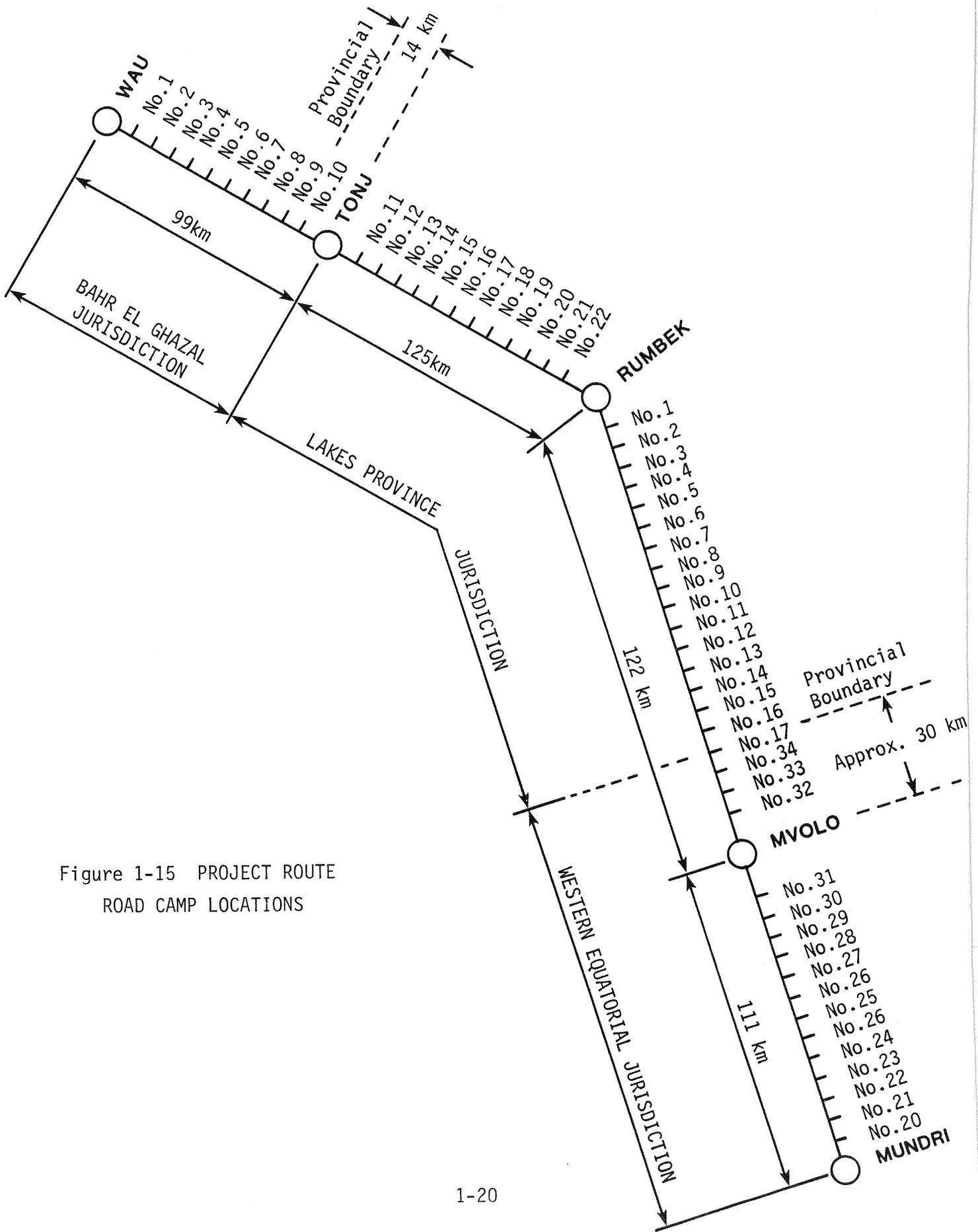


Figure 1-15 PROJECT ROUTE
ROAD CAMP LOCATIONS

formula with the exception of the Mvolo-Rumbek road section. This 122 kilometer section of roadway may have had as many as 20 road camps, however. Many of these road camps were not occupied or clearly identified during our investigations. When possible employees at the road camps were interviewed. Road camps located consisted of one or more small huts, of mud or thatched wall and thatched roof construction, used for storing hand tools and housing workers. Typical road camp buildings are shown in Figures 1-16 and 1-17. Tool inventories were generally inadequate ranging from a few shovels, to an assortment of shovels, axes, slashers, torias and an occasional wheel barrow. None of camps visited were fully staffed. Six to eight persons instead of the authorized 11 were typical.

Road Maintenance Operations

Current road maintenance activities can be grouped into the following categories:

- Surface Maintenance
- Road Side Maintenance
- Drainage and Structures and
- Facilities.

Due to the limited amount of mechanical equipment available, as well as the severe shortage of fuel to run the equipment, mechanical equipment is generally reserved for non-routine activities such as reconstruction or rehabilitation.

Surface Maintenance - Routine surface maintenance activities are labor intensive and consist primarily of patching defects with large stones and reinforcing soft areas with logs, as shown in Figures 1-18 and 1-19. Despite a proliferation of pot holes, ruts and surface depressions, little evidence of recent patching activity was found. One pothole patching operation was observed.

Pothole patching consisted of hand placement of laterite stones approximately 25 centimeters (10 inches) in diameter, in the potholes. Following placement, the stones were broken with a small hand sledge



Figure 1-16: Typical Road Camp (Road Camp #4)
Tonj-Wau Road

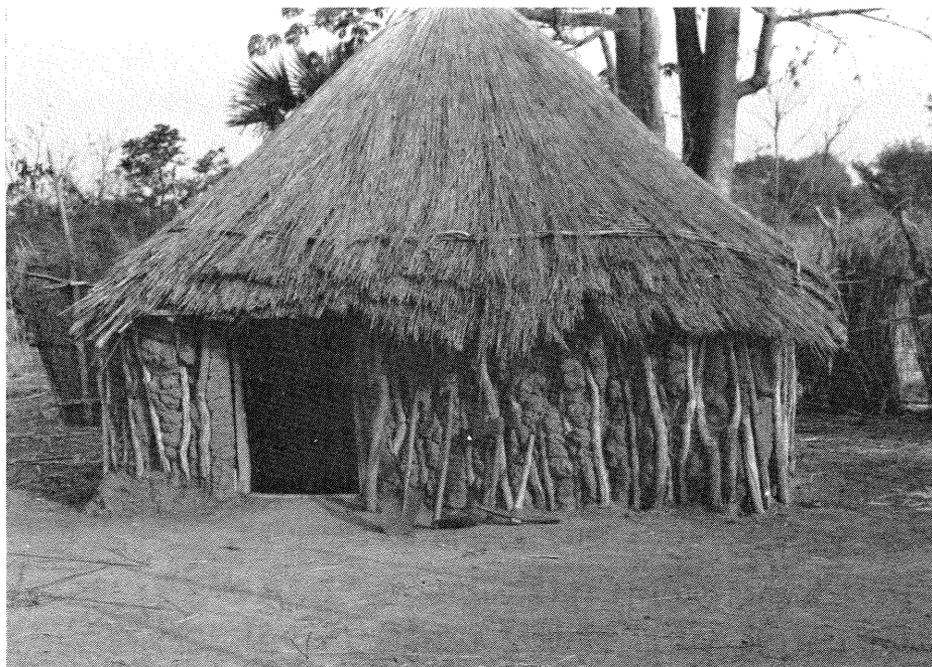


Figure 1-17: Typical Hut (Road Camp #2) Tonj-Wau Road



Figure 1-18: Recently patched pothole, Tonj-Wau Road



Figure 1-19: Roadway reinforced with logs
Rumbek-Alauklauk-Mvolo Road

hammer and then rearranged by hand. Figure 1-20 depicts a patching operation in progress.

Laterite stone and gravel is plentiful throughout most of the project area. The laterite stone used for patching is hand excavated from outcroppings near the roadway. Stones are excavated with pry bars or similar devices and then piled beside or on the roadway shoulder for future use. A typical laterite outcropping and a stockpile are illustrated in Figures 1-21, 1-22 and 1-23. The production rate was reported to be one pile, one meter (three feet) high, per man per day. Less than 24 such piles were sighted along the project road.

Lateritic gravel was also hand excavated from deposits near the road, for use in making concrete. Lateritic gravel can also be produced in sufficient quantities for surfacing activities by crawler mounted dozers equipped with ripper teeth. Several large stockpiles, each with several hundred tons of material, were produced by SRMTC personnel and equipment along the Mundri-Mvola section of road. A stockpile near Mvolo is shown in Figure 1-24.

Roadside Maintenance - Roadside maintenance includes activities such as grass cutting or removal and maintenance of safety features.

Two crews were observed along the project route removing grass from the roadside. The crews used similar techniques although one of the crews was not employed by the SRMTC, but was working under the direction of their tribal chieftan.

Grass removal was accomplished with long handle square point shovels and a locally designed tool that resembled a spear with a square point eight to 10 centimeters (three to four inches) wide. Slashers, a machete like knife, were also kept at several road camps for grass cutting but were not seen in use.

Vegetation was also controlled by burning, which is extensively practiced by local residents for hunting and grazing purposes.

Maintenance of roadside safety features was not a high priority activity. One warning sign and one speed limit sign constituted the only traffic control signing on the project route. These signs are



Figure 1-20: Pothole patching, crew from Camp #4
Tonj-Wau Road



Figure 1-21: Stone stockpiled on road shoulder
Mundri-Mvolo Road

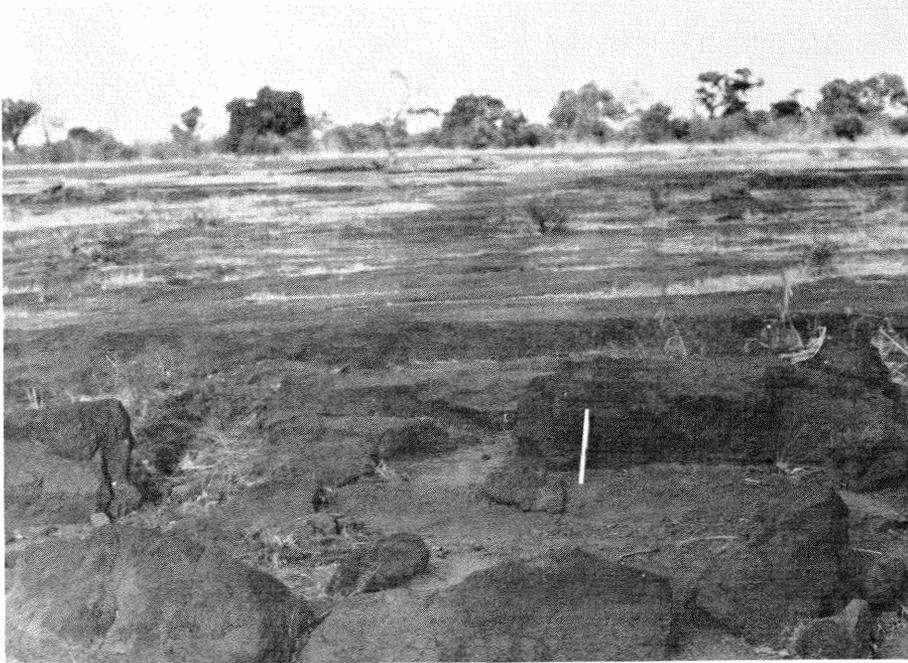


Figure 1-22 Laterite outcropping near Wau



Figure 1-23 Close-up of Laterite outcropping



Figure 1-24: Stone stockpile 1 kilometer south of Mvolo

shown in Figures 1-25 and 1-26. Missing or damaged railings, shown in Figures 1-27 and 1-28, were typical features of major bridges. No guardrail of any type was used at bridge abutments and culverts. Similarly the removal of roadway and roadside obstacles such as fallen trees was not frequently performed. In fact, gravel and soil pits were common immediately adjacent to the roadside and laterite stones were often piled on the road shoulder.

Drainage - Due to the flat road grades erosion was not a significant problem. Except for flood plain areas, the roadway was typically at the same elevation as the surrounding ground. The high water table during the rainy season, lack of roadway crown, insufficient number of cross culverts, and abundance of surface defects all contribute to reduce the structural strength of the road bed.

Concrete pipe for use in culverts is fabricated by SRMTC builders at the Rumbek Work Center. The concrete is hand mixed using portland cement, laterite stone for coarse aggregate and river sand. The concrete pipes are cast in steel forms, with wire fabric used for reinforcing. Forms and recently cast pipes are shown in Figure 1-29.

Pipes are butted end to end when installed in the field, with joints being cast-in-place using the same forms that were used in fabricating the pipes. Masonry end walls are constructed with laterite stones similar to those in Figure 1-30.

Facilities - The existing road camp buildings are maintained by workers assigned to each camp. Activities include cutting grass for rethatching roofs and digging mud for repair of the walls.

EQUIPMENT MAINTENANCE

Between 1972 and 1976 equipment maintenance work centers were established in the capitols of each of the six provinces in the Southern Region. Work centers are responsible for operating, maintaining and repairing the Ministry's road construction and maintenance equipment.



Figure 1-25: Speed limit sign near Wau



Figure 1-26: Warning sign on Tonj-Wau Road



Figure 1-27: Handrail damage on bridge near Mvolo

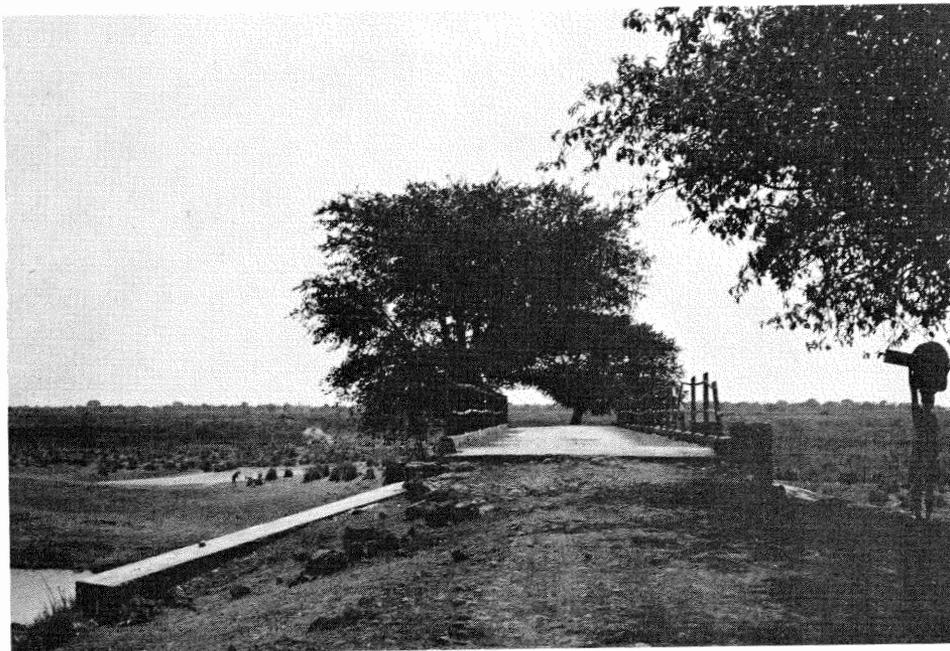


Figure 1-28 Bridge handrail damage on Rumbek-Tonj Road

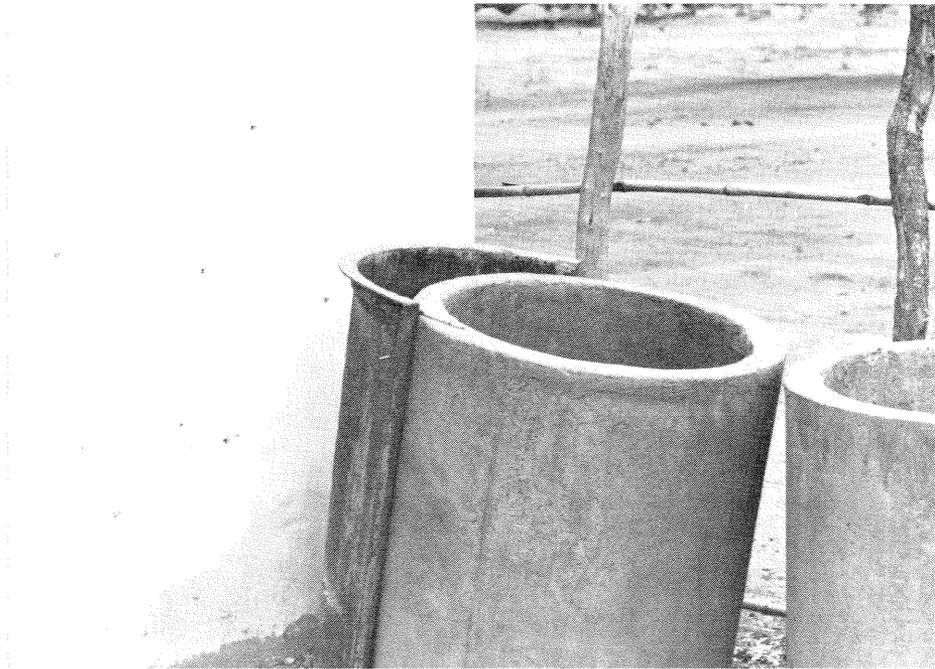


Figure 1-29: Concrete pipe made at Rumbek



Figure 1-30: Laterite stone stockpiled at Rumbek

The project's maintenance team inspected the SRMTC provincial work centers in Rumbek (Lakes Province) and Wau (Bahr el Ghazal) and the central SRMTC workshop in Juba (Eastern Equatoria). The team also inspected two other facilities in Juba. The central Motor Transport Division (MTD) which is responsible for maintaining government cars and pickup trucks, and the Canadian Agency for International Development (CIDA) shop which currently maintains equipment used on the CAID road maintenance project.

Although there was an abundance of disassembled and partially disassembled equipment and components at each of the work centers there was little if any evidence of recent repair activity. Interviews with employees and observation of the level of activity indicates that the existing equipment maintenance capability is extremely limited by lack of parts, supplies, tools, equipment and knowledge of proper equipment maintenance techniques. The work centers and other shop facilities inspected are described briefly below:

Rumbek

The Rumbek Work center shown in Figure 1-31 was established in 1976. The compound consists of three small buildings of mud wall and thatch roof construction surrounded by a stockade fence. One building functions as an office, with the other two buildings used for storage of parts and supplies, road maintenance hand tools, and other miscellaneous items.

A small sign, shown in Figure 1-32, in the unpaved yard in front of the buildings marks the area where repairs take place and an open pit behind the compound has been designated as the blacksmith's shop.

Parts, supplies and hand tools are ordered through the SRMTC headquarters in Juba. Shipments of supplies and tools had not been received in Rumbek for approximately two years.

Equipment maintenance parts and supplies on hand consisted of several half liter (1 pint) cans of grease, one 200 liter (55 U.S. gallon) drum of 140 grade transmission oil, and several piles of small parts cannibalized from vehicles.

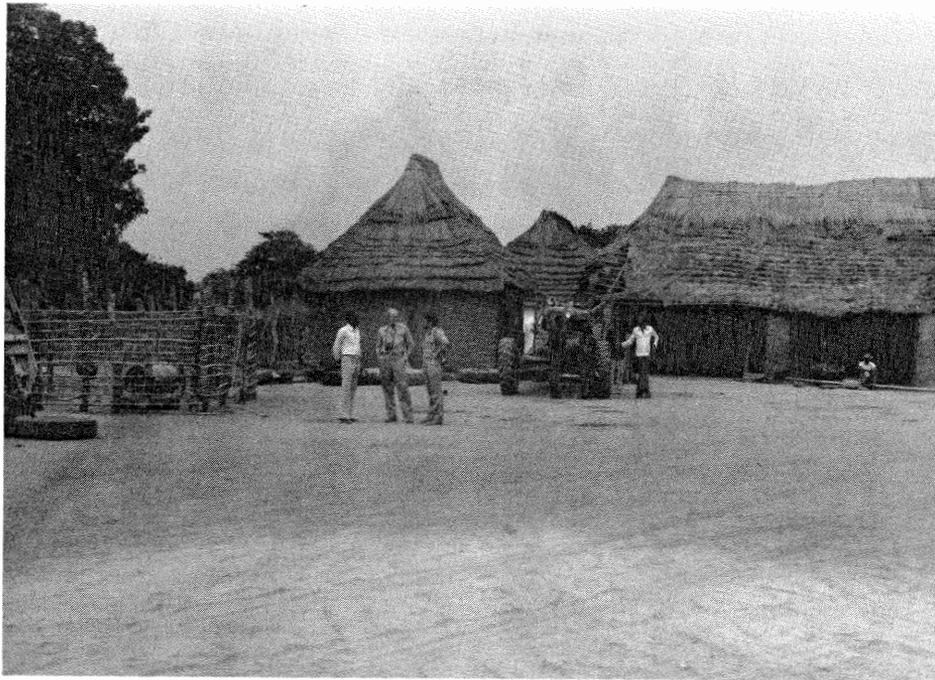


Figure 1-31: Rumbek Workcenter



Figure 1-32: Repair area at Rumbek Workcenter

Shop tools and equipment consisted of a small assortment of wrenches, kept in small tool boxes, and a platform mounted air compressor. The air compressor, shown in Figure 1-33, is reported to be operable, but has not been used recently for lack of fuel.

Road tools in stock included three to four dozen torias, one dozen short handle shovels, and one half dozen rakes, pry bars, and picks. The maintenance team was advised that most hand tools had been distributed to road camps.

The Work center has a staff of 71 employees that includes 11 mechanics and assistant mechanics. Unfortunately, these mechanics have no formal automotive training and do not speak English or Arabic well enough to receive training in Juba.

A Nisan dump truck on temporary loan from Juba, a 1974 Toyota pickup assigned to Rumbek in February 1982, and a caterpillar model 12F motor grader were the only pieces of equipment in operating condition at the Rumbek Work Center during the field evaluation period. The motor grader, in poor condition, was used primarily for transportation when and if fuel was available.

The Fiat-Allis model 16B track-type tractor shown in Figure 1-34 was located near the project road 33 kilometers north of Rumbek where it had run out of fuel nine months earlier. Other than batteries it had not been cannibalized.

The remaining equipment was in various stages of disassembly and not worthy of repair. Recognizable equipment consisted of two GMC dump trucks, one Steyr tanker truck, three Steyr dump trucks, one landrover and one Kawasaki motorcycle. The condition of these vehicles is illustrated in Figures 1-35, 1-36 and 1-37.

Wau Work Center

The facilities at Wau were slightly better than those in Rumbek. Indoor work bays with grease pits were provided in a building constructed of laterite stone blocks. An air compressor and a Ford welder were on hand and reported to be operable. Employees at the facility number 127 to 150, including 20 mechanics plus assistant mechanics.

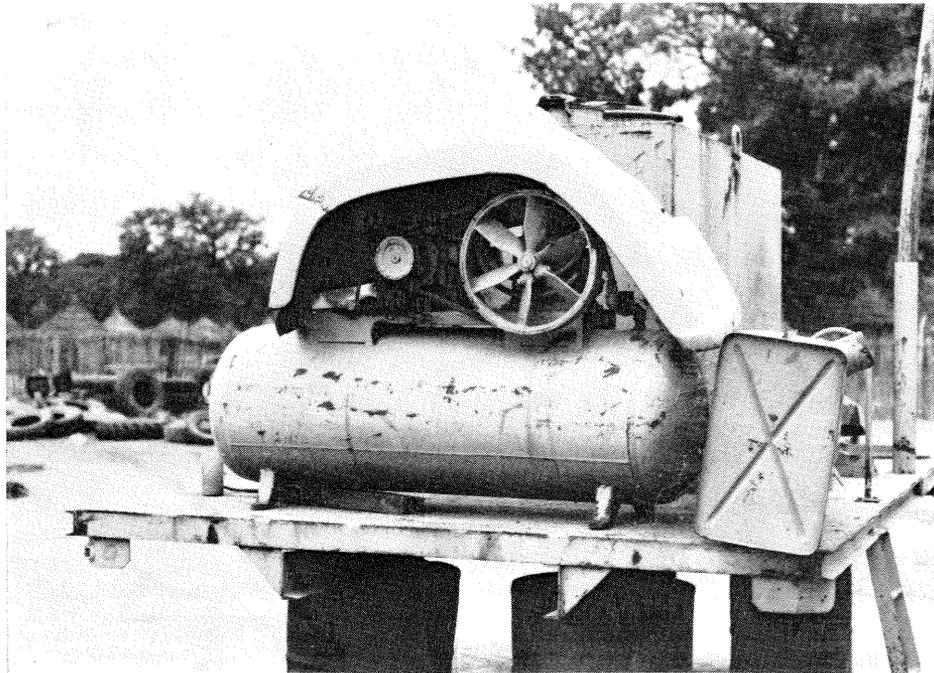


Figure 1-33: Air compressor at Rumbek Workcenter

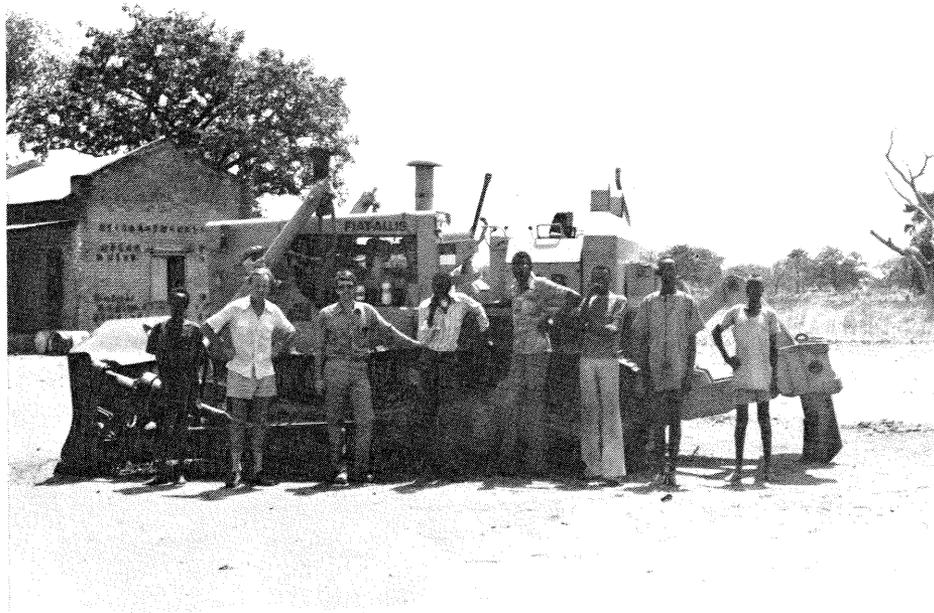


Figure 1-34: Fiat-Allis track-type tractor abandoned near Rumbek



Figure 1-35: Rumbek Workcenter



Figure 1-36: Rumbek Workcenter



Figure 1-37: Rumbek Workcenter - Tanker Truck

However, no spare parts or fuel were in stock and none of the equipment was operable at the time of inspection. Like Rumbek the majority of equipment was partially disassembled and generally not worthy of repair. Equipment on hand included three Sakai rubber tired rollers, one Gallion and Six Caterpillar (12F and 112F) motor graders, one Nissan diesel tanker truck, two Wabco pans, and one front end loader.

Juba

The facilities at the central work center in Juba were considerably better than those at Wau and Rumbek. However, like Rumbek and Wau there were numerous pieces of deadlined equipment and few spare parts available. A gift of new equipment received from the State of Qatar in January 1982, contrasted sharply with the other equipment on hand.

The new equipment consisted of 10 Berliet GBH 280 dump trucks, three Kobelco LK 700 wheel loaders, two Kawasaki KSS 952 II wheel loaders, one Komatsu D155A track-type tractor, one JOHS MOLLERS steelwheel roller, two Caterpillar 14G graders and four tanker trucks.

No spare parts or shop manuals were shipped with the equipment. Additionally, the blade linkage was not shipped for the bulldozer, and one grader and three dump trucks had broken down. In all, a total of five pieces of new equipment was down before being put in service.

T.P. O'SULLIVAN, a consulting firm working for the world bank is currently designing a new central work center to serve the entire Southern Region on a component exchange basis. The new facility will perform engine rebuilding, fuel injection repairs, crankshaft grinding and other forms of major or specialized maintenance. Additionally, the central work center will serve as a central warehouse for parts and supplies. Eventually the C.I.D.A. facility will be taken over by the SRMTC and T.P. O'SULLIVAN plans to recommend that it be used for under-carriage rebuilding for track vehicles.

T.P. O'SULLIVAN tentatively plans to recommend that caterpillar model 3304 or 3306 engines be specified for equipment whenever possible.

C.I.D.A. Work Shop

Designed originally as a model for provincial work centers the entire covered work area had been closed off for parts storage. An addition to the facility is currently under construction to correct this situation. The expatriate staff consisted of a project manager, a road engineer and master mechanic. All other staffing, including equipment operators and laborers, was supplied by SRMTC.

A shipment of parts received in February 1982 had been ordered 14 months earlier.

MTD Maintenance Shop

Like the SRMTC Work centers, the central MTD maintenance shop in Juba was limited by lack of parts, supplies and fuel. Unlike the work centers, the MTD buildings and grounds were kept neat and well organized, numbered bins were used in the stockroom, and productive work was underway.

ORGANIZATION AND STAFFING

SRMTC Headquarters

The organizational structure of the SRMTC had been restructured only a few weeks prior to the field evaluation, but the new structure had not been clearly defined.

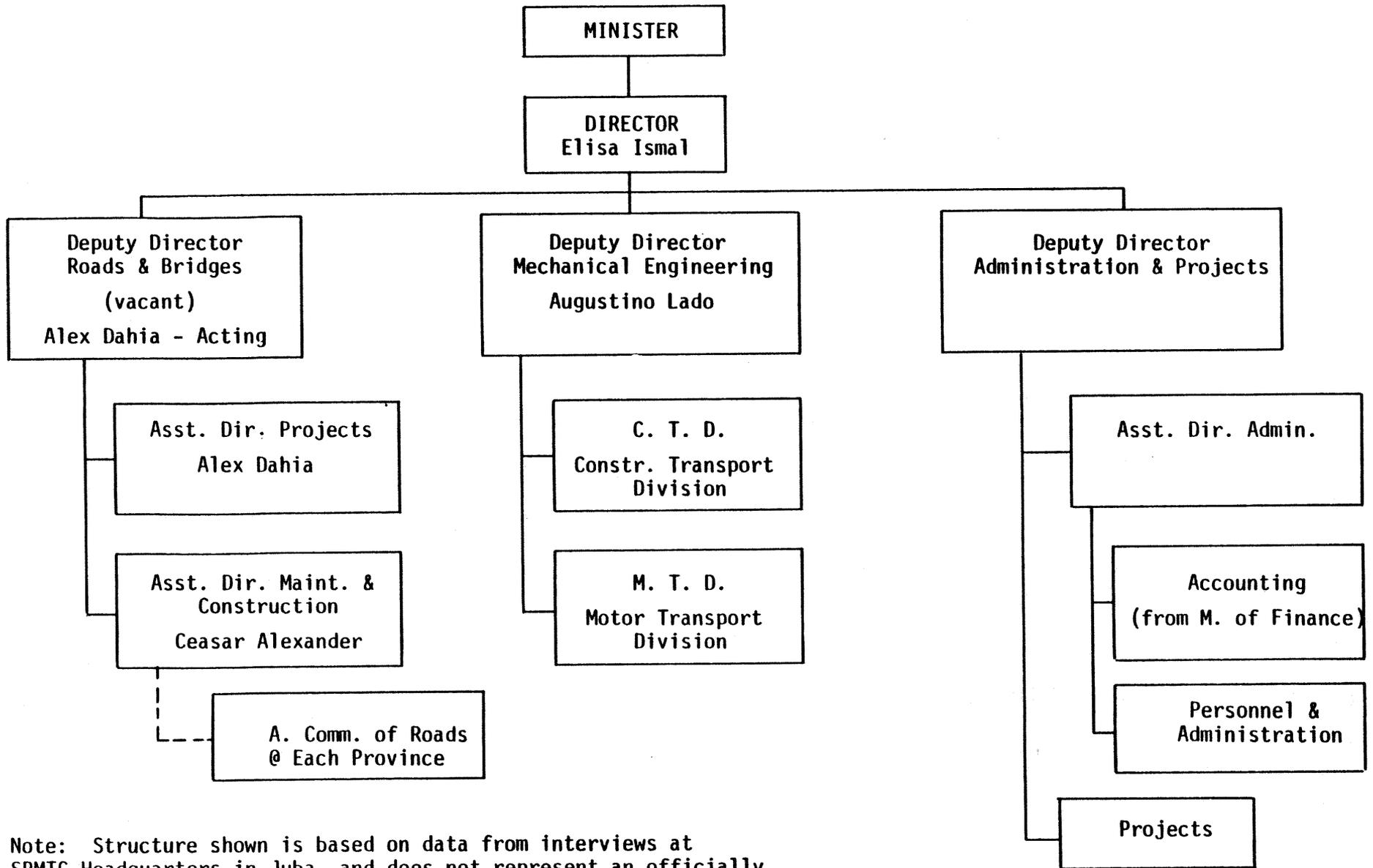
Shortly before the maintenance team's arrival in Juba, the Southern Region's Parliament had been reorganized and the previous Director of the Ministry had lost his seat in Parliament. Under Sudanese law, he was entitled to return to his former position as Director of SRMTC. His return was accommodated by dividing the Ministry into two separate branches as illustrated in Figures 1-38 and 1-39.

Provincial

The highest ranking official at the provincial level is the Province Commissioner. The Commissioner may carry a high military rank

Southern Region Ministry of Transportation and Communications

Prior to January 20, 1982



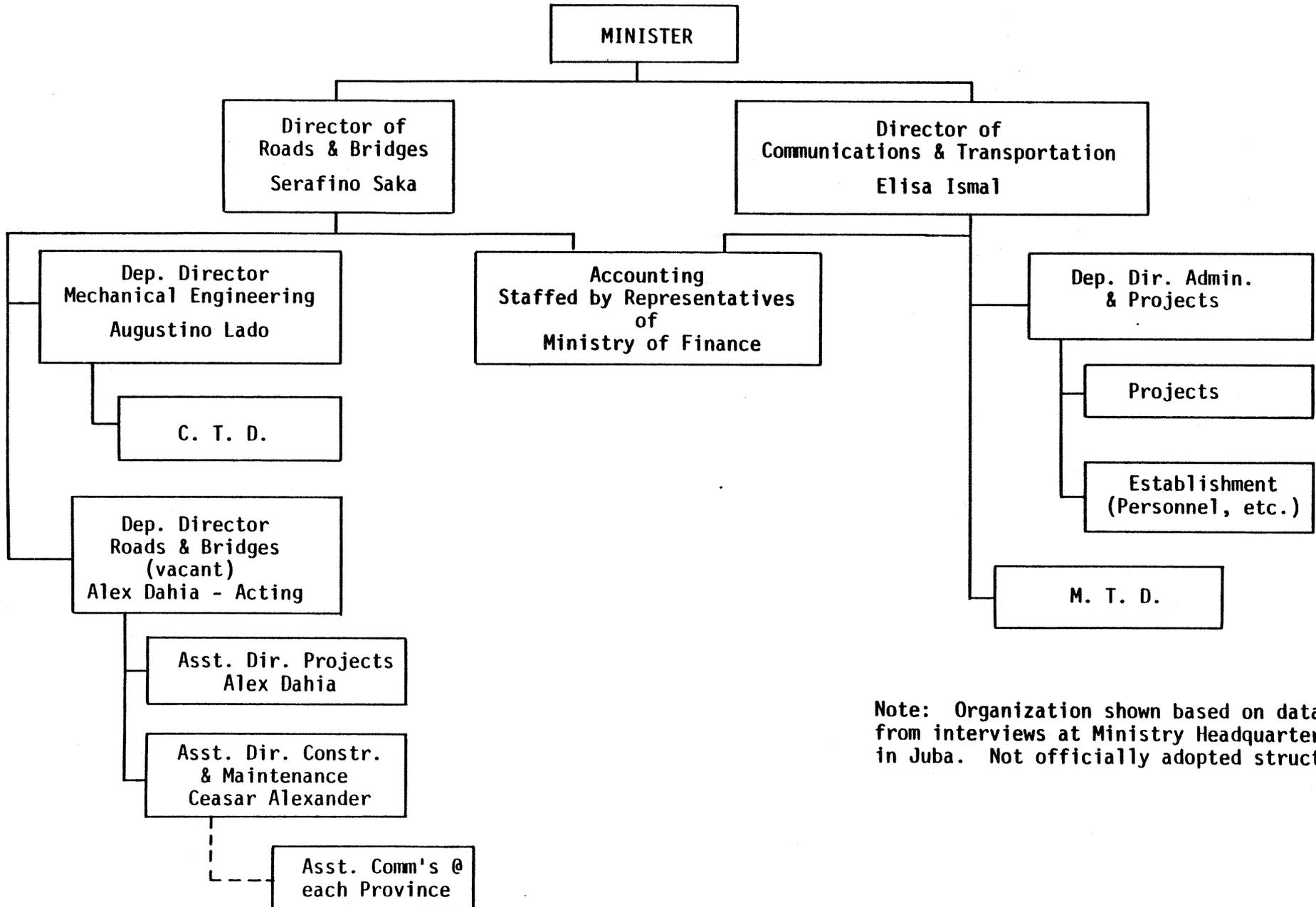
1-41

Note: Structure shown is based on data from interviews at SRMTC Headquarters in Juba, and does not represent an officially adopted structure.

Figure 1-39

ORGANIZATIONAL STRUCTURE

1/20/82 to



Note: Organization shown based on data from interviews at Ministry Headquarters in Juba. Not officially adopted structure.

and essentially acts in the capacity of a governor. Reporting to the commissioner are civilian Assistant Commissioners for various Ministries.

The Assistant Commissioner of Roads and Bridges, an SRMTC employee reports to the Province Commissioner and the SRMTC. He has jurisdiction over two major functions: equipment maintenance and road maintenance. The organization structure for the SRMTC's Road and Equipment Maintenance Organization in Lake's Province is shown in Figure 1-40.

Equipment Maintenance - The head of equipment maintenance at the provincial level is a mechanical engineer who supervises a SRMTC work center. At the three work centers visited, this position was vacant and the acting supervisors were interviewed. In each case, the acting supervisor was a technician. Technicians are individuals who have attended a technical trade school instead of seniors (high school). Technicians perform administrative duties and interpret mechanical theory for the mechanics.

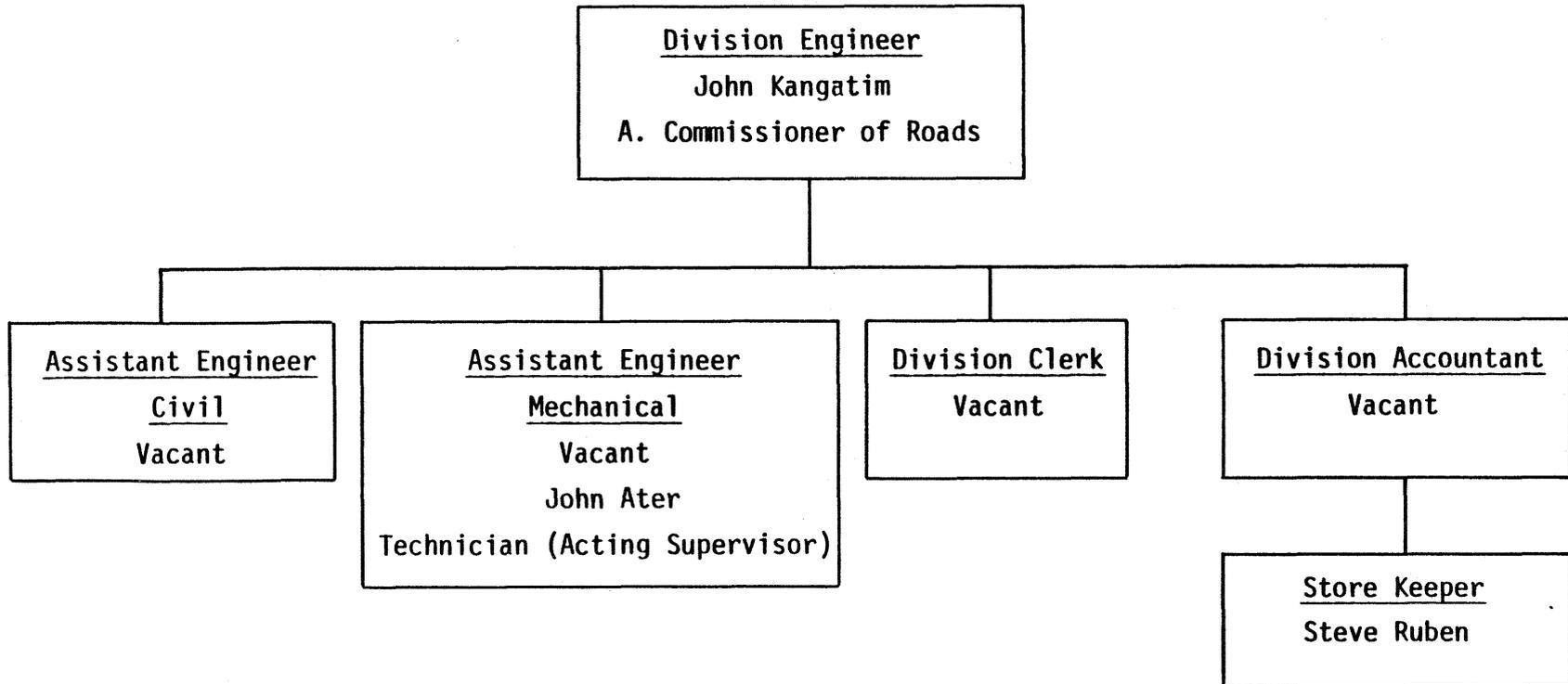
Under the current organization structure, the head of the work center also supervises personnel whose primary duties are not related to equipment maintenance, such as the carpenters, builders and drivers. The organizational structure of the Wau Work center, shown in Figure 1-41, illustrates the variety of personnel classifications assigned to the work centers.

Road Maintenance - The existing road maintenance organizational structure is based on length of road administered, as shown in Table 1-4, with the basic unit being the road camp. The SRMTC 1981/82 budget is based on this staffing formula and on each road camp being staffed with one headman, eight full time roadworkers, and three daily paid workers for a total of 12 employees per camp. Using this formula the SRMTC has determined that the Southern Region's road maintenance workforce should be 3,745 employees, which is 150 employees less than the 3,895 persons presently employed. The SRMTC is currently planning to reduce the basic road camp staff from 12 employees to seven per camp which will reduce the overall workforce by 1,182 employees.

Figure 1-40

LAKES PROVINCE ROAD AND EQUIPMENT
MAINTENANCE ORGANIZATION

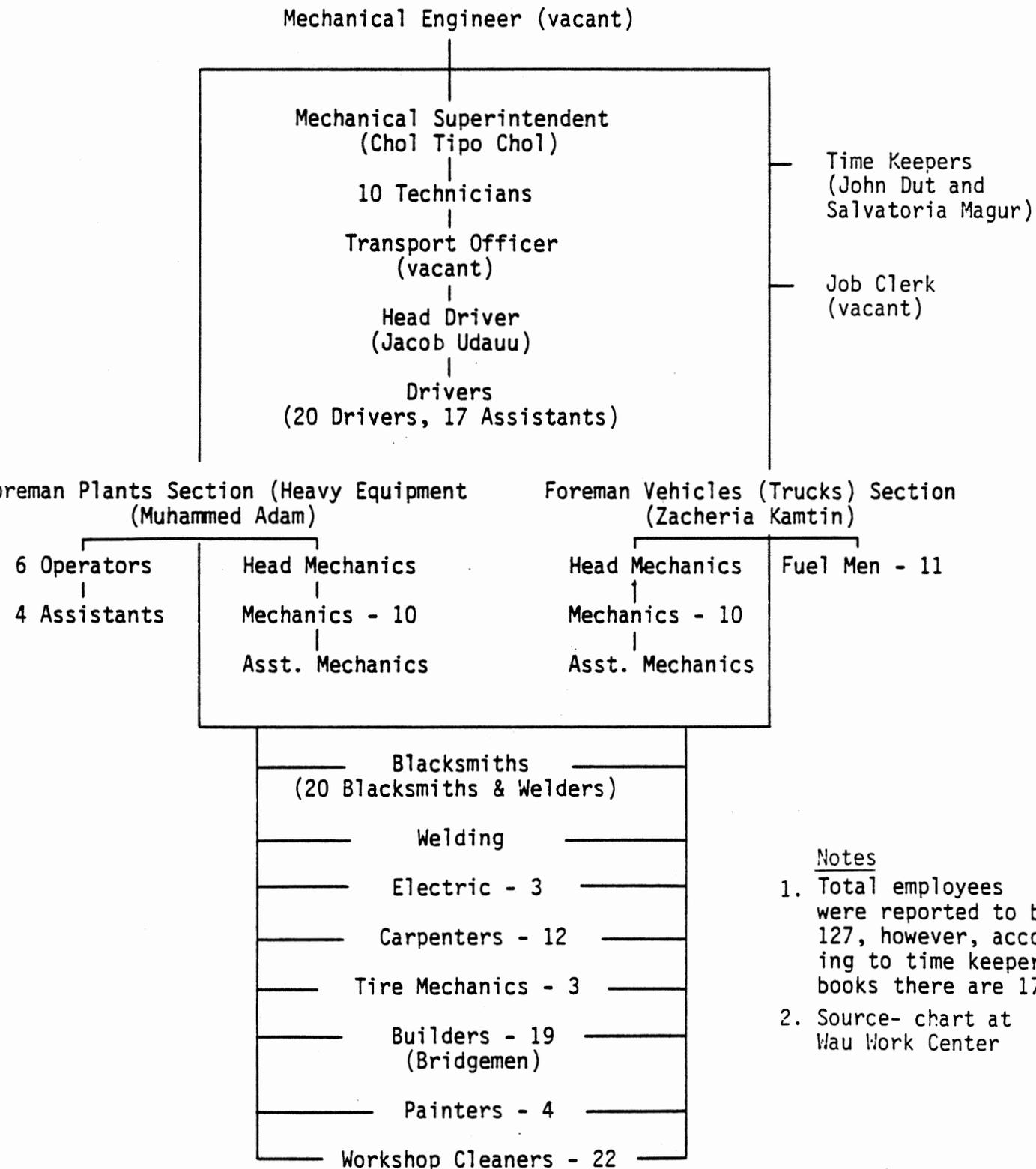
1-44



Note: Based on chart at Rumbek Workcenter.
Advised by John Ater that chart is outdated
but has not been revised.

Figure 1-41
 WAU ROAD DEPOT
 (Road Maintenance Equipment Workshop)

Personnel Organization Chart



Notes

1. Total employees were reported to be 127, however, according to time keepers books there are 179.
2. Source- chart at Wau Work Center

Table 1-4
ROAD MAINTENANCE ADMINISTRATION

<u>Title</u>	<u>Road Length Responsibility</u>
Headman	10 kilometers
Road Overseer	30 kilometers
Assistant Road Supervisor	60 kilometers
Road Supervisor	120 kilometers
Assistant Senior Road Supervisor	240 kilometers
Senior Road Supervisor	480 kilometers

Figure 1-42 shows the 29 "existing" road camps under the jurisdiction of Lakes Province. There are two overseers for the 12 camps between Rumbek and Tonj and three overseers and one road foreman for the 17 road camps between Rumbek and Mvola.

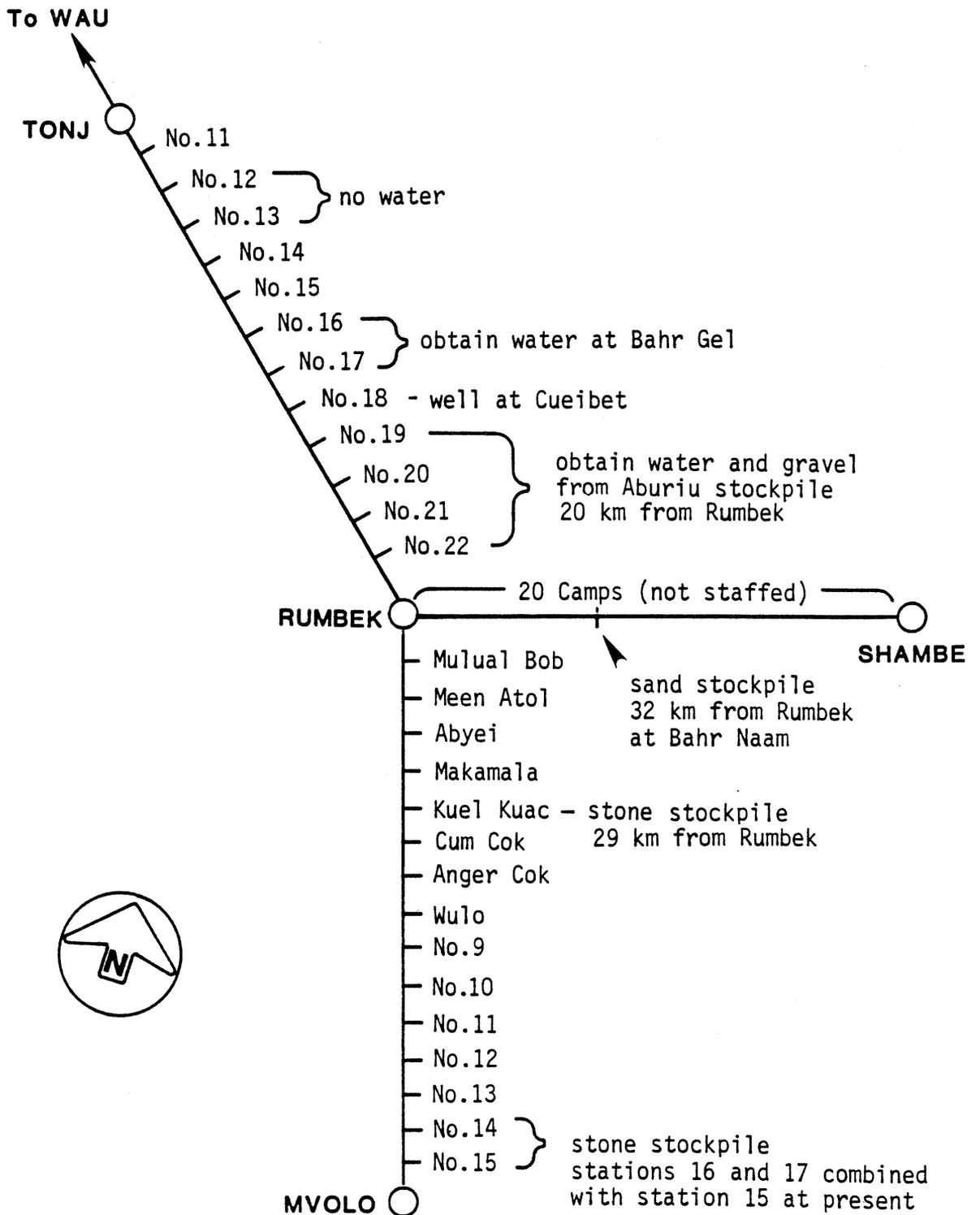
Evaluation of Current Organization and Staffing - One of the principles for good organization is that lines of authority and communication be clearly defined. Each employee should have only one immediate supervisor and decision making authority should be delegated to the lowest practical levels.

There are several areas at the provincial level that may have conflicting or unclear lines of authority. Perhaps the most significant is at the Assistant Commissioner level. He reports to the Deputy Director of Road Construction and Maintenance at the SRMTC Headquarters as well as the Provincial Commissioner. Conflicts in maintenance priorities can easily occur over maintenance programs for Trunk Roads (SRMTC responsibility) and Through or Feeder Routes (Provincial responsibility) as well as other areas such as personnel hiring and discipline.

Another area of possible conflict is the interface between road maintenance and equipment maintenance activities. Operators of road construction and maintenance equipment report to the supervisor of the equipment maintenance center rather than a road supervisor. The same situation holds true for builders and carpenters (responsible for bridges, culverts and buildings). The existing interface apparently occurs at the Assistant Commissioner level.

A closely related problem is the interface between the provincial work center and the road camps. Most of the headmen, overseers and foreman cannot read and write. Additionally, they have no means of transportation or communication with other camps or the work center other than traveling by foot from the various road camps where they live.

Vacancies at the assistant engineer positions contribute to these organizational/staffing problems.



LAKES PROVINCE

Road Maintenance Camps under Rumbek Administration

Figure 1-42

MANAGEMENT PROCEDURES

Reporting

Monthly progress reports and an annual report are prepared and sent to Juba by the Assistant Commissioner of Roads and Bridges, from which an annual budget is prepared by the Ministry. However, typical management activities such as planning, scheduling, directing and evaluating are practically non-existent for routine day to day road or equipment maintenance activities.

Communication between Provincial Work centers and road camps is poor. As previously mentioned road foremen and overseers must walk to the work center to collect pay and receive instructions. Communications between the SRMTC headquarters and Juba are similarly poor.

The typical headman cannot read or write, has little if any training in road maintenance techniques, and is unable or has no means of telling time to measure the work day. With no established schedules, plans or measurable goals and very little supervision, accountability is extremely poor. During the field evaluation period, only three crews were observed performing road maintenance activities along the project area, and one of those crews was not employed by the SRMTC. Based on observations and interviews, it is reasonable to conclude that only two to three hours of production work per week are being accomplished at the present time.

Stock Procurement & Control

Procurement is currently handled through the Regional headquarters in Juba. A local purchase order form is filled out by the division requesting supplies. Appropriate signatures to authorize the purchase are obtained and the purchase order is sent to a local vendor or Khartoum for purchasing. Usually at least two signatures are required to authorize purchases, these include the Minister of Finance and the Minister of the SRMTC. There is very little control over delivery times, as vendors, concerned over receiving payment, will not ship or release orders until they have received payment.

Once parts and supplies are received at the central workshop in Juba, the quantities are recorded in a cardex system. Stock withdrawals for materials used in the central workshop require approval of the workshop supervisor. Stock withdrawals for materials to be used at provincial workshops require the approval of the Director of the SRMTC.

ENVIRONMENTAL FACTORS

Annual precipitation in the project area averages approximately 100 centimeters (40 inches). This precipitation occurs almost exclusively during the rainy season which extends from April to October with the heaviest rainfall occurring in June and July. Maximum temperatures range from 37°C (98.6°F) during the months of January through March to 31°C (87.8°F) during the months of July through August. Mean temperatures range from 30°C (86°F), January through March, to 27°C (80.6°F) July through August.

During the rainy season a high water table and saturated ground conditions prevail. Since a majority of the project route is on flat grades, with little or no embankment, the road surface is highly susceptible to distortion, rutting and pot holes.

The dry season has higher temperatures and high evaporation rates. This contributes to the loss of fine surface material due to the action of traffic and winds. High evaporation rates are also detrimental to compaction efforts in construction and maintenance operations.

Another significant problem during the dry season is the inadequate sources of water for road camps. Road camps typically have hand dug wells that go dry periodically during the dry season. The water table fluctuates annually from a depth of approximately one meter (3.3 ft) during the rainy season to a depth of approximately seven to eight meters (23 to 26 ft) during the dry season. Many of the unoccupied road camps had inadequate wells.

Traffic volumes during the field evaluation period were estimated to be less than 10 vehicles per day. The majority of these vehicles were flatbed trucks used for transporting people between the major cities. Traffic volumes are reported to be lower during the rainy

season than during the rest of the year, due to impassable road conditions. With the low degree of economic development in the project area traffic volumes should remain fairly constant throughout the year. During the height of the rainy season, volumes may decline due to impassable road conditions.

BUDGETS

The inadequate roadway and equipment maintenance programs and the limited existing capability of the SRMTC stem to a large degree from the funding levels provided.

SRMTC laborers in road camps are still paid at the original wage rates established in 1972. Road workers interviewed in Bahr el Ghazal and Lakes Province earn 30 Sudanese piasters per day (100 piasters equals one Sudanese pound) or nine pounds per month. Prevailing wage rates for unskilled laborers in January 1982 were one pound per day with food and lodging and one and a half pounds (1.5L) per day without food and lodging. Additionally, the Road workers interviewed are rarely paid on time and had not been paid for two months at the time they were interviewed.

Government funds to purchase tools, spare parts and fuel are also limited, and consequently the flow of supplies to the provincial work centers and road camps is essentially non-existent.

The central workshop in Juba which is intended to serve as a central warehouse for the entire Southern Region has less than 1,000 line items in its inventory of which approximately 30 percent are obsolete.

SOCIAL/POLITICAL FACTORS

Although somewhat beyond the scope of an engineering analysis there are a number of social and political factors that may have contributed to the current condition of the road system including:

Lack of Experience and Recognition of Need

The Southern Region was established and given jurisdiction over internal affairs in 1972. Therefore, administration of the road system by the people of the Southern Region is a fairly recent development. The current "relaxed" attitude toward road maintenance may be a reaction to previous methods that forced those living next to the road to provide maintenance. The project road is currently used primarily for pedestrian traffic and the typical road workers may have difficulty visualizing the benefits to be derived from routine maintenance activities such as filling a pot hole.

Political Priorities

New projects are far more dramatic than maintenance, which is frequently viewed more as a drain on resources than as a benefit. As a consequence limited resources may be diverted away from maintenance activities.

Language Barriers

Although Arabic (the official language) and English are fairly common in the project area, a census taken prior to independence indicated that over 100 languages are spoken.

Illiteracy Rate

A large percentage (72 percent) of the population cannot read or write. Most headmen, the first line supervisory level, cannot read or write, and therefore directions and work reporting must be accomplished verbally.

Opportunities Abroad

Many of the most skilled and best educated Sudanese have left the Sudan for higher paying jobs in other countries such as Saudi Arabia. It has been estimated that out of a total population of approximately 18 million, one million work abroad.

Animal Traction

Use of oxen to pull plows and other farm implements has been successfully demonstrated at the USAID sponsored agricultural school in Rumbek but has not been accepted by local tribesmen whose high regard for their cattle has an almost religious significance. Small donkeys used to pull water carts in Juba, as illustrated in Figure 1-43, were the only examples of animal traction observed in the Southern Sudan.

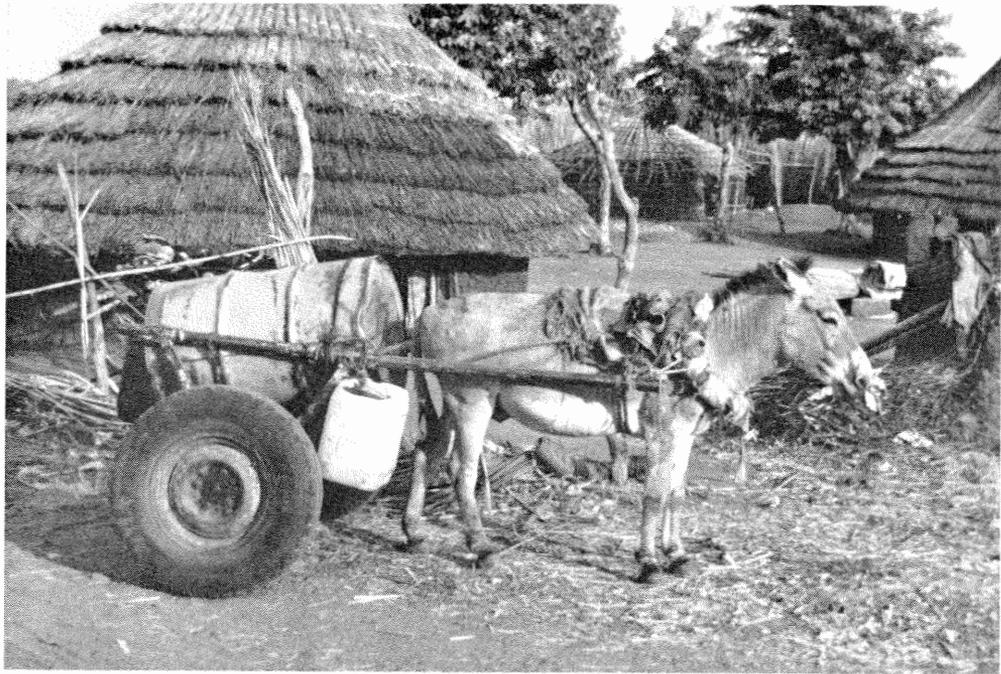


Figure 1-43: Animal drawn water trailer in Juba

CHAPTER 2 ROAD MAINTENANCE RECOMMENDATIONS

INTRODUCTION

The road maintenance recommendations contained in this chapter describe the program necessary to satisfactorily maintain the project route. These recommendations are based on the assumption that construction of the project route will be completed in substantial compliance with the design specifications. The project route will be a two-lane facility, surfaced with well graded laterite gravel that is adequately compacted.

Because of the current shortage of fuel, parts supplies, and trained mechanics, all necessary to keep road maintenance equipment operating, it is imperative that the routine road maintenance operations in the Southern Region be oriented toward labor intensive methods. However, there are certain routine activities which cannot be effectively accomplished without mechanical equipment.

Of primary concern in this regard, is the correction of corrugated surface conditions. While displaced fines can be swept into the corrugations relatively easily by hand, the rapid occurrence and reoccurrence of severe corrugations over long sections of road dictates the need for mechanized grading equipment, for routine blading and reshaping. Hauling equipment is also necessary for transporting aggregates, culvert pipe and water, particularly in view of the reluctance to use oxen for animal traction.

A balanced road maintenance program utilizing both labor intensive methods and mechanical equipment has therefore been developed. The development of this program involved the following steps:

- Determination of the work tasks necessary to satisfactorily maintain the project road.
- Preliminary selection of equipment types.

- Development of performance standards for each activity, describing the frequency, work method, labor, equipment, and material requirements and expected productivity rates.
- Estimating total annual manpower and equipment requirements, to develop an annual maintenance program.
- Conclusions and Recommendations.

WORK TASKS

A set of tasks was developed by first listing the general roadway elements that will require maintenance such as the roadway surface, drainage facilities, structures, roadside and road camp buildings. Next, maintenance requirements for each element were determined by identifying the causes and types of deterioration likely to occur and the actions necessary to correct the deterioration. For example, pot holes are caused by the action of traffic on areas with unsuitable surface material or weak, poorly drained subgrades. Correction requires removal of unsuitable material, improving the drainage if necessary and finally filling or patching the defect with suitable material.

The number of tasks must be large enough to cover and accurately describe the full range of work required, yet be small enough to permit easy record keeping by road camp personnel. This was accomplished by combining similar types of work. For example, the correction of pot holes, ruts, surface distortion and surface erosion can be combined into one task titled patching. Additionally to keep the number of tasks commonly used by the road camps to minimum, tasks that require mechanized equipment or specialized personnel (such as builders) were listed separately. The letter prefix "H" was used to designate hand maintenance tasks to be performed by road camp workers. The letter "M" was used for tasks requiring mechanical equipment. The letter prefix "B" was used for tasks performed by builders, and the letter prefix "A" was used for administrative tasks.

The final step in the determination of work tasks is the selection of work units that can be easily used for measuring the amount of work accomplished and estimating future requirements. Table 2-1 shows the recommended list of tasks and work units.

PRELIMINARY EQUIPMENT SELECTION:

Before performance standards can be developed, it is necessary to tentatively identify the types of equipment that may be required since productivity rates will depend upon the type of equipment used. For example, routine blading can be accomplished more rapidly and effectively with a motor grader than with a drag pulled by an agricultural tractor or dump truck.

The following types of equipment were selected to for use in developing of performance standards:

Agricultural or Industrial Tractors

These units are highly versatile and can be equipped with a wide assortment of attachments. Tractors can be used for routine blading, grading and pulling scarifiers, compaction equipment or small trailers for transporting personnel and materials. They can also be equipped with loader or backhoe attachments for trenching or stockpiling purposes.

Motorgraders

Even with an extended wheel base and underbody blade, the agricultural tractor cannot match the performance of a small to medium sized motor grader. The cutting action required for reshaping the roadway surface necessitates the use of motor graders.

Dump Trucks

Trucks are necessary for hauling large quantities of aggregate, and pulling trailers capable of transporting water tanks, tractors and other supplies.

Table 2-1
WORK TASKS

	TASK NUMBER	NAME	UNITS
SURFACE MAINTENANCE - HAND	H-1	Hand Stockpiling	Cubic Meters
	H-2	Hand Hauling	Cubic Meters
	H-3	Hand Patching	Cubic Meters
	H-4	Hand Spreading	Cubic Meters
	H-5	Hand Sweeping	Kilometers
	H-6	Hand Scarifying	Meters
SURFACE MAINTENANCE - MACHINE	M-1	Blading	Kilometers
	M-2	Reshaping	Kilometers
	M-3	Hauling	Cubic Meters
	M-4	Stockpiling	Cubic Meters
DRAINAGE FACILITY MAINTENANCE	H-7	Hand Ditching	Meters
	H-8	Cleaning Culverts & Bridge Drains	Each
	H-9	Erosion Repair	Cubic Meters
	B-4	Installing Underdrain	Each
STRUCTURE MAINTENANCE	B-1	Minor Repair to Structures	Square Meters
	B-2	Culvert Pipe Replacement	Pipe Section
	B-3	Making Culvert Pipe	Pipe Section
	B-5	Stockpiling Sand	Cubic Meters
ROADSIDE & SHOULDER MAINTENANCE	H-10	Brush Cutting	Meters
	H-11	Digging Soil for Huts	Cubic Meters
	H-12	Building Mud Huts	Each
ROADCAMP MAINTENANCE	H-13	Rethatch Hut Roof	Each
	A-1	Supervision	Employee Hours
ADMINISTRATION & OVERHEAD	A-2	Approved Leave	Employee Hours
	A-3	Equipment Maintenance	Employee Hours
	A-4	Overhead	Employee Hours

Utility Trailers

Trailers pulled by dump trucks are necessary for hauling water tanks, agricultural tractors, or other equipment and supplies.

Bulldozer

A track-type tractor with bulldozer blade and ripper attachment may be necessary for excavating and stockpiling activities.

Truck-Tractor and lowbed trailer

Depending upon the size of the crawler tractor a truck-tractor with lowbed trailer may be necessary. The low bed trailer can also be used for transporting disabled trucks and motor graders or hauling water tanks.

Water Tanks

Dry surface materials cannot be properly compacted without wetting. Water tanks equipped with gravity fed spray bars are necessary for wetting the roadway surface during reshaping operations. Tanks should be capable of being loaded on dump trucks, utility trailers or the low bed trailer.

Water pumps

Pumps are necessary for filling and refilling water tanks.

Fuel Trailers

It is anticipated that most equipment will be based in Rumbek. Since travel times to outlying road camps will require several hours, equipment assignments should be for several days or weeks at time. This will necessitate mobile refueling capability.

PERFORMANCE STANDARDS

The basic organizational unit of the road maintenance system is the road camp. Each road camp performs routine maintenance on a 10 kilometer section of roadway with a staff of six to 11 roadworkers supervised by a headman.

A serious problem with the existing road maintenance system is the lack of accountability for work performed, and the corresponding lack of productivity. The typical road camp does not work a full day due, at least in part, to the fact that the headman, overseers and road foreman have no means to time a seven hour day and few standards to judge the amount of work that should be performed. Standards for productivity such as that currently used for stockpiling (one man should make one pile of stone one meter high and one meter wide in one day's work) are needed for each task to serve as a gauge for a day's work. This an important function of performance standards.

Additionally, performance standards should describe the most effective method for properly performing the work, including when the work should be performed, and the tools, manpower and materials necessary. While performance standards are not a substitute for adequate supervision, they are a important tool for planning, scheduling and evaluating work programs, and form the foundation for necessary training programs.

In developing performance standards, it is important that realistic productivity rates be used. If the expected performance is too high, work programs will not meet the goals established, workers will become discouraged and substandard productivity will become normal behavior. If expected performance is too low, work programs will be wasteful and inefficient.

The expected performance or productivity rates developed in this report have taken into account the poor nutrition, characteristic of the local population, and the extremely hot weather conditions. While the rates are considerably lower than those originally prepared by USAID, they represent a significant increase over the performance observed.

The assumptions used to develop the performance standards for each task are discussed below, and the performance standards are presented in Appendix A. Road camps were assumed to have a staff of six workers and one headman. Working six hours per day (6:30 am to 2:30 pm with a one hour break and an average of one hour for travel).

Hand Tasks

The following tasks are to be performed with hand labor supplied from road camps.

Task H-1: Hand Stockpiling - High quality material is essential for making lasting repairs to surface defects. This task includes locating laterite outcroppings, excavating and breaking laterite stones with hand tools, and piling the material. For routine patching the finished material should be a blend ranging from a maximum size of two centimeters (one inch) to very fine particles. For protecting areas subject to erosion, stones 20 to 30 centimeters (8 to 12 inches) in diameter should be stockpiled.

The productivity rate currently used in Lakes Province requires that approximately one cubic meter be excavated and piled per man day of labor. Assuming that it takes roughly the same amount of time to break the stones, a production rate of 0.5 cubic meters (0.65 Yd³) per man day can be expected, or three cubic meters (4 Yd³) per day per road camp.

Task H-2: Hand Hauling - This activity includes loading laterite aggregate into dobbin borrows, transporting the material to a point near the worksite and dumping or unloading the material beside the roadway.

A dobbin borrow (see Figure 2-1) manned by two workers can haul approximately 0.25 cubic meters of gravel. Assuming that two or three men can load the dobbin borrow, in 0.25 hours or less, and move the loaded dobbin borrow at a rate of 500+ meters (1650 ft) per hour, then the following performance can be expected from a road camp with two dobbin borrows.

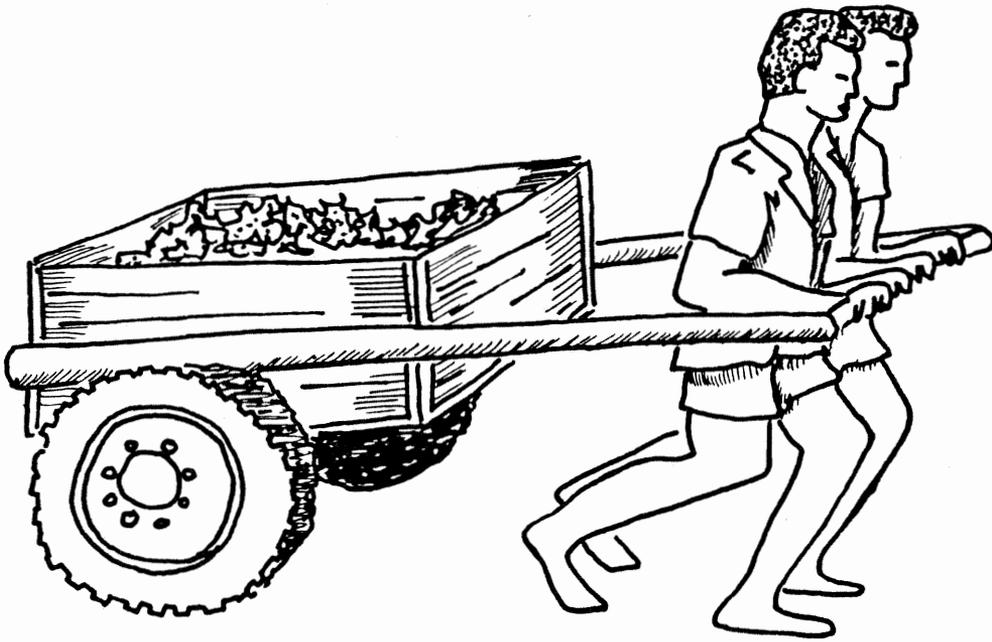


FIGURE 2-1 DOBBIN BORROW

<u>Distance</u>	<u>Quantity per six men</u>	<u>Quantity per man</u>
0.10 Km	6 m ³	1.0 m ³
0.25 Km	4 m ³	.67 m ³
0.50 Km	2 m ³	.33 m ³
1.00 Km	1 m ³	.17 m ³

Hand hauling for distances in excess of one kilometer should be performed only when mechanical equipment (dump trucks or agricultural tractors) is unavailable. Whenever mechanical hauling equipment is not engaged in reshaping, drainage facility repair or other tasks, it should be utilized to establish small stock piles along the project route to reduce hand hauling distances. If small piles of approximately eight to 10 cubic meters (10 to 13 Yd³) are placed every kilometer the maximum hand hauling would 0.5 kilometers (1650 feet) and the average hand hauling distance would be 0.25 Kilometers (825 feet).

Task H-3 Hand Patching - Repair of surface defects such as ruts, pot holes and depressions are included in this task as well as investigation and correction of the cause of the problem. Repair corrugations is not included in this task. Work should be performed on a year round basis as soon as possible after the defect is discovered to prevent deterioration of the surrounding roadway. Assuming that three workers can load and spread 0.25 cubic meters (0.33 Yd³) of aggregate in 0.5 hours, including removal of unsuitable material from the defect and compaction of the "new" material, a road camp with six workers should be expected to place three cubic meters per day using material previously hauled to a point near the worksite.

Task H-4 Hand Spreading - This task involves adding material to areas with insufficient surface aggregate or inadequate crown, when mechanical equipment is not available for reshaping. It should be performed prior to the rainy season so that the surface will drain properly and have adequate strength to support traffic with saturated ground conditions,

and again after the rainy season to repair any damage that may have occurred. Hand spreading is also necessary immediately prior to mechanical reshaping.

Using material previously hauled to the worksite, material is spread across the roadway with shovels and raked to reshape the crown and provide a smooth surface. Expected performance is two cubic meters per man day or 12 cubic meters per crew of six workers.

Task H-5 Hand Sweeping - As surface corrugations are formed, the fine aggregates are displaced by traffic and windrowed along the sides of the wheel paths and the very fine aggregates are lost in the form of dust. The loose fines can be easily swept into the corrugations by hand as a temporary solution. It is assumed that this task can be performed at a rate of one kilometer per man day or six kilometers per day for the typical road camp with six workers.

Unfortunately, the loose fines will be quickly displaced, and therefore, this task should only be performed when mechanical grading equipment is not likely to be available for extended periods of time. The wheel path corrugations are well compacted and can be satisfactorily corrected only by cutting below the corrugations, mixing and recompacting the surface material.

Task H-6 Hand Scarifying - As with Hand Sweeping, this task should only be performed when mechanical grading equipment is not available. The purpose of this task is to mix loose fines back into the road surface. The task can only be performed after a moderate rainfall has occurred, while the surface is still firm, but moist enough to be penetrated with a rake. Work is accomplished by scarifying the surface to a depth of two to three centimeters (one inch), mixing in loose fines and pulling the material toward the center of the road to form a crown. It is assumed that 20 meters (65 feet) of roadway, 6.5 meters wide, can be scarified by one man in a day. The expected performance for a six man road camp is approximately 120 meters (400 feet) of roadway per day.

Task H-7 Hand Ditching - The removal of silt from roadside ditches and flyoffs (lateral drains that provide an outlet for roadside ditches and convey runoff away from the roadbed) should be performed routinely before and during the rainy season to prevent saturation of the road bed.

The material deposited in ditch lines is generally loose unconsolidated soil which can be shoveled easily and spread on the surrounding ground. Assuming that the material can be removed at a rate four cubic meters per man per day, one man could remove silt, eight centimeters (3 inches) deep from approximately 80 meters (260 feet) of ditchline ("vee" ditch with 4 to 1 sideslopes). A crew of workers should accomplish 480 to 500 meters (1600 to 1650 feet) of ditch per day.

This task would also include removal of obstructions such as logs, rocks or other debris from the ditchline.

Task H-8 Cleaning Culverts and Bridge Drains - This involves removal of silt and debris from culverts and bridge scuppers. Material can be removed from culverts by hand shoveling, if the culvert is large enough, or by pulling a bucket or similar device through the culvert with a rope. While the amount of work required for any one structure can vary from little or none to several days of work, it is assumed that a crew of six workers can clean an average of three culverts per day. Culverts should be cleaned at least twice a year, once prior to the rainy season and as often as necessary during the rainy season.

Task H-9 Erosion Repair - Washouts represent a significant hazard to vehicles using the road and can also lead to significant damage to nearby structures. Erosion repair is routine maintenance which should be performed as soon as possible to prevent a particular condition from becoming more severe. Repairs should also include installation of rip rap, large stones 20 to 30 centimeters (8 to 12 inches) in diameter, to prevent a recurrence. Laterite aggregate should be placed in seven to 10 centimeter (three to four inch) layers, with each layer being compacted by hand tamping. It is assumed that 1.5 cubic meters can be placed per man day. The expected performance for a six man crew would therefore be nine cubic meters per day.

Task H-10 Brush Cutting - Grass and brush growing along the roadside and ditchlines should be trimmed to provide visibility along curves, at intersections and signs, to maintain drainage characteristics and to permit access to structures for inspection and cleaning. Assuming that trimming is required for a width of three meters (10 feet) on both sides of the road, and that one man can cut 600 square meters (6300 sq. ft.) per day, one man can cut brush along both sides of the road for a distance of 100 meters (330 feet) and a road camp with six workers can cut brush along 600 meters (1980 feet) of roadway per day. Brush cutting is a routine maintenance task required several times per year depending upon rainfall.

Task H-11 Digging Soil for Huts - The purpose of this task is to provide soil for repairing and building mud huts at the road camps. The task should be performed during periods when the workload for other tasks is low. It is assumed that soil can be excavated at a rate of 2 cubic meters (2.6 Yd³) per man day or 12 cubic meters (15.6 Yd³) per six man crew day. A hut approximately four meters (13 to 14 feet) in diameter will require 10 cubic meters (13 Yd³) of soil, and therefore a road camp should be able to excavate the soil for one hut in one day.

Task H-12 Building Huts - It is assumed that the mud walls for one hut can be built in five days by a crew of six workers. This task includes cutting poles to reinforce the walls and frame the roof, erecting poles and mixing and placing the mud to form the hut walls.

Task H-13 Rethatch Hut Roof - It is assumed that a thatched roof can be constructed or rethatched in two work days by a crew of six workers. Gathering and preparing materials is included in this task.

Mechanical Equipment Tasks

The following tasks will require the use of mechanized construction and maintenance equipment.

Task M-1 Blading - This task requires the use of a motorgrader or agricultural tractor. The blade is used for scraping and smoothing the roadway surface rather than cutting into the surface. In fact care should be taken to avoid breaking the compacted crust of the surface. While blading improvements are not long lasting, the task can be performed rapidly and results in a significant temporary improvement to the riding quality of the road surface.

At a working speed of 10 km per hour (6 mph), a motor grader can make two passes over 30 km (18 m.) of roadway in one day. A tractor would require four passes and could cover 15 km (9 mi) per day.

It is assumed that blading will be required four to six times per year.

Task M-2 - Reshaping - This task involves scarifying, remixing, reshaping and compacting the roadway surface. Ditchlines can also be graded at the same time. A cutting action is required to loosen compacted surface material to a depth below existing surface defects. A small or medium size motor grader is required for this task as well as equipment for compaction and wetting of the surface. The general sequence of activities and equipment requirements are listed below:

<u>Activity</u>	<u>Equipment</u>	<u>Coverage</u>	<u>Passes</u>
ditching	grader	once each side	2
scarifying	grader	once	4
wetting	truck w/ water trailer	once	2
grading	grader	twice	4
wetting	truck	once	2
compacting	tractor w/ compactor	once	4
fine grading	grader	once	2
compacting	tractor	twice	4

Production rates will depend primarily on the motorgrader's speed and efficiency. Wetting will generally not add to the reshaping time since the truck can travel ahead of the grader. Final compacting can be performed while the grader is ditching and scarifying the next section. To limit loss of moisture, it is highly recommended that reshaping be performed in short sections of approximately 200 meters (660 feet) at one time. With grader speeds of 10 kilometers per hour (six mph) and tractor speeds of eight kilometers per hour (five mph) a 200 meter section can be reshaped in 0.34 hours. Therefore, expected daily performance would be 3.5 Kilometers (2.2 miles) per day.

Equipment and equipment operators would be provided from the provincial capitol (Rumbek). Workers necessary for removing large rocks, providing traffic control or other support should be provided by local road camps as the operation passes through their area of responsibility.

Task M-3 Mechanical Hauling - Hauling rates will depend upon loading time, distance and travel speed. A truck with a three cubic meter (4 Yd^3) dump bed can be loaded in approximately 20 minutes by an agricultural tractor with a front end loader attachment. Hand loading by a crew of six workers would require approximately one hour. With an average travel speed of approximately 20 kilometers per hour (12 mph), a 10 kilometer round trip with loaded truck would require one and half to two hours per load depending on loading method.

Expected daily performance would therefore be nine to 12 cubic meters ($12 \text{ to } 16 \text{ yd}^3$) per truck per day for a 10 kilometer round trip.

Task M-4 Mechanical Stockpiling - A crawler type tractor with bulldozer blade and ripper can be used for excavating and breaking laterite stone to form an aggregate blend suitable for surface maintenance. Production rates will depend upon travel time to reach the site, the size of the machine and the amount of top soil which must be stripped. However for estimating purposes it is conservatively assumed that 100 cubic meters (130 Yd^3) can be produced per machine per day.

Builder Tasks

The following tasks require specialized or skilled labor, and will be performed by builders from the provincial maintenance headquarters.

Task B-1 - Minor Repairs to Structures - This task includes all minor repairs to concrete culverts, bridges, headwalls and other drainage structures. Work will be performed by builders and assistant builders with concrete finishing experience. For estimating purposes the expected performance is assumed to be two square meters (2.4 square yards) per day by a crew of four builders and one head builder.

Task B-2 - Culvert Pipe Replacement - This task will also be performed by builders from the provincial headquarters. A crew of six builders, one equipment operator and the head builder should be able to install an average of two sections, approximately one meter (3.3 ft) long of 0.5 meter (1.65 ft) diameter reinforced concrete pipe in a day. A truck would also be required for transporting pipe and other supplies.

Task B-3 Make Culvert Pipes - Reinforced concrete culvert pipe should be made routinely to maintain a stock of 10 to 15 sections. It is assumed that one builder and two workers could make two sections of pipe in one day.

Task B-4 Installing Underdrains - Areas in the roadway, where the subgrade does not drain properly will lack structural strength and be susceptible to rutting, pot holes and other defects. These areas should be drained by the installation of a French drain or perforated underdrain pipe.

Installation of underdrain is a task that should be assigned to the provincial builders. Six workers and a tractor with operator, supervised by a head builder should complete one installation a day or approximately 10 meters (33 feet) per day.

Task B-5 Stockpiling Sand - River sand is typically used only by the builders. Stockpiling, washing and screening sand should therefore be a responsibility of the specialized building crew. Since the builders will have good access to hauling equipment the 32 kilometer (20 mile) haul distance to Rumbek should not be a problem. The expected performance should be at least six cubic meters (eight cubic yards) per crew day including loading, screening and stockpiling.

Task A-1 Supervision - Supervisory personnel from road overseer through the manager of the road maintenance division should devote their time to planning, scheduling and directing the work program. This task provides a means for accounting for time devoted to supervision and other management functions.

Task A-2 Approved Leave - This task is necessary to account for 100 percent of an employees time in pay status. It includes sick, vacation and holiday leave.

Task A-3 Equipment Maintenance - Drivers and operators assigned to the road maintenance division should be required to perform certain preventive maintenance services to their vehicles.

Task A-4 Overhead - This task includes training and other overhead activities.

ANNUAL WORK PROGRAM

The annual work program requirements can now be determined by estimating the average workload for each task and applying the expected performance rates developed as part of the performance standards. The performance rates for each task are shown in Table 2-2..

Material Requirements

The Annex G - Technical Analysis prepared by USAID staff on the Southern Sudan references a 1974 report for the Sudan Roads and Bridges

Table 2-2
TASK PERFORMANCE RATES

	TASK NUMBER	NAME	UNITS	EXPECTED PERFORMANCE
SURFACE MAINTENANCE - HAND	H-1	Hand Stockpiling	Cubic Meters	1/2 m ³ per man per day
	H-2	Hand Hauling	Cubic Meters	1 m ³ hauled 100 m per man per day
	H-3	Hand Patching	Cubic Meters	1 m ³ per man per day
	H-4	Hand Spreading	Cubic Meters	2 m ³ per man per day
	H-5	Hand Sweeping	Kilometers	1 km of roadway per man per day
	H-6	Hand Scarifying	Meters	20 m or roadway per man per day
SURFACE MAINTENANCE - MACHINE	M-1	Blading	Kilometers	30 km of roadway per motor grader per day OR 15 km per tractor per day
	M-2	Reshaping	Kilometers	3.5 km of roadway per crew per day
	M-3	Hauling	Cubic Meters	12 m ³ over 10 km per day using front end loaders 9 m ³ over 10 km per day using hand labor
	M-4	Stockpiling	Cubic Meters	100 m ³ per day
DRAINAGE FACILITY MAINTENANCE	H-7	Hand Ditching	Meters	80 m per man per day
	H-8	Cleaning Culverts & Bridge Drains	Each	3 culverts and/or bridges per crew per day
	H-9	Erosion Repair	Cubic Meter	1 1/2 m ³ of material placed per man per day
	B-4	Installing Underdrain	Each	1 underdrain installation per crew per day
STRUCTURE MAINTENANCE	B-1	Minor Repairs to Structures	Square Meters	2 m ² of concrete patch per crew per day
	B-2	Culvert Pipe Replacement	Pipe Section	2 culvert pipe sections per crew per day
	B-3	Making Culvert Pipe	Pipe Section	2 pipe sections per crew per day
	B-5	Stockpiling Sand	Cubic Meters	6 m ³ per crew per day
	ROADSIDE & SHOULDER MAINTENANCE	H-10	Brush Cutting	Meters
H-11		Digging Soil for Huts	Cubic Meters	2 m ³ per man per day
H-12		Building Hut Huts	Each	1 hut per crew in five days
H-13		Rethatch Hut Roof	Each	1 hut per crew in two days
ROAD CAMP MAINTENANCE	A-1	Supervision	Emp. Hours	N/A
	A-2	Approved Leave	Emp. Hours	N/A
	A-3	Equipment Maintenance	Emp. Hours	N/A
	A-4	Overhead	Emp. Hours	N/A
ADMINISTRATION & OVERHEAD	A-1	Supervision	Emp. Hours	N/A
	A-2	Approved Leave	Emp. Hours	N/A
	A-3	Equipment Maintenance	Emp. Hours	N/A
	A-4	Overhead	Emp. Hours	N/A

Public Corporation (RBPC). The report contains an analysis of the reshaping, patching and replenishing requirements for 3.75 meter (12.4 ft.), 5.00 meter (16.5 ft) and 6.0 meter (19.8 ft) unpaved road surfaces. These requirements were projected as follows by USAID to meet the needs of the 6.50 meter (21.45 ft) project road. Total material losses with existing traffic volumes of 10 to 15 ADT were projected to be 23.8 cubic meters per kilometer (51.6 yd³/mile). Hand patching requirements were assumed to be 10 percent of total material losses or 2.4 cubic meters per kilometer (5.2 yd³/mi).

By projecting that 10 percent of total surface material losses are also replaced by hand, spreading an additional 2.4 cubic meters per kilometer (5.2 yd³/mi) of laterite aggregate will be required.

Although erosion did not appear to be a significant problem, a nominal amount of material must be estimated for erosion repairs. It is assumed that four cubic meters per kilometer (8.7 yd³/mi) will be required. This brings total annual surface material requirements to 8.8 cubic meters per kilometer (19 yd³/mi).

Other materials requirements for routine maintenance include perforated pipe for underdrains, portland cement, sand, gravel and reinforcing steel for repairing or fabricating concrete pipe and drainage structures and for minor repairs to bridges and box culverts.

Equipment Requirements

The time requirements and number of units for each type of equipment are discussed below:

Motorgraders - Motorgraders are primarily required for reshaping. With an expected performance of 3.5 kilometers (2.1 miles) per day per grader, 262 machine days are required for reshaping the entire project route twice a year. Reshaping should not be performed when it is extremely dry or extremely wet. Therefore, the reshaping operation should be performed at the beginning and at the end of the rainy season. Because of the relatively short period of time available, at least two new units should be acquired. The existing grader at Rumbek should be rehabilitated and used primarily as a spare.

Dump trucks - Dump trucks with utility trailers are necessary for hauling materials and hauling or towing water tanks to aid compaction during the reshaping operation. Four trucks are required for wetting the road surface, two for each of the reshaping crews. A fifth dump truck is necessary as a spare and for towing a fuel trailer. Dump trucks with water tanks/trailers are recommended in lieu of tanker trucks for flexibility and versatility. The five trucks can easily accommodate material hauling requirements during the months when reshaping is not underway. Water tanks can be fabricated to mount in the dump bed or on trailers. The trailers can be used for hauling water tanks, aggregate hoppers, equipment or personnel.

Agricultural or Industrial Tractors - Agricultural type tractors are proposed for pulling compaction equipment during the reshaping operation. Tractors are proposed in lieu of rollers for flexibility and versatility. During periods when reshaping is not underway tractors can be used for blading, hauling, loading or many other functions. To provide an essential spare for the two units assigned to reshaping, three units are proposed.

Crawler Trailer - A Track-type tractor with ripper and bulldozer in repairable condition was located near Rumbek at the time of the maintenance field evaluation. This unit can be utilized for stockpiling aggregate. The annual material requirements for the project road can be met with this unit in just 40 working days. On this basis, it would be difficult to justify a new unit for routine maintenance of the project road only.

Should a new unit be required, a somewhat smaller unit, equivalent to Caterpillar D-4 should be acquired. The smaller unit offers several advantages without a great loss in productive capability. The smaller unit would not require a low bed trailer for transport but could be towed on a utility trailer pulled by a dumptruck. A smaller dozer could also be used for grading flyoffs, spreading aggregate and other similar functions.

Truck Tractor - A truck tractor with lowbed trailer is also somewhat difficult to justify on the basis of utilization. However, one unit is recommended for transporting the track-type tractor, disabled trucks and motor graders and for serving as a spare water truck for reshaping operations. With portable aggregate hoppers the unit could also haul sand or lateritic gravel.

Other Equipment - Other types of equipment necessary include at least three water pumps, two fuel trailers, two pickup trucks for senior supervisory personnel, bicycles for road overseers, and a field service truck for equipment repairs at the worksite.

Hand Tools - Recommended hand tools for each road camp are listed in Table 2-3.

Labor Requirements

Equipment Operators - The recommended road maintenance fleet will initially consist of approximately 12 pieces of motorized equipment. To insure full utilization of this equipment it will be necessary to provide more than 12 operators to allow for any leave of absence such as sick time, vacation time, or personnel turnover that may occur.

Five heavy equipment operators are required to operate the three motor graders, the truck-tractor with lowbed trailer and the track-type tractor (bulldozer). Since the same operator can run both the truck-tractor and the bulldozer, and one motor grader will be utilized primarily as a spare, five heavy equipment operators should provide sufficient flexibility.

Eight drivers and four light equipment operators are necessary to operate the five dump trucks and three agricultural/industrial tractors. Two head drivers are also necessary for supervising the reshaping crews.

It is believed that there are currently 15 drivers, assistant drivers or head drivers, and six heavy equipment operators or assistant equipment operators at Rumbek. With adequate training the labor requirements for operators and drivers can be met with existing personnel.

Table 2-3
RECOMMENDED TOOL LIST FOR EACH ROAD CAMP

<u>Tool</u>	<u>Number Required</u>
Dobbin Barrow	- 2
Water Drum 200 liter (55 U.S. Gallon)	- 2
Shovel round point	- 6
Shovel square point	- 3
Rake garden	- 6
Slasher	- 6
Pick	- 3
Pry Bar	- 3
Sledge Hammer	- 3
Masonry Chissel	- 3
Long Bristle Push Broom	- 6
Hand Tamper	- 2
Toria	- 2
Water Bucket 9.5 liter (2.5 Gallon)	- 2
Bush Axe (bill hook)	- 2
Rope 10 meter (33 feet)	- 1
Sharpening Stone	- 2
Crown Board with Level	- 1
Watering Can 9.5 liter (2.5 Gallon)	- 2

Road Camps - Under the existing staffing formula, the 457 kilometer (274 mile) project route should have 45 road camps as shown in Figure 2-2. With six workers and one headman per camp the available labor (excluding headmen) is 76,410 mandays per year based on 283 working days, per man (365 days per year less 82 days for Sundays, Holidays and leave).

Estimated manpower requirements for each task requiring road camp labor are calculated on Table 2-4. The estimated requirements indicate a potential "surplus" of 19 working days per man per year. Depending on the effectiveness of blading and reshaping operations it is possible that additional unassigned time may be generated by reducing requirements for hand scarifying and hand sweeping. However, a surplus will provide flexibility and is necessary for the following reasons:

- Dividing annual requirements into full crew days results in a slight increase due to rounding. Approximately 269 full crew days are required.
- Labor requirements are somewhat seasonal, with heaviest work loads occurring during and immediately before and after the rainy season.
- Mechanical breakdowns and fuel shortages may reduce equipment availability thereby increasing hand hauling distances and the need for hand sweeping, hand scarifying and hand ditching.
- Expected performance rates or annual workloads may require adjustment depending on annual variations in the weather or other factors.
- The SRMTC personnel represent the only road maintenance organization in the project area, and therefore it is reasonable to assume that some maintenance for provincial roads will be provided by the SRMTC.

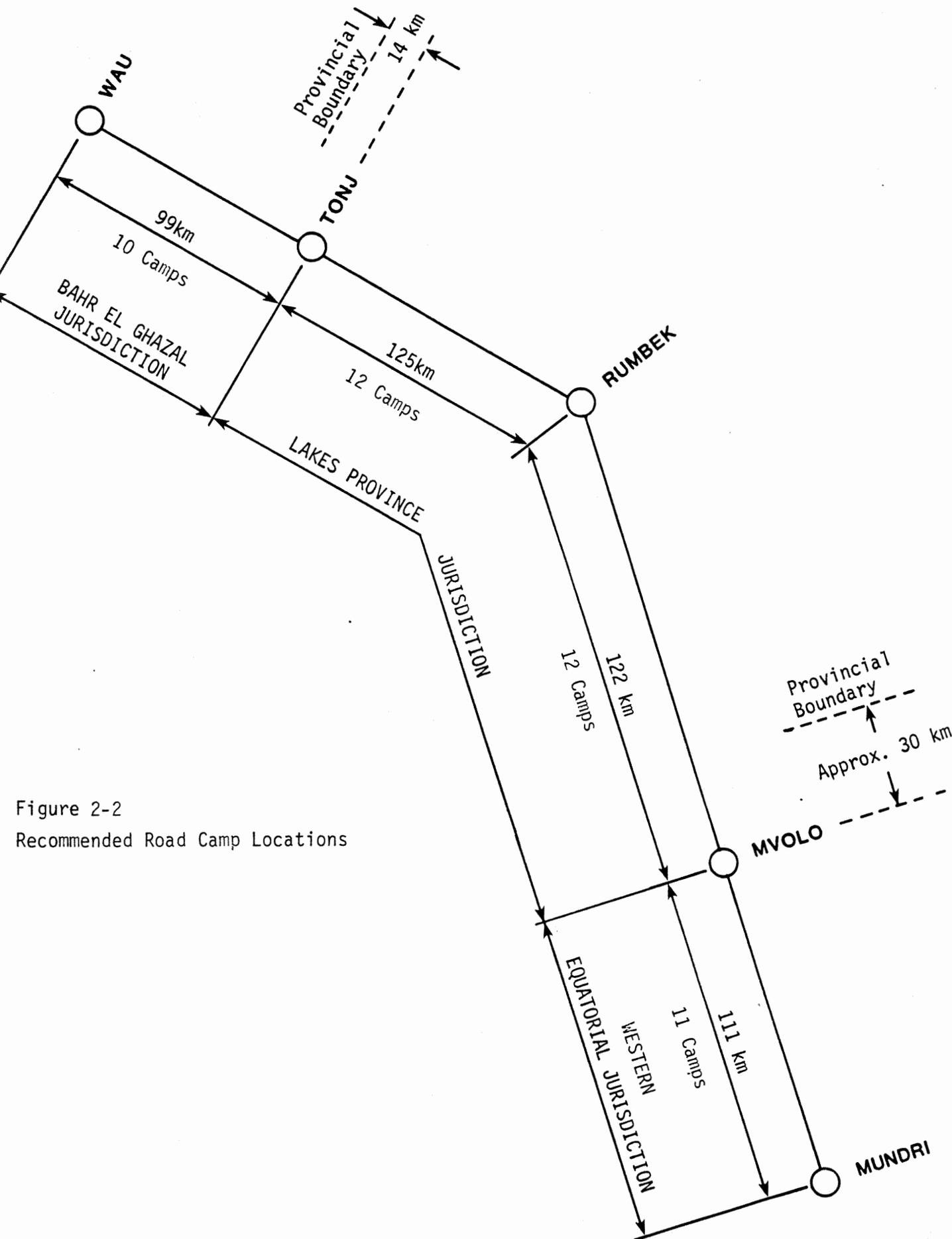


Figure 2-2
Recommended Road Camp Locations

Table 2-4
ANNUAL ROAD CAMP LABOR REQUIREMENTS

NO.	TASK NAME	COMPUTATION	ANNUAL REQUIREMENT IN MANDAYS (MD)	COMMENTS
H-1	Hand Stockpiling	$8.8 \text{ m}^3/\text{km} \times 457 \text{ km} \div 0.5 \text{ m}^3/\text{manday}$	8,043 MD	Material requirements for Hand Patching, Spreading and Erosion
H-2	Hand Hauling	$8.8 \text{ m}^3/\text{km} \times 457 \text{ km} \div 0.67 \text{ m}^3/\text{manday}$	6,002 MD	Assume stockpiles at 1 km intervals, average haul 0.5 km
H-3	Hand Patching	$2.4 \text{ m}^3/\text{km} \times 457 \text{ km} \div 1 \text{ m}^3/\text{manday}$	1,097 MD	10% of annual material losses
H-4	Hand Spreading	$2.4 \text{ m}^3/\text{km} \times 457 \text{ km} \div 2 \text{ m}^3/\text{manday}$	548 MD	10% of annual material losses
H-5	Hand Sweeping	$457 \text{ km} \times 1 \text{ time/year} \div 1 \text{ km/manday}$	457 MD	Assume entire roadway length swept once per year
H-6	Hand Scarifying	$457 \text{ km} \times 1/2 \times 1 \text{ times/year} \div .02 \text{ km/manday}$	11,425 MD	Assume 1/2 roadway length is hand scarified annually
H-7.	Hand Ditching	$457 \text{ km} \times 2 \text{ sides} \times 2 \text{ times/year} \div .08 \text{ km/manday}$	22,850 MD	Assume ditches are cleaned twice each year
H-8	Clean Culverts and Bridge Drains	$80 \text{ struct.} \times 2 \text{ times/year} \div 3 \text{ struct./days} \times 6 \text{ men/crew}$	320 MD	Assume 80 structures cleaned twice each year
H-9	Erosion Repair	$4 \text{ m}^3/\text{km} \times 457 \text{ km} \div 1.5 \text{ m}^3/\text{manday}$	1,219 MD	Assume nominal material requirements of $4\text{m}^3/\text{km}$
H-10	Brush Cutting	$457 \text{ km} \times 3 \text{ times/year} \div .1 \text{ km/manday}$	13,710 MD	Brush cutting 3 m wide each side, 3 times/year
H-11	Digging Soil for Huts	$12 \text{ m}^3 \div 2 \text{ m}^3/\text{manday} \times 45 \text{ camps}$	270 MD	Assume hut 4.2 m in diameter, walls 0.45 m thick and 1.5 m high and 1 hut per year per camp
H-12	Building Huts	$5 \text{ days/hut} \times 6 \text{ men/crew} \times 45 \text{ camps}$	1,320 MD	Build one hut per camp per year
H-13	Rethatch Hut Roof	$2 \text{ days/hut} \times 6 \text{ men/crew} \times 45 \text{ camps}$	528 MD	Rethatch one hut per camp per year
M-2	Reshaping (Mechanical)	$131 \text{ days/year} \times 6 \text{ men/crew} \times 2 \text{ crews}$	786 MD	Roadcamps provide labor to assist in reshaping operation
M-3	Mechanical Hauling	$8.8 \text{ m}^3/\text{km} \times 457 \text{ km} \div 9 \text{ m/day} \times 6 \text{ men/crew}$	2,682 MD	Loading truck to establish stockpile

TOTAL ANNUAL ROADCAMP LABOR REQUIREMENT = 71,257 Man Days

71,257 Man Days 6 men/camp 45 camps = 264 days

The projected labor surplus is adequate for the project route only if equipment is available to assist with material hauling and to perform blading and reshaping operations.

Builders - The annual labor requirements for builders are developed in Table 2-5. As shown in the table, one crew with a total of six builders or assistant builders could be utilized on the project route for less than 50 percent of the available work days. The remaining time must be directed toward other productive work such as installing drainage culverts on provincial roads, maintaining buildings or other activities.

Once the annual maintenance program requirements are known, the annual work program can be developed by distributing labor requirements. Table 2-6 presents a sample work program for a typical road camp. Labor requirements for each task have been distributed by month and balanced over a one year period. Obviously adjustments will have to be made in the field depending upon when the reshaping operation takes place on a particular section of road, growth rates of roadside vegetation, timing of the rainy season and other factors. The program can be refined and improved each year as experience and historical data is gained.

The work program is intended to serve as a general guide for the road supervisors. With the work program and performance standards, short term goals and objectives can be established for road camps. For example, the road camp headman can be given instructions on how many crew days should be spent on each task during the next two to four week period. With adequate training, based in part on the performance standards, the headman will know the proper method for accomplishing each task and the expected performance. The road overseer can measure the work completed to verify work reports.

Other Requirements - The work program focuses on routine maintenance to be performed regularly throughout the year. Major repairs to bridges and periodic replenishing (resurfacing or regravelling) the roadway surface have not been addressed.

Replacement or major structural repairs to bridge components require specialized construction equipment and should be designed by a bridge

Table 2-5
ANNUAL LABOR REQUIREMENTS FOR BUILDERS

TASK NAME	COMPUTATION	ANNUAL REQUIREMENT IN CREW DAYS	
B-1 Minor Repairs to Structures	10 repairs x 2 days/repair	20	Assume 10 days per year inspecting and repairing bridges and box culverts, headwalls, etc.
B-2 Culvert Repair/Replacement	10 culverts x 8 sections ÷ 2 sect./day	40	
B-3 Making Pipe	80 sections ÷ 2 sect./day	40	
B-4 Underdrain Installation	10 installations/year ÷ 1 inst./day	10	
B-5 Stockpiling Sand	30 m ³ ÷ 6 m ³ /day	5	Assuming 10 cubic meters needed for making pipes, 15 cubic meters for installing, 5 meters misc.
		115 crew days year	

Table 2-6
ROADCAMP CREW DAYS BY ACTIVITY

	H-1	H-2	H-3	H-4	H-5	H-6	H-7	H-8	H-9	H-10	H-11	H-12	H-13	M-2	M-3	Total
JANUARY	4	2								15					2	23
FEBRUARY	4	2				5	10									21
MARCH	3	2	1	1		10	5									22
APRIL	1	1					10	1		7				3		23
MAY	1	1					15			6					1	24
JUNE		1					15			6					1	23
JULY							15			7					1	23
AUGUST	3	2	1			10	5	1								22
SEPTEMBER	3	2	1	1		12			5							24
OCTOBER	3	2	1			5	10							3		24
NOVEMBER	4	4								10					2	20
DECEMBER	4	3			2						1	5	2		2	19
TOTAL	30	22	4	2	2	42	85	2	5	51	1	5	2	6	10	269

engineer. This type of work should be performed by contract or by specialized regional crews from Juba.

Replenishing is a periodic maintenance task performed when approximately 10 centimeters (four inches) of the original 20 centimeter (eight inch) thick layer of surface aggregate has been worn away. For a 6.5 meter (21.5 foot) road, 650 cubic meters per kilometer (1408 yd³/mi) would be required. The full length of the project road would require 297,050 cubic meters (386,165 yd³). The loading and hauling requirements for such a large quantity would require a substantially larger equipment fleet than is necessary for routine maintenance.

To replenish two kilometers per day, over 1300 cubic meters (1690 Yd³) would need to be stockpiled, loaded, hauled, spread and compacted daily. Twenty trucks with five cubic meter (6.5 Yd³) capacity would need to haul 13 loads per day.

The frequency for replenishing as estimated in the USAID Annex H Financial Analysis Plan is 13 years for the Rumbek-Wau section and 19 years for the Mundri Rumbek section. It is therefore recommended that replenishing be performed by contractor or specialized crews from the regional headquarters in Juba. However, due to variations in the quality of laterite adequate and the rapid loss of fines during the dry season, the condition and thickness of the roadway surface should be monitored annually.

CONCLUSIONS AND RECOMMENDATIONS

The emphasis of the material presented in this chapter has been, by necessity, on the methodology for developing and estimating annual maintenance program requirements to meet the future maintenance requirements of the Mundri-Rumbek-Wau Road. This methodology may be applied as a planning, scheduling, evaluating tool by senior road maintenance supervisory personnel.

The major emphasis in the field must be on accomplishing the work. This will require extensive training and improvements to the existing management system. Positive action on the following recommendations is also considered necessary.

1. Commitment to the concept of an annual maintenance program. It is essential that routine maintenance tasks be performed regularly throughout the year for the road to continue providing the level of service for which it was designed.
2. Adoption of performance standards with attainable production rates. The best methods for accomplishing each task should be adopted as standard work procedures to correct any inefficient or ineffective work practices currently used. A day's work should be measured by the amount of work performed.
3. Road camp locations and maintenance boundaries should be clearly marked in the field. According to interviews with SRMTC employees there may be as many as six extra road camps on the 122 kilometer (73 mile) section of road between Mvolo and Rumbek.
4. Equipment used to maintain the project road should be based in Rumbek, where adequate equipment maintenance facilities will be available. A cooperative agreement must be developed between Lakes Province and Bharel Ghazal Province and Western Equatoria Province to facilitate use of the equipment on the project route.
5. A method must be developed to provide for the housing and feeding of equipment operators on extended assignments away from Rumbek.
6. Convenient access to water must be provided at regular intervals along the project route, preferably at each camp. Existing wells at many camps are inadequate to support the camps during the dry season. Additionally large volumes of water will be required for compaction.

Wells should have a hand pump as well as a manhole to provide access for small mechanical pumps during the reshaping operation.

7. The thickness of the layer of surface aggregate should be measured annually at several locations to assist in planning replenishing operations.
8. Consideration should be given to future road stabilization. Much of the surface aggregate is lost in the form of dust. Stabilization with lime, calcium chloride, salt or portland cement could be applied on an experimental basis to short one or two kilometer' sections of road. Treatments which prove cost effective could be used in future construction or replenishing projects.
9. Prevailing wage rates for unskilled labor in the project ranged from one pound to one and a half pounds per day. Road camp workers currently earn nine pounds per month (30 piasters per day). To provide adequate work, incentives pay scales for road camp workers should be adjusted to prevailing local rates. A high priority should also be placed on paying employees on schedule.
10. Use of donkeys for pulling small carts loaded with gravel or water trailers should be given consideration if dump trucks are not available for hauling due to fuel shortages or other problems.
11. Headmen and other supervisory personnel should be capable of reading, writing and performing simple arithmetic computations. A program should be developed to upgrade the capability of existing supervisors, the program should include training, testing, reasonable goals and timetables for meeting those goals.

12. The concept of developing and conducting an on-going training and testing program for drivers, operators, mechanics, builders, and supervisors or candidates for such positions should be adopted to meet current and future staffing requirements, improve efficiency and provide an additional employee incentive. Tests should be routinely used to establish an individual's qualifications before promotion.

13. Funds must be budgeted for purchase of fuel, spare parts and other materials, necessary to operate and maintain the recommended equipment fleet. These materials must be supplied to provincial work centers on a timely basis.

CHAPTER 3 EQUIPMENT MAINTENANCE RECOMMENDATIONS

INTRODUCTION

The major objective of equipment maintenance is to furnish essential support to the road maintenance organization. To provide this support in an efficient, timely manner at the lowest practical cost, several different types of maintenance functions are necessary. Figure 3-1 illustrates the various equipment maintenance functions in a diagram that represents the movement of equipment through acquisition, assignment, daily use, placement in the shop for repairs and eventual disposal. Additionally, the diagram shows several of the basic resources required such as labor, parts and fuel.

This chapter focuses on the equipment maintenance functions that should be performed at the provincial level, or those that should occur after equipment has been assigned to a provincial road maintenance organization. The majority of these functions should be administered by the equipment shop or work center.

To successfully perform the provincial equipment maintenance program, the work center must meet the following requirements:

- Be housed in suitable facilities
- Have sufficient properly trained personnel
- Have the required basic tooling
- Have an adequate inventory of parts and supplies.

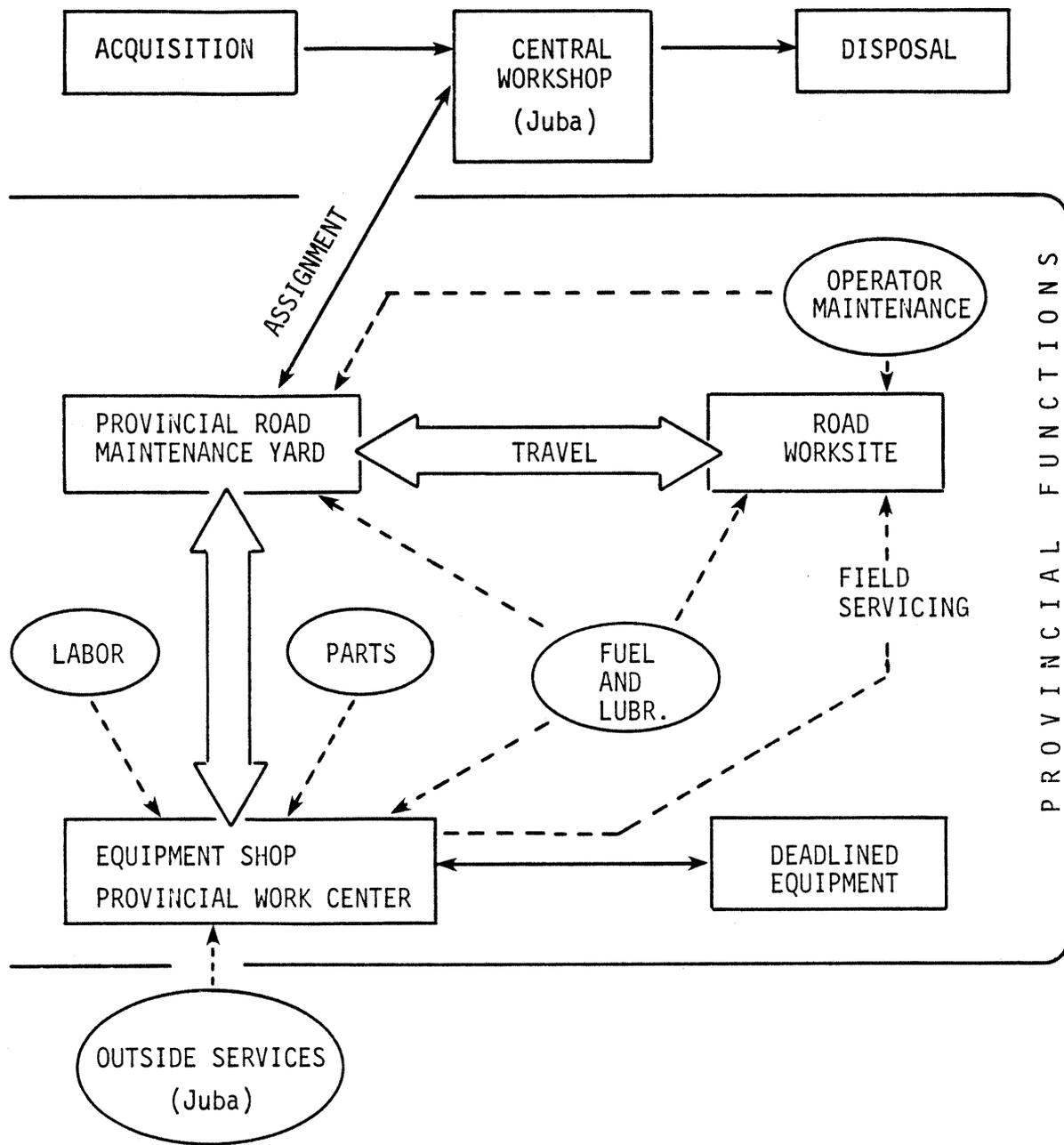
EQUIPMENT MAINTENANCE PROGRAM PARAMETERS

Each of these requirements is dependent upon one or more of the following factors which define the equipment maintenance program:

- Fleet size and make-up.
- Scope of services performed.

Figure 3-1

EQUIPMENT MAINTENANCE DIAGRAM



- Availability of outside support.
- Other factors such as climate and operational severity.

These factors are defined in more detail below, in terms of Lakes Province and the Lakes Province Work Center in Rumbek. Once the basic parameters of the equipment maintenance program for the Lakes Province are determined, recommendations can be developed to meet the basic requirements of facilities, personnel, tooling and inventory.

Fleet-Size and Make-up

The recommended compliment of equipment serviced at Rumbek will initially consist of approximately 14 new pieces of mixed transportation vehicles and maintenance units. These units are briefly described below with detailed specifications included in Appendix B.

- (a) Five (5) 4x2 diesel dump trucks in the 12,500 kg (27,500 lbs) Gross Vehicle Weight (GVW) class equipped with four cubic yard capacity dump body activated via standard hydraulic hoist.
- (b) Three (3) heavy duty agricultural or industrial-type 4x2 diesel tractors, equipped with PTO and heavy towing hitch. Other accessories recommended include:
 - Roll Over Protective Structure (ROPS) canopy (3)
 - Drag blade (2)
 - Detachable loading bucket (1)
 - Detachable backhoe (1)
 - Vibrating compactor (2)
 - Small trailer (2)
- (c) Four (4) implement transport trailers of adequate capacity and design to haul equipment such as tractors, compaction roller, demountable water tanks, or demountable aggregate hoppers. Trailers will be towed by the dump trucks.

- (d) Two (2) diesel motor graders of the 12,250 kg (27,000 lbs.) class (equivalent to Caterpillar 120 or 12 series); this equipment may feature some or all of the following optional equipment:
- All-season operator's cab;
 - Heavy duty, general purpose moldboard;
 - Scarifier;
 - Front-mounted spreader blade;
 - Rear-mounted ripper.
- (e) One (1) field service 4x4 truck in the 4,535 kg (10,000 lbs.) GVW class, diesel powered, equipped with enclosed utility body of suitable design and capacity for providing field service to maintenance equipment.
- (f) Two (2) conventional 4x4 pickup trucks, diesel powered.
- (g) One (1) diesel 6x4 with a Gross Combined Weight (GTW) rating of 36,300 Kg (80,000 lbs.) equipped with a fifth wheel for pulling a low bed equipment trailer of adequate capacity to transport motor graders, track-type tractors, water tanks, etc.
- (h) One (1) lowbed heavy equipment trailer, with 22,500 kg (50,000 lbs) capacity, designed to transport heavy equipment, water tanks, or aggregate hopper.
- (i) Four (4) demountable water tanks of approximately 7,600 liter (2,000 gal.) capacity, complete with gravity feed spray bar, and support frame for storage when not in use. Each dump truck or implement trailer will be capable of accommodating one tank. The low bed trailer will accommodate up to three tanks.
- (j) Three (3) demountable aggregate hoppers of approximately three cubic meter (4 yd^3) capacity, complete with support frames for storage. Each hopper will be designed for mounting on an implement trailer.

- (k) One (1) demountable aggregate hopper of approximately nine cubic meter (12 yd³) capacity, complete with support frame for storage. The hopper is to be designed for mounting on the lowbed trailer.
- (l) Three (3) portable water pumps, for use in filling water tanks.
- (m) One (1) track-type tractor in the 9,000 kg (20,000 lbs.) GVW class with bulldozer and ripper attachments. Equivalent to Caterpillar D4.

It is anticipated that the track-type tractor (Item "M") will be recommended only if the existing Fiat-Allis bulldozer observed at Abiriu (25 km north of Rumbek) cannot be rehabilitated or is not assigned to Lakes Province.

In addition to the compliment of new vehicles and equipment recommended, those pieces of equipment in the current inventory that are operable or economically repairable should be added to the proposed Rumbek fleet.

Of the existing equipment in Lakes Province, one Fiat-Allis track-type tractor, one Toyota pick-up truck and one Caterpillar motor grader fall into this category. If these three pieces of equipment are included in the fleet the initial compliment will be 17 vehicles. However, it is possible that the fleet may be expanded in the form of more dump trucks wheeled shovel-loaders, small bulldozers, compaction rollers, etc., as future requirements dictate.

It is therefore recommended that the Rumbek facility be designed to maintain a fleet of approximately 20 units of equipment during the initial stages of operation, with appropriate provisions for future expansion.

Scope of Maintenance Services and Availability of Support

The scope of maintenance services to be provided at the provincial level is closely related to the support provided by the regional or

central work shop in Juba. A new central workshop for Juba is currently being designed under an IBRD contract. The new facility will perform major overhauls and rebuilding of major components for the entire Southern Region, operating on a component exchange basis with provincial work centers. Eventually, additional support will be provided by the Juba facility in warehousing activities thus permitting lower stock levels in the provincial work centers.

The scope and level of equipment maintenance activities to be performed at the Rumbek Work Center can be divided into the following categories.

1. Routine Preventative Maintenance - Including inspection, lubrication and mechanical adjustments by trained mechanics, and periodic inspection and lubrication by operators and drivers.
2. General Repair - All routine repairs including extensive use of replacement components.
3. Field Service - Consisting of repairs performed from a field service vehicle equipped with proper tools and emergency supplies, operated by a trained mechanic.

An important consideration relating to each of the above categories is standardization of major components. Commonality is highly recommended for the following reasons.

- Smaller parts inventory required.
- Simplified mechanic training effort.
- Improved parts interchange system.
- Simplified shop tooling.

Another advantage of standardization of major components is simplified operator training. Operators can become familiar with fewer transmission shift patterns, controls, engines and engine responses.

Standardization can be a severe disadvantage if the units do not have good availability of parts, are not durably built, or have not been designed to facilitate ease of maintenance (i.e. poor access to components, specialized skills or specialized equipment required). However, the advantages of commonality far out weigh the disadvantages if a manufacturer with proven reliability and parts availability is selected.

Preventative Maintenance - Preventative Maintenance (PM) is commonly interpreted as the systematic servicing and inspection of equipment on a pre-determined time, distance or engine-hour basis.

The major objective of the PM program is the prevention of costly repairs and downtime due to negligence. Safety is also a primary consideration.

The Rumbek Work Center should be responsible for the performance of a rigorous PM program for its equipment, including field inspections to assure that PM functions assigned to individual equipment operators are performed in accordance with plans and schedules.

It may also be necessary for the field serviceman to perform certain PM functions not ordinarily done by operators in order to minimize the additional cost and downtime of moving field-based equipment to Rumbek for PM.

It should be noted that, under standard procedures in the private and public sectors, the field service mechanic routinely performs periodic inspection of field-based equipment in order to ascertain the need for repair and/or whether or not abuse or neglect is prevalent or suspect.

PM programs generally vary according to make and model of equipment; schedules are normally based upon respective manufacturer recommendations, and custom-blended by the owner dependent upon the severity of operating conditions, climate, temperature, etc. The PM program for the Rumbek Work Center should be based upon projected utilization rates, type of equipment manufacturers' recommendations and staffing.

An effective PM program is comprised of four elements:

1. Thorough, systematic, periodical inspection;
2. Lubrication, oil and filter changes;

3. Mechanical adjustments and the reporting of obvious or suspected defects during the inspection process;
4. Correction of defects in a timely manner.

A detailed preventive maintenance program for Rumbek should not be developed until the specific make and model of each piece of equipment has been selected, so that manufacturers recommendations can be incorporated. In developing a PM program responsibility and accountability for performing PM functions should be clearly defined and understood by all persons involved with both the maintenance and operation of the equipment. The program should define: what must be performed, when it shall be performed, where it shall be performed, how it shall be performed, who should perform it and who is responsible for seeing that it is performed properly and on time.

Schedules defining what, when, where and who should perform various PM functions are useful guides to mechanics, operators, and supervisors, and are recommended for each type of equipment. A sample schedule is shown in Figure 3-2.

General Repairs - In addition to the performance of PM and minor mechanical adjustments, the provincial work center at Rumbek must have the capability to perform various types of general maintenance and repair. The scope of general repairs to be performed in Rumbek is related to the amount of support provided by the regional work center in Juba, which will eventually perform most of the specialized or precision repairs for the entire Southern Region.

In defining the limits of maintenance for the Rumbek Work Center, factors such as response time, downtime, repair costs, volume of specialized work and the quality of work which can be expected from a maintenance shop of limited resources, have been considered. An attempt has been made to keep the complexity of repairs performed at Rumbek at a minimum. However, with all of the provinces sending components and even complete units to Juba, the central workshop could easily be overloaded. Even when the system is working at its best, a unit is likely to be out of service for several days or weeks when sent to the central workshop due to travel time, work schedules, etc.

Figure 3-2
SAMPLE PM SCHEDULE

SUDAN SOUTHERN REGION MINISTRY OF TRANSPORTATION
AND
COMMUNICATIONS

INSPECTION, LUBRICATION & MAINTENANCE SCHEDULE

Make: Caterpillar

Type: Motor Grader

Model: 120B

KEEP YOUR EQUIPMENT CLEAN

INTERVAL	ITEM	SERVICES TO BE PERFORMED BY THE OPERATOR	LUBRICANT
DAILY	1	Check engine oil level	E0**
	2	Check coolant level	
	3	Check all belts and coolant hoses	
	4	Service air cleaner (More often if needed)	
	5	Check oil level in hydraulic system	H0**
	6	Lubricate blade lift control shaft and drive pinion bearing	
	7	Lubricate ball and socket joints, blade lift arm shaft	
	8	Lubricate center shift pinion and rack	
	9	Lubricate circle reverse drive shaft	
	10	Lubricate wheel lean shaft and bevel pinion housing	
	11	Lubricate scarifier	
	12	Lubricate axle pivot and wheel lean bearings	
	13	Lubricate steering cylinder	
	14	Lubricate draft ball and steering gear	
	15	Lubricate steering tie rods, arm and block	
	16	Lubricate lean pivots and pivot pins	
	17	Lubricate circle shoes and spacer	
	18	Visual inspection of grader for oil leaks	
	19	Visual inspection of tires for cuts, rocks, inflation	
		<u>KEEP MACHINE CLEAN</u>	

INTERVAL	ITEM	SERVICES TO BE PERFORMED BY THE OPERATOR	LUBRICANT
DAILY	20	Check operation of lights, brakes and accessories	
	21	Check mouldboard blades and scarifier teeth	
	22	Start engine & check all instruments & gauges	
	23	Clean cab interior & glass	
	24	Check operation of windshield & rear glass wipers	
	25	Clean and adjust rear view mirrors	
	26	Check fire extinguisher	
	27	Check wheels for broken studs & loose nuts	
	28	Check tow chain	
	29	Check cutting edges and bits for wear & loose bolts, change if necessary	
	30	Check ball and socket, adjust if necessary	
	31	Inspect shear pin	
	32	Refuel at end of day's work	
33	Report any defects or malfunctions to your foreman and/or work center		
		SERVICES TO BE PERFORMED BY THE OPERATOR	
EACH 50* ENGINE HOURS		<u>Perform daily inspection & services</u>	
	34	Check electrolyte level in all battery cells	
	35	Check battery cables and terminals	
	36	Check brake fluid levels in master cylinder	Brake fluid
	37	Check lubricant level in transmission	MPL**
	38	Check lubricant level in rear axle housing	MPL**
39	Lubricate rear axle bracket cups	MP grease	
40	Lubricate pedal bearings, power control drive shaft and engine mount	MP grease	
		SERVICES TO BE PERFORMED BY THE OPERATOR	
EACH 100* ENGINE HOURS		<u>Perform the 50 Hour Services</u>	
	41	Lubricate high-low selector lever	MP grease
	42	Lubricate gear selector rod assembly	MP grease
	43	Lubricate governor control linkage bearings	MP grease
	44	Lubricate fan bearing	MP grease
	45	Adjust alternator and fan belts	
	46	Adjust flywheel clutch	
47	Check tire pressures w/gauge __ lbs front, __ rear		

INTERVAL	ITEM	SERVICES PERFORMED BY WORK CENTER	LUBRICANT
		<u>Perform the 100 Hour Services</u>	
	48	Change oil and filter elements, engine crankcase and flywheel clutch	EO
	49	Wash engine breather	
	50	Check oil level, power control shaft and worm gear housing	MPL
	51	Check oil level, front wheel lean control housing	MPL
200*	52	Check oil level, circle transfer gear housing	MPL
ENGINE	53	Check oil level, circle control housing	MPL
S	54	Check oil level, power control housing	MPL
	55	Check oil level, tandem drive housing	MPL
	56	Wash and oil breather tandem drive housing	
	57	Change filter element and wash breather transmission and rear axle housing	
	58	Add corrosion inhibitor to cooling system	
		<u>SERVICES PERFORMED BY WORK CENTER</u>	
		<u>Perform the 200 Hour Services</u>	
	59	Change oil and filter element, hydraulic system	HO**
	60	Check oil level blade loft control housings	MPL**
	61	Check oil level circle center shift control housing	
600*	62	Lubricate front wheel bearings	MP grease
ENGINE	63	Wash flywheel clutch compartment screen	
S	64	Adjust blade circle	
	65	Adjust center circle shift rack	
	66	Adjust center shift pin	
	67	Change filter, fuel system--more often if required	
		<u>SERVICES PERFORMED BY WORK CENTER</u>	
		<u>Perform 600 Hour Services</u>	
	68	Steam clean grader, engine & air inlet system	
	69	Clean, inspect alternator and wiring	
	70	Check engine & transmission mounts	
1200*	71	Check radiator mounts	
ENGINE	72	Check cab mounts	
S	73	Change oil transmission and rear axle housing	MPL**
	74	Change oil power control housing	MPL**
	75	Change oil power control shaft worm and gear housing	MPL**

INTERVAL	ITEM	SERVICES PERFORMED BY WORK CENTER	LUBRICANT
		<u>Perform 500 Hour Service</u>	
	76	Change oil blade lift control housing	MPL**
	77	Change oil center shift control housing	MPL**
	78	Change oil circle reverse control housing	MPL**
	79	Change oil tandem drive housing	MPL**
	80	Change coolant	
EACH 1000*	81	Repack front wheel bearings and adjust	MP grease
ENGINE	82	Adjust circle draw bar ball and socket	
HOURS	83	Measure engine valve lash and adjust	
	84	Tune up engine as required	
	85	Paint as required	
	86	Perform all essential repairs & road tests prior to release to user	

Notes

* PM service intervals to be based on manufacturer's recommendations, fuel quality, etc.

**Lubricants to be based on manufacturer's recommendations

Symbols used EO = Engine Oil, HO = Hydraulic Oil, MPL = Multi Purpose Gear Lubricant

The situation can be improved by stocking spare components and by performing moderately complex repairs that do not require specialized equipment at the provincial level.

The recommended scope of the general repair program for the Rumbek facility is illustrated in Table 3-1.

Field Service - Field service functions by respective types of work are too numerous to list in this report, but represent a major factor in minimizing lost production and extended equipment downtime.

It is often far less expensive and more convenient to perform certain types of equipment maintenance on-site, as opposed to costly delays and expenses which may be incurred by moving equipment over long distances to and from Rumbek.

The mobility and timeliness necessary for field service can only be provided if adequately trained personnel and an adequately equipped vehicle are available. In both the private and public sectors, the field service mechanic often represents the most knowledgeable, experienced and highly trained class of maintenance personnel.

Ideally, he must have diagnostic skills, intimate knowledge of just about all types of equipment and its complex componentry, the ability to make-do with non-existent or primitive working conditions, as well as being an expert welder, etc. He must understand sophisticated automotive systems and be able to properly understand complex instruction manuals. In addition, he must have the ability to communicate and work with people.

Some of the typical field service tasks include:

- Welding and brazing as required.
- Replace minor-sized components.
- Trouble-shoot and correct electrical, brake, hydraulic, power plant and drive train problems.
- Start stalled engines.
- Perform PM inspections and lube functions.
- Change tires.
- Replace broken axles, gear carrier assemblies, wheel hubs and bearings, etc.
- Supervise the extraction and towing of damaged equipment, etc.

Table 3- 1 - General Repair Program

COMPONENTS & SYSTEMS	RUMBEK ACTIVITIES	SUPPORT ACTIVITIES BY JUBA
<p><u>Power Plant</u></p> <ul style="list-style-type: none"> ● Engine ● Cooling System ● Exhaust System ● Fuel/Air System 	<ul style="list-style-type: none"> ● In-frame repairs and overhauling including rings, pistons, bearings, sleeve assemblies, etc. ● Minor repairs to valve train--i.e. those that do not require machining. ● Installation of new or rebuilt engine assemblies. ● Adjustments and general repair to cooling systems, thermostats, automatic shutters, fans, cowling, shrouds, belt drives, hoses, etc. ● Overhaul water pumps, and clean radiator tanks and cores. ● Repair or replace exhaust system pipes, hangers, mufflers, spark arresters, silencers, etc. ● Repair/replace air system lines, element housing, mounting hardware, etc. ● Periodic inspection or minor adjustment of carburetors, fuel pumps, injectors, et. ● Installation of carburetor assemblies, etc. ● Minor repair/replacement of fuel lines, tanks, caps, etc. 	<ul style="list-style-type: none"> ● All out of frame overhauling, complete assemblies sent to Juba for major overhaul; camshaft, crankshaft, cylinder head or cylinder block in need of machining. ● Valve train repairs that require machining or head planing. ● Major radiator and oil cooler repairs. ● Overhaul of air compressors, turbo chargers, on-demand automatic fans, and inter-cooler systems. ● Overhaul of fuel injection pumps, injectors, governors, and carburetor assemblies.

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COMPONENTS & SYSTEMS	RUMBOK ACTIVITIES	SUPPORT ACTIVITIES BY JUBA
<p><u>Power Train</u></p> <ul style="list-style-type: none"> ● Drive Shaft, Universal Joints, and Axles ● Clutch ● Transmissions 	<ul style="list-style-type: none"> ● Repair/replace driveline parts, including universal joints, center bearings and hanger, slip-spline joints, drive shaft sections, wheel bearings, etc. ● Repair/replace mechanical power take-offs including shafting and joints. ● Repair, adjust and overhaul clutches ● Dismantle, repair and reassemble mechanical transmissions, transfer case, power divider and differential assemblies. ● Installation of automatic, semi-automatic and power shift transmissions, hydraulic couplers, and torque converters. 	<ul style="list-style-type: none"> ● Repair damaged or sprung axle beams or housings. ● Rebuild major clutch assemblies. ● Major repair and overhauling of automatic, semi-automatic and power shift transmissions, hydraulic couplers and torque converters.
<p><u>Steering, Suspension, Brakes and Tires</u></p> <ul style="list-style-type: none"> ● Steering 	<ul style="list-style-type: none"> ● Repair/replace mechanical steering gear boxes. ● Install power steering assemblies ● Inspection and adjustment of steering geometry, and the repair/replacement of associated parts including drag links, tie-rod ends, king pins and bushings, pitman arms, steering column bushings, etc. 	<ul style="list-style-type: none"> ● Repair/overhaul power steering assemblies

Table 3-1 (continued) - General Repair Program

COMPONENTS & SYSTEMS	RUMBEK ACTIVITIES	SUPPORT ACTIVITIES BY JUBA
<p><u>Steering, Suspension, Brakes and Tires (Continued)</u></p> <ul style="list-style-type: none"> ● Suspension ● Brakes ● Tires and Rims 	<ul style="list-style-type: none"> ● Repair/replace suspension system springs, hangers, equalizer beams, shock absorbers, radius rods, torque arms, etc. ● Repair and overhaul service and emergency brake systems including shoes, pads, lines, linkage, cables, etc. ● Repair, replacement, patching, mounting and balancing of tires. 	<ul style="list-style-type: none"> ● N/A ● Machining of brake drums, rotors, etc. and overhaul of air compressors, hydrovac power boosters, etc. ● Recapping.
<p><u>Body and Frame</u></p> <ul style="list-style-type: none"> ● Body Interior ● Body Exterior 	<ul style="list-style-type: none"> ● Minor Repairs to vehicle interior including, door seals, pedals, shift levers, seat cushions, etc. ● Repair minor sheet metal damage. ● Repair/replace hinges, latches, mirrors, windows, windshield, etc. 	<ul style="list-style-type: none"> ● N/A ● Extensive body repairs and painting.
<p><u>Electrical</u></p> <ul style="list-style-type: none"> ● Ignition System ● Starting System ● Accessories 	<ul style="list-style-type: none"> ● Perform routine periodic tune up of ignition system. ● Minor repairs to charging and starting systems--replacement of batteries, cables, starter motors, generators and mounting hardware ● Installation and replacement of electrical accessories such as headlights, fuses, gauges, switches, etc. 	<ul style="list-style-type: none"> ● Overhauling of starters, alternators, etc.

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COMPONENTS & SYSTEMS	RUMBK ACTIVITIES	SUPPORT ACTIVITIES BY JUBA
<p><u>Hydraulics</u></p> <ul style="list-style-type: none"> ● Lines and Fittings ● Accessories <p><u>Miscellaneous</u></p> <ul style="list-style-type: none"> ● Lubrication, Oil Change <p><u>Mounted Equipment Repair</u></p> <ul style="list-style-type: none"> ● Buckets, Blades, Etc. ● Tracks and Undercarriage ● Towed Equipment ● Dump Bodys, Etc. <p><u>Major Rehabilitation</u></p> <ul style="list-style-type: none"> ● Complete Overhaul 	<ul style="list-style-type: none"> ● Replace lines, fittings and hoses ● Replace hydraulic motors, pumps, rams, controls. ● Apply lubricants to joints and fittings, replace oil filters and oil - GENERALLY PERFORMED AS PART OF PM PROGRAM ● Minor repairs and replacement of grader mouldboards and cutting edges, bulldozer blades, loader buckets, etc. ● Repair/replace track linkage, pads and grousers. ● General repairs to drags, rollers, trailers, etc. ● Minor repairs to dump bodies and hoist sub-frames, trailer platforms, water tanks and spray bars. Includes spot welding, etc. 	<ul style="list-style-type: none"> ● Fabricate hoses, etc. ● Repair/overhaul hydraulic motors, pumps, controls, etc. ● Track chain resurfacing, pin and roller replacement, rebuilding of trackframe and diagonal braces, rebuilding of track rollers, sprockets, idlers, dozer push frame, etc. ● Straightening and reinforcing bent or sprung frames. ● Complete tear-down or overhauling of construction equipment and trucks.

Other Factors

Other factors such as climate and operational severity may have a significant impact on the equipment maintenance program.

Climate - High temperatures and dust conditions may influence facility design, equipment specifications and PM schedules. Blowing dust and abrasive sand may contaminate repair areas, require optional filter systems and increased filter change frequencies.

Operational Severity - Factors such as high utilization rates, heavy loading, rugged terrain, or travel through muddy, saturated ground conditions will stress the equipment and may influence equipment specifications, PM schedules, and general equipment maintenance workloads.

Personnel - The shortage of trained drivers, operators and mechanics may influence equipment specifications, staffing and training. For example a high turnover among drivers may require a larger staff, on-going training programs and automatic transmissions to reduce clutch and mechanical transmission damage.

Fuel - The quality of fuel available may have a significant impact on equipment selection and PM schedules. Much of the fuel in the Southern Region is imported from Kenya and has a high sulphur content. A high sulphur content may significantly reduce engine service life, require special filters, and increase oil change frequencies (Engines with oil changes normally scheduled for every 200 engine hours with a sulphur content less than 0.4 percent, may require changes every 100 hours with a sulphur content between 0.4 percent and 0.8 percent. A master mechanic in Juba reported that Kenyan fuels have a sulphur content of 0.9%).

EQUIPMENT MAINTENANCE PROGRAM REQUIREMENTS

As mentioned previously, successful performance of the equipment maintenance program requires suitable facilities, adequate staffing, basic tooling, and an adequate inventory of parts and supplies.

Facility Requirements

The conceptual layout for the Rumbek Work Center included in the contract for this project called for separate buildings for the various equipment maintenance activities such as office, minor maintenance, lubrication, component exchange, electrical repairs, parts storage and issue, etc. This type of layout is often used for large transit operations but can result in certain inefficiencies for smaller operations, since a vehicle undergoing repairs must be moved for welding, lubrication or other maintenance services.

Greater efficiency can be obtained if these services are more conveniently located. In most modern repair facilities each repair stall has access to portable welding equipment, lubrication equipment, etc. Additionally, the shop supervisors office and parts issue are usually in the same building as the repair stalls. The increased accessibility, minimum walking distance and improved supervision result in reduced downtime and equipment maintenance costs.

The general layout, size, and configuration of the shop building or buildings, and other related areas will be determined by the project's architectural team. The following functional areas are described briefly below:

- Shop Office
- Parts Storeage
- Warehouse
- Generator/Compressor Room
- Repair and Service Area
- Main Office and Classroom

Shop Office - A shop office is generally located to facilitate observation of repair stalls, fueling area and parts issue. This area should house the Equipment Division Manager, shop supervisor, and one clerk/timekeeper with appropriate desks and files for time keeping and maintenance of historical records on individual pieces of equipment including useage, maintenance, repair and operating expenses.

Parts Storage and Issue - The parts storage and issue area should be located near the repair stalls to facilitate parts issue to mechanics. If located in the general shop building, it should be separated by counters and appropriate screens or walls for security. Typically this area is situated next to the supervisor's office and a larger warehouse area. The area is used for storing and issuing small parts, supplies and tools as well as maintaining inventory records. The area would house two storekeepers (assisted if necessary by the clerk from the shop office) as well as desks and files for maintaining inventory records. Appropriate bins and shelves must be provided for storing parts and tools (see warehouse).

Warehouse - This area provides storage for lubricants, tires and sufficient supplies for independent operation of the facility for a period of 18 months or longer, and is typically located next to the parts storage and issue area. An enclosed or designated area within the warehouse should be reserved for road maintenance hand tools, cement, wheelbarrows and other supplies. Stockroom furnishings needed for the warehouse and parts storage and issue room should include the following items: spare parts storage bins, stockrecord cardex files, rotary bins for hardware storage, storage shelves, and parts manual for each make/model of equipment assigned to Rumbek.

Generator/Compressor Room - Mechanical equipment to power air and electrical tools and equipment is generally located in or near the main shop building.

Repair and Service Area - The repair/service stalls make up the most critical area in the main shop building. Seventy-five to eighty percent equipment availability (average percentage of equipment units in operating condition at any one time) is a reasonable goal for the proposed work center. With an initial fleet of approximately 20 vehicles, four to five units would be under repair or require servicing each day. Generally these units would not require stalls at the same time, however, additional space should be provided for storage of disassembled vehicles awaiting parts or rebuilt components from Juba.

Additionally, while major repairs and rehabilitation of equipment will usually take place in Juba, there is a considerable number of existing "deadlined" vehicles in the Southern Region that could be worked on as a training exercise or as time permits at the provincial work centers.

Therefore, four repair bays are recommended for the initial period of operation. It should be possible to perform the following activities in each repair stall.

- Preventative maintenance.
- Lubrication.
- Tire repairs.
- General repairs.
- Component exchange.
- Radiator cleaning.
- Welding and minor body work.
- Electrical/Ignition system repairs.

In order to provide this essential flexibility the shop must be provided with a portable welding machine, a 4.5 metric ton (five ton) capacity moveable A-frame hoist with dual chain falls, portable ramps, portable tool chests and other types of shop equipment to be stored in the repair and service area. Each workstall should provide mechanics with easy access to air, electric, and water connections. Quick air couplers and electrical sockets should be located as required to permit the use of trouble lamps and drills, provide air for tire inflation and other purposes.

Manual methods for applying lubricants and oils must be provided. However, a centralized mechanical lube system delivering oils and grease to any stall within the work area is recommended for consideration in the building design. It is recommended that access to lubrication points on the vehicles be provided by portable ramps which can be moved to any stall. A floor pit is not recommended since pits tie up valuable production space and could pose a potential hazard due to the tendency of explosive fumes to settle in pits as well as possible injury by slipping or falling into the pit.

Reliance on hydraulic power hoisting or electric lift equipment is also not recommended for the Rumbek facility since repair or servicing of this equipment would be difficult to obtain.

Main Office and Classroom - The Assistant Commissioner of Roads functions as the Provincial Engineer, and administers both the road and equipment maintenance programs for the province. His office should be located at the work center compound but away from the shop area due to noise. Office space may include an office for the Assistant Commissioner, an office for future expansion and an office/reception area for one clerk and a senior timekeeper/paymaster. A safe should be provided for payroll or petty cash purposes.

Classroom space should be provided for 20 students. Although it is anticipated that most training will be accomplished in the shop or on the road, the space can also be utilized for conferences or other purposes.

Road Maintenance Activities - To reduce unnecessary pedestrian and vehicular traffic into and out of the equipment maintenance areas, it is recommended that road maintenance activities be physically separated from the equipment maintenance area. The existing work center facilities should be considered for this purpose.

Centralized road maintenance activities require office space for the manager of the road maintenance division (highest supervisory level of road maintenance personnel under the Assistant Commissioner), two clerks and a timekeeper. An office with space for five to seven desks should also be provided for use by two assistant managers, the head builder and two head drivers. Assignment of the builders and drivers to the road maintenance division represents a change in organization structure which is discussed in chapter 4.

The road maintenance facility should provide adequate areas for staging and assembly of road maintenance personnel assigned to Rumbek.

Storage of vehicles at the road maintenance facility should also be considered, although certain advantages such as security, convenient access to fuel, etc. can be realized by storage on the equipment maintenance compound.

Blacksmith Shop - The blacksmith functions could be performed in one stall of the shop building, however, the heat generated by a small forge may warrant a separate building.

Carpentry Shop - The carpenters could also be located in the shop building. One repair stall would be sufficient, though saw dust and wood chips could contaminate mechanical repairs. This activity does not appear to be directly related to equipment maintenance other than fabrication of truck side boards and possibly utility trailer beds. Carpentry activities are more closely related to the functions of the builders in the areas of minor bridge repair (formwork) and building maintenance. Therefore, it is recommended that the carpentry shop be included in the highway maintenance activity area. Electrical power should be provided for operation of tools.

Vehicle Fueling Area - Fuel pumps should be located so as to permit easy observation from the equipment shop supervisor's office.

The pumps should face the shop office which should be able to activate and deactivate the fuel pumps and document all fuel and engine oil transactions. (Manual recording of fuel transactions is recommended.)

Underground storage tanks with a minimum capacity of 38,000 liters (10,000 gallons) should be provided for gasoline and diesel fuels thereby providing adequate capacity for tank trailer delivery.

Fuel transfer should be accomplished by electrically powered pumps; however, an override should also be provided to permit transfer via a manual, metered, pump mechanism in case the power generator is deactivated.

The fueling area should also be furnished with water via suitable container or supply hose. An air hose with pressure chuck for control of tire pressure should also be furnished.

Vehicle Wash Area - This should be accomplished outside the main shop building in an area furnished with a water supply hose. A concrete pad should be considered to prevent rutting.

Vehicle Storage - Separate outside areas should be designated for (1) vehicles awaiting service, (2) vehicles ready for service, (3) deadlined vehicles, and (4) visitor parking areas.

Other Areas - Other areas include a rest area for breakfast or lunch breaks, personnel washroom, toilets, and a locker room for storage of a mechanics personal clothing, tools, etc.

Staffing Requirements

The equipment work center must be staffed with an adequate number of mechanics, blacksmiths, and supervisory/administrative personnel.

Mechanics - Based on an initial fleet size of approximately 20 vehicles, two or three properly trained mechanics could perform the required preventative maintenance, general repairs and field service.

The number of mechanics required will also be dependent upon (1) the amount of existing deadlined equipment that is to be rehabilitated at the Rumbek Work Center, and (2) the amount of driver abuse or negligence to which the vehicles are subjected. It is assumed that work on existing deadlined equipment will be performed only during periods of low work volume, and that an on-going training program for drivers and equipment operators, combined with periodic field service inspections will minimize vehicle abuse.

To allow for possible turnover, sickness or other leaves of absence, and workload peaks, three mechanics are recommended. Additionally three assistant mechanics are recommended to perform the simpler vehicle maintenance tasks such as lubrication and oil changes. The assistant mechanics should also serve as trainees to fill future mechanic vacancies created by shop expansion or turnover.

Blacksmith's - Minor body work, welding, repair of road worker hand tools, and other tasks requiring a blacksmith can be met by one blacksmith and one assistant blacksmith. It is also anticipated that much of the minor body work and welding will be accomplished by the mechanics, and that major bodywork will be accomplished in Juba.

Supervisory/Administrative Personnel - The Equipment Division
Manager, Shop Supervisor, Storekeepers, clerk and other supervisory or administrative personnel are discussed in detail in Chapter 4, Organizational Structure.

Tool Requirements

An adequate number of the proper types of tools and shop equipment is an essential requirement for safe, efficient and economical equipment maintenance.

Type - The many different types of tools required are dependent upon the scope of maintenance services performed, the types of equipment and the source of manufacture of the vehicles and equipment. For example, metric or english system wrenches may be required depending upon the country of equipment manufacture. Type and size of engine will also influence the type and size range of many tools and pieces of shop equipment required.

Quantity - The quantity required for each type of tool will depend upon frequency of use, work location and other factors. It is recommended that sufficient quantities of tools be acquired for the following assignments.

- Each vehicle should be assigned the tools necessary for daily or periodic adjustments performed by drivers and operators. (See Accountability discussion below). These tools should be purchased with the vehicle.
- Each mechanic should be assigned and made responsible for a complete set of general purpose tools.
- The Shop should maintain a sufficient number of general and special purpose tools to minimize the time a mechanic may spend waiting for a tool to become available, to replace tools that become lost or damaged, and to adequately supply the field service vehicle.

A listing of the tools and equipment recommended for the Rumbek Work Center is contained in Table 4-1. Tool specifications are contained in Appendix C.

Accountability - Well made tools of dependable quality represent a significant but essential investment. Loss or abuse of tools and equipment cannot be tolerated. A system that places the responsibility on the individual using the tools, for cleaning, storing or returning the tool is highly recommended. Permanently marking tools, periodic checks by supervisory personnel and neat well organized tool rooms and tool cabinets will improve accountability. Problems most frequently develop in accounting for tools assigned to vehicles and equipment or the parts rooms rather than with tools assigned to individuals.

With vehicles, the driver or operator should be responsible for checking the tool inventory daily, or whenever there is change in driver, and for securing the tools whenever the vehicle is left unattended. If periodic checks by the head driver, or other supervisors indicate that a problem or potential problem exists, tools should be collected and reassigned to the head driver, or other appropriate measures taken.

In the parts room, tools can be hung on a board with silhouettes of each tool painted behind the tools such that it will be clearly visible when a tool is loaned out. By attaching a small tag with the "borrowers" name to the silhouette when a tool is loaned, the storekeeper can determine the location of missing tools.

Inventory Requirements

An adequate level of spare parts and materials stock must be maintained to maintain shop productivity, effectively utilize shop space, reduce downtime and decrease repair backlogs.

Parts can be defined as replacement items that singly or together with other parts form a component element of an equipment unit. Examples are clutch plate, axle, valve, etc.

Materials are defined as the supplies required to service and maintain equipment. Examples are friction tape, lamps, fuses, bolts, paint, wire, filters, belts, etc.

In establishing stock levels for provincial work centers, the primary considerations are frequency of use, time required to obtain stock from commercial sources or the regional warehouse, and the type and quantity of stock items available from the regional warehouse. The existing level of parts and materials stock at both the provincial and regional levels of the SRMTC work centers is almost non-existent. Delays in excess of one year are common when ordering stock from commercial sources. Therefore, it is recommended that the initial stock levels for the Rumbek facility be sufficient to allow independent operation (within the scope previously defined) for an 18 to 24 month period.

The value of items in stock represents a considerable amount of money that is not producing any work until items are withdrawn for use. As conditions improve in the Southern Region, stock levels should be reduced in direct proportion to the immediate availability of parts and materials from the regional warehouse.

It is recommended that the initial stock of spare parts (and materials that are applicable only to particular units) be purchased at the same time new equipment is purchased. Spare parts lists for each new unit of equipment recommended are included in Appendix 2 with the equipment specifications. Similar quantities of spare parts for the three existing units in operable condition should also be ordered. These existing units include one Caterpillar motor grader, one Toyota pick-up truck and one Fiat-Allis truck-type tractor.

A listing of recommended stock levels for materials that are not unique to a particular unit are included in Appendix D.

CHAPTER 4

RECOMMENDED ORGANIZATIONAL STRUCTURE

INTRODUCTION

The recommendations presented in this chapter are directed in general toward the SRMTC organization at the provincial level, and specifically toward the SRMTC organization in Lakes Province. This is in keeping with the project's emphasis on the project route and to avoid duplication of the IBRD project which will provide recommendations at the regional level.

The SRMTC at the provincial level has two major functional areas of activity, equipment maintenance and road maintenance. Each of these two functional areas has its own goals and objectives, and requires different types of tools, equipment and personnel skills to meet those goals and objectives. Therefore, the provincial organization should be structured into two separate branches or divisions to accommodate the two major functional areas. Personnel performing road maintenance activities should be assigned to the road maintenance division. Similarly personnel and equipment performing maintenance or repair to equipment should be assigned to the equipment maintenance division.

To adequately maintain the provincial road system it is essential that the road maintenance and equipment maintenance divisions be coordinated to function as a unit. This coordination can be best achieved if both functions are under the jurisdiction of a senior level engineer/administrator such as the Assistant Commissioner for Roads and Bridges. The role of the Assistant Commissioner and his immediate staff can be described as a third functional area, administration.

ADMINISTRATION

The administrative function provides support and overall guidance to the road and equipment maintenance programs performed at that provincial level. The administrative staff includes the Assistant Commissioner, who

supervises management activities such as planning, directing, coordinating, evaluating, and training, and clerical personnel who process payroll, accounting and personnel actions.

Assistant Commissioner

As head of the provincial maintenance organization the Assistant Commissioner should serve as the Province Engineer responsible for planning, directing and coordinating the road maintenance and equipment maintenance programs for all roads within the province. The recommended organization structure is illustrated in Figure 4-1.

The duties of the Assistant Commissioner should include preparation and administration of annual work programs and reports, direct supervision of administrative personnel and coordination of activities involving other agencies. A diagram shown in Figure 4-2, illustrates the types of agencies that interact with the provincial maintenance organization.

One of the principal rules for effective organization is "unity of command." Simply stated this rule requires that each person have only one immediate supervisor. Under the existing organization, the Assistant Commissioner reports to both the Commissioner of the Province and the SRMTC Deputy Director of Road Construction and Maintenance. Since the Assistant Commissioner receives directions from two sources, the coordination of SRMTC program priorities with provincial needs and priorities represents a serious potential problem. Ideally, this problem should be eliminated by making the Assistant Commissioner responsible only to the SRMTC or only to the Commissioner. The problem can be reduced by identifying possible areas of disagreement and defining policies and guidelines for resolving differences between regional and provincial needs. Policies and guidelines should be developed by the SRMTC headquarters for approval by the SRMTC Minister and the Provincial Commissioners. If mutually acceptable policies cannot be established, the head of the provincial SRMTC maintenance organization should not be expected to report to the Province Commissioner, and should have a title other than Assistant Commissioner. This may also require a separate

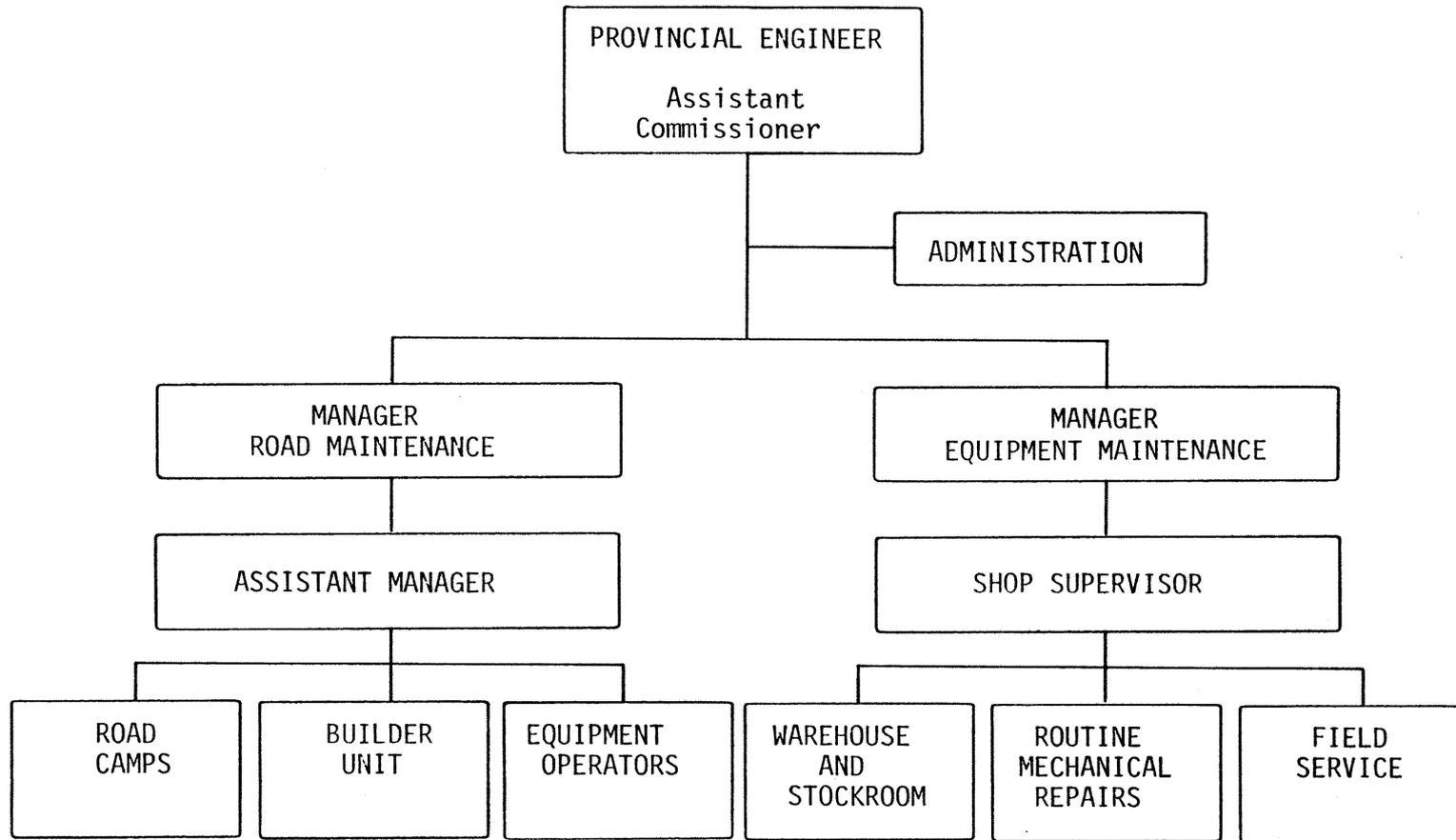


Figure 4-1. RECOMMENDED PROVINCIAL ORGANIZATION

maintenance organization for provincial roads or the transfer of all roads to the jurisdiction of the SRMTC. Parallel organizations are not recommended due to the added expense of duplicate facilities, equipment and personnel.

Another important concept of organization is "span of control." Span of control relates to the number of persons supervised by one individual. If the span of control is too large, supervision is not effective. If the span of control is too small then supervision is inefficient. Span of control is affected by the amount of other non-supervisory work performed, the complexity of the work, the location of the worksites, means of communication and other factors. An appropriate span of control for the Assistant Commissioner would be four to six employees including the equipment maintenance manager, the road maintenance manager, a clerk, and the head timekeeper/payroll clerk. The organization of the Administrative Branch is illustrated in Figure 4-3.

Clerk

A Clerk is necessary to type reports and correspondence for the Assistant Commissioner, maintain files of incoming and outgoing correspondence and assist the head timekeeper/payroll clerk.

Head Timekeeper/Payroll Clerk

This individual will process the payroll and maintain a record of hours worked by individual for the provincial maintenance organization.

ROAD MAINTENANCE DIVISION

The road maintenance division should include all personnel directly engaged in road maintenance work tasks. The recommended organization for the highway maintenance division is illustrated in Figure 4-4.

The recommended organization is based on geographic as well as functional considerations. Certain activities such as administration and tasks requiring specialized equipment or skills can be best performed if

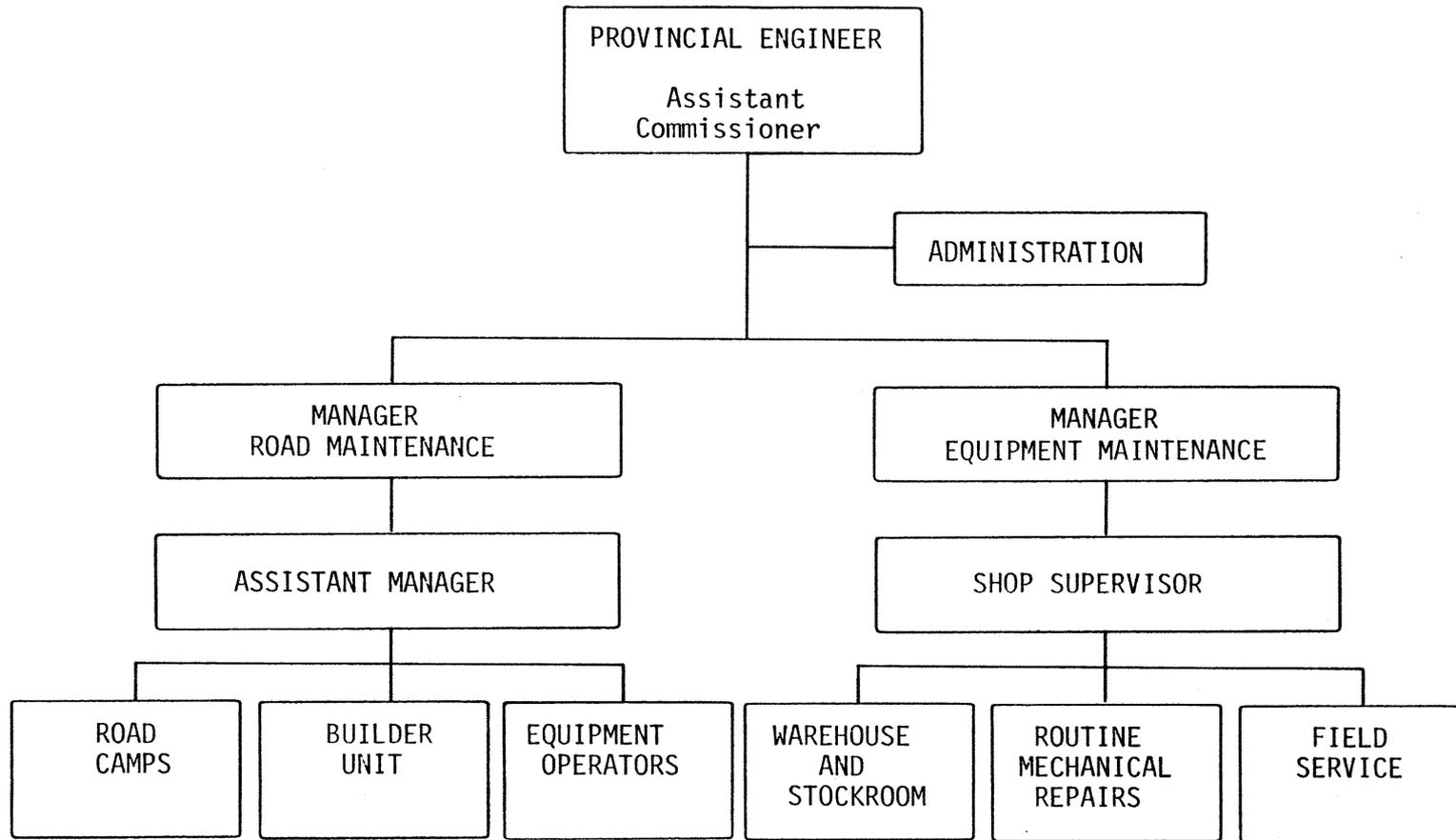


Figure 4-1. RECOMMENDED PROVINCIAL ORGANIZATION

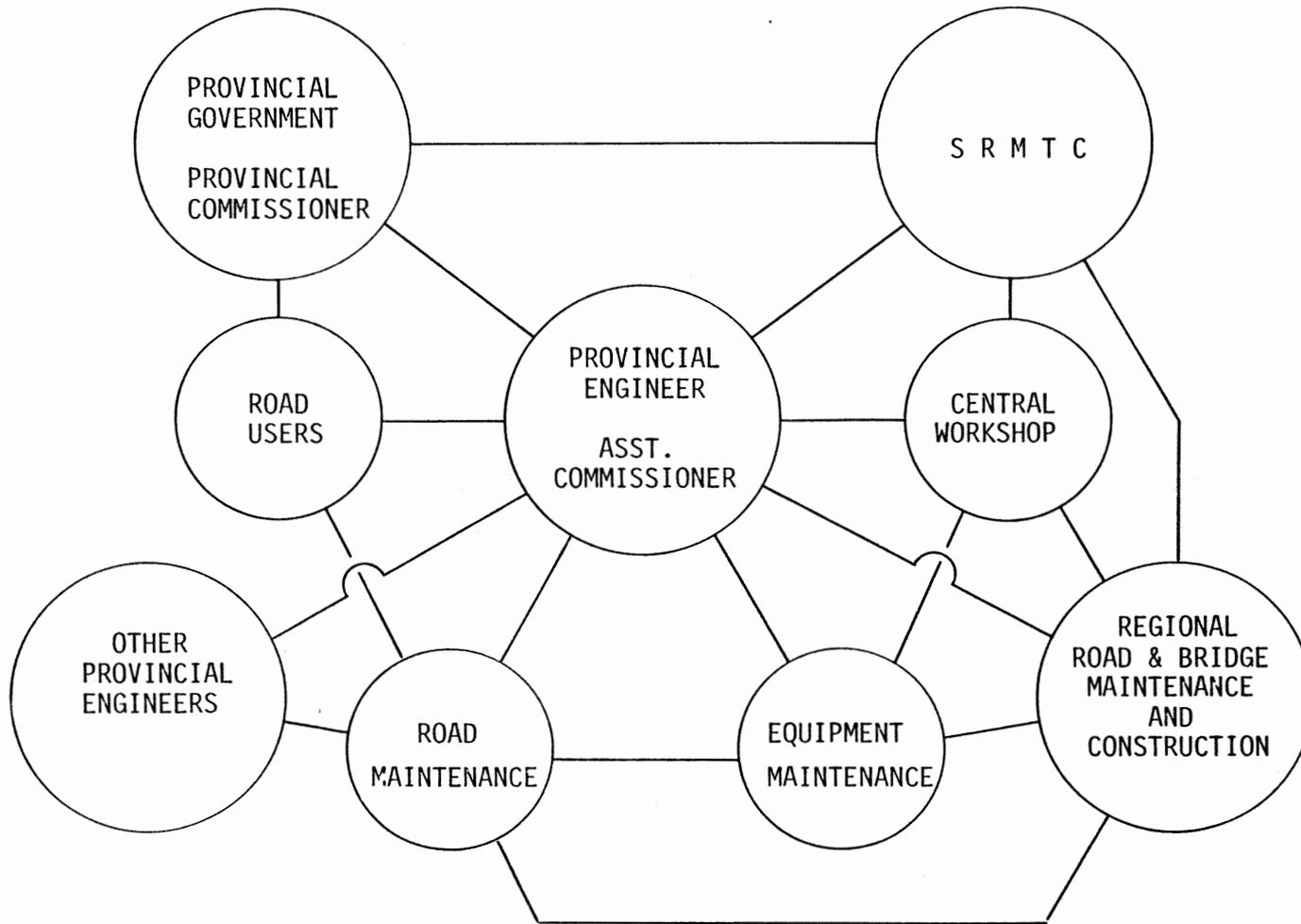


Figure 4-2. PROVINCIAL ENGINEER INTERACTION WITH OTHER AGENCIES

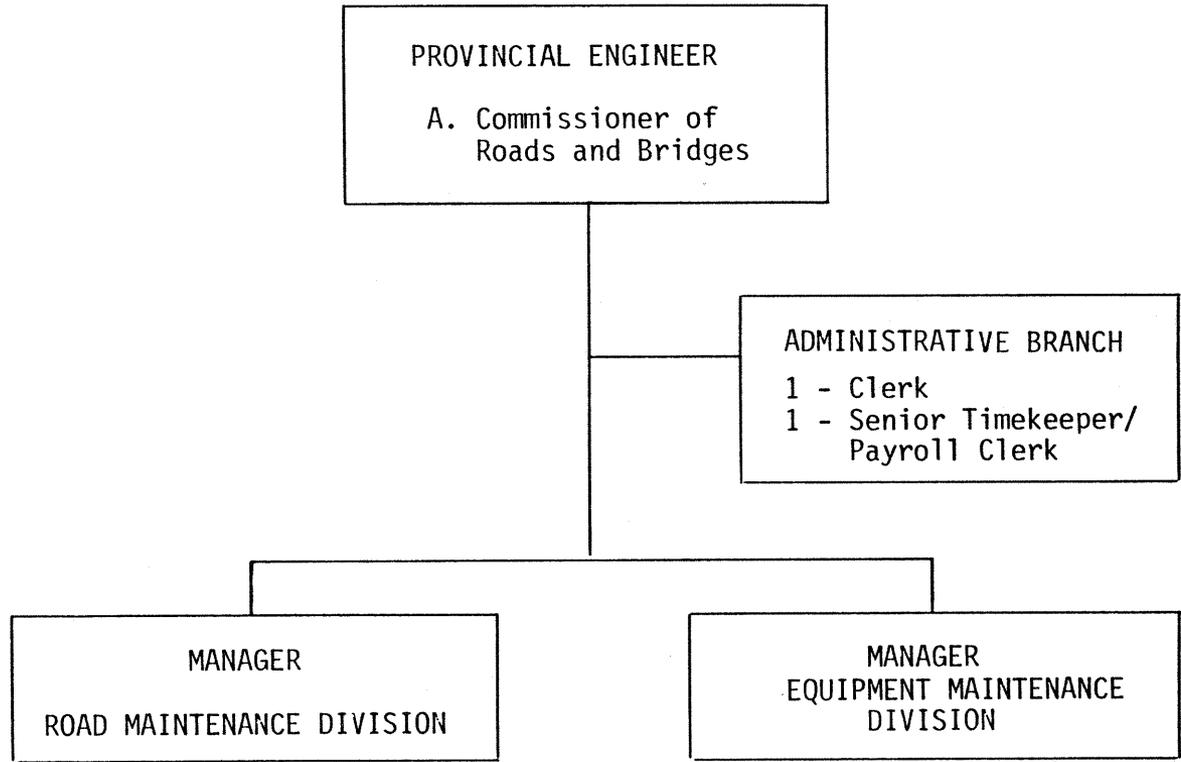


Figure 4-3. PROVINCIAL ENGINEER SPAN OF CONTROL

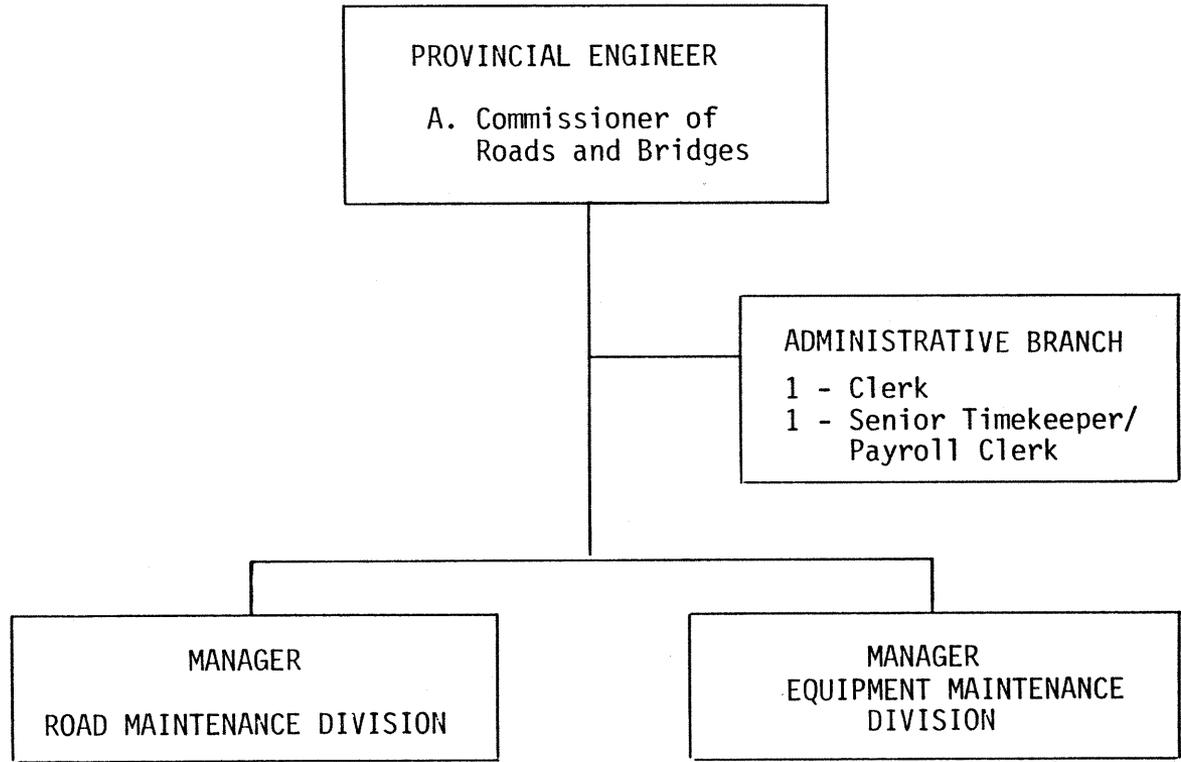


Figure 4-3. PROVINCIAL ENGINEER SPAN OF CONTROL

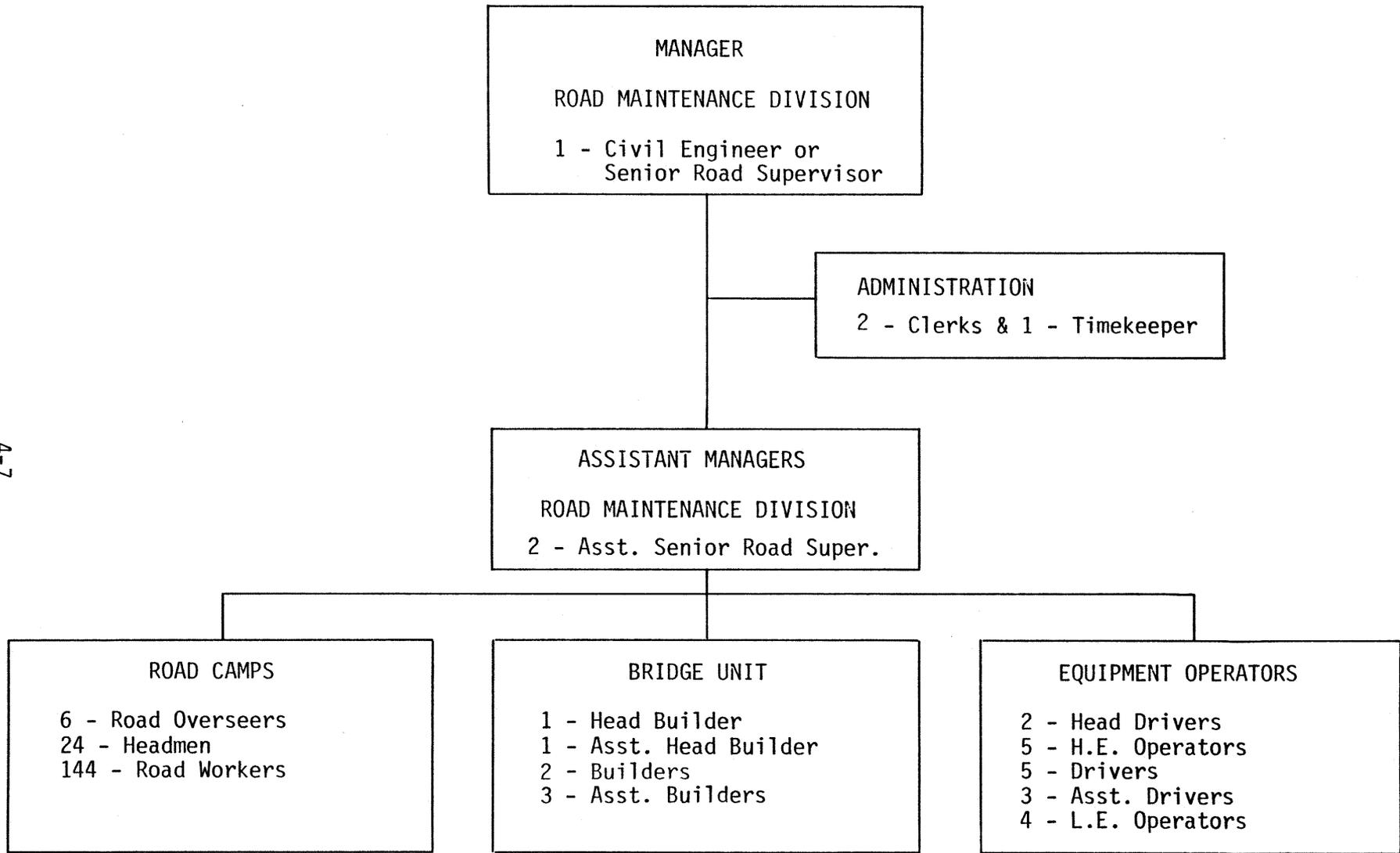


Figure 4-4. RECOMMENDED ORGANIZATION ROAD MAINTENANCE DIVISION - LAKES PROVINCE

operations are directed from a centralized location. Other activities such as the performance of tasks requiring hand labor can be best performed from small de-centralized road camps. The work tasks performed by the road maintenance division can be grouped into the following general activities:

- Road maintenance program administration
- Mechanical equipment activities
- Builder activities
- Road camp activities

Road Maintenance Program Administration

This activity includes the day to day management and administration of the provincial road maintenance program. The administrative staff includes the Road Maintenance Manager who heads the Road Maintenance Division, his assistants and clerical staff.

Road Maintenance Manager - Since the Head Builders are currently grades V and VI and will be under the supervision of the head of the Road Maintenance Division, the Division Manager should be a civil engineer, equivalent in rank with at least a Senior Road Supervisor (Grade VII). A Senior Road Supervisor with appropriate administrative and engineering experience could also serve as the Division Manager.

The span of control for this position should be no more than four or five individuals to allow adequate time for other duties. Duties should include preparation and supervision of annual work programs for road camps, builders, and mechanical equipment operations, preparation of periodic reports and annual budget requests, review of short term work schedules, periodic field evaluation of road conditions and work performance, evaluation of work reports, training, coordination of road maintenance operations, coordination of activities with the Equipment Maintenance Division and direct supervision of Assistant Managers and other administrative personnel.

Assistant Managers - Assistant Managers will receive general supervision from the Division Manager in the preparation of reports, schedules, budget requests and other management functions. They must also provide direct supervision to the road overseers, the bridge unit and reshaping crews. The span of control should be five to six individuals. Since there are a total of nine units immediately below the Assistant Manager in Lakes Province, two Assistant Division Managers are needed. The span of control for one Assistant Manager is illustrated in Figure 4-5.

The Assistant Manager should be at least equivalent to an Assistant Senior Road Supervisor (Pay Group VI) since general supervision of the Head Builder (Grade V or VI) will be required.

Mechanical Equipment Activities

Blading, reshaping and hauling are routine road maintenance tasks accomplished with mechanized equipment. The operators and drivers performing these tasks currently report to the supervisor of the equipment work center through a head driver. However, when performing road maintenance tasks, drivers and operators should be under the jurisdiction of a road maintenance supervisor. Therefore, to provide unity of command, drivers and operators should be assigned to the Road Maintenance Division.

The most important task performed with mechanical equipment is reshaping. This task will be accomplished with two independent crews and therefore two Head Drivers are required. The Head Driver will act in the capacity of a reshaping crew foreman and should therefore be knowledgeable of road repair techniques. Other duties would include completion of work reports, equipment utilization and operator maintenance reports, assignment of equipment for blading, hauling and stockpiling activities and supervision of equipment operators.

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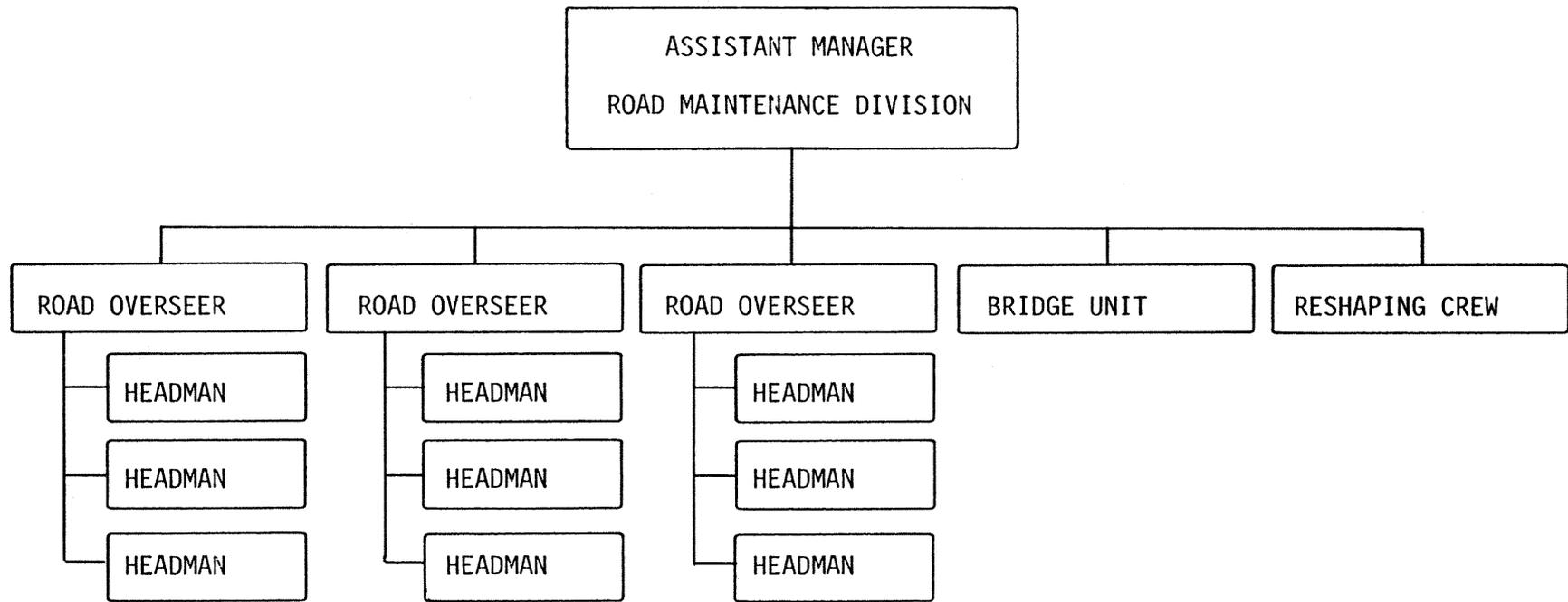


Figure 4-5. SPAN OF CONTROL FOR ONE ASSISTANT MANAGER OF THE ROAD MAINTENANCE DIVISION

Builder Activities

Minor repairs to bridges, culverts and drainage structures are routine maintenance activities that require the specialized skills of builders (carpenters, masons and concrete finishers). Under the existing system builders are supervised by a head builder who reports to the equipment work center supervisor.

To provide unity of command, builders should be assigned to the Road Maintenance Division. A Head Builder would still be required to supervise this unit, however it is recommended that the builders report to the Manager or Assistant Manager of the Road Maintenance Division. An Assistant Head Builder may also be necessary to facilitate splitting this crew for small assignments.

Road Camp Activities

The staffing formula currently used by the SRMTC authorizes the establishment of road camps every 10 kilometers (six miles) along roads maintained by the Ministry. The formula also authorizes various types of supervisory personnel based on road length. The number and types of supervisory personnel existing, authorized and recommended for the project route in Lakes Province are summarized in Table 4-1 and discussed below.

Headman - The headman is the first line supervisor and is responsible for directing the daily activities of the Road Workers assigned to one camp. In 1982, the SRMTC recommended that the number of workers per camp be reduced from 11 to six. Since all workers will typically be performing the same activity at any one time, a span of control between six and 11 is satisfactory. In addition to supervising the daily road camp activities, the headman should also be responsible for reporting work accomplished and days worked by each of the men in his camp.

Road Overseers - The road overseer is currently responsible for checking the work performed by three to five road camps. Work reports completed by the Headman should be reviewed and signed by the Road Overseer. This should include checking work completed in the field

Table 4-1
Road Camp Administration in Lakes Province

	Rumbek - Tonj Rd. 125 km			Rumbek - Mvola Rd. 122 km		
	Authorized Staff	Existing Staff	Recommended Staff	Authorized Staff	Existing Staff	Recommended Staff
Headman	12	12	12	12	15*	12
Road Overseer	4	2	3	4	3	3
Asst. Rd. Supervisor (Rd. Foreman)	2	0	0	2	1	0
Road Supervisor	1	0	0	1	0	0
Asst. Sr. Rd. Supervisor	1/2	0	1**	1/2	0	1**
Sr. Road Supervisor	0	0	1/2**	0	0	1/2**
Totals	19 1/2	14	16 1/2	19 1/2	19	16 1/2

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SUMMARY:

Total Authorized	39
Total Existing	33
Total Recommended	33

NOTES:

* Existing number of headmen may be as high as 20; 17 camps under Rumbek jurisdiction (camps 15 through 17 have been combined); 3 camps (32 through 34) under Mundri jurisdiction.

**Assignment to specific road section not recommended as discussed under road maintenance program administration.

against work reports in terms of quality and quantity, and checking work in progress to insure that proper work methods are being used and that the men reported to be working are on the job.

The Road Overseer should be responsible for turning in the work reports completed by the Headmen, reporting deficiencies requiring the provincial bridge crew, and making arrangements for road camps to assist on operations accomplished with mechanical equipment.

In view of the close supervision that must be provided to Headmen and the travel distances involved the span of control should be no more than four Headmen for each road overseer. The Road Overseer should devote his full time to supervising Headmen and should not be expected to function in a dual capacity as a road camp Headman.

Assistant Road Supervisors - With adequately trained road overseers this position is not necessary for the project route. When verbal instructions are passed through several levels of supervision, misinterpretation of the instructions is a likely result. Direct contact between the Road Overseers and supervisory personnel based in Rumbek will improve communications between Rumbek and the road camps.

Road Supervisors through Senior Road Supervisors - It is recommended that supervisors above the Assistant Road Supervisor level be based in Rumbek to direct maintenance operations throughout the province. The duties and responsibilities of senior road maintenance supervisory personnel are discussed in detail under the heading road maintenance program administrative activities.

EQUIPMENT MAINTENANCE DIVISION

The equipment maintenance division should include all personnel whose primary duties relate to the repair and maintenance of mechanical equipment. The recommended organization is illustrated in Figure 4-6. The equipment maintenance work tasks can be grouped into the following general activity areas, which will all be based at the work center:

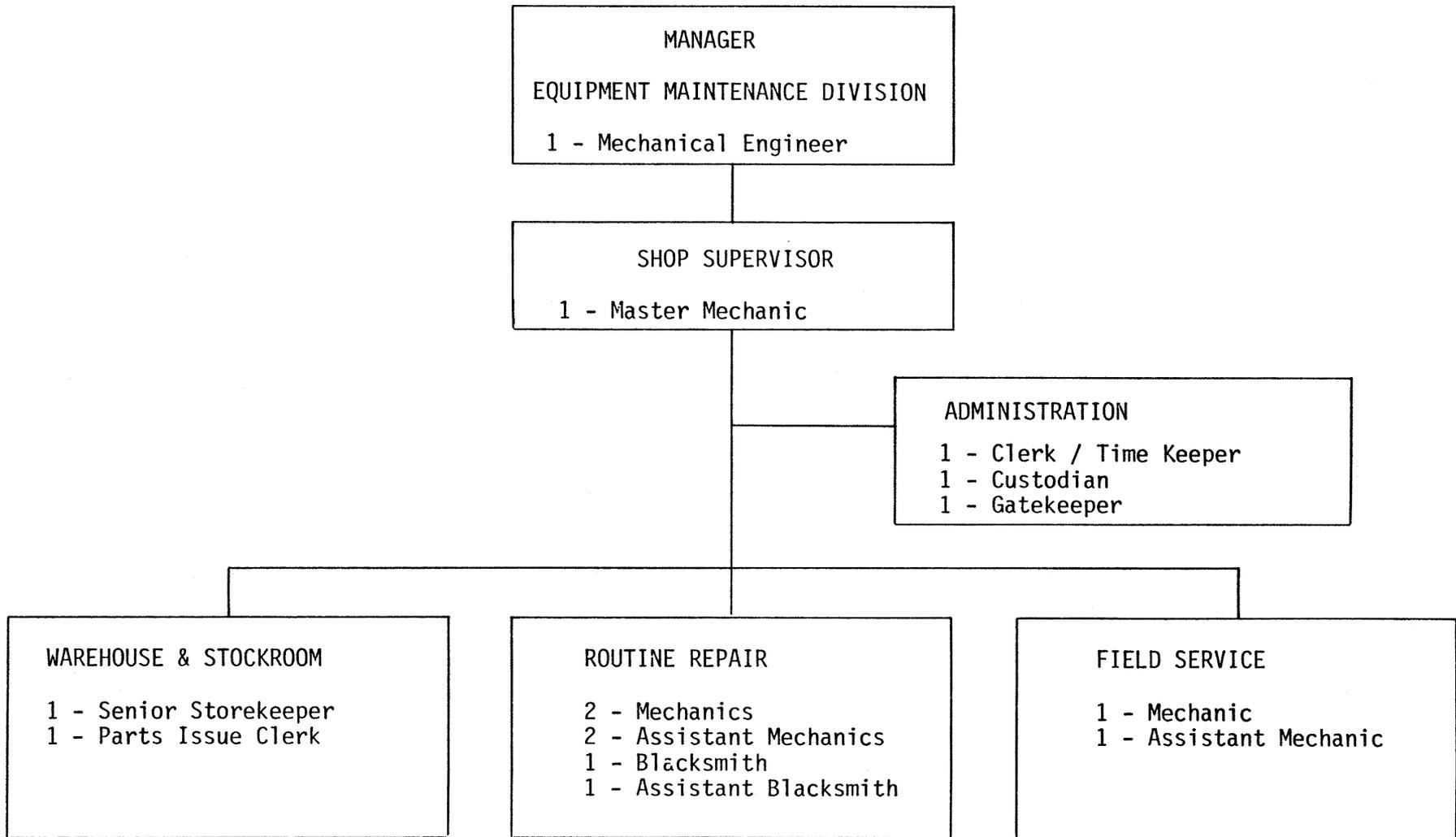


Figure 4-6. RECOMMENDED ORGANIZATION - EQUIPMENT MAINTENANCE DIVISION

- Administration
- Routine Mechanical Repairs (including preventative maintenance and component replacement)
- Field Service
- Warehouse and Stockroom Operations

Administration

Administration includes day to day management and administration of the equipment maintenance program. Staffing for this activity includes the Equipment Maintenance Division Manager, a Shop Supervisor a clerk/time keeper, and other staff such as custodians and gatekeepers.

Equipment Maintenance Division Manager - This individual would answer directly to the Provincial Engineer and be responsible for maintaining an effective working relationship between user (Road Maintenance) and shop. This relationship invariably requires good communication channels and an understanding of user plans and problems.

The Manager is responsible for overseeing the various equipment maintenance support functions including the shop office, warehouse and stockroom operations, providing equipment-related assistance to the Road Maintenance Division Manager, the performance of mechanical equipment inspections in the field, and the preparation of reports and budget requests.

The Manager provides general direction and supervision to the Shop Supervisor in planning and scheduling work to be performed in the shop, and makes arrangements for components or equipment to send to Juba for major repairs, overhauling or rebuilding. The Manager should be a mechanical engineer with experience in administration.

Shop Supervisor - The Shop Supervisor receives general supervision from the Equipment Maintenance Manager and assistance in planning and scheduling repairs.

The Shop Supervisor is responsible for developing shop repair orders (job descriptions), requisitioning of parts and supplies for the repairs, mechanic assignment and supervision, shop supervision and control, final inspection of work performed, general housekeeping, shop safety, and other related duties. Performance of these duties will require extensive knowledge of mechanical equipment, and therefore the shop supervisor should be a master mechanic.

The Shop Supervisor is also responsible for assignment and control of the Field Service Mechanic, the lowbed trailer driver (when not assigned to road maintenance tasks), gatekeepers, and the custodian.

Clerk/Time Keeper - One Clerk is necessary to keep personnel records including hours worked by equipment personnel for pay purposes, and to compile and maintain equipment utilization records, fuel useage records, and maintenance/repair records for each vehicle.

The clerk will also type reports prepared by the Equipment Maintenance Manager or the Shop Supervisor and will assist the storekeeper in unloading parts shipments, and distribution of parts, tools and supplies.

Custodian - The Custodian (Kaffir) performs general housekeeping and janitorial duties, but can also be utilized as a pump attendant at the fuel island.

Routine Mechanical Repairs

Equipment repairs and maintenance performed at the provincial work centers will generally be limited to preventative maintenance and general repairs of minor to moderate complexity to equipment and equipment components. These repairs and maintenance will be performed by mechanics and assistant mechanics. Minor body work may also be performed by mechanics or blacksmiths.

Mechanics - The mechanics will receive direct supervision and guidance from the Shop Supervisor. Mechanics will also assist in training and supervising assistant mechanics as directed by the Shop Supervisor.

Assistant mechanics will perform vehicle lubrication and other entry level tasks.

Blacksmiths - The blacksmiths will be supervised by the shop supervisor. Work will include minor bodywork and repair of Road Maintenance hand tools, dobbin borrows, wheelbarrows, bicycles and other similar items.

Field Service

Field service consists of emergency repairs, preventative maintenance, lubrication or other services performed on the road maintenance worksite. Field service will be provided by an experienced shop mechanic and an assistant mechanic. When not making road calls the field service mechanic will perform routine repairs and equipment maintenance in the provincial shop.

Warehouse and Stockroom Operations

The warehouse and stockroom stores and distributes parts, supplies and tools required by the Road and Equipment Maintenance Division. Staff required includes a senior storekeeper, and one parts issue clerk. Additional manpower necessary for unloading shipments or retrieving large or heavy objects from the warehouse, can be obtained by utilizing Assistant Mechanics, Custodians or the Manager's Clerk on a temporary basis.

Senior Storekeeper - The senior storekeeper should be responsible for operation and control of the warehouse and parts room. He will receive general supervision from the Shop Supervisor and Equipment Maintenance Manager in determining maximum and minimum inventory levels, and reorder points. The senior storekeeper will be responsible for preparing purchase orders, and submitting the orders for appropriate signatures on a timely basis to obtain spare parts, supplies, tools fuel, lubricants and other items needed by the work center.

He should routinely inspect the warehouse and check actual quantities in stock against quantities listed on stock control cards. The reasons for any differences should be determined and steps taken to correct the problem.

He should also monitor usage rates and reflect significant changes by adjusting reorder dates or quantities. He should identify obsolete parts and take appropriate steps to remove them from inventory.

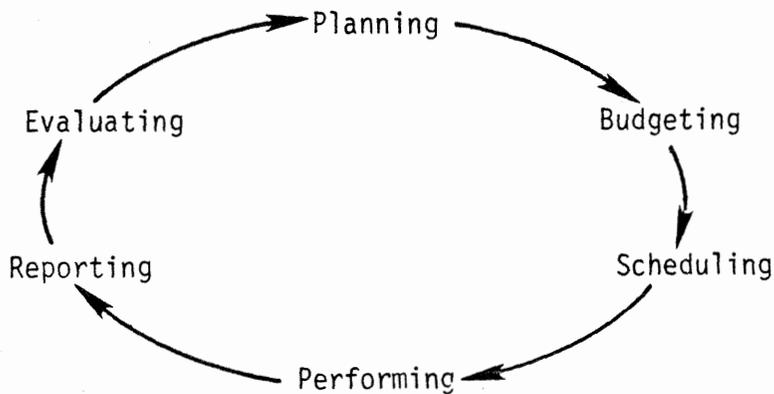
The senior storekeeper will supervise and assist in parts issue, and the recording of all stock transactions.

Parts Issue Clerk - The parts issue clerk will perform the distribution of parts, supplies and tools, record all transactions on proper forms, and maintain a cardex or similar stock inventory form.

Chapter 5
MANAGEMENT RECOMMENDATIONS

INTRODUCTION

The major cost items of a road maintenance program are labor, equipment and supplies. Management activities must focus on obtaining results from the investment in labor and equipment. The relationship of major management activities is illustrated below:



Planning

Planning should be a continuous process of establishing long and short term goals and objectives, and evaluating various alternatives to meet those goals and objectives. It involves determining in advance: What is to be performed, when it is to be performed, how it is to be performed and who is going to perform it.

Planning conserves valuable resources and promotes efficiency and effectiveness through the selection of alternative courses of action, improves program continuity by establishing short and long term goals and objectives, and improves employee morale through the achievement of specific goals.

Budgeting

Budgeting is the process of determining the resources necessary to implement the plan for a specific budget period. It involves determining the number of people, pieces of equipment, materials and supplies required to meet the goals and objectives established by the planning process.

Scheduling

Scheduling is the assignment of specific resources to accomplish a small portion of the plan within a specific time period.

Performing

Performing includes supervision and direction of work to insure that the work is performed properly and on time.

Reporting

Reporting is the process of documenting the work accomplished and the resources expended.

Evaluating

Evaluating consists of determining if the planned objectives were met in terms of level of service, work accomplished, and resources expended. Evaluating should identify programs which require improvement or that could be performed differently.

Management activities should be performed in varying degrees by all levels of supervisors, from the Assistant Commissioner to the Headman. Specific management activities will depend upon the level of the supervisor within the organization and the functional area of responsibility, such as road maintenance or equipment maintenance.

ROAD MAINTENANCE PROGRAM MANAGEMENT

Planning

Long range planning generally applies to planning periods that are longer than one year. Regraveling, reconstruction or expansion of the road system are examples of items that must be considered in long range planning. Long range provincial plans should be developed by the Assistant Commissioner, with considerable input from the road maintenance and equipment maintenance division managers, and other provincial governmental agencies. Long range plans should be submitted to the regional headquarters of the SRMTC annually for approval.

Short term planning generally applies to planning periods of one year or less. Short term plans should be developed by the division manager. An annual plan with estimated manpower and other resource requirements should be prepared and submitted to the Assistant Commissioner for approval.

As part of the planning process, an annual inspection of the SRMTC's provincial roads should be conducted between October and December. The inspection should be carried out by the division manager and assistant manager, and should cover every mile of road and each road camp. The road overseer for a specific section of road should accompany the division manager when his section of road is inspected.

The annual inspection is performed to serve several purposes:

- Sections of roadway are identified where deterioration or other problems indicate a need for regraveling, rehabilitation or other improvements.
- Special maintenance problems are identified and plans for correction are developed.
- Notes are made of areas requiring specialized skills such as builders or contract maintenance.
- Notes are made of minor maintenance needs and ways to improve routine maintenance.

The results of the inspection should be recorded on a log showing: location, type of work required, estimated units of work, and proposed timing and duration of the work. A sample log is shown in Figure 5-1.

INSPECTION LOG

INSPECTION TEAM							DATE	
<i>J. Jacobs</i>			<i>R. Brown</i>		<i>J. Jones</i>		<i>15 Oct. 1983</i>	
DIVISION MANAGER			ASST. MANAGER		ROAD OVERSEER			
LOCATION			TASK		ESTIMATED WORK			
ROUTE	FROM	TO	NO.	DESCRIPTION	YEAR TO BE DONE	NO. OF WORK UNITS	CREW SIZE	MAT'L
<i>Rumbek-Tong</i>	<i>Road Camp 15</i>	<i>Road Camp 16</i>	<i>B-1</i>	<i>Replace Culverts</i>	<i>1984</i>	<i>6</i>	<i>Builder Crew - 6 men</i>	<i>6 sections of pipe</i>
<i>Rumbek-Tong</i>	<i>Road Camp 11</i>	<i>Road Camp 20</i>	<i>-</i>	<i>Replenishing</i>	<i>1985</i>	<i>120 km</i>	<i>provincial replenishing crew</i>	

The inspection logs will provide information for developing or modifying annual work programs and an annual scheduling calendar. For example, the inspection may determine that four crew days of hand patching (Task H-3) per year may be inadequate for certain sections of road.

The inspection log will also provide information for updating long range plans and budgeting.

Budgeting

The annual budget should be developed by the Assistant Commissioner based on the proposed annual work programs prepared by the division managers.

Scheduling

Annual Calendar - An annual work scheduling calendar should be developed by the Road Maintenance Division Manager to provide general guidelines for scheduling maintenance activities which, out of necessity or desirability, are best performed during specific times of the year. For example, ditching (either by hand or as part of the mechanical reshaping operation) should be performed before and as required during the rainy season. The annual work scheduling calendar shows each activity and the months in which they should be performed. A sample calendar is shown in Figure 5-2.

Equipment - Many of the routine hand maintenance tasks can be performed throughout the year. The critical activities are those which require mechanical equipment. The annual work scheduling calendar should be used as a guide by the Assistant Managers and Head Drivers to prepare a Provincial Equipment schedule for a one (minimum) to three month period, similar to the schedule in figure 5-3. The equipment schedule should be coordinated with the equipment division and then used to establish weekly work schedules for the road camps. Day to day adjustments in the equipment schedule should be made by the head drivers, when necessary due to equipment breakdowns, need for emergency road

maintenance, weather or other reasons. The assistant managers, the equipment division, and road overseers affected by the changes should be notified when schedule changes are made.

Weekly Work Schedules - Weekly schedules should be prepared by the Head Drivers, Head Builders and Road Overseers for each crew under their supervision. Weekly schedules should be reviewed by the Assistant Managers. Depending upon the qualifications of the Road Overseers, Head Drivers, and Head Builders, it may be necessary for the Assistant Managers to prepare or assist in preparation of the weekly schedules initially (the majority of the road camp schedules will be the same or very similar). A typical schedule suitable for use by the Head Builders and Head Drivers is shown in figure 5-4.

The schedule prepared by the Road Overseer is combined on the same form as the weekly work report for road camps and is described under reporting.

On the Thursday preceding the week to be scheduled, the Head Driver, Head Builder or Road Overseer should take the following steps in preparing a Weekly Work Schedule:

- Check to see if any work is left over from previous schedule
- Review the Provincial Equipment Schedule to determine if mechanical equipment tasks are scheduled.
- Check the Work Scheduling Calendar to see which tasks should receive the major effort.
- Consider road conditions and select tasks most urgently needed.
- Refer to the Performance Standards to determine the crew days required for each task.
- Complete the Weekly Work Schedule, and in the case of the road overseer advise the Headmen under his supervision.

The Weekly Work Schedule is prepared with seasonal weather as a consideration. The work scheduled includes the type of work which could be performed, weather permitting. Obviously, adverse weather or equipment failures may disrupt the work scheduled and alternative work

WEEKLY WORK SCHEDULE

FOREMAN R. Nair SCHEDULE PERIOD - FROM: Jan 10, 1975 TO: Jan 15, 1975

EMPLOYEES	DAY OF WEEK							JOB	TASK	JOB DESCRIPTION/LOCATION	JOB	TASK	JOB DESCRIPTION/LOCATION
	S	M	T	W	T	F	S						
R. Nair	-	6	6	6	5	6	6	1	M-1	Roadwork - Rumbek-Tonj	9		
S. Jacob	-	3	3	3	3	3	3						
F. Duf	-	3	3	3	3	3	3	2	M-3	Hauling Sand for R. to Bokh Dams in Rumbek	10		
F. Sand	-	2	2	3	3	3	3						
R. Young	-	1	1	1	1	1	1	3	M-3	Hauling - Road work 11 to 17 Rumbek-Tonj	11		
W. Adams	-	5	5	4	4	4	4						
T. Black	-	4	4	4	4	4	4	4	M-4	Stockpiling - Rumbek-Tonj	12		
J. Brown	-	7	7	7	7	7	7						
								5	A-4	Overhead - Training	13		Alternate Assignment
								6	A-1	Supervision	14	A-3	Equipment Maintenance - Haul 2701 grader, W. to Juba
								7	A-2	Approval Lease	15		
								8			16		

EQUIP. NUMBER	EQUIPMENT DESCRIPTION	DAY OF WEEK							EQUIP. NUMBER	EQUIPMENT DESCRIPTION	DAY OF WEEK						
		S	M	T	W	T	F	S			S	M	T	W	T	F	S
2710	Motor grader		1	1	1	1	1	1									
3020	Dump truck		3	3	3	3	3	3									
3021	Dump truck		3	3	3	3	3	3									
3022	Dump truck		2	2	3	3	3	3									
2827	Bull Dozer		4	4	4	4	4	4									
3130	Truck tractor		4	4	4	4	4	4									
3131	Lowbed trailer		4	4	4	4	4	4									

5-9

must be planned so that work time will not be wasted in waiting for a schedule change. Alternative assignments should be listed on the schedule.

Performing

The Performance Standards establish the proper procedure for performing each task, and the average amount of work to be accomplished daily. Supervisors are responsible for insuring that work is performed properly, on schedule, and at an adequate level of productivity.

The Road Overseers should visit work sites for each of the four camps under their supervision each week on Friday or Saturday to determine that proper work methods are being used; that the schedule is being followed; that the proper number of men are working; and that amount and quality of work performed is acceptable. These visits should also be used to determine if problems exist, to give the Headman the next week's schedule, and to advise him of road conditions which require immediate attention, collect work reports, and conduct other business as necessary. Worksite visits should also be conducted on an unscheduled, unannounced basis throughout the week. Camps that are not performing adequately should be visited more frequently to determine the cause for the inadequate performance. Recurring problems should be reported by the Road Overseer to the Division Manager or Assistant Manager.

The Head Drivers and Head Builders should generally be at the site where their crew is working. However, when they have people working at several locations such as stockpiling, they should periodically check on the progress of the work to verify the quality and amount of work performed. The Assistant Managers should have the use of a pick-up truck on Saturdays or Mondays to collect work reports from the road overseers and advise them of any schedule changes.

The Manager and Assistant Managers should periodically inspect and evaluate road conditions and work quality. Scheduled and unscheduled visits should be made to work sites to observe work in progress. These work inspection visits should be made both with and without the road overseer. Information obtained from these visits may be used to modify

Performance Standards, Work Schedules, or Work Programs. However, the primary purpose is to insure that the work is being performed and that the road is being adequately maintained. Poor performance cannot be ignored because it will only get worse. The following steps, or a similar procedure approved by the SRMTC should be used with individuals who do not perform satisfactorily.

- Discuss inadequate performance with the individual or individuals involved.
- If performance does not improve issue verbal warning.
- If no improvement is noted or problem soon reappears, issue written warning.
- If no improvement occurs take disciplinary action, such as suspension without pay or reduced pay.
- If problem continues the employee should be laid off.

Existing productivity levels (as observed in January and February of 1982) were far from adequate. This lack of productivity stems, at least in part, from inadequate tools and supplies, low salaries, late payment of salaries, and poor communications between road camps and office. Improving employee morale and instilling a good work attitude will require improvement of these conditions and a strong effort by all supervisory personnel.

Reporting

In order for the road maintenance program to function properly, information must be reported, processed and then used for review and analysis purposes. Information to be reported includes:

- Supervisor in charge of the work.
- Date.
- Location.
- Task performed.
- Work accomplished.
- Resources used (labor, equipment, material).

The sample daily work report shown in Figure 5-5 will capture all of this information, and is recommended for the crews supervised by head drivers or head builders.

With road camps, work will generally be confined to a small area and the only significant resources used will be labor. This permits considerable simplification of the work report. A combined weekly schedule and work report is recommended similar to the sample report shown in Figure 5-6.

The Road Overseer fills in the schedule portion, lists alternate assignments on the back, and then verbally advises the Headman of work priorities and alternate assignments. He may also assist by filling in employee names. The Headman can then check the appropriate boxes on the work report as work is completed. With training, the Headman should also be able to fill in the work accomplished. To assist the Headman in reporting alternate assignments, each Headman should be given an illustrated list of work tasks, such as that shown in Figure 5-7.

Evaluating

The evaluating process involves three steps: processing, review and analysis, and corrective action.

Processing - In addition to hours worked by each employee, weekly and daily work reports contain valuable management information. However, in order for this information to be used effectively, the volume of information must be reduced, organized and provided as reports to the appropriate levels of supervision. The information contained in these reports and frequency of reports should be tailored to meet the needs of each level of management. For example, the Assistant Commissioner may be primarily interested in provincial summaries on a quarterly basis, while the road maintenance manager may require more detail on a monthly basis. The basic management information reports recommended for the Lakes Province are listed below. Each report is illustrated and described on the following pages.

FIGURE 5-6

WEEKLY WORK REPORT

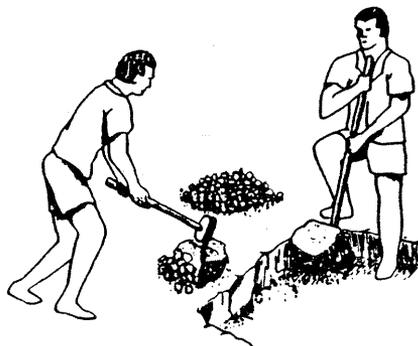
PROVINCE <i>LAKES</i>	ROAD CAMP <i>7</i>	HEADMAN <i>S. Stone</i>
ROUTE <i>Rumbek-Munda</i>	PERIOD <i>Jan. 10 - Jan. 15</i>	ROAD OVERSEER <i>R. Jacobs</i>

		SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
SCHEDULED TASKS *			<i>H-1</i>	<i>H-1</i>	<i>M-2</i>	<i>H-3</i>	<i>H-1</i>	<i>H-3</i>
TASKS PERFORMED			✓	✓	<i>H-1</i>	<i>H-2</i>	<i>H-3</i>	✓
EMPLOYEES	<i>S. Stone</i>		✓	✓	✓	✓	✓	✓
	<i>M. Jones</i>		✓	✓	✓	✓	✓	✓
	<i>R. Jones</i>		✓	✓	✓	✓	✓	✓
	<i>L. Brown</i>		✓			✓	✓	✓
	<i>J. Black</i>		✓	✓	✓	✓	✓	✓
	<i>T. Able</i>		✓	✓	✓	✓	✓	✓
	<i>N. Baker</i>		✓	✓		✓	✓	✓
WORK ACCOMPLISHED			<i>3</i>	<i>3</i>	<i>3</i>			

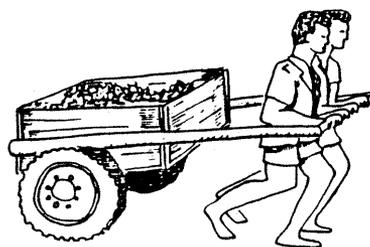
* ALTERNATE ASSIGNMENTS ON BACK

FIGURE 5-7 WORK TASKS

H-1 HAND STOCKPILING



H-2 HAND HAULING



H-3 HAND PATCHING



H-4 HAND SPREADING



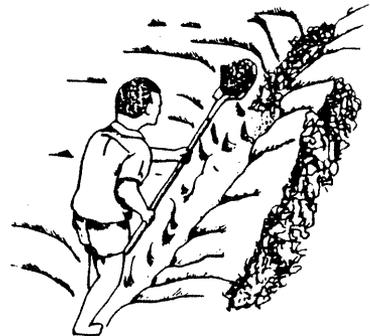
H-5 HAND SWEEPING



H-6 HAND SCARIFYING



H-7 HAND DITCHING



**H-8 CLEANING CULVERTS
AND BRIDGE DRAINS**

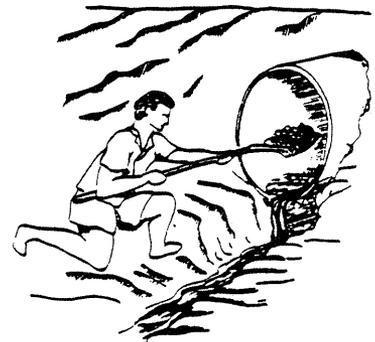
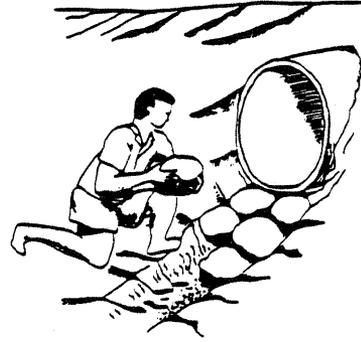


Figure 5-7 (Continued)

H-9 EROSION REPAIR



H-10 BRUSH CUTTING



H-11 DIGGING SOIL FOR HUTS



Figure 5-7 (Continued)

H-12 BUILDING MUD HUTS



H-13 RETHATCHING HUT ROOF

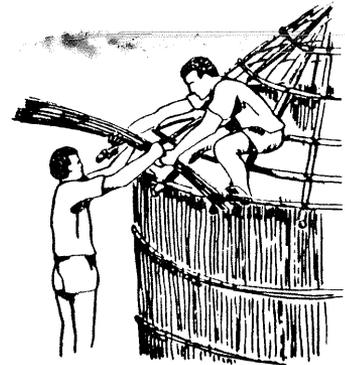
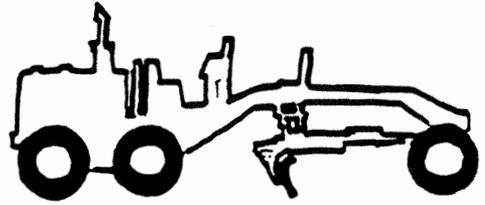
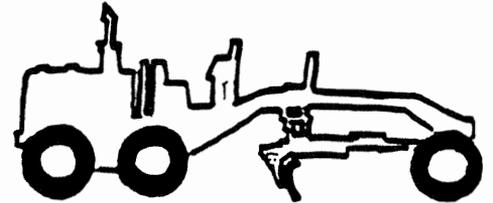
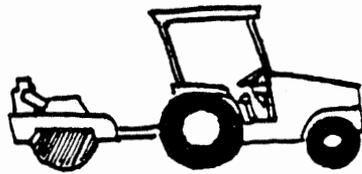


Figure 5-7 (Continued)

M-1 BLADING



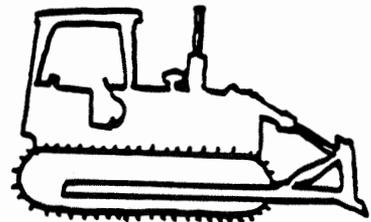
M-2 RESHAPING



M-3 HAULING



M-4 STOCKPILING



<u>Figure No.</u>	<u>Report No.</u>	<u>Title</u>
5-8	1	Monthly Work Accomplishment
5-9	2	Monthly Labor Report
5-10	3	Task Accomplishments
5-11	4	Task Labor
5-12	5	Task Productivity
5-13	6	Exception Report
5-14	7	Program Status
5-15	8	Program Summary Status
5-16	9	Provincial Summary of Work Accomplished
5-17	10	Provincial Summary of Labor
5-18	11	Equipment Use Record
5-19	12	Equipment Use Summary

Report #1 Montly Work Accomplishment

Description - A separate sheet for each crew is completed each month at the provincial office to record units of work accomplished for each task. Units of work accomplished are entered under the day the work was performed in the appropriate row for the task performed. Rows are totaled at the end of the month.

Use - The report serves primarily as a spread sheet on which the clerk can tabulate the work performed by a crew. The totals for the various tasks are used when compiling reports 2 and 3.

The report can also be used by management as a reference when evaluating crew performance.

Comments - Care must be taken when filling in accomplishments for tasks that involve more than one crew. For example, work accomplished with mechanical equipment may involve a reshaping crew and a road camp crew. It is suggested that the units accomplished as reported by the head driver be counted when summarizing the province's total work output. Units reported by the road camp for tasks involving mechanical equipment should be circled to avoid double counting.

MONTHLY WORK ACCOMPLISHMENT

MONTH		CREW		LOCATION		SUPERVISOR																												
March 1983		Road Camp 10		Rumbek-Muolo Rd		P. Jones																												
TASK	WORK UNITS																															TOTAL UNITS	TOTAL DAYS	AVG. PER DAY
	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			
H-1	3	4	4			3																										14	4	3.5
H-2								4																								4	1	4
H-3							3																									3	1	3
H-4									6																							6	1	6
H-5																																-	-	-
H-6																						120	100	150	150			150			670	5	134	
H-7										400	500		600	600	400	500	500	400		500											4,400	9	489	
H-8																					3										3	1	3	
H-9																																		
H-10																												600	600	600	700	2550	4	638
H-11																																		
H-12																																		
H-13																																		
M-1																																		
M-2																																		
M-3																																		
M-4																																		
B-1																																		
B-2																																		
B-3																																		
B-4																																		
B-5																																		
A-1																																		
A-2																																		
A-3																																		
A-4																																		
TOTAL																																		

5-21

9

9

9

Report #2 - Monthly Labor

Description - A separate sheet for each camp is completed each month to record man days expended on each task.

Use - The report serves primarily as a spread sheet for tabulating the man days worked by each crew on the various tasks. The totals for each task are used to compile reports 3 and 5.

Comment - Total Work Units accomplished for each task are obtained from Report 1 and used to compute average productivity.

Report #3 - Task Accomplishments

Description - A separate sheet is compiled for each task summarizing the work performed each month, by each of the crews. Totals from the completed report 1 sheets are entered under the appropriate month for each crew.

Use - The information contained on this report is used in preparing and evaluating reports 5, 6, 7, and 9.

Report #4 - Task Labor

Description - A separate sheet is prepared for each task summarizing the man days expended each month by crew. Totals from the completed report 2 sheets are entered under the appropriate month for each crew.

Use - This report is used in preparing and evaluating reports 5, 6, 7, and 10.

Report #5 - Task Productivity

Description - A separate sheet is completed for each task. Average work units accomplished are obtained from Report 2 and entered in the appropriate month column for each crew. The average monthly productivity for the entire province is computed by dividing total work accomplished (from report 1) by total man days worked (from report 2).

MONTH March 1983

CREW Road Camp 10

LOCATION Rumbek-Muolo Road

SUPERVISOR R. Jones

TASK	MAN DAYS EXPENDED																															TOTAL MAN DAYS	TOTAL WORK UNITS	AVG. PER M. DAY
	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			
H-1	6	7	7			5																										25	14	.6
H-2								7																								7	4	.6
H-3							7																									7	3	.4
H-4									7																							7	6	.9
H-5																																		
H-6																					7	7	7	7			7					35	670	19
H-7										7	7																					63	4,400	70
H-8																					7											7	3	.4
H-9																																		
H-10																												7	7	7	7	28	2550	91
H-11																																		
H-12																																		
H-13																																		
M-1																																		
M-2																																		
M-3						5																										5	9	1.8
M-4																																		
B-1																																		
B-2																																		
B-3																																		
B-4																																		
B-5																																		
A-1																																		
A-2																																		
A-3																																		
A-4																																		
TOTAL																																		

Report 3

TASK ACCOMPLISHMENTS

TASK NUMBER	YEAR 1983												
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
H-1													
RUMBEK-TONJ RD. CAMP 11	16	12											
12	18	10											
13	9	15											
14	4	12											
15	4	14											
16	12	6											
17	12	8											
18	18	6											
19	20	6											
20	12	12											
21	15	10											
22	9	10											
RUMBEK-MVOLA RD. CAMP 1	9	9											
2	12	8											
3	16	6											
4	9	10											
5	9	8											
6	4	12											
7	6	12											
8	12	8											
9	12	6											
10	14	6											
11	6	8											
12	15	6											
RESHAPING CREW 1	N/A												
RESHAPING CREW 2	N/A												
BUILDERS CREW 1	N/A												
TOTAL	273	220											
AVERAGE UNITS/ CREW	11.4	9.2											

5-24

Report
TASK LABOR

TASK NUMBER	MAN DAYS WORKED												YEAR
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
H-1													
RUMBEK-TONJ RD.CAMP 11	25	24											
12	40	21											
13	18	28											
14	12	15											
15	8	30											
16	28	21											
17	24	20											
18	36	15											
19	20	20											
20	30	30											
21	28	20											
22	30	30											
RUMBEK-MVOLA RD.CAMP 1	20	20											
2	29	16											
3	30	15											
4	26	24											
5	20	20											
6	15	21											
7	15	21											
8	15	24											
9	24	14											
10	30	14											
11	15	14											
12	30	21											
RESHAPING CREW 1	N/A	N/A											
RESHAPING CREW 2	N/A	N/A											
BUILDERS CREW 1	N/A	N/A											
TOTAL	568	498											
AVERAGE MAN DAYS/CREW	24	21											

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TASK PRODUCTIVITY

TASK NUMBER	AVERAGE WORK UNITS ACCOMPLISHED PER MAN DAY												YEAR 1983
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
RUMBEK-TONJ RD.CAMP 11	.6	.5											
12	.5	.5											
13	.5	.5											
14	.8	.8											
15	.5	.5											
16	.1	.3											
17	.5	.4											
18	.6	.4											
19	.6	.3											
20	.4	.4											
21	.5	.5											
22	.3	.3											
RUMBEK-MVOLA RD.CAMP 1	.5	.5											
2	.4	.5											
3	.5	.4											
4	.3	.4											
5	.5	.4											
6	.3	.6											
7	.4	.6											
8	.8	.3											
9	.5	.4											
10	.5	.4											
11	.4	.6											
12	.5	.3											
RESHAPING CREW 1													
RESHAPING CREW 2													
BUILDERS CREW 1													
* TOTAL ACCOMPLISHED	273	220											
** TOTAL MAN DAYS	568	498											
AVERAGE PRODUCTIVITY	.5	.4											

*TOTAL ACCOMPLISHED FROM REPORT 3

** TOTAL MAN DAYS FROM REPORT 4

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Use - This report can be utilized by the Assistant Division Managers or the Manager to compare crew productivity. The report should be reviewed with Road Overseers and Head Drivers so they can see how their crew(s) compares with other crews.

Report #6 - Exception Report

Description - This report highlights the important information contained in reports 5 and 3. Crews whose performance is significantly above or below the provincial average (limits should be established by the division manager) are listed for each task.

Use - The reasons for significant differences in performance should be determined. If the work accomplished is low, the crew may be understaffed, reporting work inaccurately, or using improper work methods. If productivity is too high the crew may have determined a better work method, may be reporting work inaccurately, or may not be achieving the desired quality. If the high productivity rates are accurate and the work is of acceptable quality the crew should be rewarded. When low productivity rates occur attempts should be made to improve them.

Report #7 - Program Status

Description - A separate sheet is prepared for each task on a monthly basis. Planned accomplishments and planned labor expenditures for each crew, taken from the annual work program are compared with actual work accomplished and man days worked.

Use - The report is used to identify crews which are performing over or under the planned level, and tasks that require reduced or added emphasis. When combined with information from field observations, it can be determined if the plan should be modified or if crew schedules should be modified to meet the planned goals.

Report 7
PROGRAM STATUS

MONTH Feb 1983 TASK H-1

CREW	ACCOMPLISHMENTS (WORK UNITS)				LABOR (MAN DAYS)				
	THIS MONTH		YEAR TO DATE		THIS MONTH		YEAR TO DATE		
	PLANNED	ACTUAL	PLANNED	ACTUAL	PLANNED	ACTUAL	PLANNED	ACTUAL	
Rumbek - Tonj Road Camo	11	6	12	18	28	14	24	42	49
	12	6	10	18	28	14	21	42	61
	13	6	15	18	24	14	28	42	46
	14	6	12	18	16	14	15	42	27
	15	6	14	18	18	14	30	42	38
	16	6	6	18	18	14	21	42	49
	17	6	8	18	20	14	20	42	44
	18	6	6	18	24	14	15	42	51
	19	6	6	18	26	14	20	42	40
	20	6	12	18	24	14	30	42	60
	21	6	10	18	25	14	20	42	48
	22	6	10	18	19	14	30	42	60
Rumbek - Movlo Road Camp	1	6	9	18	18	14	20	42	40
	2	6	8	18	20	14	16	42	45
	3	6	6	18	22	14	15	42	45
	4	6	10	18	19	14	24	42	50
	5	6	8	18	17	14	20	42	40
	6	6	12	18	16	14	21	42	36
	7	6	12	18	18	14	21	42	36
	8	6	8	18	20	14	24	42	39
	9	6	6	18	20	14	14	42	38
	10	6	6	18	20	14	14	42	44
	11	6	8	18	14	14	14	42	29
	12	6	6	18	21	14	21	42	52
Reshaping Crew	1	0	0	0	0	0	0	0	0
Reshaping Crew	2	0	0	0	0	0	0	0	0
Builders Crew	1	0	0	0	0	0	0	0	0
Province Total		144	220	432	493	336	498	1008	1066

Report #8 - Program Summary

Description - This report summarizes the data contained in the sheets for report 7.

Use - Copies of this report should be submitted to the Assistant Commissioner on a monthly basis. It provides a summary of the work accomplished and labor expenditures for the entire province and provides a comparison of actual work performed with planned work performance.

Report #9 - Provincial Summary of Work Accomplished

Description - This report displays the work accomplished by the entire province on each task for each month. Totals from the sheets for report 3 are entered under the appropriate month column for each task row.

Use - Copies of this report should be submitted periodically to the regional headquarters in Juba. It should also be used by the Division Manager and Assistant Commissioner during the annual planning and budgeting process.

Report #10 - Provincial Summary of Labor

Description - This report summarizes the labor expenditures for the entire province on each task for each month. Totals from the sheets for report 4 are entered each month for each task.

Use - This report should be submitted periodically to the regional headquarters in Juba. It should also be used by provincial personnel in preparation of annual budgets and work plans.

Report #11 - Equipment Use Record

Description - A separate sheet is filled out each month for each piece of equipment to record the number of hours the vehicle was used for each task, or the reason the unit was not used.

Use - Equipment represents a significant investment and management should attempt to achieve maximum utilization. This report will document problems such as lack of fuel, or inadequate parts inventory that reduce

PROGRAM SUMMARY

MONTH Feb. 1983

TASK	ACCOMPLISHMENTS (WORK UNITS)				LABOR (MAN DAYS)			
	THIS MONTH		YEAR TO DATE		THIS MONTH		YEAR TO DATE	
	PLANNED	ACTUAL	PLANNED	ACTUAL	PLANNED	ACTUAL	PLANNED	ACTUAL
H-1 Hand Stockpiling	144	220	432	493	336	498	1008	1066
H-2 Hand Hauling								
H-3 Hand Patching								
H-4 Hand Spreading								
H-5 Hand Sweeping								
H-6 Hand Scarifying								
H-7 Hand Ditching								
H-8 Cleaning Culverts								
H-9 Erosion Repair								
H-10 Brush Cutting								
H-11 Digging Soil								
H-12 Building Huts								
H-13 Rethatching								
M-1 Blading								
M-2 Reshaping								
M-3 Hauling								
M-4 Stockpiling								
B-1 Structure Repair								
B-2 Pipe Replacement								
B-3 Making Pipe								
B-4 Installing Underdrain								
B-5 Stockpiling Sand								
A-1 Supervision								
A-2 Approved Leave								
A-3 Equipment Maintenance								
A-4 Overhead								

Report 9

PROVINCIAL SUMMARY - WORK ACCOMPLISHED (UNITS)

PROVINCE Lakes

YEAR 1983

TASK	UNITS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
H-1	m. ³	273												
H-2	m. ³	250												
H-3	m. ³	242												
H-4	m. ³	605												
H-5	km.	95												
H-6	m.	-												
H-7	m.	1000												
H-8	Each	3												
H-9	m. ³	-												
H-10	m.	150,000												
H-11	m. ³	10												
H-12	Each	4												
H-13	Each	4												
M-1	km.	440												
M-2	km.	-												
M-3	m. ³	700												
M-4	m. ³	1000												
B-1	m. ²	4												
B-2	pipe sect.	10												
B-3	pipe sect.	12												
B-4	Each	-												
B-5	m. ³	72												
A-1	N/A													
A-2	N/A													
A-3	N/A													
A-4	N/A													

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Report 10

PROVINCIAL SUMMARY - LABOR (MAN DAYS)

PROVINCE LAKES YEAR 1983

TASK	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
H-1	568												
H-2	500												
H-3	460												
H-4	330												
H-5	90												
H-6	-												
H-7	14												
H-8	7												
H-9	-												
H-10	1450												
H-11	14												
H-12	140												
H-13	56												
M-1	20												
M-2	-												
M-3	220												
M-4	10												
B-1	14												
B-2	35												
B-3	42												
B-4	-												
B-5	84												
A-1	225												
A-2	789												
A-3	70												
A-4	140												
	5278												

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MONTHLY EQUIPMENT USE RECORD

STOCK NO.			TYPE				MONTH			
DATE	OPERATOR	UNITS	TASK PERFORMED				NOT IN SERVICE			
			M-1	M-2	M-3	M-4	NO WORK	NO FUEL	REPAIR/ SERVICE	WAITING PARTS
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										
TOTALS										

utilization. The report may also assist in evaluating recurring or chronic mechanical problems stemming from operator abuse, improper application, or overloading the capacity of the unit.

This report is prepared by the Road Maintenance Division but should be sent to the Equipment Maintenance Division.

Report #12 - Equipment Use Summary

Description - This report summarizes the information compiled on the sheets for report 11, by vehicle type.

Use - Types of equipment with low utilization (50 to 60 percent) should be evaluated. Evaluation may determine: that parts inventories should be upgraded; that different types of equipment should be considered for future purchases; that excess equipment should be shared or even reassigned to other provinces; or that repair facilities should be improved.

MONTHLY EQUIPMENT USE SUMMARY MONTH _____

DATE	EQUIPMENT TYPE	UNITS	TASK PERFORMED				NOT IN SERVICE			
			M-1	M-2	M-3	M-4	NO WORK	NO FUEL	REPAIR/SERVICE	WAITING PARTS
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										
TOTALS										

EQUIPMENT MAINTENANCE PROGRAM MANAGEMENT

Planning

Systematic shop planning is a basic requirement for efficient management of equipment servicing and repair. Planning involves developing shop control procedures designed to utilize available shop manpower and space in a manner that will promote optimum use of the Work Center facilities. The shop control procedures should satisfy the following objectives:

- Responsiveness to user requirements.
- Minimizing downtime and maximizing equipment availability.
- Performing repairs and servicing with the lowest expenditure of labor and material cost.
- Maintaining optimum productivity.
- Establishing a high level of workmanship.

Scheduled Work - Scheduled equipment maintenance includes routine services and repairs that are predictable in advance and can be scheduled in proportion to mechanic and shop space availability. Examples of scheduled work include preventive maintenance, lubrication and servicing. These services are generally performed on a pre-determined schedule based on engine hours or kilometers.

The work center should establish the service interval for each vehicle in terms of engine hours or kilometers and weeks or months. However, it is recommended that the user be responsible for adherence to the schedule. The work center should be contacted by the road maintenance division several days prior to the need for PM servicing of a unit, in order to allow time for scheduling.

Non-Scheduled Work - Non-scheduled equipment maintenance is unpredictable in nature. Often there is no warning until the equipment failure actually occurs, such as a broken axle shaft. Repair of breakdowns must receive a high priority to minimize equipment downtime and usually takes precedence over scheduled repairs.

Balancing the Workload - The shop workload must be responsive to the user by planning daily workloads to provide the capability of absorbing a reasonable amount of non-scheduled work.

Non-scheduled work is estimated to represent approximately 50 percent of the workload in the public sector. This 50 percent includes some routine servicing performed at the same time to reduce the number of trips to the shop, thereby improving equipment availability. The remaining 50 percent is schedulable in advance.

The amount of non-scheduled work can be reduced if PM inspections are carefully executed. Signs of wear or damage may be detected and can be scheduled instead of waiting for a failure to occur that will result in a non-scheduled repair. Thorough mechanical inspection can also reduce workloads by detecting problems at an early stage. For example, replacing an oil seal may prevent the ultimate destruction of a transmission.

Chronic mechanical problems also increase shop work loads and should be diagnosed for cause. Corrective actions should be taken to insure that the problem is resolved. Such problems are often traceable to improper operation, negligence, abuse, improper equipment application component weakness (unfit to meet needs), or improper shop workmanship.

The shop supervisor should be notified of problems that are not commonly associated with normal wear and tear. The road maintenance division should be advised if correction is the user's responsibility. One of the following situations may be indicated:

- The operator may require additional training.
- The user may be overloading the equipment.
- The unit's PM schedule is not being followed.
- Future acquisition specifications may need to be revised.
- Troublesome components may need to be replaced by components better designed to meet the needs of the user.

Budgeting

Equipment maintenance costs can be broken down into three categories: operating costs such as fuel and lubricants; repair costs such as mechanic labor; overhead, parts and supplies, and depreciation.

Depreciation represents the loss in value of a unit of equipment during its service life. Depreciation can be calculated in a number of ways, but the most most appropriate method is to divide the original cost (less salvage value, if any) by the estimated number of years of service. Depreciation should be budgeted at the Regional Level in order to set aside the funds necessary for replacement of vehicles and equipment.

Estimates of manpower requirements and parts and supplies should be developed by the division manager. These estimates should be submitted to the Assistant Commissioner for preparation of the annual budget.

Scheduling Shop Work

A primary requirement of the scheduling process is that the available shop resources be known in advance. The daily schedule must be planned in a manner that will accommodate most anticipated equipment maintenance needs.

Scheduling Information - There are several basic types of information required for the preparation of an effective and responsive daily shop work schedule. Information is needed on each of the following subjects:

- The quantity of work-in-progress.
- User reports of mechanical problems that developed on the previous day.
- Repair priorities.
- Availability of shop manpower and needed skills.
- Availability of shop space.
- Availability of required parts and supplies.
- Adequate shop tooling to meet specific job requirements.

Only when information on each of these items is known, can effective scheduling be performed.

Work in Progress - Work-in-progress is defined as repairs in the process of being accomplished. The term covers a wide variety of time frames, which may represent a few hours to finish a job or several weeks while a unit is being overhauled.

Work-in-progress represents the amount of resources already committed. Once the balance of shop resources which are not committed is determined, the shop can proceed to plan its daily workload of scheduled and non-scheduled repair accordingly.

It should be stressed that loading the work center with excessive amounts of scheduled work can result in an unacceptable level of response for non-scheduled, priority-type equipment maintenance demands.

User Reports - A key input in determining the type and nature of work to be performed is the users' report of mechanical problems. As part of the PM program the operator must perform daily inspections of the equipment. Problems noted should be listed and sent to the shop supervisor. A sample reporting form is shown in Figure 5-20.

The user is responsible for taking a unit out service until repairs can be made when mechanical defects or safety problems are detected such as faulty steering or brakes.

The work center should have the authority to take a unit out of service when continued operation may lead to serious damage or deterioration of the unit.

Repair Priorities - Responsibility for determining repair priorities should primarily be a function of the road maintenance division. The road maintenance division manager should determine which units are most urgently needed and notify the work center.

The shop should schedule work to be responsive to the users needs. Available resources should be focused on jobs having the greatest impact on equipment availability and user requirements.

Shop Schedules - Shop schedules should be prepared on a weekly basis. The schedule is used for monitoring work-in-progress and should identify the following:

USER REPORT OF EQUIPMENT PROBLEMS

UNIT NO.	ODOMETER OR HOUR METER	KMS. HRS.	DATE
<p>ENGINE</p> <p><input type="checkbox"/> Knocks</p> <p><input type="checkbox"/> No Power</p> <p><input type="checkbox"/> Noisy</p> <p><input type="checkbox"/> Leaks Oil</p> <p><input type="checkbox"/> Oil Pressure</p> <p>CLUTCH</p> <p><input type="checkbox"/> Slips</p> <p><input type="checkbox"/> Grabs</p> <p><input type="checkbox"/> Chatters</p> <p><input type="checkbox"/> Free Travel</p> <p>TRANSMISSION</p> <p><input type="checkbox"/> Noisy</p> <p><input type="checkbox"/> Disengages</p> <p><input type="checkbox"/> Leaks Oil</p> <p>REAR AXLE</p> <p><input type="checkbox"/> Noisy</p> <p><input type="checkbox"/> Leaks Oil</p>	<p>FUEL</p> <p><input type="checkbox"/> Pump</p> <p><input type="checkbox"/> Lines</p> <p><input type="checkbox"/> Carburetor</p> <p>STEERING</p> <p><input type="checkbox"/> Wanders</p> <p><input type="checkbox"/> Shimmy</p> <p><input type="checkbox"/> Hard</p> <p><input type="checkbox"/> Free Play</p> <p>BRAKES</p> <p><input type="checkbox"/> Grab</p> <p><input type="checkbox"/> Squeal</p> <p><input type="checkbox"/> Air Pressure</p> <p><input type="checkbox"/> Weak</p> <p><input type="checkbox"/> Won't Release</p> <p><input type="checkbox"/> Pedal Travel</p> <p><input type="checkbox"/> Fluid</p>	<p>ELECTRICAL</p> <p><input type="checkbox"/> Lights</p> <p><input type="checkbox"/> Horn</p> <p><input type="checkbox"/> Battery</p> <p><input type="checkbox"/> Charging System</p> <p><input type="checkbox"/> Starter</p> <p><input type="checkbox"/> Wiring</p> <p>SPRINGS</p> <p><input type="checkbox"/> Broken</p> <p><input type="checkbox"/> Shifted</p> <p>EXHAUST</p> <p><input type="checkbox"/> Leaks</p> <p><input type="checkbox"/> Muffler</p> <p><input type="checkbox"/> Tall Pipe</p> <p>COOLING SYSTEM</p> <p><input type="checkbox"/> Leaks</p> <p><input type="checkbox"/> Overheats</p>	<p>GENERAL</p> <p><input type="checkbox"/> Wheels</p> <p><input type="checkbox"/> Hubs</p> <p><input type="checkbox"/> Tires</p> <p><input type="checkbox"/> Cab</p> <p><input type="checkbox"/> Body</p> <p><input type="checkbox"/> Windshield Wipers</p> <p>OTHER</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p><input type="checkbox"/> IN USE</p> <p><input type="checkbox"/> NOT IN USE</p> <p>_____</p> <p style="text-align: center;">DRIVER'S SIGNATURE</p> <p>_____</p> <p style="text-align: center;">HEAD DRIVER'S SIGNATURE</p>

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- Personnel assigned to the shop.
- Repair activities and space allocation.
- Units of equipment on which work must be performed.
- Mechanic assignments.
- Repair time estimates.
- Planned release time.

A sample schedule is shown in Figure 5-21. The schedule is divided into segments which represent the work days and hours available. The schedule is used to balance available personnel and shop space to meet equipment maintenance needs.

The schedule can be posted on a blackboard to provide up-to-the-minute information of the work-in-progress and the work waiting to be performed.

The schedule also identifies the assignments made to individual mechanics and the time allocated for repair.

Performing

Shop - Supervision of the repairs and servicing performed by work center personnel is a key element in providing timely equipment repairs of high quality workmanship.

In addition to preparing daily work schedules, the shop supervisor should perform the following:

- Conduct an inspection of equipment brought to the shop to determine work required.
- Prepare work orders to authorize repairs.
- Inspect the repairs in progress to insure that work is being performed properly.
- Conduct a final inspection of equipment before it is returned to the user to insure high quality workmanship.

Warehouse

An adequate inventory of spare parts, tools and supplies is an essential requirement for the operation of the provincial work center. Management of the inventory requires strict accountability of the stock on hand through documentation of all stock transactions.

DAILY EQUIPMENT REPAIR SCHEDULE

WORK CENTER <i>Rumbek</i>			WEEK ENDING				
MECHANICS AND ASSISTANT MECHANICS	BAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		789101112120T	789101112120T	789101112120T	789101112120T	789101112120T	789101112120T
GENERAL REPAIR							
<i>Jones</i>	<i>1</i>	<i>Motor grader</i>					
<i>Smith</i>	<i>2</i>	<i>Truck #3022</i>	<i>Truck 3021</i>				
<i>Jacobs</i>	<i>3</i>		<i>Truck 3021</i>				
PREVENTIVE MAINTENANCE							
<i>White</i>							
<i>Brown</i>	<i>4</i>	<i>3022 Truck</i>					
<i>Thomas</i>							
FIELD SERVICE							
<i>Jacobs</i>							
<i>White</i>							

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There are several types of transactions involving parts and materials including; issues or withdrawals, requisitions and transfers, receiving, and adjustment.

Issues - The most common type of transaction involves the issue of stock to an employee. This type of transaction may also be called a withdrawal.

No parts or materials should be issued without the approval of management personnel authorized to make such approvals. The withdrawal of stock by mechanics should be approved by the division manager or shop supervisor. The withdrawal of stock by road maintenance personnel should be approved by the division manager or assistant managers. The head builder should be authorized to withdraw materials used in bridge or culvert repair.

Requisition - Requisitions are used to request or re-order parts and materials from the central warehouse in Juba. Requisitions may be filled by purchase from commercial vendors or through a transfer of stock-on-hand.

Receiving - The quantities and condition of stock received from the requisition process should be documented by a receiving report.

Adjustment - At least once a year a physical count of all stock-on-hand should be conducted preferably under the supervision of a storekeeper or auditor from the central warehouse. When the count does not agree with inventory records an adjustment must be made to the records. All adjustments should be documented and all significant discrepancies investigated.

Management of the inventory involves maintaining up-to-date records of the stock level of each item in the inventory, and establishing re-order points and re-order quantities for each item, and establishing procedures for purging obsolete items. Procedures should also be developed for storage and use of used or salvaged parts. Canabilization of parts should be strictly controlled and require authorization from the Equipment Division Manager.

The operation of the stock room and warehouse should be evaluated by the Equipment Division Manager on a semi-annual basis. A warehouse evaluation checklist is shown in Figure 5-22.

Reporting

Shop - Two basic records are required to document operating and repair costs, shop work orders and fuel tickets.

The shop work order authorizes work to be performed and collects expenditures of labor, parts and materials on a specific unit of equipment. A sample work order is shown in Figure 5-23. The work order should identify the unit, record the hour meter or odometer, the work required, the work performed and the labor, parts and materials expended. To assist in reporting and evaluating the work performed, it is recommended that a coding system be developed similar that shown in Table 5-1.

The fuel ticket records the amount of fuel, oil or other fluids used in operating a specific vehicle, as well as the location the fuel was dispensed. A sample fuel ticket is illustrated in Figure 5-24.

Warehouse - The equipment maintenance division is responsible for maintaining records of the materials and supplies stocked for road maintenance and equipment maintenance programs.

The basic records required are stock transaction tickets used to document all stock transactions and inventory control cards to show the quantity of stock on-hand.

A separate inventory control card should be maintained for each item in the inventory. The cards should be updated at the same time that the stock is issued or received.

Evaluating

Shop - Historical records of the number and type of repairs performed, and the man hours required to perform various types of repair are necessary for planning and budgeting shop resources (labor, parts and materials) and for evaluating equipment units. Fuel consumption records

Figure 5-22
SEMI-ANNUAL WAREHOUSE EVALUATION REPORT

Location _____ Date _____

STOCK ROOM

Yes	No

- 1 Stock control levels on bins
- 2 Stock number on bins
- 3 Stock in numerical order
- 4 Stock in bins, not on floor
- 5 Out of stock - on reorder list
- 6 Stocking fast moving items based upon control levels or bins
- 7 Obsolete stock being returned annually
- 8 General appearance clean
- 9 Inventory on or under recommended level

CARD FILE

Yes	No

- 10 Cards kept current and posted to daily
- 11 Warehouse issue reference card kept up-to-date
- 12 Cards filed in numerical order
- 13 Stock being ordered according to movement on cards
- 14 General appearance - neat or clean

CATALOGS AND FLEET REFERENCE MANUAL

Yes	No

- 15 Catalog rack kept up-to-date with revised catalogs
- 16 Fleet Reference Manual kept up-to-date and revised periodically

TIRES

Yes	No

- 17 Tire issue records up-to-date
- 18 Defects being returned for credit
- 19 Tire issue reports completed quarterly
- 20 Tire stock area generally neat

REPAIR SHOP WORKORDER

EQUIPMENT TYPE		NUMBER		WORKCENTER	
METER READING			DATE		
OUT OF SERVICE			RETURN TO SERVICE		
TIME	DATE		TIME	DATE	

REPAIR TYPE			
SCHEDULED	<input type="checkbox"/>	ACCIDENT	<input type="checkbox"/>
NON-SCHEDULED	<input type="checkbox"/>	OVERHAUL	<input type="checkbox"/>
FIELD SERVICE	<input type="checkbox"/>		<input type="checkbox"/>
PM (INTERVAL _____)	<input type="checkbox"/>		<input type="checkbox"/>
COMPONENT EXCHANGE	<input type="checkbox"/>		<input type="checkbox"/>

REPAIRS REQUIRED		EST. HOURS
PROBLEM	CORRECTIVE PROCEDURE	
TOTAL		

WORK PERFORMED							
LABOR			PARTS				
EMPLOYEE	TIME	REPAIR	PART NO.	DESCRIPTION	QTY.	COST	REPAIR

Table 5-1
REPAIR CLASSIFICATION CODES

<u>Code</u>	<u>Components and Systems</u>	<u>Code</u>	<u>Electrical</u>
	<u>Power Plant</u>		
01	Engine	41	Ignition
02	Cooling System	42	Charging/Starting System
03	Exhaust System	43	Lights and Accessories
04	Fuel/Air System		
			<u>Hydraulics</u>
	<u>Power Train</u>	51	Lines and Fittings
11	Drive Shaft, Universal Joints and Drive Axles	52	Accessories and Controls
12	Clutch		<u>Miscellaneous Maintenance</u>
13	Transmissions	61	Lubrication, Oil Change
		62	Cleaning
		63	Painting
	<u>Steering Suspension and Brakes</u>		
21	Steering and Front Axle		<u>Mounted Equipment</u>
22	Suspension	71	Buckets, Blades
23	Brakes	72	Tracks and Undercarriage
24	Tires and Rims	73	Towed Equipment
		74	Dump Bodies
	<u>Body and Frame</u>		
31	Body Interior		<u>Rehabilitation</u>
32	Body Exterior	81	Overhaul

FIGURE 5-24

FUEL TICKET	
UNIT NO.	
LOCATION	
METER READING	KM.
	HR.
DATE	
PRODUCT	QUANTITY
GASOLINE	LITERS
DIESEL	LITERS
ENGINE OIL	LITERS
FLUIDS	
COOLANT	
OTHER	
OPERATOR SIGNATURE	
<hr/>	

are also necessary for budgeting provincial fuel requirements and for evaluating vehicles and equipment.

The following reports generated from the information obtained from fuel tickets and shop work orders, are recommended for the provincial work center shop:

<u>Figure No.</u>	<u>Report No.</u>	<u>Title</u>
5-25 -	#13 -	Monthly Equipment Maintenance.
5-26 -	#14 -	Monthly Equipment Maintenance Labor.
5-27 -	#15 -	Annual Equipment Maintenance.
5-28 -	#16 -	Annual Equipment Maintenance Labor.
5-29 -	#17 -	Daily Fuel Report.
5-30 -	#18 -	Monthly Fuel Report.
5-31 -	#19 -	Annual Fuel Summary.
5-32 -	#20 -	Monthly Vehicle Fuel Report.
5-33 -	#21 -	Vehicle Maintenance Report.

Report #13 Monthly Equipment Maintenance Report

Description - The number of repairs performed each day (as determined from shop work orders) are entered under the appropriate day column on the row for the repair code of the work performed.

Use - The report is used to tabulate the number and type of equipment repairs performed in a month. Information from this report is used to develop an annual report.

Report #14 Monthly Equipment Maintenance Labor Report

Description - The man hours expended each day on equipment maintenance are recorded under the appropriate column on the row for the type of repair performed. At the end of the month, the total number of repairs for each type of repair (from Report 13) can be entered on the report to calculate average man hours required for each repair code.

Use - The report is primarily used as a spread sheet for tabulating shop labor distribution. The information contained on this report is used to prepare an annual summary.

Report #15 Annual Equipment Maintenance

Description - The total number of repairs completed for each repair code (taken from Report 13) is entered in the column for the month in which they were performed. Average repairs per unit are computed by dividing number of repairs by fleet size.

Use - The report will provide information for planning and budgeting purposes. For example, the equipment manager can utilize this report to estimate the number and type of repairs that may be expected if the fleet size is increased or decreased by multiplying the projected fleet size by the average number of repairs per unit.

Report #16 - Annual Equipment Maintenance Labor Description

Description - The total man hours expended each month for each equipment repair code are displayed by this report. Average man hours per repair type can be computed by dividing man hours by the number of repairs performed.

Use: The report can be used to identify training needs and special skills to seek when hiring additional staff.

Report #17 Daily Fuel Report

Description - The report is divided into three sections, inventory, distribution, and meter readings. Separate sheets should be filled out for mobile fuel tanks.

The inventory section functions like an inventory control card. Quantities on hand in underground tanks are measured by dip stick at the beginning and end of each day. The distribution section tabulates the quantities distributed. The meter readings are recorded at the same time that the inventory quantity is determined.

Use - Fuel and oil are essential to the road maintenance program and the use of this valuable commodity must be carefully monitored. The Daily Fuel Report tabulates the fuel distributed each day and provides a check against the pump meter readings and actual quantities in the tanks. It will help spot pilferage and leakage problems.

Report 16

ANNUAL SHOP LABOR

PROVINCE										YEAR					
REPAIR CODE	MAN HOURS												TOTAL MAN HOURS	NO. OF REPAIR	AVG. MH/ REPAIR
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.			
01															
02															
03															
04															
11															
12															
13															
21															
22															
23															
24															
31															
32															
41															
42															
43															
51															
52															
61															
62															
63															
71															
72															
73															
74															
81															
TOTALS															

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**Report 17
DAILY FUEL REPORT**

	GAS	DIESEL	OIL	FLUIDS	COOL- ANT	OTHER	
PREVIOUS QUANTITY							INVENTORY
RECEIVED							
TOTAL							
DISTRIBUTED							
EQUIPMENT NO.							DISTRIBUTION
TOTAL							
PRESENT							METER READING
PREVIOUS							
DISTRIBUTED							
DATE	LOCATION				BY		

Report 18
MONTHLY FUEL REPORT

MONTH

DATE	LITERS OF GASOLINE	DIESEL	ENGINE OIL	FLUIDS	COOLANT	OTHER
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						

Report #18 Monthly Fuel Report

Description - Daily quantities of fuel and oil are tabulated on this report each month.

Use - The report is used to tabulate daily fuel and oil distribution over a one month period.

Report #19 Annual Fuel Summary

Description - The monthly totals for gasoline, diesel fuel, oils and fluids are entered under the appropriate month.

Use - The report will show annual fuel useage and peak demand periods. It can be used for planning and budgeting purposes.

Report #20 Monthly Vehicle Fuel Report

Description - A separate sheet is maintained for each vehicle, recording fuel oil and other fluids used. The hour meter or odometer reading shown on the first and last fuel tickets of the month for fuel distributed to the unit are entered at the top of the page and used to calculate fuel consumption.

Use - Fuel efficiency should be considered when disposing of equipment or purchasing additional units. This report will indicate which units are most fuel efficient. Sudden changes in efficiency may indicate mechanical problems or pilferage.

Report #21 - Vehicle Maintenance Report

Description - A separate sheet is kept on each vehicle. Monthly fuel useage and repairs are entered on this form each month.

Use: The report summarizes the operating and repair cost of a vehicle and should be reviewed when selecting specific units for trade-in or overhaul, or when preparing to purchase additional units.

ANNUAL FUEL REPORT

PROVINCE

YEAR

LITERS PER MONTH**FUEL OR FLUID TYPE****JAN.****FEB.****MAR.****APR.****MAY****JUNE****JULY****AUG.****SEP.****OCT.****NOV.****DEC.****TOTAL**

GASOLINE

DIESEL

ENGINE OIL

FLUIDS

COOLANT

OTHER

Report 20
MONTHLY VEHICLE FUEL REPORT

UNIT
 MONTH

DATE	LITERS OF GASOLINE	DIESEL	ENGINE OIL	FLUIDS	COOLANT	OTHER
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						

LITERS OF FUEL OR MAN HOURS PER MONTH

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
FUEL-GAS OR DIESEL													
ENGINE OIL													
FLUIDS													
COOLANT													
OTHER													
- REPAIR CODES -													
01													
02													
03													
04													
11													
12													
13													
21													
22													
23													
24													
31													
32													
41													
42													
43													
51													
52													
61													
62													
63													
71													
72													
73													
74													
81													

5/22/19

It is recommended that individual files be established for each vehicle. All shop work orders and reports pertaining to a specific unit of equipment should be placed in the file established for that vehicle.

Warehouse Reports

It is important for management to be aware of the type and number of parts and supplies on hand. At least semi-annually the senior storekeeper should issue a listing of the stock-on-hand. On a more frequent basis, listings of items in short supply (those below the re-order point) and items out-of-stock should be issued.

These reports are necessary for scheduling work and may also indicate the need for adjusting re-order points and re-order quantities.

CHAPTER 6 TRAINING

INTRODUCTION

A comprehensive training program is an essential requirement for the adequate maintenance of the project route and other roads in the Southern Region. At the provincial level very few of the Ministry employees have received the technical training or formal education necessary to perform their maintenance functions effectively. Consequently, the quality and quantity of work performed is generally inadequate.

Labor, equipment and materials under-utilized or used in producing poor quality work are wasted. Training is necessary to standardize and improve work quality, as well as to increase productivity and efficiency.

TRAINING PROGRAMS

Training is recommended in the following general areas:

- Language and math.
- Mechanic training.
- Road maintenance techniques.
- Operator training.
- Management training.
- Storekeeping.

Language and Math

Most Road Overseers and Headmen cannot read or write. In addition, the mechanics at the Rumbek Work Center are not sufficiently fluent in either Arabic or English to receive training at the Central Work Shop in Juba.

Training in reading and writing as well as simple math are recommended for Road Overseers and Headmen. Headmen should be able to read simple instructions written by the overseers, measure and calculate work units accomplished, and fill in work reports. The overseer must be

able to fill out work schedules for the Headman, check the measurements and work unit calculations reported by the Headman, and read written instructions prepared by the Assistant Division Managers.

Mechanics should receive training to improve their language skills in either Arabic or English. The ability to speak and understand these languages will facilitate technical training.

Mechanic Training

The mechanics currently employed at the Rumbek Work Center have little or no experience in the basic fundamentals of equipment component functions and inadequate knowledge of how components and systems should be inspected, serviced and repaired.

The subjects recommended for inclusion in the mechanic training program are listed in Table 6-1. The emphasis placed on the training of each topic should be based upon the fleet make-up at the provincial level.

Road Maintenance Techniques

All levels of management in the road maintenance division should receive training in the proper methods for performing each task. Related topics include:

- Compaction - Including basic concepts of moisture and density relationships, optimum moisture content, and gradation of aggregates. Trainees should include supervisory personnel from Headmen through division managers.
- Equipment Operation - Including the application and limitations of motor graders, compactors, tractors, and other equipment assigned to the provincial road maintenance program. Instruction should emphasize the importance of preventative maintenance, and safety. Trainees should include head drivers, road overseers, assistant managers and the division manager.
- Drainage - The importance of providing adequate drainage should be explained as well as methods for correcting poor subgrade drainage and making erosion repairs. Use of a carpenter's level

Table 6-1
 TRAINING PROGRAM FOR MECHANICS

SUBJECT	COMPONENTS	EXTENT
Ignition System - Conventional and electronic, 6 and 12 volts	Distributor, sparkplugs, primary and secondary wiring	Inspection, testing, trouble-shooting, cleaning, adjustments, repairs, lubrication, etc.
Fuel System, Gasoline - Conventional carburetion and fuel injection; single through four barrels	Fuel tank, lines and valves, filtration system, fuel pump, carburetor, air inlet filter, governor, fuel injection, controls, etc.	Inspection, trouble-shooting, adjustments, repairs, etc.
Fuel System, Diesel - Variable depending upon fleet make-up	Fuel tank, lines and valves, pump, injection distribution system, governor, injector and HP lines, return lines, filtration system, water separator, etc.	Inspection, trouble-shooting, injector calibration, timing adjustments, minor repairs.
Charging Systems - Alternator and generator, 6 through 24 volts	Housings and internal parts; cooling and shielding; drive mechanism; regulators, switches and wiring system, etc.	Inspection; trouble-shooting; testing; adjustments; repairs; component replacement
Starting System - Electric, pneumatic and hydraulic, 6 through 24 volts	Housings; armature and brushes; field; lock-out and overheat, protective devices; Bendix drive; solenoid and starting switches; batteries and carriers; cables and wiring systems.	Inspection, testing and trouble-shooting; adjustments; cleaning procedures; general repairs; lubrication.
Clutch - Dry and wet, single, dual and multi-plate	Pressure plate, discs, pilot bearing and facings; clutch brake; application and release mechanism; power-assist mechanism.	Inspection, testing and trouble-shooting; adjustment; disassembly and reassembly procedures; installation; repair; lubrication.

Table 6-1
 TRAINING PROGRAM FOR MECHANICS
 (Continued)

SUBJECT	COMPONENTS	EXTENT
Torque Converter and Fluid Coupling - Single and dual stage.	Housing, rotors, stator disc; bearings and seals; shafts, valves, cooling and filtration systems; pump; oil reservoir if required.	Inspection, purging and testing; adjustments; minor repair; trouble-shooting; lubrication.
Transmission, Auxiliary and Transfer Case - Mechanical, semi-automatic, automatic and power shift. Single and compound gearcase, multi-range, gear splitter, 3 through 20-speed versions, mechanical single or dual lever, pneumatic, hydraulic or electric shift control.	Housings; gears, shafts, bearings and gears; synchronizers; levers, linkage and controls; seals; filters and coolers; lubrication and purging; oil pump.	Inspection, trouble-shooting and minor adjustments; repair and overhaul of the smaller, simpler mechanical types.
Axles, Drive Type - Single, double and triple reduction; worm, planetary, chain-and-sprockets and ring and pinion gear type; hydrostatic; hydraulic and electric drive system. Single, tandem and front.	Generally restricted to the common mechanical versions such as differential case, gears, shafts, bearings and seals; oil pump and filter; single and 2-speed; shift and control mechanism; power and lock-out mechanism; traction-assist devices; axles and shafts.	Inspection, trouble-shooting and adjustments; purging; lubrication. (Note: Machining requirements excluded.)
Driveline Servicing and Maintenance - Conventional light, medium and heavy duty versions.	Tubing, splined ends and yokes; U-joint crosses and needle bearings; slip-spline joints; flanges; center bearing and hanger.	Inspection, vibration trouble-shooting; angle-check and adjustment; balancing, indexing and alignment; lubrication.

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Table 6-1
 TRAINING PROGRAM FOR MECHANICS
 (Continued)

SUBJECT	COMPONENTS	EXTENT
Axles, Steering and Trailing - Single and tandem steer or trailing.	Tubular and I-beam, independently sprung; spindles, hubs, wheel bearings and seals; King pin and bushings.	Inspection, gauging, steering geometry checks; adjustments; lubrication. (Note: Straightening not a required part of the course.)
Steering System - Manual, hydraulic and power-assist.	Wheel, column and gearbox; linkage, tierods and Pitman arm and radius rods.	Inspection, trouble-shooting and adjustments; geometric alignment; wheel and tire balance; lubrication. (Note: Overhauling hydro-steering pumps and/or integral gearbox not a course requirement.)
Brake System - Mechanical, pneumatic, hydraulic and power-assist.	Compressor, vacuum pump, hydro-vac power units; drums, discs and rotors; wet or dry system; reservoirs, valves and controls; linkage, hoses and lines; cylinders, dust shields; brake linings; adjustment mechanism.	Inspection, trouble-shooting and adjustments; brake relining and drum replacement; general repairs; lubrication. (Note: Compressor overhauling and brake drum/disc/rotor grinding and dressing need not be part of the training course.)
Air Inlet System - Wet and dry, single or dual phase filtration systems.	Housings and filter elements; gauge; hoses and clamps; inlet manifolds; hanger and fixtures.	Inspection and trouble-shooting; servicing and minor adjustments; replacements as required.

Table 6-1
 TRAINING PROGRAM FOR MECHANICS
 (Continued)

SUBJECT	COMPONENT	EXTENT
Air Injection System - Natural aspiration, turbocharged and supercharged.	Turbocharger and supercharger pumping mechanism; air conduits; drive and cooling mechanism; lubrication system.	Inspection, Trouble-shooting; servicing, minor repairs and adjustments. (Note: Overhauling of air charging systems need not be part of the course.)
Cooling System - Liquid and/or air cooled systems.	Radiator Ass'y.; fan and fan drive system; shutters and thermostats; water pump; cowling; filtration; water jackets, hoses, clamps and lines.	Inspection, testing, trouble-shooting; adjustments; general repair. (Note: Major core and tank overhauling not a course requirement.)
Hitches and Coupling Devices - Fifth wheels, pintle hooks; drawbars; couplers.	Mounting plates; king pins; locking devices; safety chains; tow slings and hooks; shock absorbers.	Inspect, adjust and lubricate; general repairs.
Suspension System - Leaf spring; coil spring; air bag; leveling beam.	Spring leaves; U-bolt hangars; center bolts; coil spring units; shock pads and insulators; shock absorbers; torque and radius rods; rigid beams.	Inspect, replace, repair, tighten, adjust.
Framework Rails and Crossmembers - Passenger vehicle, truck and trailer; channel and I-beams; straight and tapered.	Longitudinal rails; reinforcement rails and fish plates; cross members and gussets.	Inspect; drilling and welding; basic procedures for minor straightening.
Engine Maintenance	Block and cylinder head assemblies.	Inspect, test and adjust; in-frame minor overhauling; tune-ups. (Note: Major overhauling including machining of block, cylinder head and crankshaft not a course requirement.)

Table 6-1
 TRAINING PROGRAM FOR MECHANICS
 (Continued)

SUBJECT	COMPONENT	EXTENT
Diagnostic Shop Equipment	Testers and analysers; tune-up machines.	General familiarity with testing procedures to determine and correct mechanical condition; perform routine adjustments to various systems; assure that equipment is in proper condition for reliable service.
Exhaust System - Conventional	Manifolds; gaskets and seals; exhaust piping, clamps and hangers; mufflers; shields; rain caps; spark arrenters.	Inspect and repair as required.
Power take-offs - Crankshaft direct drive; transmission mounts; belt driven; electric.	Gear reduction housing, internal shafts and gears; spacers and seals; drive-line shafting and U-joints; driveline hangers; control mechanism; purging devices.	Inspection, trouble-shooting and adjustments; general repair as required; lubrication.
Drive Belts and Sheaves - Single, double and multi-belt drives	Sheaves and belts; adjustment mechanism; mounting hardware.	Inspection and trouble-shooting; adjustments and replacements.
Instruments and Gauges - Instrument panel switches, lights, gauges, etc., such as odometers; tachometers; fuel; oil pressure and temperature; brake system reserve pressure; volt-meter/amp-meter; pyrometer; engine hour meter, etc.	N/A	Inspect and test; change as required.

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Table 6-1
 TRAINING PROGRAM FOR MECHANICS
 (Continued)

SUBJECT	COMPONENT	EXTENT
Tires - Bias-ply and radial, all types of equipment.	Tires, tubes, flaps and core valves.	Change and repair; inspect, mate and match; balance; maintain required pressure; remove in time for recapping salvage.
Wheels and Rims - Spoke and disc.	Wheel hubs, bearings and seals; wheels and rims; lock rings; spacer bands; rim clamps; nuts and studs.	Inspect, tighten, balance and install.
Lights and Accessories	Head; tail; stop; directional; instruments; fan; air conditioner; defogger; bulbs and sealed beams; motors; switches; wiring; safety fuses; mounting hardware.	Inspect, test and adjust; repair/replace as needed. (<u>Note</u> : Major electrical repair functions not part of course.)
Hydraulics - Low, medium and high pressure; on-demand power systems.	Accumulators; tanks, lines, filters and valves; pumps, motors and cylinder assemblies; mounting brackets, braces and hardware; oil coolers; controls.	General inspection, testing, inspection and minor repairs; lubrication. (<u>Note</u> : Pump, motor and cylinder overhauling not required in the course.)
Welding, Brazing, Cutting and Soldering	N/A	General basic instructions, arc and oxy-acetylene.
Body and Painting	Cab and passenger body; van, dump and platform body.	Minor repair and painting; glass replacement; seat cushion rebuilding; rebuilding/repairing dump box, platform and trailer decks, tailgates, etc.

Table 6-1
 TRAINING PROGRAMS FOR MECHANICS
 (Continued)

6-9

SUBJECT	COMPONENT	EXTENT
On-board Electronics	Electronic speed controls, automatic engine shut-down systems, central lube analysers, automatic brake application mechanism, fuel consumption analysers, etc.	Understanding of basic functional characteristics and replacement of electronic componentry.
Battery Maintenance - All automotive models.	Batteries; battery case; cables.	Testing, inspection, cleaning terminals, replenishing electrolyte solutions (non-sealed type); general repair of battery compartments.
Shop Documents and Reports	N/A	General instructions in the preparation of the reports, orders and other documents in equipment and shop operations. Includes the maintenance of individual equipment repair and operating costs, equipment usage, labor charges, etc.
Housekeeping Instruction	N/A	Includes safety programs; responsibility and accountability for keeping all shop areas in clean and orderly condition; return of designated tools and equipment to the tool storage area, etc.

for checking crown and ditchline grades should also be demonstrated. Trainees should include all levels of supervision from Headman up to division manager.

- Concrete - Basic instruction in storage and handling of cement and aggregates, mixing, handling, placing, finishing and curing of concrete and mortar. Instruction should also cover material properties, water-cement ratio, slump, and aggregate gradation. Trainees should include the Head Builder, Assistant Head Builder and the Assistant Division Managers.

Operator Training

Each piece of road maintenance equipment represents a significant capital investment. Operator training is an essential requirement for insuring the safe, efficient and productive utilization of equipment resources.

Damage and accelerated wear due to operator abuse, negligence or ignorance makes up a significant portion of equipment repair. The failure to check coolant and engine oil levels, failure to inspect components for leaks, and failure to observe instruments or gauges are common examples of operator negligence.

Drivers, operators and head drivers should receive training in the operation and care of vehicles and equipment. Special emphasis should be placed on performance of driver oriented preventative maintenance, daily equipment inspection, reporting of equipment problems, and safety.

Management Training

There is a considerable reluctance to change in any organization. Changes in long-practiced work routines are particularly difficult. There is often a considerable amount of resistance among supervisory personnel, who dislike being forced to plan their activities a week or more in advance. Training for supervisory personnel is necessary to overcome this resistance.

The training program for supervisory personnel should:

- Explain how the road and equipment maintenance programs will be carried out and each supervisors role in its successful execution. The relationship between each organizational unit should also be defined.
- Provide a detailed explanation of the use of performance standards in planning weekly work loads and evaluating work efforts.
- Demonstrate procedures for completing work reports, schedules and other reports.

Supervisory personnel should also receive instruction in the following areas:

- Importance of proper communications.
- Shop and field safety.
- Importance of good housekeeping.
- Importance of good workmanship and accountability for poor workmanship.
- Care, use and accountability for tools and equipment.
- Manpower planning and the high cost of unproductive labor.
- Crew leadership.

Storekeeping

The existing inventory of parts and supplies at the provincial work centers is almost non-existent. Training for warehouse and stockroom personnel is recommended in the following areas:

- Responsibility and accountability.
- Documentation of all transactions.
- Requisitioning procedures.
- Preparation of receiving, issue or transfer reports.
- Fuel and lubricant inventory control.
- Parts obsolescence control.
- Lead-time and other considerations in ordering parts and supplies including establishment of reorder points and reorder quantities.

- Documentation of receipt of inferior parts and supplies.
- Security precautions.
- Efficient utilization of available space including parts and parts bin identification.
- Shop tool storage, issue and accountability.

TRAINING METHODOLOGY

The training programs in general must be structured to relate to the backgrounds and lifestyles of the trainees to be involved in the program. Most of the trainees have had very little formal education or technical training, and the training program will represent a new learning environment in addition to introducing new technical skills and techniques. Therefore, the training methodologies to be used must be designed to motivate interest and acceptance of the new techniques presented. The following general guidelines are recommended for the training programs.

1. Keep lectures to a minimum and when lectures are necessary, maximum use should be made of visual aids. Classroom work should be supplemented with field activities or practical problem solving exercises based on every-day experiences.
2. Primary emphasis should be placed on demonstration and on-the-job type training. Techniques are demonstrated by the instructor either in the classroom or at the job site and then practiced by the trainees until an adequate skill level is achieved.
3. Training courses should be taught or based in the provincial work centers to promote familiarity with the tools, equipment and facilities available to the provincial work force, and to minimize travel distances for trainees permitting most trainees to return to their homes at the end of the day.
4. Whenever possible, courses should be conducted and administered as a joint effort between Technical Assistants (TA) and Ministry counterparts. This arrangement will provide the counterparts with the experience necessary to continue training programs on an on-going basis after the project has been completed. It will

also facilitate modification of the training program if necessary to meet the Ministry's needs, and should minimize problems associated with language barriers.

5. Appropriate incentives should be considered to encourage willing participation. For example, transportation, lodging and food could be provided for trainees who live more than 20 to 30 kilometers from the training site.

Language and Mathematics

The mathematical skills required by Headmen and Road Overseers could be incorporated into the road maintenance techniques training program. However, a more effective approach for both language and mathematics would be to utilize local elementary and secondary public school teachers.

A gradual increase in job qualifications such as requiring that all Headmen and overseers must be able to read and write within a two year period is recommended and should help to provide the necessary incentive for trainees. Stipends should be paid to teachers to provide them with an incentive.

Mechanic Training

The mechanic's training program should be conducted by a TA master mechanic and Ministry counterparts.

The training methodology should initially be conducted primarily in the shop, with the master mechanic demonstrating the proper techniques for inspection, servicing and repair of new and existing equipment. The use of manufacturers operating manuals and lubrication charts should also be demonstrated. The importance of good housekeeping and the care and proper use of shop tools and equipment should be stressed.

Following demonstration by the instructor, trainees should participate under the close supervision of the instructor until satisfactory proficiency levels are achieved. A certification program should be developed to indicate areas of proficiency for each trainee.

Road Maintenance Techniques

Road maintenance training should be taught by a TA maintenance engineer and Ministry counterparts.

Simple experiments such as the compaction of dry, moist and saturated sand can be conducted in a hands-on workshop environment to illustrate the importance of moisture content in compaction. Other simple experiments can be similarly conducted to illustrate important concepts such as aggregate gradation.

Once basic concepts are understood, the training program should focus on field demonstrations of the proper techniques for performing each road maintenance task. Following each demonstration trainees should participate until the concept or techniques are understood. A high skill level is not required for supervisory personnel.

Use of written course materials should be kept at a minimum. However, heavily illustrated notebooks showing each step involved in the performance of an individual task would be of considerable value. Step by step illustration could be composed of photographs taken by the TA or through realistic drawings. Stylized graphic representations are not recommended.

Operator Training

Candidates for operator training should be given an eye examination and should be required to demonstrate skill level prior to selection.

Training should be a joint effort with the Technical Assistants and Ministry counterparts. Proper techniques for inspecting, fueling, operating and performing daily preventative maintenance and minor mechanical adjustments should be demonstrated by instructors and then practiced by the trainee. A testing and certification program is recommended to indicate types of equipment that each trainee is qualified to operate.

Management Training

The management training program will require classroom training and should be conducted in a informal workshop style, utilizing practical real life examples, and visual aids. Field trips should be used when possible to maintain a high level of interest.

Instructors should explain and then demonstrate how each report or form should be filled in and how the report should be used. Trainees would then be given problem solving exercises requiring the completion or analysis of various forms and reports.

Storekeeping

The training of stockroom and warehouse personnel should be conducted as an on the job training program. Technical assistants and Ministry counterparts should work with the storekeeper, equipment division manager and shop supervisor in establishing warehouse procedures, organization and placement of stock in the stockroom and warehouse, and filling in the inventory control cards.

TRAINING RESOURCE REQUIREMENTS

It is estimated that the technical training program will require three technical assistants for a two to three year period. The initial formal training for the Management, Roadway Maintenance Techniques, Operators and Storekeepers should be accomplished in the first year. During the remainder of the project technical assistants would monitor day to day operations and provide advice and direction in the implementation and administration of road and equipment maintenance programs, as well as the establishment of on-going training programs.

The Mechanic Training Program will require a minimum of two to three years to develop the diagnostic and repair skills necessary to maintain the provincial equipment fleet.

The estimated cost for providing training and maintenance management technical assistance is shown in Table 6-2.

Table 6-2
 TRAINING AND MAINTENANCE MANAGEMENT
 TECHNICAL ASSISTANCE COST ESTIMATE

<u>Employee Classification</u>	<u>Annual Base Pay (US)</u>	<u>25% Post Differential</u>	<u>Assignment Duration</u>	<u>Total Direct Salaries</u>
Project Manager	35,000	8,750	3.5 years	153,125
Master Mechanic	30,000	7,500	3.5 years	131,250
Road Maintenance Engineer	30,000	7,500	2.5 years	131,250
			<u>9.5</u>	
Total Direct Salaries				415,625
Overhead and Profit (150%)				<u>623,435</u>
Total Salaries				1,039,060
 <u>Reimbursable Expenses</u>				
Round trip air fare - including air and surface shipment of goods - avg. family 3 members (9 trips)		6,000/trip	54,000	
Annual R&R - every 6 months to Athens or every 4 months to Niarobi, 3 in family (9 trips)		3,000/trip	27,000	
Annual home leave, 3 in family (24 trips)		6,000/trip	144,000	
Education, allowing 3 away from post (8 child years)		6,000/trip	48,000	
Subsistence - housing provided on site (114 months)		750/month	85,500	
Total Reimbursable Expenses			<u>358,500</u>	<u>358,500</u>
TOTAL (approximate)				<u>\$1,397,560</u> =====

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Stockpiling	Cubic Meters	H-1

Task Description:

Locate sources of laterite, remove from ground, break stones, and stockpile aggregate blend.

When to Perform:

Stockpiling is a routine activity and should be performed as needed to supply material for hand spreading, hand patching and erosion repair.

Expected Performance:

One half cubic meter per man per day.
Three cubic meters per six men.

Crew Size:

One roadcamp crew of six road workers.

Equipment:

Shovels - 1 for each man
Pry bar - 3 for each crew
Sledgehammer - 3 for each crew
Masonry chisel - 3 for each crew
Picks - 3 for each crew

Material:

N/A

Work Method:

1. Pry laterite stones from ground.
2. Break stones to form a blend varying from very small fines to a maximum particle size of 2-3 centimeters (approximately 1 inch) in diameter. Occasionally it will be necessary to stockpile stones 20-30 centimeters (8-12 inches) in diameter for use as rip rap in erosion control.
3. Pile aggregate.

Reporting:

Report number of men used and cubic meters of aggregate stockpiled.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hauling	Cubic Meters-Meters	H-2

Task Description:

Haul aggregate blend from stockpiles to areas where the material is needed for hand patching, hand spreading, and erosion repair, or other tasks.

When to Perform:

Hauling is a routine activity and should be done as necessary to supply material to areas where needed.

Expected Performance:

<u>Distance Hauled</u>	<u>Daily Quantity Per 6 Men</u>	<u>Daily Quantity per Man</u>
100 meters	6 cubic meters	1 m ³
250 meters	4 cubic meters	2/3 m ³
400 meters	2 cubic meters	1/3 m ³
1 kilometer	1 cubic meter	1/6 m ³

Crew Size:

One roadcamp crew of six workers in three man groups.

Equipment:

Shovels - 1 for each man
Dobbin barrows - 2 per crew

Material:

Laterite gravel blend. Gravel should vary in particle size from very fine to a maximum of 2-3 centimeters (approximately 1 inch) in diameter. Stones 20-30 centimeters (8-12 inches) in diameter can be used for slope protection in erosion repair.

Work Method:

1. Shovel aggregate into dobbin barrows.
2. Haul material to temporary storage site near work area.
3. Dump aggregate outside the shoulder and ditchline of the roadway so as not to create a hazard for traffic, or drainage obstruction.

Reporting:

Report number of men used, cubic meters hauled, and distance.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hand Patching	Cubic Meters	H-3

Task Description:

Fill ruts, potholes, surface erosion, and depressions in roadway surface with suitable material to restore structural strength and provide a smooth surface. This task includes determination of the cause of the local surface failure and the necessary steps to correct the condition.

When to Perform:

This task should be performed routinely on a year round basis. Ruts, potholes and depressions should be corrected quickly to prevent the defect from worsening. In addition, this task should be performed before reshaping activities (January and July) and before and during the rainy season.

Expected Performance:

One cubic meter (1.3 cubic yards) per man per day.
Three cubic meters (3.9 cubic yards) per three men per day.
Six cubic meters (7.8 cubic yards) per six men per day.

Crew Size:

One roadcamp crew of six road workers in work groups of three road workers.

Equipment and Tools:

Water drum - 1 for every 3 men
Dobbin barrow - 1 for every 3 men
Shovel - 1 for each man
Hand tamper - 1 for every 3 men
Pick - 1 for every 3 men
Rake - 1 for every 3 men
Bucket - 1 for every 3 men

Material:

Laterite gravel blend from stockpiles. Blend should vary in particle size from very small fines to a maximum particle size of 2-3 centimeters (approximately 1 inch) in diameter.

Work Method:

A. Determine and correct the cause of local surface failure.

1. Remove and dispose of poor subgrade material soft (organic) soil lacking structural properties or clays which do not drain properly.
2. Where lack of surface drainage is resulting in erosion or ponding of water on the road shoulders, the roadway crown should be reshaped to provide drainage.
3. Schedule other tasks necessary to correct the problem, and perform as soon as possible.
 - Where road ditches are ponding water regrade ditchline (Task H-7).
 - Where frequent washouts occur a culvert should be installed (Task B-2).
 - Where the subgrade stays wet after rains causing soft spots in the roadway surface, underdrains should be installed (Task B-4).
 - Where there is insufficient surface material additional material should be brought in (Task H-4).

B. Patch ruts and potholes.

1. Dig out the sides and bottom of holes to provide straight vertical sides and a flat bottom. Material should be removed until solid, compacted material is reached. Materials removed should be spread on the roadway surface or shoulders.
2. Wet bottom and sides of hole.
3. Add material in a layer 7 to 10 centimeters (3-4 inches) thick. Wet material and compact. Repeat, wetting and compacting each layer, to bring surface level with roadway.

Reporting:

Report number of men and cubic meters of material used.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hand Spreading	Cubic Meters	H-4

Task Description:

Hand spread material on roadway surface to add material and restore crown when mechanical equipment is not available for reshaping. Hand spreading is also used prior to mechanical reshaping in areas where additional surface material is needed.

When to Perform:

Hand spreading should be performed twice each year in areas that require additional surface material, once before the rainy season so that the road surface drains properly and once after the rainy season to restore the roadway surface.

Expected Performance:

Two cubic meters (2.6 cubic yards) per man per day.
Six cubic meters (5.2 cubic yards) per three men per day.
Twelve cubic meters (10.4 cubic yards) per six men per day.

Crew Size:

One roadcamp crew of six workers in work groups of three road workers.

Equipment and Tools:

Dobbin barrow - 1 for every 3 men
Shovel - 1 for each man
Rake - 1 for each man
Crown board - 1 for each roadcamp

Material:

Laterite gravel blend previously hauled from stockpiles. Blend should vary in particle size from very small fines to a maximum particle size of 2-3 centimeters (approximately 1 inch) in diameter.

Work Method:

1. Load material on dobbin barrow and spread the material with shovels.
2. Rake surface smooth and shape crown.
3. Headman should periodically check crown with crown board. Road should slope away from the center at a rate of 4 centimeters per meter (approximately $1\frac{1}{2}$ inches per yard).

Reporting:

Report number of men used and cubic meters of material spread.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hand Sweeping	Kilometers	H-5

Task Description:

Sweep loose fine material into wheel path corrugations when mechanical equipment is not available for blading.

When to Perform:

This task should be performed on a routine basis to fill corrugations as loose fine material collects on the shoulders and edge of the roadway and in the center.

Expected Performance:

Two kilometers (1.2 miles) of roadway per 2 men work group per day.
Six kilometers (3.6 miles) of roadway per 6 men per day.

Crew Size:

One roadcamp crew of six workers in two men work groups.

Equipment:

Long bristle push broom - 1 for each man

Material:

None

Work Method:

Sweep loose fines into wheel path corrugations using 1 man of each work group on each side of the road.

Reporting:

Report number of men used and kilometers of roadway swept.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hand Scarifying	Meters	H-6

Task Description:

Rake the surface of the road to re-mix the fine material and restore roadway crown. Perform in areas where there are loose fines on the roadway when mechanical equipment is not available for reshaping.

When to Perform:

Perform after rainfall when surface is still firm but wet enough so that rake can scarify surface. Perform in areas with loose fine surface material.

Expected Performance:

20 meters (65 feet) of roadway, 6.5 meters (21.5 feet) wide, per man per day.
120 meters of roadway per six men crew.

Crew Size:

One roadcamp crew with six road workers.

Equipment:

Rakes - 1 for each man

Materials:

None

Work Method:

Scarify surface with rake approximately 2 to 3 centimeters (approximately 1 inch) deep. Pull material toward center of road with rakes to form crown.

Reporting:

Report number of men used and length of road scarified in meters.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hand Ditching	Meters	H-7

Task Description:

Clean roadside ditches and flyoffs of silt and debris. Restore roadside ditches and flyoffs to their original size and shape.

When to Perform:

This task should be performed routinely as needed before and during the rainy season. During rains ditches should be checked once a month to insure that water is not ponding. Ponding over a period of time can saturate the roadbed reducing strength and stability. Culverts should be inspected for cleaning at the same time roadside ditches are being cleaned.

Expected Performance:

80 meters of ditch per man per day.
480 meters of ditch per six men per day.

Crew Size:

One roadcamp crew of six workers.

Equipment:

Shovels - 1 for each man
Hand tamper - 1 for each crew

Material:

N/A

Work Method:

1. Shovel silt from botton of ditch or flyoff down to design grade line.
2. Remove obstructions such as logs, rocks, or debris.
3. Inspect culverts and schedule for cleaning as soon as possible under Task H-8.
4. Schedule erosion repairs, Task H-9, for eroded ditchlines.
5. Vegetation may be removed entirely from ditches in relatively level areas. On steep ditches, vegetation should be cut and preserved to help prevent erosion.

Reporting:

Report number of men used and meters of ditch cleaned.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Cleaning Culverts and Bridge Drains	Each	H-8

Task Description:

Clean culverts and stream bed channels leading to and from the culverts of all silt and debris. Clean out bridge drains.

When to Perform:

Cleaning culverts and bridge drains should be scheduled twice each year, once before the start of the heavy rains (March or April) and again during the rainy season (July or August). In addition, any culvert found to be blocked should be cleaned as soon as possible so as to prevent a possible washout.

Expected Performance:

Average of three culverts and/or bridge drains per crew per day.

Crew Size:

Six laborers.

Equipment:

Shovels - 6 for each crew
Toria - 2 for each crew
Bucket - 1 for each crew
Rope, 8m, (26 feet) - 1 for each crew
Dobbin Barrow - 2 for each crew
Pry bars - 2 for each crew

Material:

None

Work Methods:

A. Culverts

1. Clean silt and debris out of culverts with shovels and torias. For soil in the middle of culverts that cannot be reached by hand, use a wooden pole to pass one end of a rope through the culvert. Use the rope to drag a bucket through the culvert to clean silt or debris.
2. Clean silt and debris out of streambed channel leading into and out of culvert with shovels for approximately 5 meters (16 feet) on each side.
3. Load material in dobbin barrows and dispose of where it will not be washed into the culvert.
4. Dirt and gravel may be used to fill nearby eroded areas in slopes but should not be used for roadway patching.
5. During the cleaning, culverts should be checked for broken or misaligned pipe sections or corrosion of the bottom of the pipe. Problems found should be reported to the road overseer so that repairs can be scheduled as soon as possible.

B. Bridges

1. Clean deck drains on bridges with pry bars.
2. Shovel all dirt and debris off of bridge decks.
3. Remove debris (trees, logs, brush) lodged in stream channel and haul away from banks and burn.

Reporting:

Report men used and structures cleaned.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Erosion Repair	Cubic Meters	H-9

Task Description:

This task consists of repairing erosion damage to cut and fill slopes, roadside ditches, stream channel at culvert ends, behind bridge abutment backwalls and wingwalls, and on river banks.

When to Perform:

Erosion repair is routine maintenance. It should be performed as soon as possible when erosion damage is found to prevent the condition from worsening.

Expected Performance:

1½ cubic meters of material placed per man per day.

Crew Size:

Six laborers

Equipment:

Shovels - 1 for each man
Dobbin barrow - 1 for every 3 men
Hand tamp - 1 for every 3 men

Material:

Laterite gravel mixed with soil. Additionally, stones 20-30 centimeters (8-12 inches) in diameter for rip rap as needed.

Work Method:

1. Fill eroded areas with stone and gravel mixed with soil. Tamp to compact.
2. Depending on location, perform the following preventive measures:
 - Widen ditch.
 - Line ditch with rip rap, or place rip rap over eroded areas.
 - Build a series of small check dams in the bottom of ditches on steep slopes (over 3 centimeters per meter). Check dams are made of logs with rocks on the downstream side to prevent erosion as the water goes over the log.
 - For eroding cut slopes, dig small V-shaped ditch slightly above the top of the slope. Pile the dirt on the downhill side of the ditch to form a berm. Water should be diverted parallel to the top of the cut slope and carried to the roadside ditch or natural drainage channel.
 - For eroding fill slopes, build a small berm along the outside edge of the shoulder to divert water to natural ground elevation or to intermediate down channels lined with rip rap.

Reporting:

Report man hours spent and cubic meters of material placed.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Brush Cutting	Meters of Road	H-10

Task Description:

Cut grass, weeds, brush and trees along the shoulders of the road and in roadside ditches. Brush cutting is done to maintain sight distances, drainage characteristics, visibility to signs, and for inspection and easy access to bridges and culverts. Removal of fallen trees from the road and shoulders is included in this task.

When to Perform:

Brush cutting should be performed when grass and brush height reaches one half meter (approximately 20 inches). Brush cutting should be done when need for other tasks is not great.

Expected Performance:

100 meters of road, 3 meters wide on both sides per man per day.
600 meters of road, 3 meters wide on both sides per six men per day.

Crew Size:

One roadcamp crew with six road workers.

Equipment:

Swing blade or slasher - 1 for each man
Bush axe (bill hook) - 2 for each crew

Work Method:

1. Cut grass, weeds, and brush to a height of 8-10 centimeters (approximately 3-4 inches) for a distance of 3 meters (approximately 10 feet) outside the edge of shoulder on each side of the road.
2. Cut tree branches extending into this area.
3. Cut vegetation from around the ends of bridges and culverts to provide for inspection and easy access.

Reporting:

Report men used and length of road completed in meters.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Digging Soil for Huts	Cubic Meters	H-11

Task Description:

Dig and stockpile soil for use in building mud huts at the road camps. These huts will be for storing tools or housing road camp workers.

When to Perform:

Digging soil for huts should be done during the lag time when all other road maintenance tasks are caught up.

Expected Performance:

Two cubic meters per man per day
Twelve cubic meters per six men crew per day

Crew Size:

One roadcamp crew with six road workers.

Equipment:

Shovels - 1 for each man
Dobbin barrows - 1 for every 3 men
Picks - 3 for each crew

Material:

None

Work Methods:

Dig soil and haul in dobbin barrow to road camp location.

Reporting:

Report number of men used and cubic meters of material stockpiled.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Building Mud Huts	Each	H-12

Task Description:

Cut wood poles for frame and place mud to form walls of hut. This task includes erecting a frame for the thatch roof.

When to Perform:

Building mud huts should be done during times when the need for all other road maintenance tasks is not great.

Expected Performance:

One hut per six man crew in five days.

Crew Size:

One crew of six road workers.

Equipment:

Bush Axe (bill hook) - 2 for each crew
Shovels - 1 for each man
Dobbin barrow - 2 for each crew
Water bucket - 2 for each crew

Material:

Soil and water.

Work Method:

1. Erect wood frame.
2. Place mud for walls.
3. Erect roof frame.

Reporting:

Report number of men used.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Rethatch Hut Roofs	Hours	H-13

Task Description:

Cut grass, bundle, dry, and install on roof frame of hut. This task includes removing old thatch from roofs.

When to Perform:

Rethatching hut roofs should be performed as needed during the times when the need for all other road maintenance tasks is not great.

Expected Performance:

One hut per six men crew in two days.

Crew Size:

One six men crew

Equipment:

Slashers - 1 for each man

Material:

Grass

Work Method:

If suitable for thatch roof, grass should be cut from road sides to accomplish two tasks at once.

Reporting:

Report number of men used.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Blading	Kilometers	M-1

Task Description:

Use motor grader or agricultural tractor to smooth the roadway surface. Blading is accomplished by dragging or spreading the loose surface material and does not involve cutting into the compacted surface.

When to Perform:

The entire length of roadway should be bladed when severe corrugations occur or approximately once every 2 months. Blading will not be necessary during the two periods that the road is reshaped. If possible, blading should be done when aggregate and fines are moist. Blading should not be done under extremely wet conditions.

Expected Performance:

Motor grader - 30 km (18.5 mi.) of roadway per day.
Agricultural tractor with moldboard - 15 km (9.25 mi.) of roadway per day.

Crew Size:

One operator

Equipment:

One grader or agricultural tractor

Material:

N/A

Work Method:

1. Perform daily equipment check.
2. Adjust moldboard and wheels.
 - Position moldboard so that end of blade is at outside edge of shoulder.
 - Tilt blade slightly forward.
 - Angle blade 30° so that material is moved toward center of road.
 - Lean front wheels 10° to 15° toward center of road (motor grader blading only).
3. Begin blading at approximately 10 km/hr (6 mi/hr). If blade bounces reduce speed until smooth blading action occurs.
4. Periodically blade against the flow of traffic to eliminate drifting of aggregate onto ends of bridges and into intersections.
5. At bridge crossings an extra pass or two may be needed to fit the crown to match the bridge deck. If aggregate is piled on end of bridge, drive onto bridge, put grader or tractor in reverse and pull off excess aggregate.

Reporting:

Report engine hours and kilometers bladed.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Reshaping	Kilometers	M-2

Task Description:

Scarifying, grading, wetting and compacting the road surface to restore riding quality and design grade and cross section. Bringing in additional surface material may also be required as part of this task. Reshaping is required to correct corrugations, flattened crown, erosion, or rutting due to traffic and weather.

When to Perform:

Reshaping should be performed twice a year by reshaping crews--once before the start of heavy rains (February - April) and once after the heavy rains (August - October). Avoid scheduling reshaping activities under extremely wet or extremely dry conditions.

Expected Performance:

3.5 kilometers per day per crew

Crew Size:

One motor grader operator
Once tractor driver
Two truck drivers
Six laborers from nearest road camp

Equipment:

One agricultural tractor and pulling compactor
One motor grader with scarifier attachment
Two dump trucks with water tanks
One portable water pump (15-20 gpm)
Crown board and carpenters level
3 Shovels
1 Dobbin barrow
3 Rakes

Material:

Laterite gravel blend from stockpiles. Blend should vary in particle size from very small fines to a maximum particle size of 2-3 centimeters (approximately 1 inch) in diameter.

Work Method:

Reshape road in 200 meter sections to prevent excess evaporation and blowing of fines.

A. Mechanical Operations

1. Perform daily equipment checks. Set moldboard and make one pass along each side of the road with motor grader, bringing washed material out of the ditch onto roadway surface.
2. Scarify road surface as deep as the average corrugation, usually about 5-7 centimeters (2-3 inches) with motor grader. Breaking crust might require use of the scarifier attachment if the road surface is too hard to cut easily with the grader blade. If the blade is used to scarify the following procedures apply:
 - Tilt blade back at the top and forward at the bottom cutting edge.
 - Angle moldboard about 30° to 45° to provide rolling aggregate in a mixing action toward center of the road.
 - Lean front wheels 10° to 15° toward center of the road.
 - Continuously adjust blade to get good cutting and mixing action.
 - An extra pass may be needed to cut to the bottom of ridges and windrow aggregate to the center of the road.
3. Where a large amount of surface material is needed to maintain grade, use dump truck to bring in material.
4. Wet scarified surface to provide moisture for compaction. Determine wetting rate by applying water until surface materials will form a loose ball when squeezed in a person's hand. Applying 1.25 liter (1/3 gallon) per square meter (yard) will use approximately 28,500 liters (7,500 gallons) per 3.5 km (2.1 miles) per roadway.
5. Grade roadway surface with motor grader to obtain a smooth surface with the proper crown. Blade should be set in a more vertical position for normal grading. Two passes will probably be required for each side of the roadway. Road should slope away from center at a rate of 4 centimeters per meter (approximately 1½ inch per yard). If the motor grader does not have a crown gage, periodically check slope with a carpenter's level and crown board.
6. Wet surface. Applying 1.25 liter (1/3 gallon) per square meter (yard) will use approximately 28,500 liters (7,500 gallons) per 3.5 km (2.1 miles) of roadway.

Reshaping M-2 (Continued)

Work Method:

7. Make one pass over surface with tractor and compactor (two passes per side of roadway).
8. Fine grade surface making one pass on each side of road with motor grader to smooth any loose material.
9. Compact surface. Will require at least 4 passes over each side of roadway.

B. Hand Operations

1. Pick up and dispose of oversize rocks that may become dislodged during grading.
2. Rake surface to smooth where needed.
3. Assist dump truck drivers in pumping water to refill tanks.
4. Load trucks when additional amount is needed.
5. Direct traffic at worksite.

Reporting:

Report engine hours, number of men used, and kilometers of roadway reshaped.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Hauling - Truck	Cubic Meters - Kilometers	M-3

Task Description:

Load laterite aggregate blend into dump truck with tractor and front end loader or hand labor. Haul from stockpiles to locations along the roadway where material is needed for hand patching, erosion repair, and reshaping.

When to Perform:

Hauling by truck should be performed routinely to establish small stockpiles of aggregate at one or two kilometer intervals or whenever large amounts of material are needed.

Expected Performance:

Twelve cubic meters per day over a distance of ten kilometers using tractor and front end loader. Nine cubic meters per day over a distance of ten kilometers using hand loading.

Crew Size:

- One truck driver
- One tractor driver or six laborers

Equipment:

One dump truck
One tractor with front end loader or six shovels

Material:

•
Laterite gravel blend. Blend should vary in particle size from very small fines to a maximum particle size of 2-3 centimeters (approximately 1 inch) in diameter. Stones 20-30 centimeters (8-12 inches) in diameter for use as rip rap in erosion repair.

Work Method:

1. Load dump truck. (If loading from stockpile produced by bulldozer remove large stones.)
2. Haul material where needed. If material is not to be spread the same day it is hauled and dumped, it should be dumped outside the shoulder and ditchline of the roadway so as not to create a hazard for traffic.

Reporting:

Report men used, engine hours, cubic meters of material and distance, in kilometers, hauled.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Stockpiling - Mechanical	Cubic Meters	M-4

Task Description:

Locate source of laterite, strip topsoil and vegetation, excavate and crush laterite, and stockpile aggregate blend.

When to Perform:

Stockpiling aggregate is a routine maintenance task to be performed as needed to supply aggregate for patching, spreading and erosion repairs to the roadway surface.

Crew Size:

One heavy equipment operator

Expected Performance:

100 cubic meters (30 cubic yards) per day

Equipment:

One track-type tractor with bulldozer and ripper
One truck tractor with low bed trailer

Material:

N/A

Work Method:

1. Unload track-type tractor at aggregate source, to be located by local roadcamp headman, or road foreman. Perform equipment checks.
2. Strip topsoil and vegetation.
3. Using ripper and bulldozer attachments scarify and break laterite.
4. Push into stockpile.
5. Load equipment and move to next work site.

Reporting:

Report engine hours and cubic meters of material produced.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Minor Repairs to Structures	Square Meters	B-1

Task Description:

Repair spalled or cracked concrete on culverts, headwalls, and bridges with a concrete or mortar patch. Culvert pipes that are badly cracked, caved in, or misaligned from settlement or heaving should be replaced. See Task B-2. Where there is severe settlement of bridge abutments or piers, the road supervisor should be notified and replacement scheduled through SRMTC headquarters in Juba.

When to Perform:

Minor repairs to structures should be performed routinely on a year round basis.

Expected Performance:

Two square meters of concrete patch per crew per day.

Crew Size:

Three assistant builders and a builder (concrete finisher) under the supervision of the head builder.

Equipment:

Dump truck - one for each crew
Picks - one for each laborer
Shovels - one for each laborer
Water drum - one for each crew
Water bucket - one for each crew
Masonry chisel - two for each crew
Masonry hammer - two for each crew
Concrete trowel - one for each crew
Wheel barrow - one for each crew

Material:

Cement
Washed sand
Crushed stone $\frac{1}{2}$ - $2\frac{1}{2}$ centimeters (3/16 - 1 inch) in diameter
Wood for forms if necessary
Nails for forms if necessary

Work Method:

A. Bridges and Headwalls

1. Chip away all loose and deteriorated concrete from around cracks and spalls using masonry hammers and chissels. (Only cracks open greater than 1 centimeter (3/8 inch) should be repaired.) Chip away concrete from sides of spalls so that the inside diameter of the hole is greater than the outside diameter.
2. Wet existing concrete before patching.
3. Patch spalls less than 5 centimeters (2 inches) deep with mortar using the following mix:

- 1 part cement

- 3 parts sand

- maximum of 2/5 part water (3 US gallons per cubic foot of cement)

Patch spalls greater than 5 centimeters deep and repair broken section with concrete using the following mixture:

- 1 part cement

- 2 parts sand

- 4 parts crushed stone

- maximum of 3/4 part water (5.5. US gallons per cubic foot of cement)

Concrete or mortar that has started to harden or that has been mixed longer than 30 minutes should not be used.

4. Large patches or repairs to corners of bridge units may require that a steel pin be grouted into existing concrete with mortar to anchor patch
5. When wood forms are used to place concrete, they should be coated with oil or saturated with water immediately before concrete is placed to prevent the concrete from sticking to the wood.
6. Allow concrete to cure for two days before removing forms. Once forms are removed, new concrete should be covered with burlap, cloth, or straw and kept wet for two days.

Minor Repairs to Structures B-1 (Continued)

Work Method:

B. Culvert Pipe

1. Dig down to expose area of culvert pipe to be patched.
2. Patch cracks and small spalls with mortar using the mix given above.
3. Patch holes in pipe with concrete using the mix given above.
4. See Task "Culvert Pipe Replacement" for method of backfilling around culvert pipe.

Reporting:

Report men and materials used and square meters patched.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Culvert Pipe Replacement	Each	B-2

Task Description:

Replacing badly cracked, caved in, or misaligned (from settlement or heaving) culvert pipes with reinforced concrete culvert pipe sections. This task includes installation of new culverts.

When to Perform:

Damaged culvert sections that restrict drainage so that there is a chance of washing out the roadway should be replaced immediately. Otherwise culvert pipe replacement should be scheduled during the dry season.

Expected Performance:

Install average of two culvert pipe sections per day per crew.

Crew Size:

Six assistant builders and a builder (concrete finisher) under the supervision of the head builder.

Equipment:

Dump truck for hauling material
Shovels - one for each laborer
Picks - three for a crew
Hand tamps - three for a crew
Carpenter's level - one for a crew
Level board 2.5 - 3 meters (8-10 feet) - one for a crew
Water drum -209 liter (55 gallon) - one for a crew
Water bucket - one for a crew
Wheel barrow - one for a crew
Masonry chissel - two for a crew
Masonry hammer - two for a crew
Concrete trowel - one for a crew

Material:

Cement
Washed sand
Crushed stone $\frac{1}{2}$ - $2\frac{1}{2}$ centimeters (3/16 - 1 inch) in diameter
Sand, stone sand, or stone screenings

Work Method:

1. Remove old pipe and dig trench 60 centimeters (24 inches) wider and 8 centimeters (3 inches) deeper than new pipe. When installing a new culvert, the bottom of the trench should slope between 1-4 centimeters over a distance of 1 meter (1/8 - 1/2 inch per foot). The bottom of the pipe openings at both ends (inlet and outlet) should match the elevation of the stream channel. When removing pipe sections, remove entire joint between pipe sections using hammers and chissels.
2. Add 10 centimeters (4 inches) of sand, stone sand, or stone screenings for the width of the trench and the length of replacement, except that a good quality soil that will not allow the free flow of water should be used for the outer 1 meter (3 feet) at the end of the culvert.
3. Wet and compact the bottom layer. Shape center of trench so that new pipe sections will be on the same slope as the existing sections.
4. Install new pipe section using metal forms to pour concrete joints. Reinforcement wire mesh should overlap at least one mesh in the concrete joint between pipe sections. Wet ends of the pipe sections to be joined. use the following concrete mixture for placing the joint:
 - one part cement
 - two parts cleaned sand
 - four parts crushed stone
 - maximum of 3/4 parts water (5.5 US gallons per cubic foot of cement)
5. Wet concrete should be rodded with a metal rod to insure that all air space is full. Concrete that has been mixed longer than 30 minutes should not be used.
6. Allow concrete joint to cure 24 hours before removing forms. Provide some form of temporary traffic control to steet vehicles away from the open ditch.
7. Backfill to the center of the pipe with sand, stone sand, or stone screenings, except that a good quality soil that will not allow the free flow of water should be used for the outer 1 meter (3 feet) at the end of a culvert. Fill to roadbed with good quality soil free from large rocks or clods. Fill to road surface with a laterite aggregate blend. Fill should be added in layers 10 centimeters (4 inches) thick, then wetted and compacted. Fill height over pipe should be 30 centimeter (1 foot) minimum.

Reporting:

Report number of culvert pipe sections replaced or installed and number of men used.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Making Culvert Pipe	Each	B-3

Task Description:

Make reinforced concrete pipe sections for use in replacing broken culvert pipe or installing new culverts.

When to Perform:

Culvert pipe should be made routinely to maintain a stock of 10-15 sections.

Expected Performance:

Two pipe sections per crew per day.

Crew Size:

Two laborers
One concrete finisher

Equipment:

Metal forms - 2 sets
Shovels - 1 for each laborer
Wheel barrow - 1 for each crew
Water bucket - 1 for each crew

Material:

Cement
Washed sand
Crushed stone, $\frac{1}{2}$ - $2\frac{1}{2}$ centimeters (3/16 - 1 inch) in diameter
Welded steel mesh or bar mat

Work Method:

1. Tie wire mesh reinforcement with wire so that it overlaps one mesh. Except on end pipe sections, wire should extend from each side of the concrete enough so that wire can be lapped one mesh when the concrete joint is placed between pipe sections. On end pipe sections there should be 5 centimeters (2 inches) of concrete cover over one end of the reinforcement. There should be a minimum of $3\frac{1}{2}$ centimeters ($1\frac{1}{2}$ inches) concrete cover between reinforcement and inside and outside of pipe.
A preferred alternative would be to modify existing forms so that the ends of the pipe are shaped to form tongue and groove joints.
2. Place concrete in form using the following mixture:
 - one part cement
 - two parts sand
 - four parts crushed stone
 - maximum of $\frac{3}{4}$ part water (5.5. US gallons per cubic foot of cement)

Concrete that has been mixed for longer than 30 minutes should not be used.

3. Allow concrete to cure for two days before removing forms.

Reporting:

Report men used and number of pipe sections made.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

<u>Task Name</u>	<u>Units</u>	<u>Task Number</u>
Installing Underdrains	Each	B-4

Task Description:

Install perforated pipe or French drain under roadway surface to drain water over to roadside ditch.

When to Perform:

Underdrains should be installed at locations under the road or shoulder where underground water is trapped causing the roadbed to remain continuously wet. This work should be performed by the bridge crew when such a condition is found to exist.

Expected Performance:

One underdrain should be installed in one day.

Crew Size:

Six laborers and a tractor driver under the supervision of the foreman of the bridge crew.

Equipment:

- Tractor with trailer for hauling material
- Hand tamps - two for each crew
- Shovels - one for each laborer
- Picks - three for a crew
- Carpenter's level - one for a crew
- Level board 2.5 - 3 meters (8-10 feet) - one for a crew
- Water drum 209 liter (55 gallons) - one for a crew
- Water bucket - one for a crew

Material:

- Perforated pipe 10 centimeters (4 inches) in diameter if available.
- Sand, stone sand or stone screenings reasonably free from an excess of soft or unsound particles.
- Crushed gravel or stone smaller than 2.5 centimeters (1 inch) in diameter.

Work Method:

A. Perforated pipe underdrain

1. Dig a trench 30 centimeters (1 foot) wide leading from the point of underground seepage to the roadside ditch. The slope very gradually, approximately 1-2 centimeters over a distance of 1 meter (1/8 to 1/4 inch per foot), toward the roadside ditch. Check slope with level board and carpenter's level.
2. Spread a layer of crushed stone and sand 8 centimeters (3 inches) deep in the bottom of the trench and compact with hand tamps.
3. Lay perforated pipe in the trench with perforation facing down.
4. Fill trench up to half the depth of the pipe with crushed stone and sand compact.
5. Add porous granular backfill consisting of crushed stone mixed with sand to a height equal to the level of saturated (wet) roadbed. The minimum height of granular backfill should be 30 centimeters (1 foot) above the top of the pipe. Material should be added in 15 centimeter (6 inch) layers and compacted with hand tamps.
6. Any remaining portion of the trench above the granular backfill should be filled with the laterite aggregate blend used on the roadway surface. This material should be added in layers 7-10 centimeters (3-4 inches), wetted, and compacted with hand tamps.

B. French drain

1. Perform Step 1 above.
2. Add crushed stone and sand to a height equal to the level of saturated roadbed. The minimum height of this porous granular backfill should be 30 centimeters (1 foot). Material should be added in 15 centimeter (6 inch) layers and compacted with hand tamps.
3. Perform Step 6 above.

Reporting:

Report number of men worked and feet of underdrain.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Stockpiling Sand

Cubic Meters

B-5

Task Description:

Locate sources of sand, remove from river bank, screen, load, haul and stockpile.

When to Perform:

Stockpiling sand is a routine activity and should be performed as needed to supply material for making concrete pipe, repairing structures and installing pipe.

Expected Performance:

Six cubic meters per six men.

Crew Size:

One crew of six builders or assistant builders
One driver

Equipment:

Dump truck - 1 for each crew
Shovels - 1 for each man
Screen (0.5 cm) - 1 for each crew
Wheel barrow or dobbin barrow - 1 for each crew

Material:

River sand

Work Method:

1. Shovel sand from river bank or sand bar.
2. Screen sand through 0.5 cm (1/4 inch) mesh, remove small pieces of organic material by hand or by washing.
3. Load into dump truck and haul to worksite or maintenance yard.
4. Stockpile.

Reporting:

Report number of men used and cubic meters of sand stockpiled.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Supervision

Employee Hours

A-1

Task Description:

Planning and scheduling of maintenance activities, inspection of maintenance work sites, and other administrative duties performed by supervisory personnel.

When to Perform:

Perform as required or directed to insure efficient use of employees, equipment and materials.

Expected Performance:

N/A

Crew Size:

One Supervisor (Road Overseer or higher)

Equipment:

N/A

Material:

N/A

Work Method:

1. The supervisor completes forms for scheduling and reporting activities.
2. Inspects work sites to insure compliance with performance standards.

Reporting:

Report man-hours worked.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Approved Absence

Employee Hours

A-2

Task Description:

Reporting all time charged by maintenance forces to holidays, annual leave, sick leave, and all other approved absences for which payment will be made.

When to Perform:

Perform in accordance with SRMTC Policy.

Expected Performance:

N/A

Crew Size:

Employee

Equipment:

N/A

Material:

N/A

Work Method:

Obtain prior approval for absences if required.

Reporting:

Report total number of hours employee is absent.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Equipment Maintenance

Employee Hours

A-3

Task Description:

Maintaining or repairing equipment by road maintenance personnel including transportation of equipment from one location to another for repairs, routine preventive maintenance and minor repairs or mechanical adjustments to insure safe and reliable equipment.

When to Perform:

Perform when minor equipment failure occurs due to normal use or need for routine preventive maintenance occurs.

Expected Performance:

N/A

Crew Size:

Driver or Operator

Equipment:

N/A

Material:

N/A

Work Method:

1. Service and make minor repairs to vehicles and equipment.
2. Check water, tires, fan belts, transmission, front end, rear end, brakes, heater, lights, wipers, etc.
3. Clean truck.

Reporting:

Report man-hours worked.

PERFORMANCE STANDARD

SOUTHERN REGION MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Overhead

Employee Hours

A-4

Task Description:

Attending training conferences and safety meetings held to assist maintenance personnel in the proper performance of their job functions. Also includes other overhead activities such as cleaning road maintenance compound.

When to Perform:

As required or directed by supervisor.

Expected Performance:

N/A

Crew Size:

One employee

Equipment:

N/A

Material:

N/A

Work Method:

Attending training session or perform overhead activity as directed.

Reporting:

Report man-hours worked.

Appendix B

(Chapter 28 of TECHNICAL SPECIFICATIONS)

CHAPTER 28 - ROAD MAINTENANCE EQUIPMENT

- 28.01.00 - 4x4 Half Ton Pick-up
- 28.02.00 - 4x4 Service Truck
- 28.03.00 - Track-Type Tractor
- 28.04.00 - Motor Grader
- 28.05.00 - Reserved
- 28.06.00 - 4x2 Dump Truck
- 28.07.00 - 6x4 Tractor
- 28.08.00 - Industrial Tractor
- 28.09.00 - Implement Trailer, w/Demountable 4 Yard Hopper
- 28.10.00 - Lowbed Trailer, w/Demountable Water Tanks and demountable
12 Yard Hopper
- 28.11.00 - Portable Water Pump
- 28.12.00 - Fuel Trailer
- 29.13.00 - Water Tank and Aggregate Hopper Support Stands

General Notes

1. Specifications presented in this chapter contain non-competitive elements. The majority of these specifications are based upon Caterpillar engines or equipment for the following reasons.
 - ability to use high sulphur content fuels
 - availability of parts and service from Nairobi dealership
 - predominance of Caterpillar equipment in existing fleet
 - proven ease of maintenance and durability
 - commonality of equipment components
2. All engines are diesel fueled for the following reasons: reduced fire hazard, reduced fuel pileferage, lower cost fuel, fuel efficiency, increased engine life, dependability and ease of maintenance.
3. Each item includes: specifications, bid questionnaire and spare parts list

ROAD MAINTENANCE EQUIPMENT COST ESTIMATE

Item No.	Quantity		Unit Price (FOB US \$)	Total (FOB US \$)
28.01.00	2	4 x 4 Pick-up Truck	12,000	24,000
28.02.00	1	4 x 4 Service Van	14,000	14,000
28.03.00	1	D4E Track-Type Tractor	53,000	53,000
28.04.00	Alt.1 2	120G Motor Grader	102,000	204,000
	Alt.2 2	120B Motor Grader	76,000	- -
28.06.00	5	4 x 2 Dump Truck	32,000	160,000
28.07.00	1	6 x 4 Truck Tractor	70,000*	70,000
28.08.00	3	6 x 4 Industrial Tractor	20,000	60,000
	1	Loader and Backhoe	17,000	17,000
	2	Utility Trailer	8,000	16,000
	2	Roller	15,000	30,000
	2	Rear Drag Block	1,000	2,000
28.09.00	4	Implement Trailers	14,200	56,800
	3	Aggregate Hoppers - 3 m ³ cap.	3,000	9,000
28.10.00	1	Lowbed Trailer	24,300	24,300
	4	Water Tanks	6,400	25,600
	1	Aggregate Hopper - 9 m ³ cap.	8,000	8,000
28.11.00	3	Water Pumps	4,000	12,000
28.12.00	2	Fuel Trailer	4,500	9,000
28.13.00	4	Support Stands	5,000	20,000
				809,700
		Spare Parts (Estimated @ approx. 25%)		205,000
		Shipping (Estimated @ approx. 15%)		120,000
				<u>\$1,139,700</u>
				=====

B-2

* Unit prices estimated (awaiting quotes).

SPECIFICATIONS

ITEM NO. 28.01.00 1/2-TON 4X4 PICKUP

It is the purpose and intent of these Specifications to describe a conventional 4X4 pickup, diesel powered, 1/2-ton rating, GMC Model K-1500 or approved equal.

The vehicle shall be of current production, standard (short) wheelbase, and be equipped with wideside type pickup body of approximately 2 meters (6.5 feet) in length w/standard tailgate.

Subject equipment will be utilized on unpaved roads under conditions of extreme dust and heat. It is absolutely mandatory that the cooling and filtration systems be satisfactory for tropic/desert zone operations.

28.01.01. ENGINE

- .01.1 GMC 6.2 Liter or approved equal.
- .01.2 Designed for diesel fuel having a minimum cetane rating of 35.
- .01.3 Heavy duty cooling and filtration systems.

28.01.02. TRANSMISSION

- .02.1 Heavy duty automatic.

28.01.03. AXLES

- .03.1 Minimum rating 1575 Kg. (3500 lbs.), front.
- .03.2 Minimum rating 1665 Kg. (3700 lbs.), rear.

28.01.04. SUSPENSION SYSTEM

- .04.1 Satisfactory to provide a GVW rating of 2745 Kg. (6100 lbs.), minimum.
- .04.2 Heavy duty, double-acting shock absorbers, F&R

28.01.05. WHEELS & TIRES

- .05.1 Wheels shall be standard for model quoted.
- .05.2 Tires shall be Michelin, tubeless, traction tread, load rating equal to P235-75R15, minimum, or equal.
- .05.3 Matching, mounted spare tire.
- .05.4 Interchangeable F&R.

28.01.06. BRAKE SYSTEM

- .06.1 Standard for model quoted.

28.01.01 1/2-TON PICK-UP (Con't.)

28.01.07. STEERING SYSTEM

.07.1 Standard for model quoted.

28.01.08. ELECTRICAL SYSTEM

- .08.1 63 AMP capacity charging system, minimum.
- .08.2 Optional heavy duty starter, if available.
- .08.3 Heavy duty battery package, Delco Freedom or equal.
- .08.4 Standard lighting system.

28.01.09. FUEL SYSTEM

- .09.1 Standard w/auxiliary fuel tank.
- .09.2 Water separator.
- .09.3 Optional, increased capacity fuel filtration system.

29.01.10. CAB & BODY

- .10.1 Standard two-door cab & seating arrangement.
- .10.2 Standard temperature controls.

28.01.11. COOLING SYSTEM

- .11.1 Optional, heavy duty, increased capacity type.
- .11.2 Standard temperature controls.

28.01.12. COLOR

- .12.1 Solid, high visibility type yellow.

28.01.13. MISC. ACCESSORIES

- .13.1 Hydraulic jack & wheel wrench.
- .13.2 Defogger fan.
- .13.3 Dual WC mirrors (chromed model not required).
- .13.4 Non-rotating amber flasher, electronic strobe type, roof-mounted, Whelan or approved equal.

28.01.14. GENERAL

All equipment normally offered as standard production line items shall be furnished, whether or not specifically itemized and delineated in these brief general Specifications.

All workmanship in the installation of non-standard accessories shall be of optimum quality through out.

ITEM NO. 28.01.00
1/2-TON PICKUP, 4X4

DETAILED BID QUESTIONNAIRE

Bidder's name & business address _____
_____ Tel. No. _____

Make _____ Model _____ Year _____

Gross Vehicle Weight rating _____ Kgs.

Note any deviations from Bid Specifications _____

Price quoted for two (2) units as described in Specifications including all transportation and delivery expense to Rumbek, Lakes Province, Sudan, Africa via Port of Mombasa, Kenya. \$ _____.

Bid may be declared invalid if all questions in the Bid Questionnaire are not answered. Purchaser reserves the right to award the Bid to the best interest of all concerned in the final analysis, or to reject any or all Bids.

1. ENGINE

Make _____ Model _____ Displacement _____
Designed for 35 cetane diesel fuel? _____ Rated KW _____
HD cooling & filtration systems? _____.

2. TRANSMISSION

Make _____ Model _____ Speeds _____ HD series? _____

3. AXLES

Make, model & rated capacity, front _____
Make, model & rated capacity, rear _____
Automatic locking front hubs? _____ Same ratio F&R? _____

4. SUSPENSION SYSTEM

Rated capacity, front _____ Rated capacity, rear _____
HD shock absorbers furnished F&R? _____

5. WHEELS & TIRES

HD, interchangeable wheels F&R? _____ Mounted spare tire
furnished? _____ Size & type Michelin tires _____

BID QUESTIONNAIRE, Item No. 28.01.00 (Con't.)

6. BRAKE SYSTEM

Type & size, front _____ Type & size, rear _____

7. STEERING SYSTEM

Mechanical or power steering system? _____

8. ELECTRICAL SYSTEM

Make, model & capacity alternator _____

Optional HD starter furnished? _____

Number, make & model batteries _____

9. FUEL SYSTEM

Fuel Cap., main tank _____ liters Auxiliary tank _____ liters.

Water separator furnished? _____ Optional filtration system? _____

10. CAB & BODY

Standard cab & sheet metal? _____ Type seat _____

Body type & size _____

11. COOLING SYSTEM

HD cooling system furnished? _____ Cooling system filtered? _____

12. COLOR

Describe color furnished _____

13. Note any deviations in respect to the miscellaneous accessories stipulated in the Bid _____

14. All standard production line equipment furnished? _____
All installation & workmanship of optimum quality? _____

Name & title of person authorized to sign the Bid:

_____ Date: _____

Note any appropriate comments: _____

ITEM NO. 28.01.00
1/2-TON PICKUP, 4X4

SPARE PARTS LIST

Bidder shall supply the following items for subject vehicle, and be responsible for overseas packaging. Parts and supplies listed below shall include all transportation and delivery expense to Rumbek, Sudan, the shipment of which shall accompany the vehicle.

All items listed below shall be genuine replacement parts, and shall properly fit the make and model vehicle quoted.

Item	Quantity	Description	Total Price
1	1	Set (4) axle shafts	\$ _____
2	1	Set (4) brake linings	_____
3	1	Front spring assembly	_____
4	1	Rear spring assembly	_____
5	1	Complete set universal joints, F&R	_____
6	2	Set fan belts	_____
7	24	Oil filter elements	_____
8	2	Injector assembly	_____
9	1	Complete set injection lines	_____
10	1	Set transmission bearings & seals	_____
11	1	Front wheel hub complete w/bearings	_____
12	1	Rear wheel hub complete w/bearings	_____
13	1	Complete starter assembly	_____
14	1	Complete alternator assembly w/pulley	_____
15	1	Set (4) seal beam lights	_____
16	4	Set (4 set) shock absorbers	_____
17	1	Quart matching cab/body paint	_____
18	2	Complete set engine gaskets & seals	_____
Total packaged & delivered cost.			_____

Name & title of person authorized to sign the Bid:

_____ Date: _____

Note any appropriate comments: _____

ITEM NO. 28.02.00
4X4 SERVICE TRUCK

SPECIFICATIONS

It is the purpose and intent of these Specifications to describe a 4X4 SERVICE TRUCK, diesel powered, equipped with a lockable compartment, all-weather type field service body.

Chassis shall be current production model GMC Special Heavy Hauler series w/6.2 Liter V8-8 diesel engine, 1-ton 4WD Model K-3500 rated at 4950 Kg. (11,000 lbs.) GVW, or approved equal.

Cab-to-axle dimension shall be approx. 1.3 meters (50 in.), and designed to accommodate a Stahl Model "COM-PAK CHALLENGER" 834 service body, or approved equal. Wheelbase of the truck chassis shall be appropriate for the GA stipulated above.

Subject equipment will be utilized to service road maintenance equipment under conditions of extreme heat and dust, in a tropic/desert zone having ambient temperatures ranging from 20 through 55 degrees Celsius (70° to 130°F.)

28.02.01. ENGINE

- .01.1 Designed for diesel fuel having a cetane rating of 35, minimum.
- .01.2 GMC 6.2 Liter, or approved engine of Approx. the same general performance characteristics.
- .01.3 Heavy duty cooling and filtration systems.

28.02.02. TRANSMISSION

- .02.1 Heavy duty automatic.

28.02.03. AXLES

- .03.1 Heavy duty, optional capacity F&R

28.02.04. SUSPENSION SYSTEM

- .04.1 Heavy duty type, optional capacity rating.
- .04.2 HD double-acting shock absorbers F&R.

28.02.05. WHEELS & TIRES

- .05.1 Heavy duty wheels, dual rear.
- .05.2 Tires shall be radial, tubeless, largest capacity option available, traction tread, interchangeable F&R.
- .05.3 Mounted, matching spare tire.

28.02.00 - 4X4 SERVICE TRUCK (Con't.)

28.02.06. BRAKE SYSTEM

.06.1 Standard for model quoted.

28.02.07. STEERING SYSTEM

.07.1 Manual w/power assist.

28.02.08. ELECTRICAL SYSTEM

- .08.1 63AMP capacity, minimum.
- .08.2 Optional heavy duty starter, if available.
- .08.3 Standard battery package.

28.02.09. FUEL SYSTEM

- .09.1 Standard w/auxiliary fuel tank.
- .09.2 Water separator.
- .09.3 Optional, increased capacity fuel filter(s).

28.02.10. CAB

.10.1 Standard cab & sheet metal for model quoted.

28.02.11. SERVICE BODY

- .11.1 All-steel construction, weather-sealed body w/ optional roof, Stahl or equal.
- .11.2 Approx. 2.4 cubic meters (80 ft.³) of lockable space inside, and 0.75 cubic meters (25 ft.³) lockable storage compartments outside.
- .11.3 Body overall length Approx. 2.1 meters (83") by 1.6 meters (63") overall width and 1.2 meters (49") in overall height: for chassis CA Approx. 1.27 meters (50").
- .11.4 Front & rear windows.
- .11.5 Standard tool compartments & shelving.

28.02.12. COLOR

.12.1 Chassis shall be painted w/conventional solid, single color Bright Yellow #51; matching paint shall be applied to the body.

28.02.13. MISC. ACCESSORIES

- .13.1 Hydraulic jack & wheel wrench.
- .13.2 Dual WC type mirrors w/HD bracing.
- .13.3 Defogger fan.
- .13.4 Standard Hot Climate Kit.
- .13.5 (Note: heater/defroster not required).

ITEM NO. 28.02.00
4X4 SERVICE TRUCK

DETAILED BID QUESTIONNAIRE

Bidder's name & business address: _____
_____ Tel. No. _____

Make _____ Model _____ Year _____

Gross Vehicle Weight rating _____ Lbs.

Note any deviations from Bid Specifications: _____

Price quoted for one (1) unit as described in the Specifications including all preparation, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya: \$ _____.

Bid may be rejected if all items listed in the Bid Questionnaire are not answered. Purchaser reserves the right to reject any or all Bids, and award the contract to the best interest of all concerned in the final analysis.

1. ENGINE

Make _____ Type _____ Model _____ C.I.D. _____
Rated at _____ HP @ _____ RPM Min. fuel cetane rating _____
HD cooling & filtration systems included? _____

2. TRANSMISSION

Make _____ Type _____ Model _____ Speeds _____
Oil cooling system included? _____

3. AXLES

Front wheel hubs equipped w/automatic lock-up device? _____
Make, model & rated capacity (front) _____ Lbs. _____

Make, model & rated capacity (rear) _____ Lbs. _____

Gear ratio (front) _____ Gear ratio (rear) _____

4. SUSPENSION SYSTEM

Type & capacity, front _____
Type & capacity, rear _____
HD double-acting shock absorbers F&R? _____

BID QUESTIONNAIRE, Item No. 28.02.00 (Con't.)

5. WHEELS & TIRES

HD wheel size, dual rear _____
HD wheel size, front _____
Radial Michelin tires, traction tread? _____
Tire size & ply rating _____
Wheels interchangeable F&R? _____
Mounted, matching spare tire furnished? _____

6. BRAKE SYSTEM

Type & size, front _____
Type & size, rear _____
Power-assist hydraulic system? _____

7. STEERING SYSTEM

Manual system w/power assist? _____

8. ELECTRICAL SYSTEM

Alternator rated capacity _____ AMPS HD starter? _____
Maintenance-free battery package? _____

9. FUEL SYSTEM

Standard tank Cap. _____ liters Auxiliary tank Cap. _____ liters
Water separator furnished? _____ Optional filter? _____

10. CAB

Standard cab & sheet metal furnished? _____

11. SERVICE BODY

Make _____ Model _____
Installed by: _____
All-metal, weather-sealed construction? _____
Optional roof furnished? _____
Lockable doors & compartments? _____
Body length _____ Width _____ Height _____
Inside storage space _____ cu. m. Outside compartments _____ cu. m.

12. COLOR

Describe color _____
Complete unit same color? _____

BID QUESTIONNAIRE, Item No. 28.02.00 (Con't.)

13. MISC. ACCESSORIES

Note any deviations from Bid Specifications: _____

Name & title or person authorized to sign the Bid:

_____ Date: _____

ITEM NO. 28.02.00
4X4 SERVICE TRUCK

SPARE PARTS LISTS

Bidder shall supply the following listed items for subject vehicle, and be responsible for overseas packaging. The parts and supplies listed shall include all handling, transportation and delivery expense to Rumbek, the shipment of which shall accompany the vehicle.

All items shall be genuine replacement parts, and shall properly fit the make and model quoted by Bidder.

Item	Quantity	Description	Total Price
1	1	Set (4) axle shafts	\$ _____
2	1	Set (4) brake linings, F&R	_____
3	1	Front spring assembly	_____
4	1	Rear spring assembly	_____
5	1	Complete set or universal joint assemblies, F&R drive shafts	_____
6	1	Set of fan belts	_____
7	12	Oil filter elements	_____
8	6	Fuel filter elements	_____
9	2	Injector assembly	_____
10	1	Complete set injector lines	_____
11	1	Front wheel hub complete with bearings and seals	_____
12	1	Rear wheel hub complete with bearings and seals	_____
13	1	Complete starter assembly	_____
14	1	Complete alternator assembly	_____
15	1	Set (4) seal beam lights	_____
16	1	2- Set (4) shock absorbers	_____
17	1	Complete set transmission bearings and seals	_____
18	1	Complete set engine gaskets and seals	_____
19	1	Quart matching cab/body paint	_____
Total packaged & delivery cost			\$ _____

Name and title of person authorized to sign the Bid:

_____ Date: _____

Note appropriate comments: _____

ITEM NO. 28.03.00
CATERPILLAR MODEL D4E TRACTOR-DOZER

SPECIFICATIONS

The purpose and intent of these Specifications is to describe a CATERPILLAR MODEL D4E TRACTOR w/bulldozer blade, diesel powered, Approx. working weight 9,000 Kg. (20,000 lbs.) or approved equal.

The unit will be used for general road maintenance functions in a tropical district experiencing ambient temperatures ranging 20 through 55 degrees celsius (70^o to 130^o F.).

The unit should have optional, heavy duty cooling and air inlet filtration elements designed for extreme dust and heat.

28.03.01. ENGINE

- .01.1 Caterpillar Model 3304, standard production series w/all standard eatures & accessories normally provided for same.
- .01.2 Pressure lubricated and filtered system.
- .01.3 Dry type air inlet filter w/primary & secondary elements.
- .01.4 Designed for No. 2 fuel oil w/35 octane rating.
- .01.5 24-volt, optional HD service starting system.
- .01.6 Glow plug starting assist not required.
- .01.7 HD, sealed 50-amp alternator package.
- .01.8 Standard exhaust & muffler.

28.03.02. TRANSMISSION

- .02.1 Planetary type power shift w/high-capacity, high-torque oil clutches.
- .02.2 3-speeds forward & reverse.
- .02.3 Integral, single-stage torque converter.
- .02.4 Standard performance gearing.

28.03.03. TRACK ROLLER FRAME

- .03.1 Boxed-channel construction.
- .03.2 Lifetime lubricated track rollers, carrier rollers and idlers.
- .03.3 Standard size, disc-type idlers.
- .03.4 Standard oscillation system.

28.03.04. TRACK SYSTEM

- .04.1 Standard 330 mm (13") shoes.
- .04.2 Sealed and lubricated track assembly.
- .04.3 Two-piece master link & track adjusters.

CAT. MODEL D4E TRACTOR-DOZER (Con't.)

28.03.05. FINAL DRIVES

.05.1 Standard production type.

28.03.06. STEERING SYSTEM

.06.1 Hydraulically actuated, multiple disc steering clutches.
.06.2 Mechanically actuated, oil cooled contracting band brakes.

28.03.07. HYDRAULIC SYSTEM & CONTROLS

.07.1 Standard system consisting of pump, reservoir, filtration system and controls.
.07.2 Raise, hold, lower & float positions.

28.03.08. CAB

.08.1 Canopy, open type on four (4) posts.

28.03.09. COLOR

.09.1 Standard manufacturer's color.

28.03.10. BULLDOZER

.10.1 Multiple box section mouldboard, heat treated.
.10.2 DH-2 heat treated cutting edge & end bits.
.10.3 Hydraulic angle & tilt type.
.10.4 All essential blade controls.

28.03.11. OPTIONAL EQUIPMENT

.11.1 Heavy duty radiator guard.
.11.2 Swinging drawbar (not for winch use).
.11.3 Back-up alarm.
.11.4 Lighting system, F&R.
.11.5 Complete vandalism kit including instrument panel guard and cap locks for engine oil filter, engine oil dipstick, fuel & hydraulic tanks, radiator, transmission filler, etc.
.11.6 Precleaner/prescreener filtration.
.11.7 Tool kit.
.11.8 Engine enclosure, perforated, lockable.
.11.9 Front pull hook.
.11.10 Air cleaner extension.
.11.11 Crankcase guard.
.11.12 Fuel tank guard.
.11.13 Radiator core protector grid.
.11.14 Shock-dampening seat.

Note: All standard equipment shall be provided whether specifically identified in the Specifications or not.

ITEM NO. 28.03.00
CATERPILLAR MODEL D4E TRACTOR-DOZER

DETAILED BID QUESTIONNAIRE

Bidders' name & address: _____ Tel. No. _____

Make _____ Model _____ Year _____

Approx. Wgt. w/specified attachments & options: _____

Please quote for one (1) unit as described in Specifications including all accessories and optional equipment including all handling, preparation, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via Port of Mombasa, Kenya: \$ _____

Bid may be rejected unless all items listed in the Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids, and to make the contract award to the best interest or all concerned in the final analysis.

1. ENGINE

Make _____ Model _____ Drawbar KW _____
Designed to use 35 cetane diesel fuel? _____
Optional HD starting system furnished? _____
Alternator capacity _____ AMPS Maintenance-free battery? _____

2. TRANSMISSION

Standard power shift packafe? _____ Filtered? _____

3. TRACK ROLLER FRAME

Sealed, lifetime-lubricated rolls & idlers? _____
Standard track frame construction? _____

4. TRACK SYSTEM

Track shoe width _____ mm. Sealed & lubricated track? _____
Two-piece master link & track adjustment? _____

5. FINAL DRIVE

Standard system & gearing provided? _____

BID QUESTIONNAIRE, Item No. 28.03.00 (Con't.)

6. STEERING SYSTEM

Hydraulic, multiple-disc clutches? _____
Oil cooled band brake system? _____

7. HYDRAULIC SYSTEM & CONTROLS

Describe hydraulic system: _____

Includes all standard controls? _____

Hydraulic system filtered? _____

8. CAB

Describe cab furnished: _____

9. COLOR

Describe: _____

10. BULLDOZER ATTACHMENT

Mouldboard length, height & thickness: _____
Hydraulic angle & tilt provided? _____

11. OPTIONAL EQUIPMENT

Note any deviations from the Specifications: _____

Signature of person authorized to sign the Bid Questionnaire:

Name _____ Title _____ Date _____

(Please attach brochure describing the unit to the Bid
Questionnaire)

Note appropriate comments: _____

ITEM NO. 28.03.00
TRACK-TYPE TRACTOR

SPARE PARTS LIST

Bidder shall supply the following listed items for the subject equipment and be responsible for proper overseas packaging.

The parts and supplies listed herein shall be the manufacturer's genuine, recommended replacement items, and designed specifically to fit the vehicle make and model furnished by the Bidder.

Quotations shall include handling, packaging, transportation and all related delivery expense FOB Rumbek, the shipment of which shall accompany the vehicles.

Item No.	Quantity	Description	Total Price
1	1	Complete track chain Ass'y. for one (1) side including master link connection and cleats, installed.	\$ _____
2	12	Cleat bolts w/nuts.	_____
3	2	Track roller Ass'y.	_____
4	2	Master track links for field repair.	_____
5	1	Set of tools for repairs to track in the field.	_____
6	1	Case primary oil filters.	_____
7	1	Case secondary oil filters.	_____
8	1	Case primary fuel filters.	_____
9	1	Case secondary fuel filters.	_____
10	1	Case hydraulic fuel filters.	_____
11	1	Set drive belts.	_____
12	1	Alternator w/regulator	_____
13	1	Complete starter Ass'y.	_____

Item No.	Quantity	Description	Total Price
14	1	Complete set engine gaskets and seals.	_____
15	1	Complete set final drive gaskets & seals.	_____
16	1	Complete set hydraulic hose	_____
17	1	Complete set of hydraulic cylinder gaskets & seals. (Note: All cylinders)	_____
18	4	Operators Manual	_____
19	2	Repair Manuals	_____
20	2	Parts List for track-type tractor including attachments.	_____
Total cost-----			\$_____

Note any deviations from the Specifications: _____

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.04.00
MOTOR GRADER (Alternate 1)

SPECIFICATIONS

The purpose and intent of these Specifications is to describe a diesel powered Motor Grader, tandem drive w/articulated frame and hydraulic power controls.

Operating weight shall be not less than 12,900 Kg. (28,000 lbs.) including listing attachments, full tank of fuel, a mounted spare tire, a set of (4) tire chains and a 175-pound operator.

The Motor Grader shall be current model Caterpillar 120-G or aproved equal, new, and a standard production series. It is preferable that all major components furnished are of one make.

The Unit shall be used for general road maintenance functions, gravel surfaced, in ambient temperatures ranging from 20 through 55 degrees celsius (70° to 130° F.).

28.04.01. ENGINE

- .01.1 Caterpillar model 3304 turbocharged diesel.
- .01.2 7 liter (425 cu. in.) displacement.
- .01.3 93KW (125 HP) flywheel rating.
- .01.4 Direct injection fuel system.
- .01.5 Full-flow oil filter & cooler.
- .01.6 Dry type air filter w/primary & secondary elements and automatic dust ejector and service indicator.
- .01.7 Designed for using No. 2 fuel, ASTM Spec. D396 w/minimum cetane rating of 35.
- .01.8 24-volt direct starting system.
- .01.9 35-amp alternator.
- .01.10 Standard battery arrangement.

28.04.02. TRANSMISSION

- .02.1 Direct drive power shift.
- .02.2 6-forward & reverse speeds, single lever control.
- .02.3 Transmission lock to prevent accidental engagement.
- .02.4 Geared speeds 0 to 40 Km/h. (0 to 25 mph), forward.
- .02.5 Foot pedal control for inching capability.

28.04.03. BLADE & MOULDBOARD

- .03.1 Hardened, curved cutting edge of DH-2 steel.
- .03.2 Width & thickness 152 x 16 mm (6 X .62 in.), minimum.
- .03.3 High carbon steel mouldboard .3658 X 610 X 19 mm (12 ft. X 24 in. X .75 in.)
- .03.4 Full hydraulic control independent of engine rpm.

28.04.03. BLADE & MOULDBOARD (Con't.)

- .03.5 Designed for using more than one control without decrease in response speed.
- .03.6 Mouldboard sideshift shall be manual, 380 mm (15 in.), RH only.
- .03.7 90-degree maximum angle blade position, R&L.
- .03.8 Circle shall be fabricated box-section 1530 mm (60.25 in.) diameter w/uniform, flame-cut teeth.
- .03.9 360-degree circle rotation.
- .03.10 Circle drive slip clutch not required.
- .03.11 Blade beam shall be 140 X 32 mm (5.50 X 1.25").
- .03.12 Optional centershift bank sloping extension not required.
- .03.13 Optional hydraulic mouldboard sideshift not required.

28.04.04. DRAWBAR

- .04.1 Solid section A-frame, 140 X 80 mm (5.5 X 3.5 in.) w/four shoes.
- .04.2 Horizontal & vertical adjustment.

28.04.05. FRAME

- .05.1 Flanged, single-box section from front bolster to articulated joint.
- .05.2 Top & bottom 280 X 19 mm (11 X 0.75 in.)
- .05.3 Side plates 209 X 10 mm (8.25 X .375 in.) minimum
- .05.4 Weight 117 Kg/m (78.41 lb./ft.) minimum.
- .05.5 Rear frame shall be of two solid channels integral w/final drive case.

28.04.06. STEERING SYSTEM

- .06.1 Full hydraulic front wheel steering system.
- .06.2 50-degree range R&L.
- .06.3 Hydraulic frame steering system, 20-degree R&L.

28.04.07. BRAKE SYSTEM

- .07.1 Air-actuated, oil disc brakes on all four tandem wheels, self-compensating for wear.
- .07.2 Manually engaged, air disengaged multiple oil disc parking brake located in transmission case.
- .07.3 Provisions for activating the transmission neutral lock mechanism to prevent machine movement if the engine is started w/transmission in gear.
- .07.4 Individual, dual air circuit system for each tandem.
- .07.5 Spring-actuated, non-modulated parking brake designed for use to prevent run-away if the air supply should fail.

28.04.08. AXLES

- .08.1 Solid steel arched bar, front.
- .08.2 Hub-mounted odometer.
- .08.3 32-degree oscillation, minimum.
- .08.4 Wheel lean 18-degree R&L, minimum.
- .08.5 Forged heat-treated steel rear axle, full-floating.

28.04.09. TANDEMS

- .09.1 Wheel axle spacing 1.50 m. (5 ft).
- .09.2 Drive chain pitch Approx. 44 mm (1.75 in.)
- .09.3 Tandem housing sidewall thickness 16 mm (0.62 in.) minimum.

28.04.10. WHEELS & TIRES

- .10.1 Interchangeable rim & wheel assemblies.
- .10.2 Seven (7) 13.00 X 24 8-ply rating G-2 tubeless traction-type tires, including mounted matching spare.

28.04.11. CAB

- .11.1 Protective canopy only, ROPS design.

28.04.12. HYDRAULIC SYSTEM

- .12.1 Closed center, constant pressure system w/variable displacement pump.
- .12.2 Hydraulic lock valves in all control circuits.
- .12.3 Constant pressure, parallel control valve circuit design.
- .12.4 Hydraulic controls for front wheel steering, articulated steering, wheel lean, blade control & all attachments.

28.04.13. ACCESSORIES GROUP

- .13.1 Back-up alarm.
- .13.2 Defroster fan.
- .13.3 Drive train differential w/lock & unlock system.
- .13.4 Overlay end bits.
- .13.5 Hydraulic jack.
- .13.6 Front-mounted headlights (2).
- .13.7 Rear-mounted floodlight (1).
- .13.8 Center-mounted blade floodlights (2).
- .13.9 Outside mirrors R&L.
- .13.10 Scarifier, V-type w/11 teeth.
- .13.11 Suspension type operator's seat.
- .13.12 Tool kit.
- .13.13 Transmission guard.
- .13.14 Vandalism protection kit.

ITEM NO. 28.04.00
MOTOR GRADER (ALTERNATE 2)

BID SPECIFICATIONS

The purpose and intent of these Specifications is to describe a diesel powered Motor Grader, tandem drive, rigid frame and mechanical control system.

Operating weight shall be not less than 12,000 Kg (26,400 lbs.) including listed attachments, full tank of fuel, a mounted spare tire, a set of (4) tire chains and a 175-pound operator.

The Motor Grader shall be a current model Caterpillar 120-B or approved equal, new, and a standard production series. It is preferable that all major components be of one make.

The unit shall be used for general road maintenance functions, gravel surfaced, in ambient temperatures ranging from 20 through 50 degrees celsius (70° to 130° F.)

28.04.01. ENGINE

- .01.1 Caterpillar model 3306, natural aspiration.
- .01.2 10.5 liter (638 cu. in.) displacement.
- .01.3 93 KW (125 HP) flywheel rating.
- .01.4 Precumbustion chamber fuel system.
- .01.5 Pressure lubrication system.
- .01.6 Dry type air filter w/primary & secondary elements.
- .01.7 Designed for No. 2 fuel w/35 cetane rating, Min.
- .01.8 24-volt direct starting system.
- .01.9 17-amp alternator.
- .01.10 Discharge safety device & master disconnect switch.
- .01.11 Standard battery arrangement.

28.04.02. TRANSMISSION

- .02.1 Constant mesh w/helical gears.
- .02.2 Six (6) forward & four (4) reverse gears.
- .02.3 Geared speeds thru Approx. 35.5 Km/h. (22 mph) forward.
- .02.4 Double-disc, oil lubricated & cooled clutch Asmb.
- .02.5 Pressure lubricated & filtered oil system.

28.04.03. BLADE & MOULDBOARD

- .03.1 Powered mechanical control system w/shear pin.
- .03.2 High carbon steel mouldboard w/box-section reinforcement, 3660 X 600 X 22 mm (12 ft X 24 in. X 0.88 in.)
- .03.3 90-degree maximum angle-blade position, R&L.
- .03.4 Circle fabricated of T-section steel.

- .03.5 360-degree circle rotation.
 - .03.6 Maximum side reach outside rear wheels 2240 mm (88 in.) minimum.
 - .03.7 V-type scarifier w/11 teeth.
- 28.04.04. DRAWBAR
- .04.1 Box-section, A-shaped 140 X 89 X 13 mm (5.5 X 3.5 X 0.5 in.) w/spherical joint coupling & four circle support shoes.
- 28.04.05. FRAME
- .05.1 Special rolled beams, triple-box-section.
 - .05.2 244 X 279 mm (9.6 X 11 in.) width X thickness
 - .05.3 Weight per foot range 170 Kg/m (115 lb./ft.) minimum through 226 Kg/m (152 lb./ft.) maximum.
 - .05.4 Ground clearance 1420 mm (4 ft.-8 in.)
 - .05.5 Maximum vertical section modulus 1868 cm³ (114 in³)
- 28.04.06. STEERING SYSTEM
- .06.1 Hydrostatic via hydraulic cylinder. Front wheel lean R&L.
- 28.04.07. BRAKE SYSTEM
- .07.1 Two wheel, hydraulic, self-adjusting, 430 X 101 mm (17 X 4 in.)
 - .07.2 Mechanical parking brake on transmission shaft.
- 28.04.08. AXLES
- .08.1 Arched front axle, forged; heat treated spindles.
 - .08.2 Solid forged heat treated rear w/tapered roller bearings.
- 28.04.09. TANDEMS
- .09.1 Welded box section construction.
 - .09.2 51 mm (2 in.) pitch roller chain w/adjustable sprocket mounting.
- 28.04.10. WHEELS & TIRES
- .10.1 Seven (7) 13.00 X 24 8-ply rating, traction-type tires including mounted matching spare.
 - .10.2 Interchangeable detachable rims.
 - .10.3 Tandem rear wheels w/tapered bearings.
- 28.04.11. CAB
- .11.1 Canopy type.
- 28.04.12. HYDRAULIC SYSTEM
- .12.1 Sealed, filtered system w/vane pump.

28.04.13. ACCESSORIES GROUP

- .13.1 Rear mounted flood lights.
- .13.2 Hydraulic jack.
- .13.3 Tool kit.
- .13.4 Four wheel brakes.
- .13.5 Tire inflation kit.

DETAILED BID QUESTIONNAIRE

Item No. 28.04.00

MOTOR GRADER

Bidder's name & business address: _____
Tel. No. _____

Make _____ Model _____ Year _____

Aproximate working weight w/specified options _____ Kgs.

Please quote for two (2) units as described in Specifications including all accessories and optional equipment including handling preparation, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya; Price, each \$ _____ Total price \$ _____

Bid may be rejected unless all items listed in bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids, and award the contract to the best interest of all concerned in the final analysis.

1. ENGINE

Make _____ Model _____ Rated flywheel KW _____
Aspiration _____ Displacement _____ cu. l.
Type primary filter _____ Type secondary filter _____
Designed to use 35 cetane, high sulphur content fuel? _____
Describe fuel filtration system: _____

All cooling/filtration systems designed for hot, dusty climate conditions? _____

Standard or optional charging system? _____
Standard or optional starting system? _____
HD, maintenance-free battery package furnished? _____
Battery master disconnect switch provided? _____

2. TRANSMISSION

Make _____ Model _____ Type _____
Constant mesh? _____ Maximum geared roadspeed _____ Km/Hr
Transmission lock-out provided? _____
No. forward speeds _____ No. reverse speeds _____
Transmission cooled & filtered? _____ Magnetic drain plug? _____
Device provided for inching capability? _____

BID QUESTIONNAIRE, Item No. 28.04.00 (Con't.)

3. BLADE & MOULDBOARD

Dimensions & type steel, cutting edge _____
Dimensions & type steel, mouldboard _____
Full hydraulic control independent of engine RPM? _____
Designed for simultaneous operation of controls? _____
Type mouldboard sideshift _____ Max. range, RH _____ mm.
Max. blade angle position, _____ RH _____ degrees LH _____ degrees.
Describe circle fabrication _____
Circle rotation _____ degrees.
Describe blade beam type & dimensions _____

4. DRAWBAR

Horizontal & vertical adjustments provided? _____
A-frame dimensions _____ No. shoes _____

5. FRAME

Describe type & dimensions _____
Average weight per foot of frame _____ Kgs. Type steel _____
Size top & bottom plates _____ Size side plates _____
Describe articulated steering joint _____
Rear frame made of solid channels? _____ Integral w/final drive?
_____.

6. STEERING SYSTEM

Full hydraulic front wheel & articulated steering system? _____
Front wheel steering degrees _____ RH _____ LH.
Hydraulic frame steering degrees _____ RH _____ LH

7. BRAKE SYSTEM

Type service brake actuation _____
Self-compensating brakes on all tandem drive wheels? _____
Describe engagement/disengagement and the location of the parking brake system: _____
Equipped w/transmission neutral lock mechanism to prevent starting the engine w/transmission in gear? _____
Individual brake circuits for each tandem? _____
Parking brake designed to prevent run-away? _____

8. AXLES

Solid steel, arched front axle? _____
Degrees of oscillation _____
Degrees of wheel lean _____ RH _____ LH
Full-floating, heat treated steel rear axle? _____
Hub odometer reading in kilometers furnished? _____

BID QUESTIONNAIRE, Item No.28.04.00 (Con't.)

9. TANDEMS

Wheel axle spacing _____ mm. Drive chain pitch _____ mm.
Tandem housing sidewall thickness _____ mm.

10. WHEELS & TIRES

Wheels & tires interchangeable F&R? _____
Adequate chain clearance provided? _____
Make, size, type & ply rating, tires: _____
General purpose tread? _____ Sidewalls equipped w/scuff ribs? _____
Tire load range _____ Designed for optimum recapability? _____
Tubed or tubeless? _____ Matching, mounted spare furnished _____
for each unit? _____

11. CAB

Describe type cab furnished: _____

12. HYDRAULIC SYSTEM

Describe type: _____
Variable displacement pump? _____ Hydraulic lock valves provided
for all circuits? _____ Type control valves circuit: _____
Hydraulic controls for all functions provided? _____

13. ACCESSORIES GROUP

Note any deviations from the Specifications: _____

Signature of person authorized to sign the Bid Questionnaire:

Name _____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.04.00
MOTOR GRADER

SPARE PARTS LIST

Bidder shall supply the following listed items for the subject equipment and be responsible for proper overseas packaging.

The parts and supplies listed herein shall be the manufacturer's genuine, recommended replacement items, and designed specifically to fit the vehicle make and model furnished by the Bidder.

Quotations shall include handling, packaging, transportation and all related delivery expense FOB Rumbek, the shipment of which shall accompany the vehicles.

Item No.	Quantity	Description	Total Price
1	12	Complete sets cutting edges w/bolts & nuts.	\$ _____
2	6	Primary air filter elements	_____
3	6	Secondary filter elements	_____
4	1	Case primary oil filters	_____
5	1	Case secondary oil filters	_____
6	1	Case hydraulic Syst. Fltrs.	_____
7	1	Case primary fuel filters	_____
8	1	Case secondary fuel filters	_____
9	2	Complete sets drive belts	_____
10	1	Complete set of hydraulic hoses, all locations	_____
11	1	Complete set of engine gaskets & seals	_____
12	1	Complete set (4) injector lines	_____
13	2	Injector Ass'y.	_____
14	1	Water pump Ass'y.	_____
15	1	Hydraulic pump Ass'y.	_____

16	1	Alternator Ass'y.	_____
17	1	Starter Ass'y.	_____
18	1	Voltage regulator	_____
19	1	Case air filter elements	_____
20	2	Scarifier teeth	_____
21	6	Blade control shear pins	_____
22	4	Tires, tubes & flaps	_____
23	2	HD, cartridge type manual grease guns	_____
24	2	Cases grease gun cartridges	_____
25	1	Headlight Ass'y.	_____
26	4	Operator's Manual	_____
27	2	Repair Manual	_____
28	2	Parts List for motor grader including attachments	_____

Total cost-----\$ _____

Note any deviations from the Specifications: _____

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.06.00

4X2 DUMP TRUCK

SPECIFICATIONS

It is the purpose and intent of these specifications to describe a dump truck chassis, 4X2 drive, powered by a naturally aspirated Caterpillar Model 3208 diesel engine rated at 130 KW (175HP) GVW rating shall be not less than 12,375 Kg (27,500 lbs.).

The unit shall be of current production, Ford Model LN-8000 or approved equal.

Subject equipment shall be of rugged design suitable for general road maintenance services in tropical climate conditions with an ambient temperature range of 20 through 55 degrees celsius (70° to 130° F.). Cooling and filtration systems shall be satisfactory under conditions of extreme dust and heat.

The unit may be utilized to tow an implement trailer, the gross combined weight of the complete truck, trailer and payload of which is approximately 22,500 Kg. (50,000 lbs.).

28.06.01. ENGINE

- .01.1 Caterpillar Model 3208 (no substitute).
- .01.2 Naturally aspirated, Max. KW Approx. 130 (175 HP)
- .01.3 Standard charging & starting electrical system.
- .01.4 Cooling & filtration systems designed to meet the conditions described in the 3rd paragraph of this Specification.
- .01.5 A heavy duty cranking system w/overheat switch protection device is preferred, if available.

28.06.02. TRANSMISSION

- .02.1 Allison automatic designed for dump truck application, MT-650 series w/TC-370 torque converter, or improved versions thereof.
- .02.2 Deep 1st gear ratio for starting under unfavorable conditions offering abnormal rolling resistance.
- .02.3 Provisions for PTO mounting, converter-driven, standard SAE 6-bolt arrangement, drive gear rating 400 N.m. (300 lb. ft.), minimum.
- .02.4 Optional oil cooling and filtration system.
- .02.5 Hydraulic controlled, manual shift from 1st to 2nd; automatic gear selection above 2nd gear.
- .02.6 Automatic lock-up clutch in 4th and 5th gears.

28.06.00 - 4X2 DUMP TRUCK SPECS (Con't.)

28.06.03. FRAME, WB & CA

- .01.1 Full channel, full-depth frame preferred.
- .03.2 Inner channel reinforcement preferred, reverse "L" acceptable.
- .03.3 Wheelbase shall provide a CA (cab to rear axle) of Approx. 2134 mm (84 in.), and to offer proper weight distribution for a 2.7 m. (9 ft.) dump body with a 300 mm. (12 in.) overhang.

28.06.04. BRAKE SYSTEM

- .04.1 Hydraulic w/hydrovac-assist system.
- .04.2 Optional capacity brake drum & linings.
- .04.3 Sufficient capacity to operate similar brake system on a dual axled implement trailer.

28.06.05. AXLES

- .05.1 4050 Kg. (9,000 Lbs.) minimum capacity rating, front.
- .05.2 Oil lubricated front wheel bearings w/visible oil reservoir, Mechanic or Sealco.
- .05.3 9,450 Kg. (21,000 Lbs.) minimum capacity rear axle, single speed, double reduction, geared to provide an Approx. maximum speed of 80 Km/h (50 MPH) Rockwell, or Eaton, or equal.
- .05.4 Magnetic drain plug.

28.06.06. SUSPENSION SYSTEM

- .06.1 HD suspension system, minimum capacity 4050 Kg (9,000 Lbs.) front and 9,450 Kg. (21,000 Lbs.) rear; overload springs, rear.
- .06.2 HD double-acting shock absorbers, front.

28.06.07. STEERING SYSTEM

- .07.1 Standard power steering system.

28.06.08. WHEELS, RIMS & TIRES

- .08.1 HD service cast spoke wheel/hub assemblies.
- .08.2 3-piece demountable rims, type M-7.50VM X 20 w/5 degree taper Goodyear, Firestone, or equal.
- .08.3 Lock ring #LR20M; Base rim #B8020LWD; flange #F7520M.
- .08.4 Wheel rims shall be interchangeable F&R.
- .08.5 Single front and dual rear.
- .08.6 Rim spacers shall offer adequate clearance to prevent tire chaffing under full load.
- .08.7 Clearance between the inner dual tire sidewall and any part of the suspension system shall be not less than 1-1/2".
- .08.8 Michelin 10.00X20 Type XZZ w/12-ply rating, front, or equal.

28.06.00 - 4X2 DUMP TRUCK SPECS (Con't.)

- .08.9 Michelin 10.00X20 Type XR (or approved equal traction tread design) w/range F-12 ply rating, dual rear.
- .08.10 Tires shall be tubed type all around.
- .08.11 Mounted, matching spare, front.
- .08.12 Mounted, matching spare, rear.

28.06.09. CAB & SHEET METAL

- .09.1 Conventional, standard model.
- .09.2 Radiator mounting designed to accept direct, crankshaft-driven PTO & hydraulic pump.

28.06.10. FUEL SYSTEM

- .10.1 130 liter (50 gal.) capacity, minimum.
- .10.2 Dual fuel tank arrangement acceptable.
- .10.3 Fuel shut-off valve(s) at tank outlet.
- .10.4 Fuel tank balance line, if dual arrangement.
- .10.5 Tanks should be so mounted as to prevent the overflow of fuel.
- .10.6 Diesel fuel water separator.
- .10.7 Tanks should have minimum ground clearance of 30 cm (12 in).

28.06.11. GAUGES & INSTRUMENTS

- .11.1 Oil pressure.
- .11.2 AMP meter.
- .11.3 Fuel guage(s).
- .11.4 Engine hour meter, Hobbs or equal.
- .11.5 Engine coolant temperature.
- .11.6 Air inlet filter restrictor guage.
- .11.7 Brake system pressure/vacumn guage.
- .11.8 Odometer shall register in kilometers.
- .11.9 Key-type starter switch.
- .11.10 Standard light switches.

28.06.12. FILTRATION SYSTEMS

- .12.1 Optional, heavy duty coolant, engine oil, fuel, air inlet, hydraulic oil & transmission filters; spin-on liquid type elements preferred.

28.06.13. DUMP BODY

- .13.1 3-cubic meter (4 yd³) capacity (struck).
- .13.2 No provisions for sideboards.
- .13.3 8-gauge steel fabrication, welded construction, header, tailgate sides & floor.
- .13.4 Body shall be approximately 2.7 X 2.4 mm (9 X 8 ft)
- .13.5 General aggregates hauling type.

28.06.00 - 4X2 DUMP TRUCK SPECS (Con't.)

- .13.6 Longitudinal rails shall be I-beam, channel or box-channel type..
- .13.7 6-cross members, minimum.
- .13.8 Tailgate shall be designed to also trip at the top, and be supported at the bottom for use as body extension.
- .13.9 Tailgate hinges, latch & hardware shall be of Heavy Duty (HD) construction & design.
- .13.10 Conventional, adjustable tailgate spreader chains.
- .13.11 Manual tailgate trip handle w/safety latch, within easy reach of driver.

28.06.14. HYDRAULIC HOIST

- .14.1 Rated capacity 9 metric tons (10 tons), minimum.
- .14.2 Under-body, piston type hoist arrangement.
- .14.3 Single-acting system w/raise, hold & float control valve.
- .14.4 Over-travel safety chain.
- .14.5 Hoist framework shall be of HD construction throughout.
- .14.6 Greasable HD hinge pins & retainer brackets.
- .14.7 Hoist frame assembly shall be attached to chassis frame rails via a minimum of three (3) L-type mounting pads, each of which shall be secured with four-1/2" Grade 6 bolts.
- .14.8 No welding to chassis frame rails allowed.

28.06.15. PTO & PUMP

- .15.1 PTO shall be transmission-mounted, Chelsea or equal.
- .15.2 Pump shall be gear type w/integral control valve, minimum capacity rating 38 liter/minute (10 GPM) @ 1,000 RPM @ 1,000 PSI, Commercial or equal.
- .15.3 Manual controls in-cab type.
- .15.4 An oil reservoir of 38 liter (10 gallon) capacity, minimum, shall be provided if the oil supply is not integral w/cylinder design.

28.06.16. MISC. ACCESSORIES

- .16.1 Reinforced rear cross member designed for towing an implement trailer w/GVW Approx. 9,000 Kg. (20,000 lbs.), some 15% of which shall be supported by the hitch device.
- .16.2 Tow hitch shall be bolted to the center of the rear cross member, Holland or equal to Model T-100-A, swivel type pintle hook, vertical load rating 1800 Kg. (4,000 lbs.), gross trailer rating 9 metric tons (10 ton) minimum.
- .16.3 Safety break-away chain rings, R&L.
- .16.4 Front tow hooks.
- .16.5 Locking, T-handle type hand throttle.
- .16.6 Front bumper.
- .16.7 Brush type radiator guard.
- .16.8 West coast type mirrors, R&L.

28.06.00 - 4X2 DUMP TRUCK SPECS (Con't.)

- .16.9 Shock absorbers, HD double-acting, front.
- .16.10 Stemco wheel seals, front.
- .16.11 Roof vent.
- .16.12 Vacuum-over-hydraulic trailer brake connections designed for simultaneous application of truck & trailer brakes via pedal, and independent hand control application valve, Velvac or equal, complete w/all apparatus normally installed on the truck chassis.
- 16.13 Trailer connectors w/dust caps shall be attached to the rear cross member, w/provisions against damage.

ITEM NO. 28.06.00
DETAILED BID QUESTIONNAIRE

DUMP TRUCK

Bidder's name & business address: _____

Tel. No. _____

Make _____ Model _____ Year _____

Approx. curb weight including body & hoist _____ Kgs.

Rated GVW _____ Kgs. Rated GCW _____ Kgs.

Note any deviations from Bid Specifications: _____

Price quoted for five (5) units as described in the general Specifications including body & hoist installation, handling, preparation, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya: Price, each \$ _____ Total Price \$ _____

Bid may be rejected unless all items listed in Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids, and award the contract in the best interest of all concerned in the final analysis.

1. ENGINE

Make _____ Model _____ Year _____ Rated KW _____

@ _____ RPM Max. rated torque _____ N.m. @ _____ RPM

Aspiration _____ Displacement _____

Alternator rated capacity _____ AMPS. Cooling & filtration

systems designed for the operating conditions described in 3rd paragraph, Page 1 of this Specifications? _____

HD cranking system w/overheat switch protection included? _____

Maintenance-free battery pack furnished? _____

2. TRANSMISSION

Make _____ Type _____ Model _____

Rated input torque capacity _____ N.m.

Make torque converter _____ Model _____

TC input torque rated capacity _____ N.m.

Equipped with optimum cooling & filtration systems? _____

PTO openings available for driving hoist hydraulic pump? _____

Magnetic drain plug provided? _____ Oil Cap. _____ l.

BID QUESTIONNAIRE, Item No. 28.06.00 - (Con't.)

3. FRAME WB & CA

Type frame _____ Type steel _____
Type frame all reinforcement _____
Wheelbase _____ mm. Cab-to-axle _____ mm.

4. BRAKE SYSTEM

Type _____ Type power assist _____
Brake size, front _____ Rear _____
Service brake system of sufficient capacity to safely operate
the brake system of a dual axled implement trailer? _____
Type parking brake _____

5. AXLES

Front: Make _____ Model _____ Rated Cap. _____ Kgs.
Rear: Make _____ Model _____ Rated Cap. _____ Kgs.
Type reduction _____ Speeds _____ Gear ratio _____
Approx. geared road speed _____ Km/h Magnetic drain plug? _____
Front wheel hubs equipped with oil lubricated bearings? _____
Type front hub oil seals _____

6. SUSPENSION SYSTEM

Rated capacity, Front _____ Kgs. Rated Cap., rear _____ Kgs.
Front axle equipped with HD double-acting shock absorbers? _____
Overload springs furnished, rear axle? _____

7. STEERING SYSTEM

Type power assist system: _____

8. WHEELS, RIMS & TIRES

HD wheel hub assemblies F&R? _____
Make & type rims _____
Rim & tire assemblies interchangeable F&R? _____
Clearance between inner sidewalls of dual tires _____ mm.
Make, type, size & ply rating, front tires: _____

Make, type, size & ply rating, rear dual tires: _____

Tube type tires? _____
Mounted, matched spare tire (front) furnished? _____
Mounted, matched spare tire (rear) furnished? _____

9. CAB & SHEET METAL

Describe cab, mounting arrangement, hood, grill and fender hardware:

BID QUESTIONNAIRE, Item No. 28.05.00 - (Con't.)

10. FUEL SYSTEM

Single or dual fuel tanks? _____ Total Cap. _____ liters
Fuel balance line & shut-off valves, if dual arrangement? _____
Water separator make & model _____
Fuel tank ground clearance _____ mm.
Fuel gauges for each tank? _____

11. GUAGES & INSTRUMENTS

Note any deviations to Specifications: _____

12. FILTRATION SYSTEMS

Make & type air inlet filter(s): _____
Make & type cooling system filter(s): _____
Make & type fuel filter(s): _____
Make & type engine oil filter(s): _____

13. DUMP BODY

Make _____ Model _____ Struck capacity _____ cu. m.
Steel guage, floor _____ Sides _____ Headboard _____
Tailgate _____ . Approx. length, inside _____ mm.
Approx. width, inside _____ mm. Sideboard height _____ mm.
Headboard height _____ mm. Tailgate height _____ mm.
Type & size longitudinal rails _____
Type, size & number of cross members _____
Tailgate trip top & bottom? _____ Spreader chains furnished? _____
HD latch & hinge hardware? _____ Type tailgate trip control _____

14. HYDRAULIC HOIST

Make _____ Model _____ Class _____ Rated Capacity _____
_____ Kgs. Type hoist _____
Over-travel chain provided? _____ Standard control system? _____
Describe hoist frame assembly: _____
Greaseable body hinge pins? _____ Describe hoist frame fastenings to
truck chassis: _____

15. PTO & PUMP

Make & model PTO _____
Make, model & capacity rating, hydraulic pump _____

Name & address of firm responsible for mounting PTO, pump, body, hoist
and control system: _____

BID QUESTIONNAIRE, Item No. 28.06.00 - (Con't.)

COLOR

Body & hoist same color as the truck (high visibility yellow)?

16. MISC. ACCESSORIES

Note any deviations from the Bid Specifications in respect to the accessories listed: _____

Signature of person authorized to sign the Bid Questionnaire:

Name _____ Title _____ Date _____

Please attach brochures describing the truck chassis, it's major components, body & hoist and PTO/pump assembly, and any other information which may be of value in making the Bid award decision.

Note appropriate comments: _____

ITEM NO. 28.06.00
SPARE PARTS LIST

DUMP TRUCKS

Bidder shall supply the following listed items for the subject vehicles and be responsible for proper overseas packaging.

The parts and supplies listed herein shall be the manufacturer's genuine, recommended replacement items, and designed specifically to fit the vehicle make and model furnished by the bidder.

Quotations shall include handling, packaging, transportation and all related delivery expense FOB Rumbek, the shipment of which shall accompany the vehicles.

Item No.	Quantity	Description	Total Price
1	1	Complete fan-to-flywheel Caterpillar Model 3208 engine identical in every respect to the engines installed in truck chassis. It shall include water pump; fan & belts; cylinder heads; injection pump, injectors & lines; cylinder heads; inlet & exhaust manifolds; charging system; starting system; filters attached to the engine; flywheel; crankcase pan, etc. The engine shall be fully assembled as described.	\$ _____
2	1	Allison automatic transmission assembly complete with covers & exterior hardware, identical to the model installed in the truck chassis.	
3	1	Complete front axle assembly including beam; hubs, spindles & bearings; tie rod & tie rod ends, etc.	\$ _____ _____
4	2	Sets inner/outer front wheel bearings complete with oil seals	_____
5	1	Complete rear axle housing w/gear carrier & all internal parts.	_____
6	1	Rear axle overhaul kit including ring & pinion gears, side gears, bearings, seals & gaskets.	_____

SPARE PARTS LIST, Item No. 28.06.00 - (Con't.)

7	1	Pair front springs.	_____
8	1	Pair rear springs including overload springs, fully assembled.	_____
9	1	Pair front spring U-bolts w/nuts.	_____
10	1	Pair front spring U-bolts w/nuts.	_____
11	1	Pair front spring center bolts w/nuts.	_____
12	1	Pair rear spring center bolts w/nuts.	_____
13	1	Complete drive shaft assembly, transmission-to-rear axle, including U-joints, slip-joints, etc.	_____
14	1	Drive shaft center bearing w/hanger (Note: Delete if not used.)	_____
15	1	Set king pins & bushings.	_____
17	1	Power steering pump assembly.	_____
18	1	Water pump w/pulley.	_____
19	1	Alternator assembly w/pulley.	_____
20	1	Voltage/current regulator.	_____
21	2	Complete HD starter assembly including Bendix drive gear.	_____
22	2	Hydrovac power brake booster Assy.	_____
23	1	Pair rear wheel hubs w/bearings & seals.	_____
24	3	Spare rim assemblies.	_____
25	3	Spare dual wheel spacer bands.	_____
26	2	Complete kit of one set each front & rear wheel studs, nuts, clamps, etc.	_____
27	2	Complete sets F&R brake shoes w/linings.	_____
28	2	Hydraulic brake cylinders, front.	_____
29	2	Hydraulic brake cylinders, rear.	_____

SPARE PARTS LIST, Item No. 28.06.00 - (Con't.)

30	2	Hyd. brake overhaul kits, front cylinder.	_____
31	2	Hydraulic brake cylinder overhaul kits, rear.	_____
32	1	Pair front brake drums.	_____
33	1	Pair rear brake drums.	_____
34	1	Radiator assembly w/core & tanks.	_____
35	3	Engine thermostat w/gaskets	_____
36	1	Complete set of guages including fuel, oil pressure, temperature, hour meter, ampmeter, speedometer, etc.	_____
37	1	Set door hinges, RH.	_____
38	1	Set door hinges, LH.	_____
39	1	Window elevator w/crank, RH.	_____
40	1	Window elevator w/crank, LH.	_____
41	2	Inner/outer door handle assembly w/keys, RH.	_____
42	2	Inner/outer door handle assembly w/keys, LH.	_____
43	1	Complete seat cushion Ass'y.	_____
44	3	Floor matt, insulated.	_____
45	2	Windshield glass w/insulating rubber seal.	_____
46	2	Door glass.	_____
47	1	Rear cab window glass.	_____
48	1	Radiator grill assembly.	_____
49	3	Sets drive belts.	_____
50	1	Pair axle shafts.	_____

SPARE PARTS LIST, Item No. 28.06.00 - (Con't.)

51	2	Complete sets U-joint overhaul kits including crosses, cups & bearings.	_____
52	2	Pair WC rear view mirror frame & glass.	_____
53	12	Headlamp sealbeam units.	_____
54	48	Replaceable spin-on primary oil filters.	_____
55	48	Replaceable spin-on secondary oil filters.	_____
56	48	Replaceable primary fuel filters.	_____
57	48	Replaceable secondary fuel filters.	_____
58	24	Replaceable cooling system filters.	_____
59	24	Replaceable Allison Trans. oil filters	_____
60	2	Sets Allison transmission oil seals & gaskets.	_____
61	2	Set differential oil seals & gaskets.	_____
62	1	Hoist cylinder assembly (Note: two (2) cylinder assemblies if twin hoist.).	_____
63	1	Set tailgate hinges.	_____
64	2	Sets hydraulic hoist cylinder overhaul kits.	_____
65	4	Sets hydraulic hoist seals & gaskets.	_____
66	2	Sets hoist hinge pins.	_____
67	2	Sets tailgate latching hooks, bottom.	_____
68	2	Complete tail light assemblies.	_____
69	6	Red (rear) reflectors.	_____
70	6	Amber (sides & front) reflectors.	_____
71	1	RH door assembly w/glass & hardware.	_____
72	1	LH door assembly w/glass & hardware.	_____
73	2	Shop Repair Manual	_____

SPARE PARTS LIST, Item No. 28.06.00 - (Con't.)

74	10	Driver's Instruction Manual	_____
75	2	Parts List, including hoist assembly, Allison transmission, etc.	_____
76	3	Gallons paint matching truck/body color.	_____
77	2	Gallons premium quality primer.	_____
78	5	Cartridge-type manual grease guns, HD design.	_____
		Total cost.....	\$ _____

Note any deviations from the Specifications: _____

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.07.00
6X4 TRACTOR

SPECIFICATIONS

It is the purpose and intent of these Specifications to describe a heavy duty, tandem drive tractor designed for road maintenance equipment transport via lowbed semi-trailer, gross combined weight rating 36,000 Kg. (80,000 lbs.) minimum.

The unit shall be of current production, Ford Model LNT-8000 or approved equal, conventional cab type.

Subject unit shall be used to pull a variety of trailers over gravel and dirt roads in tropical temperatures ranging from 20 through 55 degrees Celsius (70° to 130° F.). Cooling and filtration systems shall be satisfactory under operating conditions of extreme heat and dust.

The frame shall be suitable for mounting an upright-type HD winch behind the cab.

28.07.01. ENGINE

- .01.1 Caterpillar Model 3306 (no substitute).
- .01.2 185 Kw (250 HP), turbocharged version.
- .01.3 Standard electric charging system.
- .01.4 Heavy duty cranking system w/overheat protection cut-off device.
- .01.5 Optional capacity, maintenance-free batteries.
- .01.6 Cooling & filtration systems designed for extreme applications re: heat and dust conditions.

28.07.02. TRANSMISSION

- .02.1 Allison Heavy Duty (HD) automatic Model HT-750DR.
- .02.2 5-speed version w/8.04 1st gear ratio.
- .02.3 Allison TC-350 torque converter, stall torque ratio 3.1 w/automatic lock-up clutch provided in 4th & 5th gear.
- .02.4 Optional cooling & filtration system.
- .02.5 Engineered match-up of transmission/engine package.

28.07.03 AXLE, FRONT

- .03.1 5400 Kg (12,000 lbs.) rated capacity, Rockwell FF971 or equal.
- .03.2 HD hydraulic double-acting shock absorbers.
- .03.3 Matching suspension system.

28.07.00 - 6X4 TRACTOR SPECS (Con't.)

28.07.04 AXLE, TANDEM REAR

- .04.1 19,800 Kg 44,000 lbs. rating, double reduction, Rockwell SRDD-DD or equal.
- .04.2 Geared to provide Max. speed of 80 Km/h (50 MPH).
- .04.3 Rockwell "Extra-Life" universal U-joint series, HD design, or equal.
- .04.4 1270 mm (50 in) tandem axle spacing.
- .04.5 Interaxle power divider, lock-out not required.
- .04.6 Hendrickson Model RS w/rubber load cushions, capacity to match tandem axle rating.

28.07.05. BRAKE SYSTEM

- .05.1 Full air, mechanical brake adjustment (manual type).
- .05.2 Outboard mounted brake drums, tandem axles.
- .05.3 Optional, maximum size drums & linings.
- .05.4 Standard compressor, air reservoir & brake controls.
- .05.5 Trailer brake control valve.

28.07.06. STEERING SYSTEM

- .06.1 Standard system w/hydraulic power assist.

28.07.07. FRAME

- .07.1 HD construction thruout.
- .07.2 Full length inner channel reinforcement preferred, reverse "L" acceptable if designed for heavy duty winching application (see winch details).
- .07.4 Cab-to-axle shall be 3050 mm (120 in) Approx., w/matching wheelbase.
- .07.5 HD cross members, bolted construction preferred.
- .07.6 Front frame extension rails not required.

28.07.08. COOLING SYSTEM

- .08.1 Designed for tropic zone application.
- .08.2 Bolted radiator tanks preferred.
- .08.3 Cooling system filter.

28.07.08. FUEL SYSTEM

- .09.1 Total fuel capacity 570 liters (150 gallons) minimum.
- .09.2 HD saddle-type preferred, but dual frame-mounted tanks acceptable if saddle tanks interfere w/winch mounting and drive arrangement.
- .09.3 Water separator.
- .09.4 Fuel gauges.
- .09.5 Fuel balance line, w/shut-off valves at each tank outlet.
- .09.6 Tanks shall be mounted in such manner as to offer maximum ground clearance.

28.07.00 - 6X4 TRACTOR SPECS (Con't.)

28.07.10. CAB & SHEET METAL

- .10.1 Conventional cab design, off-set acceptable.
- .10.2 HD sheet metal, butterfly hood acceptable.

28.07.11 WHEELS & TIRES

- .11.1 HD cast spoke wheels.
- .11.2 HD demountable rims & attaching hardware.
- .11.3 Interchangeable rims, F&R.
- .11.4 Rim spacers shall be of HD design, and have sufficient width to prevent dual tire inner sidewall chaffing under full load.
- .11.5 Sufficient clearance between inner dual tire sidewall and suspension system to allow for abnormal tire casing expansion.
- .11.6 Michelin radial 10.00 X 20 tires, tube type, or equal.
- .11.7 Load range F, 12-ply rating.
- .11.8 Highway tread, front.
- .11.9 Traction tread rear, XR type preferred.

28.07.12. WINCH

- .12.1 13,500 Kg (30,000 lb.) pull capacity on bare drum, minimum.
- .12.2 Ramsey upright HD model R-30A, or equal.
- .12.3 Minimum 20 meters (65 ft) of 6X19 cable w/6X25 filler wire.
- .12.4 Cable size 16 mm (5/8 in)
- .12.5 2.5 m. (8' ft) alloy steel chain w/clevis-pin type hook, load rating maximum available for use with 12.7 mm (1/2 in) chain, #331 Crosby-Laughton or equal.
- .12.6 Winch support/bracing of 12.7 mm (1/2 in) steel plate bolted to tractor siderails (no welding allowed), w/bracing designed for HD winching application.
- .12.7 Adequate clearance between rear of cab & winch for normal servicing & adjustments.
- .12.8 PTO shall be extra-heavy-duty type designed for mounting on the Allison transmission.
- .12.9 HD double bearing jackshaft.
- .12.10 Sprocket drive gearing to provide maximum reduction for winching disabled construction equipment.
- .12.11 #80 roller drive chain.

28.07.13. FIFTH WHEEL COUPLER

- .13.1 HD 914 mm (36 in) Holland Model 3500 or equal, angle mounted.
- .13.2 Mounting height Approx. 216 mm (8.5 in.)
- .13.3 HD 51 mm (2 in) pin coupler size.
- .13.4 Non-adjustable mounting type.
- .13.5 Minimum of four (4) 19 mm (3/4 in) Grade 6 bolts, each side.

28.07.14 - 6 X 4 TRACTOR SPECS (Con't.)

28.07.14. COLOR

- .14.1 Shall be high-visibility Highway Yellow.

28.07.15. MISC. ACCESSORIES

- .15.1 Mounted spare tire matching front.
- .15.2 Mounted spare tire matching rear.
- .15.3 Trailer brake hose/electric connector lines.
- .15.4 Locking, T-handle type hand throttle.
- .15.5 Front bumper.
- .15.6 Front tow hooks, Holland Model 1274 or equal.
- .15.7 HD radiator guard.
- .15.8 Non-rotating amber flashers, heavy duty mirror mounted R&L, electronic strobe type, Whelen or approved equal.
- .15.9 9 metric ton (10-ton) hydraulic jack & handle.
- .15.10 Wheel change wrenches.
- .15.11 Roof vent.
- .15.12 Defogger electric fan, caged heavy duty type.
- .15.13 Stemco wheel seals, front.
- .15.14 Air-suspended, adjustable driver's seat, Bostrom heavy duty series or approved equal.
- .15.15 Standard passenger seat arrangement.
- .15.16 Exhaust pyrometer.
- .15.17 Electric engine hour meter, Hobbs or approved equal.
- .15.18 Low oil pressure/high engine temperature alarm system, Kysor or approved equal.
- .15.19 Optional capacity filtration systems for air inlet, fuel, cooling and engine lubricating oil.

28.07.16. GENERAL

All equipment normally offered as standard production line items shall be furnished, whether or not specifically itemized or not in these Specifications.

Optimum workmanship shall be provided in the mounting of the winch apparatus, fifth wheel coupler and other accessories.

ITEM NO. 28.07.00
6X4 TRACTOR

DETAILED BID QUESTIONNAIRE

Bidder's name & business address: _____
_____ Tel. No. _____

Make _____ Model _____ Year _____
Approx. curb weight including fifth wheel & winch _____ Kgs.
GVW rating _____ Kgs. GCW rating _____ Kgs.

Note any deviations from Bid Specifications: _____

Price quoted for one (1) unit as described in the Specifications including all handling, preparation, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya: \$ _____.

Bid may be rejected unless all items listed in Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids, and award the contract to the best interest of all concerned in the final analysis.

1. ENGINE

Make _____ Model _____ Displacement _____
Aspiration _____ Rated KW _____ @ _____ RPM
Maximum rated torque _____ lb/ft @ _____ RPM
Alternator rated capacity _____ AMPS
HD cranking system w/overheat protection device? _____
Make, type & number maintenance-free batteries: _____

Cooling & filtration systems designed for extreme heat & dust application?

2. TRANSMISSION

Make automatic _____ Model _____ GCW rating _____ Kgs.
Maximum horsepower rating _____ No. forward speeds _____
Make torque converter _____ Model _____ Matched to
the engine & transmission package? _____ Stall ratio _____
Automatic lock-up in 4th & 5th gears? _____
Equipped with optimum cooling & filtration systems? _____
Magnetic oil drain plug provided? _____ Oil Cap. _____ l.

BID QUESTIONNAIRE, Item No. 28.07.00 (Con't.)

3. AXLE, FRONT

Make _____ Model _____ Rated Cap. _____ Kgs.
Suspension system rated capacity _____ Kgs.
HD, double-acting shock absorbers provided? _____
Oil lubricated front wheel bearings? _____

4. AXLE, TANDEM REAR

Make _____ Model _____ Rated capacity _____ Kgs.
Double reduction, single-speed? _____ Geared speed _____ Km/h.
Rockwell "Extra-Life" U-joints provided? _____
Tandem axle spacing _____ mm. Interaxle PD provided? _____
Make suspension system _____ Model _____
Type suspension _____ Rated Cap. _____ Kgs.

5. BRAKE SYSTEM

Full air w/mechanical, manual adjustment brakes? _____
Outboard-mounted brake drums provided? _____
Size linings, front _____ Size linings, rear _____
Trailer brake control valve & hose provided? _____
Trailer hose/electric cord suspension furnished? _____

6. STEERING SYSTEM

Describe: _____

7. FRAME

Full-channel type? _____ Type steel _____
Type framerail reinforcement: _____
Wheelbase _____ Ins. CA _____ mm. Frame designed for HD
winch mounted behind cab? _____
Welded, riveted or bolted frame construction? _____

8. COOLING SYSTEM

Designed for extreme heat applications? _____
Bolted radiator top & bottom tank construction? _____
Describe cooling system filtration: _____

9. FUEL SYSTEM

Describe fuel tank(s) & mounting arrangement: _____

Tanks interfere w/winch installation & operation? _____
Water separator provided? _____ Describe filtration system: _____

Tank-to-ground clearance _____ mm. Fuel balance line & shut-off valves
provided (if dual mounting)? _____
Fuel gauges for each tank? _____

BID QUESTIONNAIRE, Item No. 28.07.00 (Con't.)

10. CAB & SHEET METAL

Describe cab, mounting arrangement, hood, grill & fender hardware: _____

11. WHEELS & TIRES

HD wheel hub assemblies F&R? _____

Make & type rims _____

Rim & tire assemblies interchangeable F&R _____

Clearance between dual tandem tires _____ mm. Clearance between

tire sidewall and nearest point of the suspension system (tandem axle

inner duals) _____ mm. Tandem axle spread _____ mm.

Make, type, size, ply & tread, front tires: _____

Make, type, size, ply & tread, tandem dual tires: _____

Mounted, matching spare furnished (front)? _____

Mounted, matching spare furnished (rear)? _____

All tires tube type? _____

12. WINCH

Make _____ Model _____ Rated Cap. _____ Kgs.

Name & address of firm which will mount the winch: _____

Describe winch cable furnished: _____

Describe chain & hook furnished: _____

Describe winch mounting, bracing, etc.: _____

Cab-to-winch clearance _____ mm. Height from top of bare winch

drum to chassis frameroils _____ mm. Describe type & location

or winch control levers: _____

PTO make _____ Model _____ Rated Cap. _____

PTO designed to properly fit the Allison transmission? _____

Describe the double bearing jackshaft: _____

Sprocket drive ratio _____ to _____. Describe the type & size

winch sprockets & roller drive chain: _____

Will any welding or cutting be performed to the truck chassis framework

during the winch installation? _____

BID QUESTIONNAIRE, Item No. 28.07.00 (Con't.)

13. FIFTH WHEEL COUPLER

Make _____ Model _____ Type _____
Size _____ Rated Capacity _____ Kgs.
Size King pin _____ Number & size attaching bolts _____
Permanent, non adjustable mounting designed for lowbed trailer services?
_____ Mounted height _____ mm.

Name & address of firm which will mount the fifth wheel:

14. COLOR

Describe: _____

15. MISC. ACCESSORIES

Note any deviations from the Specifications: _____

Signature of person authorized to sign the Bid Questionnaire:

Name _____ Title _____ Date _____

(Please attach brochures describing the truck chassis and it's major power plant & driveline components, the winch and the fifth wheel coupler, and any other information which may be of value in making the Bid award.)

Note appropriate comments: _____

ITEM NO. 28.07.00
6X4 TRACTOR

SPARE PARTS LIST

Bidder shall supply the following listed items for subject tractor.

All items shall be of premium quality, and replacement parts shall be identical in every respect to those furnished in the original assembly of the tractor.

Shipment of the items shall accompany delivery of the tractor.

Bidder shall be responsible for handling, overseas packaging, transportation and delivery expense FOB Rumbek.

Item No.	Quantity	Description	Total Price
1	1	Complete set engine gaskets & seals.	\$ _____
2	1	Front hub.	_____
3	1	Rear hub.	_____
4	1	Set front wheel bearings & seals.	_____
5	1	Set rear wheel bearings & seals.	_____
6	1	Pair front axle spindles, L&R.	_____
7	1	King pin replacement set (Front).	_____
8	1	Set tie rod ends.	_____
9	1	Differential overhaul kit including ring & pinion, bearings, spiders, gaskets & seals.	_____
10	1	Complete front spring assembly.	_____
11	1	Pair rear springs (if used).	_____
12	1	Rear suspension system overhaul kit.	_____
13	1	Set (4) brake drums, rear.	_____
15	1	Set F&R brake shoes w/linings.	_____

SPARE PARTS LIST, Item No. 28.07.00 (Con't.)

16	1	Complete driveline Ass'y. including splined ends, yokes, shafts, tubes, U-joints, etc., including drive shaft to the rearmost drive axle.	_____
17	1	Windshield glass w/insulator rubber.	_____
18	1	Door glass.	_____
19	1	Pair front spring U-bolts.	_____
20	1	Pair rear spring U-bolts (if used).	_____
21	1	Windshield wiper motor.	_____
22	1	Set wiper blades.	_____
23	1	Complete set (4) spring center bolts.	_____
24	1	Power steering pump Ass'y.	_____
25	1	Water pump Ass'y.	_____
26	1	Radiator core/tanks Ass'y.	_____
27	1	Alternator Ass'y. w/pulley.	_____
28	1	HD starter Ass'y. w/Bendix drive.	_____
29	1	Voltage regulator Ass'y.	_____
30	1	Complete set drive belts.	_____
31	1	Case (12) primary fuel filters.	_____
32	1	Case (12) secondary fuel filters.	_____
33	1	Case (12) primary oil filters.	_____
34	1	Case (12) secondary oil filters.	_____
36	1	Case (12) Allison Trans. filters.	_____
37	1	Case (4) dry air filter elements.	_____
38	1	Case (6) differential oil filters (if used).	_____
39	1	Case (6) cooling system filters (if used).	_____

40	2	Spare rim Ass'y.	_____
42	4	Tire, tube & flap Ass'y.	_____
43	1	Complete set Allison Trans. bearings, seals & gaskets.	_____
44	1	Set differential seals & gaskets.	_____
45	1	HD, cartridge type manual grease gun.	_____
46	4	Headlight seal beam lamps.	_____
47	2	Shop Repair Manual.	_____
48	2	Parts List, including winch & PTO.	_____
49	2	Driver's Instruction Manual.	_____
50	2	Winch Operator's Instruction Manual.	_____
51	1	Case grease gun cartridges.	_____
		Total cost -----	\$ _____

Note any variations in the parts to be furnished: _____

Signature of person authorized to sign the Bid:
 _____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.08.00
INDUSTRIAL 4X2 TRACTOR

BID SPECIFICATIONS

The purpose and intent of these Specifications is to describe an Industrial 4X2 Tractor, diesel powered, Ford Model 545 or equal.

Tractor shall be a new, current standard production model equipped with torque converter power-reversing transmission. It shall be designed to accept suitable front end loader and backhoe attachments.

Subject equipment will be utilized for general road maintenance functions, including towing a variety of equipment.

Tractor shall be equipped for operations featuring extreme dust, and ambient temperatures ranging from 20 through 50 degrees celsius (70^o to 130^oF.).

Filtration systems shall be of optional capacity.

28.08.01. ENGINE

- .01.1 Approximate 41 Kw (55 HP) net rating.
- .01.2 Approximate displacement 3.2 liter (201 cubic meters)
- .01.3 Performance ratings shall be as per SAE J816b.
- .01.4 Standard charging & starting systems.
- .01.5 Spin-on replaceable filter elements.

28.08.02. TRANSMISSION

- .02.1 Torque multiplication Approx. 2.78-to-1.
- .02.2 Minimum 4-speeds forward & reverse.
- .02.3 Filtered and cooled, if available.

28.08.03. AXLE, FRONT

- .03.1 Rated capacity 4,500 Kg. (10,000 lbs.) minimum.
- .03.2 Box beam construction or equal.
- .03.3 Designed for heavy duty service applications.

28.08.04. AXLE, REAR

- .04.1 Rated capacity 5,200 Kg. (11,500 lbs.) minimum.
- .04.2 Double reduction, inboard planetary preferred.
- .04.3 Designed for heavy duty service applications.

28.08.05. BRAKES

- .05.1 Fully enclosed.
- .05.2 Wet disc, self-energizing type.
- .05.3 Interlock pedal latch & parking brake latch.

BID SPECIFICATIONS (Con't.)

.06. STEERING SYSTEM

.06.1 Hydrostatic via engine-driven pump.

28.08.07. ELECTRICAL SYSTEM

- .07.1 12-volt HD maintenance-free battery(s).
- .07.2 32-AMP capacity alternator, minimum.
- .07.3 Voltage & current regulator.
- .07.4 Key-type cranking switch,, w/safety device.
- .07.5 Two (2) headlights.
- .07.6 One (1) rear floodlight.
- .07.7 One tail light.
- .07.8 Instrument panel lights.

28.08.08. INSTRUMENTS & GUAGES

- .08.1 Engine temperature guage.
- .08.2 Oil pressure guage.
- .08.3 Fuel guage.
- .08.4 Ampmeter.
- .08.5 Engine hour meter, Hobbs insulated or approved equal.
- .08.6 Air cleaner restrictor guage.

28.08.09. TIRES

- .09.1 7.50 X 16, 8-ply, truck type, front.
- .09.2 16.9 X 24 R4, 8-ply, rear.
- .09.3 Mounted, matching spare tire, front.
- .09.4 Mounted, matching spare tire, rear.

28.08.10. CAB

- .10.1 HD 4-post canopy, open type.
- .10.2 Designed to provide visibility for loader/backhoe type services.

28.08.11. TOOLS

- .11.1 Wheel change wrenches.

28.08.12. EXHAUST SYSTEM

- .12.1 Vertical, muffled, equipped with rain cap.

28.08.13. ACCESSORIES GROUP

- .13.1 Electronic strobe flasher, amber, Whelen or approved equal, cab-mounted.
- .13.2 Differential lock.
- .13.3 Vandalism kit.

28.08.00 - BID SPECIFICATIONS (Con't.)

- .13.5 Swinging drawbar.
- .13.6 3 Point hitch (Cat. I.)/hydraulics
- .13.7 Single spool remote hydraulic valve
- .13.8 Linkage stabilizers
- .13.9 Rear view mirror

28.08.14. COLOR

- .14.1 Manufacturer's standard, high visibility type.

28.08.15. LOADER EQUIPMENT

- .15.1 1575 Kg. (3,500 lbs.) capacity rating, Min.
- .15.2 General materials bucket, SAE struck capacity 0.38 m³ (0.5 yd³) minimum.
- .15.3 Dump height 2590 mm. (8 ft 6 in.) minimum.
- .15.4 Digging depth 102 mm (4 in.) minimum.
- .15.5 Reversible seat.
- .15.6 Integral loader frame.
- .15.7 Double-acting cylinders.
- .15.8 Float control valve.
- .15.9 Full-flow filter w/replaceable element.
- .15.10 Hydraulic oil heat exchanger or cooler.
- .15.11 Filter micron rating not less than 10.
- .15.12 Standard hydraulic pumping/reservoir system, manual control valves & pressure relief valve.
- .15.13 Standard lift & bucket cylinders.
- .15.14 Hydraulic cylinder guards, if available.
- .15.15 Working Wgt. Approx. 4,500 Kg. (10,000 Lbs.) w/counterweight.

28.08.16. BACKHOE EQUIPMENT

- .16.1 Standard trenching model.
- .16.2 610 mm (24 in) wide, 0.18 m³ (6.5 ft³) SAE struck Cap. rating.
- .16.3 180 degree swing w/automatic cushioning.
- .16.4 4.2 meter (14 ft) reach boom.
- .16.5 Cylinder digging force at bucket 3990 Kg. (8,950 lbs.), min.
- .16.6 Cylinder digging force at dipperstick 2957 Kg. (6,500) lbs., Min.
- .16.7 Max. digging depth Approx. 4200 mm. (14 ft)
- .16.8 Loading reach Approx. 2100 mm. (14 ft)
- .16.9 Loading height Approx. 3000 mm (10 ft)
- .16.10 Standard hydraulic cylinders.
- .16.11 Standard controls & valves.
- .16.12 Operated from the hydraulic system used for powering the front end loader attachment.

28.08.00 - BID SPECIFICATIONS (Con't.)

28.08.17. STABILIZERS

- .17.1 Standard pads.
- .17.2 Hydraulic operation.
- .17.3 Spread support Approx. 2100 mm (7 ft)
- .17.4 Working weight Approx. 5400 Kg. (12,000 lbs.) complete with all attachments & required counterweights.

28.08.18. UTILITY TRAILER

- .18.1 3.6 metric ton (4 ton) capacity
- .18.2 Smooth steel construction
- .18.3 1.8 X 3 meter (6 X 10 ft.) body with 0.6 m. (2 ft.) sides.
- .18.4 1 meter (3 ft.) approximate deck height
- .18.5 Single axle, 4,550 Kg. (10,000 lbs) capacity
- .18.6 11L-16, 8 Ply, F3 Laborer Tires, or equal, with mounted matching spare.
- .18.7 Midwest scissors hoist w/one D.A. cylinder actuated from tractor remote valve with hoses and quick couplers

28.08.19. ROLLER

- .19.1 Tractor drawn, vibrating roller, Rosco Vibratow III, or approved equal.
- .19.2 Steel wheel, 1372 mm (54 in.) wide
- .19.3 Approx. working weight 3200 Kgs. (7,000 lbs.) min.
- .19.4 Transport wheels, including tires 7.50 X 15, 10 Ply, and mounted matching spare.
- .19.5 11.9 KW (16 HP) Duetz Diesel Model F1L-511 or approved equal.

28.08.20. GRADING BLADE

- .20.1 2.4 meter (8 ft.) rear grading blade, 13 mm. (1/2 in.) thick, 150 mm (6 in.) wide.
- .20.2 Angle, reverse, tilt and offset adjustments.

ITEM NO. 28.08.00
DETAILED BID QUESTIONNAIRE

INDUSTRIAL TRACTORS

Bidder's name & business address: _____

_____ Tel. _____

Make _____ Model _____ Year _____

Prices quoted for subject equipment as described in Specifications shall include installation cost of accessories, handling, overseas preparation, transportation and all delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya.

- (a) One (1) tractor equipped w/loader & backhoe----- \$ _____
- (b) Two (2) tractor only \$ _____
- (c) Two (2) utility trailer \$ _____
- (d) Two (2) vibratory roller \$ _____
- (e) Two (2) Grading blade \$ _____

Total price for all units, FOB Rumbek..... \$ _____

Bid may be rejected unless all items listed in Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids, and to award the contract in the best interest of all concerned in the final analysis.

Approx. working weight, tractor only _____ Kgs.
Approx. working weight, tractor w/loader and backhoe _____ Kgs.

Note any deviations from Bid Specifications:

Front end loader attachment installed by:

Backhoe attachment installed by:

BID QUESTIONNAIRE, Item No. 28.08.00 - (Con't.)

1. ENGINE

Make _____ Model _____ Flywheel KW _____ cu. l. _____
Aspiration _____ Rated maximum torque _____ @ _____ RPM
Performance ratings as per SAE J816b?
Spin-on replaceable filter elements (oil/fuel/water)? _____

2. TRANSMISSION

Torque converter multiplication ratio _____
No. forward speeds _____ No. reverse speeds _____
Transmission filtered & cooled? _____

3. AXLE, FRONT

Type _____ Rated Cap. _____ Kgs.
Designed for front end loader application? _____

4. AXLE, REAR

Type _____ Rated Cap. _____ Kgs.
Double reduction, planetary final drive? _____
Designed for HD service including backhoe application? _____
Approx. maximum geared road speed, high gear _____

5. BRAKE SYSTEM

Type service brakes _____ Application _____
Wet disc, self-energizing type? _____
Equipped with interlock pedal latch? _____

6. STEERING SYSTEM

Type _____ Actuation _____

7. ELECTRICAL SYSTEM

Alternator rated capacity _____ AMPS Maint-free batteries? _____
Optional HD starter furnished? _____
Key-type switch equipped w/safety switch? _____
Two (2) headlights, one (1) taillight and one (1) rear
floodlight furnished & installed? _____
Instrument panel lights furnished? _____

8. INSTRUMENTS & GUAGES

Note any deviations from Specifications? _____

BID QUESTIONNAIRE, Item No. 28.08.00 - (Con't.)

9. TIRES

Make, type & size, front: _____
Make, type & size, rear: _____
Mounted, matching spare front tire for each unit? _____
Matched, mounted rear tire for each unit? _____

10. CAB

Describe type: _____
Designed for loader/backhoe operations? _____

11. TOOLS

Wheel change wrenches furnished? _____

12. EXHAUST SYSTEM

Vertical type exhaust system provided w/rain cap? _____

13. ACCESSORIES GROUP

Note any deviation from Specifications: _____

14. COLOR

Tractor, accessories (loader/backhoe) same color as the manufacturer's standards? _____

15. LOADER EQUIPMENT

Make _____ Model _____ Capacity rating _____ Kgs.
SAE struck capacity rating _____ cu. m.
Max. dump height _____ Max. digging depth _____
Reversible seat furnished? _____
Integral loader frame design? _____ D.A. cylinders? _____
Equipped w/float control valve? _____
Describe type hydraulic oil filter: _____
Describe type hydraulic oil cooler: _____
Hydraulic filter rating _____ Microns
Standard bucket & lift cylinders? _____
Hydraulic cylinder guards furnished? _____
Approx. weight of tractor w/loader attachment _____ Kgs.

16. BACKHOE ATTACHMENT

Make _____ Model _____ Bucket width _____ m.
SAE struck capacity _____ cu. m.
Boom length _____ m. Degrees swing, R&L _____
Swing equipped w/automatic cushioning device? _____

BID QUESTIONNAIRE, Item No. 28.08.00 - (Con't.)

16. BACKHOE ATTACHMENT

Max. cylinder digging force at bucket _____ Kgs.
Max. cylinder digging force at dipper stick _____ Kgs.
Max. digging depth _____ Max. loading reach _____
Max. loading height _____ Intergrated hydraulic system? _____

17. STABILIZERS

Type _____ Spread _____
Actuation _____
Tractor working weight w/loader & backhoe _____ Kgs.

18. UTILITY TRAILER

Make _____ Model _____ Struck capacity _____ cu. m.
Steel guage, floor _____ Sides _____ headboard _____
Tailgate _____ Approx. length inside _____ mm.
Aprox. width inside _____ mm. Sideboard height _____ mm.
Headboard Height _____ mm. Tailgate height _____ mm.
Axle capacity _____ Kgs. Tire size _____
Hoist type _____ capacity _____ Kgs.

19. ROLLER

Make _____ Model _____
Engine, make _____ Model _____ Rated _____ Kw
Steel wheel roller, width _____ mm Working Weight _____ Kgs.
Transport wheels _____ Tire size _____

20. GRADING BLADE

Make _____ Model _____ Length _____ m.
Width _____ mm. thickness _____ mm.
Adjustments, angle _____ reverse _____ tilt _____
Offset _____ max. offset _____ mm.

Signature of Person authorized to sign Bid Questionnaire:

Name _____ Title _____ Date _____
(Please attach brochures describing the tractor and attachments)

Note any appropriate comments: _____

ITEM NO. 28.08.00
SPARE PARTS LIST

INDUSTRIAL TRACTOR

Bidder shall be responsible for supplying the following listed spare parts for subject equipment including handling, overseas packaging, transportation and delivery FOB Rumbek.

All items furnished shall be genuine replacement parts, and be identical in every respect to the parts used during the original assembly of subject equipment.

Shipment shall accompany delivery of the equipment to Rumbek.

Item No.	Quantity	Description	Total Price
1	1	Complete engine gasket & seal kit.	\$ _____
2	1	Complete engine rebuilding kit including valves, pistons, rings and bearings.	_____
3	1	Water pump Ass'y.	_____
4	1	Alternator/regulator Ass'y.	_____
5	1	Starter Ass'y.	_____
6	3	Sets drive belts.	_____
7	1	Set injector lines.	_____
8	1	Set injector Ass'y.	_____
9	3	Case (12) engine oil primary filters.	_____
10	3	Case (12) engine oil secondary filters.	_____
11	3	Case (12) fuel oil primary filters.	_____
12	3	Case (12) fuel oil secondary filters.	_____
13	1	Case hydraulic oil filters.	_____
14	1	Case air cleaner filter elements.	_____
15	3	HD manual grease guns, cartridge type.	_____
16	6	Case grease cartridge.	_____
17	1	Pair front axle wheel hubs.	_____

SPARE PARTS LIST, Item No. 28.08.00 - (Con't.)

Item No.	Quantity	Description	Total Price
18	2	Pair front wheel bearings & seals.	_____
19	1	Pair rear axle wheel hubs.	_____
20	2	Pair rear wheel bearings & seals.	_____
21	2	Front wheel Ass'y.	_____
22	2	Rear wheel Ass'y.	_____
23	1	Set front wheel studs & nuts.	_____
24	1	Set rear wheel studs & nuts.	_____
25	4	Front tires w/tubes & flaps.	_____
26	4	Rear tires w/tubes & flaps.	_____
27	1	Pair bucket lift cylinder Ass'y.	_____
28	1	Complete set backhoe Cyl. Ass'y.	_____
29	1	Complete set hydraulic hoses for loader and bucket attachments.	_____
30	1	Set hydraulic hoses for stabilizers.	_____
31	6	Operator's Instruction Manual.	_____
32	2	Shop Manuals including attachments.	_____
33	2	Parts List including attachments.	_____
Total cost -----			\$ _____

Note any variations to the parts requested in Bid:

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.09.00
IMPLEMENT TRAILERS

SPECIFICATIONS

It is the purpose and intent of these Specifications to provide a brief description of an implement trailer designed to gross a minimum of 9,000 Kg. (20,000 lbs.) of combined weight.

The unit shall be of current production, Eager Beaver, Wisconsin, Clark or approved equal, designed for heavy duty service.

This equipment shall be used for hauling road maintenance equipment, and also serve as the carrier for demountable hopper body and water tank.

The suspension system and framework must be designed to withstand high impact shocks transmitted via rough, primitive roads.

28.09.01. TRAILER DIMENSIONS

- .01.1 Low platform type, no beavertail.
- .01.2 Platform length shall be Approx. 5 meters (17 ft) including overhang.
- .01.3 Overall width shall be 2.4 m (8 ft) maximum.
- .01.4 Platform height shall be Approx. 864 mm (34 in).
- .01.5 Towpole section shall be of heavy duty design, and have a length of Approx. 1.36 m. (4.5 ft).
- .01.6 Towpole hitch shall be lunette eye type, 2700 Kg. (6000 lbs.) vertical load rating 13500 Kg. (30,000 lbs.) gross trailer rating, Holland Model 12281 matching the Holland T-100-A swivel type pintle hook attached to the dump truck chassis, or an approved equal. Standard tri-adjustment in height preferred.
- .01.7 A heavy duty, manual type, hand-cranked towpole support jack rated at 7.2 metric tons (8 tons), minimum, shall be provided.
- .01.8 Towpole shall be equipped w/break-away safety chains.
- .01.9 Platform deck shall be 51 mm (2 in) hardwood plank, installed lengthwise.
- .01.10 Removable sections of the platform deck to accommodate the bottom discharge hopper (See detailed hopper Specs.)
- .01.11 The platform shall be equipped with satisfactory latching arrangement for securing both the demountable hopper body and the demountable water tank, interchangeably (See tank details Item No. 28.10.00 Section 9).
- .01.12 Load latching rings shall be provided, four (4) rings on each side of the trailer platform.

28.09.02. LOADING RAMPS

- .02.1 Heavy duty, detachable type loading ramps shall be provided consisting of two (2) complete sections designed to offer a maximum slope of 15 degrees.

IMPLEMENT TRAILERS, Item No. 28.09.00 (Con't.)

28.09.02. LOADING RAMPS

- .02.2 Ramp attachments at the rear of the trailer shall be designed to provide adjustments in loading width or spread, and equipped with satisfactory on-board storage mechanism consisting of a minimum of three (3) hook-type fixtures on each side of the trailer w/matching ramp rings.
- .02.3 Ramp sections shall be designed to support heavy equipment, have a minimum width of 300 mm (12 in) and a cleated surface to facilitate loading/unloading of machinery.
- .02.4 Ramps shall have a minimum thickness of 127 mm (5 in), if hardwood, or of equal strength if fabricated of other material.

28.09.03. BRAKE SYSTEM

- .03.1 Hydraulic w/vacuum assist, manual adjustable type.
- .03.2 Optimum brake shoe/drum size shall be furnished.
- .03.3 Trailer brake connections.
- .03.4 Hydrovac trailer brake kit for installation on the dump truck, complete w/brake hose & couplers (Note: five (5) kits required.)

28.09.04. WHEELS & TIRES

- .04.1 Heavy duty dual wheels on each axle, Michelin 8.25 X 15-14-G or Michelin 7.50 X 15-16-G. Disc wheels preferred.
- .04.2 One (1) mounted, matching spare wheel & tire for each trailer.

28.09.05. SUSPENSION SYSTEM

- .05.1 Rated capacity 9000 Kg. (20,000 lbs.) minimum.
- .05.2 Satisfactory oscilation and articulation for services over rough, unpaved road surfaces.
- .05.3 Cushioned type suspension system, springs and/or walking beam type.
- .05.4 Hutchinson, Clark or approved equal.

28.09.06. AXLE(s)

- .06.1 Manufacturer's choice of tandem axles as per Section 4.1/5.1, or single axle of 9,000 Kg. (20,000 lbs.) rating w/Michelin 10.00 X R15 dual tires, type XZZ, PR-LR 14-G, or equal, including mounted, matching spare for each trailer.
- .06.2 Standard Forge or approved equal.
- .06.3 Timken bearings or approved equal.
- .06.4 Oil lubricated wheel bearings, Sealco or approved equal.

28.09.07. FRAME

- .07.1 Standard heavy duty frame & cross members.

IMPLEMENT TRAILERS, Item No. 28.09.00 (Con't.)

28.09.08. HOPPER TYPE BODY

- .08.1 Demountable, bottom discharge design, manual gate type, designed for hauling general road maintenance materials and common aggregates. Engineered for mounting on the implement trailer. Four (4) units required.
- .08.2 Approx. SAE struck capacity 3.1 m³ (4 yd³)
- .08.3 Discharge gate opening Approx. 600 mm (24 in)
- .08.4 Hopper shall be fabricated from 10-gauge steel plate.
- .08.5 Hopper dimensions shall be Approx. 2.4 m (8 ft) long X 1.2 m (4 ft) wide X 1.1 m (3.6 ft) high; the rectangular top section shall be Approx. 600 mm (24 in) high, and the bottom section sloped at 60 degrees shall be Approx. 508 mm (20 in) in height.
- .08.6 Discharge gates shall be of twin, hinged door design w/manual tripping device; gates shall be designed for individual and simultaneous opening, and spreader chains installed so as to permit control of the discharge rate.
- .08.7 Shell, gates and hopper support framework shall be amply reinforced resulting in a rigid structure designed to absorb loading impacts of a front end loader having a bucket capacity of Approx. 1350 Kg. (3000 lbs.)
- .08.8 Gates shall be closed via a crank-and-cable system located at each end of the hopper, one for each set of gates, and equipped with satisfactory latch device designed to fully absorb the imposed laden weight.
- .08.9 Gate discharge opening shall be Approx. 600 mm (24 in) and designed to discharge the material in windrow-fashion between the trailer's longitudinal framerails w/minimum flow interference. Removable deck section to permit discharge.
- .08.10 Hopper support legs shall be fabricated from 4.7 X 51 X 51 mm (3/16 in X 2 in X 2 in) angle, a minimum of eight (8) to be used joining the hopper to it's subframe.
- .08.11 Hopper subframe shall be fabricated of heavy I-beam, channel or angle and welded into a rigid structure.
- .08.12 Hopper support legs shall be of sufficient length to allow full opening of the gates.
- .08.13 Satisfactory mechanical device shall be provided for securing the hopper subframe to the trailer, a manual operation performed without the use of bolts for rapid mounting/demounting, and offer ease of accessibility.
- .08.14 Hopper rim shall be reinforced to minimize damage due to contact with the loading apparatus.
- .08.15 Hopper trip device shall be operable from driver's (left) side.
- .08.16 Lifting eyes shall be provided, one at each corner of the hopper.

IMPLEMENT TRAILERS, Item No. 28.09.00 (Con't.)

28.09.09. COLOR

- .09.1 Trailer and hopper shall be painted Highway H-Visibility Yellow.

28.09.10. LIGHTS

- .10.1 Electric lights not required.

ITEM NO. 28.09.00
DETAILED BID QUESTIONNAIRE

IMPLEMENT TRAILERS

Bidder's name and business address: _____

_____ Tel. No. _____

Make _____ Model _____ Year _____ Rated Cap. _____ Kgs.

Approximate shipping weight _____ Kgs. Length _____ Width _____

Prices quoted in the Bid shall include the following package:

- (a) Four (4) implement trailers.
- (b) Four (4) demountable hopper bodies.

Prices quoted in the Bid shall include all overseas packaging, handling, preparation, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya.

- (a) Price, total of four (4) trailers..... \$ _____
- (b) Price, total of four (4) hoppers..... _____

Total package cost ----- \$ _____

Note any deviations from Bid Specifications: _____

Bid may be rejected unless all items in the Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids.

Purchaser reserves the right to award the contract in the best interest of all concerned in the final analysis.

1. TRAILER DIMENSIONS

Low platform type without beavertail ramp? _____

Platform overall length including overhang _____ m. _____ mm.

Platform height _____ mm. Overall width _____ mm.

Towpole length _____ mm. Total overall length _____ m.

Type towpole hitch _____ Vertical load rating _____ Kgs.

gross trailer rating _____ Kgs. Lunette eye make _____

Size pin opening _____ mm. Lunette designed to match the pintle hook?

Make & model pintle hook: _____

Describe tow pole construction: _____

Tow pole hitch adjustable in height? _____ Type tow pole support: _____
Rated support capacity _____ Kgs.
Break-away safety chains provided? _____ Plank thickness _____ mm.
Plank material _____ Planks installed lengthwise? _____
Platform overhang behind axle suspension center line _____ mm.
Describe removable platform section to accomodate the bottom, gravity-discharge hopper body: _____

Describe trailer-mounted mechanism designed to latch the hopper body: _____

Number & location of load binding rings: _____

2. LOADING RAMPS

Detachable type? _____ Max. slope angle on level ground _____ degrees.
Ramp size & construction details: _____

Ramp arrangement designed for loading equipment of varying width? _____
Describe the method and design for on-board storage of the ramps: _____

Ramps designed to handle machinery ranging upwards to a maximum concentrated weight of _____ mm.

3. BRAKE SYSTEM

Type _____ Total brake area (linings) _____ Sq. mm.
Trailer brake connections furnished? _____
Five (5) brake installation kits furnished for installation on the dump trucks? _____ Kits designed to provide synchronized brake application of tractor and trailer combination? _____
Independent, steering column-mounted trailer brake application valve furnished? _____ Brake connecting hoses w/quick-couplers furnished for each (5) trucks? _____

4. WHEELS & TIRES

Make & type wheels _____
Dual or single wheel arrangement? _____ Wheels interchangeable at all mounting positions? _____ Make, type, size, tread pattern and ply rating, tires: _____

Mounted, matching spare tire furnished for each trailer? _____

BID QUESTIONNAIRE, Item No. 28.09.00 - (Con't.)

5. SUSPENSION SYSTEM

Make _____ Type _____ Rated Cap. _____ Kgs.
Describe suspension system: _____

Essential oscilation/articulation for operating on rough road surfaces,
and over undulating terrain in off-highway service? _____

6. AXLES(S)

Make _____ Model _____ Dual or tandem? _____
Single or dual wheels? _____ Describe Michelin tires, if
different from those listed under Section 4: _____

Oil lubricated wheel bearings? _____ Make seals _____

7. FRAME

Longitudinal frame rail size & type: _____
Type and number of cross members: _____
Shielding provided to protect brake mechanism in-line w/hopper discharge
gates? _____

8. HOPPER TYPE BODY

Demountable type engineered as an integral part of the trailer when
used? _____ Rated capacity, SAE struck _____ cu. m.
Satisfactory for handling general road maintenance material? _____
Hopper shell material & gauge: _____
Mechanical discharge gates provided? _____ Describe gate
fabrication, reinforcements, hinge & trip arrangement: _____

Discharge gate opening, maximum: length _____ mm. Width _____ mm.
Describe mechanism used to close the gates: _____

Describe mechanism used to hold the gates fully closed under fully
loaded, dynamic conditions: _____

Describe type & location of gate release controls _____

Independent hopper compartment gate release/return controls? _____
Hopper slope _____ degrees. Type gate hinges _____
Latching device for holding the hopper in travel position: _____

BID QUESTIONNAIRE, Item No. 28.09.00 - (Con't.)

Section 8, Con't.

Describe hopper subframe: _____

Number, type & size legs: _____

Overall height above trailer platform _____ mm.

Type hopper rim reinforcement to prevent damage during loading phase: _____

Describe compartment divider: _____

Lifting eyes at each corner for lifting/storage of the hopper? _____

9. COLOR

Describe color of trailer & hopper: _____

Note: The implement trailers will be utilized as required to haul water; the water tanks will be so designed as to offer demountable interchangeability for utilization within the truck dump bodies, the (22.5 metric ton) 25-ton lowbed trailer plus the implement trailers.

The system utilized to fasten the water tank to the implement trailer platform should be the same used for the demountable hopper body; additional water tank information will be found in the 22.5 ton (25-ton) lowbed trailer general specifications, Item NO. 28.10.00 Section .09.

ITEM NO. 28.09.00
SPARE PARTS LIST

IMPLEMENT TRAILERS

Bidder shall be responsible for the supply of the following listed spare parts for subject equipment, including handling, preparation, crating for overseas shipment, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya.

All items listed shall be genuine replacement parts, and identical in every respect to the parts furnished in the original assembly of the trailers.

Shipment of subject parts shall accompany delivery of the trailers at Rumbek.

Item No.	Quantity	Description	Total Price
1	1	Complete axle Ass'y. including wheel hubs & bearings.	\$ _____
2	2	Wheel hubs.	_____
3	2	Sets wheel bearings w/seals.	_____
4	1	Complete suspension system (springs, balance beams, etc.	_____
5	1	Tow pole lunette eye.	_____
6	1	Tow pole suspension system.	_____
7	1	Pair loading ramps.	_____
8	2	Sets trailer hose w/connectors.	_____
9	1	Complete set brake drums.	_____
10	2	Complete sets brake linings.	_____
11	2	Pairs hydraulic wheel Cyl.	_____
12	2	Spare wheels.	_____
13	4	Spare tires, unmounted.	_____
14	2	Complete sets wheel studs and nuts for two (2) wheels.	_____

SPARE PARTS LIST, Item No. 28.09.00 - (Con't.)

<u>Item No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Total Price</u>
15	2	Wheel bearing oil seal kits.	_____
16	1	Gallon matching paint enamel.	_____
		Total cost	\$ _____

Note any variations in the parts to be furnished:

ITEM NO. 28.10.00
SPECIFICATIONS

LOWBED TRAILER, WITH HOPPER AND WATER TANKS

It is the purpose and intent of these Specifications to describe briefly a lowbed semi-trailer of the type generally utilized by the trade for transporting heavy machinery, minimum capacity rating 22.5 metric tons (25 tons) at 64 Km/h. (40 MPH).

The unit shall be of current production, Fontaine, Eager Beaver, Clark or approved equal designed for heavy duty service.

This equipment will be used entirely on unpaved, primitive type roads; the suspension system and framework must be designed for high impact shocks transmitted via rough road surfaces.

In addition to moving machinery the trailer should be so designed as to rapidly accept integrated water tank and hopper body which are part of these Specifications.

28.10.01. TRAILER DIMENSIONS

- .01.1 Bed length shall be approximately 7.8 m. (26 ft).
- .01.2 Overall width shall be 2.4 m (8 ft.) maximum.
- .01.3 Platform height shall be 1016 mm. (40 in.) maximum.
- .01.4 Gooseneck height shall be Approx. 457 mm. (18" in) higher than platform height.
- .01.5 Kingpin shall be located Approx. 60 mm (24 in) from the front of the trailer gooseneck, and a minimum of 1980 mm (78 in) of clear space from pin-to-gooseneck end in order to provide adequate clearance for jackknifing the tractor.
- .01.6 Gooseneck section shall be Aprox. 3 m. (10 ft) in length.
- .01.7 A suitable roller shall be installed on the front end of the gooseneck, heavy duty type w/greaseable bearings, for supporting/guideing the winch cable; fairlead preferred.
- .01.8 Clearance between king pin mounting plate and the ground shall be Approx. 1200 mm (48 in).
- .01.9 King pin size shall be 51 mm. (2 in) replaceable type.

28.10.02. DECK TYPE

- .02.1 Platform shall be of the straight type (no beavertail).
- .02.2 Heavy duty, demountable ramps shall be provided, and designed to offer a maximum slope of Approx. 15 degrees.
- .02.3 The ramp attachments to the rear of the trailer shall be designed to provide adjustments in loading width, or spread, and be equipped with satisfactory storage arrangement for supporting one ramp on each side of the trailer. Support hardware shall consist of a minimum of three (3) hook-type fixtures on each side of the trailer, with matching rings attached to each ramp.

28.10.00 LOWBED TRAILER SPECIFICATIONS (Con't.)

- .02.4 Ramp sections shall be designed to support heavy equipment, have a minimum width of 300 mm. (12 in) and a cleated surface to facilitate loading/unloading.
- .02.5 Ramps shall be of 150 mm (6 in) hardwood thickness, or of equal or superior strength if fabricated of steel. Combination steel and wood acceptable.
- .02.6 Platform deck shall be equipped with a minimum of six (6) lashing rings on each side.

28.10.03. BRAKES

- .03.1 Brakes shall be full air, shoe/drum minimum size 311 mm X 191 mm (12-1/4 in X 7-1/2 in) with bolted linings.
- .03.2 Brakes shall be manual adjustable type.
- .03.3 Brake connections shall be provided at the gooseneck.

28.10.04. WHEELS & TIRES

- .04.1 Heavy duty, platform trailer disc wheels, interchangeable at all wheel positions, Budd or approved equal.
- .04.2 Eight (8) Michelin 10.00 X R-15 tires in dual mounted arrangement on tandem axles, type XZZ, PR-LR 14-G, or equal.
- .04.3 Two (2) matching, mounted spare tires shall be furnished.

28.10.05. SUSPENSION SYSTEM

- .05.1 Rated at 22,500 Kg. (50,000 Lbs.), minimum.
- .05.2 Cushioned type suspension shall consist of balanced beam, springs and/or walking beams equipped with heavy duty type retaining brackets.
- .05.3 Hendrickson, Hutchinson, Rockwell or approved equal.

28.10.06. TANDEM AXLE ASSEMBLY

- .06.1 Rated at 22,500 Kg. (50,000 lbs.), minimum.
- .06.2 Standard Forge or approved equal.
- .06.3 Heavy duty spindles.
- .06.4 Timken bearings or approved equal.
- .06.5 Oil lubricated wheel bearings, Stemco or approved equal.

28.10.07. DECKING

- .07.1 Decking shall be of 51 mm (2 in) Min. hardwood planks installed lengthwise. (See details in hopper body specifications, section 10).

28.10.08. FRAME

- .08.1 Longitudinal beams and cross members shall be of the type and strength generally furnished to the trade, and properly reinforced to provide a strong and rigid frame designed to resist high impact and twisting stresses.

LOWBED TRAILER, Item No. 28.10.00 (Con't.)

28.10.09. WATER TANKS

- .09.1 Four (4) water tanks or 7600 liter (2,000 gallons) approximate capacity shall be provided, all-steel construction, 10 guage.
- .09.2 Surge-control baffles shall be installed.
- .09.3 Tank configuration shall be rectangular, and approximately 2.4 m. (8 ft) long by 2 m. (6.57 ft) wide by 1.64 m. (5.4 ft) high.
- .09.4 An air relief valve for venting purposes while charging/discharging the tank, and a 100 mm (4 in) filler cap shall be provided.
- .09.5 Each tank shall be equipped with a suitable spray bar made or common pipe of 51 mm (2 in) diameter by 2.4 m (8 ft) in length; the spraybar shall be furnished with 30 mm (12 in) extension R&L w/suitable pipe tread couplings, and end caps when the extensions are not being used. Discharge shall be via gravity, the rate of which is controllable by a gate valve.
- .09.6 Spray bar discharge holes shall be 6.35 mm (1/4 in) diameter at Approx. 152 mm (6 in) intervals, including extensions. Suitable means for carrying the extensions on-board when not in use shall be provided.
- .09.7 Tanks shall be designed for rapid demountability, and interchangeable for use within the truck dump body, the implement trailers and the lowbed trailer. Implement trailers and the dump body shall accommodate one tank. The lowbed trailer shall accommodate one, two or three tanks.
- .09.8 The lowbed trailer tanks used in double and triple arrangement shall be butted end-to-end in the center of the trailer deck, the last of which shall have it's spraybar extending clear of the trailer to provide optimum spray discharge pattern.
- .09.9 Each tank shall be mounted on a satisfactory frame, secured to the frame via bolting arrangement, and an oak insulator 3/4" thick by suitable width shall be used between the tank and the support frame.
- .09.10 Satisfactory latching devices shall be provided for each tank; the devices attached to the tanks shall provide essential interchangeability required for mounting the tanks on the implement trailers, and be so designed as to prevent unnecessary vertical and longitudinal movement when secured to the trailer deck. The latching mechanism shall not require the use of bolts for rapid mounting and dismounting.
- .09.11 Latching devices installed on the trailer shall not protrude above trailer deck when not in use to minimize possible damage, and to provide a clear deck for hauling machinery.
- .09.12 An access ladder, permanently attached on the driver's (left) side shall be provided for each tank to facilitate tank loading purposes.

LOWBED TRAILER, Item No. 28.10.00 (Con't.)

- .09.13 Tanks when used in double and triple arrangement shall be connected via suitable quick-couplers and flexible hose of proper length.
- .09.14 Hose shall be of non-pressurized premium quality w/rubber exterior friction protective covering, 76 mm (3 in) in diameter.
- .09.15 A rust-proof 76 mm (3 in) gate valve shall be provided for each tank outlet connection, located for accessibility to the driver.
- .09.16 A satisfactory drain plug shall be provided for each tank for purging purposes.
- .09.17 Four (4) lift eyes shall be provided, one at each corner of the tank, and of proper capacity to support the tank when not in use.

28.10.10. HOPPER TYPE BODY

- .10.1 Demountable, bottom discharge design, manual gate type designed to haul general road maintenance materials and aggregates. Removable platform section shall be provided designed to discharge material via gravity between the trailer's longitudinal framerails. One (1) unit only.
- .10.2 Approx. hopper capacity 9 m³ (12 yd³), SAE struck.
- .10.3 Discharge gate opening Approx. 600 mm. (24 in.), gates equipped with spreader chains to control discharge rate.
- .10.4 Hopper shall be fabricated of 10-gauge steel plate.
- .10.5 Hopper dimensions shall be Approx. 4.5 m (15 ft) long X 1.8 m. (6 ft) wide X 1.3 m. (4.3 ft) high; the rectangular upper section shall be 710 mm (28 in) in height, and the lower section sloped at 60 degrees shall be Approx. 600 mm (24 in) in height.
- .10.6 A vertical divider shall be used resulting in two (2) hopper compartments of Approx. the same size, serving as a reinforcement of the hopper sides; each compartment shall have individual discharge gates.
- .10.7 Discharge gates shall be of the hinged, twin type equipped with gate tripping device designed to permit individual and simultaneous gate opening; trip controls shall be located on driver's (left) side of the trailer.
- .10.8 Shell, gates and hopper support framework shall be amply reinforced resulting in a rigid structure designed to absorb loading impacts of a front end loader equipped with a bucket capacity of 1350 Kg. (3000 lbs.) of material.
- .10.9 Gates shall be closed via a crank-and-cable system located at each end of the hopper, one for each set of gates, and equipped with satisfactory latch device designed to fully absorb the imposed laden weight.
- .10.10 Protruding or exposed brake apparatus shall be protected by proper shields to prevent damage during the discharge process.

LOWBED TRAILER, Item No. 28.10.00 (Con't.)

- .10.11 Hopper rim shall be reinforced to minimize damage caused by contact with loading apparatus.
- .10.12 Hopper support legs shall consist of a minimum of eight (8) legs fabricated from 6.35 mm X 102 mm X 102 mm. (1/4 in X 4 in X 4 in) angle.
- .10.13 Hopper subframe shall be constructed of heavy I-beam, channel, box-beam or equal and welded into a strong and rigid structure.
- .10.14 Hopper support legs shall be welded to the subframe, leg length being sufficient to allow the full opening of discharge gates.
- .10.15 Satisfactory mechanical device shall be provided for securing the hopper subframe to the trailer, a manual operation performed without the use of bolts in order to provide efficient, rapid mounting/dismounting; the methods used to couple the hopper to the trailer shall offer good accessibility to perform the task.
- .10.16 Lifting eyes shall be provided, one at each corner.

28.10.11. COLOR

- .11.1 Trailer and hopper shall be Highway High Visibility Yellow.

28.10.12. LIGHTS

(Not required)

ITEM NO. 28.10.00
DETAILED BID QUESTIONNAIRE

LOWBED TRAILERS

Bidder's name & business address: _____
_____ Tel. No. _____

Make _____ Model _____ Year _____ Rated Cap. _____ Tons

Approx. trailer shipping weight _____ Kgs.

Approx. hopper shipping weight _____ Kgs.

Approx. water tank shipping weight (each) _____ Kgs.

Total price for the trailer package shall include:

- (a) One (1) lowbed trailer \$ _____
- (b) One (1) hopper body _____
- (c) Four (4) water tanks _____
- Total package cost ----- _____

Bid price shall include all handling, preparation, packaging, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via Port of Mombasa, Kenya.

Note any deviations from Bid Specifications: _____

Bid may be rejected unless all items in the Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids.

Purchaser reserves the right to award the contract in the best interest of all concerned in the final analysis.

1. TRAILER DIMENSIONS

Bed length _____ Overhang _____ Non-beavertail design? _____
Overall width _____ Platform height _____ Size pin _____
Pin location from front of trailer _____ Overall height _____
Height, pin mounting plate to ground _____ Gooseneck Lgt. _____
Clearance, pin to gooseneck end and/or landing gear _____
Landing gear type & rated Cap.: _____
Front of gooseneck equipped w/winch fairlead? _____

BID QUESTIONNAIRE, Item No. 28.10.00 - (Con't.)

2. DECK & RAMPS

Plank type & thickness: _____
Planks installed lengthwise? _____ Provisions for removal of deck
section to facilitate hopper discharge? _____
Ramp loading slope on level ground _____ degrees, Approx.
Describe mechanism provided to support the ramps at the rear of the
trailer during loading/unloading process: _____

Ramp spread variable for accomodating machinery of different type and
width configurations? _____
Each ramp equipped with suitable on-board, in-transit storage devices to
accomodate one (1) ramp on each side of the trailer? _____

Ramps designed for heavy duty service? _____
Describe type & location of load lashing rings: _____

3. BRAKES

Service brake type and size: _____

Automatic application when air pressure loss occurs? _____
Shielded brake connections provided at gooseneck? _____
Dust shields provided for each brake drum? _____
Type brake adjustment mechanism: _____
Automatic moisture drain valve provided? _____
Brake lines & valves protected against damage during the hopper discharge
process? _____

4. WHEELS & TIRES

Make, type & size wheels: _____
Make, type, size & ply rating, tires: _____

Two (2) mounted, matching spare tires furnished? _____
Interchangeable wheels at all positions? _____

5. SUSPENSION SYSTEM

Make _____ Model _____ Cap. rating _____ Kgs.
Type suspension system: _____

6. TANDEM AXLE ASSEMBLY

Make _____ Model _____ Gross Cap. _____ Kgs.
HD spindles? _____ Make wheel bearings _____
Make wheel bearing oil seals? _____

BID QUESTIONNAIRE, Item No. 28.10.00 - (Con't.)

7. DECKING

(Note: Included in Section 2, above.)

8. FRAME

Describe type steel, framerails & cross members: _____

Essential articulation and oscillation for off-road service? _____

9. WATER TANKS

Type _____ Size _____ Gauge _____

Approx. capacity _____ l. Size filler opening _____ mm.

Air vent provided? _____ Size detachable spraybar _____

Size and spread of drain holes _____

300 mm (12 in.) spraybar extension R&L? _____ Type on-board

storage method provided: _____

Gate valve control accessible to driver? _____

Plumbing system so designed as to permit individual/multiple discharge

when more than one tank is used? _____

Tanks designed for rapid demountability? _____

Type of lashing system used to secure tank to trailer: _____

Trailer-mounted lashing devices protrude above deck level when tank(s)
are not in use? _____

Trailer lashing system also integrated for fastening the hopper to the
deck? _____ Lashing system designed to accommodate up to and

including three (3) tanks? _____

Describe tank subframe & insulator: _____

All essential apparatus furnished for lashing tanks & hopper _____

Describe tank access ladder: _____

Describe tank plumbing system (valves & location, type couplers, type &
size flexible hose, etc.): _____

Tank drain plug provided? _____ Describe lift eyes: _____

COLOR

Paint matching the trailer and hopper? _____

BID QUESTIONNAIRE, Item No. 28.10.00 - (Con't.)

LIGHTS & REFLECTORS

(Not required)

10. HOPPER TYPE BODY

Approx. hopper capacity, SAE struck _____ cu. m.
Gravity discharge type? _____ Manual trip release? _____
Manually operated gate closing system? _____
Individual gates for each (two) hopper sections? _____
Max. gate opening _____ W _____ L System designed for
separate and simultaneous hopper discharge? _____ Trip control
type & location: _____
Gate plate gauge _____ Max. Lgt. _____ Max. Width _____
Overall height above trailer deck: _____ Spreader
chains adjustable to provide varying discharge width? _____
Discharge method design for windrow pattern between trailer framrails?
_____ Describe mechanism used to hold gates in closed position under
full load: _____

Describe vertical hopper compartment divider: _____

Hopper slope angle _____ degrees. Describe hopper shell and
gate reinforcements: _____

Describe gate closing and latch system: _____

Describe hopper rim reinforcement: _____

Describe hopper subframe: _____

Describe method used to secure hopper subframe to trailer: _____

Lift eyes provided at each corner of the hopper? _____

11. COLOR

Same color as trailer and water tanks? _____

12. LIGHTS & REFLECTORS

(Not Required)

Signature of person authorized to sign the Bid Questionnaire:
_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.10.00
SPARE PARTS LIST

LOWBED TRAILERS

Bidder shall supply the following listed items for subject equipment and be responsible for overseas packaging, handling, transportation and delivery expense FOB Rumbek.

All items shall be of premium quality, and replacement parts shall be identical in every respect to the parts furnished in the original assembly of the trailer.

Shipment of the items shall accompany delivery of the trailer.

Item No.	Quantity	Description	Total Price
1	6	Load binding chains, HT 9.5 mm. (3/8 in.) w/hooks.	\$ _____
2	6	HD load binders.	_____
3	2	HD, side-opening, 254 mm. (10 in.) size, bronze bushed swivel-shackled snatch blocks, 10-ton Cap., Johnson or equal.	_____
4	1	Complete set of brake drums.	_____
5	1	Complete set of brake linings w/matching bolts.	_____
6	2	Air brake cylinders.	_____
7	2	Slack adjusters.	_____
8	2	Wheel hub w/bearings, seals and retainer nuts.	_____
9	2	Sets of wheel studs & nuts.	_____
10	2	Wheels w/lock rims.	_____
11	4	Tires w/tubes & flaps.	_____
12	2	Sets wheel bearings & seals.	_____
13	1	Kit of all parts required to completely rebuild one (1) side of the suspension system.	_____

SPARE PARTS LIST, Item No. 28.10.00 (Con't.)

14	2	Gate valves.	_____
15	1	Complete set of hose w/couplings connecting the tanks and the spraybar.	_____
16	1	Kit containing spare tank and hopper fastening devices (if applicable).	_____
17	1	Kit containing spare parts to repair gate hinges, latch and closing mechanism.	_____
Total cost -----			\$ _____

Note any variations in the parts to be furnished: _____

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

ITEM NO. 28.11.00
SPECIFICATIONS

WATER PUMP

It is the purpose and intent of these Specifications to briefly describe a diesel powered water pump, portable, wheel-mounted, having a rated capacity of 380 liters/min. (100 GPM).

The pump and engine must be of rugged construction for operations in which high ambient temperatures prevail, and waters subject to considerable contamination.

The wheeled carrier shall be on pneumatic tires, and an axle and suspension system designed for towing at moderate to high speeds over rough, dirt roads. It is essential that wheel spindles and bearings be designed for this type of service.

28.11.01. WATER PUMP SECTION

- .01.1 Tompson Model HDLW or approved equal.
- .01.2 Rated capacity approximately 380 liters/minute (100 GPM)
- .01.3 Engine speed adjustable control for operations demanding less than the pump's maximum rated GPM delivery rate.
- .01.4 10 meter (35 ft) head, minimum, and able to deliver water through hose lengths up to 30 meters (100 ft) maximum.
- .01.5 Pump shall have mechanical seals, grease-lubricated.
- .01.6 Pump shall be 51 mm. (2 in) size, self-priming, cast iron housing.
- .01.7 Pump shall be designed for pumping contaminated waters.
- .01.8 Pump shall be designed for easy, field-type repairs.

28.11.02. ENGINE

- .02.1 Tompson Model 520, Lombardini diesel fueled, 5.5 Kw (7.5 HP) rated output, or an approved equal.
- .02.2 Manual rope starting system.

28.11.03. HOSE

- .03.1 Suction line shall be 7.5 m X 51 mm (25 ft X 2 in) premium quality, equipped w/quick-couplers, and basket filter on suction end.
- .03.2 Discharge hose shall be 51 mm. (2 in) diameter, premium quality, rust-proof quick-couplers. Four (4) 7.5 m. (25 ft) sections shall be furnished completely assembled w/couplers.

28.11.04. TRAILER MOUNT

- .04.1 Ample capacity, designed for towing, lunette eye coupler, heavy duty frame, suspension, axle, wheels and tires.

WATER PUMP, Item No. 28.11.00 (Con't.)

- .04.2 A matching, mounted spare wheel shall be furnished for each unit.
- .04.3 Tow pole shall be equipped with suitable, folding pole support device.
- .04.4 Brakes not required.
- .04.5 Lights not required.
- .04.6 Reflectors shall be provided, amber front and sides, red at each rear corner.
- .04.7 A heavy duty, cartridge insert grease gun shall be furnished for each unit.
- .04.8 An Operator's Manual, Repair Manual and Parts List shall be furnished.
- .04.9 Safety breakaway chains shall be provided.

28.11.05. COLOR

- .05.1 Entire unit shall be painted Highway H-V Yellow.

28.11.06. HOSE STORAGE

- .06.1 Means shall be provided to carry the suction and discharge hose aboard the trailer in transit.

ITEM NO. 28.11.00
DETAILED BID QUESTIONNAIRE

WATER PUMPS

Bidder's name and address: _____

_____ Tel. No. _____

Make _____ Model _____ Year _____

Approximate working weigh, less hoses _____ Kgs.

Price quoted for subject equipment as described in the Bid Specifications shall include handling, overseas packaging, transportation and all delivery expenses FOB Rumbek, Lakes Province, Sudan,, Africa via the Port of Mombasa, Kenya.

Price, each unit \$ _____ Total price, three (3) units:
\$ _____.

Note any deviations from Bid Specifications: _____

Bid may be rejected unless all items listed in Bid Questionnaire are answered. Purchaser reserves the right to reject any and all Bids, and to award the contract in the best interest of all concerned in the final analysis.

1. WATER PUMP

Make _____ Model _____ Size _____ Type _____
Rated LPM _____ Head _____ Self-priming? _____
Adjustable speed control? _____ Mechanical greaseable seals?
_____ Designed for contaminated water pumping? _____

2. ENGINE

Make _____ Model _____ Type _____ Cooling _____
Rated KW _____ Starting System _____ Fuel Cap. _____ liters

3. HOSE

Suction line length & diameter _____ Type _____
Discharge line overall length & diameter _____
No. discharge hose lengths provided _____ All hoses
provided equipped w/quick-couplers? _____

BID QUESTIONNAIRE, Item No. 28.11.00 (Con't.)

4. TRAILER

Rated capacity _____ Kgs. Tire size _____ Ply _____

Mounted, matching spare wheel & tire for each unit? _____

Describe frame construction: _____

Designed for towing at highway speeds? _____

Describe tow pole & hitch: _____

Folding tow pole support provided? _____ Operator's

Manual, Repair Manual & Parts List furnished? _____

Describe grease gun furnished w/each unit: _____

Safety break-away chains furnished? _____ Means provided

for storage of hoses in transit? _____

Color _____

Name and title of person authorized to sign the Bid:

_____ Title _____ Date _____
Signature

Note appropriate comments: _____

ITEM NO. 28.12.00
WATER PUMP

SPARE PARTS LIST

Bidder shall supply the following listed items for subject equipment, and be responsible for overseas packaging including all preparation, handling, transportation and delivery expense, FOB Rumbek.

Shipment of the items listed shall accompany delivery of the trailerized pumps.

All items shall be of premium quality; replacement parts shall be identical in every respect to the parts furnished in the original assembly of the unit.

Item	Quantity	Description	Total Price
1	2	Water pump rebuilding kit	\$ _____
2	3	Starting rope Ass'y.	_____
3	2	Wheel hub w/seals	_____
4	2	Sets wheel bearings	_____
5	24	Oil filter elements	_____
6	24	Fuel filter elements	_____
7	2	Spare wheels less tires	_____
8	2	Spare tires, dismounted	_____
9	1	Pair springs	_____
Total cost -----			\$ _____

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.12.00

FUEL TRAILER

SPECIFICATIONS

It is the purpose and intent of these Specifications to describe a trailerized refueling tanker, capacity approximately 950 liters (250 Gals.) and designed for towing over unpaved roads having a rough surface.

Suspension system must be designed to absorb high impact road shocks.

28.12.01. TANK SECTION

- .01.1 Tank shall be fabricated of 10 gauge steel plate.
- .01.2 Surge baffles shall be installed.
- .01.3 An air vent shall be provided.
- .01.4 Lockable filler cap shall be provided.
- .01.5 Tank shall be secured to the trailer frame, using a 3/4" oak insulator between the tank and frame, and bolted for easy removal/installation.
- .01.6 Tank shall be reinforced as required.

28.12.02. FUEL TRANSFER PUMP

- .02.1 Manual, crank type fuel pump, top-mounted, lockable, F-156 Fill-Rate or approved equal.
- .02.2 Crank shall deliver Approx. 40 to 60 liter/minute (10 to 15 GPM) at six revolutions.
- .02.3 Fuel suction pipe shall be 25 mm. (1 in) diameter, and of sufficient length to clear the bottom of the tank by Approx. 3 mm (1/8 in).
- .02.4 Drain plug shall be spot welded to prevent pilferage.
- .02.5 Fuel hose shall be 5 m. (16.5 ft) in length, minimum, and equipped with nozzle.
- .02.6 Nozzle shall be provided with device designed to hold it securely in shielded and protected location while in transit.
- .02.7 Flowmeter on discharge side shall be non-resettable accumulator w/maximum readout of 100,000 liters.
- .02.8 A resettable meter shall be provided for recording actual fuel dispensation, with a maximum readout of 1000 liters before resetting.

28.12.03. TRAILER SECTION

- .03.1 Single axle, brakes not required, rated capacity 2000 lbs. Min.
- .03.2 High speed, truck-type wheel spindles & bearings.
- .03.3 Michelin 7.00-15 TBLS-6-D single tires, or approved equal.
- .03.4 Truck-type disc wheels.
- .03.5 Mounted, matching spare tire for each unit.

SPECIFICATIONS, Item No. 28.12.00, (Con't.)

- .03.6 Heavy duty frame w/spring & shock absorber suspension.
- .03.7 Heavy duty tow pole, 1.8 m. (6 ft.) long w/lunette eye hitch, safety break-away chains and folding, adjustable-height tow pole support.

28.12.04. COLOR Highway H-V Yellow. (Lights not required).

ITEM NO. 28.12.00
FUEL TRAILERS

DETAILED BID QUESTIONNAIRE

Bidder's name and business address: _____
_____ Tel. _____

Make _____ Model _____ Year _____ Cap. _____ liters

Prices quoted for subject equipment as described in the Bid Specifications shall include assembly, handling, overseas packaging, transportation and delivery expense FOB Rumbek, Lakes Province, Sudan, Africa via the Port of Mombasa, Kenya.

Price, each unit \$ _____ Total, three (3) units \$ _____

Note any deviations from Bid Specifications: _____

Bid may be rejected unless all items listed in Bid Questionnaire are answered.

Purchaser reserves the right to reject any and all Bids, and to award the contract in the best interest of all concerned in the final analysis.

1. TANK SECTION

Capacity _____ liters Steel thickness _____ guage

Type & number of surge baffles: _____

Type air vent: _____ Lockable filler cap? _____

Describe tank reinforcement: _____

Describe type insulator & attachment to the trailer frame: _____

2. FUEL TRANSFER PUMP

Make _____ Type _____ Rated GPM _____

Fuel suction pipe length X diameter _____

Drain plug spot welded? _____ Describe fuel discharge hose and nozzle assembly: _____

Describe the nozzle holding device: _____

Describe accumulator & delivery meters: _____

BID QUESTIONNAIRE, Item No. 28.12.00 (Con't.)

3. TRAILER SECTION

Make & type axle: _____
Rated axle capacity _____ Kgs. Truck-type spindles, bearings and
wheels? _____
Make, type & size tires: _____
Describe trailer frame assembly: _____
Describe tank-to-frame mounting method: _____
Mounted, matching spare wheel and tire furnished for each unit? _____
Describe tow pole & hitch: _____
Safety chains furnished? _____
Describe tow pole support: _____
Suspension system rated capacity _____ Kgs.
HD shock absorbers double-acting type? _____

4. COLOR

Describe color: _____
Approximate shipping weight _____ Kgs.

Signature of person authorized to sign the Bid:

_____, Title _____, Date _____

Note appropriate comments: _____

ITEM NO. 28.12.00
FUEL TRAILERS

SPARE PARTS LIST

Bidder shall supply the following listed items for subject equipment, and be responsible for overseas packaging including all preparation, handling, transportation and delivery expense FOB Rumbek.

Shipment of items listed shall accompany delivery of the fuel trailers.

All items shall be of premium quality; replacement parts shall be identical in every respect to the parts furnished in the original assembly of the units.

Item No.	Quantity	Description	Total Price
1	1	Complete pump assembly.	\$ _____
2	1	Complete hose & nozzle assembly.	_____
3	2	Wheel hubs w/seals.	_____
4	2	Sets wheel bearings & seals.	_____
5	24	Fuel filters (if used).	_____
6	2	Spare wheels less tires.	_____
7	2	Spare tires, dismounted.	_____
8	1	Pair springs.	_____
9	1	Pair shock absorbers.	_____
		Total cost -----	\$ _____

Signature of person authorized to sign the Bid:

_____ Title _____ Date _____

Note appropriate comments: _____

ITEM NO. 28.13.00
SUPPORT STANDS

SPECIFICATIONS

It is the purpose and intent of these Specifications to describe in general terms a set of four (4) stands, so-called, to support the following demountable equipment when not in use:

- (a) Four (4) 7600 liter (2000 Gals.) water tanks, Max. Wgt. estimate 1,350 Kg. (3000 lbs.) and 2.4 m long X 2 m. wide X 1.6 m. high.
- (b) Three (3) hopper bodies, Max. Wgt. Approximately 1,350 Kg. (3000 Lbs.) 3 m³ (4 yd³) Cap. rating; size approximately 2.4 m. long X 1.2 m. wide X 1.8 m. high (8' X 4' X 6').
- (c) One (1) hopper body, Max. Wgt. Approximately 2250 Kg. (5000 Lbs.) 9 m³ (12 yd³) capacity; 4.5 m. long X 1.8 m. wide X 2.0 m. high.

Three stands will support two (2) water tanks or two (2) three cubic meter hopper bodies. One stand will support the four cubic meter hopper body.

The stands shall be fabricated of suitable steel sections, bolted construction w/suitable post pads to provide adequate support on unpaved surfaces.

The stands shall permit storage of two (2) of the above-listed demountable pieces of equipment, in tandem arrangement, with adequate space between supporting members to allow backing dump trucks, implement trailers and lowbed trailer under same; the suggested distance between supporting posts is 2.7 m. (9 ft) minimum.

The demountable equipment shall be lifted, lowered and held in suspension by two (2) manual chain hoists rated at 900 Kg. (2000 lbs.) Cap., each.

The stands shall be painted Highway High Visibility Yellow.

One (1) pair of extra chain hoists shall be furnished.

COST ESTIMATE
ROAD MAINTENANCE HAND TOOLS

ROAD CAMP TOOLS	Quantity/ Crew	Project Total	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Dobbin Borrow	2	90	300.00	27,000.00
Water Drum	2	90	6.00	540.00
Shovel, Round Point	6	270	14.00	3,780.00
Shovel, Square Point	6	270	17.00	4,590.00
Rake, Garden	6	270	9.00	2,430.00
Slasher	6	270	10.00	2,700.00
Pick	3	135	26.00	3,510.00
Pry Bar	3	135	21.00	2,835.00
Hammer, Sledge 4lbs.	3	135	17.00	2,295.00
Chisel, Masonry	3	135	6.00	810.00
Broom, Long Bristle, Push	6	270	11.00	2,970.00
Tamper, hand	2	90	13.00	1,170.00
Toria or Mattock	2	90	25.00	2,250.00
Bucket, Water, 9.5 liter	2	90	8.00	720.00
Axe, Bush	2	90	21.00	1,890.00
Rope, 10 meter	1	45	5.00	225.00
Stone, Sharpening	2	90	4.00	360.00
Crown Board, w/level	1	45	20.00	900.00
Can, Watering, 9.5 liter	2	90	6.00	540.00
Subtotal				61,515.00
<u>BRIDGE CREW TOOLS</u>				
Pick	4	12	6.00	72.00
Shovels, Round Point	3	9	14.00	126.00
Shovels, Square Point	3	9	12.00	108.00
Water Drum, 200 liter	2	6	6.00	36.00
Water Bucket	2	6	8.00	48.00
Chisel, Masonry	2	6	6.00	36.00
Hammer, Masonry	2	6	15.00	90.00
Trowel, Concrete Finishing	3	9	11.00	99.00
Trowel, Painting	2	6	7.00	42.00
Hoe, Concrete Mixing	2	6	24.00	144.00

COST ESTIMATE
ROAD MAINTENANCE HAND TOOLS
(Continued)

BRIDGE CREW TOOLS (Cont.)	Quantity Crew	Project Total	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Wheel Barrow .15m ³ (5 Ft ³)	2	6	75.00	450.00
Level - 1 meter (3 Ft)	2	6	20.00	120.00
Tamper, Hand	3	9	13.00	117.00
Aprons, Nail	3	9	13.00	117.00
Hammer, Claw	3	9	15.00	135.00
Subtotal				1,740.00
TOTAL				\$63,255.00 =====

PROPOSED WORKSHOP TOOLS AND EQUIPMENT

General Shop

			<u>FOB U.S.\$</u>	
Item No.	<u>Quantity</u>	<u>Description</u>	<u>Unit Price</u>	<u>Total Price</u>
1	1	Wrench, giant adjustable, 24"	93.55	93.55
2	1	Wrench, giant adjustable, 36"	449.00	449.00
3	1	Air hammer	46.95	46.95
4	1	Tester, voltage/amperes, portable	152.80	152.80
5	1	Pressure blow gun	5.65	5.65
6	1	Tester, compression, gas and diesel	21.00	21.00
7	1	Tester, fuel injection	115.20	115.20
8	1	Spark plug cleaner	396.00	396.00
9	1	Glaze breaker, engine cylinder	14.45	14.45
0	1	Ring groove cleaner, engine	24.10	24.10
1	1	Ring compressors	14.50	14.50
2	1	Ring spreader	17.75	17.75
3	1	Grinder, valve seat	5.95	5.95
4	1	Reamer, ridge, cylinder	5.30	5.30
5	1	Valve resurfacers	25.95	25.95
6	1	Hone, engine cylinder	2561.00	2561.00
7	1	Tester, battery, 600 amp. capacity	191.05	191.05
8	1	Charger, battery, constant current	160.00	160.00
9	3	Flashlight	515.95	515.95
0	1	Carrier, battery	4.75	14.25
1	4	Filler bulb, battery	14.35	14.35
2	4	Filler, battery	8.75	35.00
3	3	Apron, acid proof, each mechanic	8.75	35.00
4	3	Pair, acid proof gloves, each mechanic	9.00	27.00
5	1	Balancer, wheel, static	1.92	5.76
6	1	Wheel alignment set HD	849.00	849.00
7	1	Tire demounter, air operated, HD	1540.20	1540.00
8	2	Tire inflator w/guage	5000.00	5000.00
9	1	Vulcanizer	25.20	50.40
0	1	Welding set, electric, portable	600.00	600.00
1	1	Welding set, oxy-acetylene, portable	439.98	439.98
2	1	Set, body & fender tools	246.93	246.93
3	1	Set, blacksmithing tools	335.60	335.60
4	1	Set, body repair jack, hydraulic	400.00	400.00
5	1	Forge, coal fired	769.85	769.85
6	1	Anvil, 140-150 lbs.	800.00	800.00
7	1	Tube bending set	240.00	240.00
8	1	Metal snips (shear set)	6.40	6.40
9	1	Grinder, disc type, electric, portable	38.35	38.35
0	1	Grinder, bench type, electric	215.49	215.49
1	1	Sander, electric, portable	313.30	313.30
2	1	Drill, electric 1/2", w/2 sets drill bits	88.32	88.32
3	1	Drill, electric, 3/4" w/2 sets drill bits	235.00	235.00
4	1	Bolt cutter, HD	702.00	702.00
			69.20	69.20

I. General Shop (Cont.)

Item No.	Quantity	Description	FOB U.S.\$	
			Unit Price	Total Price
45	3	Blow torch	248.95	746.85
46	3	Soldering gun, electric, HD	79.30	237.90
47	1	Punch & chisel set	137.00	137.00
48	1	Extractor, screw/bolt/stud, set	11.75	11.75
49	1	Set, C-clamps, steel, deep-throat	108.00	108.00
50	1	Set, pipe & adjustable wrenches	120.30	120.30
51	1	Set, paint spray gun, 1 Qt. capacity	154.80	154.80
52	1	Set, tap & die, Eng. & Metric	157.25	157.25
53	1	Set, micrometers, 1-6", outside	251.95	251.95
54	1	Micrometer, 1½-6", inside	66.99	66.99
55	1	Caliper, 0-6" Eng. and Metric	32.99	32.99
56	2	Set, master feeler guage	4.50	9.00
57	1	Set, carpenter tools	224.67	224.67
58	1	Engraver, electric, vibrating	24.40	24.40
59	1	Set, steel stamping, letters & numbers	34.70	34.70
60	6	Air hose w/quick coupler ends, 3/8" X 35'	57.35	344.10
61	1	Set, combination center drill & countersink, 1/8", 3/16", 1/2", 5/16" and 7/16"	45.00	45.00
62	2	Vise, bench type, 6"	182.50	365.00
63	1	Vise, drill press	34.99	34.99
64	1	Vise, blacksmith	40.00	40.00
65	1	Vise, combination pipe and bench	165.10	165.10
66	1	Vise, tool room	24.99	24.99
67	1	Vise, bench, chain type	36.99	36.99
68	1	Vise, woodworking, 12" capacity	69.99	69.99
69	1	Sling, engine lift	172.50	172.50
70	1	Stand, engine/transmission, repair, portable	2720.00	2720.00
71	6	6' X 4' shields, welding/painting, portable	63.30	379.80
72	4 pr.	Stand, safety	96.00	384.00
73	2	Jack, hydraulic, floor, 5 T	626.25	1252.50
74	2	Jack, hydraulic, floor, 10 T	848.40	1696.80
75	2	Jack, hydraulic, floor, 20 T	982.95	1965.90
76	1	Dolly, dual wheel	710.00	710.00
77	1	Hoist, ratchet, hand, 3 T	282.50	282.50
78	1	Hoist, ratchet, hand, 1½ T	146.00	146.00
79	4	Grease gun, hand	10.10	40.40
80	2	Pump, oil recovery, suction type	8.50	17.00
81	2	Pump, rotary, hand	67.99	135.98
82	3	Set, oil filler measure	20.00	60.00
83	4	Set, funnel	12.00	48.00
84	3	Fuel can w/nozzle, 5 gallon	14.40	43.20
85	3	Fuel can w/nozzle, 2.5 gallon	11.20	33.60
86	2	Helmet, welding (arc)	25.25	50.50
87	4	Goggles, welding oxy-acetylene	6.55	26.20
88	8	Face shield, general purpose	4.15	33.20
89	3	Set, general shop tools: creeper; trouble light; hammer; crowbar; wrecking bar; tape and steel rules, Eng. & Metric; pipe taps; cutter; reamers	235.00	705.00
90	1	Kit, tire patching, all sizes	25.00	25.00

I. General Shop (Cont.)

Item No.	Quantity	Description	FOB U.S. \$	
			Unit Price	Total Price
91	2	Sledge hammers, 8 lbs.	28.80	57.60
92	2	Sledge hammers, 10 lbs.	33.75	67.50
93	8	Kit, first aid	42.46	339.68
94	12	Fire extinguisher, dry powder	32.97	395.64
95	2	Set hex key wrenches, Eng. & Metric	12.35	24.70
96	2	Drop cord	36.25	72.50
97	2	Gloves, welding (arc)	13.75	27.50
98	2	Floor mops, pail, wringer	112.97	225.94
99	1	½" Impact wrench, heavy equipment	154.95	154.95
00	2	Step ladder, wood, 6', HD	63.95	127.90
01	3	Sweeper broom long handle, 18-24" wide	8.00	24.00
02	1	Brake fluid pump	25.00	25.00
03	1	Brake bleeder tank	209.15	209.15
04	1	Bearing packer	99.50	99.50
05	3	Mechanic's seat	30.50	91.50
06	2	Oil drain pans, set	12.00	24.00
07	1	Transmission/differential floor jack	1325.00	1325.00
08	1	Air chisel	32.60	32.60
09	8	Waste cans	70.25	562.00
10	1	Safety cage, tire inflation	209.00	209.00
11	1	Oil seal driver set	444.00	444.00
12	1	Set, bearing/gear puller	250.35	250.35
13	1	Set, riveting tools	33.45	33.45
14	1	Set, pilot bearing tools	50.00	50.00
15	1	Set, axle nut sockets, 6 & 8 point, 2-3/32" - 4 7/8"	510.00	510.00
16	1	Steam cleaner outfit	1759.00	1759.00
17	1	Headlight aimer/tester	215.40	215.40
18	1	Tester, radiator pressure	83.10	83.10
19	1	Tester, hydraulic flow/pressure/temperature	1102.30	1102.30
20	3	Mechanic's tool cabinet/work bench, rollaway	455.75	1367.25
21	2	Mechanic's workstands	421.80	843.60
22	1	Hydraulic floor press, 5 T	670.85	670.85
23	1	Drill press, floor, HD, drills to 1" diameter	749.80	749.80
24	1	A-frame hoist w/dual chain falls, manual	1192.38	1192.38
25	1	Gauge, brake drum	22.20	22.20
26	1	Power hack saw, floor type, semi-portable	1514.97	1514.97
27	1	Small parts recirculating wash tank	624.00	624.00

II. Stockroom

Item No.	Quantity	Description	FOB U.S.\$	
			Unit Price	Total Price
1-S	100	Bin, spare parts storage	5.00	500.00
2-S	15	File, Cardex type, stock record card	20.00	300.00
3-S	3	Bins, rotary, hardware storage	825.00	2475.00
4-S	1000 L.F.	12" metal storage shelves & support hardware	2.50	2500.00
5-S	1000	Bin tags, identification/transactions	.01	10.00

III. Office

1-0	3	Typewriters, 13" carriage	200.00	600.00
2-0	6	Chairs	70.00	420.00
3-0	3	Calculator, electronic, rechargeable	100.00	300.00
4-0	4	Desk lights	35.00	140.00
5-0	2	Embossing machine w/extra tapes	18.00	36.00
6-0	3	File cabinets, steel, lockable, w/folders	220.00	660.00
7-0	3	Desks, metal, lockable drawers	230.00	690.00

IV. Mechanics Hand Tools

1-M	3	Tool set, general purpose	511.23	1533.69
2-M	3	Wrench, torque, 3/4" Square drive	224.05	672.15
3-M	3	Tools, socket set 3/4" drive	423.90	1271.70
4-M	3	Wrench, oil filter	5.45	16.35
5-M	3	Timing light, ignition	104.90	314.70
6-M	3	Ignition wrench set	33.75	101.25
7-M	3	Spark plug guage set	4.40	13.20
8-M	3	Hydrometer/battery	7.50	22.50
9-M	3	Pliers, battery cable terminal	7.00	21.00
10-M	3	Brush, battery terminal	4.35	13.05
11-M	3	Set, jumper cable	31.45	94.35
12-M	3	Brake-spring pliers	23.80	71.40
13-M	3	Tire pressure guage	3.60	10.80
14-M	3	Tire tread guage	2.30	6.90
15-M	3	Tire tool set	75.05	225.15
16-M	3	Wheel lug wrench, 4-way, HD	35.40	106.20
17-M	3	Hacksaw frame, handle, w/blades	26.65	79.95
18-M	3	Set, screwdrivers, square & Phillips	47.85	143.55
19-M	3	Pliers, snap ring	18.40	55.20
20-M	3	Remover, valve core	1.85	5.55
21-M	3	Carrier battery	5.80	17.40
22-M	3	Set, deep sockets, spark plug	30.00	90.00
23-M	3	Tester, electric light wiring system (circuit tester)	4.50	14.50
24-M	3	Set, metric socket 1/2" drive	96.05	288.15
25-M	3	Set, metric socket, 3/4" drive	26.30	78.90
26-M	3	Set, feeler guage	5.00	15.00
27-M	3	Set, metric wrenches, 6mm-19mm, combination	100.65	301.95
28-M	3	Set, pliers	34.25	102.75

Field Service Truck Tools

Item No.	Quantity	Description	FOB U.S.\$	
			Unit Price	Total Price
1-FS	1	Oxy-acetylene cutting/brazing/welding outfit	306.98	306.98
2-FS	1	Portable, gasoline powered welding outfit	966.03	966.03
3-FS	1	3/4" drive socket set, Standard & Metric	468.45	468.45
4-FS	1	1/2" drive HD torque wrench w/English & Metric read-out. Sears DIGITORK or approved equal.	59.99	59.99
5-FS	1	HD come-along, 2-ton Cap. Min., Porto-Power or approved equal	390.80	390.80
6-FS	1	12 piece mechanic's HD screw driver set, including Phillips head	52.84	52.84
7-FS	1	Tap & die set, standard and metric. Set includes 41 piece English and 36-piece Metric. Sears part numbers 9H5201 and 9H52102, or approved equal	114.98	114.98
8-FS	1	Set pliers including diagonal-cut, slip-joint, arc-joint and ignition system pliers	28.94	28.94
9-FS	1	5-ton hydraulic jack	31.60	31.60
10-FS	1	10-ton hydraulic jack	48.00	48.00
11-FS	1	Chain hoist, 2000 lbs. Cap.	199.50	199.50
12-FS	1	HD bolt cutter	69.20	69.20
13-FS	1	HD, cartridge-type manual grease gun	10.10	10.10
14-FS	3	HD, 5-gallon Cap. fuel cans w/discharge spout	14.40	43.20
15-FS	1	HD punch & chisel set	119.60	119.60
16-FS	1	Set, deep-throat welding C-clamps	113.63	113.63
17-FS	1	6-inch HD vise	182.50	182.50
18-FS	1	Oil recovery suction pump	8.50	8.50
19-FS	1	10-gallon Cap. oil drain pan	8.00	8.00
20-FS	1	2-Qts. oil filler can	10.00	10.00
21-FS	1	Set sledge hammers (4 & 8#)	47.60	47.60
22-FS	1	Brake bleeder kit	25.00	25.00
23-FS	1	Electric tester	4.50	4.50
24-FS	1	Hydraulic system portable tester. (GPM flow rate/oil temperature/oil pressure).	1102.30	1102.30
25-FS	1	Oil filter wrench	5.45	5.45
26-FS	1	Ignition timing light	104.90	104.90
27-FS	1	Battery hydrometer tester	7.50	7.50
28-FS	1	HD, 4-way wheel lug wrench	35.40	35.40
29-FS	1	Set larger tire removal tools	58.85	58.85
30-FS	1	Tire patching/field vulcanizing kit	30.00	30.00
31-FS	1	HD battery strap	5.80	5.80
32-FS	1	HD tire pressure guage	3.60	3.60
33-FS	1	Tire tread depth guage	2.30	2.30
34-FS	1	10-Qts. pail w/cleaning brush	12.00	12.00
35-FS	1	Set HD, 12-foot battery jumper cables	31.45	31.45
36-FS	1	Battery cable terminal pliers	7.00	7.00
37-FS	1	Spark plug guage set	4.40	4.40
38-FS	1	Set mechanic's hammers	65.20	65.20
39-FS	1	Brake-spring pliers	23.80	23.80
40-FS	1	Set oil seal removal/installation tools	622.05	622.05
41-FS	1	Set bearing pullers	401.20	401.20
42-FS	1	Set deep-sockets, spark plug, English & Metric	30.00	30.00
43-FS	1	Engine-driven air compressor	600.00	600.00
TOTAL				\$68,569.86

OTHER SHOP EQUIPMENT

The following items have been removed from the original list of proposed workshop equipment contained in Table H-7 from the report by USAID. It was felt that these items should be included under the architectural recommendations for the design of the workshop.

- extractor fans: Table H-7 calls for 12 - 18" diameter fans. The size and number of fans should be determined from the volume of the proposed workshop.
- stationary lube unit: A centralized, pneumatic delivery type, reeled and wall mounted should be considered.
- shop compressor: Table H-7 calls for 60 CFM capacity. The following air powered tools are on the proposed list: 20 ton truck service jack, tire changer, air hammer, impact wrench, and pressure blow gun. The air hammer and impact wrench use 4 CFM each. The tire changer requires 140-150 psi and the jack 90-180 psi. The compressor should have 120 gallon capacity min. tank with 200 psi working pressure and safety guards if belt drive. A DeVilbiss 175 psi, two stage horizontal air compressor, 20 HP, with 75 CFM delivery was priced at \$8,164.00.
- generator: The Caterpillar 3304 naturally aspirated diesel generator was priced at \$18,770.00.
- 38,000 liter fuel storage tanks: The following should be determined: metal or fiberglass; underground or above ground; venting system; location and size of filler caps, which should be a lockable type; antirust coating, if underground; color and type support system, if above ground; size and location of pump island including pump mounting base diagram, and the make/model pump(s) to assure they will match the pre-cast island base mounting system.
- gasoline pump: The following should be determined: make and model or approved equal; pump delivery capacity; length hose; type nozzle; filtration system and water trap; color, etc. Pumps should be lockable and meet general safety standards.
- diesel pump: Same as above. A spare hose complete with nozzle should be provided along with quantity of filter elements.

Not in Table H-7, but required for the workshop:

- portable ramps: These ramps should support a dump truck, which are specified at 27,500 lbs. GVW in the vehicle specifications (empty weight approximately 15,000 lbs). The ramps should be custom built as they are not readily available in this capacity range. Units should be fabricated on site or if fabricated elsewhere, shipped dismantled with bolts and hardware for assembly.

TOOL DESCRIPTIONS

<u>Item No.</u>	<u>Description</u>
1	Wrench, giant adjustable, 24" Screw type, fully adjustable, 2½" capacity.
2	Wrench, giant adjustable, 36" 1/8" increments of jaw adjustment from 2-3/4" to 4-1/2"
3	Air hammer HD, pistol grip, .401" chisel shank opening, 2500-3000 blows per minute, 1/4" air inlet thread size w/nipple for adapting to Milton or standard industrial style couplers.
4	Tester, voltage/amperes, portable Portable which checks amps, tach, dwell, voltage and resistance. Power supply thru batteries, must perform the following tests: (a) tach checks; (b) diode efficiency; (c) DC voltage; (d) continuity; (e) dwell check; (f) standard ignition circuit; (g) electronic ignition circuit; (h) cranking circuit; (i) plug wire resistance
5	Pressure blow gun Rubber tipped, lever-type, up to 150 psi inlet pressure, 1/4" pipe thread w/nipple for adapting to Milton or standard industrial style couplers.
6	Tester, compression, gas & diesel Gasoline engine compression tester w/flex hose, screw in adaptors to fit 14mm, 18mm, and 5/8", 0-300 psi (0-21 kg. per sq. cm.) Diesel engine compression tester 0-1000 psi capacity
7	Tester, fuel injection Tests for leakage, "pop-off" pressure, spray pattern, and "chatter" on a wide variety of diesel fuel injectors for automotive, construction equipment and farm diesel engines. 5,000 psi capacity.
8	Spark plug cleaner Fit all sizes of plugs, air operated, sand blast type.
9	Deglazer, engine cyclinder 2" to 7" capacity with medium stones. Fit standard 1/2" chuck electric drill. Replacement stones.
10	Ring groove cleaner, engine Piston range 2-3/4" to 5" diameter, cutter blade sizes 5/64", 3/32", 1/8", 5/32" and 3/16".
11	Piston ring compressors For cars, light and heavy trucks, tractors, diesels. 2-1/2" - 7" capacity, 2 units.
12	Ring spreader (installer) Jaws handle rings from 3/64" to 1/4".

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
13	Grinder, valve seat Dual cup valve grinder w/cup diameters of 1-1/8" and 1-3/8" and a replacement cup for each size.
14	Reamer, ridge cylinder Heavy duty, for 2-11/16" to 5-5/16" bores
15	Valve resurfacer (refacer) Bench model, HD, two electric motors for driving valve collet and grinding wheel independently, w/valve stem and rocker arm grinding attachment, grinding stone and oil and collets for sizes 9/32" - 3/4". Similar to Black and Decker catalogue No. 6305.
16	Hone, engine cylinder Attaches to 1/2" drill, 3" to 6-1/2" capacity w/rough, medium and fine stone sets and counter balance spring.
17	Tester, battery, 600 amp capacity 6/12/24 volts
18	Charger, battery, constant current For 6, 12 and 24 volt batteries, adaptable to 220V - 50 Hz input
19	Flashlight HD, hold 2 D-cell batteries
20	Carrier, battery Side gripping type with cross member notched to prevent slipping.
21	Filler bulb, battery Rubber bulb with min. capacity 6 oz.
22	Filler, battery Equipped with valve to prevent overfilling.
23	Apron, acid proof, each mechanic Medium weight rubber coated cotton, bib style apron.
24	Pair, gloves, acid proof, each mechanic PVC coating over jersey liner, knit wrist.
25	Balancer, wheel, static, truck Handle wheel diameters up to 24", widths to 15". Set of truck wheel weights.
26	Wheel alignment set, heavy duty Set should consist of the following: set of 2 HD ramp style truck turntables, camber/caster/steering axis inclination gauge for wheels 15" to 24", toe gage for tread widths up to 96", and a steering wheel holder.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
27	Tire demounter, air operated, HD Change truck tires, wheel widths 6.0" to 15", diameters 16.5" to 24".
28	Tire inflator w/guage Dual foot chuck, calibrated to 100 psi, 1/4" female thread w/male nipple for Milton or standard industrial style couplers.
29	Vulcanizer Handle up to 13.00 X 24 tubes.
30	Welder, Electric, AC/DC, adaptable to 220V - 50 Hz 50 - 200 Amp ranges on AC and DC, 1/4" diameter electrode capacity, 10' work cable w/work clamp, 12' electrode cable w/electrode holder. Assortment of 1/8" electrodes for all welding positions, 10 lbs contact type and 10 lbs. general type. Similar to Craftsman 250-amp AC-DC Arc Welder.
31	Welder, oxy-acetylene Two pairs of standard tanks, tank truck, 50 ft. 1/4" siamese hose with connections, couplings, and two-stage, brass oxygen and acetylene regulators for automatic adjustment as cylinder pressure drops. Minimum 2" diameter guages, white-and-black.
32	Set, body fender tools With cross chisel, short pick, round point finish, shrinking, and utility pick hammers, dollies, spoons, slidehammer set, standard files, suction disc, and pull rods.
33	Set, blacksmithing tools One 24 oz. cross or straight pein hammer. One 32 oz. ball pein hammer, heat treated, machined face and pein, hickory handles. One 4 lb. hand sledge hammer, double faced, drop-forged, tempered steel head, hickory handle. Two wire hand scratch brushes. One vernier calipers (see Item No. 55). 12" machinists rule w/sliding measurement indicator, stainless steel, graduations in 32nds and 1mm. Two pair flat-jawed tongs. The following fire tools: rake, poker, and shovel. The following anvil tools: hardie, top & bottom fullers, swage, flatter, mandril, heading tool, saddle, cupping tool, drifts, twisting wrench, and punch set.
34	Set, body repair jack, hydraulic 4-ton capacity with extensions and other basic parts for pushing, pulling, and horizontal or vertical spreading. Set should include extensions, flat head, ram toe, rubber head, concave head, plunger toe, 2-clamp hooks, 2-5' chains, 2-pull clamps, chain pull collar, and wedge ram. Similar to Blackhawk Porto-Power Set 65004.
35	Forge Coal burning w/electric blower. Similar to Champion 400.
36	Anvil, 140-150 lbs. Cast alloy, face 15-3/4m x 4 in., 7/8 in. hardie hole, 9/16 in. pritchel hole, 10-1/4 in. long horn.

TOOL DESCRIPTIONS (CONT.)

Item No.	Description
37	Tube bending set Six pieces for 1/4 to 5/8 inch outside diameters. Tempered spring coils.
38	Metal snips (shear set) Straight cut, offset left and right cut (3 units).
39	Grinder, 7" HD, disc type, electric, portable with grinding guard, adaptable to 220V - 50 Hz. Five flat, reinforced, 7" X 1/4", aluminum oxide grinding discs-for fine grinding.
40	Grinder, Bench type Electric, double shielded, equipped with heavy chip brakes, with one 60 and one 40 grit grinding wheel - precision balanced AC motor 1 HP single phase, adaptable to 220V - 50 Hz, wheel diameter 10 or 12 inches. Also 1 wire brush wheel, and 2 each, extra 40 and 60 grit grinding wheels- 1" X 10" or 12".
41	Sander, electric, portable Orbital, adaptable to 220V - 50 Hz. One dozen each, medium and coarse sanding sheets - 3-2/3" X 9".
42	Drill, electric, 1/2" with two sets drill bits and chuck keys. HD, reversible, pistol grip, adaptable to 220V - 50 Hz. Two sets of 15 high speed drill bits from 1/16" to 1/2" in 32nd sizes for 1/2" chucks with metal indexed container.
43	Drill, electric, 3/4" with two sets drill bits and chuck keys HD, Spade handle with removable top handle, adaptable to 220V - 50 Hz. Two sets of 5 high speed drill bits from 7/16" to 3/4" with case.
44	Bolt cutter, HD 36", 5/8" capacity, with replacement jaws. Jaws should be high-carbon alloy tool steel.
45	Blow torch. HD with brass forged torch handle, tip mixer, reverse flow check valves, brass forged cutting attachment, welding tips numbers 1,3,5,7 for welding plates up to 5/16" thickness, cutting tips numbers 1, 3, and 5 for cutting steel up to 6" thick, #2 heating tip, round file welder's lighter, welding tip cleaner, wrench, instruction manual and parts list in a metal case.
46	Soldering gun, electric, HD, adaptable to 220V - 50 Hz, dual heat, trigger control, 150-175 watt range. Three pounds of 50/50 tin-lead, solid wire solder, 1/8", and one pound of 40/60 tin-lead, resin core solder, 3/32".

TOOL DESCRIPTIONS (CONT.)

Item No.	<u>Description</u>
47	Punch and chisel set Includes 6 pin punches 3/32" - 5/16", 5 cold chisels 5/16" - 5/8", 6 starter punches 3/32" - 5/16", 3/8" and 1/2" center punches, counter-sink punch, and 2 heavy duty chisels 3/4" and 1".
48	Extractor set, screw/bolt/stud Spiral flute extractors sizes #1 - 6.
49	Set, C-clamps, steel, deep throat 4 sizes up to 8" capacity
50	Set, pipe and adjustable wrenches 6", 10", and 15" adjustable wrenches and 8", 12" and 18" pipe wrenches
51	Set, paint spray gun, 1 Qt. capacity Spray gun, siphon cup and attachment, pneumatic with 1/4" MPT air inlet and 25' of 3/8" hose (1/4" female fittings or male fittings with adaptors) and a male nipple for a Milton or standard industrial style coupler.
52	Set, tap and die, Eng. and Metric With 8 NC hexagon dies 1/4" - 3/4", 8 NF hexagon dies 1/4" - 3/4", metric hexagon dies 6 X 1.00, 7 X 1.00, 8 X 1.25, 9 X 1.25, 10 X 1.50, 11 X 1.50, and 12 X 1.75 and matching NC, NF and metric plug style taps. Cased in HD carrying/storage box.
53	Micrometers, outside 1" to 6" in 5 parts (0.001" readings)
54	Micrometer, inside 1-1/2" to 6" (0.001")
55	Calipers, Vernier, Eng./Metric to 6" for inside, outside and depth measurements, stainless steel with chrome plated scales, .001 graduations on standard scale, .05 mm graduations on metric scale, thumb lock
56	Set, master feeler gauge Blade thickness ranging from .002" to .035" with metric equivalents and holder.
57	Set, carpenter tools 7-1/4" - 1-1/2" HP portable circular saw, adaptable to 220 V - 50 Hz with two combination crosscut/rip blades, wrench for changing blades, instruction manual and parts list; 3' level with plumb/level readings; steel rafter square with 24 X 2" body, 16-1/2" tongue; 2-16 oz. claw hammers, drop-forged steel head, hickory handle; pull-n-pry bar - 15"; 3-1/2 lb. double bit axe; bevel filed, coarsecut hand saw; 4 pc. wood-chisel set 1/2" - 1-1/4"; HD brace and 6 auger bits - 1/4" to 1"; 6 ft. folding rule.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
58	Engraver, electric, vibrating For marking steel, stone, wood or other hard surfaces. Adaptable to 220V - 50 Hz.
59	Set, steel stamping letters and numbers 1/8" characters. Letter stamp set with 26 characters and period, with case. Figure stamp set for numerals 0 - 9, with case.
60	Air hose with quick coupler ends, 3/8" X 35' General purpose, oil and abrasion resistant cover, 250 PSI working pressure. Milton or standard industrial style couplers.
61	Set, combination center drill and countersink 1/8", 3/16", 1/2", 5/16" and 7/16" w/case.
62	Vise, bench type Mechanic's vise with 6" jaws, opening capacity of 5", swivel base.
63	Vise, drill press General purpose, 3" capacity vise that bolts to drill press, Item No. 123.
64	Vise, blacksmith, post or box vise, hinged jaws
65	Vise, combination, pipe and bench 5" jaw width, with steel pipe jaws, swivel base.
66	Vise, tool room Economy service vise with swivel base, 4" jaws
67	Vise, bench, chain type For 1/8" to 3" OD pipe
68	Vise, woodworking, 12" capacity
69	Sling, engine lift Dual steel chain type, 5' length with hooked end, 5,000 lbs. capacity at 60° sling to load angle. A-frame not required.
70	Stand, engine/transmission repair, portable Side mounting, 5,000 lb. capacity, mounted unit rotating and locking device, on casters, with adapter plates for Caterpillar 3304 and 3208 engines.
71	6' X 4' shield, welding/painting, portable Single panel, flame and water resistant, provide protection from welding rays.
72	Stand, safety Jack stand, 5 ton capacity, with ratchet action height adjustment.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
73	Jack, hydraulic, floor, 5T Service jack with locking "T" bar handle, manual, swivel caster wheels on rear.
74	Jack, hydraulic, floor, 10T Service jack with locking "T" bar handle, manual, swivel caster wheels on rear.
75	Jack, hydraulic, floor, 20T Truck service jack, low height, operate on air pressure, with nipple for Milton or standard industrial style couplers, 2-7/8" min. screw extension, large rubber wheels.
76	Dolly, dual wheel Hydraulic jacking mechanism, swivel casters, 1000 lbs. capacity.
77	Hoist, ratchet, hand 3 T Chain type, standard 5' travel, safety hooks top and bottom, brake system.
78	Hoist, ratchet, hand, 1-1/2 T Cable type, 35' travel.
79	Grease gun, hand Heavy duty, hold 14.5 ounce grease cartridge
80	Pump, oil recovery, suction type Hand suction gun with flexible hose.
81	Pump, rotary, hand Fits 55 gallon drums, bushing fits 2" openings, with rubber hose, lockable.
82	Set, oil filler measure W/delivery spouts and positive trigger release mechanism.
83	Set, funnels Galvanized. Typical set should include 1 qt. size with flexible hose and screen, 4 qt. size, and transmission filler with flexible hose and reducer tip.
84	Fuel can with nozzle. 2.5 gallon In compliance with SAE safety standards, metal, HD.
85	Fuel can with nozzle. 5 gallon In compliance with SAE safety standards, metal, HD.
86	Helmet, welding (arc) With adjustable sweat band.
87	Goggles, welding oxy-acetylene Number 5 lens.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
88	Face shield, general purpose Clear, lightweight, adjustable headband
89	Set, general shop tools: Steel tape, 1/2" or 3/4" blade with Eng. and Metric graduations; steel rule with Eng. and Metric graduations; heavy duty creeper; heavy duty 16 gage-3 conductor trouble light with grounded tool tap outlet and 25' or longer cord; single face, 2-1/2 or 3 lb. heavy duty hammer; pipe taps NPT and BSP (British Standard Pipe Tapered Thread) in 1/4", 3/8", 1/2" and 3/4" sizes; reamers for 1/8" to 1" diameters; heavy duty pipe cutter for 1/8" to 2" O.D. pipes; 30" X 3/4" crowbar; wrecking bar.
90	Kit, tire patching, all sizes handle, reamer, needles, razor blades and 60 plugs.
91	Sledge hammer, 8 lbs. Double faced, drop-forged, tempered steel head, 32-36" hickory handle.
92	Sledgehammer, 10 lbs. Double faced, drop-forged, tempered steel head, 32-36" hickory handle.
93	Kit, first aid Industrial kit for up to 25 people includes adhesive bandages, burn creme, first-aid ointment, ammonia inhalent, aspirin tablets, stretch bandage, adhesive tape, iodine, eye wash, forceps, blunt scissors, instruction booklet and metal case.
94	Fire extinguisher, dry powder (dry chemical) A:B:C rated for all types of fires - wood, fabric, rubbish, grease, flammable liquid, and electrical. Minimum rating of 3A, 20B:C, 10 lb. charge, posi- tive squeeze grip, operation, w/o wall mounting fixture.
95	Set, hex key wrenches, Eng. and Metric Includes 11 Eng. sizes 5/64" through 3/8" and metric sizes 2, 2.5, 3, 4, 5, 6, 8, and 10 mm.
96	Drop cord 50', grounded, 12 guage wire, vinyl cable
97	Gloves, welding (arc)
98	Floor mops, pail and wringer All steel, galvanized bucket and mop wringer. Six gallon capacity bucket with ball bearing casters. Wringer to handle any size mop. Locking mop handle and one dozen 16 oz. cotton mop heads.

TOOL DESCRIPTIONS (CONT.)

Item No.	Description
99	Impact wrench, heavy equipment, 1/2" Including impact sockets, 6 point, 1/2" drive, 1/2" through 1" in 1/16" increments. Working torque range of 25-250 ft./lbs., maximum torque of 350 ft./lbs., adaptable to Milton or standard industrial style couplers.
100	Step ladder, wood, 6', HD
101	Push broom, long handle, 18"-24" wide
102	Brake fluid pump hand operated easy grip 2-way pump, plastic tubing, reservoir jar with lid, adapters.
103	Brake bleeder tank 2.5 gallon capacity diaphragm, w/basic adapters, hoses and fittings. Charged from air source, built in pressure relief valve.
104	Bearing packer Manual with sufficient capacity to service large truck wheel bearings. Not the universal bearing packer which attaches to grease gun.
105	Mechanic's seat (creeper seat)
106	Oil drain pans, set Galvanized steel, 1 pan-10 qt. capacity, and 1 pan-10 gallon (U.S.) capacity
107	Transmission/differential floor jack Low lift type, 2000 lb. capacity, with four mounting arms and two attachment chains
108	Air chisel Includes two each flat chisels 3/4" blade short and long length, and two wide chissel. Standard .401" shanks
109	Waste cans Galvanized can with flat lid, 20 gallons or more capacity
110	Safety cage, tire inflation Four or five bar cage of sufficient size to accommodate tires through 13.00 X 24.
111	Oil seal driver set Set includes discs in sizes 3-1/16" to 4-1/2" diameter (1/16" increments), a handle that assembles with the discs to provide a pilot, a spacer, and a driver. Similar to OTC set No. 27795.

TOOL DESCRIPTIONS (CONT.)

Item No.	Description
112	Set, bearing/gear puller Typical set should include 2, 5, and 7 ton grip pullers, (7 ton long jaw), 2 and 3 jaw, and a bearing pulling attachment with spread range of 3/8" to 4-5/8".
113	Set, riveting tools Industrial hand riveter w/nose pieces for 1/8", 5/32" and 3/16" diameter rivets and a stock of assorted rivets.
114	Set, pilot bearing tools Pilot bearing puller, capacity 7/8" to 2" I.D., 1" reach.
115	Set, axle nut sockets, 6 and 8 point 2 - 3/32" through 4-7/8" 3/4" drive (2-3/32"; 2-3/8"; 2-1/2"; 2-9/16"; 2-3/4"; 2-7/8"; 3"; 3-1/8"; 3-1/4"; 3-3/8", 3-1/2"; 3-3/4"; 3-7/8"; 4"; 4-1/8"; 4-3/8" and 4-7/8")
116	Steam cleaner outfit Diesel powered; portable on large, rubber wheels; 25' min. hose length; insulated, long-handled tubular nozzle holder, pump output of 70 gph min. Similar to Jenny Model 200. 100 lbs. of powdered cleaner for heavy dirt, oil, and grease removal.
117	Headlight aimer/tester Kit with driver and passenger side aimers, 7" and 5-3/4" circular adapters, and 6" and 8" rectangular adapters
118	Tester, radiator pressure with truck adapters
119	Tester, hydraulic flow/pressure/temperature For testing systems up to 30 GPM at pressures up to 2500 psi, portable, adaptable to "in-line" testing with inlet and outlet hose attachments, 6 min., adaptor unions for various type/size hydraulic systems, temperature guage up to 240 ⁰ F; dual pressure guages to permit accurate readings at low pressure. w/case.
120	Mechanic's tool cabinet/work bench, roll away 3' approximate height. Drawers w/locking system. Heavy duty.
121	Mechanic's work stands Six to eight foot work platform, high strength steel, 25 lb. per sq. ft. capacity with a safety factor of 4, approx. 12 sq. ft. work platform that can be adjusted to different heights, lockable swivel casters.
122	Hydraulic floor press, 5 Ton H-frame press for floor mounting; hydraulic hand pump, hose and ram w/ 6" min. stroke; ram and pump removable.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
123	Drill press Floor, HD, drill through 1" diameter, single phase, 1 HP electric motor adaptable to 220 V - 50 Hz, slotted utility table, 3/4" chuck, designed for permanent mounting to the floor.
124	A-frame hoist Gantry leg assemblies on HD swivel wheels of 12" diameter, min., w/I-beam. Two chain hoists (chain falls), 1-1/2" ton capacity.
125	Gauge, brake drum
126	Power hack saw, floor type, semi-portable 7" band saw with 3/4 HP motor, adaptable to 220V - 50 Hz., HD steel housing, table and stand with two wheels. Recirculating and filtered coolant, variable set vise, with three blades - 14 teeth per inch.
127	Small parts recirculating wash tank Five gallon capacity, electric driven, adaptable to 220V-50 Hz, filtered circulation with basket rack, drain and safety cover. Similar to Graymills Model H-42 RN. Cleaning fluid with flash point greater than 140 ^o F, 50 gal.
1-S	Bin, spare parts storage Steel units, approximately 18" deep, floor standing
2-S	File, cardex type, stock record cards
3-S	Bins, rotary, hardware storage Approximately 5' tall.
4-S	H.O. metal storage shelves and support hardware open shelves, 4 or 5 shelves per unit, min. width 12", adjustable height, 20 gauge steel.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
5-S	Bin tags, identification/transactions 1" X 3", white, self-adhesive
1-0	Typewriter, manual, 14", 18", and 24" carriage with extra ribbons.
2-0	Chairs, steel framed, 3 swivel and 3 armed style side chairs
3-0	Calculator, electronic, rechargeable, +, -, x, ÷, one memory, printer.
4-0	Desk lamps, 100 watt
5-0	Embossing machine, using 3/8" tapes. W/extra self-adhesive tapes
6-0	File cabinets, steel, lockable, with folders, closed bottoms, 4-drawer
7-0	Desks, metal, lockable drawers
1-M	Tool set, general purpose, inches Fully portable tool set and chest with a broad assortment of sockets, handles and attachments included in 1/4", 3/8" and 1/2" drives in a complete range of openings from 3/16" through 1". Combination wrenches from 1/4" to 1-1/4". Openings in increments of 1/16".
2-M	Torque wrench 3/4" square drive with range from 0 - 600 ft. lbs. (0 - 80 cm/kg) with increments of 10 lbs. (2 cm/kg) on dial.
3-M	Socket set, 3/4" drive 16 HD, six point sockets from 1" to 2", ratchet and flex handles, universal joint, and short and long extensions in metal tool chest.
4-M	Oil filter wrench Belt type, fit any spin-on oil filter up to 6" diameter, use with 1/2" square drive wrench.
5-M	Timing light, ignition Heavy duty with timing advance.
6-M	Ignition wrench set 8 sizes open end wrenches from 3/16" to 3/8", ignition file, screw starter and screw driver.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
7-M	Spark plug gauge set Stamped in English and Metric sizes.
8-M	Hydrometer, battery Direct reading with a range of 1.100 to 1.300. Unbreakable.
9-M	Pliers, battery cable terminal
10-M	Brush, battery terminal
11-M	Jumper cables Color coded clamps, 400 amps, 12' length.
12-M	Brake spring pliers For trucks, 20" long.
13-M	Tire pressure gauge Calibrated in 1 or 2 lb. increments from 10 to 150 psi.
14-M	Tire tread gauge
15-M	Tire tool set with lock ring remover iron, two tubeless tire irons, straight tire spoon, and wheel weight pliers.
16-M	Wheel lug wrench, 4-way, HD truck
17-M	Hacksaw, standard Frame, adjustable to accept 8", 10", and 12" blades, handle and five each fine, medium and coarse 10" blades.
18-M	Set, screwdrivers, square and Phillips Set should include a #1, #2, #3, #4, and #2 stub shank Phillips; standard tips 3/16" short and long shank, 1/4" stubby, short and long shank, and 5/16" long shank; plastic handles.
19-M	Snap ring pliers
20-M	Remover, valve core, slotted end, operates like screwdriver for removing tire valve cores
21-M	Carrier battery
22-M	Spark plug sockets 3/8" square drive sockets size 5/8", 13/16", and 14mm and 18mm, with rubber retainer.
23-M	Circuit tester, heavy duty Checks AC or DC wiring up to 36 volts, use with power "on".

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
24-M	Set, metric sockets, 1/2" square drive Six-point standard sockets from 15mm through 32mm.
25-M	Set, metric sockets, 1/4" square drive Ten, 6-point standard sockets from 5mm through 14mm.
26-M	Set, feeler guage Blades thicknesses from .002" to .023" stamped with metric equivalents.
27-M	Set, combination metric wrenches 6mm through 19mm.
28-M	Set, pliers Multi-purpose tongue-and-groove, slip joint with wire cutter, and long nose.
1-FS	Oxy-acetylene cutting/brazing/welding outfit. One pair of standard tanks; 25' ft. 1/4" siamese hose with connections; two-stage, brass oxygen and acetylene regulators for automatic adjustment as cylinder pressure drops, min. 2" diameter guages, white-and-black; brass forged torch handle; tip mixer; reverse flow check valves; brass forged cutting attachment; cutting tips numbers 1 and 3 for cutting steel up to 3"; welding tips numbers 3, 5, and 7 for welding plates up to 5/16" thickness; set of tip cleaners; welder's goggles with #5 lens; round file welders lighter with 6 extra flints; 2 dozen 1/8" flux-coated gas brazing rods; metal carrying case.
2-FS	Portable, gasoline powered welding outfit. 50-140 amp range AC, 3/32" diameter electrode capability, 10' work cable with work clamp, 12' electrode cable with electrode holder. 3500 watts of AC, 120/240 volt standby electrical power. Recoil start engine. Assortment of 3/32" electrodes for all welding positions, 50 contact type and 50 general type.
3-FS	3/4" drive socket set, standard and Metric. 16 HD six-point standard sockets from 1" to 2", six-point HD metric sockets in 19, 27, 30, 35, and 38 mm sizes, ratchet and flex handles, universal joint, and short and long extensions in metal tool chest.
4-FS	1/2" drive HD torque wrench English and Metric readout, to 150 ft-lbs in 1 ft-lb. increments (200 NM in 2 NM increments). Sears DIGITORK or approved equal.
5-FS	HD come-along, 2-ton capacity min. Welded steel frame, steel ratchet drum, ratchet and pawl load holding, drop-forged steel hooks, 30' min. cable.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
6-FS	Set, HD mechanic's screwdrivers, including Phillips head. Same as item no. 18-M plus one 3/8" X 12" slotted screwdriver.
7-FS	Tap and die set, standard and metric. Set includes 41-piece English and 36-piece Metric. Sears part numbers 9HT5201 and 9HT52102, or approved equal.
8-FS	Set pliers. Ignition pliers, 1/2" jaw capacity, 3 adjustments; multi-purpose tongue-and-groove, 9-1/2" long, 1-1/2" capacity; slip-joint, 8" long, 2 positions, with wire cutter; diagonal-cut, 7".
9-FS	5-ton hydraulic jack Welded construction, work horizontally or vertically, screw extension, 2" Min., with handle.
10-FS	10-ton hydraulic jack Welded construction, work horizontally or vertically, screw extension, 2-3/4" Min., with handle.
11-FS	Chain hoist, 2000 lbs. cap. Ratchet type, standard 5' travel, safety hooks top and bottom, brake system.
12-FS	HD bolt cutter. See item No. 44.
13-FS	HD, cartridge-type manual grease gun. Hold 14.5 ounce grease cartridge.
14-FS	HD, 5-gallon cap. fuel can w/nozzle. See item No. 85.
15-FS	HD punch and chisel set. See item No. 47.
16-FS	Set, deep throat, welding C-clamps Spindles, handles and pads copper plated for splatter protection. Steel splatter shield enclosing spindle. Three clamps-4", 6", and 8" capacities.
17-FS	6-inch HD vise. See item No. 62.
18-FS	Oil recovery suction pump. See item No. 80.
19-FS	10-gallon cap. oil drain pan. Galvanized steel.

TOOL DESCRIPTIONS (CONT.)

<u>Item No.</u>	<u>Description</u>
20-FS	2-qts. oil filler can.
21-FS	Set sledge hammers (4# and 8#) Double faced, drop-forged, tempered steel head. Hickory handles: 4# - 14 - 16", 8# - 32 - 36".
22-FS	Brake bleeder tank and fluid pump.
23-FS	Electric tester See item No. 23-M.
24-FS	Hydraulic system portable tester. See item No. 119.
25-FS	Oil filter wrench. See item No. 4-M.
26-FS	Ignition timing light. See item No. 5-M.
27-FS	Battery hydrometer See item No. 8-M.
28-FS	HD, 4-way wheel lug wrench. See item No. 16-M.
29-FS	Set, larger tire removal tools. Lock ring remover iron, 2-tubeless tire irons, and straight tire spoon.
30-FS	Tire patching/field vulcanizing kit. 1-pint vulcanizing liquid, 70 patches various sizes 1½" X 2½" to 2½" X 5-3/4"
31-FS	HD battery strap. See item No. 21-M.
32-FS	HD tire pressure guage. See item No. 13-M.
33-FS	Tire tread depth guage.
34-FS	10-qts. pail with cleaning brush. Galvanized steel pail w/handle. HD parts cleaning brush, nylon bristles.
35-FS	Set HD jumper cables. See item No. 11-M.
36-FS	Battery cable terminal pliers.
37-FS	Spark plug guage set. Stamped in English and Metric.

TOOL DESCRIPTIONS (CONT.)

Item No.	Description
38-FS	Set mechanic's hammers. One each of the following hammers w/hickory handles: 1 lb. rubber mallet; 2 lb. hand drilling hammer, drop-forged from high carbon steel; 2 to 2½ lb. bronze hammer; 8 oz. and 24 oz. ball pein hammers, heat-treated, machined face and pein.
39-FS	Brake spring pliers. See Item No. 12-M.
40-FS	Set oil seal removal/installation tools. One slide hammer puller set w/reversible jaw slide hammer puller with 2½ lb. hammer, 3 medium-jaws, 3 pilot-bearing jaws, 3 long-jaws, puller hook, and cross block. One lever type seal puller with two size tips. One seal driver set. See Item No. 111 for description of seal driver set.
41-FS	Set bearing pullers. One 5 ton 2 or 3 jaw-long jaw grip puller with reach of 5½" max. and spread of 7" max. One 13 ton 2-jaw-long jaw grip puller with reach of 15¼" max. and spread of 15½" max. One 10 ton push-puller, spread of 2-1/8" to 7-1/4", forcing screw tip end threaded 5/8" - 18, and 2 pair of legs-- 6-3/4" and 15-3/4" reach with 5/8"-18 threaded ends. One bearing pulling attachment, spread range 3/8" to 4-5/8", with 5/8"-18 threaded holes. One internal pulling attachment, jaw spread range of 1-1/2" to 7" and reach of 5-1/4", with 5/8" - 18 threads in cross block tapped hole.
42-FS	Set deep-sockets, sparkplug. See Item No. 22-M for description.
43-FS	Engine driven air compressor 4-cycle, 2-cylinder gasoline engine, 4 HP, recoil start. 12 gallon air tank, constant speed unloader control, belt guards, minimum output 6 CFM at 100 psi

APPENDIX D

Materials

Efficient operation of the Lakes Province Work Center will require a wide variety of spare parts, supplies and materials which are not available from commercial suppliers in Lakes Province.

The spare parts necessary to maintain each vehicle or piece of maintenance equipment for an eighteen to twenty-four month period should be purchased at the same time the unit is purchased. Suggested spare parts for each equipment type have been included in the bid specifications. These items will make up a large portion of the provincial stock inventory.

Fuel, engine oil, lubricants and other fluids are also an essential inventory item. Approximate annual requirements are estimated below (more accurate projections will require selection of specific vehicles by make and model and manufacturer's service recommendations):

Gasoline	-	8,000 Liters (diesel fleet recommended)
Diesel Fuel	-	550,000 Liters
Engine Oil	-	8,000 Liters
MP Grease	-	650 kg
Transmission Fluid	-	950 Liters
Hydraulic Oil	-	2,000 Liters
Differential Oil	-	500 Liters
Brake Fluid	-	200 Liters

There are numerous other types of materials, spare tools and spare parts necessary for operation of the road maintenance and equipment maintenance programs. The attached listing is representative of the types of items required. The list includes only replacement items to be stored in the warehouse.

Building design details, and vehicle selection will influence the kind and number of items that should be included. For example, english system threaded fasteners are listed. Depending upon vehicle selection, metric system fasteners may also be required. (The stocking of threaded fasteners could be significantly reduced by equipping the workshop with a metal lathe.)

MATERIALS ESTIMATE

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Folders, Manila	100 EA	5	11.00	55.00
Cards, Inventory	500 EA	5	29.00	145.00
Ribbons, Typewriter	EA	20	2.50	50.00
Ink Roller, Calculator	EA	20	4.00	80.00
Paper, Calculator	DZ Rolls	10	10.00	100.00
Paper, Carbon Set	Ream	20	11.00	220.00
Paper, Carbon, Typewriter	100 SH	20	9.00	180.00
Paper, Carbon, Pencil	100 SH	20	8.00	160.00
Paper, Typewriter	Ream	30	10.00	300.00
Envelopes, Clasp	100 EA	5	15.00	75.00
Stapler	EA	5	20.00	100.00
Staples	(5000) BX	5	3.00	15.00
Staple Remover	EA	10	1.00	10.00
Clips, Paper	(1000) BX	5	4.00	20.00
Bands, Rubber	LBS	5	7.00	35.00
Pencils, Wood, No. 2 Lead	DZ	20	2.50	50.00
Pencils, Wood Red Lead	DZ	20	3.50	70.00
Pencil Sharpener	EA	5	11.00	55.00
Eraser, Pencil or Ink	DZ	20	4.00	80.00
Fluid, Correction	EA	30	1.50	45.00
Tape, Adhesive, Clear	Roll	48	1.00	48.00
Pens, Ball Point, Black	DZ	5	4.50	22.50
Marker, Ink, Black	DZ	2	12.00	24.00
Marker, Ink, Red	DZ	2	12.00	24.00
Twine, Binding (480 ft.)	Roll	50	4.50	225.00
Wire, Brace, 9 gauge	Roll	10	30.00	300.00

MATERIALS ESTIMATE
(Continued)

Item	Units	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Wire, Black Annealed, 9 ga.	Roll	10	24.00	240.00
Wire, Black Annealed, 16 ga.	Roll	10	30.00	300.00
Cord, Chalk Line, 8 oz.	EA	20	1.20	24.00
Cord, Chalk Line, Nylon No. 18	EA	20	1.60	32.00
Cords, Sash No. 8	FT	1,000	.10	100.00
Hose, Garden 3/4 in. x 35 ft.	EA	25	13.00	325.00
Cleaner, Bowl	EA	100	.50	50.00
Cleaner, Floor Soap	5 GAL	25	6.00	150.00
Mop, Wet	EA	25	1.00	25.00
Handle, Wet Mop	EA	10	2.20	22.00
Rags, White Cotton	LBS	200	.85	170.00
Brush, Toilet Bowl	EA	10	.60	6.00
Lamps, 60 Watt	EA	50	.20	10.00
Lamps, 100 Watt	EA	50	.20	10.00
Lamps, 200 Watt	EA	50	.35	17.50
Water Cooler, 3 Gal.	EA	10	10.50	105.00
Water Cooler, 5 Gal.	EA	10	15.00	150.00
Water Cooler, 10 Gal.	EA	10	22.00	220.00
Choke Cleaner	EA	50	1.30	65.00
Oil, Dry	BG	50	3.50	175.00
Broom, Sweeping	EA	10	3.00	30.00
Broom, Push	EA	10	8.00	80.00
Gas Can, 5.0 Gal.	EA	10	14.00	140.00
Gas Can, 2.5 Gal.	EA	10	11.00	110.00
Rope, Manila, 1/2 in.	FT	1,000	.15	150.00
Paddlocks	EA	25	2.70	67.50

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Pencils, Carpenter	EA	100	.30	30.00
Crayon, Lumber	DZ	12	2.20	26.40
Paint, Primer	GAL	10	8.00	80.00
Tape, Masking 2 in. x 60 yd.	Roll	25	5.00	125.00
Tape, Duct 2 in.	Roll	25	4.00	100.00
Dobbin Barrow	EA	4	300.00	1,200.00
Water Drum	EA	10	6.00	60.00
Shovel, Round Point	EA	20	14.00	280.00
Shovel, Square Point	EA	20	17.00	340.00
Rake, Garden	EA	20	9.00	180.00
Slasher	EA	20	10.00	200.00
Pick	EA	20	26.00	520.00
Chisel, Masonry	EA	20	6.00	120.00
Broom, Long Bristle	EA	20	11.00	220.00
Tamper, Hand	EA	20	13.00	260.00
Toria or Mattock	EA	20	25.00	500.00
Bucket	EA	20	8.00	160.00
Axe, Bush	EA	20	21.00	420.00
Stone, Sharpening	EA	20	4.00	80.00
Level, Carpenters	EA	10	20.00	200.00
Trowel, Finishing	EA	5	11.00	55.00
Trowel, Painting	EA	5	6.00	30.00
Aprons, Nail	EA	5	13.00	65.00
Gloves, Acid Proof	PR	20	2.00	40.00
Aprons, Acid Proof	EA	10	9.00	90.00
Axe	EA	10	21.00	210.00
Hammer, Sledge	EA	20	17.00	340.00
Hammer, Masonry	EA	20	15.00	300.00
Hammer, Claw	EA	5	15.00	75.00

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Nails, Common 6 d	LBS	50	.35	17.50
Nails, Common 8 d	LBS	50	.35	17.50
Nails, Common 10 d	LBS	50	.35	17.50
Nails, Common 16 d	LBS	50	.35	17.50
Nails, Common 20 d	LBS	50	.35	17.50
Nails, Common 30 d	LBS	50	.35	17.50
Nails, Common 40 d	LBS	50	.35	17.50
Nails, Common 60 d	LBS	50	.35	17.50
Nails, Common 80 d	LBS	50	.35	17.50
Nails, Case Hrd, Cr Cut, 8 d	LBS	50	.65	32.50
Nails, Case Hrd, Cr Cut, 16 d	LBS	50	.65	32.50
Nails, Galvanized Roofing	LBS	50	.35	17.50
Tire Wedges	EA	6	7.10	42.60
Tire Wrenches, 4-Way	EA	8	8.10	64.80
Hack Saw, Frames	EA	12	3.50	42.00
Hack Saw, Blades	EA	50	.20	10.00
Digging Iron	EA	10	21.00	210.00
Crow Bars	EA	10	7.50	75.00
Brush, Wire	EA	20	1.50	30.00
Broom, Long Bristle	EA	20	11.00	220.00
Bolt Cutter	EA	5	70.00	350.00
Jaws, Bolt Cutter	EA	10	20.00	200.00
Handle, Pick or Mattock	EA	50	4.00	200.00
Handle, Axe	EA	50	4.00	200.00
Handle, Sledge	EA	50	4.00	200.00
Handle, Tamper	EA	50	3.00	150.00
Handle, Rake	EA	50	3.00	150.00
Handle, Claw Hammer	EA	10	1.00	100.00
Folding Rules 6 Ft	EA	20	4.00	80.00

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Steel, Angle 6x3-1/2x3/8 in.	FT	100	3.25	325.00
Steel, Channel, 4 in.	FT	100	1.60	160.00
Steel, Flat 1/8x3 in.	FT	100	.50	50.00
Steel, Flat 1/2x8 in.	FT	100	3.60	360.00
Steel, Reinforcing Rod 1/2 in.	FT	1000	.15	150.00
Chain, 3/8 in.	FT	200	1.50	300.00
Chain, 1/2 in.	FT	200	3.25	650.00
Chain, 5/8 in.	FT	200	1.75	350.00
Chain, 3/4 in.	FT	200	1.20	240.00
Connecting Link, 3/8 in.	EA	25	1.10	27.50
Connecting Link, 1/2 in.	EA	25	1.10	27.50
Connecting Link, 5/8 in.	EA	25	1.30	32.50
Connecting Link, 3/4 in.	EA	25	1.30	32.50
Hook, Grab 5/16	EA	10	2.25	22.50
Hook, Grab 3/8	EA	10	1.75	17.50
Hook, Grab 1/2	EA	10	2.35	23.50
Hook, Grab 5/8	EA	10	3.05	30.50
Hook, Grab 3/4	EA	10	1.30	13.00
Hook, Slip #23 (3/8)	EA	10	2.05	20.50
Hook, Slip #25 (1/2)	EA	10	4.85	48.50
Hook, Slip #27 (5/8)	EA	10	7.50	75.00
Hook, Slip #31 (3/4)	EA	10	7.60	76.00
Cable, 5/8 in. diameter	FT	200	.35	70.00
Cable, Clamps 5/8 in.	EA	50	1.20	60.00
Rod Welding, 3/16	LBS	100	.40	40.00
Rod Welding, 1/8	LBS	100	.60	60.00
Rod Welding, 5/32	LBS	100	.70	70.00
Oxygen/Accetylene (40 & 60 Ft ³)	PR	5	210.00	1,050.00

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cotter Pins, Steel 3/16"x1"	(1000)PKG	1	15.60	15.60
" 3/16"x1-1/2"	(500)PKG	1	10.40	10.40
" 3/16"x2"	(500)PKG	1	13.00	13.00
" 3/16"x3"	(250)PKG	1	9.00	9.00
" 1/4"x2"	(250)PKG	1	10.50	10.50
" 1/4"x2-1/2"	(250)PKG	1	12.50	12.50
" 5/16"x1"	(250)PKG	1	9.60	9.60
" 5/16"x1-1/2"	(250)PKG	1	12.50	12.50
" 5/16"x2"	(250)PKG	1	15.75	15.75
" 5/16"x3"	(125)PKG	2	11.00	22.00
" 3/8"x2"	(125)PKG	2	11.20	22.40
" 3/8"x3"	(125)PKG	2	15.00	30.00
" 1/2"x3"	(125)PKG	2	42.00	84.00
Cap Screw, Hex, Gr.8, UNRF 1/4"x1/2"	100 EA	3	6.40	19.20
" " x3/4"	100 EA	3	6.85	20.55
" " x1"	100 EA	3	7.25	21.75
" " x1-1/4"	100 EA	3	8.10	24.30
" " x1-1/2"	100 EA	3	9.20	27.60
" " x2"	100 EA	2	11.55	23.10
" " x2-1/2"	100 EA	2	15.30	30.60
" " x3"	100 EA	2	20.35	40.70
" " x3-1/2"	100 EA	2	25.80	51.60
Cap Screw, Hex, Gr. 8, UNRF 5/16"x1/2"	100 EA	3	8.55	25.65
" " x3/4"	100 EA	3	9.10	27.30
" " x1"	100 EA	3	10.35	31.05
" " x1-1/4"	100 EA	3	11.75	35.25
" " x1-1/2"	100 EA	3	13.15	39.45

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cap Screw, Hex, Gr. 8, UNRF 5/16"x2"	100 EA	2	15.95	31.90
" " x2-1/2"	100 EA	2	19.45	38.90
" " x3"	100 EA	2	23.45	46.90
" " x3-1/2"	100 EA	2	31.60	63.20
" " x4"	100 EA	2	41.85	83.70
Cap Screw, Hex, Gr. 8, UNRF 3/8"x1/2"	100 EA	3	11.85	35.55
" " x3/4"	100 EA	3	12.60	37.80
" " x1"	100 EA	3	14.00	42.00
" " x1-1/4"	100 EA	3	15.50	46.50
" " x1-1/2"	100 EA	3	17.35	52.05
" " x1-3/4"	100 EA	3	19.25	57.75
" " x2"	100 EA	2	21.40	42.80
" " x2-1/2"	100 EA	2	25.15	50.30
" " x3"	100 EA	2	29.00	58.00
" " x3-1/2"	100 EA	2	40.45	80.90
" " x4"	100 EA	2	48.70	97.40
" " x4-1/2"	100 EA	1	67.70	67.70
" " x5"	100 EA	1	73.80	73.80
" " x5-1/2"	100 EA	1	79.90	79.90
" " x6"	100 EA	1	86.10	86.10
Cap Screw, Hex, Gr. 8, UNRF 1/2"x3/4"	100 EA	2	25.35	50.70
" " x1"	100 EA	2	27.75	55.50
" " x1-1/2"	100 EA	2	31.70	63.40
" " x2"	100 EA	2	40.25	80.50
" " x2-1/2"	100 EA	1	48.60	48.60
" " x3"	100 EA	1	59.85	59.85
" " x3-1/2"	100 EA	1	65.00	65.00

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cap Screw, Hex, Gr. 8, UNRF 1/2"x4"	100 EA	1	75.20	75.20
" " x4-1/2"	100 EA	1	96.40	96.40
" " x5"	100 EA	1	106.35	106.35
" " x5-1/2"	100 EA	1	116.20	116.20
" " x6"	100 EA	1	126.10	126.10
Cap Screw, Hex, Gr. 8, UNRF 9/16"x1"	100 EA	1	52.90	52.90
" " x1-1/2"	100 EA	1	59.35	59.35
" " x2"	100 EA	1	66.30	66.30
" " x2-1/2"	100 EA	1	78.85	78.85
" " x3"	100 EA	1	91.60	91.60
" " x3-1/2"	100 EA	1	104.35	104.35
" " x4"	100 EA	1	117.00	117.00
" " x6"	100 EA	1	167.45	167.45
Cap Screw, Hex, Gr. 8, UNRF 5/8"x1"	100 EA	1	55.60	55.60
" " x1-1/2"	100 EA	1	62.55	62.55
" " x2"	100 EA	1	69.35	69.35
" " x2-1/2"	100 EA	1	83.20	83.20
" " x3"	100 EA	1	96.40	96.40
" " x3-1/2"	100 EA	1	115.25	115.25
" " x4"	100 EA	1	129.10	129.10
" " x4-1/2"	100 EA	1	136.25	136.25
" " x5"	100 EA	1	149.65	149.65
" " x5-1/2"	100 EA	1	162.85	162.85
" " x6"	100 EA	1	176.25	176.25
Cap Screw, Hex, Gr. 8, UNRF 3/4"x1-1/2"	100 EA	1	102.95	102.95
" " x2"	100 EA	1	115.35	115.35
" " x2-1/2"	100 EA	1	139.90	139.90

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cap Screw, Hex, Gr. 8, UNRF 3/4"x3"	100 EA	1	158.85	158.85
" " x3-1/2"	100 EA	1	177.40	177.40
" " x4"	100 EA	1	196.35	196.35
" " x4-1/2"	100 EA	1	205.15	205.15
" " x5"	100 EA	1	223.05	223.05
" " x5-1/2"	100 EA	1	241.05	241.05
" " x6"	100 EA	1	259.25	259.25
Cap Screw, Hex, Gr. 8, UNRC 1/4"x1/2"	100 EA	3	6.00	18.00
" " x3/4"	100 EA	3	6.50	19.50
" " x1"	100 EA	3	6.70	20.10
" " x1-1/4"	100 EA	3	7.50	22.50
" " x1-1/2"	100 EA	3	8.75	26.25
" " x2"	100 EA	2	10.90	21.80
" " x2-1/2"	100 EA	2	14.35	28.70
" " x3"	100 EA	2	19.05	38.10
" " x3-1/2"	100 EA	2	24.30	48.60
" " x4"	100 EA	2	32.00	64.00
Cap Screw, Hex, Gr. 8, UNRC 5/16"x1/2"	100 EA	3	8.10	24.30
" " x3/4"	100 EA	3	8.65	25.95
" " x1"	100 EA	3	9.85	29.55
" " x1-1/4"	100 EA	3	11.00	33.00
" " x1-1/2"	100 EA	3	12.20	36.60
" " x2"	100 EA	2	15.10	30.20
" " x2-1/2"	100 EA	2	18.40	36.80
" " x3"	100 EA	2	22.05	44.10
" " x3-1/2"	100 EA	2	29.55	59.10
" " x4"	100 EA	2	39.10	78.20

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cap Screw, Hex, Gr. 8, UNRC 3/8"x1/2"	100 EA	3	11.20	33.60
" " x3/4"	100 EA	3	11.95	35.85
" " x1"	100 EA	3	13.25	39.75
" " x1-1/4"	100 EA	3	14.75	44.25
" " x1-1/2"	100 EA	3	16.50	49.50
" " x1-3/4"	100 EA	3	18.30	54.90
" " x2"	100 EA	2	20.20	40.40
" " x2-1/2"	100 EA	2	23.65	47.30
" " x3"	100 EA	2	27.30	54.60
" " x3-1/2"	100 EA	2	38.10	76.20
" " x4"	100 EA	2	45.70	91.40
" " x4-1/2"	100 EA	1	63.60	63.60
" " x5"	100 EA	1	69.30	69.30
" " x5-1/2"	100 EA	1	75.00	75.00
" " x6"	100 EA	1	80.95	80.95
Cap Screw, Hex, Gr. 8, UNRC 7/16"x3/4"	100 EA	3	17.95	53.85
" " x1"	100 EA	3	20.75	62.25
" " x1-1/4"	100 EA	3	22.50	67.50
" " x1-1/2"	100 EA	3	25.50	76.50
" " x1-3/4"	100 EA	3	28.60	85.80
" " x2"	100 EA	2	31.70	63.40
" " x2-1/2"	100 EA	2	37.60	75.20
" " x3"	100 EA	2	43.80	87.60
" " x3-1/2"	100 EA	2	51.40	102.80
" " x4"	100 EA	2	62.45	124.90
" " x4-1/2"	100 EA	1	75.75	75.75
" " x5"	100 EA	1	82.50	82.50
" " x5-1/2"	100 EA	1	102.30	102.30
" " x6"	100 EA	1	110.25	110.25

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cap Screw, Hex, Gr. 8, UNRC				
1/2"x3/4"	100 EA	2	23.85	47.70
" " x1"	100 EA	2	26.20	52.40
" " x1-1/2"	100 EA	2	30.00	60.00
" " x2"	100 EA	2	37.90	75.80
" " x2-1/2"	100 EA	1	45.70	45.70
" " x3"	100 EA	1	56.35	56.35
" " x3-1/2"	100 EA	1	63.60	63.60
" " x4"	100 EA	1	71.65	71.65
" " x4-1/2"	100 EA	1	90.75	90.75
" " x5	100 EA	1	100.05	100.05
" " x5-1/2"	100 EA	1	109.35	109.35
" " x6"	100 EA	1	118.60	118.60
Cap Screw, Hex, Gr. 8, UNRC				
9/16"x1"	100 EA	1	49.70	49.70
" " x1-1/2"	100 EA	1	55.90	55.90
" " x2"	100 EA	1	62.95	62.95
" " x2-1/2"	100 EA	1	74.45	74.45
" " x3"	100 EA	1	86.35	86.35
" " x3-1/2"	100 EA	1	98.25	98.25
" " x4"	100 EA	1	110.10	110.10
" " x6"	100 EA	1	157.70	157.70
Cap Screw, Hex, Gr. 8, UNRC				
5/8"x1"	100 EA	1	52.35	52.35
" " x1-1/2"	100 EA	1	58.90	58.90
" " x2"	100 EA	1	65.85	65.85
" " x2-1/2"	100 EA	1	78.40	78.40
" " x3"	100 EA	1	90.75	90.75
" " x3-1/2"	100 EA	1	108.60	108.60
" " x4"	100 EA	1	121.60	121.60

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Cap Screw, Hex, Gr. 8, UNRC 5/8"x4-1/2"	100 EA	1	128.45	128.45
" " x5"	100 EA	1	140.95	140.95
" " x5-1/2"	100 EA	1	153.40	153.40
" " x6"	100 EA	1	165.95	165.95
Cap Screw, Hex, Gr. 8, UNRC 3/4"x1-1/2"	100 EA	1	99.40	99.40
" " x2"	100 EA	1	108.70	108.70
" " x2-1/2"	100 EA	1	131.85	131.85
" " x3"	100 EA	1	149.55	149.55
" " x3-1/2"	100 EA	1	167.25	167.25
" " x4"	100 EA	1	185.00	185.00
" " x4-1/2"	100 EA	1	193.45	193.45
" " x5"	100 EA	1	210.40	210.40
" " x5-1/2"	100 EA	1	227.25	227.25
" " x6"	100 EA	1	244.25	244.25
Nuts, Hex UNC 1/4"	100 EA	30	3.90	117.00
" 5/16"	100 EA	30	5.10	153.00
" 3/8"	100 EA	30	6.65	199.50
" 7/16"	100 EA	30	10.55	316.50
" 1/2"	100 EA	20	14.80	296.00
" 9/16"	100 EA	10	21.55	215.50
" 5/8"	100 EA	10	28.55	285.50
" 3/4"	100 EA	10	43.80	438.00
" 7/8"	100 EA	1	71.40	71.40
" 1"	100 EA	1	120.70	120.70
Nuts, Hex UNF 1/4"	100 EA	30	3.90	117.00
" 5/16"	100 EA	30	5.10	153.00
" 3/8"	100 EA	30	6.65	199.50
" 7/16"	100 EA	30	10.55	316.50

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Nuts, Hex UNF 1/2"	100 EA	20	14.80	296.00
" 9/16"	100 EA	10	21.55	215.50
" 5/8"	100 EA	10	28.55	285.50
" 3/4"	100 EA	10	43.80	438.00
" 7/8"	100 EA	1	71.40	71.40
" 1"	100 EA	1	120.70	120.70
Washers, Flat 1/4"	LBS	100	.45	45.00
" 5/16"	LBS	150	.45	67.50
" 3/8"	LBS	175	.40	70.00
" 7/16"	LBS	300	.40	120.00
" 1/2"	LBS	300	.40	120.00
" 9/16"	LBS	100	.40	40.00
" 5/8"	LBS	150	.40	60.00
" 3/4"	LBS	225	.40	90.00
" 7/8"	LBS	15	.40	6.00
" 1"	LBS	20	.40	8.00
Washers, Split lock 1/4"	100 EA	60	.60	36.00
" 5/16"	100 EA	60	.90	54.00
" 3/8"	100 EA	60	1.20	72.00
" 7/16"	100 EA	60	1.70	102.00
" 1/2"	100 EA	40	2.30	92.00
" 9/16"	100 EA	20	3.20	64.00
" 5/8"	100 EA	20	3.80	76.00
" 3/4"	100 EA	20	6.50	130.00
" 7/8"	100 EA	2	9.40	18.80
" 1"	100 EA	2	15.40	30.80
Screws, Lag 1/4"x2"	100 EA	1	13.70	13.70
" " x3"	100 EA	1	17.70	17.70
" " x4"	100 EA	1	21.65	21.65

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Screws, Lag 1/4"x5"	100 EA	1	28.75	28.75
" " x6"	100 EA	1	32.75	32.75
" 3/8"x2"	100 EA	1	17.20	17.20
" " x3"	100 EA	1	21.90	21.90
" " x4"	100 EA	1	26.65	26.65
" " x5"	100 EA	1	33.85	33.85
" " x6"	100 EA	1	41.35	41.35
" 1/2"x4"	100 EA	1	40.70	40.70
" " x6"	100 EA	1	56.75	56.75
" " x8"	100 EA	1	91.40	91.40
Screws, Machine, Slotted Pan 6-32x1/2"	100 EA	2	1.75	3.50
" " x3/4"	100 EA	2	2.20	4.40
" " x1"	100 EA	2	2.65	5.30
" " x1/2"	100 EA	2	3.50	7.00
" " x2"	100 EA	2	5.20	10.40
Screws, Machine, Slotted Pan 8-32x1/2"	100 EA	2	2.35	4.70
" " x3/4"	100 EA	2	2.85	5.70
" " x1"	100 EA	2	3.55	7.10
" " x1-1/2"	100 EA	2	4.75	9.50
" " x2"	100 EA	2	6.75	13.50
Screws, Machine, Slotted Pan 10-32x1/2"	100 EA	2	3.70	7.40
" " x3/4"	100 EA	2	4.70	9.40
" " x1"	100 EA	2	4.70	9.40
" " x1-1/2"	100 EA	2	6.10	12.20
" " x2"	100 EA	2	8.50	17.00
" " x2-1/2"	100 EA	2	11.10	22.20
" " x3"	100 EA	2	12.35	24.60

MATERIALS ESTIMATE
(Continued)

Item	Unit	Quantity	Unit Price (FOB US \$)	Total Cost (FOB US \$)
Nuts, Machine Screw 6	100 EA	5	5.50	27.50
" 8	100 EA	5	6.00	30.00
" 10	100 EA	10	6.25	62.50
Screw, Wood, Slotted Flat				
6x1	100 EA	5	6.00	30.00
" 6x1-1/2	100 EA	5	8.50	42.50
" 6x2	100 EA	5	11.50	57.50
" 8x1	100 EA	5	6.45	32.25
" 8x1-1/2	100 EA	5	8.50	42.50
" 8x2	100 EA	5	11.50	57.50
" 10x1	100 EA	5	7.50	37.50
" 10x1-1/2	100 EA	5	11.75	58.75
" 10x2	100 EA	5	15.25	76.25
" 10x3	100 EA	5	20.50	102.50
Tapping Screw, Slotted Pan				
6x1/2	100 EA	5	3.50	17.50
" 6x3/4	100 EA	5	4.00	20.00
" 8x1/2	100 EA	5	4.25	21.25
" 8x1	100 EA	5	5.25	26.25
" 10x1/2	100 EA	5	5.00	25.00
" 10x1	100 EA	5	6.50	32.50
" 10x1-1/2	100 EA	5	8.50	42.50
TOTAL				\$96,259.15 =====