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BULK WHEAT HANDLING AND STORAGE PILOT PROJECT IN PAKISTAN

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BULK WHEAT HANDLING AND STORAGE PILOT PROJECT IN PAKISTAN

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EXECUTIVE SUMMARY

The handling and storage costs for wheat are substantially higher in the bagged grain system currently in use in Pakistan than in the bulk system in use in the U.S., even though Pakistan's labor costs are dramatically lower. The two major differences between the U.S. and Pakistan grain movement systems are the handling and storage methods used and the element of competition resulting from private-sector involvement in the U.S. grain system.

The proposed conversion from a bagged grain handling, transportation, and storage system in Pakistan to an entirely bulk system is directed towards achieving such goals as foreign exchange savings on imported bags, reduction of grain losses, and reduction of handling and transportation costs. In addition, a bulk system allows for rapid grain handling, thus reducing the impact of inclement weather conditions during the harvest period by allowing the harvesting process to be completed within a shorter period of time.

A report by the Kansas State University Food and Feed Grain Institute (FFGI) entitled Review of the Feasibility of Bulk Wheat Handling and Storage in Pakistan indicated that there are no obvious technical reasons that would prevent Pakistan from converting to bulk handling and storage systems for wheat. However, currently available studies and reports on grain handling and storage in Pakistan give no guidance for achieving the objective of the introduction of commercial bulk systems. Most of the costs and technical factors associated with bulk system operations in Pakistan are unknown. Therefore, the report concluded that before large-scale commercial introduction of bulk systems is undertaken in Pakistan, an adaptation stage should be completed. To achieve this, the report recommended that a series of activities including pilot projects, training, and comprehensive planning be undertaken.

Based on recommendations presented in the report, the Ministry of Food, Agriculture and Cooperatives (MINFA) of the Government of Pakistan (GOP) requested that FFGI undertake and complete a detailed plan for a bulk wheat handling and storage pilot project in Pakistan. The recommended pilot project consists of six activities divided into two major components of the overall project.

The principal component includes the bulk test corridors which cover all handling, storage, and transport operations from the farm to final destination at flour mills; collection and analysis of data obtained from the tests conducted in the bulk corridors; and development of a systemwide implementation plan (SWIP) for commercial handling and storage systems. The objectives for this component are (1) to use two bulk test corridors to determine the performance of different types of facilities and equipment in the bulk handling and storage system under different operating environments, (2) to compare the results of one bulk test corridor with the other to determine the technical and economic feasibility of the individual components of the system, (3) to develop a SWIP based on the analysis of the technical and economic information generated by the bulk test corridors, and (4) to provide a set of systematized facilities for orientation, training, and demonstrations.

The bulk test corridors have been designed in accordance with historical grain flows, and therefore they have facilities, handling systems, and transport that are of sufficient size to simulate full-scale farm-to-market operations.

If the test corridors are used on a smaller scale, the results generated will not be applicable to the actual situation; larger-scale corridors are not considered to be economically feasible even for test purposes. By using full-scale models, the existing facilities will be easily incorporated into permanent systems if the pilot project is found to be successful.

The bulk test corridors were selected to represent geographical areas in which the movement of grain is from surplus areas of production to deficit regions where not enough grain is available for consumption. All components of the food system--including storage, collection, handling, transport, and distribution--will be present. The bulk test corridors selected were (1) Punjab (Dipalpur-Okara-Chichawatni) to NWFP (Peshawar), and (2) Sind (Khairpur) to Baluchistan (Quetta). These areas will make use of existing facilities which will include bulk silos and bunker storage. The existing system of procuring farmers' grain in bags will be discouraged but will not be abruptly discontinued so as not to exert unnecessary pressures on the producer/middleman, which may reduce the quantity of grain procured.

The Punjab to Peshawar corridor is to test a number of different types of storage facilities in the production area, including flat-bottomed corrugated steel bins, hopper-bottomed steel bins, and bunkers. Existing concrete silos and hexagonal bins will be incorporated into the system. In addition, a number of different types of handling equipment of different capacities will be tested and evaluated. The Punjab to Peshawar corridor will include two different types of origination terminals linked with two different types of destination terminals. A total of 96,000 MT of wheat will be handled each year. Wheat will originate from two different areas in this corridor, Dipalpur and Chichawatni.

The Khairpur to Quetta corridor will be limited to testing the results of modifications of existing silo facilities in Khairpur and Quetta, as well as additional backup testing of bulk handling at procurement centers, existing silo complexes, transport systems, and flour mills. A total of 60,000 MT of wheat will be handled each year, with the sole origination point being the Khairpur area.

Within the two bulk test corridors, different methods of transporting wheat will be tested to determine the effectiveness and cost of handling wheat in bulk. The tests will be common to both corridors and involve several different types of trucks as well as a new design for railcars. Bulk truck tests will incorporate five different truck types available for the handling of bulk grain. A single unit train composed of new railcars will be tested from Chichawatni to Peshawar and from Khairpur to Quetta. The unit train will consist of 30 identical railcars, each with a capacity of 50 MT. The cars will be designed to handle wheat and other whole grains in bulk. These railcars will operate under the control of Pakistan Railways and will be pulled by a dedicated locomotive which will stay with the train at all times. Utilization will be maximized by rapid loading and unloading through high-capacity terminal facilities.

The data collection process incorporated into the operation of the bulk test corridors will provide a structure within which to collect operational information to be used for later analysis. The information will include (1) quantity and quality of grain purchased, stored, and shipped, (2) all operational costs, and (3) technical operating factors.

The secondary component of the pilot project consists of improving the potential operating capability of existing silo facilities outside the bulk test corridors, specifically those at Faisalabad, Karachi, and Multan; conducting experimental applications of different bulk handling and storage designs in PASSCO warehouses and hexagonal bins; and conducting preliminary engineering surveys and feasibility studies for port grain terminal facilities. The objectives for this component are (1) to bring existing silo facilities outside the bulk test corridors up to the same level of operational efficiency as those which will be located within the bulk test corridors, (2) to test different bulk handling systems in PASSCO warehouses and hexagonal bins in order to determine the best technical and economical equipment configuration, and (3) to provide for port facility planning preparatory work which can be incorporated into the SWIP.

The activities under the second component are especially important when taking into consideration the SWIP. If the test corridors prove to be successful and a decision is made to implement changes in the entire handling and storage system, it will be necessary to understand how best to improve and modify the existing bag and bulk storage facilities, which can only be done through a procedure such as proposed under the secondary component of the pilot project. In addition, the technical and economic information gathered from these facility improvements will be useful in checking the information provided by the test corridors.

The scope of activities under this project is quite large and complex. There are numerous and varied elements which are subject to different time constraints, such as the wheat harvest period which provides a specific time for conducting tests. Therefore, a phased approach will be required, with target completion dates centered around the wheat harvest period of April/May of each year. Under the assumption that the project can be started by March 1988, the main target dates for completion of various physical components of the project will be May 1989, May 1990, and May 1991. Test operations of bulk corridors will be completed in May 1993. This allows a period of at least 2 full years for test operation of all of the elements of the bulk test corridors. The project activities will be carried out by MINFA, PASSCO, and a specialized foreign consultant organization.

Since this is a pilot project whose purpose is to test the feasibility of introducing commercial bulk grain storage systems into Pakistan, the requirement for initial investment is greater than for establishing commercial grain operations in a system which already has existing bulk handling. The total cost of the pilot project, which is $48,382,000, encompasses construction of new facilities, rehabilitation of and additions to existing facilities, storage facilities and equipment for flour mills, specialized transport equipment, training, technical assistance, data collection and analysis, and planning.

All of the components of collection, transportation, handling, and storage of grain in bulk, from the farm to the flour mill, are included in this project. High-capacity equipment has been selected for the project so that the rapidity of bulk grain handling can be tested in Pakistan and so that the facilities thus equipped can expand their storage capacity in the future without having to install new higher-capacity equipment. The facilities are designed as high-capacity handling terminals, not as long-term storage terminals. All equipment is to be imported, including safety equipment, spare parts, tools,

and portable generators. These items should have been included in the initial construction of the facilities that are scheduled to be improved, but since they were not, these expenses must be added to the capital costs of the project.

The trade-offs involved in the investment outlay for the pilot project bulk handling and storage facilities are the benefits of labor cost reduction; bag cost elimination; value of rapid receiving, handling, and shipping of grain; reduction of handling losses; and basis for development of a commercial bulk handling and storage system.

Investment outlay in the bulk test corridors amounts to $38 million. Potential savings resulting from bulk handling and storage of wheat amount to $2.9 million annually. The payback period in this case is 13 years. If the expected 6-percent grain loss reduction is attributed to the operations of the bulk test corridors, then this additional savings of $1.1 million annually would reduce the payback period for the bulk test corridors to 9 years. However, the pilot facilities have a capacity to handle more than 156,000 MT of wheat per year. If the amount of wheat handled in the bulk test corridors is doubled, then the payback period would be 7 years based on potential operational savings, and 5 years if the additional benefits of grain loss reduction are considered.

Since the 156,000 MT of grain projected to be handled under the pilot project is well below the capacity of the system, the project is underutilized at the present time, but will be able to easily accomodate future increases in grain volume. Due to this underutilization, the total cost of the project may seem to be quite extravagant, depending on the methods utilized to analyze these costs. However, based on the factors presented above, capital costs of the pilot project are not excessive.

SECTION I

INTRODUCTION

Background

Under the Storage Technology Development and Transfer (STDT) component of the Food Security Management (FSM) project sponsored by the Government of Pakistan (GOP) and the United States Agency for International Development (USAID), the Kansas State University Food and Feed Grain Institute (FFGI) sent a team to Pakistan to conduct a study and make recommendations relative to bulk handling and storage of wheat in Pakistan. The team made on-site reviews of current bulk storage conditions and conducted a review of studies to date on the feasibility of public-sector bulk storage facilities. These studies and reports suggest that financial benefits are possible by converting to bulk handling and storage. However, they fail to provide complete cost/benefit analyses of either a total system or its major components. The reports fail to provide a complete overall view of the eventual objective, nor do they define specific phased plans which could be reasonably implemented.

The team determined that there is no technical reason to prevent Pakistan from successfully converting to bulk handling and storage systems for wheat. The technical skill is available. The construction industry is highly developed. Considerable capability exists throughout the country for the supply, manufacture, and maintenance of machinery.

However, available studies and reports give no guidance for achieving the objective of the introduction of commercial bulk systems. Some of the costs and technical factors associated with bulk systems are unknown. Therefore, it was concluded that before large-scale commercial introduction of bulk systems is undertaken in Pakistan, an adaptation stage should be completed. To achieve this, the FFGI team recommended that a series of activities including pilot projects, training, and comprehensive planning be undertaken.

Terms of Reference

Based on the above study and the recommendations presented in the consultants' report entitled Review of the Feasibility of Bulk Wheat Handling and Storage in Pakistan, the Ministry of Food, Agriculture and Cooperatives (MINFA) of the GOP requested in January 1987 that FFGI undertake and complete a detailed plan for a bulk wheat handling and storage pilot project in Pakistan. The planning work was undertaken by a team of three engineers and an economist, and was divided into three phases. The activities in Phase I were carried out in Pakistan and included (1) site visits to various wheat storage and processing centers, (2) discussions with officials from central and provincial governments and private agencies who work with wheat storage, transportation, handling, and processing, (3) collection of data and information, and (4) definition of the scope of the pilot project. Phase II was carried out in the U.S., and its main activities consisted of (1) preparation of conceptual drawings for the project, (2) determination of technical and other needs of the project, (3) preparation of cost estimates, work plan, and schedules, and (4) project analysis and draft report preparation. The activities under Phase III, which took place in Pakistan, included (1) presentation and discussion of

the draft report with officials from GOP agencies and USAID, and (2) revision and modification of the draft report. After the activities in all the phases had been completed, the final report was prepared in the U.S. and sent to the GOP and USAID. The detailed Statement of Work is shown in Appendix I.

Pilot Project Concept

The GOP's interest in eventual conversion from a bagged grain handling, transportation, and storage system to an entirely bulk system is based on the desire to achieve such goals as foreign exchange savings on imported bags, reduction of grain losses, and reduction of handling and transportation costs. In addition, a bulk system allows for rapid grain handling. Bulk handling during the harvest period reduces the impact of inclement weather conditions by allowing the harvesting process to be completed within a shorter period of time.

The current cost for wheat moved from production centers within central Punjab to consumption areas in Peshawar is estimated at approximately Rs 950/MT ($1.52/bu). This cost includes Rs 600/MT for procurement, storage, and handling, plus Rs 350/MT for transport and distribution in NWFP. By comparison, the cost for wheat purchased from farmers and moved from a central Kansas country elevator to the Port of Houston (a distance equivalent to that between central Punjab and Peshawar) is approximately Rs 537/MT ($0.86/bu) for procurement, handling, storage, and transport. The current cost for wheat moved from production centers within Punjab to flour mills in Lahore is estimated at approximately Rs 600/MT ($0.96/bu). By comparison, the cost of wheat moved to a flour mill in Kansas City from a country elevator where grain is purchased from farmers (equivalent to distances within Punjab) is approximately Rs 237/MT ($0.38/bu). The handling and storage costs for wheat are substantially higher in the bag system in Pakistan than in the bulk system in use in the U.S., even though Pakistan's labor costs are dramatically lower. The two major differences between the U.S. and Pakistan grain movement systems are the handling and storage methods used and the element of competition resulting from private-sector involvement in the U.S. grain system.

As stated earlier in this section, a comprehensive economic analysis on the feasibility of the conversion to a commercial bulk wheat handling and storage system is not possible at this stage, because a complete set of accurate and detailed data for a bulk system in Pakistan is not available for making the comparison with the bagged system. Due to the lack of data necessary for constructing commercial storage systems, it was proposed that an adaptation stage be implemented before attempting to introduce commercial systems.

The pilot project recommended for this purpose consists of six activities divided into two major components of the overall project. The structure and breakdown of project activities is illustrated in Figure 1, showing the sequence of activities for Component I and Component II leading to the final goal of implementation of a commercial bulk wheat handling and storage system.

The principal component includes the bulk test corridors which cover all handling, storage, and transport operations from the farm to final destination at flour mills; collection and analysis of data obtained from the tests conducted in the bulk corridors; and development of a systemwide implementation plan (SWIP) for commercial handling and storage systems. The objectives for

this component are (1) to use two bulk test corridors to determine the performance of different types of facilities in the bulk handling and storage system under different operating environments, (2) to compare the results of one bulk test corridor with the other to determine the technical and economic feasibility of the individual components of the system, (3) to develop a SWIP based on the analysis of the technical and economic information generated by the bulk test corridors, and (4) to provide a set of systematized facilities for orientation, training, and demonstrations.

Since the findings to date are inconclusive as to the benefits of bulk grain systems in Pakistan, the bulk test corridors will generate the needed information to ensure that commercial system introduced will be applicable to Pakistani conditions. These bulk test corridors have been designed in accordance with historical grain flows, and therefore they have facilities, handling systems, and transport that are of sufficient size to simulate full-scale farm-to-market operations. If the test corridors are used on a smaller scale, the results generated will not be applicable to the actual situation; larger-scale corridors are not considered to be economically feasible even for test purposes. By using full-scale models, the existing facilities will be easily incorporated into permanent systems if the pilot project is found to be successful. This will reduce the need for new construction, thereby maximizing the usefulness of the existing facilities and reducing the cost of the project. Another important consideration for the bulk test corridors is the operational period needed to produce valid results. In this case, a minimum period of 2 years of operation is required to obtain the data that will enable commercial systems to be tailored to local conditions and needs.

The bulk test corridors were selected to represent geographical areas in which the movement of grain is from surplus areas of production to deficit regions where not enough grain is available for consumption. All components of the food system--including storage, collection, handling, transport, and distribution--will be present. The bulk test corridors selected were (1) Punjab (Dipalpur-Okara-Chichawatni) to NWFP (Peshawar), and (2) Sind (Khairpur) to Baluchistan (Quetta). These areas will make use of existing facilities which will include bulk silos and bunker storage. Other available facilities, such as the warehouses belonging to the Pakistan Agricultural Storage and Services Corporation (PASSCO), will be dealt with under the secondary component of the project so that they may be gradually incorporated into a commercial bulk system as the need for bag handling of grain decreases. The existing system of procuring farmers' grain in bags will be discouraged but will not be abruptly discontinued so as not to exert unnecessary pressures on the producer/middleman, which may reduce the quantity of grain procured.

The secondary component of the pilot project consists of improving the potential operating capability of existing silo facilities outside the bulk test corridors, specifically those at Faisalabad, Karachi, and Multan; conducting experimental applications of different bulk handling and storage designs in PASSCO warehouses and hexagonal bins; and conducting preliminary engineering surveys and feasibility studies for port grain terminal facilities. The objectives for this component are (1) to bring existing silo facilities outside the bulk test corridors up to the same level of operational efficiency as those which will be located within the bulk test corridors, (2) to test different bulk handling systems in PASSCO warehouses and hexagonal bins in order to determine the best technical and economical equipment configuration, and

(3) to provide for port facility planning preparatory work which can be incorporated into the SWIP.

The activities under the second component are especially important when taking into consideration the SWIP. If the test corridors prove to be successful and a decision is made to implement changes in the entire handling and storage system, it will be necessary to understand how best to improve and modify the existing bag and bulk storage facilities, which can only be done through a procedure such as proposed under the secondary component of the pilot project. In addition, the technical and economic information gathered from these facility improvements will be useful in checking the information provided by the test corridors.

Finally, success of the pilot project depends on making a single agency responsible for the planning, management, and operation of the project. This agency must have in-depth experience in procurement, storage, handling, and distribution of wheat. It is recommended that PASSCO be the implementing agency for this pilot project since it satisfies the requirement for experience in the areas mentioned above, and since its management structure is conducive to multifaceted operations such as those represented in the project.

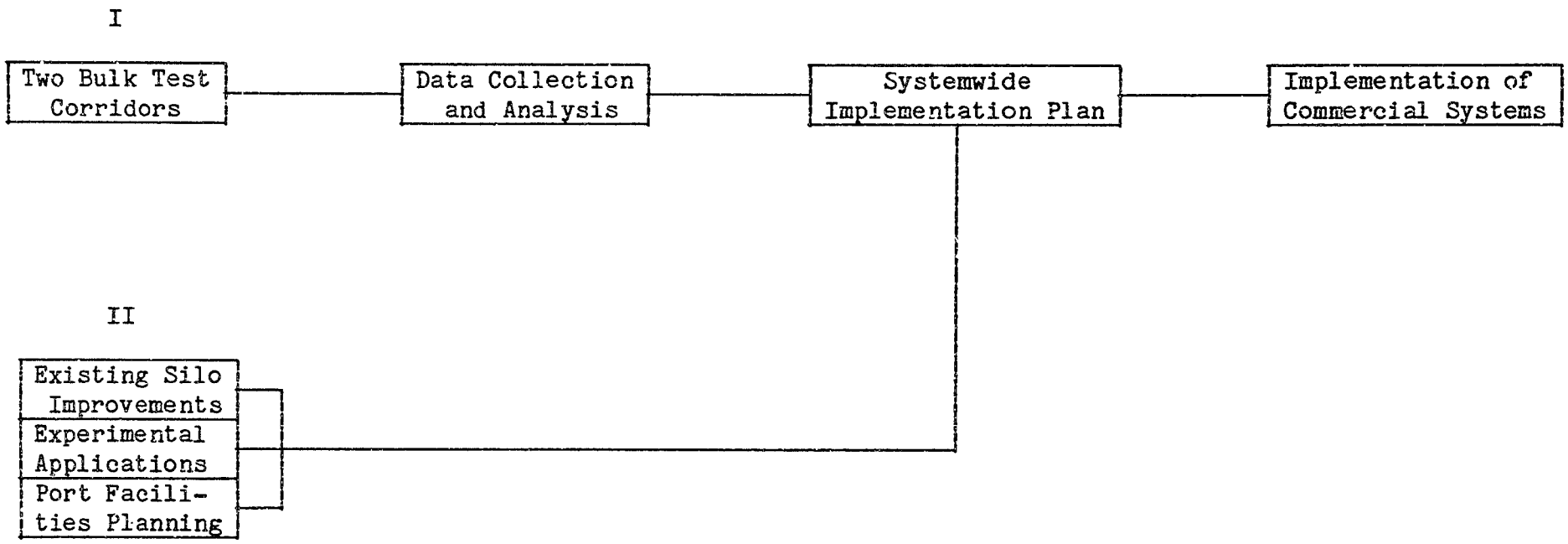


FIGURE 1. Components of Bulk Wheat Handling and Storage Pilot Project

SECTION II

EXISTING SYSTEM

Since PASSCO is likely to be the agency to manage the pilot project, and since a major portion of the marketable wheat surplus (56.4 percent in Sind and 45.6 percent in Punjab) is purchased by PASSCO and Provincial Food Departments (PFDs), the team's effort was directed towards studying the elements of the postharvest system for wheat that involve PASSCO and PFD operations. Any existing activity related to bulk grain handling and storage within other agencies was also studied.

Harvesting and Threshing

In Pakistan, a large quantity of wheat is harvested manually and threshed mechanically. The manual harvesting method consists of cutting the straw a few inches above the ground by using sickles, forming the cut wheat into bundles, and making the bundles into stacks in the middle of the field. The stacks remain in the field until threshers are available, usually on a hired basis. The threshers are driven by tractor power-take-off and thresh the grain at a rate of 0.5 to 0.75 MT/hr. The threshing charge in 1987 was Rs 7 per 40-kg bag. Some farmers also use animals for threshing.

In major wheat-producing areas of Punjab and Sind, self-propelled combine harvesters have been introduced in recent years, and the usage of combines is apparently spreading rapidly. The predominant type is Clas 68 with a 14-ft header, but some John Deere 1055R combines are also used. The combines are generally owned and operated by the private sector and are available for hire to farmers. In the 1987 harvest season, the custom harvest rate was about Rs 400 per acre for wheat, Rs 350 per acre for rice, and Rs 350 per acre for sunflowers. Under the present conditions, the Clas 68 combine has a capacity of about 25 acres per day on a 9-hr basis. The demand for custom combining seems to be very high, and one combine was reported to have harvested 850 acres of wheat, 350 acres of rice, and 350 acres of sunflowers last year.

Possible reasons for the expansion of combine usage are (1) wheat harvested by combine contains less foreign material, such as straw, as compared to manually-harvested and mechanically-threshed grain, (2) combine harvesting eliminates substantial amounts of labor for stacking after manual harvest and subsequent threshing, (3) time is saved and land is freed for planting other crops such as cotton, and (4) field losses are reduced.

Grain harvested by combine is transported from the field in 10-MT bulk lots to a nearby temporary bulk pile usually within about 1 km from the field. Subsequent bagging is done before delivery to the procurement centers.

Pakistani farmers can choose to sell wheat to local shopkeepers, itinerant traders (Beopari), commission agents (Arhti), or to the government procurement centers at the official price set by the government. Grain received in the procurement centers from small farmers is generally bagged in the field and then transported by animal-drawn carts, tractor-driven trolleys, or trucks. In some areas, 80 to 90 percent of the grain received in the government procurement centers comes from the Arhtis. Arhtis perform a vital role by providing

financing to farmers. During the harvest season, Arhtis employ subagents who own carts or other modes of transport. Arhtis or their subagents sometimes transport the grain in bulk from the field to a collection point and store grain in a temporary bulk pile before bagging the grain for onward transportation to procurement centers.

Purchase Centers

Government purchase centers are divided between PASSCO and PFD operation under the uniform annual Wheat Procurement Policy formulated by the GOP. PASSCO is mandated to procure wheat from Punjab and Sind (and this year from Baluchistan) and deliver the procured grain to deficit provinces, usually NWFP and Baluchistan. The procurement provinces are divided into zones, zones are divided into projects, and projects are subdivided into purchase centers. According to the 1987 Wheat Procurement Policy, PASSCO grain purchases were restricted to 14 zones consisting of 49 projects or 281 purchase centers. The procurement target was fixed at 1.68 million MT in Punjab, 60,000 MT in each of Sind and Baluchistan. The purchase price for 1987 was fixed at Rs 2 per kg, and a delivery charge of Rs 0.85 per standard bag of 95-kg net weight was paid to the sellers if they did the unloading, stitching, and stacking of bags at purchase centers.

The purchase centers are usually mobile and set up in open fields, factory premises, or local shop compounds each year, depending on the convenience, availability of space, and cost of rent. Producers and Arhtis tender the bagged grain to purchase centers for sale. Lots consisting of less than 10 bags are not accepted. In addition, wheat not meeting the Fair Average Quality (FAQ) standard is rejected. FAQ is a subjective standard regarding moisture, foreign material, damage, and insect infestation. The main reason for rejecting wheat is excessive foreign material. The sellers can use the purchase center facilities to clean the grain at their own expense, usually by manual sieving and winnowing, so as to upgrade the grain to the FAQ standard.

The bags for grain tendered by producers and Arhtis are distributed at the purchase centers. Since jute bags are an imported commodity, an elaborate and time-consuming procedure is used for inventory control. Bags are stenciled showing PASSCO's name, commodity name with production year, and identifying codes for zone, project, and purchase center. The stenciled bags are issued to growers who tender stocks up to 500 bags on their personal surety upon certification by members of national/provincial assemblies, councilors, magistrates, and bank managers. Alternatively, a cash security of Rs 16 per bag up to 1,000 bags is accepted. The security money is returned as soon as grain is delivered in the same bags. Sewing thread and other supplies are to be supplied by the sellers.

Each purchase center is managed by a purchase inspector, an assistant purchase inspector, and two to three security guards. Most purchase centers are generally accessible from nearby population centers by motor vehicles. Some purchase centers have relatively difficult access to transportation because of inadequate roads. Many purchase centers are connected to electric power lines, even though power is not dependable. Grain from the purchase centers is transported to "reservoirs" for storage during and immediately after harvest because purchase centers in general do not have any storage facilities.

Dipalpur Reservoir

This reservoir is located in the Okara zone, a major wheat-producing area of Punjab. The reservoir has access to good roads but not to rail lines, is connected to public electricity, and is served by ten purchase centers with a total 1987 procurement target of 50,000 MT of wheat. Grain is received and shipped in bags. Storage consists of two bulkheads, bag storage on brick dunnage, and bag storage in the warehouse. Each bulkhead consists of an asphalt floor designed to shed water, and a 4-ft high removable side wall made of corrugated galvanized sheet metal with steel supports. The bulkhead is 250 ft long and 50 ft wide, with a capacity of 2,700 MT, and covered by 100-ft x 60-ft sections of imported plastic cover. To reduce the cost, PASSCO plans to use local tarpaulins this year. The bulkheads have been used for the last 3 years, and wheat with 8 to 9 percent moisture content was successfully stored for 9 months with very negligible losses.

Bag storage on brick dunnage is done by making stacks of 30 ft x 30 ft each. A number of stacks (eight stacks in a particular year) are clustered together by leaving a 10-ft space between stacks. The stacks are covered by tarpaulins. Up to 20,000 MT was stored in this form.

The PASSCO facility also consists of two 100-ft x 50-ft house-type godowns (HTG). As the HTG space was not sufficient, bulkheads and bag storage on brick dunnage were added.

Okara Warehouses

Grain from the Dipalpur reservoir is moved to Okara for longer-term storage and onward shipment. Like Dipalpur, this site does not have any railway siding, and shipment by rail is done from the nearby railway station. The site has access to good roads, electric supply, and is about a 30-minute drive from Dipalpur.

This PASSCO facility consists of 17 HTGs each with 1,100 MT of bag storage capacity. To eliminate the problem of severe shortages of storage space, PASSCO improvised bulk storage methods by which the warehouse capacities could be substantially increased. One of the methods consisted of building retaining walls made of grain bags, inside and parallel to the warehouse walls, leaving about 3 ft of space between the retaining wall and warehouse walls. The space formed by the retaining walls was used to store bulk grain. By this method the storage capacity was increased to 1,500 MT. In another method, the retaining walls were made of removable galvanized iron sheets and steel supports. With this method, the storage capacity was increased to 1,700 MT. The third method consisted of using a set of grain handling equipment to fill the warehouse by opening the bags at the equipment intake located outside the building. This method was intended to minimize the labor requirement of the first two methods. However, all three methods consisted of emptying and filling the bags during receiving and shipping of grain.

This site also has a bulkhead with the same construction features as Dipalpur except for minor differences in dimensions: the Okara bulkhead is 200 ft long and 60 ft wide. Filling is done with mobile diesel-powered inclined bucket elevators and/or electric-powered inclined transport augers.

NLC Silos

Under the supervision of the National Logistic Cell (NLC) of the Pakistan Defense Ministry, a number of bulk grain storage projects were undertaken at Chichawatni, Khairpur, Quetta, Faisalabad, and Karachi. The Chichawatni and Khairpur silos are operational and managed by PASSCO. In these two silos, grain is received and shipped in bags, thus reducing the benefits of bulk storage and handling. The Quetta silo is completed but not in operation. The remaining silos are at various stages of construction.

Chichawatni Silo

Located in the Sahiwal zone of Punjab, another major wheat-producing area, this silo was engineered by local consultants. Civil construction was done locally. Mechanical and electrical equipment was supplied and erected by a Danish manufacturer. The project was undertaken in 1981 and the silo became operational in 1985. The 50,000-MT facility consists of 14 free-standing concrete bins each with a 50-ft diameter and 71-ft wall height, with a metal cone roof fixed to the bin wall. A small bagging house with 1,000 MT of bagged grain storage capacity is also provided.

In 1986, the silo received grain from purchase centers located up to 25 miles away. The procurement target for 1987 was set at 50,000 MT to be accomplished through four purchase centers located within a 15-mile radius of the silo. Transportation data for this silo for 1987 are given in Table 1, Appendix II. During harvest, grain is received at the silo at a maximum rate of 1,000 MT in a 10-hour working day. Shipment from the silo goes mainly to Peshawar in NWFP and is carried through road and rail transport. Rail shipment is somewhat limited because of the lack of engine availability on a timely basis, the difficulty of moving the railcars by mechanical means, and the payment of demurrage to the railway. About 90 percent of the grain is shipped by truck because of the speed, flexibility, and ease of loading of this method. However, the cost of transportation to Peshawar by truck is generally higher than by train. A large amount of carry-over from 1986 operations has reduced the available storage space of the silo. Rapid grain movement out of the silo, additional provisions for storage in the purchase centers, and arrangement for the grain to bypass the silo are possible measures for relieving the pressure on the facility. However, there are many problems including design, structural, mechanical, electrical, operational, and maintenance aspects that will prevent rapid grain movement. Some of the problems are listed below.

Design. The fertile production areas are located on the east side of the busy Multan-Lahore railway track, but the silo is located to the west of it. Passing trains create a long waiting period for the incoming and outgoing vehicles. This reduces the vehicle turnover rate, especially during the busy harvest period, and prevents the full utilization of silo handling capacities. If the Chichawatni silo had been located on the east side of the railway track, the silo could have been utilized as a purchase center, in addition to its main role as a reservoir. This would eliminate one step in the grain storage and handling process. Because of this design constraint, an unnecessary purchase center at Mundi, which is only 1 mile away from the silo and to the east of the railway, was developed to serve the area farmers.

The silo site is at a lower level than the surrounding area. Inadequate drainage causes water seepage into the bins. The bins have a flat bottom with

only one small discharge opening at the center to feed grain into an unloading screw conveyor. This leaves a large amount of grain that can not be removed by the conveyor, thus requiring the use of slow and laborious processes of manual removal of grain. Bin filling is difficult and slow because gates are operated from difficult-to-access places on the bin tops. Grain reception is halted during rain because there is no roof above the receiving area.

Structural. Excessive vibration of the headhouse during cleaner operation could create major problems.

Mechanical. Lightweight and inadequate spout design and specifications resulted in rapid wear.

Electrical. Outside insulation of electrical cables was deteriorating rapidly. There is no standby electric generator. Work stoppages occur frequently because of load shedding and other causes of power outage. Lighting for work and site security is inadequate.

Operational. The portable aeration fans are difficult to handle and appear abandoned. The bagging machine was designed for 85-kg bags. After the recent government directive to standardize bag size at 100 kg, the use of the bagging machine was discontinued and bagging and weighing are done manually. This has considerably slowed down operations. Government policy discourages the use of grain cleaners except for export grain. There is no provision for separation of magnetic material from the grain. The lack of automatic equipment makes insect control difficult.

Maintenance. Maintenance of overhead equipment is difficult because of inadequate accessibility and workspace. Inadequate workshop facilities, including tools and spare parts, make maintenance difficult. Maintenance manuals are not available.

Khairpur Silo

PASSCO's grain procurement activity is restricted to the Khairpur zone of Sind. The zone consists of two projects at Gambat (12 purchase centers) and Kandyaro (10 purchase centers), each with a 1987 grain procurement target of 30,000 MT. The Khairpur silo serves as a reservoir for this zone. The silo has the same storage capacity, specifications, and construction features as the Chichawatni silo.

The silo was commissioned in 1983 and the quantity of grain handled since then has varied from a low of 4,000 MT in 1983 to a high of 28,400 MT in 1985. Shipment in 1987 through April was 22,800 MT.

Grain is received in trucks during a period extending from mid-April to the end of June at a maximum rate of 1,100 MT in a 10-hr working day. Unlike the Chichawatni silo, the purchase centers serving this silo are located as far away as 100 km. Sometimes grain may be received from as far away as Nowabshah, a surplus wheat area about 250 km from Khairpur. The long distance and relative inferiority of roads leading to the silo from the purchase centers will have to be of special consideration in the pilot project design.

About 90 percent of the grain goes to Quetta in Baluchistan and very little to Peshawar in NWFP. The maximum shipment rate is about 600 MT per day accomplished by rail (70 percent) and road (30 percent).

Many of the problems at this site are the same as at Chichawatni, including design, structural, mechanical, electrical, maintenance, and rail shipment problems. The same operational problems exist; however, in the Khairpur silo each bin is provided with a separate aeration fan. Water seepage into the rail receiving pit and tunnel needs to be corrected. The bin temperature monitoring system is inoperable. There is improper leveling of the railway platform and receiving pit. The weigh bridge gives erroneous readings.

Quetta Silo

Located in the capital of Baluchistan, the silo was intended to serve as a main grain receiving and distribution point in the province. Even though NLC has declared the silo as ready for usage, PASSCO refuses to accept the silo in the present form because of numerous major problems, and the silo remains idle. The major problems include poor design and construction of equipment and use of substandard materials and specifications. Major improvement work will be needed to bring the silo up to operating standards.

The projected 1987-88 wheat deficit for Baluchistan is 480,000 MT. In 1986, 390,000 MT of wheat was received in Baluchistan from Punjab and Khairpur: 330,000 MT by rail and the remainder by road. Of the grain received by rail, only 30,000 MT was received at rail stations other than Quetta.

The projected amount of grain to be received in Quetta in 1987 from the Khairpur silo is 53,000 MT, of which 40,000 MT will be received by rail and the remainder by road. A one-way trip from Khairpur to Quetta takes a week by rail and one day by road.

In Quetta, wheat is distributed by the PFD to 15 flour mills ranging in milling capacity from 30 to 80 MT per 24-hr day.

PASSCO Hexagonal Bins, Khanewal

This facility consists of two identical sets of 98 hexagonal bins each, a third set with 42 hexagonal bins, and a HTG. The storage capacity is 3,500 MT for each of the two identical sets, 1,500 MT for the third set, and 500 MT for the HTG. A truck scale (80 MT) was under construction to receive bulk grain. A bulk grain receiving hopper and shipping provisions were also under consideration.

PASSCO has been experimenting for some time with various methods of mechanizing the filling and emptying of the bins. The results of the experiment indicated that the use of a bucket elevator for vertical lifting and a fixed screw conveyor for horizontal transportation was the most economical method of bin filling. Other methods were also tested using different combinations of bucket elevators or pneumatic conveyors for vertical lifting, and manual labor or screw conveyors or pneumatic conveyors for horizontal transport of grain on the bin top. Pneumatic conveyors, piping, and screw conveyors have technical deficiencies related to the selection of construction materials, structural needs, and erection procedures.

The Khanewal facility receives grain from 18 purchase centers. The procurement target for 1987 in these purchase centers has been set at 40,000 MT. About 90 percent of the grain procured in Khanewal usually comes from Arhtis. The average farm size serving this facility ranges from 10 to 20 acres and as such Arhtis play a major role. About 100 Arhtis operate in this area and each of them typically employs about 15 subagents for helping in grain transportation. Subagents usually use bullock carts since tractors, trolleys, and trucks are generally unavailable due to the planting of cotton and harvesting of wheat. Each Arhti can tender for sale up to 40 MT wheat per day to the Khanewal facility, making a total of about 4,000 MT daily.

Food Department Hexagonal Bins, Peshawar

NWFP Food Department grain storage consists of seven locations - three in Peshawar, one in Nowshera, one in Charchadda, and two in other places. The total annual wheat received from outside the province is 360,000 MT, of which 200,000 MT is transported by rail and the remainder by road. The average monthly quantity shipped is 30,000 MT. Grain purchased from within the province was only 10,000 MT last year.

The storage capacity for the three sites in Peshawar is 50,500 MT and consists of 44 HTGs and four identical clusters of 42 hexagonal bins each. The cluster plan view is identical to the first set of the Khanewal hexagonal bin layout. Each bin capacity is about 36 MT, making a total hexagonal bin capacity of 6,000 MT. The hexagonal bins, even though they are old, seem to be in reasonable condition for bulk grain storage. The hexagonal bins are used for long-term storage. Grain was stored in these bins for more than 2 years without any substantial damage.

Filling and emptying the bins is labor-intensive and slow. The bags are lifted to the top of the bin and opened by manual labor for bin filling; the grain is bagged and the bags are stitched manually during bin emptying. The labor cost in 1987 for putting the grain in and out of the bins was Rs 26 per MT, which was Rs 15 per MT higher than putting the grain in and out of the HTGs.

The hexagonal bin site also includes 24,500 MT of HTG storage and is located in a congested area of Peshawar. The site does not have any rail siding and is served by trucks (10 to 12 MT capacity) and trailers (30 to 40 MT capacity). During harvest time about 1,000 to 1,200 MT of wheat is received in a day from small trucks or combinations of trucks and trailers. Since most of the grain is received by rail, the PFD operates a rail siding in another location in Peshawar. The grain is unloaded from the train, loaded into trucks, and sent to the storage points in Peshawar or elsewhere. This rail siding is also located in a congested area of Peshawar.

Food Department Silo, Multan

This facility consists of both bulk and bag storage. The total storage capacity is 53,220 MT, of which 42,220 MT is in bulk and 11,000 MT in three HTGs. The bulk facility includes a 15-MT truck scale and an 8-ft x 8-ft bulk receiving hopper grate. The storage units consist of six bolted steel tanks 60 ft in diameter with 40-ft eave height, and four bolted steel tanks 80 ft in diameter with 40-ft eave height. The storage tanks are generally in good

condition, but many problems exist. The major problem is the inability to mechanically remove the residual grain in the flat-bottomed bins because of an insufficient number of discharge holes. The facility is operational but inefficient because grain is received and shipped in bags.

Wheat is usually received from purchase centers up to 30 miles away at a maximum rate of 1,100 MT daily. The grain is usually shipped to local flour mills and deficit areas within Punjab at a capacity of about 450 MT/day. Four large local flour mills (milling capacity of 600 MT/24 hr) and several smaller mills are served. The area serving this facility includes some farms as large as 1,000 acres of land.

Flour Mills

Quetta Flour Mills. There are fifteen private flour mills in Quetta with milling capacities ranging from 60 to 144 MT/24-hr day (Table 3, Appendix II). The actual practical range of the capacities could be as low as 30 to 80 MT/24-hr day.

The flour mills at Bolan and Jamal were visited by the team. These two mills are located in a congested area of Quetta. Space for additional bulk storage capacity in these two mills was found to be somewhat limited.

Each flour mill in Quetta typically has a covered storage capacity of 100 to 500 MT. Eight flour mills also have additional uncovered storage space varying from 400 to 1,600 MT.

Peshawar Flour Mills. The team visited two flour mills in the Peshawar area at Bilour and Ashraf. The Bilour flour mill was built in 1969, is equipped with eight roller machines, and has a milling capacity of 160 MT/24-hr day. The Ashraf flour mill was built in 1986 and has an identical milling capacity and number of roller machines as the Bilour flour mill. Adequate space is available in these flour mills for constructing additional bulk facilities.

Private millers in Quetta and Peshawar do not have any experience in bulk grain storage and handling within their mills, and as such expressed concern regarding weighing and other operational procedures of a bulk system. However, the millers were eager to participate in the pilot project activities.

SECTION III

RECOMMENDED PROJECT: BULK TEST CORRIDORS

The purpose of this first component of the pilot project is to test farm-to-mill systems for the purchase, handling, storage, and sale of wheat in bulk. The bulk test corridors will consist of the collection of grain at the purchase center, transportation of the grain to the storage center, storage of the grain, transportation to the dispatch terminals, and final delivery to flour mills. Each of these functions will be accomplished by providing adequate facilities with equipment for bulk transport, weighing, handling, storage, quality control, and preservation.

Two main corridors have been selected for the pilot project. One corridor is from Okara-Dipalpur-Chichawatni (central Punjab) to Peshawar (NWFP). The second corridor is from Khairpur (northern Sind) to Quetta (Baluchistan). Both corridors are designed to facilitate the primary mission of PASSCO, which is to redistribute excess wheat production from surplus areas to deficit areas. The geographic locations involved in the bulk test corridors can be seen in Figure 2. This figure also illustrates major highways and rail lines.

Bulk Test Corridor: Punjab to Peshawar

This corridor is to test a number of different types of storage facilities in the production area, including flat-bottomed corrugated steel bins, hopper-bottomed steel bins, and bunkers. Existing concrete silos and hexagonal bins will be incorporated into the system. In addition, a number of different types of handling equipment of different capacities will be tested and evaluated.

The Punjab to Peshawar corridor will include two different types of origination terminals linked with two different types of destination terminals. The flow of wheat and projected volumes are presented in Figure 3. The geographic location of procurement and related storage centers is illustrated in Figure 4. A total of 96,000 MT of wheat will be handled each year. Wheat will originate from two different areas in this corridor, Dipalpur and Chichawatni.

Dipalpur Area. The Dipalpur origination area is shown in Figure 5. This area includes the Dipalpur Bulk Dispatch Terminal; the Mobile Purchase Centers (MPC) at Amli Moti, Mazharabad, and Dipalpur market; and the Bulk Purchase and Storage Centers at Sukhpur, Pipli Pahar, and 40/D. The Dipalpur Bulk Dispatch Terminal will be the headquarters for the operations of the entire area.

Four purchase centers will serve as origination points for the Dipalpur Bulk Dispatch Terminal. No wheat will be stored overnight at any of these four purchase centers. Three of these centers--the MPCs at Amli Moti, Mazharabad, and the Dipalpur village market--will be equipped for bulk handling. Mobile equipment will be set up at the three MPCs during the harvest season. Wheat arriving in bulk at the three MPCs will be weighed, purchased, and loaded immediately into waiting trucks. As the trucks are filled, they will move to the Dipalpur Bulk Dispatch Terminal and discharge the wheat into storage. Any bags of wheat arriving at the three MPCs will immediately be opened and loaded in the trucks. However, the purchase of wheat in bags will be discouraged by providing better service for wheat that arrives in bulk.

The fourth purchase center at Dharma will continue with the present bag handling system. Wheat procured at this center will be moved in bags daily to the Dipalpur Bulk Dispatch Terminal where the bags will be opened and the wheat received into the bulk facilities.

The Bulk Purchase and Storage Centers at Sukhpur, Pipli Pahar, and 40/D will receive and store wheat in bulk until it is needed for shipment to Peshawar. Any bags of wheat arriving at these centers will be opened and the wheat will be placed into bulk storage. As with the MPCs, handling of bagged wheat will be discouraged by providing better service for wheat that arrives in bulk.

When harvest is complete, the mobile equipment at all these facilities will be moved to the Dipalpur Bulk Dispatch Terminal where it will be used to facilitate movement and handling of wheat throughout the year.

Dipalpur Bulk Dispatch Terminal

The Dipalpur Bulk Dispatch Terminal will be developed on the site where bulkhead storage has been used for a number of years. This facility will become the central collection, storage, and dispatch facility. The site plan and flow diagram for this terminal are shown in Figures 6 and 7, respectively.

The principal features of the Dipalpur Bulk Dispatch Terminal facility will include two existing bulkheads of 2,700 MT of capacity each, a new 5,000-MT bulkhead, 5,000 MT of storage in hopper-bottomed bins, loading and unloading equipment for the storage facilities, truck receiving and loading facilities, and mainterance facilities for the region. The design specifications for this terminal are as follows:

- Annual throughput: 15,000 MT
- Average receipt during 30-day harvest period: 500 MT/day
- Truck receiving rate during harvest: 17 30-MT or 50 10-MT trucks/day
- Receiving handling rate: 200 MT/hr
- Average dispatch rate throughout year: 50 MT/day
- Loading handling rate: 200 MT/hr

Table 1 presents a list of the storage facility and equipment requirements at this location.

Mobile Purchase Centers

The MPCs at Amli Moti, Mazharabad, and the Dipalpur market will be equipped to sample, test, receive, weigh, and move between 3,000 and 5,000 MT of wheat to the Dipalpur Bulk Dispatch Terminal during a 30-day harvest season. Each center will be designed to handle up to 300 MT daily. The site plan for the Amli Moti and Mazharabad MPCs is shown in Figure 8. The site plan for the MPC at the Dipalpur market will be similar.

The centers at Amli Moti and Mazharabad are Type MPCA centers, and the major equipment will include the following:

1. Three 30-MT semitrailer trucks with solid metal covers, center slot filling, and hopper-bottom discharge. The trailers will be convertible for use in hauling general box cargo. These trucks will be used for movement of wheat to Peshawar throughout the year.

2. One portable platform scale suitable for weighing trolleys filled with bulk wheat.

3. One portable electric-motor-powered inclined conveyor with dump pit suitable for receiving bulk wheat from trolleys and loading it into the trucks.

4. Four portable hopper scales for weighing small quantities of bulk wheat that do not arrive in trolleys or wheat that arrives in bags. They are similar to the platform scales presently in use for weighing bagged wheat except that they have a bulk hopper in place of the platform.

5. Four wheel-mounted electric-motor-powered inclined conveyors to move bulk grain into the hopper scales and from the hopper scales into the trucks.

6. One mobile office and grain laboratory complete with sampling and testing equipment.

7. One trailer-mounted generator set.

The center at the Dipalpur market is a Type MPCB center, and will handle wheat piled in bulk in the market area. The equipment at this center includes the same hopper scales, office, laboratory, and generator set. Additional equipment is as follows:

1. Five 10-MT capacity self-dumping grain trucks with solid metal covers and center slot filling. These trucks will also be used within the Dipalpur Bulk Dispatch Terminal throughout the year to unload the bulkheads into vertical storage in preparation for loading wheat onto the larger long-haul trucks.

2. Four tractor-mounted inclined conveyors with pick-up scoop and auger suitable for picking up bulk wheat piled on the ground, or dumped from bulk scales, and loading it into the trucks.

3. Two small wheel-loaders suitable for picking up grain from piles and loading hopper scales.

Bulk Purchase and Storage Centers

Bulk Purchase and Storage Centers will be constructed at Sukhpur, 18 km west of Dipalpur, and at Pipli Pahar and 40/D, 18 km north of Dipalpur. The site plan for Sukhpur is shown in Figure 9, with the other centers being similar in nature except for the type of storage facilities used. The facilities at Sukhpur will consist of flat-bottomed corrugated steel bins similar to farm storage found in the United States. The facilities at Pipli Pahar and 40/D will consist of bulkheads. Storage facility and equipment requirements for these three centers are given in Table 2.

Tractor-mounted inclined conveyors will be used to transfer wheat from trolleys, carts, and small trucks to portable bulk scales similar to those used at the MPCs. From the bulk scales, the wheat will be conveyed by tractor-mounted inclined conveyors into the storage facilities. The wheat will remain in storage until dispatched to Peshawar throughout the year by 30-MT bulk trucks.

Operations personnel will be dispatched from the Dipalpur Bulk Dispatch Terminal along with the trucks to be loaded. The trucks will be tare-weighed at the terminal and then proceed to the centers. At Sukhpur, the trucks will be loaded by means of sweep augers and vertical augers built into the bins. At Pipli Pahar and 40/D, the trucks will be loaded by means of portable equipment. Bulkheads which are opened will be moved as quickly as possible to avoid damage resulting from exposure to the weather. The loaded trucks will then return to Dipalpur to be sampled and weighed prior to departure for Peshawar.

The facilities will remain unattended except at harvest and during intermittent visits by maintenance and operations personnel from the Dipalpur Bulk Dispatch Terminal.

Chichawatni Area. The Chichawatni origination area is shown in Figure 10. This area centers around an existing concrete silo which will become the Chichawatni Bulk Dispatch Terminal and serve as the central storage and handling point for wheat.

Wheat for this silo will be provided by four MPCs. The MPC at the Chichawatni village market will be equipped and operated as a Type MPCB center (as previously described for the Dipalpur market). The other three centers at Ghaziabad, Dad Fatiana, and S-182/9-L will be equipped as Type MPCA centers (as described for Mazharabad and Amli Moti).

Chichawatni Bulk Dispatch Terminal

The Chichawatni silo has deficiencies which must be corrected in order for it to operate at full potential. These deficiencies were discussed at some length in Section II. The general deficiencies will be corrected as a part of this pilot project, as outlined in Table 3. In addition, to facilitate rapid turnaround of the bulk trucks during harvest, a new high-capacity pit and conveying system will be added. This high-capacity receiving facility will be combined with improvements to the bulk truck and railcar loading systems to produce a modern terminal facility capable of handling the projected throughput efficiently. The site plan and flow diagram for this silo are illustrated in Figures 11 and 12, respectively.

Principal improvements to the silo will include an additional truck receiving pit, an additional bucket elevator with a capacity of 400 MT/hr for bulk truck receiving and railcar loading, replacement of all bin top drag conveyors with new drag conveyors of a capacity of 400 MT/hr, new suspended steel hoppers in two bins for use as railcar loading bins, new bulk scale system and conveyor for railcar loading with a capacity of 400 MT/hr, a new truck loading surge bin, a new 70-ft platform truck scale, trackage to the west of the railcar loading point to permit storage of 30 loaded hopper cars, enclosing of both truck pits and the railcar loading areas, addition of sand fill hoppers to all bins except for those in which a suspended hopper will be installed, replacement of all spouting and bin discharge screw conveyors, construction and equipping of a new maintenance shop, and procurement of new sampling and testing equipment. The addition of hopper bottoms will reduce the bulk storage capacity from 50,000 MT to approximately 43,000 MT.

The facility will be capable of receiving hopper-bottomed and flat-bottomed self-dumping trucks of both 10-MT and 30-MT capacity. All trucks will stop on the platform truck scale where the wheat will be sampled by means of a remote-control sample probe. Samples will be tested in the laboratory adjacent to the scale office. The gross weight of the truck and wheat will be recorded and the truck will then proceed to the new receiving pit. Hopper-bottomed trucks will pull over the pit, where the gates will be opened and the wheat will flow by gravity into the pit. Flat-bottomed self-dumping trucks will pull across the pit and be positioned adjacent to the pit such that they can discharge their load by gravity through the rear of the truck body into the pit. The trucks will then proceed to the truck scale where the tare weight of the empty truck will be recorded.

Wheat in the truck receiving pit will be discharged into a series of chain drag conveyors and a bucket elevator for elevation to the top of the bins. On the top of the bins, chain drag conveyors will discharge wheat to any one of the bins. The peak conveying capacity of the system will be 400 MT/hr.

The overall average rate for unloading grain from trucks will be between 5 and 10 minutes per 30-MT truck. Therefore, the facility is capable of receiving up to 64 30-MT trucks/8-hr day using the new pit. This is a peak receiving capacity of nearly 2,000 MT/8-hr day. The silo will be loaded to its capacity of 50,000 MT during harvest.

Wheat arriving at the silo in bags will be received at the existing pit. The bags will be opened at the existing pit and the wheat elevated with the existing bucket elevators into the new bin top chain drag conveyors for distribution to the bins. The reception of bagged wheat at the silo during harvest will be discouraged. The reception of bulk wheat will be given preference in order to assure rapid turnaround of trucks from the MPCs as well as private trucks. Bulk wheat will be purchased at the silo only in quantities of 5 MT or greater.

Wheat will be shipped from the silo both by rail and by truck. Two bins will be equipped with suspended hoppers, and sand fill cone hoppers will be installed in all remaining bins. The sand fill cone hoppers will allow for gravity flow of the wheat to the screw conveyor during reclaim from storage, thus eliminating the need for wheat to be moved by hand to the discharge auger. The two bins with suspended hoppers will be designated as railcar and bulk truck loading bins.

When wheat is to be reclaimed from the storage facilities, a unit train composed of 30 50-MT bulk slot-top hopper-bottomed railcars will be brought to the site by a Pakistan Railways locomotive. Loading of the new slot-top hopper-bottomed railcars will be from a surge bin located over the track. The bin will be equipped with a retractable loading spout. Wheat which is to be loaded into the railcars will be drawn from one of the two existing bins with suspended hoppers which are designated to serve as loadout bins. The wheat will be discharged to a conveyor, and be elevated by the new bucket elevator to an automatic sampler and be weighed by an automatic bulk scale. The scale will discharge to a conveyor which will deliver the wheat to the surge bin above the track. The locomotive will position the unit train so that the first car is under the new loading spout. The locomotive will remain attached to the cars and the group of ten cars near the loading point will be un-

coupled. The operator will use an undertrack hydraulic railcar advancer to advance the group of ten cars under the loading spout as they are loaded. When the group of ten cars is loaded, the locomotive will push them to the storage track beyond the loading point. The remaining 20 empty cars will be moved back and positioned under the loading point and the process will be repeated until all 30 cars are loaded. Loading time for all 30 hopper cars is estimated at approximately 6 hours.

Large bulk trucks arriving at the site to receive a load of wheat will be weighed at the platform truck scale. From the scale they will proceed to the loading position. They will be loaded from an overhead surge bin by means of a telescopic, movable spout. The truck will be positioned under the spout for loading by gravity from the surge bin. The surge bin will be filled from the same existing main bins and new elevating system as the railcar loading system. Upon completion of loading, the truck will proceed to the truck scale for weighing prior to departure from the site.

Transport from Punjab to Peshawar. A total of 96,000 MT of wheat will be transported throughout the year from the Punjab to Peshawar. Of the wheat to be moved in the Punjab to Peshawar corridor, 60,000 MT per year will originate in the Chichawatni area. Road movement will be 35,000 MT per year, and the unit train will move 25,000 MT per year. With each train handling 1,500 MT per trip, 17 trips per year will be required. A unit train will move from the Chichawatni silo at intervals of approximately 3 weeks.

Wheat movement from the Chichawatni silo to Peshawar will be by either rail or road. All wheat movement from the Dipalpur Bulk Dispatch Terminal will be by road. Truck movements will be more or less continuous throughout the year, handling a total of 71,000 MT for this bulk corridor. Assuming 300 working days per year, 237 MT of wheat per day must be transported by road, or the equivalent of eight 30-MT trucks per day.

A total of 23,000 MT per year will be moved in this corridor by bulk unit train. The unit train described in more detail in a later subsection will carry 1,500 MT per trip in approximately 15 trips per year.

Peshawar Area. In the Peshawar area, wheat receipts will be split evenly between two terminals, as shown in Figure 3. The existing hexagonal bins at the major PFD godown on Kohat road will be modified to facilitate bulk handling, and a new Peshawar Bulk Dispatch Terminal will be developed on the main highway and rail line just east of Peshawar. Both terminals will be equipped to handle the large bulk trucks operating over the long road haul. The Peshawar Bulk Dispatch Terminal will also be equipped to handle the unit trains.

Peshawar Bulk Dispatch Terminal

The Peshawar Bulk Dispatch Terminal will be a new facility located on a site selected for easy access to road and rail. The general area favored is along the north side of the main highway from Islamabad just east of the city of Peshawar. This area would allow the best access for trucks and the unit train traveling from Punjab, and most of the road and rail traffic congestion would be avoided. This would allow rapid turnaround of the long-haul trucks and the unit train.

Figure 13 is the site plan which shows the general arrangement of the proposed facility. Figure 14 is the flow diagram for the facility showing major components of the equipment. Principal operating features of the terminal are described below. Storage facility and equipment requirements for the terminal are presented in Table 4.

A unit train arriving at the site will be spotted on a single track which passes over the receiving pit. The train will be broken into three 10-car units. After the first car is positioned over the pit, the hopper gates will be opened by the operator by means of a power-assisted gate opener and the wheat will be discharged by gravity into the pit. The pit will be capable of holding the entire contents of one railcar. As the wheat is being conveyed away from the pit, the under-track advancer will move the string of 10-car units forward, thus locating the next car over the pit.

Wheat in the pit will be discharged onto a belt conveyor which will have a peak conveying capacity of 400 MT/hr. This rate, together with efficient railcar handling, will permit reception of a complete 1,500-MT unit train within one day. The rapid turnaround will allow for maximum utilization of the cars and could reasonably allow the line locomotive to remain with the train.

All wheat received by rail will pass through an automatic sampler and automatic bulk weigher. The weighed and sampled grain will then be conveyed by belt conveyor, bucket elevator, and chain drag conveyor to bins for storage.

It should be noted that when the rail receiving pit is not in use for receiving railcars, the pit may be used for receiving wheat from hopper-bottomed, flat-bottomed self-dumping, and flat-bottomed non-dumping trucks. All trucks will stop on the platform truck scale where the wheat will be sampled by means of a remote-control sample probe. Samples will be tested in the laboratory adjacent to the scale office. The gross weight of the truck and wheat will be recorded and the truck will then proceed to the receiving pit. Hopper-bottomed trucks will pull over the pit where the gates will be opened and the wheat will flow by gravity into the pit. For flat-bottomed non-dumping trucks, a hydraulic platform truck dumper will be provided. Both flat-bottomed self-dumping and non-dumping trucks will be positioned on the platform dumper and will discharge their load by gravity through the rear into the pit. The trucks will then proceed to the truck scale where the tare weight of the empty truck will be recorded. The overall average rate for unloading grain from trucks will be between 5 and 10 min for each 30-MT truck.

Wheat in the truck receiving pit will be discharged onto a belt conveyor, which in turn will discharge to a bucket elevator, to a chain drag conveyor, and into the bins. The peak conveying capacity of system will be 400 MT/hr.

Surge storage of 6,000 MT of capacity is provided in steel bins. The storage bins will be equipped with suspended hopper bottoms so that all grain is discharged by gravity into reclaim chain drag conveyors of 400 MT/hr capacity. The reclaim conveyors deliver the grain to the shipping belt conveyor, which serves either the receiving bulk scale or the bulk truck loading bins through a chain drag conveyor. The shipping belt conveyor serves the dual purpose of railcar receiving as well as shipping.

Each of the bulk truck loading bins has a holding capacity of 70 MT. Wheat is discharged by gravity from these bulk truck loading bins into the top of the 10-MT trucks which will deliver the wheat to the flour mills.

A portable bagging machine will be available to bag wheat for movement to mills which are not equipped to handle wheat in bulk. The bagging unit will be served by one of the bulk truck loading bins.

The Peshawar Bulk Dispatch Terminal is expected to eventually become the principal destination for wheat moved into this area. Therefore, the basic layout provides for substantial expansion of handling facilities as well as storage. With relatively minor improvements and the addition of storage capacity, the facility could be capable of handling all of the wheat distributed in the area.

Peshawar Hexagonal Bin Bulk Terminal

A general arrangement layout of the proposed facility is shown in Figure 15. This facility will provide an opportunity to test the use of hexagonal bins with bulk handling equipment. In addition, it will support the test of bulk dispatch terminals in the wheat deficit areas. The facility will be equipped to receive wheat from 30-MT hopper-bottomed grain trucks arriving from Punjab, and load trucks of any type for delivering wheat to nearby mills. The equipment requirements for this facility are given in Table 5.

All trucks will stop on the platform truck scale where the wheat will be sampled by means of a remote-control sample probe. Samples will be tested in the laboratory adjacent to the scale office. The gross weight of the truck and wheat will be recorded. The truck will then back over the receiving pit adjacent to the east end of the scale platform. The gates on the bottom of the truck body will be opened and the wheat will flow by gravity into the pit. When the truck is empty, it will pull forward to the truck scale where the tare weight of the empty truck will be recorded. The overall average rate for unloading wheat from trucks will be between 5 and 10 minutes per 30-MT truck.

Wheat in the truck receiving pit will be discharged into a series of chain drag conveyors and a bucket elevator for elevation to the top of the hexagonal bins. On the top of the hexagonal bins, a cross conveyor will discharge wheat into the hexagonal bins. The peak conveying capacity of the system will be 400 MT/hr. Since the bins are grouped together, up to three bins can be filled with one conveyor discharge gate.

The hexagonal bins provide surge storage of 6,000 MT. The bins are equipped with suspended hopper bottoms so that all grain is discharged by gravity. Screw conveyors will be installed at the center line of two rows of bins in the north-to-south direction. Spouts will be installed from the discharge of the existing hoppers to the screw conveyors. These reclaim screw conveyors will be designed so that shut-off gates will not be necessary. The operation of the screw in any particular line will draw wheat from all of the bins in that line. The reclaim screw conveyors will deliver the wheat to a collection chain drag conveyor along the south boundary of the bins. This conveyor will in turn discharge wheat to the inclined conveyor and to the bucket elevator. The bucket elevator will discharge the wheat into a 70-MT capacity bulk loading surge bin. Wheat is discharged by gravity from these bulk truck loading

bins into the top of the 10-MT trucks which will deliver the wheat to the flour mills.

Peshawar Area Dispatch

Wheat will be dispatched from the two terminals to four flour mills selected for conversion to bulk handling. This movement of wheat is illustrated in Figure 3. Wheat will be transported from the terminals to the mills in 10-MT trucks. These smaller trucks will facilitate movement through congested city streets and within the flour mill sites. It is anticipated that these trucks will be hired from private-sector operators and that some modifications will be necessary to ensure that the truck beds can hold bulk grain without spillage.

Peshawar Area Flour Mills

Four flour mills have been selected for inclusion in the bulk test corridor. The Aftab and Ashraf mills will be served by the new bulk dispatch terminal. The Bilour and Universal mills will be served by the hexagonal bin facility. Each of the mills has a rated milling capacity of 160 MT/24 hr. If it is assumed that they will produce at a rated capacity for 12 hr/day for 300 days/year, they will consume 24,000 MT of wheat/year. The delivery to each mill will therefore be an average of 80 MT/day. This will require an average of eight 10-MT truckloads of wheat/day for 300 days/year.

Facilities for handling bulk wheat at the mills include a truck hoist which will raise the front end of the trucks so that the wheat will flow by gravity into a shallow receiving pit, through a conveyor, up a bucket elevator, and into one of two steel storage bins. All of the mills will accept the weights provided by the platform truck scales at the dispatch terminals as the official weight of the wheat. A bulk scale will provide a check on the quantity of wheat entering the mills. Storage facility and equipment requirements for the Ashraf and Bilour mills are described in Table 6. Figures 16 and 17 show the proposed layouts for the bulk receiving facilities at the Ashraf and Bilour mills, respectively. The Aftab and Universal mills will require similar facilities.

Bulk Test Corridor: Khairpur to Quetta

This corridor will be limited to testing the results of modifications of existing silo facilities in Khairpur and Quetta, as well as additional backup testing of bulk handling at procurement centers, existing silo complexes, transport systems, and flour mills.

The flow of wheat and projected volumes are presented in Figure 18. The geographic location of procurement and related storage centers is illustrated in Figure 19. A total of 60,000 MT of wheat will be handled each year, with the sole origination point being the Khairpur area.

Khairpur Area. The amount handled in bulk from five MPCs at Agra, Village Bhaffi, Baharo, Sagyoon, and Pipri will be 15,000 MT. An additional 45,000 MT will arrive in bags from other procurement centers.

Khairpur Silo

The Khairpur silo has the same deficiencies as the silo at Chichawatni, and these will be addressed in the same manner in the pilot project. Once the deficiencies are corrected, the operations of this silo will be identical to the silo facility at Chichawatni. Table 3 describes the modifications and equipment required. Figures 11 and 12 illustrate the site plan and flow diagram for this facility.

Mobile Purchase Centers

Five MPCs will be established in Sind to support the Khairpur Silo. Type MPCB centers will be established at Agra and Village Bhaffi, while Type MPCA centers will be used at Baharo, Sagyoon, and Pipri. These units will test the feasibility of procurement of wheat in bulk at these various locations in Sind. It is estimated that each center will be capable of purchasing approximately 3,000 MT during a normal harvest period. All procurements are planned to be moved to the silo daily.

Equipment which will be included with the MPCs will be the same as that described for the MPCs in the Dipalpur area, except that the number of trucks will be increased to accomodate the longer distances to be covered. In Sind, six 30-MT trucks will be assigned to each MPCA and ten 10-MT trucks will be assigned to each MPCB.

Transport from Khairpur to Quetta. A total of 60,000 MT of wheat will be transported throughout the year from Khairpur to Quetta. The unit train will move 50,000 MT per year. With each train handling 1,500 MT per trip, 34 trips per year will be required. A unit train will move from the Khairpur silo at intervals of approximately 2 weeks. Truck movements will be more or less continuous, handling 10,000 MT per year. Assuming 300 working days per year, the handling requirement is 35 MT per day.

Quetta Area. Wheat will be received at the existing Quetta Terminal Silo. This silo will be equipped to handle bulk unit trains as well as bulk trucks.

Quetta Terminal Silo

The facility is located on a site with easy access to road and rail. The facility has not yet been placed in operation, since major improvements are necessary before it can be operated under the pilot project. These improvements and equipment requirements are described in Table 7. Figure 20 is the site plan which shows the general arrangement of the facility and proposed improvements. Figure 21 is the flow diagram for the facility.

A unit train arriving at the site will be spotted on a single track which passes over the receiving pit. The train will be uncoupled from the line locomotive, but the cars will remain coupled together in one string. The hydraulic railcar positioner will push the cars over the pit. After the first car is stopped over the pit, the hopper gates will be opened by the operator by means of a power-assisted gate opener and the wheat will be discharged by gravity into the pit. The pit will be capable of holding the entire contents of one railcar. As the wheat is being conveyed away from the pit, the cars will move forward, locating the next car over the pit. The line locomotive

will move empty cars from the back track as they emerge form the pit area and onto the storage track for recoupling into unit train configuration.

Wheat in the pit will be discharged onto a belt conveyor which will have a peak conveying capacity of 400 MT/hr. This rate, together with efficient railcar handling, will permit reception of a complete 1,500-MT unit train within one day. The rapid turnaround will allow for maximum utilization of the cars and could reasonably allow the locomotive to remain with the train.

All wheat received by rail will pass through an automatic sampler and automatic bulk weigher. The weighed and sampled grain will then be conveyed by belt conveyor, bucket elevator, and chain drag conveyor to bins for storage.

This facility is capable of receiving wheat from all types of trucks, including flat-bottomed non-dumping, flat-bottomed self-dumping, and hopper-bottomed trucks. All trucks will stop on the platform truck scale where the wheat will be sampled by means of a remote-control sample probe. Samples will be tested in the laboratory adjacent to the scale office. The gross weight of the truck and wheat will be recorded. Hopper-bottomed trucks will back over the receiving pit adjacent to the end of the scale platform where the gates will be opened and the wheat will flow by gravity into the pit. When the truck is empty, it will pull forward to the truck scale where the tare weight of the empty truck is recorded. For flat-bottomed non-dumping trucks, a hydraulic platform truck dumper will be provided. Both flat-bottomed self-dumping and non-dumping trucks will be positioned on the combination scale platform dumper and will discharge their load by gravity through the rear into the pit. The tare weight will be recorded while the truck is on the same platform. The overall average rate for unloading grain from trucks will be between 5 and 10 min for each 30-MT truck.

Wheat in the truck receiving pit will be discharged onto a belt conveyor, which in turn will discharge to a bucket elevator, to a chain drag conveyor, and into the bins. The peak conveying capacity of system will be 400 MT/hr.

The existing silo provides storage for 60,000 MT of wheat. Grain will be discharged from the bins into reclaim chain drag conveyors with a capacity of 200 MT/hr. The reclaim conveyors deliver the grain to either of the two 400-MT/hr bucket elevators. The bucket elevators will discharge the wheat into a 70-MT capacity bulk loading surge bin for loading into 10-MT bulk delivery trucks. The bin will be located adjacent to the truck scale so that trucks will be loaded while they are on the truck scale platform. The tare weight of the empty truck will be recorded. Wheat will then flow by gravity into the top of the truck from the overhead bin. The gross weight will then be recorded and the truck will be dispatched to the mills.

The quantity of wheat which will move through the Quetta Terminal Silo is much more than can be processed by the two mills designed for installation of bulk handling facilities under the pilot program. Therefore, it will be necessary to bag wheat at the Quetta Terminal Silo for distribution to other mills. The bucket elevator will transport grain to the bagging facilities, which will be improved to assure adequate bagging capacity.

Quetta Area Dispatch

Wheat will be dispatched from the Quetta Terminal Silo to two flour mills selected for conversion to bulk handling, as illustrated in Figure 18. The 10-MT feed-body trucks will facilitate movement through congested city str ets and within the flour mill sites. These specialized trucks, as described in a later subsection, will be furnished and operated by the silo operator.

Quetta Area Flour Mills

Two flour mills have been selected for inclusion in the bulk test corridor. The Bolan and Jamal mills are within the city and across the street from each other. The site plan is shown in Figure 22. Each of the mills has a rated milling capacity of 100 MT/24 hr. If it is assumed that they will produce at rated capacity for 12 hr/day for 240 days/year, they will each consume 12,000 MT of wheat/year. The delivery to each mill, therefore, will be an average of 50 MT/day, or the equivalent of five 10-MT trucks/day for 240 days/year.

Once the wheat is delivered to the mill, it is placed in storage until it is needed for milling. The wheat is then conveyed into the mill's existing receiving pit for elevation into the holding bins in the cleaning section. A bulk weigher will monitor the quantity of wheat entering the mill. The mill will accept the weights recorded by the platform scale at the Quetta Terminal Silo as the official weights of wheat received.

The storage facility and equipment requirements for handling bulk wheat at the mills are presented in Table 8.

Bulk Transport Tests

Within the bulk test corridors, different methods of transporting wheat will be tested to determine the effectiveness and cost of handling wheat in bulk. The tests will be common to both corridors and involve several different types of trucks as well as a new design for railcars. Bulk wheat handling vehicles are illustrated in Figure 23. A list of transport equipment for project activities is detailed in Table 9.

Bulk Truck Test. Bulk truck tests will incorporate five different truck types available for the handling of bulk grain.

Hopper-Bottomed Trucks

A total of 33 30-MT semitrailer truck units will be included as components of the MPCs. These units will include the enclosed hopper-bottomed grain trailer and tractor. These trucks will also be used for the long-haul movement of wheat from Sind to Quetta and Punjab to Peshawar. The trailers to be furnished will be convertible to allow backhaul of various types of cargo other than grain. These trucks will provide a test of the effectiveness and efficiency of this type of transport.

Self-Dumping Trucks

A total of 30 10-MT bulk grain-body trucks will be included as components of the MPCs. This type of body is equipped with a hydraulic lift and is commonly

found in use on farm trucks in the U.S. These units will be available for movement within the production areas throughout the year as well as during the harvest period. They will provide an effective test for this type of vehicle in the rural environment in Pakistan.

Feed-Body Trucks

Four special-purpose feed-body trucks are included as part of the Quetta area mill supply system. These trucks will be equipped with on-board conveyors which permit them to discharge their bulk load without dumping or without the need for a large receiving pit. The discharge conveyor is mounted on a hydraulic arm so that the conveyor can be positioned over the receiving hopper while the truck is parked nearby. The wheat will be conveyed to the hopper, up the bucket elevator, and into the bins.

The mills are located on narrow streets and the space within the mill property is very limited. The small size and style of discharge of these trucks will permit them to maneuver within the confined spaces.

Existing Truck Conversions

The large existing fleet of trucks can be utilized to transport grain over the long hauls with only relatively minor modifications. This project will include a program to test various methods of modification to make the existing truck bodies suitable for transporting wheat in bulk without spillage.

Bulk Trolleys

Several different types of bulk trolleys (farm wagons) in use in the U.S. will be used in the wheat-producing areas of Pakistan as tests for movement of wheat from the farm to purchase centers. In addition, the design of trolleys currently in use in Pakistan will be reviewed in an effort to improve the efficiency of the units for use in hauling and discharging bulk wheat.

A total of 30 single-axle trolleys of the type currently in use in Pakistan and ten U.S.-type units will be used in the Dipalpur area to facilitate the movement of grain in bulk from the farm to the purchase centers.

Unit Train Test. As discussed in the bulk test corridor descriptions above, a single unit train composed of new railcars will be tested from Chichawatni to Peshawar and from Khairpur to Quetta. The unit train will consist of 30 identical railcars, each with a capacity of 50 MT. The cars will be designed to handle wheat and other whole grains in bulk. The cars will be enclosed with a steel top and be sealable for security. They will have a center slot in the top to facilitate filling while being moved under a telescopic spout. The hopper bottom will allow the wheat to flow by gravity through gates and be discharged into a pit between the rails. Figure 23 provides a general arrangement for a railcar of the type to be developed for Pakistan.

These railcars will operate under the control of the Pakistan Railways and will be pulled by a dedicated locomotive which will stay with the train at all times. Utilization will be maximized by rapid loading and unloading through high-capacity terminal facilities.

Data Collection and Analysis

The purpose of the data collection element in the operation of the bulk test corridors is to provide a structure within which to collect operational information to be used for later analysis. The information will include (1) quantity and quality of grain purchased, stored, and shipped, (2) all operational costs, and (3) technical operating factors.

A grain accounting system is a system designed to manage grain flows and inventories as well as to collect data on the quantity and quality of grain purchased, handled, stored, and dispatched. A grain accounting system suitable for bulk grain handling and storage will be installed at each of the following major grain terminals: Dipalpur Bulk Dispatch Terminal, Chichawatni Silo, Peshawar Bulk Dispatch Terminal, Peshawar Hexagonal Bin Bulk Terminal, Khairpur Silo, and Quetta Silo Terminal. The grain accounting system at each of these installations will measure the flow of grain arriving from the allied purchase centers, within the terminal, and dispatched from the terminal.

The grain accounting system will measure and record information on the quantity of wheat at each stage of operations, the condition of grain (moisture content, foreign material, insect infestation, broken kernels, heat damage, etc), and the quantities transported (transport modes, transport times, and differences in the weight and condition of grain before and after shipping).

Data from each facility grain accounting system will be summarized monthly and these summaries will be forwarded to PASSCO headquarters in Lahore, where a data set will be compiled for each terminal and an aggregate data set will be compiled for each corridor and for all locations. A physical inventory of grain in storage will be conducted on a quarterly basis to determine grain loss and to indicate any adjustments needed in the grain accounting system.

Operational cost data for each terminal, purchase center, purchase and storage center, and mode of transport will be generated by a cost accounting system which will be located at PASSCO headquarters in Lahore. This cost accounting system will be linked to PASSCO's financial accounting system and will separate costs incurred in each of the above facilities into given expense (labor, electricity, repairs) and activity (purchasing, handling, storage) categories.

The technical operating factors to be considered are operations and maintenance. The data to be collected on operations are the period and condition of wheat in storage, including temperature, moisture content, duration and time of aeration, and chemical insect control measures; power requirements; labor requirements; time, duration, and volume of operations; and miscellaneous operational problems. The data to be collected on maintenance are timeliness of scheduled maintenance, equipment failures, time required for repair of equipment due to failure, and miscellaneous maintenance problems.

These data will be collected through a specially-designed worksheet onto which the above information will be recorded. Responsibility for the collection of data will lie with the chief engineer of each facility. These worksheets will be summarized monthly and these summaries will be forwarded to the PASSCO headquarters in Lahore.

PASSCO will also collect quantity, quality, and operational cost data on their handling and storage of wheat in bags. PASSCO will also be responsible for collection of data concerning costs of farmers or merchants delivering bagged grain, PFD operational costs for handling bagged grain in Baluchistan and NWFF, and costs to flour millers for moving bagged grain from PFD warehouses to the flour mill. These data will be used as the basis for comparison with the information collected from the bulk test corridors. PASSCO will also be responsible for collection of transportation cost data by different modes and types of transport in both the bulk corridors and the existing parallel bagged grain system.

Figure 24 provides a graphic representation of a bagged grain versus a bulk grain corridor. The figure illustrates the segments of each corridor for which data must be collected for analysis.

The data collected by the above processes will be used to analyze the differences in investment and operating costs by expense and activity category among the various types of facilities on a per-unit basis. This analysis will allow the measurement of differences in facility types, management and technical factors, and various modes of transport throughout the system. The resulting comparisons among different types of bulk facilities and between bulk and bag grain operations will allow initial determination of the technical and economic feasibility of different facility and system configurations within the pilot project and the pilot project as a whole. The results of the analysis will create a database which will be utilized in the development of the SWIP.

Systemwide Implementation Plan

A comprehensive plan for conversion to bulk wheat handling and storage in Pakistan will be developed. The SWIP will be based on data provided by the bulk corridor tests as well as all other studies and tests carried out under the pilot project, and will provide the overall direction for the bulk conversion program on a countrywide basis. It will determine the sizes, capacities, and priorities for development of each of the facilities, and will set forth specific objectives on the basis of need and financial benefits.

The SWIP will produce an overview status report of the pilot project on an annual basis during the life of the project. These annual reports will recommend any changes in emphasis or direction which may be necessary as the project develops.

TABLE 1

STORAGE FACILITY AND EQUIPMENT REQUIREMENTS
DIPALPUR BULK DISPATCH TERMINAL

Quantity	Description
1	Platform truck scale, 10 ft x 70 ft
1	Remote-control hydraulic sample probe
1	Truck scale office and laboratory with equipment
1	Receiving pit, 30 MT capacity
2	Receiving chain drag conveyors, 200 MT/hr capacity
2	Bucket elevators, 200 MT/hr capacity
2	Bin top chain drag conveyors, 200 MT/hr capacity
2	Screw conveyors for distribution to bulkheads, 80 MT/hr capacity
5	Open screw conveyors for distribution among bulkheads, 80 MT/hr capacity
1	Bolted-steel truck loading surge bin with hopper bottom, 70 MT capacity
1	Bulk truck dust-free loading spout
8	Bolted-steel storage bins with steel hopper bottoms, 625 MT capacity
1	Bulkhead, 5,000 MT capacity
1	Maintenance shop and equipment

TABLE 2

STORAGE FACILITY AND EQUIPMENT REQUIREMENTS
BULK PURCHASE AND STORAGE CENTERS

Quantity	Description
	Sukhpur
1	Portable platform trolley scale, 10 ft x 10 ft
1	Office and laboratory with equipment
4	Tractor-mounted inclined augers with pick-up scoops
4	Bulk platform scales
5	Bin unloading sweep augers with truck loading augers
5	Bolted corrugated steel storage bins with flat bottoms, 1,885 MT capacity
1	Roadway
	Pipli Pahar
1	4-wheel drive pick-up truck
1	Portable platform trolley scale, 10 ft x 10 ft
1	Mobile office and laboratory with equipment
4	Tractor-mounted inclined augers with pick-up scoops
4	Bulk platform scales
1	Bulkhead, 5,000 MT capacity
1	Bulkhead, 2,700 MT capacity
2	Electric wheel-mounted inclined conveyors
1	Trailer-mounted generator
	4C/D
1	4-wheel drive pick-up truck
1	Portable platform trolley scale, 10 ft x 10 ft
1	Office and laboratory with equipment
4	Tractor-mounted inclined augers with pick-up scoops
4	Bulk platform scales
2	Bulkheads, 2,700 MT capacity
2	Electric wheel-mounted inclined conveyors
1	Trailer-mounted generator

TABLE 3

KHAIRPUR AND CHICHAWATNI SILO MODIFICATIONS

The following new equipment and/or modifications will be required at both sites in order to bring the facilities up to standards and capacities suitable for the bulk wheat handling and storage pilot project.

Quantity	Description
1	Bulk truck receiving shed with truck hoist
1	Receiving pit, 30 MT capacity
1	Bulk truck receiving drag conveyor, 400 MT/hr capacity
1	Platform scale, 10 ft x 70 ft, 100 MT capacity
1	Hydraulic remote-control bulk truck sampling probe
2	Surge bins with support tower for loading, 30 MT capacity
2	Retractable dust-free loading spout
1	Bulk truck loading transfer jet belt conveyor, 400 MT/hr capacity
1	Bulk railcar loading transfer jet belt conveyor, 400 MT/hr capacity
1	Bulk railcar loading shed
1	Hydraulic railcar positioner
1	Bucket elevator, 400 MT/hr capacity
1	Cross drag conveyor for storage distribution, 400 MT/hr capacity
4	Drag conveyors for storage distribution, 400 MT/hr capacity
1	Six-position dual distributor (turnhead), 100 MT/hr capacity
1	Bulk hopper scale with support tower, 400 MT/hr capacity
12	Hopper filled sloping bin bottoms
12	Silo discharge augers, 50 MT/hr capacity
2	Steel bin hoppers with support structure
1	Drag conveyor for reclaim, 400 MT/hr capacity
2	Railway spurs with turnouts, frogs, etc., 500 ft long
1	Site drainage pump
2	Bin top cross-over walkway bridges
1	Parking lot to store the MPC equipment and bulk trucks while not in operation
	All new catwalks and spouting
	All equipment above grade will be remotely controlled from the office
	All exposed electrical cable will be covered
	Roadways will have to be modified to ensure 45-ft radius turns

TABLE 4

STORAGE FACILITY AND EQUIPMENT REQUIREMENTS
PESHAWAR BULK DISPATCH TERMINAL

Quantity	Description
1	Weigh bridge, 10 ft x 70 ft
1	Hydraulic truck dumper, 10 ft x 70 ft
1	Truck receiving hopper, 30 MT capacity
1	Hydraulic railcar positioner
1	Railcar receiving hopper, 54 MT capacity
1	Truck receiving hopper discharge chain conveyor, 400 MT/hr capacity
1	Railcar receiving hopper discharge chain conveyor, 400 MT/hr capacity
2	Receiving/scale return belt conveyors, 400 MT/hr capacity
1	Scale/bulk loadout transfer belt conveyor, 400 MT/hr capacity
1	Bulk hopper scale
1	Bulk loadout transfer chain conveyor, 400 MT/hr capacity
2	Retractable bulk truck loading spouts
1	Wheel-mounted bagging unit, 300 kg/min capacity
2	Bucket elevators, 400 MT/hr capacity
2	Storage distribution chain conveyors, 400 MT/hr capacity
2	Storage reclaim chain conveyors, 400 MT/hr capacity
2	Storage reclaim cross chain conveyors, 400 MT/hr capacity
8	35° hopper-bottomed steel bins, 750 MT capacity
2	35° hopper-bottomed steel bins, 70 MT capacity
1	Hydraulic remote-control bulk truck sample probe
1	Scale office and laboratory with equipment
1	Maintenance shop with equipment
1	Truck receiving shed
1	Railcar receiving shed

TABLE 5

EQUIPMENT REQUIREMENTS
PESHAWAR HEXAGONAL BIN BULK TERMINAL

Quantity	Description
1	Platform truck scale, 10 ft x 70 ft
1	Hydraulic remote-control bulk truck sample probe
1	Truck scale office and laboratory with equipment
1	Receiving pit, 30 MT capacity
1	Receiving chain drag conveyor, 400 MT/hr capacity
1	Bucket elevators, 400 MT/hr capacity
1	Bin top chain drag conveyor, 400 MT/hr capacity
8	Bin top chain drag conveyors, 200 MT/hr capacity
16	Bin bottom reclaim screw conveyors, 20 MT/hr capacity
2	Bin bottom reclaim chain drag conveyors, 100 MT/hr capacity
1	Bolted-steel surge bin with hopper bottom for truck loadout, 70 MT capacity
1	Bulk truck dust-free loading spout

TABLE 6

STORAGE FACILITY AND EQUIPMENT REQUIREMENTS
BILOUR, ASHRAF, UNIVERSAL, AND AFTAB FLOUR MILLS

Each mill will require one set of the following equipment.

Quantity	Description
1	Bucket elevator, 50 MT/hr capacity, approximately 45 ft high
1	Storage reclaim screw conveyor, 50 MT/hr capacity
1	Receiving pit, 5 MT capacity
1	Receiving screw conveyor, 50 MT/hr capacity
2	45° hopper-bottomed steel bins, 15 ft dia x 32 ft high
1	Truck hoist
1	Bulk weigher

TABLE 7

QUETTA SILO MODIFICATIONS

The following new equipment and/or modifications will be required in order to bring the facilities up to standards and capacities suitable for the bulk wheat handling and storage pilot project.

Quantity	Description
1	Bulk truck receiving shed
1	Receiving pit, 30 MT capacity
1	Bulk truck receiving drag conveyor, 400 MT/hr capacity
1	Hydraulic truck dumper/platform scale combination unit, 10 ft x 70 ft
1	Hydraulic remote-control bulk truck sampling probe
1	Bulk truck loading bin, 70 MT capacity
2	Retractable bulk truck loading spouts
1	Bulk railcar receiving shed
1	Hydraulic railcar positioner
1	Railcar receiving hopper, 30 MT capacity
1	Railcar receiving drag conveyor, 400 MT/hr capacity
1	Railcar receiving transfer drag conveyor, 200 MT/hr capacity
2	Bucket elevator, 400 MT/hr capacity
1	Railcar receiving/bagging transfer jet belt conveyor, 200 MT/hr capacity
1	Drag conveyors for storage distribution, 400 MT/hr capacity
6	Drag conveyors for storage distribution, 200 MT/hr capacity
1	Bulk hopper scale, 400 MT/hr capacity
30	Silo discharge drag conveyors, 100 MT/hr capacity
3	Storage reclaim drag conveyors, 200 MT/hr capacity
1	Storage reclaim drag conveyor, 200 MT/hr capacity
1	Storage reclaim drag conveyor, 200 MT/hr capacity
2	Railway spurs with turnouts, frogs, etc., 400 ft long
1	Scale office/laboratory/control room building
1	Maintenance shop completely equipped with tools, equipment, and parts
	All new electrical installation with equipment totally remotely controlled

TABLE 8

STORAGE FACILITY AND EQUIPMENT REQUIREMENTS
JAMAL AND BOLAN FLOUR MILLS

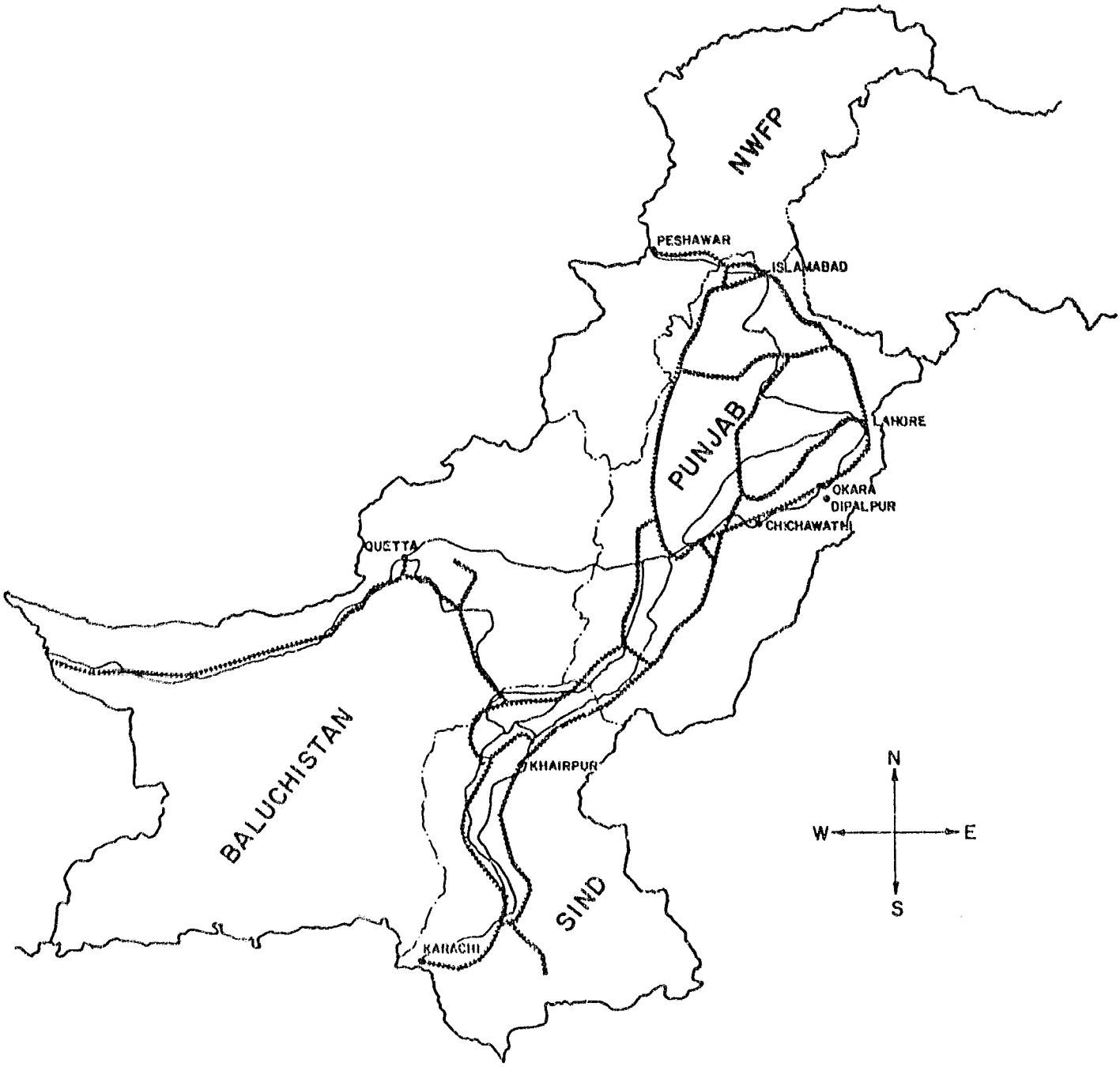
Each mill will require one set of the following equipment.

Quantity	Description
1	Bucket elevator, 50 MT/hr capacity, approximately 45 ft high
1	Storage reclaim screw conveyor, 50 MT/hr capacity
1	Receiving hopper, mounted directly onto the bucket elevator leg's boot
2	45° hopper-bottomed steel bins, 9 ft dia x 32 ft high
1	Bulk weigher

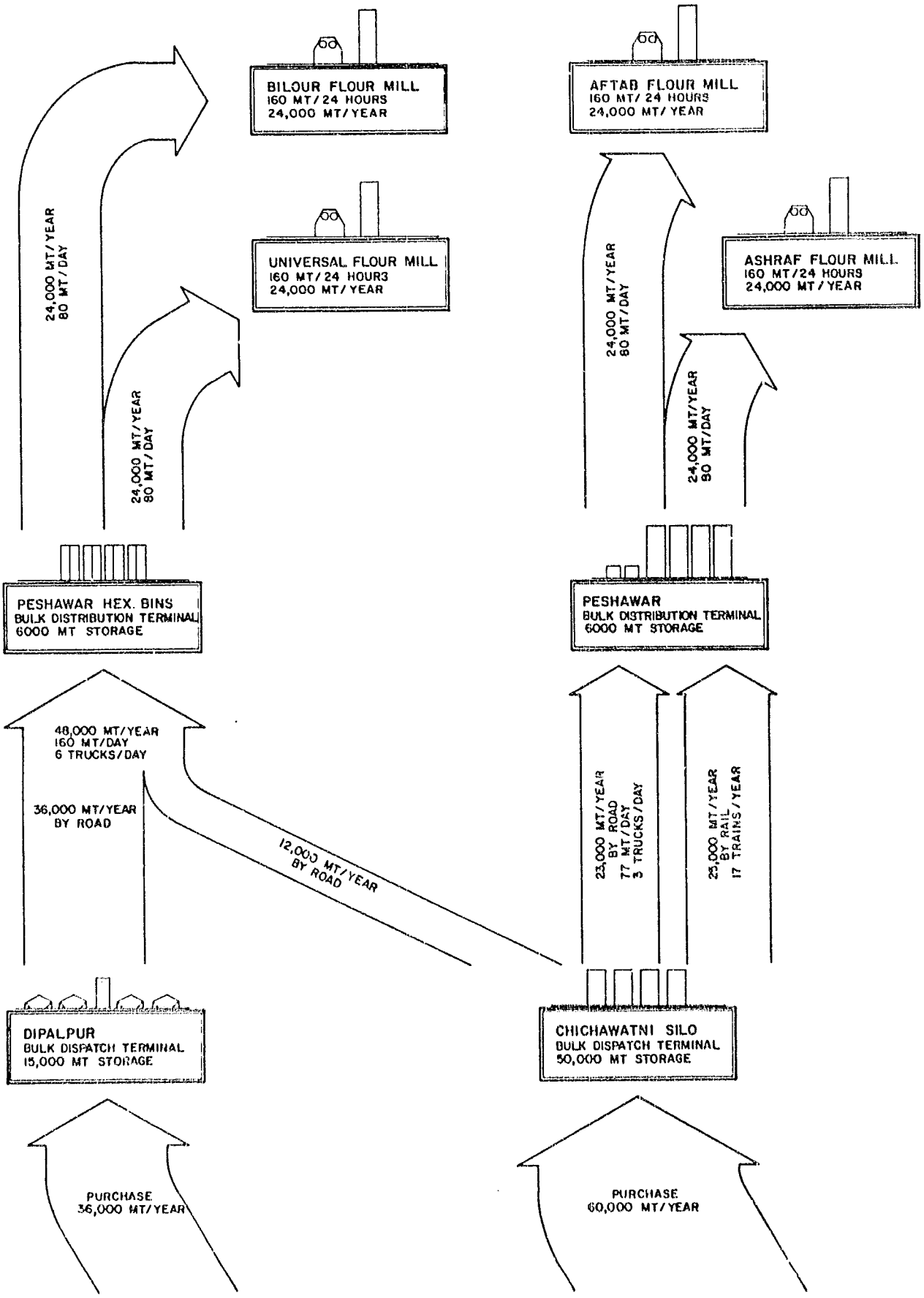
TABLE 9

TRANSPORTATION EQUIPMENT REQUIREMENTS

Quantity	Description
	Truck
33	30-MT semitrailer/tractor units with bulk grain hopper-bottomed trailers
30	10-MT bulk grain-body trucks with hydraulic lifts for grain body
4	Feed-body bulk trucks, 10 MT capacity, with 50 MT/hr capacity discharge augers
30	Pakistan-type single-axle trolleys
10	U.S.-type double-axle farm wagons
	Rail
30	Bulk grain hopper-bottomed railcars with enclosed steel center-slotted top for filling railcar



KSU KANSAS STATE UNIVERSITY	Food and Feed Grain Institute Shellenberger Hall Manhattan, Kansas 66506 (913) 532-6161	BULK WHEAT HANDLING AND STORAGE PILOT PROJECT PAKISTAN
		MAP OF PAKISTAN
		SEPTEMBER, 1987 FIGURE 2



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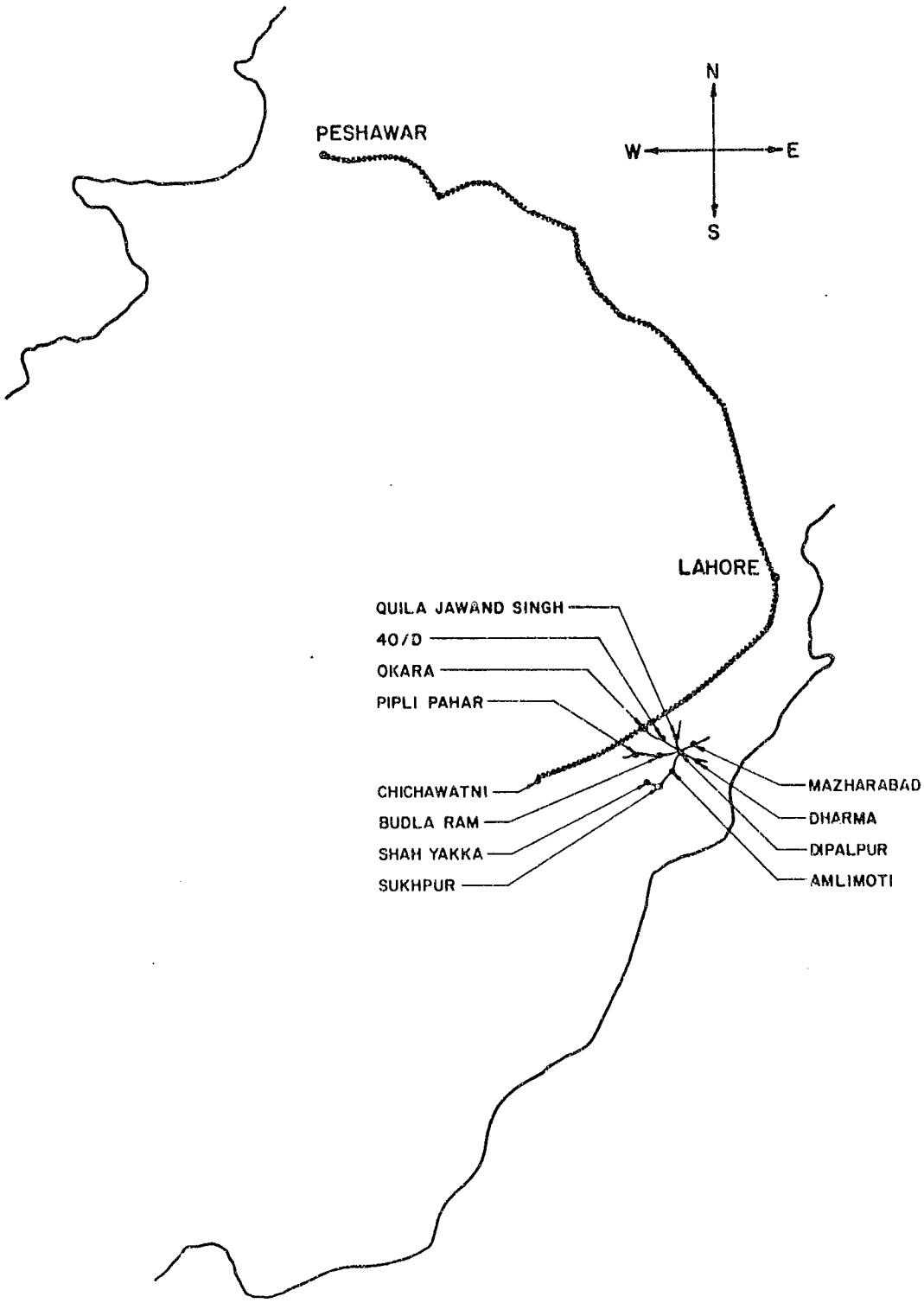
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT

PAKISTAN

PUNJAB TO PESHAWAR BULK CORRIDOR FLOW CHART

SEPTEMBER, 1987 FIGURE 3



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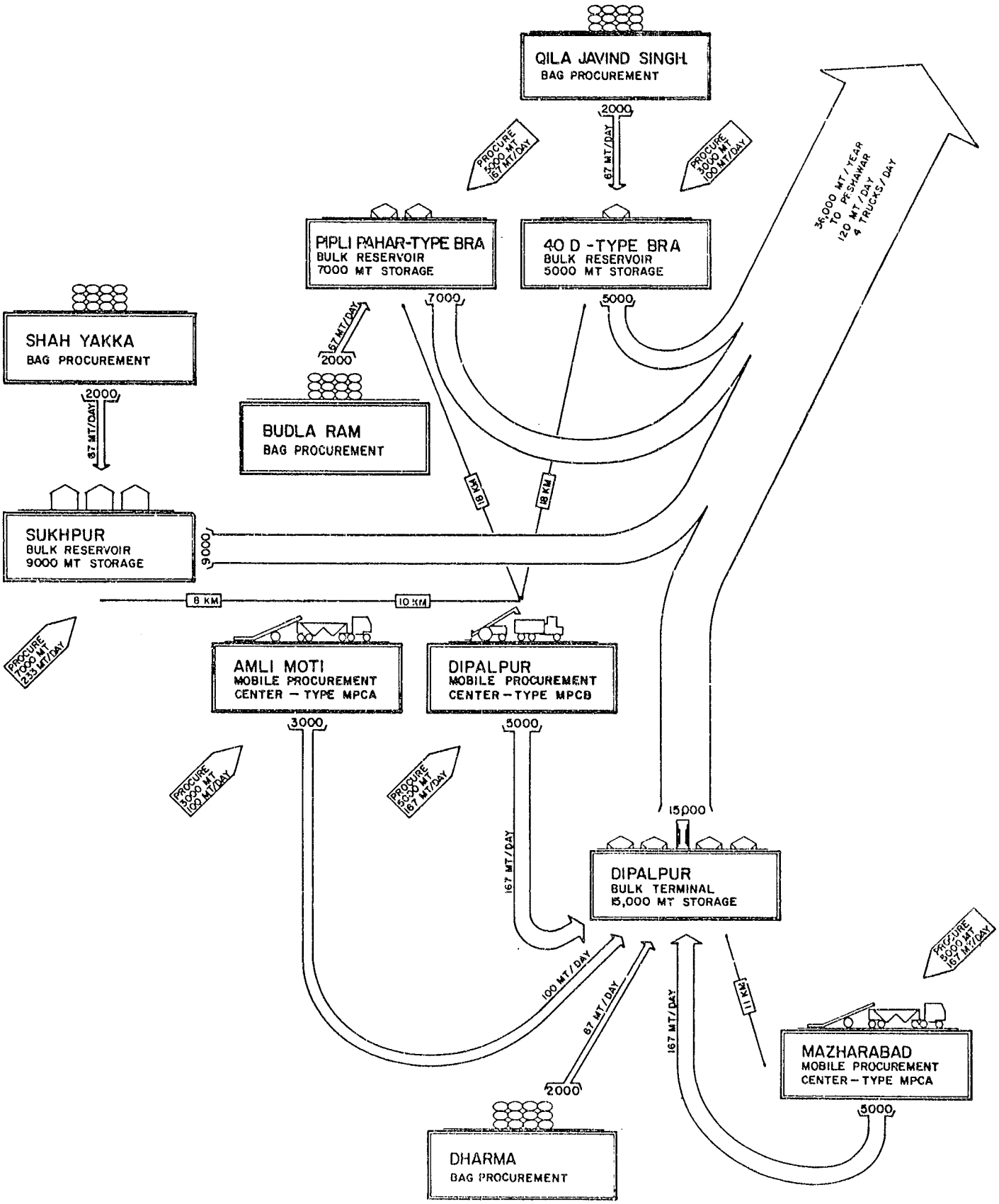
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

LOCATION OF FACILITIES
PUNJAB

SEPTEMBER, 1987 FIGURE 4



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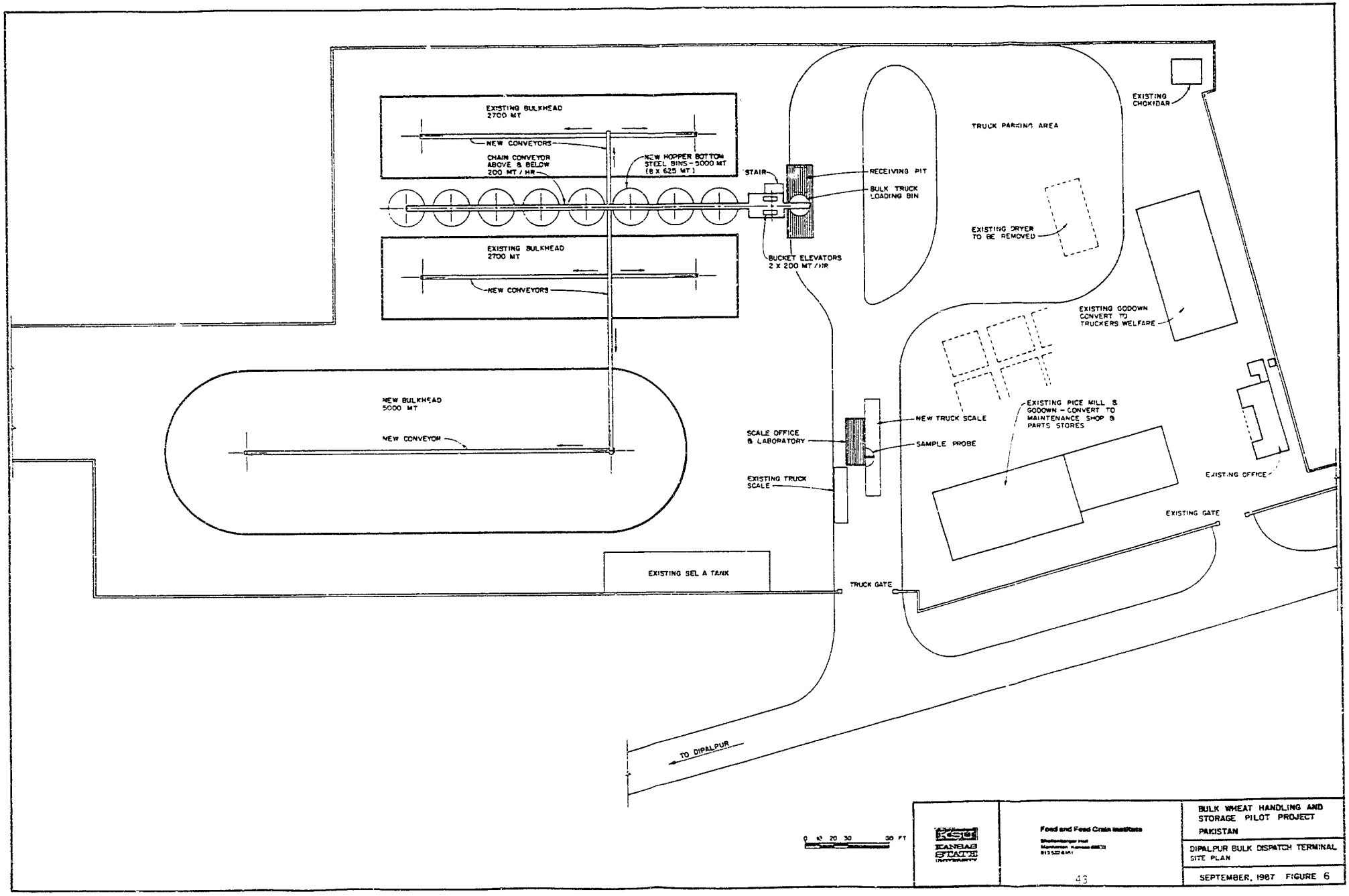
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

DIPALPUR AREA
FLOW CHART

SEPTEMBER, 1987 FIGURE 5


EXISTING BULKHEAD
2700 MT
NEW CONVEYORS
CHAIN CONVEYOR
ABOVE & BELOW
200 MT / HR
NEW HOPPER BOTTOM
STEEL BINS - 5000 MT
(8 X 625 MT)
STAIR
RECEIVING PIT
BULK TRUCK
LOADING BIN
EXISTING BULKHEAD
2700 MT
NEW CONVEYORS
BUCKET ELEVATORS
2 X 200 MT / HR
TRUCK PARKING AREA
EXISTING
CHOKIDAR
EXISTING DRYER
TO BE REMOVED
EXISTING GODOWN
CONVERT TO
TRUCKERS WELFARE
NEW BULKHEAD
5000 MT
NEW CONVEYOR
SCALE OFFICE
& LABORATORY
NEW TRUCK SCALE
SAMPLE PROBE
EXISTING PICE MILL &
GODOWN - CONVERT TO
MAINTENANCE SHOP &
PARTS STORES
EXISTING TRUCK
SCALE
EXISTING OFFICE
EXISTING GATE
EXISTING SEL A TANK
TRUCK GATE
TO DIPALPUR
0 10 20 30 50 FT
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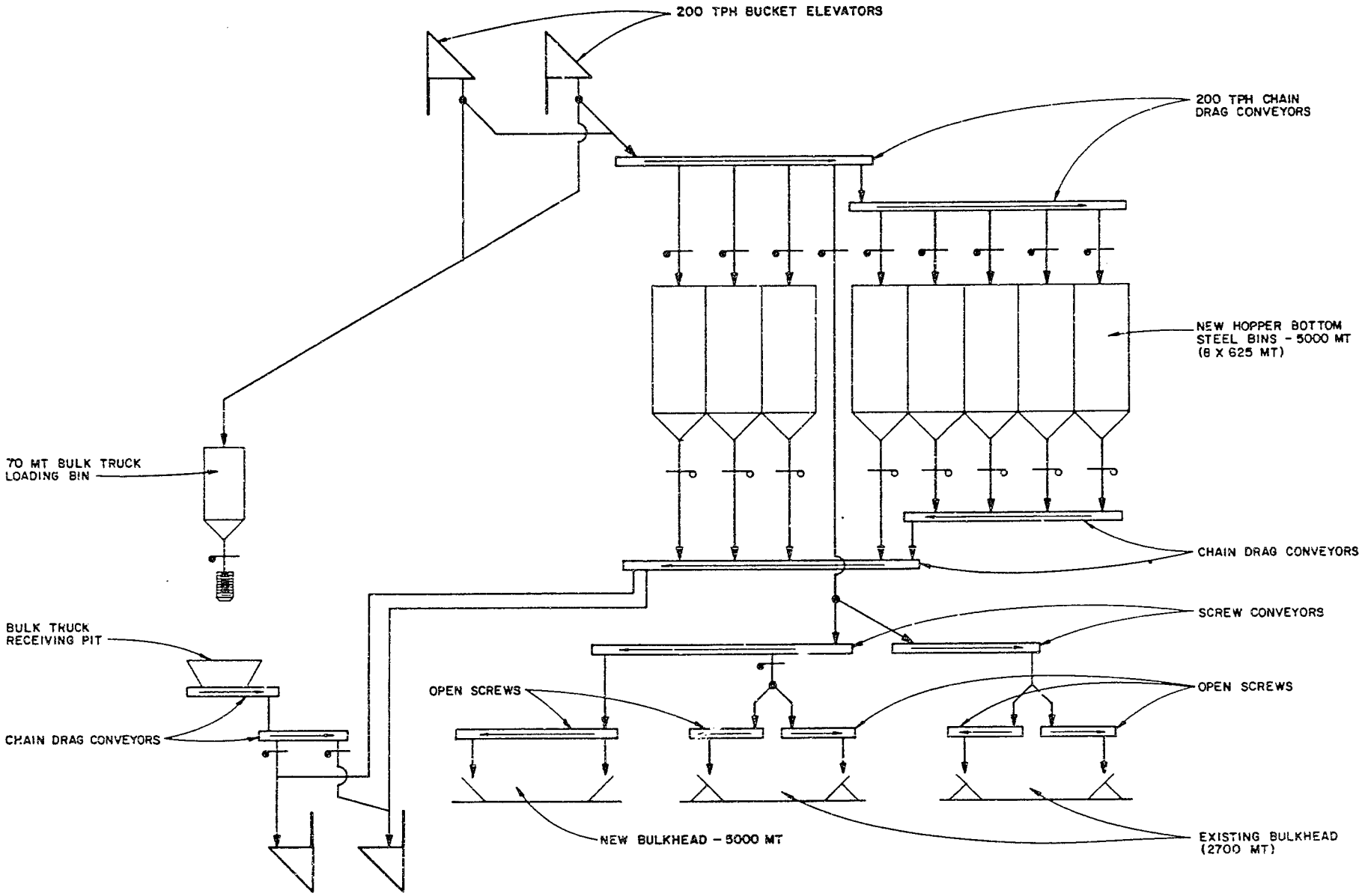
BULK WHEAT HANDLING AND
STORAGE PILOT PROJECT
PAKISTAN
DIPALPUR BULK DISPATCH TERMINAL
SITE PLAN
SEPTEMBER, 1987 FIGURE 6



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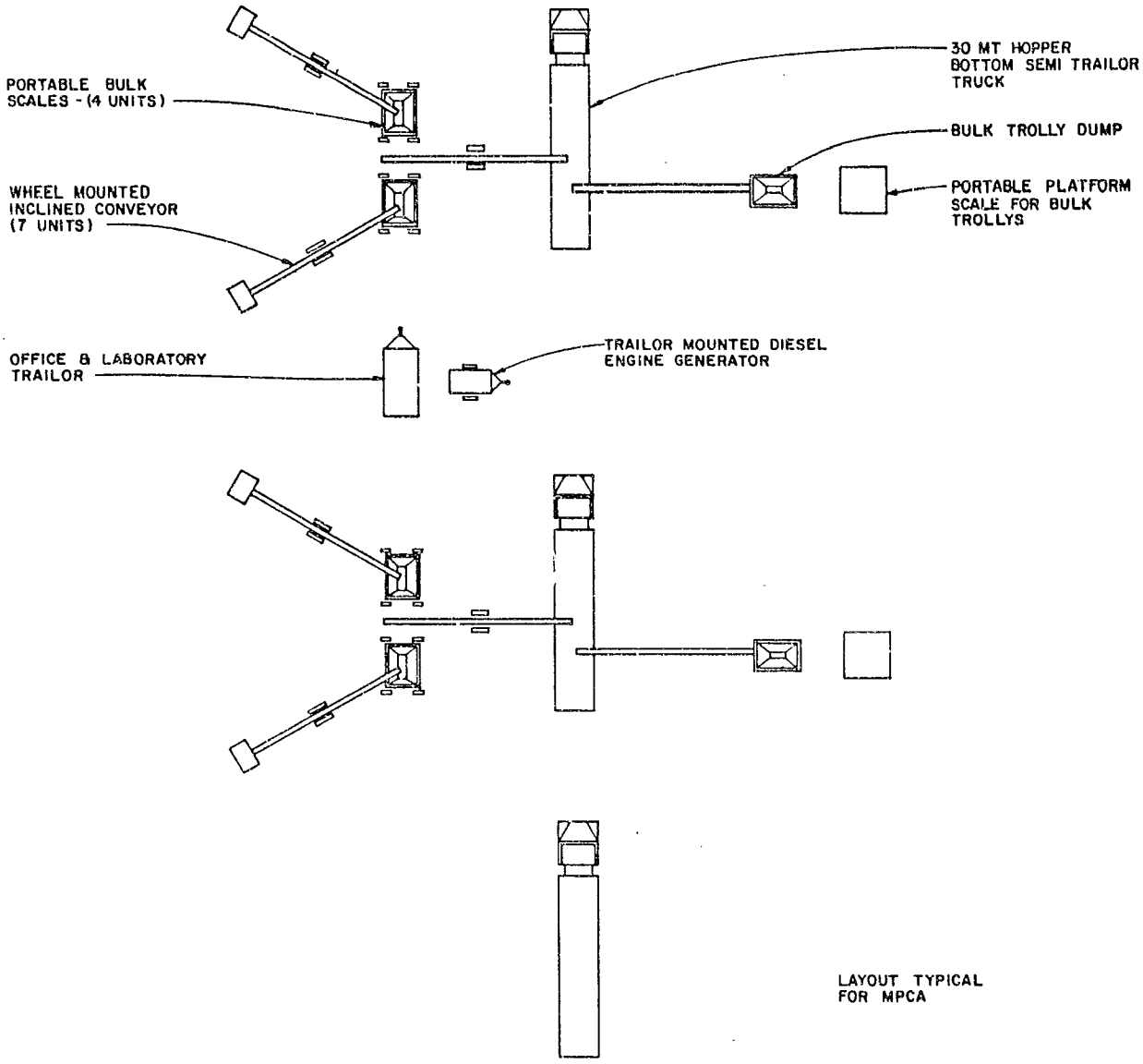
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT

PAKISTAN

DIPALPUR BULK DISPATCH TERMINAL FLOW DIAGRAM

SEPTEMBER, 1987 FIGURE 7



0 10 20 40

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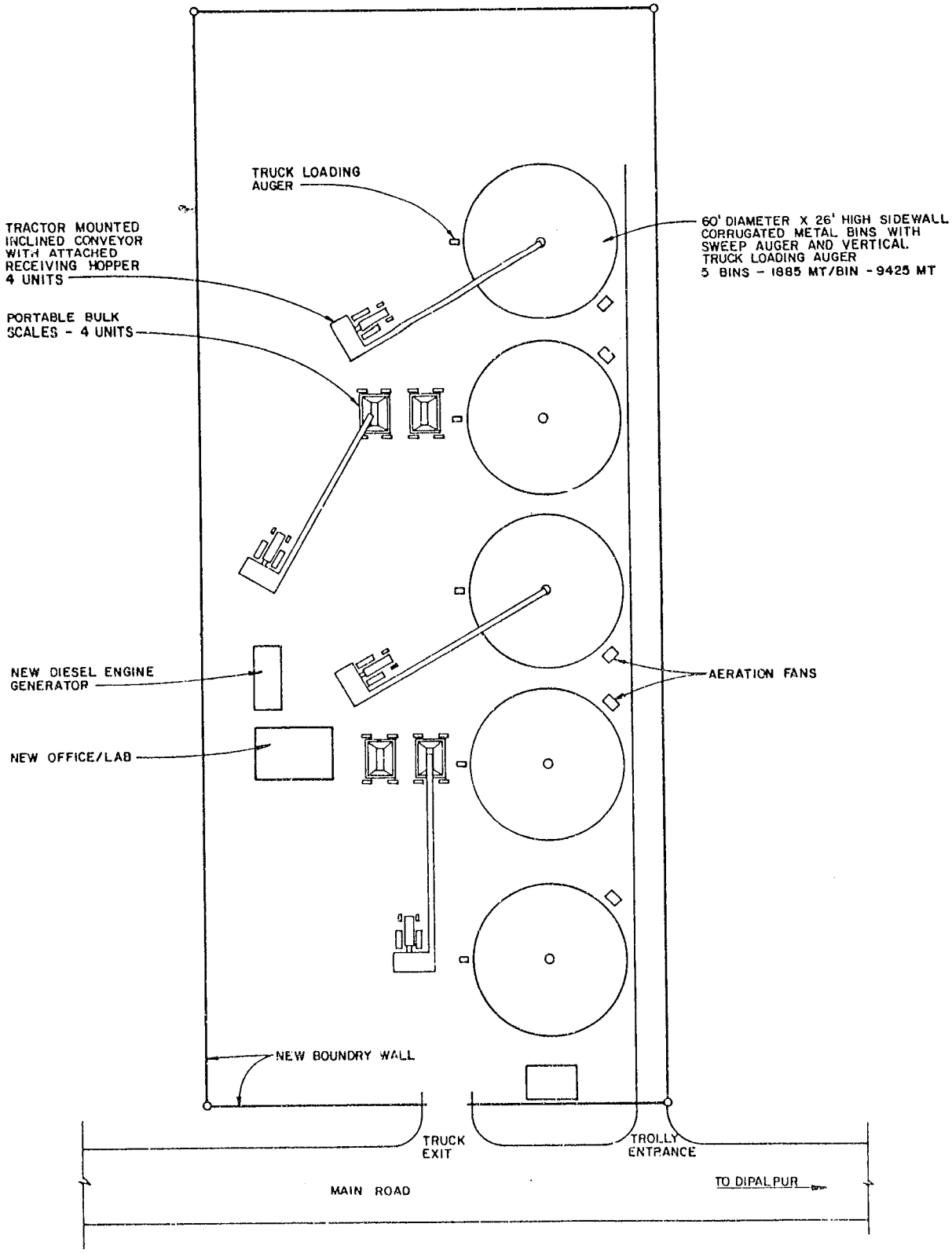
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

MOBILE PURCHASE CENTER SITE PLAN

SEPTEMBER, 1987 FIGURE 8



0 10 20 30 60 FT

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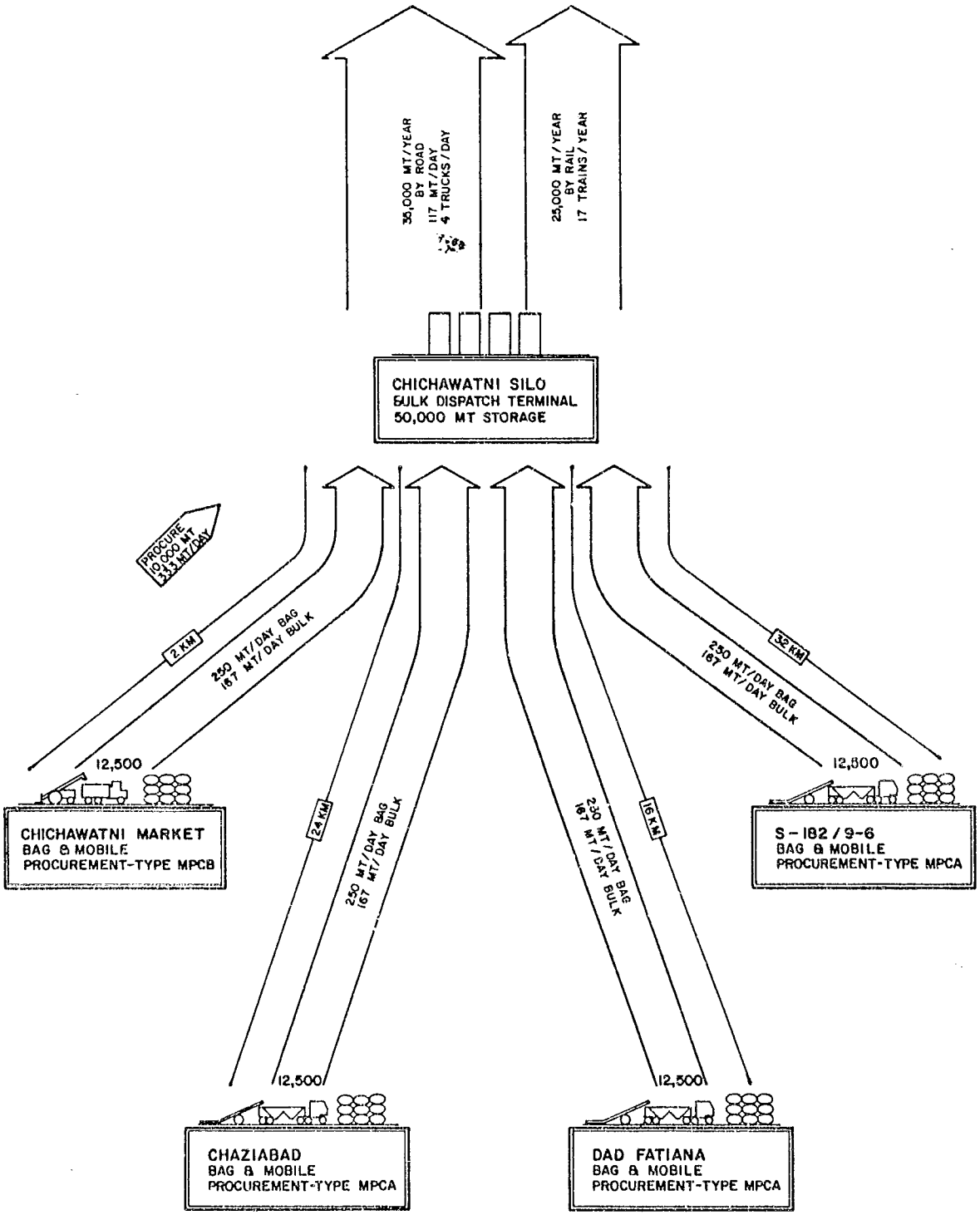
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

SUKHPUR BULK PURCHASE & STORAGE CENTER
SITE PLAN

SEPTEMBER, 1987 FIGURE 9



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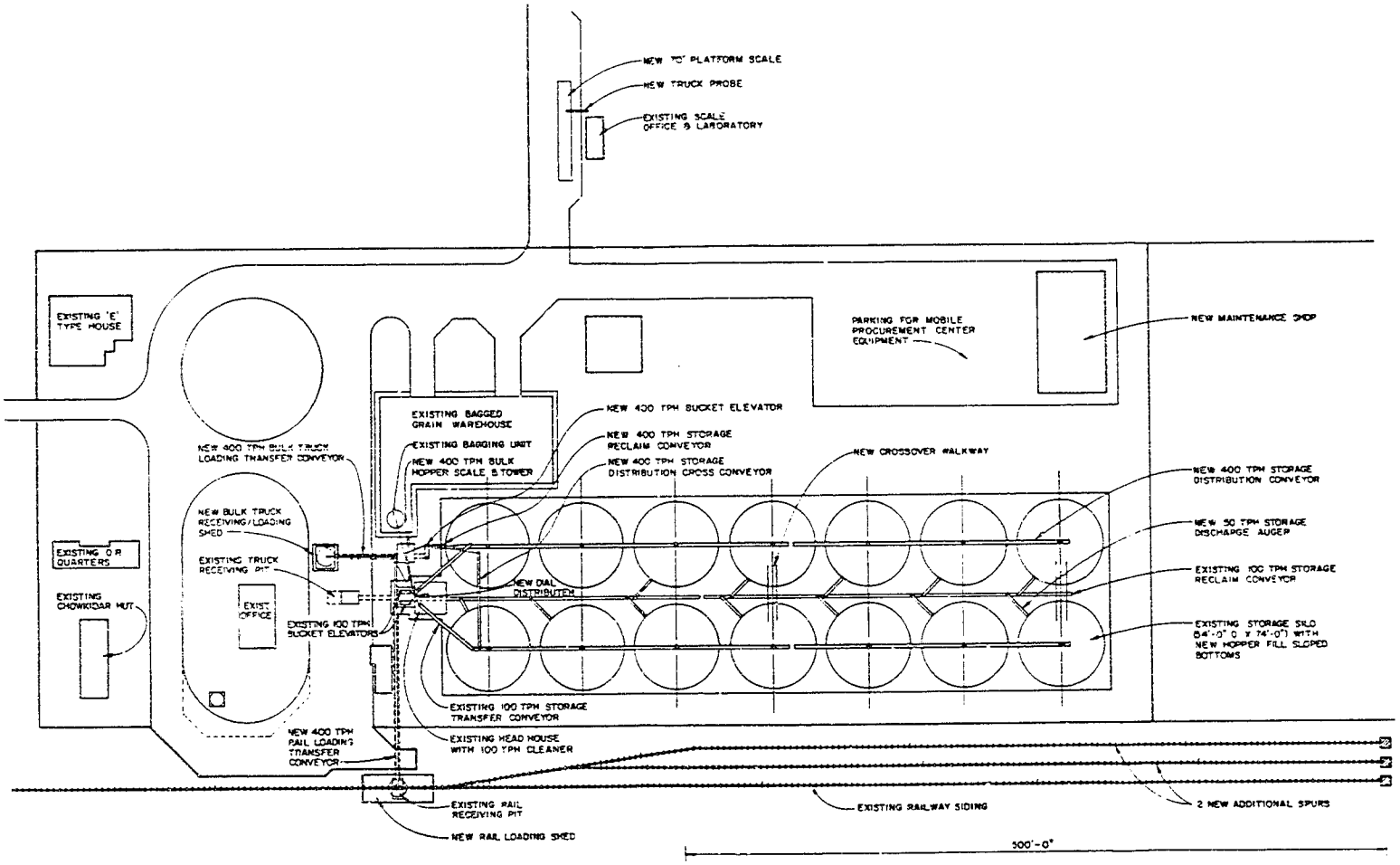
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

CHICHAWATNI AREA
FLOW CHART

SEPTEMBER, 1987 FIGURE 10



0 10 20 40 FT

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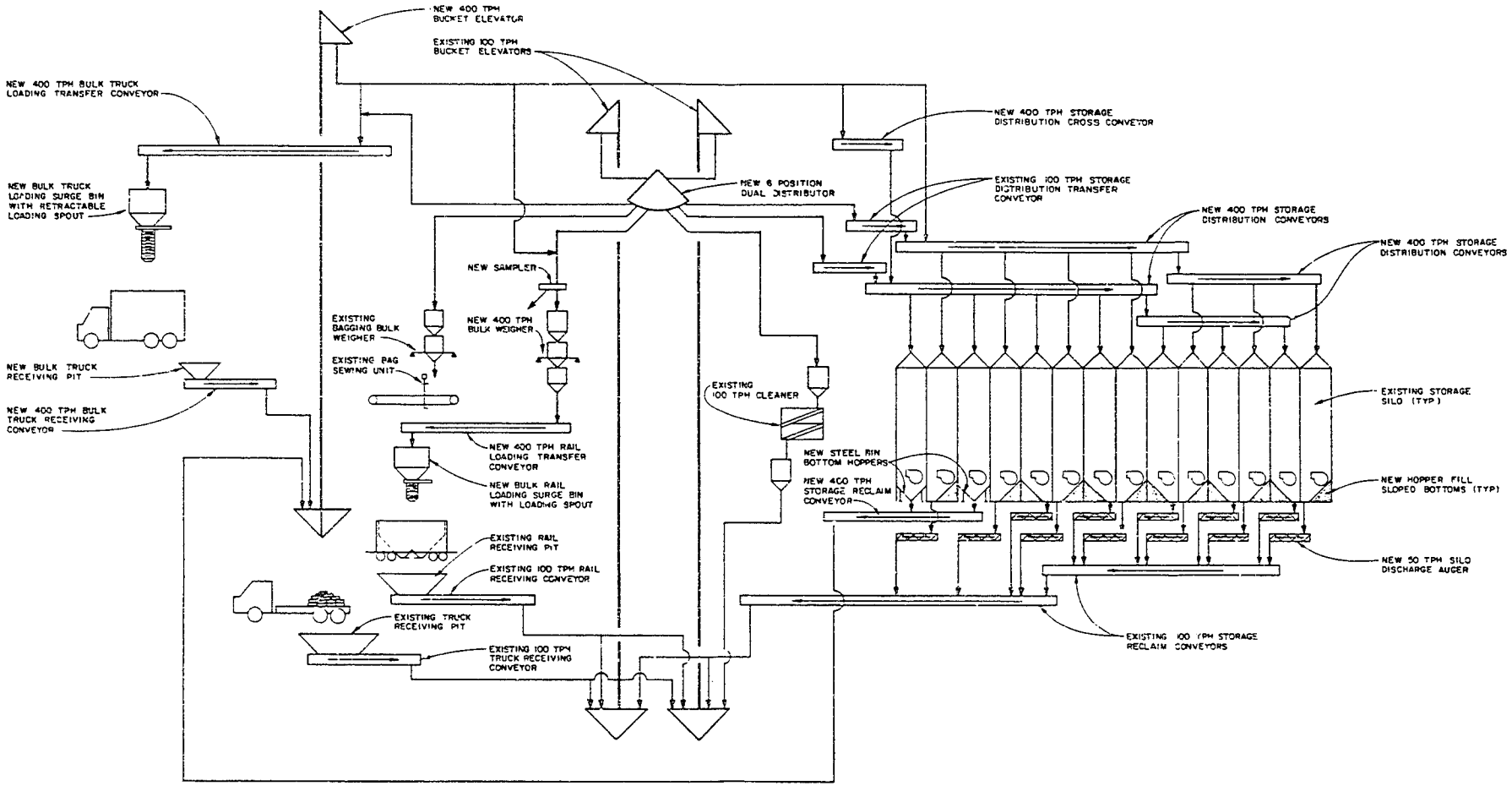
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT

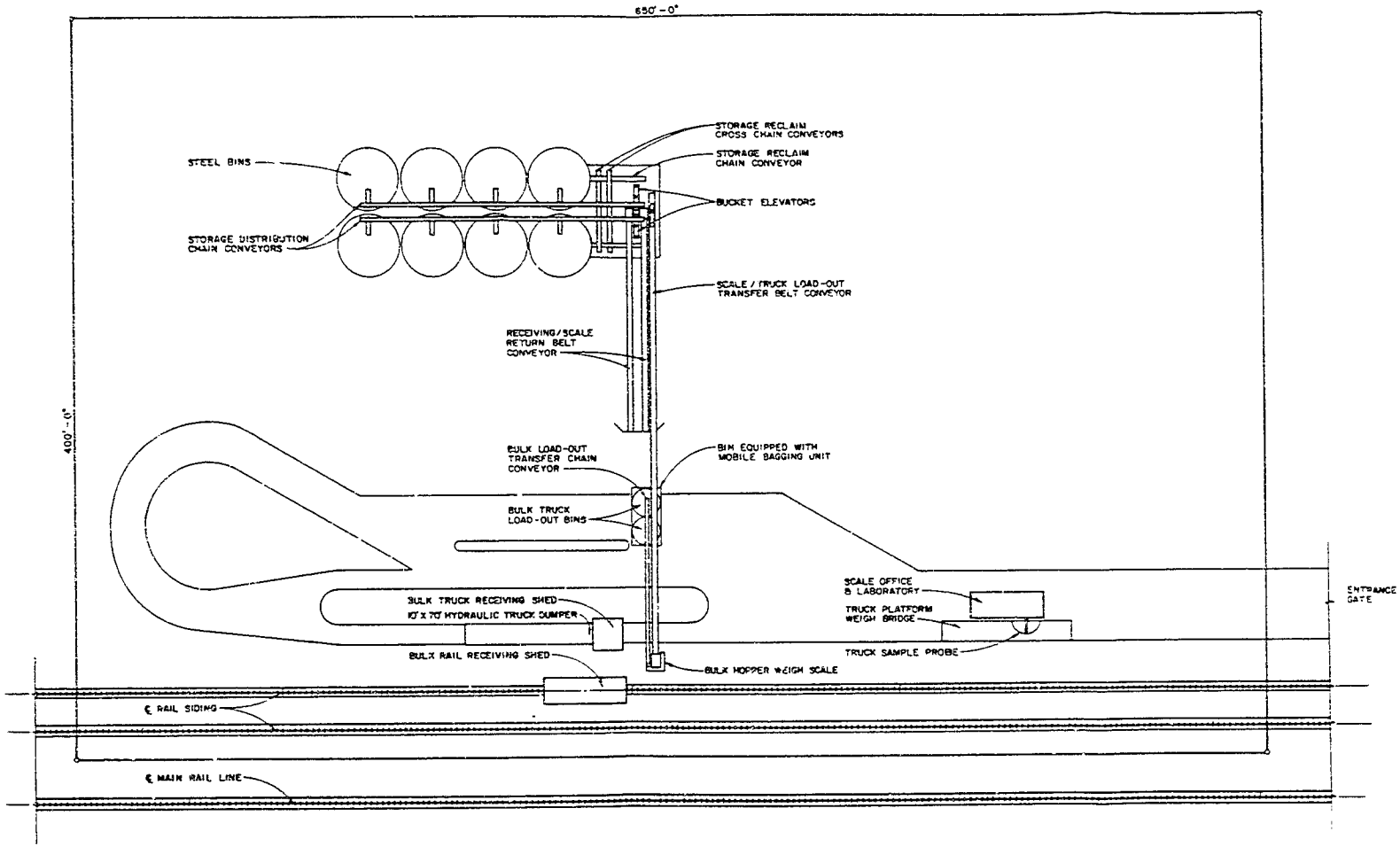
PAKISTAN

KHAIRPUR - CHICHAWATNI SITE PLAN

SEPTEMBER, 1987 FIGURE 11



KSU KANSAS STATE UNIVERSITY	Feed and Feed Grain Institute Manhattan, Kansas 66506 913-532-6161	BULK WHEAT HANDLING AND STORAGE PILOT PROJECT PAKISTAN
		KHAIRPUR - CHICHAWATNI FLOW DIAGRAM
	51	SEPTEMBER, 1987 FIGURE 12



0 10 20 30 60 FT

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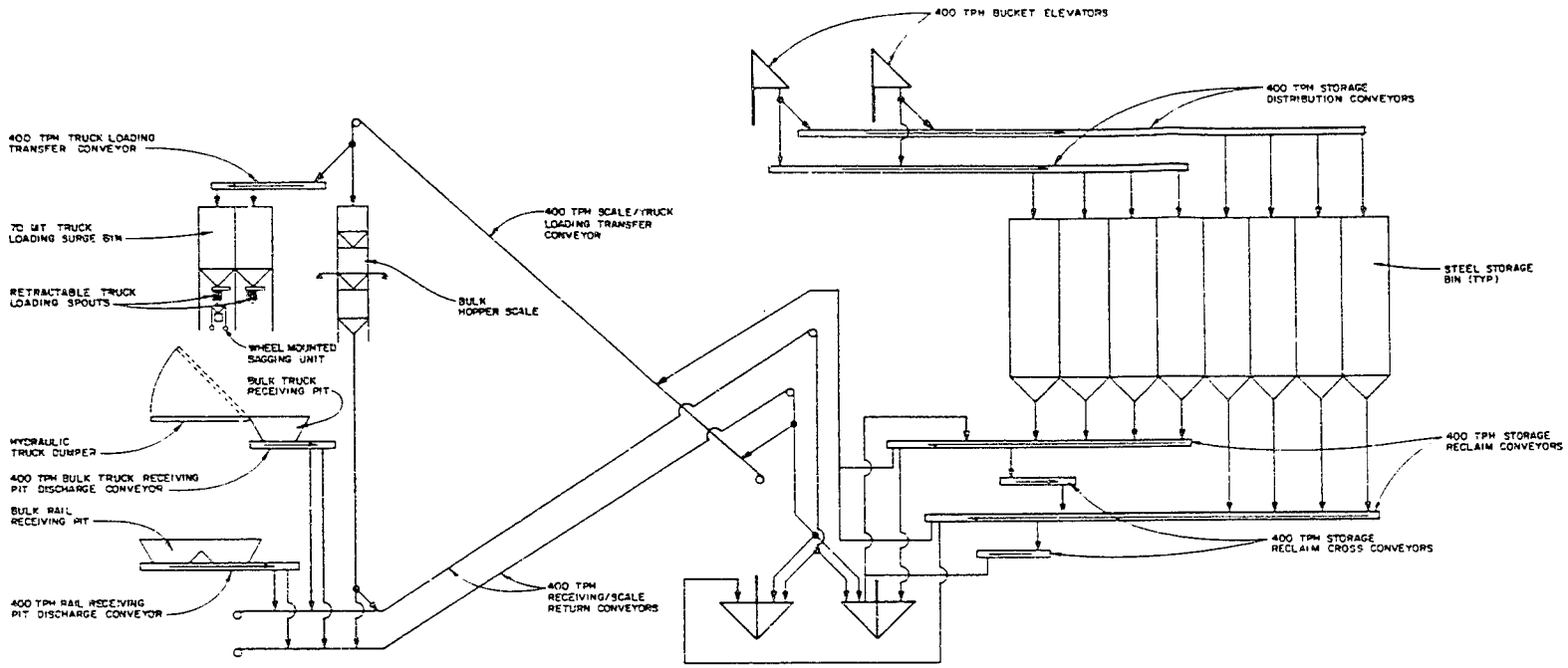
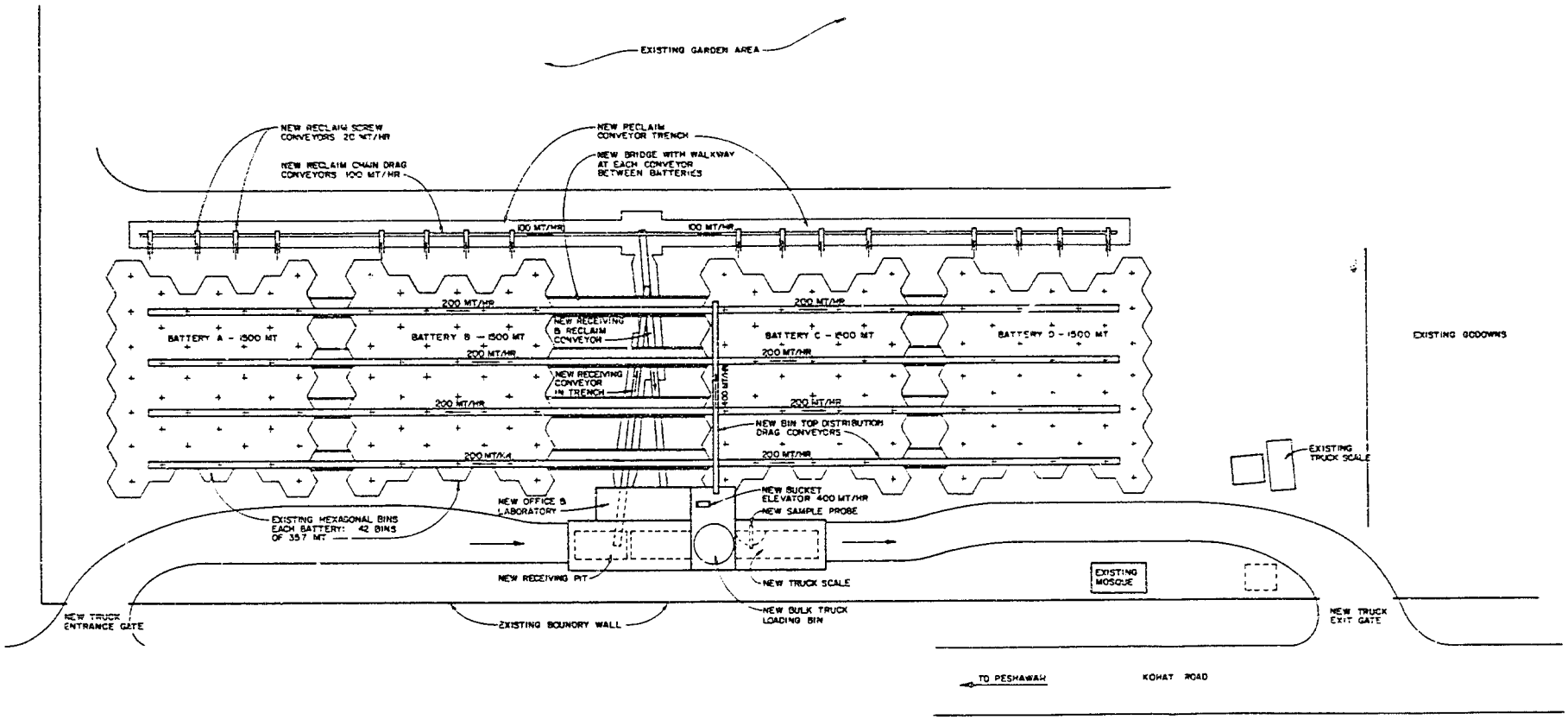
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

PESHAWAR BULK DISPATCH TERMINAL
SITE PLAN

SEPTEMBER, 1987 FIGURE 13



KSU KANSAS STATE UNIVERSITY	Food and Feed Grain Institute Shellenberger Hall Manhattan, Kansas 66506 913 532-6161 55	BULK WHEAT HANDLING AND STORAGE PILOT PROJECT PAKISTAN PESHAWAR BULK DISPATCH TERMINAL FLOW DIAGRAM SEPTEMBER, 1987 FIGURE 14



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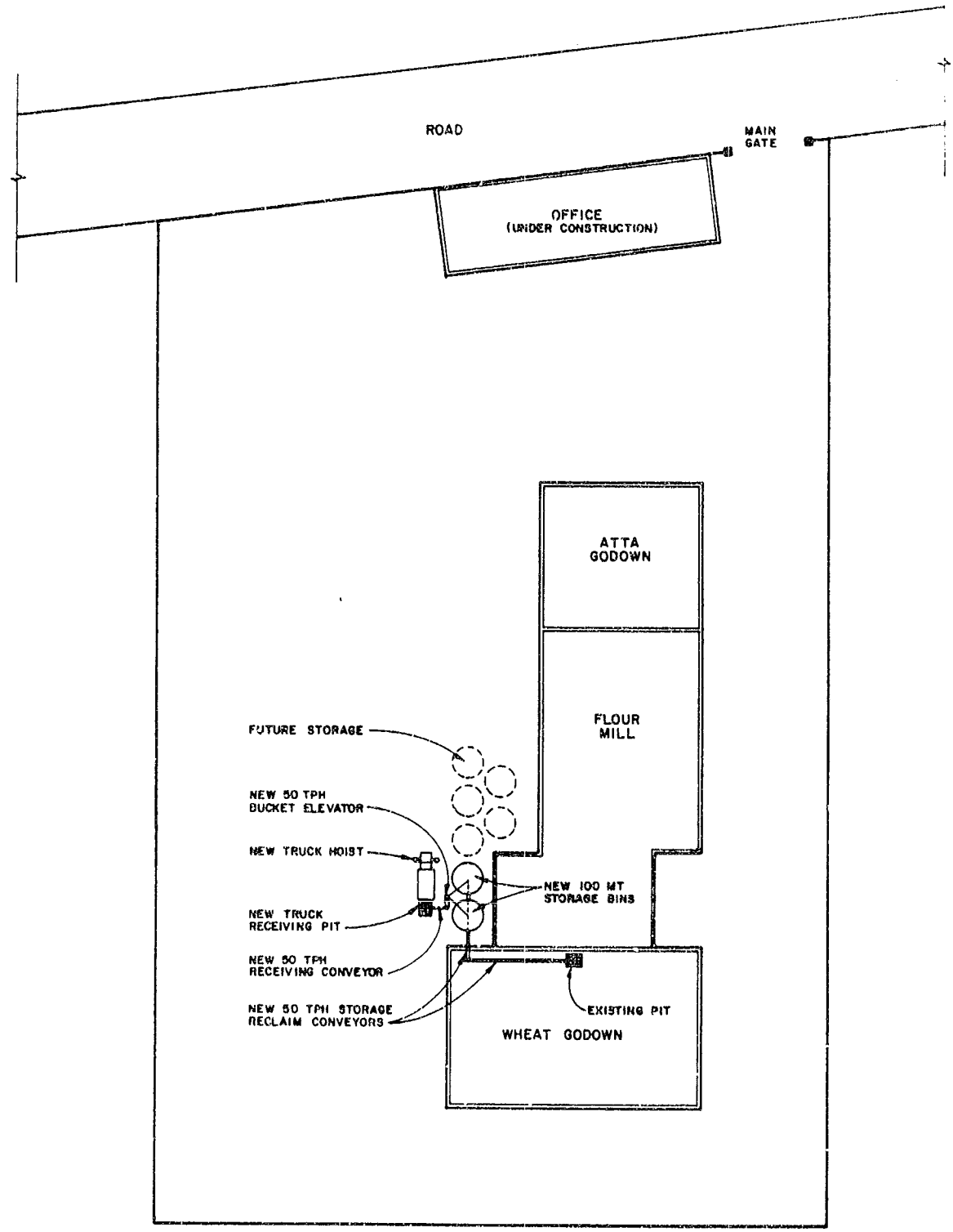
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT

PAKISTAN

PESHAWAR HEXAGONAL BIN BULK TERMINAL

SITE PLAN

SEPTEMBER, 1967 FIGURE 15



0 20 40 80 FT

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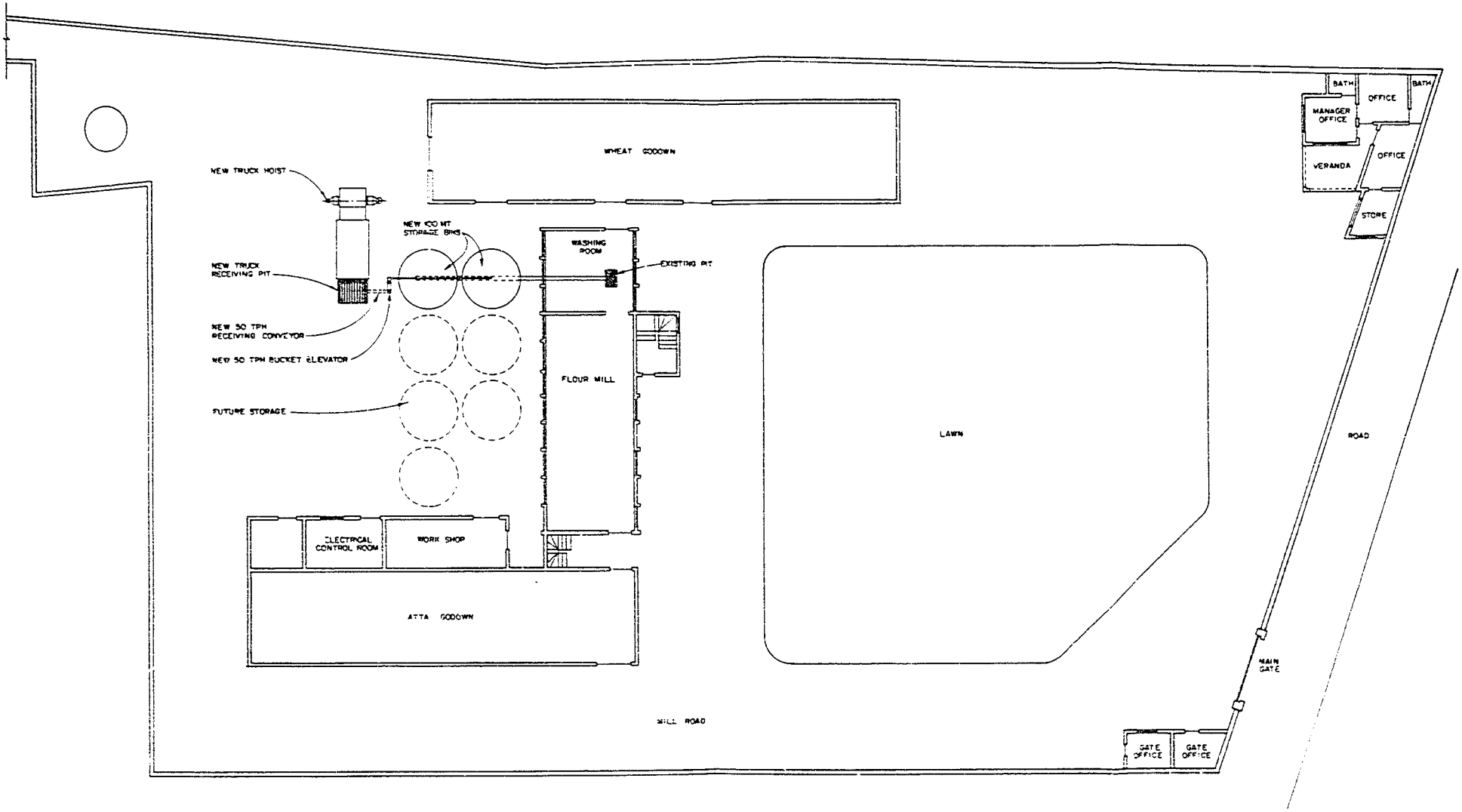
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

ASHRAF FLOUR MILL
SITE PLAN

SEPTEMBER, 1987 FIGURE 16



0 6 12 24 FT

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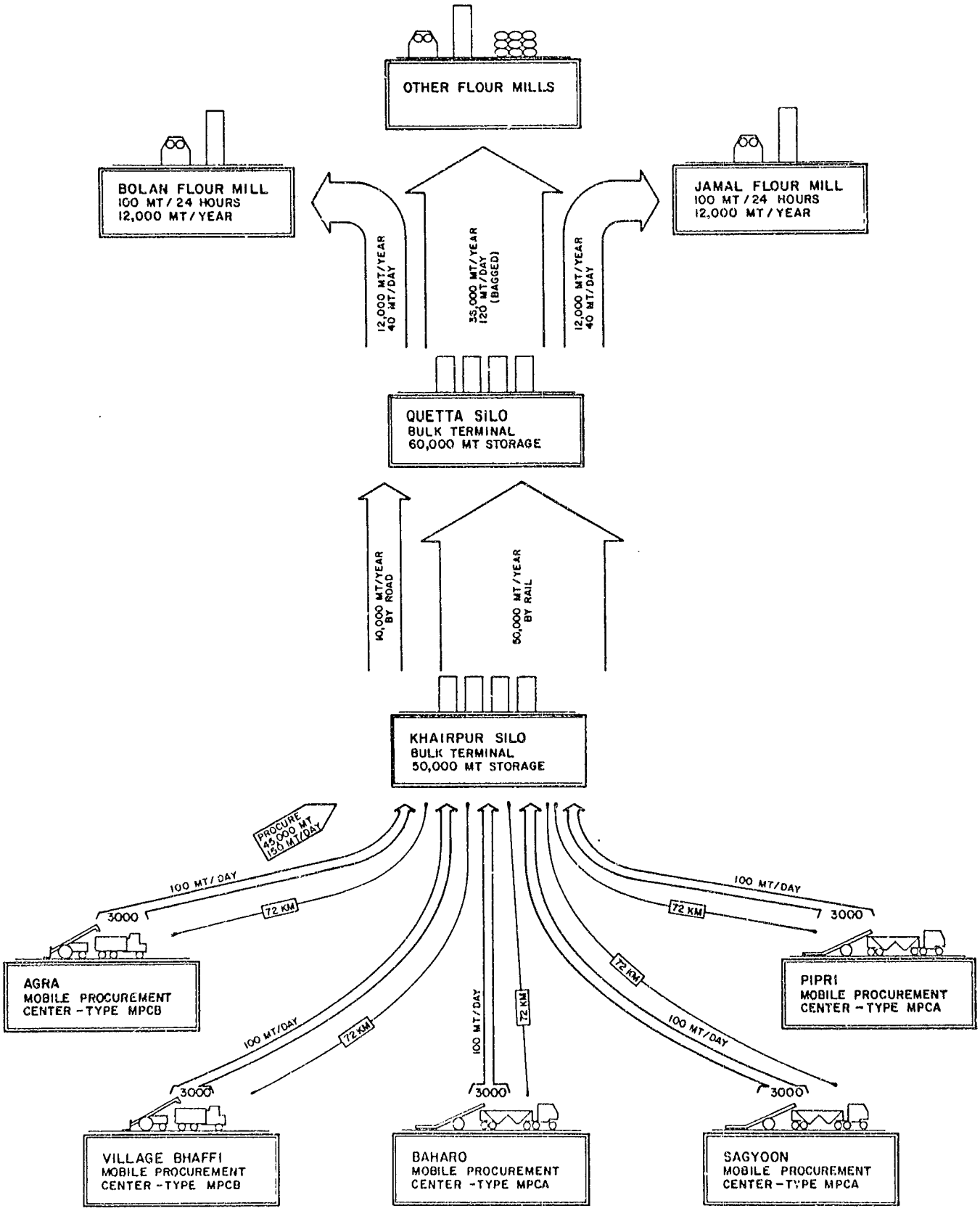
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

BILOUR FLOUR MILL
SITE PLAN

SEPTEMBER, 1987 FIGURE 17



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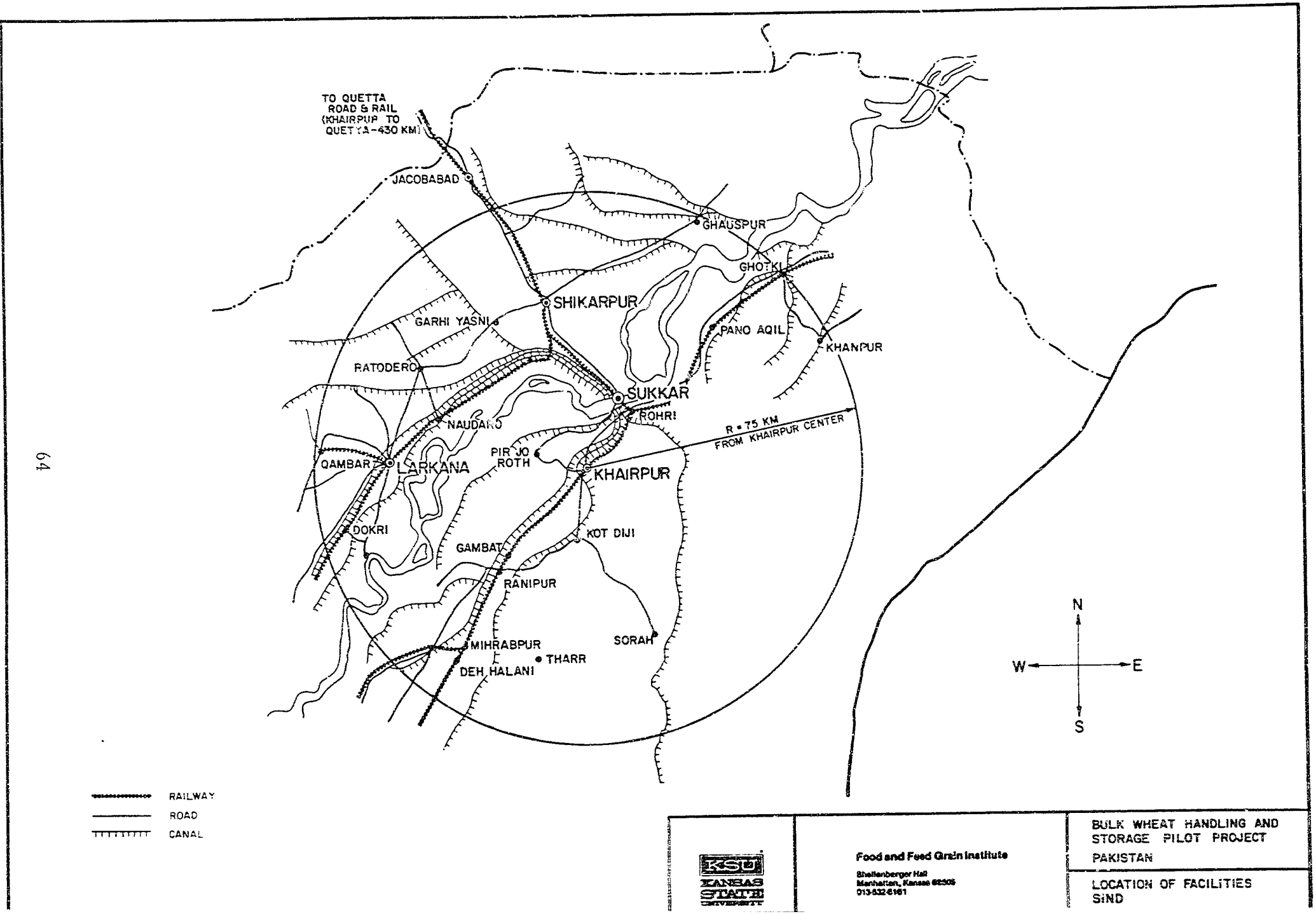
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

KHAIRPUR TO QUETTA
BULK CORRIDOR
FLOW CHART

SEPTEMBER, 1987 FIGURE 18



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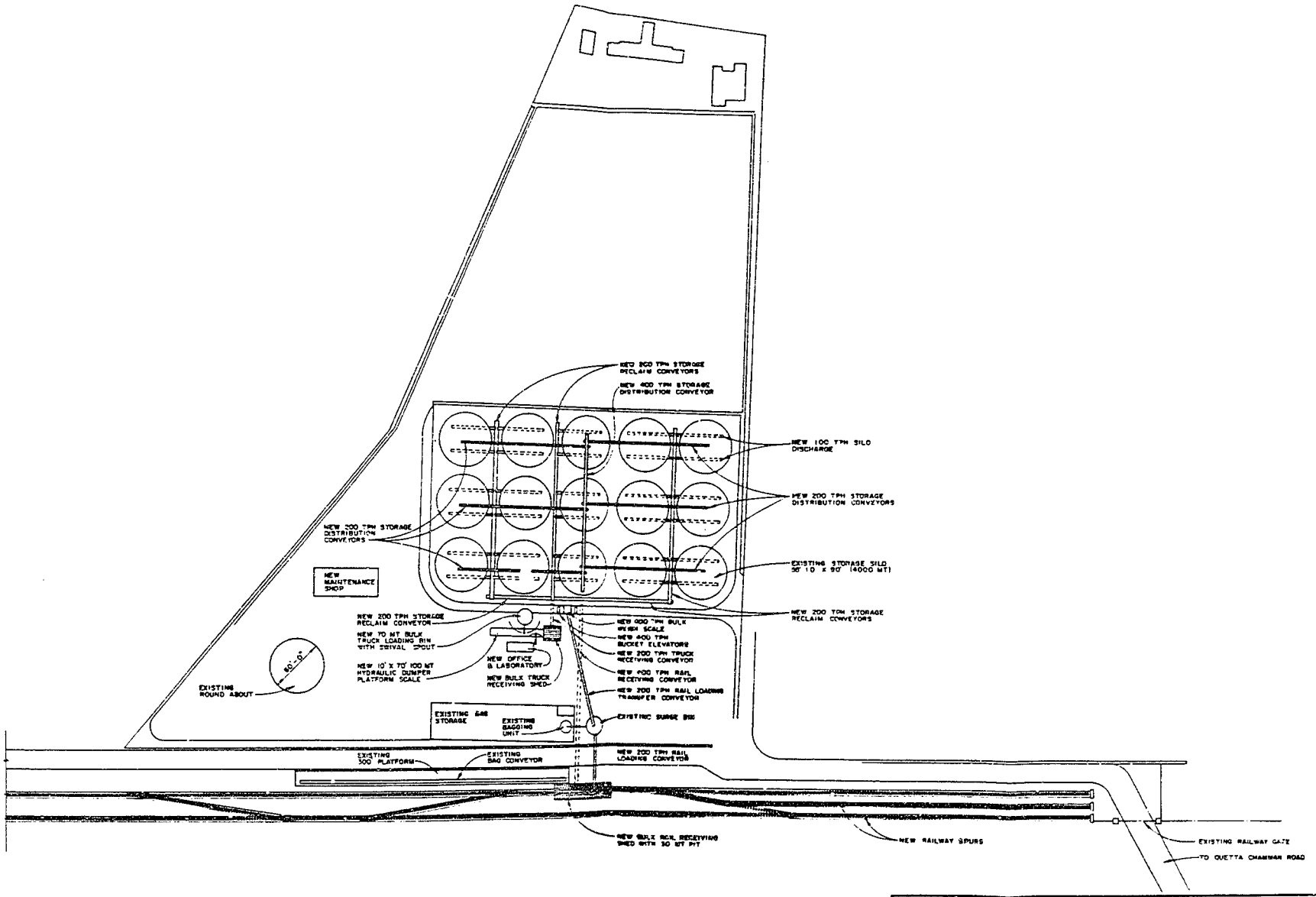
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT

PAKISTAN

LOCATION OF FACILITIES
SIND


NEW 200 TPH STORAGE RECLAIM CONVEYORS
NEW 400 TPH STORAGE DISTRIBUTION CONVEYOR
NEW 100 TPH SILO DISCHARGE
NEW 200 TPH STORAGE DISTRIBUTION CONVEYORS
NEW 200 TPH STORAGE DISTRIBUTION CONVEYORS
EXISTING STORAGE SILO 56' 10" x 90' (4000 MT)
NEW MAINTENANCE SHOP
NEW 200 TPH STORAGE RECLAIM CONVEYOR
NEW 200 TPH STORAGE RECLAIM CONVEYORS
NEW 70 MT BULK TRUCK LOADING BIN WITH SWIVAL SPOUT
NEW 400 TPH BULK WEIGH SCALE
NEW 400 TPH BUCKET ELEVATORS
NEW 200 TPH TRUCK RECEIVING CONVEYOR
NEW 10' X 70' 100 MT HYDRAULIC DUMPER PLATFORM SCALE
NEW OFFICE & LABORATORY
NEW BULK TRUCK RECEIVING SHED
NEW 400 TPH RAIL RECEIVING CONVEYOR
NEW 200 TPH RAIL LOADING TRANSFER CONVEYOR
EXISTING ROUND ABOUT
90'-0"
EXISTING BAG STORAGE
EXISTING BAGGING UNIT
EXISTING SURGE BIN
EXISTING 300 PLATFORM
EXISTING BAG CONVEYOR
NEW 200 TPH RAIL LOADING CONVEYOR
NEW BULK RAIL RECEIVING SHED WITH 30 MT PIT
NEW RAILWAY SPURS
EXISTING RAILWAY GATE
TO QUETTA CHAMAN ROAD
0 25 50 100 FT
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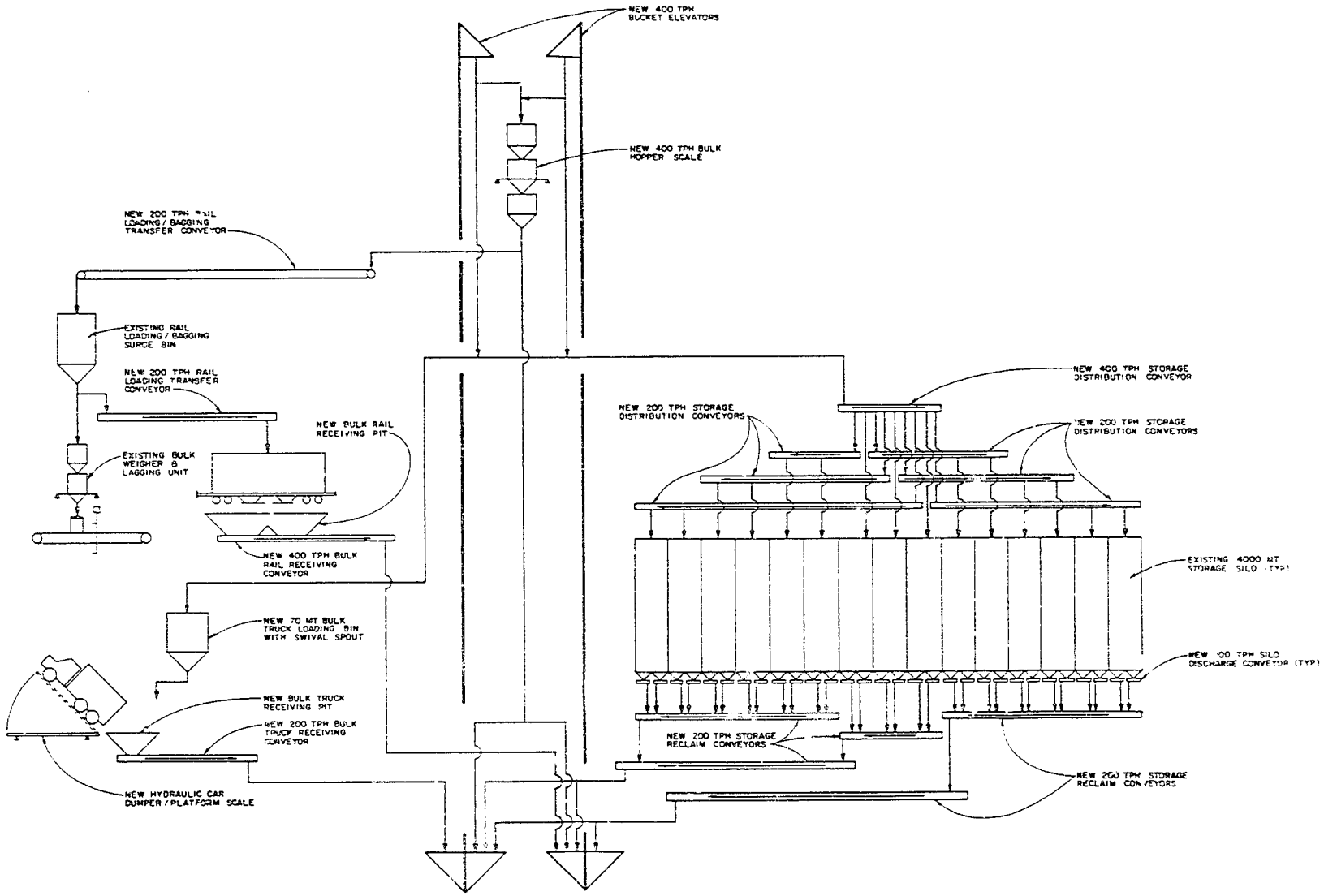
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN
QUETTA TERMINAL SILO
SITE PLAN
SEPTEMBER, 1987 FIGURE 20



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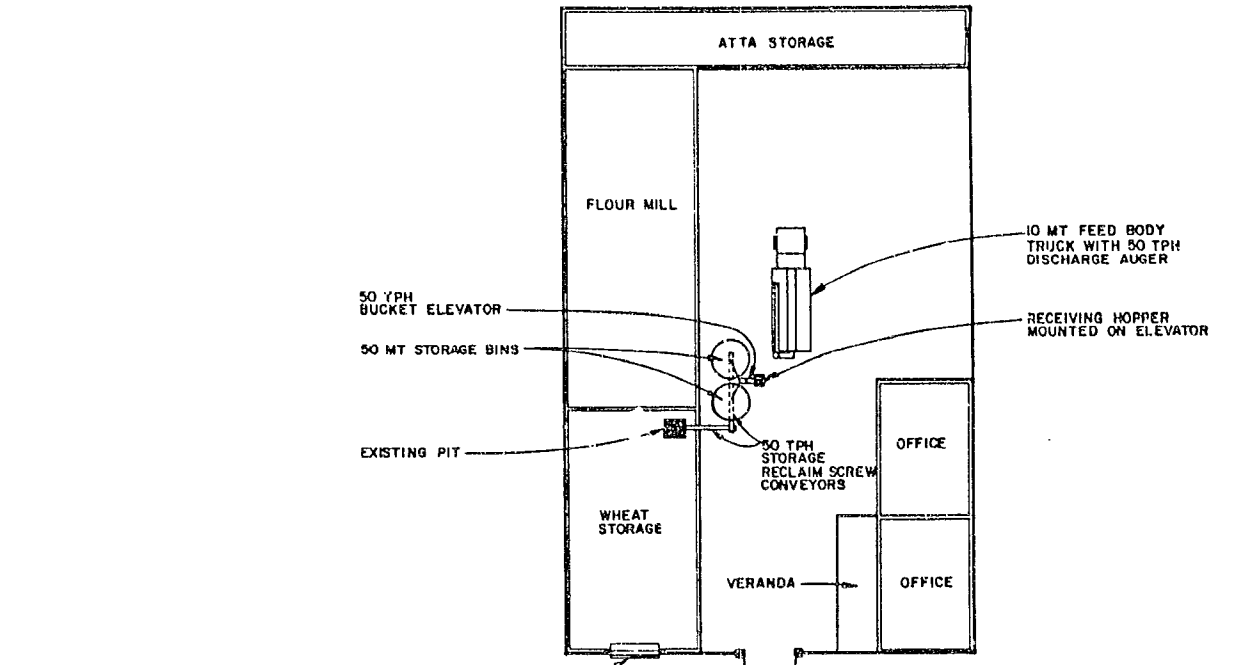
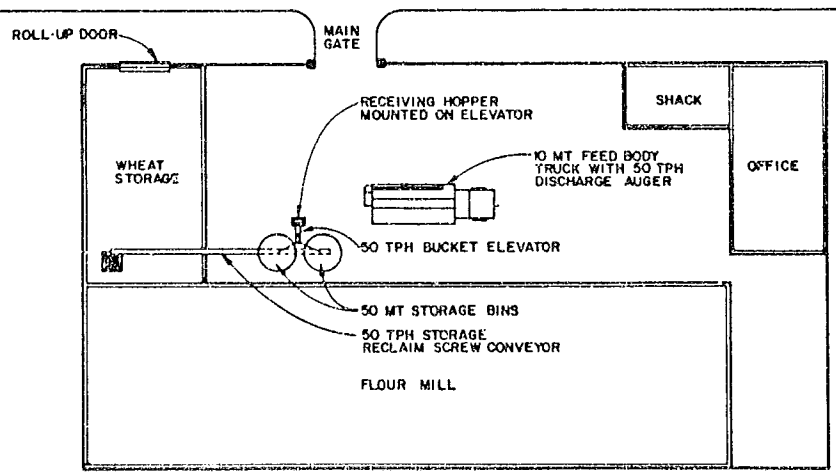
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

QUETTA TERMINAL SILO
FLOW DIAGRAM

SEPTEMBER, 1987 FIGURE 21

JAMAL FLOUR MILL





BOLAN FLOUR MILL

0 10 20 40 FT

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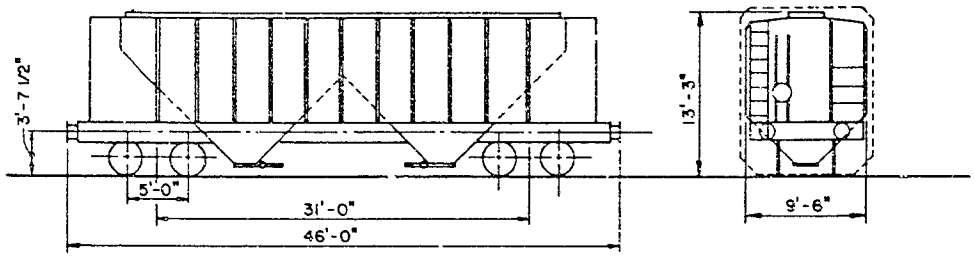
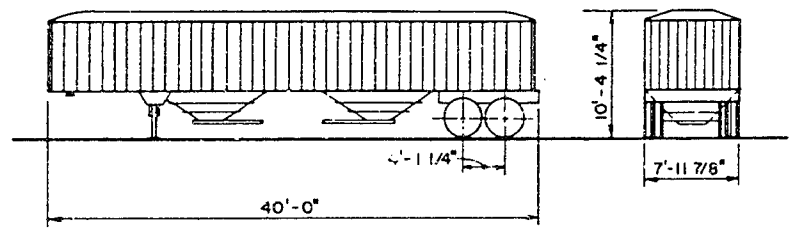
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

JAMAL & BOLAN FLOUR MILLS SITE PLAN

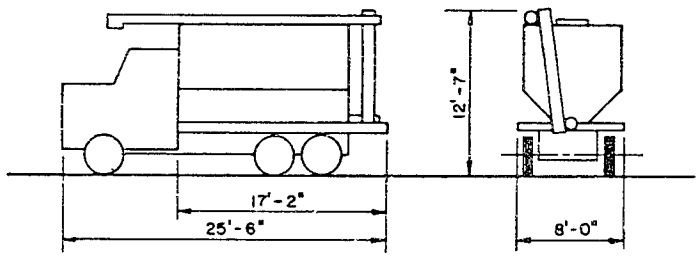
SEPTEMBER, 1987 FIGURE 22



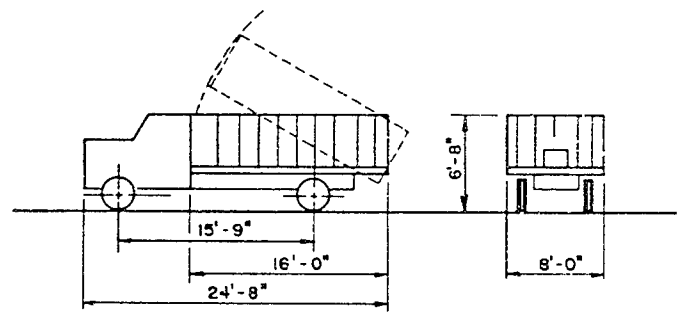
TYPICAL 50 MT BULK RAIL WAGON



TYPICAL 30 MT BULK HOPPER TRAILER



TYPICAL 10 MT FEED BODY TRUCK
WITH DISCHARGE AUGER



TYPICAL 10 MT SELF DUMPING BULK TRUCK

0 2 4 8 16 FT.

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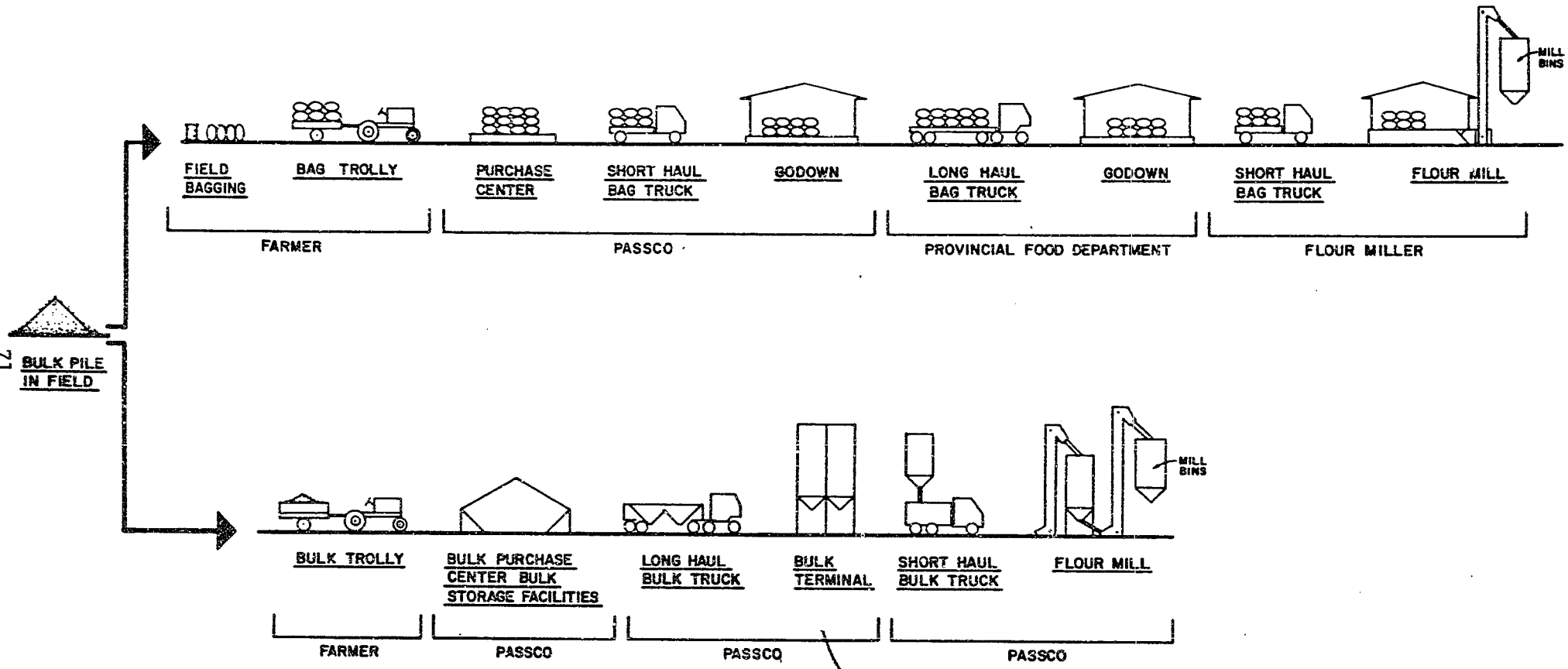
BULK WHEAT HANDLING AND STORAGE PILOT PROJECT
PAKISTAN

BULK WHEAT HANDLING VEHICLES
ELEVATIONS



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BULK WHEAT HANDLING AND STORAGE PILOT PROJECT

PAKISTAN

SEGMENTS OF BAG AND BULK GRAIN CORRIDOR REQUIRING A DATA COLLECTION EFFORT

SEPTEMBER, 1987 FIGURE 24

SECTION IV

RECOMMENDED PROJECT: OTHER BULK STORAGE IMPROVEMENTS

The secondary component of the pilot project, as described in Section I, consists of improving the potential operating capability of existing silo facilities outside the bulk test corridors, specifically those at Faisalabad, Karachi, and Multan; conducting experimental applications of different bulk handling and storage designs to PASSCO warehouses and hexagonal bins; and conducting preliminary engineering surveys and feasibility studies for port grain terminal facilities.

Existing Silo Facilities

Pakistan has a total of six grain silo facilities at various sites throughout the country. Three of these silos, located at Quetta, Chichawatni, and Khairpur, are to be incorporated into the bulk test corridors. Modifications to these silos are detailed in Section III. The other three silos are located in Multan, Karachi, and Faisalabad. The silos at Karachi and Faisalabad are only partially complete and construction has been stopped. The Multan silo, which has been in operation for some time, is not within the bulk test corridors but could benefit from some improvement. These three silos will be reviewed in detail as part of this project.

Karachi and Faisalabad Silos. A detailed study will be undertaken to determine if the Karachi and Faisalabad silos should be completed. Design modifications which may be necessary will be identified and a plan for continuation of the project will be developed. The activities to be undertaken as part of the study are to (1) review all structures completed, under construction, or planned, (2) inventory and evaluate mechanical equipment as stored on site, (3) review plans for the proposed completed facility, (4) recommend modification to the design as required, (5) prepare cost estimates of proposed completion of construction, (6) prepare a project plan and schedule, and (7) prepare a financial analysis of the proposed facility.

A complete report will be prepared detailing the findings and recommendations of the study.

Multan Silo. Although the Multan silo has been operating for some time, there are certain apparent deficiencies that should be rectified if the silo is to reach its full operating potential, as noted in Table 2, Appendix II. A study will be made of the Multan silo to determine and define necessary improvements. The activities to be undertaken in this study are to (1) review all structures, (2) evaluate mechanical equipment as installed, (3) review the concept of the completed facility, (4) observe operations and maintenance procedures, (5) recommend modifications required, (6) prepare cost estimates of the proposed modifications, (7) prepare a project plan and schedule, and (8) prepare a financial analysis of the facility after modification.

A complete report will be prepared detailing the findings and recommendations of the study.

Experimental Applications

Certain existing grain storage facilities in Pakistan could be converted to bulk handling and storage procedures. However, the technical methods will vary according to the different facilities. It is not known whether specific technical methods will be cost-efficient if implemented in the various facilities. The determination of whether individual facilities can be utilized for bulk handling and storage of wheat requires the experimental application of different techniques. Studies will be carried out to determine the most feasible and economical methods for conversion of existing bag facilities to bulk units. Experiments will be conducted at the following sites.

Okara. At their godowns in Okara, PASSCO has for some time been conducting experiments with storing wheat in bulk. These efforts will be reinforced under this project. Equipment will be provided for loading and unloading the bulkhead and for continued conversion of godowns to bulk handling. In addition, development of improved methods for loading and unloading bulk wheat into the godowns will be studied. Wheat stored in bulk at Okara will be moved in bulk to the terminals at Peshawar.

Specific equipment which will be assigned to Okara for trial purposes and for assisting with the present bulk stores is as follows.

1. Two tractor-mounted inclined conveyors with pick-up scoop and auger suitable for picking up bulk wheat from the ground.

2. Two portable electric inclined conveyors with dump pit suitable for receiving bulk wheat from trucks.

3. Two small wheel loaders.

4. One trailer-mounted generator set.

Khanewal. The primary objective of the work at the Khanewal facility will be to develop the most economical and efficient methods for mechanizing typical hexagonal bin facilities located in the wheat-producing areas. Experiments for conversion of the Khanewal hexagonal bins will be conducted by installing a system of screw conveyors on the bin top and under the bins to provide mechanized loading and unloading. The proposed installation will make use of the existing platform truck scale for determining receiving and shipping weights for bulk grain. Sampling and laboratory equipment will be provided, as well as bagging facilities. The arrangement of equipment will be similar to the Peshawar Hexagonal Bin Bulk Terminal except that the receiving equipment will have a lower capacity.

Bini-Shells. A comprehensive study will be completed to identify and offer solutions to possible problems with bulk storage of wheat in existing bini-shell structures. Specifically, the study will (1) review the structures for adequacy to support pressures from bulk wheat, (2) develop methods for mechanized bulk loading and unloading, (3) review problems of water leakage and excessive heating of wheat and propose solutions to these problems, (4) prepare preliminary site layouts for two selected facilities, (5) prepare cost estimates of the proposed modifications, (6) prepare a project plan and schedule, and (7) prepare a financial analysis of the proposed facility.

A complete report will be prepared detailing the findings and recommendations of the study.

Port Facilities Planning

Pakistan has a growing need for handling ocean-borne imports and exports of grain, oilseeds, oilseed meal, and other agriculturally-derived products. These activities could be centralized into a public service facility which would be available to individual merchants, private firms, private-sector groups, or government agencies. Such a public terminal silo facility might be a profitable operation which would encourage growth of the private sector in merchandising and processing. A reduction in handling costs and an improvement in the dependability of scheduling would help both the government and the private sector. Furthermore, the ability to efficiently handle large volumes of imported food grains is an important aspect of food security considerations in time of national disaster or other major disruptions to production.

A detailed feasibility analysis and preliminary engineering study will be carried out to analyze the role of various government and private-sector organizations in the planning, design, construction, ownership, and operation of the facility. Planning for the port grain handling facility will be integrated into the overall movement to convert to bulk wheat handling in Pakistan.

The comprehensive analysis and preliminary engineering study will (1) review navigation constraints at the ports of Quasim and Karachi, including vessel length and draft, (2) estimate throughput quantities of various commodities which might be handled by the facilities, (3) review potential berths and sites, both existing and planned, (4) review existing port operations as they relate to grain handling, (5) develop concepts for improvement of grain handling systems, particularly as related to conversion to bulk handling, (6) define a phased program for development, (7) prepare preliminary site layouts and general arrangement drawings for proposed facilities, including arrangement of berths to be used for grain, (8) prepare outline specifications for the structures and equipment proposed, (9) prepare a description of the operations, (10) define a phased program for development, (11) prepare estimates of capital requirements and operating costs and benefits for the present and proposed facilities, (12) estimate the impact of the improved facilities on ocean freight rates for grain and other bulk agricultural commodities, (13) prepare a project plan and schedule, (14) recommend and describe the organization for operations and maintenance of the facility, and (15) prepare a financial analysis of the proposed facilities.

A complete report will be prepared detailing the findings and recommendations of the study.

Relationship to Bulk Test Corridor Results

If the bulk test corridors prove to be successful and a decision is made to implement changes in the entire wheat handling and storage system, it will be necessary to understand how best to improve and modify the existing bag and bulk storage facilities. The technical and economic information gathered from the above activities can be used to verify the information gained in operating the bulk test corridors, and to provide an additional set of information on

facilities outside the bulk test corridors. The compilation of this information will provide the SWIP with a better set of data with which to develop a comprehensive plan for countrywide bulk wheat handling and storage.

SECTION V

IMPLEMENTATION PLAN AND SCHEDULE

In order for this pilot project to be carried out in the most efficient manner possible, the implementation plan and schedule sets forth the nature and sequence of the activities required to produce the desired end results. In addition, the needs in the areas of technical assistance and training are presented and integrated into the project schedule.

Project Schedule

The scope of activities under this project is quite large and complex. There are numerous and varied elements which are subject to different time constraints, such as the wheat harvest period which provides a specific time for conducting tests. Therefore, a phased approach will be required, with target completion dates centered around the wheat harvest period of April/May of each year. Under the assumption that the project can be started by March 1988, the main target dates for completion of various physical components of the project will be May 1989, May 1990, and May 1991. Test operations of bulk corridors will be completed in May 1993. This allows a period of at least 2 full years for test operation of all of the elements of the bulk test corridors. Figure 25 provides an overall view of the implementation schedule for all elements of the pilot project.

Figures 26 and 27 provide a detailed view of the schedule for the two bulk test corridors. These figures provide separate schedules for each facility within the bulk test corridors.

In the Punjab to Peshawar corridor, as seen in Figure 26, active operations of the bulk test facilities will start with the MPCs serving the Dipalpur area and the Chichawatni silo during the harvest of 1989. The bulkheads at Pipli Pahar and 40/D will also be activated during this harvest. The following harvest in May of 1990 will see the full operation of the complete Dipalpur area facilities as well as the Peshawar Hexagonal Bin Bulk Terminal and two of the flour mills. This will provide at least partial operation of a complete corridor by the harvest of 1991. The operations period of the project will then continue until May 1993.

In the Khairpur to Quetta corridor, as seen in Figure 27, active operations of the bulk test facilities will start with the MPCs serving the Khairpur silo during the harvest of 1989. Completion of the modifications to the Khairpur and Quetta silos will be staged to be ready for the harvest of 1990. The completion of the unit train and the flour mill facilities will allow full operation of this corridor at that time. The test operations period of the project will then continue until May 1993.

The major study work related to the existing silos, partially-completed silos, and port facilities will be completed during the first year of the project. In addition, support activities related to the Okara site will be undertaken together with the mechanization of the Khanewal hexagonal bins.

Project Organization

The project activities will be carried out by MINFA, PASSCO, and a specialized foreign consultant organization.

MINFA will be responsible for the general direction of the project. A group composed of representatives from all principal Pakistani organizations, government and private-sector, which will be directly affected by the project should be established as an advisory committee to MINFA. This group will meet periodically to review and evaluate the progress of the project.

Day-to-day management of the project during the engineering and construction stage will be carried out by the consultant organization, which will be responsible for the design, engineering, procurement, training, construction, and commissioning of the recommended project. The consultant organization will report directly to MINFA and work closely with PASSCO. The consultant organization will contract for the supply of equipment, materials, and construction services. Portions of the consultant organization's services will be subcontracted to local professional engineering organizations. After construction of the facilities is completed, the consultant organization will remain as technical advisor for the operation of the bulk test corridors.

Ownership and management of completed facilities will be the responsibility of PASSCO. Ownership of all equipment and facilities provided under the project will pass directly from the supplier to PASSCO. PASSCO will work with PFDs, private transport firms, milling companies, and the railroad to carry out the test operations which include the collection and analysis of data.

The management structure to be used by PASSCO in operation of the bulk test corridors is shown in Figures 28 through 32.

Technical Assistance

The technical assistance to be provided covers a wide range of activities over the entire life of the project. This technical assistance will be provided by the foreign consultant organization, and the major components include the following:

1. Economic analysis, operations evaluation, and conceptual design of bulk grain handling and storage facilities adapted to conditions in Pakistan. This will include the preparation of studies, evaluations, and basic designs for the facilities and equipment included in the pilot project.

2. Detailed site studies, including evaluation of existing structures, machinery, electrical systems, and utilities; topographic and boundary surveys; soil borings and foundation analysis; and other items related to the design of the pilot project.

3. Detailed design and development of tender and procurement documents for the facilities and equipment to be supplied and/or constructed by U.S. and Pakistani contractors.

4. Procurement and expediting assistance, including evaluation of tenders, coordination of international and domestic freight, customs clearance,

inspection of goods received, warehousing, consignment of goods to project site, and assignment of goods to PASSCO.

5. Construction inspection, coordination, and quality control.

6. Assistance during all phases of placement and operation of facilities and equipment.

7. Training of Pakistani personnel for maintenance and operations of equipment, and management of facilities and overall systems.

8. Assistance with operations and the collection of data during the test period.

Technical assistance should be contracted through the foreign consultant organization. A project team will be established under the direction of a single project director. The composition of this team would vary from time to time according to project requirements.

No definitive staffing plan for the technical assistance component has been set up at this time. However, it has been anticipated that the consulting organization would have an ex-patriate resident staff varying from two to six individuals in Pakistan during the entire project period. The composition of this staff would vary from time to time depending on project activities.

The resident staff would be supported by a full-time Pakistani contingent as well as U.S. and Pakistani specialists as needed. Design and procurement services for the specialized equipment and facilities would be carried out in the U.S., while testing and surveys would take place in Pakistan. The design of the ancillary buildings, civil works, and related items would take place in Pakistan. Coordination and reviews would take place in both the U.S. and Pakistan.

Training

To ensure the successful operation of the bulk test corridors as well as the bulk transport tests, various categories of PASSCO employees will be trained in the operation of bulk grain handling and storage facilities. Training is viewed as a continuous process throughout the life of the project, and is represented as such in the implementation schedule. The overall training program includes external short-term training and in-country short-term training for PASSCO employees. Placement of management employees in the bulk facilities should occur within the first 3 months of the implementation of the project so that training can begin prior to any construction work on the facilities. In this way, training would be completed in time for trainees to participate in the construction process.

External short-term training will consist of two specialized training programs to be conducted in the U.S. Both programs should emphasize training in actual operating handling and storage facilities, with minimal time spent in the classroom.

The first external training program will address general aspects of grain facility management, and will be presented to the general managers of the six

bulk terminal facilities. This 8-week program will cover such topics as fundamentals of bulk grain storage, general management, supervision of day-to-day operations of storage facilities, and operation and maintenance of equipment related to bulk grain storage facilities.

The second external training program will address the needs of the six bulk terminal operation managers in the area of grain facility management and operation. This 12-week program will cover such topics as general management, general operations and supervision of bulk grain equipment, supervision and decision-making involved in day-to-day operations of storage facilities, fundamentals of bulk grain storage, inventory control processes, and grain quality control techniques and procedures.

In-country training will include a continuous series of specialized courses addressing all phases of bulk wheat handling and storage operations. A 2-week course in operations management training will be provided to the six chief operation inspectors. Since these inspectors are responsible for the supervision of the procurement centers, this training will include such topics as bulk purchasing processes, mobile equipment operation, grain inspection techniques, and grain accounting procedures.

A series of 1-week short courses on facility equipment and maintenance will be provided for sub-assistant engineers (maintenance) and their staffs. These courses will be continuous over the life of the project, and will cover maintenance of various types of bulk handling equipment. Each course will be limited to only one type of equipment, so trainees will attend a number of these courses during the project's duration. It is expected that a minimum of 30 persons will be trained in these courses.

A course in grain accounting systems will be provided for grain terminal accountants, chief operation inspectors, purchase inspectors, and PASSCO headquarters staff. This 3-week course will provide instruction in the use of a bulk grain accounting system designed to meet the needs of the project. It is estimated that 60 persons will receive training in this course. After project operations begin, it may be necessary to present a refresher course on this topic.

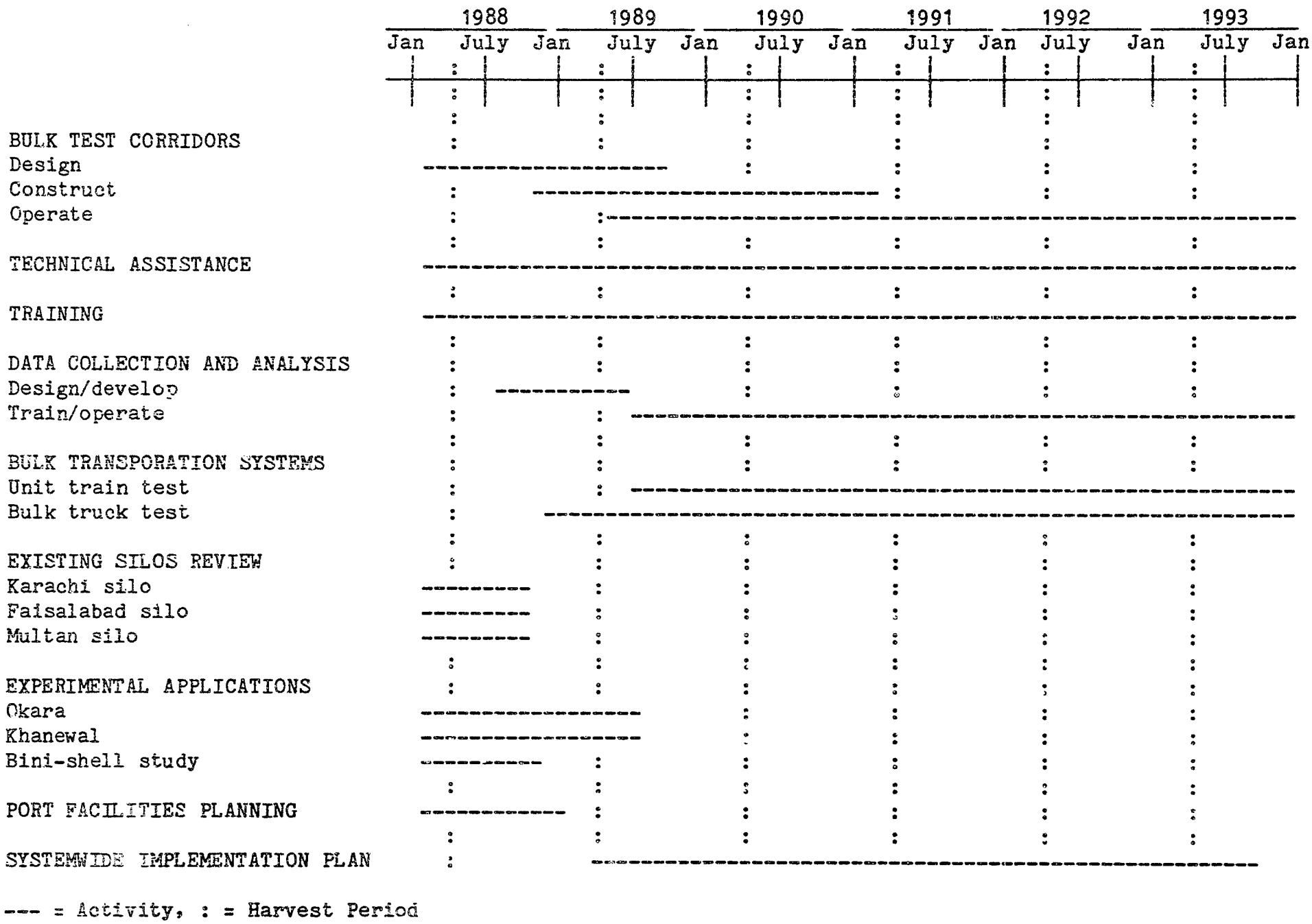
A 5-week course on data collection and analysis will be presented to PASSCO headquarters employees involved in this function. This course will consist of training in collecting data from the grain accounting system and other project reports, arraying this information in a previously-determined format, and analyzing the data to evaluate the results of the project.

A summary of external and in-country training programs is presented in Table 10.

TABLE 10

TRAINING REQUIREMENTS FOR PASSCO PERSONNEL

Training Program	Type of Personnel	Number of Personnel	Location	Duration
External Short-Term				
Grain Facility Management	General managers of bulk terminals	6	U.S.	8 weeks
Grain Facility Management and Operation	Operation managers of bulk terminals	6	U.S.	12 weeks
In-Country Short-Term				
Operations Management Training	Chief operations inspectors	6	Pakistan	2 weeks
Facility Equipment and Maintenance	Sub-assistant engineers and staff	30	Pakistan	1 week each
Grain Accounting Systems	Terminal accountants, chief operations inspectors, purchase inspectors, PASSCO headquarters staff	60	Pakistan	3 weeks
Data Collection and Analysis	PASSCO headquarters employees	5	Pakistan	5 weeks



--- = Activity, : = Harvest Period

FIGURE 25. Pilot Project Implementation Schedule

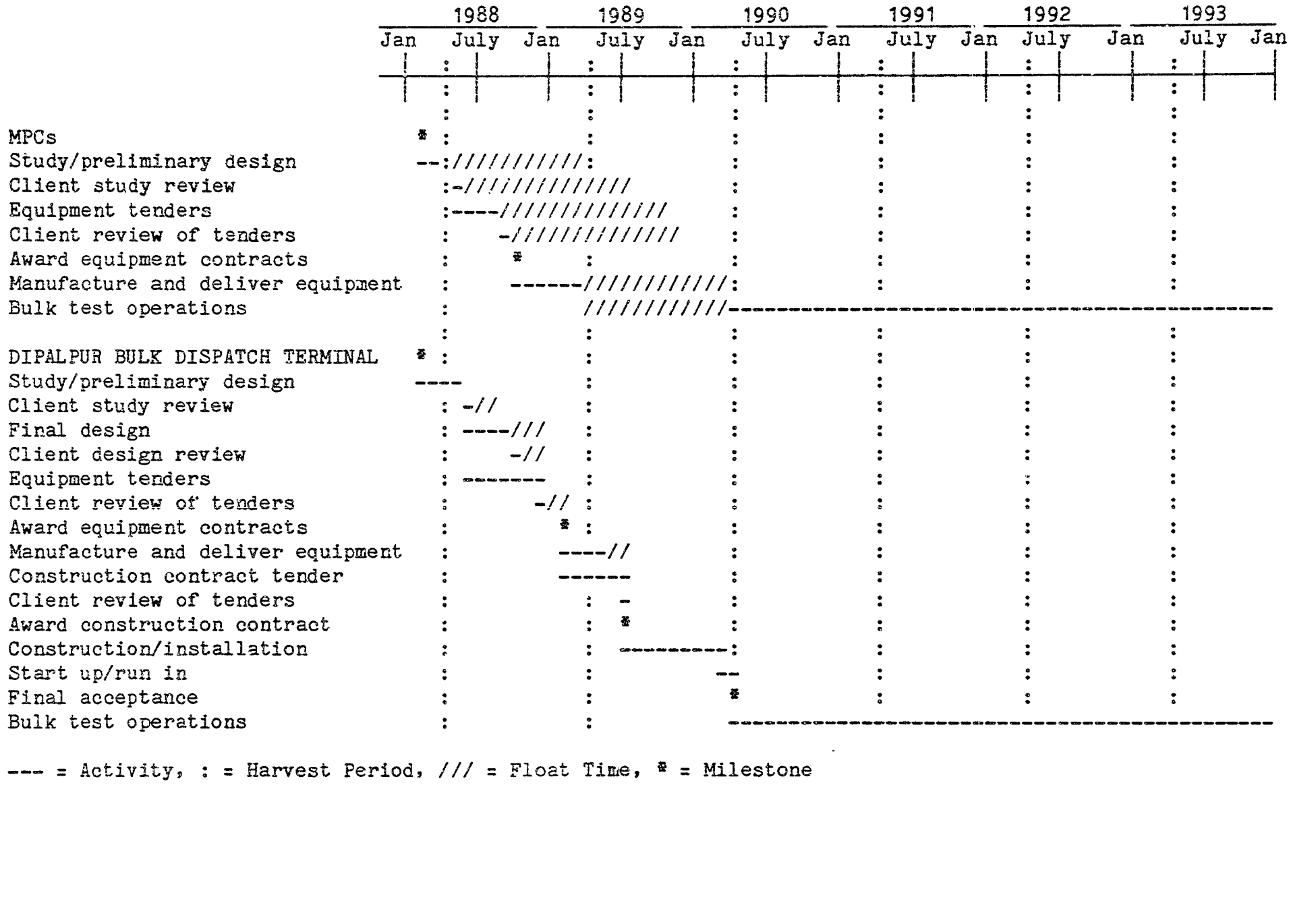
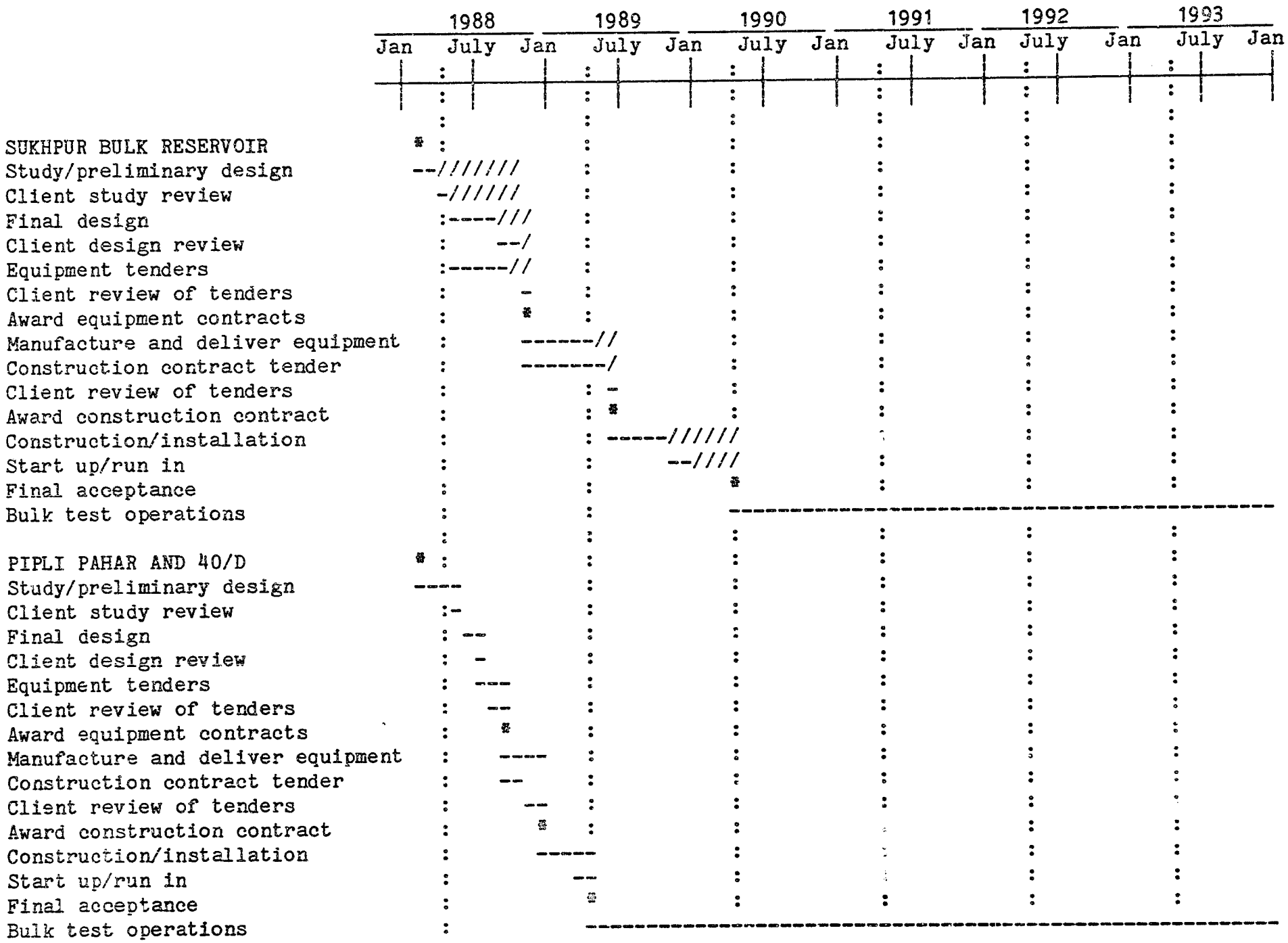


FIGURE 26. Implementation Schedule: Punjab to Pershawar Bulk Test Corridor



--- = Activity, : = Harvest Period, /// = Float Time, ▪ = Milestone

FIGURE 26 (Cont.)

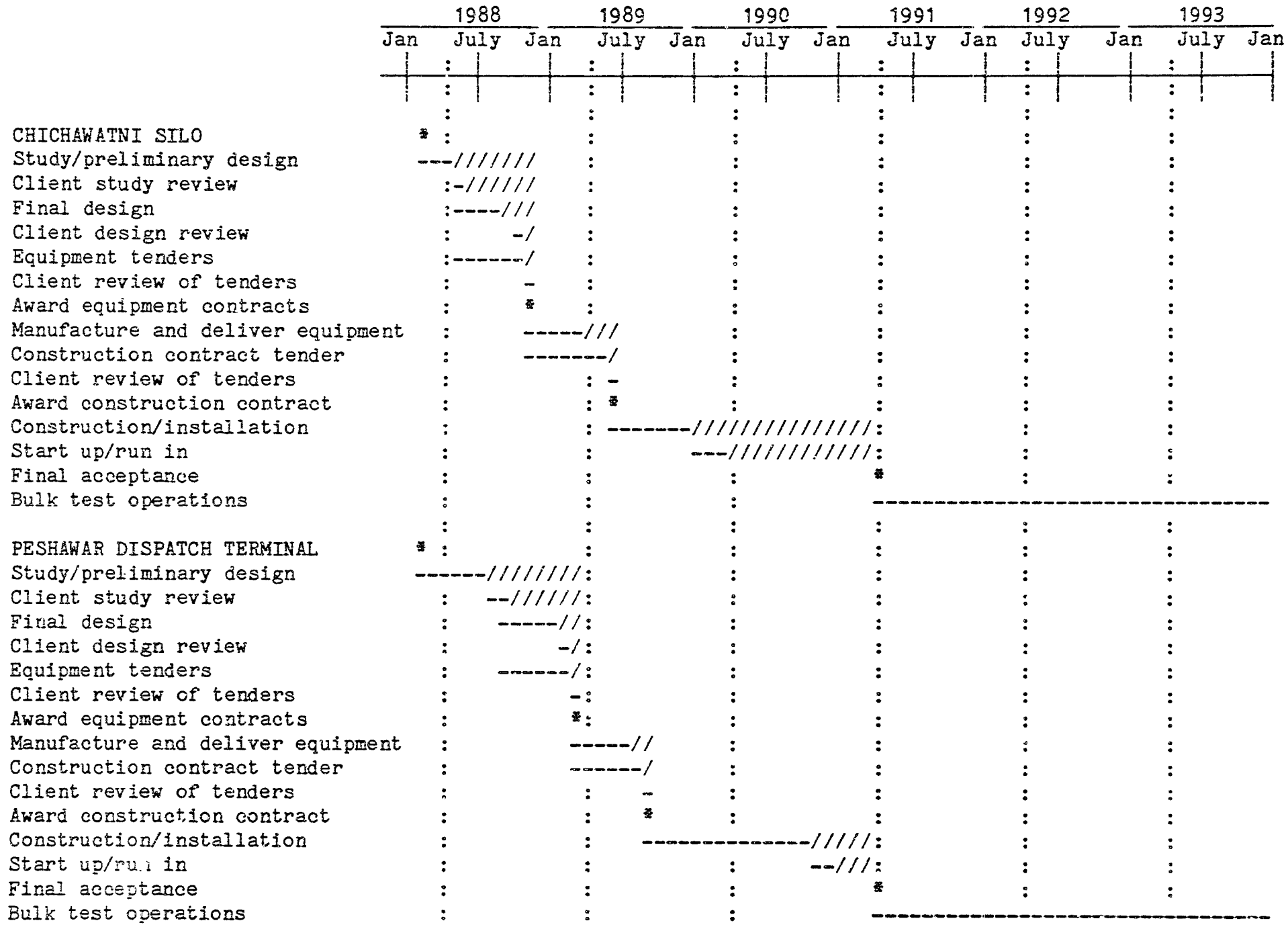


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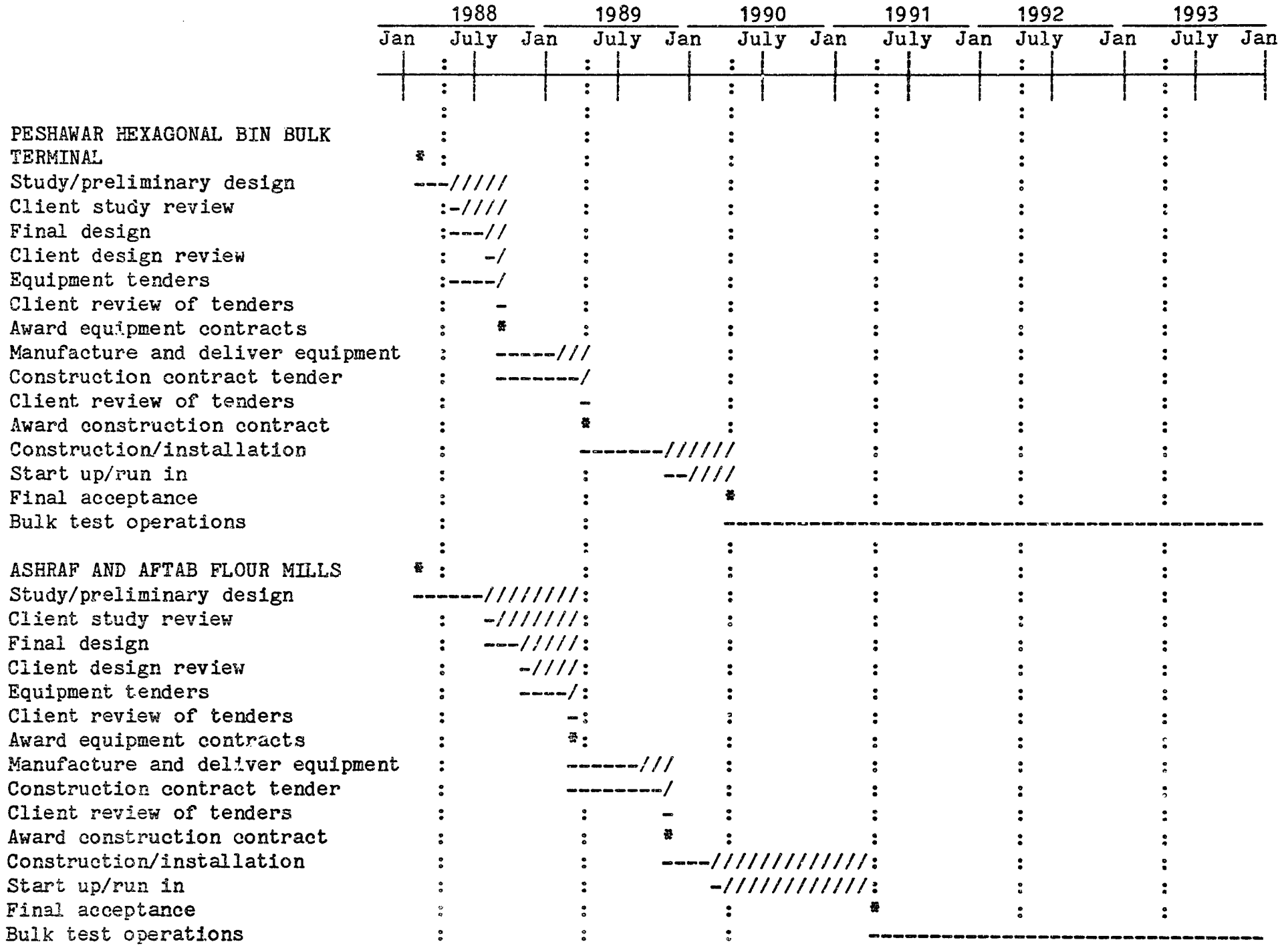
FIGURE 26 (Cont.)



--- = Activity, : = Harvest Period, /// = Float Time, * = Milestone

```
                                   1988          1989          1990          1991          1992          1993
                                Jan   July   Jan   July   Jan   July   Jan   July   Jan   July   Jan   July   Jan
                                 |     :     |     :     |     :     |     :     |     :     |     :     |     :     |
                                 |     :     |     :     |     :     |     :     |     :     |     :     |     :     |
                                       :           :           :           :           :           :
BILOUR AND UNIVERSAL FLOUR MILLS     * :           :           :           :           :           :
Study/preliminary design             -----/////     :           :           :           :           :
Client study review                  :  -////      :           :           :           :           :
Final design                         :  --//////   :           :           :           :           :
Client design review                 :     -////   :           :           :           :           :
Equipment tenders                    :  -------/   :           :           :           :           :
Client review of tenders             :         -   :           :           :           :           :
Award equipment contracts            :         *   :           :           :           :           :
Manufacture and deliver equipment    :         ------///       :           :           :           :
Construction contract tender         :         --------/       :           :           :           :
Client review of tenders             :           :     -       :           :           :           :
Award construction contract          :           :     *       :           :           :           :
Construction/installation            :           :     ---////:           :           :           :
Start up/run in                      :           :        -///:           :           :           :
Final acceptance                     :           :           *:           :           :           :
Bulk test operations                 :           :           :-----------------------------------------
```

--- = Activity, : = Harvest Period, /// = Float Time, * = Milestone

FIGURE 26 (Cont.)

```
                                   1988          1989          1990          1991          1992          1993
                                Jan   July   Jan   July   Jan   July   Jan   July   Jan   July   Jan   July   Jan
                                  |     :     |     :     |     :     |     :     |     :     |     :     |
                                  |     :     |     :     |     :     |     :     |     :     |     :     |
                                        :           :           :           :           :           :
MPCs                                *   :           :           :           :           :           :
Study/preliminary design            --://////       :           :           :           :           :
Client study review                   :-/////       :           :           :           :           :
Equipment tenders                     :----//       :           :           :           :           :
Client review of tenders              :     -       :           :           :           :           :
Award equipment contracts             :     *       :           :           :           :           :
Manufacture and deliver equipment     :     ------///////////:           :           :           :
Bulk test operations                  :           ///////////-----------------------------------------
                                      :           :           :           :           :           :
KHAIRPUR SILO                       *   :           :           :           :           :           :
Study/preliminary design            ---///////      :           :           :           :           :
Client study review                   :-//////      :           :           :           :           :
Final design                          :--/////      :           :           :           :           :
Client design review                  :   -///      :           :           :           :           :
Equipment tenders                     :------//     :           :           :           :           :
Client review of tenders              :     -/      :           :           :           :           :
Award equipment contracts             :      *      :           :           :           :           :
Manufacture and deliver equipment     :      ----///             :           :           :           :
Construction contract tender          :      -----//             :           :           :           :
Client review of tenders              :           --            :           :           :           :
Award construction contract           :           :*            :           :           :           :
Construction/installation             :           :---------////////////////:           :           :
Start up/run in                       :           :         -/////////////:           :           :
Final acceptance                      :           :           :           *           :           :
Bulk test operations                  :           :           :           ---------------------------
```

--- = Activity, : = Harvest Period, /// = Float Time, * = Milestone

FIGURE 27. Implementation Schedule: Khairpur to Quetta Bulk Test Corridor

```
                                   1988          1989          1990          1991          1992          1993
                                Jan   July  Jan   July  Jan   July  Jan   July  Jan   July  Jan   July  Jan
                                 |     :     |     :     |     :     |     :     |     :     |     :     |
                                 |     :     |     :     |     :     |     :     |     :     |     :     |
                                       :           :           :           :           :           :
QUETTA SILO                     *      :           :           :           :           :           :
Study/preliminary design        ---//////          :           :           :           :           :
Client study review               :-/////          :           :           :           :           :
Final design                      :---///          :           :           :           :           :
Client design review              :   -//          :           :           :           :           :
Equipment tenders                 :-----/          :           :           :           :           :
Client review of tenders          :     -          :           :           :           :           :
Award equipment contracts         :     *          :           :           :           :           :
Manufacture and deliver equipment :     ----/////  :           :           :           :           :
Construction contract tender      :     --------/  :           :           :           :           :
Client review of tenders          :                : -         :           :           :           :
Award construction contract       :                : *         :           :           :           :
Construction/installation         :                : --------//////////////:           :           :
Start up/run in                   :                :         -/////////////:           :           :
Final acceptance                  :                :           :           *           :           :
Bulk test operations              :                :           :           ------------------------------

BOLAN AND JAMAL FLOUR MILLS     *      :           :           :           :           :           :
Study/preliminary design        -------///////     :           :           :           :           :
Client study review               :    -//////    :           :           :           :           :
Final design                      :    ----///    :           :           :           :           :
Client design review              :       -///    :           :           :           :           :
Equipment tenders                 :    ------/    :           :           :           :           :
Client review of tenders          :          -    :           :           :           :           :
Award equipment contracts         :          *    :           :           :           :           :
Manufacture and deliver equipment :          -----///         :           :           :           :
Construction contract tender      :          -------/         :           :           :           :
Client review of tenders          :           :     -         :           :           :           :
Award construction contract       :           :     *         :           :           :           :
Construction/installation         :           :     -----/////////////:   :           :           :
Start up/run in                   :           :           -/////////////:   :           :           :
Final acceptance                  :           :           :           *           :           :
Bulk test operations              :           :           :           ------------------------------
```

--- = Activity, : = Harvest Period, /// = Time Float, * = Milestone

FIGURE 27 (Cont.)

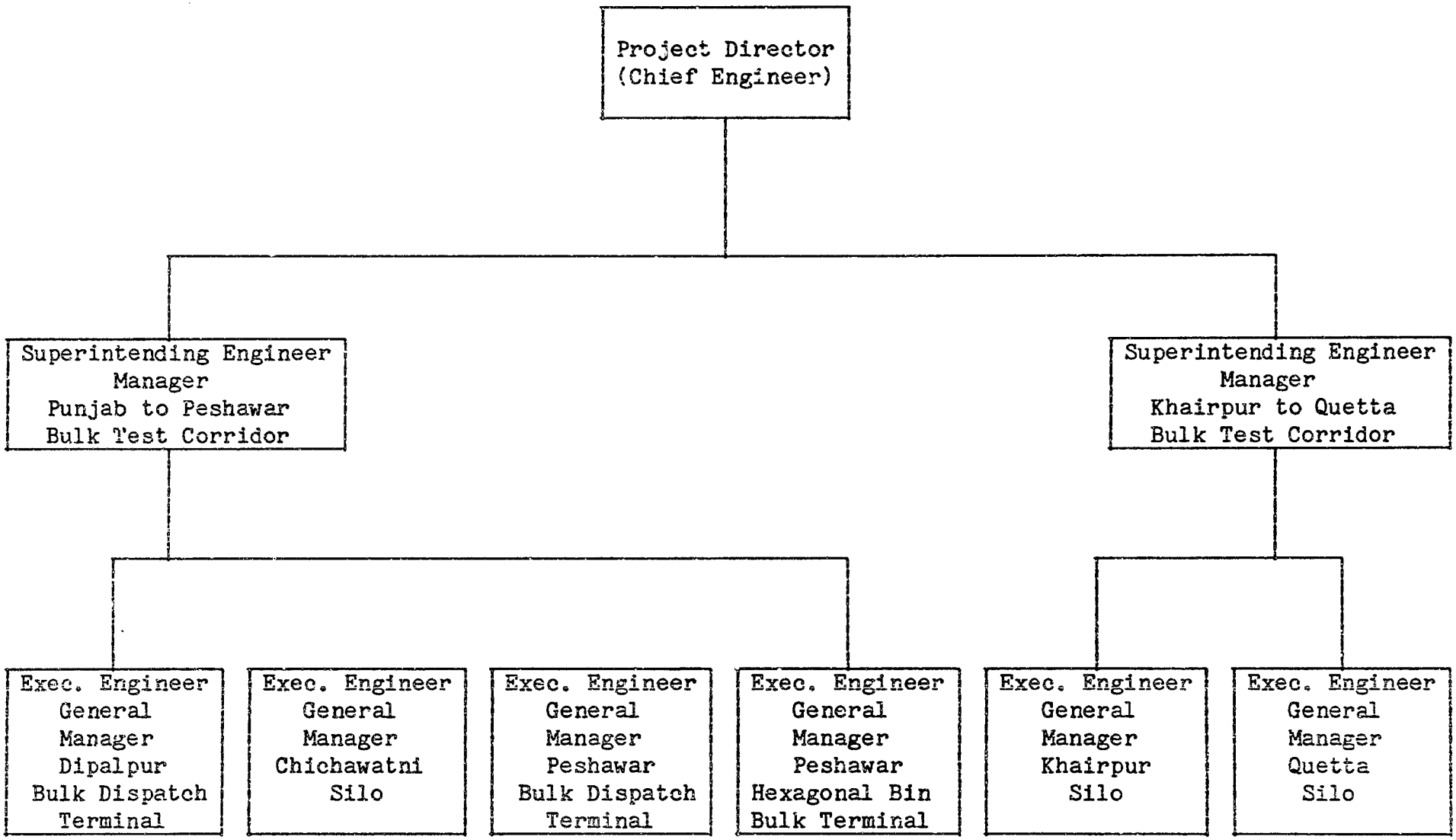


FIGURE 28. PASSCO Project Management Structure

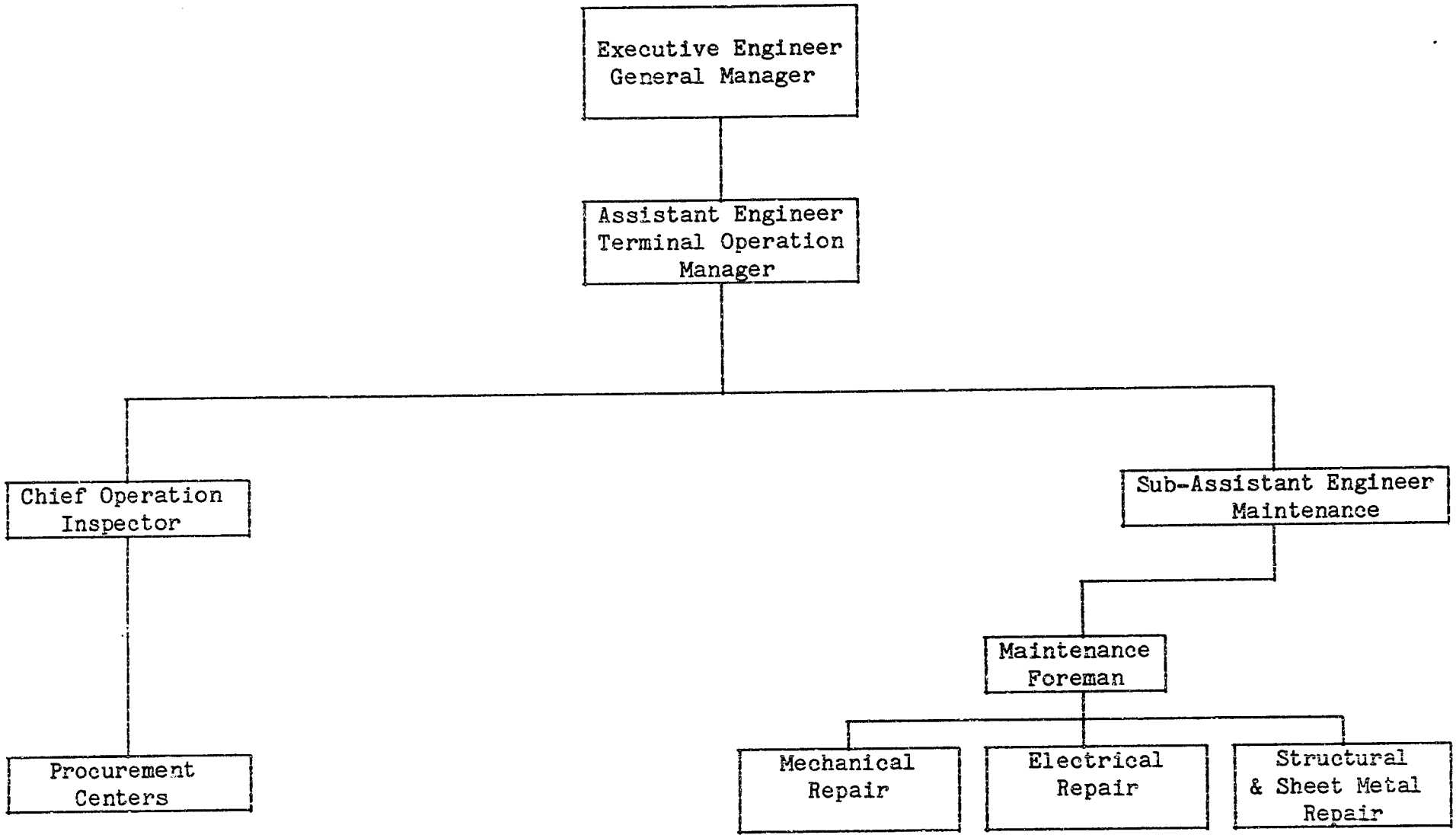


FIGURE 29. PASSCO Management Structure, Bulk Terminals

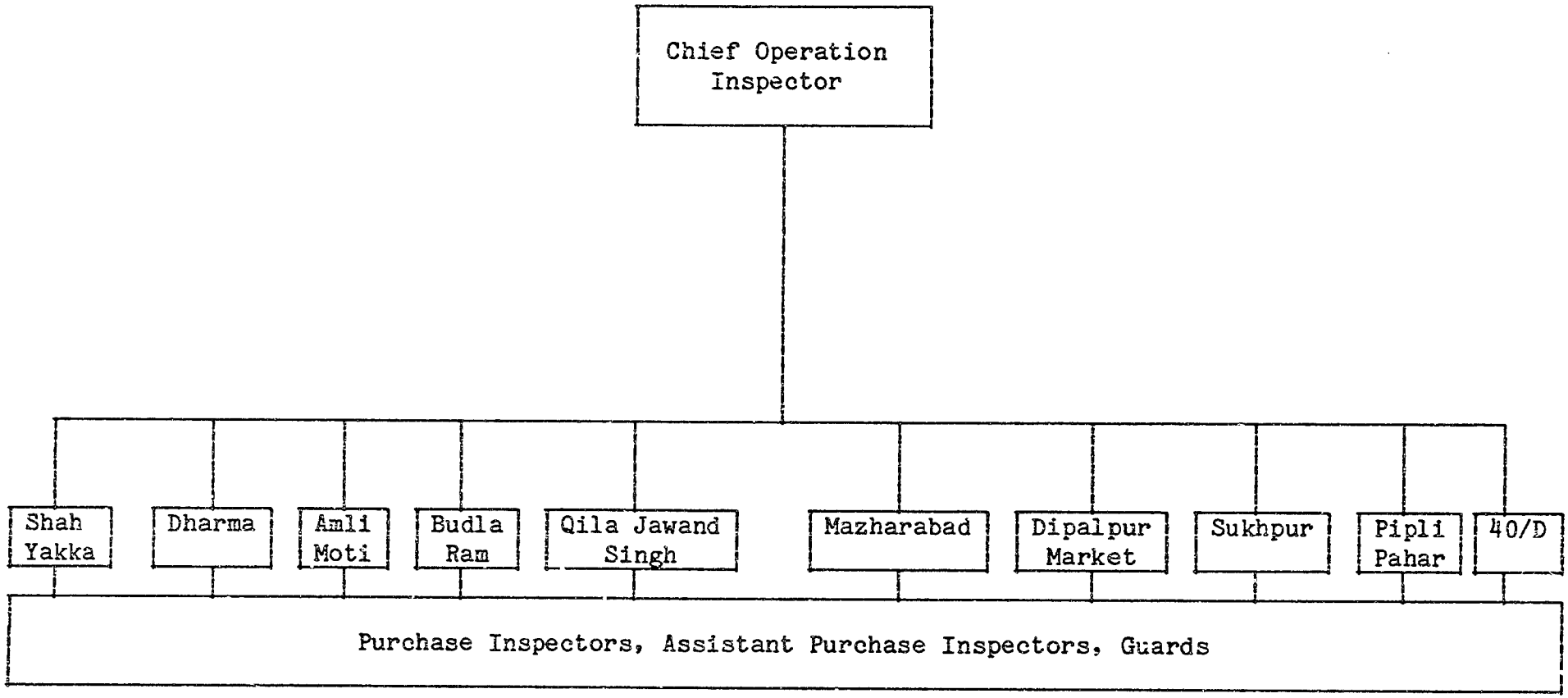


FIGURE 30. PASSCO Management Structure, Dipalpur Area Procurement Centers

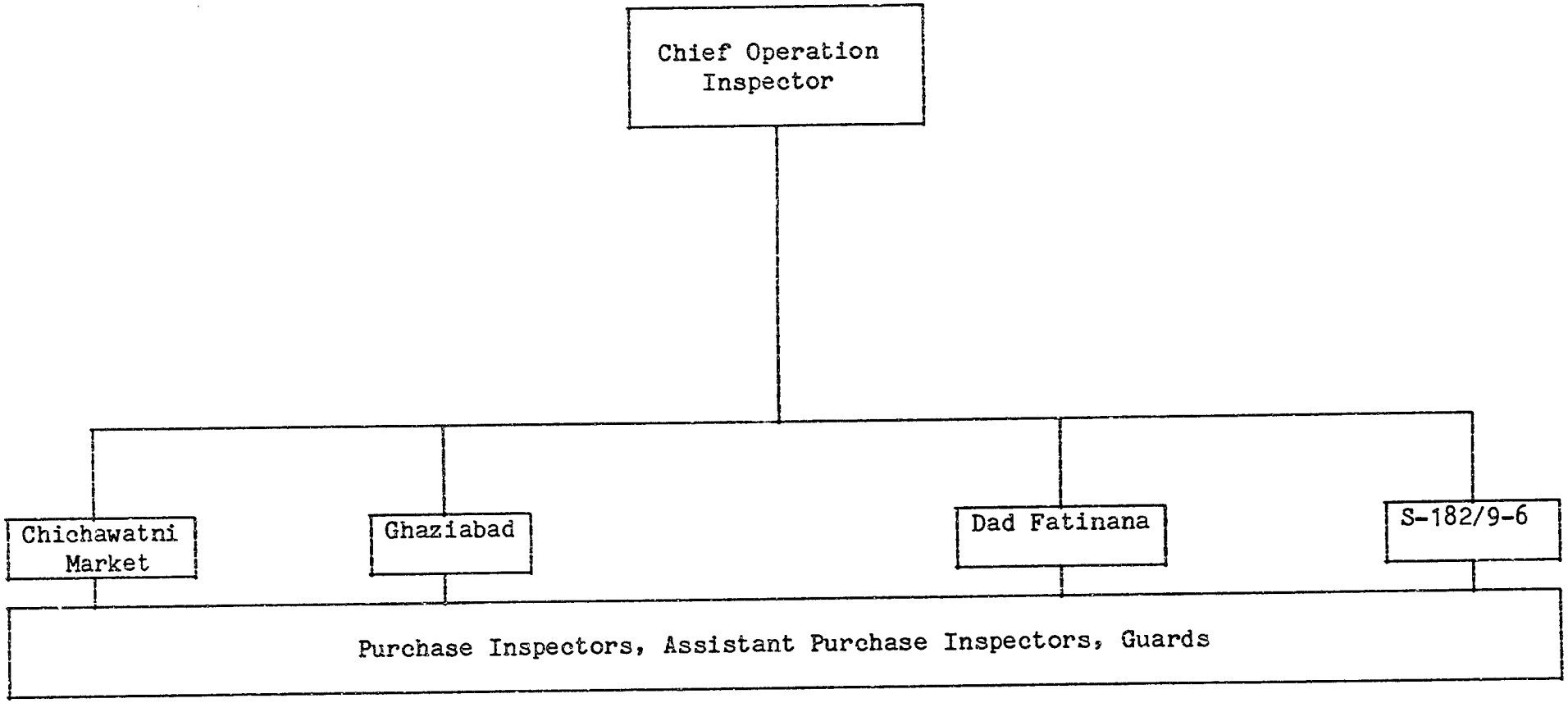


FIGURE 31. PASSCO Management Structure, Chichawatni Area Procurement Centers

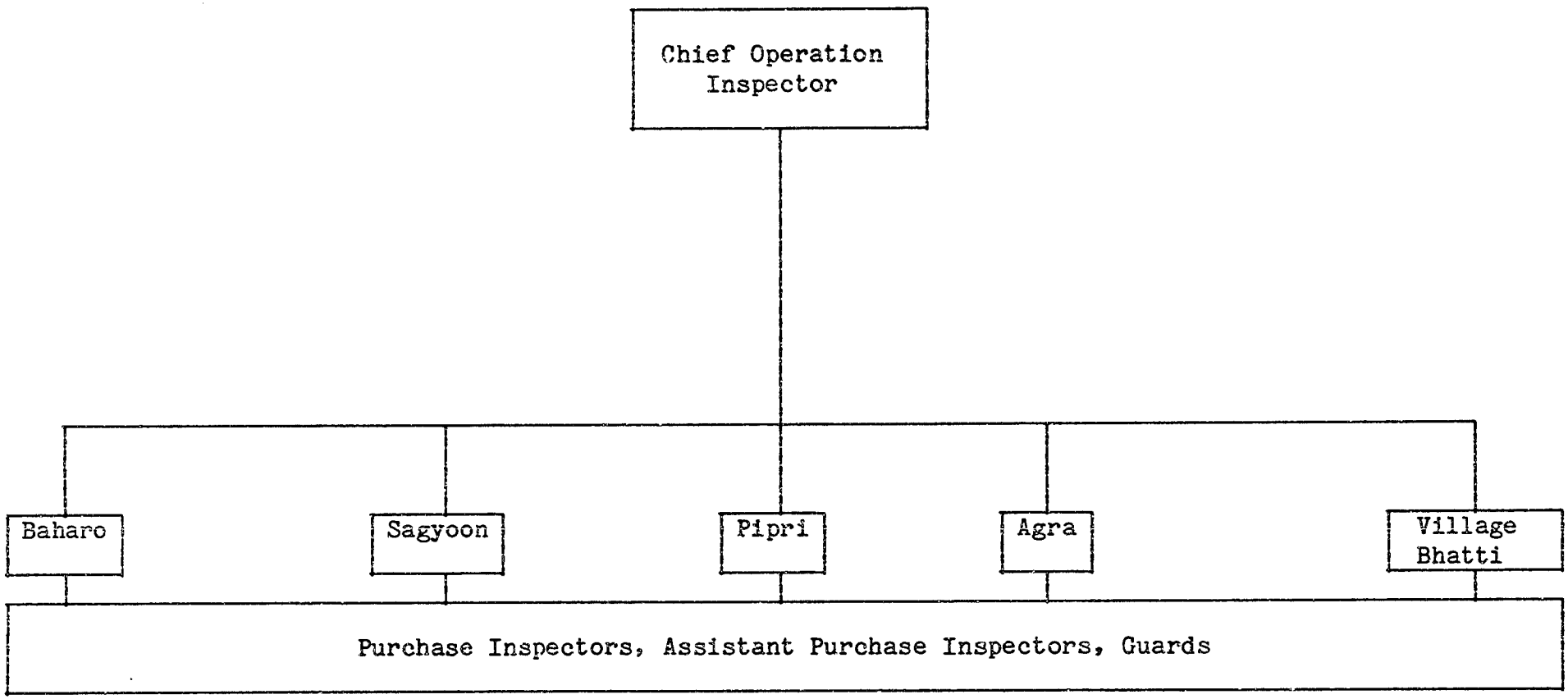


FIGURE 32. PASSCO Management Structure, Khairpur Area Procurement Centers

SECTION VI

PROJECT BUDGET

Project costs for the two bulk test corridors as well as for the bulk transport tests have been divided into two categories for purposes of cost estimation. The first category is capital costs for the purchase of equipment, upgrading of existing storage facilities, and construction of required new storage facilities. The second category is operations and maintenance costs involved in implementing the bulk test corridors and bulk transport tests.

Capital Costs

The total capital costs estimated for the recommended project result from detailed budget cost estimates prepared from the layout drawings, Figures 3 through 22.

Budget-level quotations for cost estimates were obtained from U.S. suppliers of equipment. The cost estimates were based on the importation of all grain handling equipment from the U.S., to be purchased by PASSCO and turned over to a general contractor for installation. Although Pakistan has significant manufacturing capability, the equipment for the pilot project is highly specialized and therefore should be purchased from an experience manufacturer. However, the design team has seen evidence that in the future much of this equipment could be manufactured locally, especially if interested manufacturers have prototypes to work from. Equipment imported under the pilot project can eventually serve as a model for future in-country manufacturing should the GOP wish to implement bulk grain handling on a systemwide basis.

Pakistani general contractors have sufficient experience and capability to construct the pilot facilities for this project, therefore budgets for civil works are based on use of local Pakistani contractors. Pakistani general contractors were interviewed to obtain local labor and material costs, overhead, and markups for various regions in Pakistan.

Using the general arrangement drawings in Figures 3 to 22, approximate quantity takeoffs for material and equipment were made for each facility. The delivered on-site cost of equipment was derived by adding inland freight charges (U.S. and Pakistan), export packing, ocean freight, and freight forwarding charges to the equipment quotations provided by U.S. suppliers. Construction and installation costs were then estimated for Pakistani general contractors who would take possession and install the equipment, construct the civil works, and manage the overall construction of the facilities. Appropriate markup and overhead were applied depending on locational factors, and a total facility cost estimate was determined. A 10-percent contingency was then applied. All costs are shown in 1987 U.S. dollar equivalent. The total project capital cost budget is estimated to be:

Bulk Test Corridors	$ 45,532,000.00
Other Bulk Storage Improvements	2,850,000.00
Total Project Capital Cost	$ 48,382,000.00

As discussed in Section III, each corridor is comprised of new facilities and equipment in combination with existing bulk storage facilities that will be converted and upgraded to properly meet the handling requirements for the corridors. The new facilities to be established will be the mobile procurement centers, bulk purchase and storage centers, the bulk dispatch terminal at Peshawar, and receiving facilities at the flour mills. Existing facilities at Chichawatni, Khairpur, Quetta, Dipalpur, and Peshawar will be converted and modified such that they can be successfully utilized within the grain flow of their respective corridors.

The final cost component for the corridors is the technical assistance and training required to ensure the success of the pilot project. The costs for technical assistance and training are the results of estimates of manpower and expenses necessary to complete the recommended scope of services.

Table 11 summarizes the total costs of the bulk test corridors, detailing separately the costs for new facilities, conversion of existing facilities, transportation equipment, and technical assistance and training.

Table 12 presents the estimated capital cost of the bulk test corridors by individual facility for each component within the respective corridors.

Other elements of the pilot project that are not directly within the individual bulk test corridors are discussed in Section IV. Cost estimates for these improvements are presented in Table 13.

Operations and Maintenance Costs

Operations and maintenance costs for the bulk test corridors include labor, fuel, utilities, maintenance, supplies, and miscellaneous costs. An estimate of annual operating costs for the corridors is presented in Table 14, and is broken down by facility within the two corridors.

TABLE 11

BULK TEST CORRIDORS
ESTIMATED CAPITAL COSTS
($)

Item		Cost
NEW FACILITIES		
Mobile Procurement Centers	6,867,000	
Bulk Purchase and Storage Centers	1,641,000	
Bulk Dispatch Terminal (Peshawar)	5,889,000	
Flour Mill Receiving	832,000	15,229,000
CONVERSION OF EXISTING FACILITIES		
Chichawatni Silo	3,700,000	
Khairpur Silo	3,700,000	
Dipalpur Bulk Dispatch Terminal	3,817,000	
Quetta Silo	5,000,000	
Peshawar Hexagonal Bins	3,386,000	19,603,000
TRANSPORTATION EQUIPMENT		3,450,000
		38,282,000
TECHNICAL ASSISTANCE/TRAINING		7,250,000
TOTAL: BULK TEST CORRIDORS		45,532,000

TABLE 12

BULK TEST CORRIDORS
ESTIMATED CAPITAL COSTS
($)

Item	Cost	
PUNJAB TO PESHAWAR CORRIDOR		
DIPALPUR TO PESHAWAR		
2 Units MPCA	798,000	
1 Unit MPCB	561,000	
Dipalpur Bulk Dispatch Terminal	3,817,000	
Sukhpur Bulk Reservoir	838,000	
Pipli Pahar Bulk Reservoir	486,000	
40/D Bulk Reservoir	317,000	
Peshawar Hexagonal Bin Bulk Terminal	3,386,000	
Ashraf Mill	118,000	
Aftab Mill	118,000	
Subtotal		10,439,000
CHICHAWATNI TO PESHAWAR		
3 Units MPCA	1,197,000	
1 Unit MPCB	561,000	
Chichawatni Silo	3,700,000	
Peshawar Bulk Dispatch Terminal	5,889,000	
Bilour Mill	118,000	
Universal Mill	118,000	
Subtotal		11,583,000
TOTAL		22,022,000
KHAIRPUR TO QUETTA CORRIDOR		
3 Units MPCA	2,004,000[1]	
2 Units MPCB	1,746,000[1]	
Khairpur Silo	3,700,000	
Quetta Silo	5,000,000	
Bolan Mill	180,000	
Jamal Mill	180,000	
TOTAL		12,810,000
TOTAL		34,832,000
TRANSPORTATION		
Bulk Truck Test	250,000	
Unit Train Test	3,200,000	
TOTAL		3,450,000
TECHNICAL ASSISTANCE/TRAINING		7,250,000
TOTAL: BULK TEST CORRIDORS		45,532,000

[1]Additional trucks included in cost of mobile procurement centers, reference Section III, page 24.

TABLE 13

OTHER BULK STORAGE IMPROVEMENTS
ESTIMATED CAPITAL COSTS
($)

Item		Cost
Silo Studies: Karachi, Faisalabad, Multan	150,000	
Okara/Khanewal Bulk Storage	2,500,000	
Port Facilities Planning	200,000	
TOTAL: OTHER BULK STORAGE IMPROVEMENTS		2,850,000

TABLE 14

PROJECT BUDGET
ESTIMATED ANNUAL OPERATING COSTS FOR BULK TEST CORRIDORS
($)

Location	Labor	Fuel	Utilities	Maintenance	Supplies	Miscellaneous	TOTAL
PASSCO, Lahore	21,360	1,200	-	-	1,200	600	24,360
Dipalpur Area	112,920	48,000	12,000	24,000	6,000	600	203,520
Chichawatni Area	75,840	54,000	12,000	24,000	6,000	600	172,440
Peshawar Hexagonal Bins	54,000	1,200	12,000	24,000	6,000	600	97,800
Peshawar Bulk Dispatch Terminal	60,000	1,200	12,000	24,000	6,000	600	103,800
Khairpur Silo	74,520	240,000	12,000	24,000	6,000	600	357,120
Quetta Silo	60,000	1,200	12,000	24,000	6,000	600	103,800
Temporary Truck Drivers	113,400	-	-	-	-	-	113,400
Private Truckers and Railways	-	-	-	-	-	-	1,980,000
TOTAL	572,040	346,800	72,000	144,000	37,200	4,200	3,156,240

SECTION VII

PROJECT ANALYSIS

The purpose of a pilot project is to determine the technical and economic feasibility of a system or operation as to its applicability for being expanded to a larger system. Pilot projects are therefore experimental projects which provide technical and economic data for analysis and decision-making. Because of their purpose, pilot projects can not be subjected to detailed technical and economic analyses, since conducting such detailed analyses implies that sound and accurate data are currently available in sufficient quantity to allow the analysis of an opportunity and the decision on how to correctly implement a full-scale operation.

The ultimate goal of the bulk wheat handling and storage pilot project is to test the technical and economic feasibility of a farm-to-market system for handling, transporting, and storing wheat in bulk form. Therefore, the analyses of the pilot project provided in this section are limited to (1) the existing technical factors which indicate that bulk wheat handling and storage in Pakistan could be successful, (2) the estimated project costs, (3) the potential impact on labor opportunities and grain marketing in Pakistan, and (4) the probable impact of this program on the private sector.

Analysis of Technical Factors

The determination of the probable technical feasibility of a pilot project depends on various factors. In this case, the factors involved relate to individual elements in the wheat postharvest system and other systems. These factors will either support or oppose the technical soundness of the proposed project.

Bag versus Bulk System. Grain storage and handling systems can be divided into two general categories: bag systems and bulk systems. Each system has advantages and disadvantages, depending on the situation in which the system is used. The following is a comparison of the applicable characteristics of the two systems.

1. Grain Loss. The grain loss in a properly-managed bulk system is negligible, usually lower than 0.5 percent a year. In a bag system, the loss is higher. Particular methods of handling bags result in excess grain spillage. Even if such spillage is swept up, the grain can become seriously contaminated with foreign material. Further information on grain loss is contained in a later subsection.

2. Storage Space. Depending on the size of the warehouse, the loss of storage capacity in a bag system due to necessary aisleways and overhead spaces ranges from 20 to 50 percent. PASSCO's adoption of bulk storage practices instead of bag storage in their HTGs increased the storage capacity from 1,100 MT to 1,700 MT.

3. Operating Expense. Because of the need to purchase bags and the manual labor involved in their handling, a bag system incurs more material, labor, and management costs than a bulk system.

4. Inventory Management. It is more difficult to manage a large number of bags in a warehouse than to manage bulk grain in bins.

5. Insect Control. The application of insecticides in a bagged-product warehouse requires much effort and preparation. Insecticide application in bulk is relatively easy and more effective.

6. Handling Rate. The bag system currently used in Pakistan presents many constraints, including its inability to move grain as rapidly as required by the present and future conditions created by higher supply and demand. Because of its mechanized nature, a bulk system allows grain to be handled, stored, and transported very rapidly. This allows for faster harvesting and prevents grain from being exposed to inclement weather conditions in the fields or procurement centers.

7. Capital Expenditure. Initial investment in a bulk system is usually higher than for a bag system.

8. Foreign Exchange. In a developing country, a bulk system involves mainly imported equipment and materials, whereas a bag system relies less on imported materials and more on materials that can be procured locally. This situation is somewhat different in Pakistan because the manufacturing sector is capable of producing many types of grain handling equipment on an experimental basis. PASSCO has been using locally-fabricated equipment for converting warehouses in Okara to bulk handling. The availability of spare parts for local equipment is expected to offer at least a partial solution to the maintenance problems typically associated with bulk systems in developing countries.

9. Construction. In a country where bulk storage technology is new, extensive expatriate technical assistance will be required for at least the initial period of introduction and implementation. However, since Pakistan's construction industry is highly developed, this need could possibly be partially met with local expertise. Nevertheless, without any expatriate assistance, especially in design and implementation, the project will have a high probability of failure, as has been the case in certain bulk storage projects in Pakistan in recent years. For a bag system in Pakistan, expatriate supervision is generally not necessary.

10. Flexibility in Operation. A bag system is more flexible and versatile than a bulk system, since various types and grades of cereal grains, legumes, and oilseeds may be stored in the same facility. With a bulk system, only one type of product should be stored in any one storage bin or warehouse. However, this should not be a factor in the proposed project, because only one grain is to be considered.

    It should be noted that the introduction of a bulk system facilitates the movement towards a well-structured set of grades and standards since under a bulk system the commingling of low-quality grain and high-quality grain not only is impractical from a sound marketing viewpoint, but also leads to the possibility of deterioration of the high-quality grain.

11. Supporting Infrastructure. For a bulk system, the necessary requirements are availability of an electrical or mechanical power source, a pool of skilled operational and maintenance staff, good paved roads, bulk hand-

ling trucks or railcars, and a bulk weighing system. For a bag system, all that is needed is relatively less skilled manpower, good roads, and any conventional (general-purpose trucks or railcars) or traditional (manpower, animal power) transport system.

Experiences in Other Developing Countries. While bulk grain systems are firmly established in the developed countries of the world, many developing countries are using limited bulk handling and storage systems with considerable economic benefits and success. Most of the bulk systems in developing countries deal with imported grain rather than domestic production, however Pakistan will be using bulk handling and storage for its domestic production.

The developing countries using successful bulk grain storage and handling systems include Bangladesh, Jordan, Costa Rica, Egypt, and Turkey. The system in Bangladesh has been operational since 1971 and consists of one import silo and three inland concrete silos with a total storage capacity of 225,000 MT. The bulk grain system in Jordan was built in 1980, consisting of one import silo, two inland silos, and integrated flour milling facilities. The total storage capacity of the system is 335,000 MT. In both these countries, imported grain and the grain that moves within the silo network are stored and handled in bulk. Processors and government grain outlets that are not equipped to handle bulk grain continue to use a bag system. In Costa Rica, the government grain marketing agency and some private grain processors use a combination bulk-bag system. In Egypt, the first bulk silos were built in 1962, and the bulk storage capacity today consists of 600,000 MT either operating or under construction, with an additional 300,000 MT in the planning stages. The Egyptian system consists of receiving and storing grain in bulk, while the initial shipment is in bags with provision for eventual bulk dispatch. Turkey uses a combination of bag and bulk systems to handle its domestic grain production.

It should be noted that the success of bulk grain handling and storage systems can not be generalized and depends in great measure on the particular situation encountered in the individual country. However, experience does unquestionably indicate the technical benefits of the bulk system over the bag system.

Harvesting and Related Bulk Transportation. Harvesting and threshing methods influence the decision for or against bulk storage practices. Small quantities of manually-harvested grain are generally stored in bags. Mechanical threshing practices are well established and widely used in the project area. Although combine harvesting has only been introduced recently, it is rapidly gaining popularity for the reasons given in Section II. Wheat is available in bulk from both the thresher and the combine. Availability of large quantities of mechanically-harvested and threshed grain usually sets the stage for the adoption of a bulk handling and storage system, because of its speed and economy of scale. If PASSCO were equipped to receive grain in bulk, the unnecessary and costly step of bagging grain after threshing or combining could be eliminated.

Bulk transportation of grain from threshers and combines poses no major difficulty since the existing tractor-driven trolleys are already being used to transport bulk grain from the field to a collection point where bagging is done. The trucks that are generally used to move bagged grain could also

easily be converted to bulk handling by the private sector, once the bulk transportation of grain is accepted.

Weighing. This is possibly the most critical link in the entire bulk system. The success of the pilot project will greatly depend on the proper adoption, operation, and maintenance of a bulk weighing system. This system must be reliable, accurate, and honest in order to be accepted by sellers. With the discontinuation of the bag system, sellers will no longer have this means of visual reference to estimate and check the weight of commodity sold. Therefore, if the new bulk weighing system does not give results which are comparable to those which the former system has led sellers to expect, the implementation of the new bulk system is likely to encounter considerable resistance. Because of the fact that the bulk system is a totally new concept, a great deal of education and training must be undertaken to ensure that procurement and storage center staff as well as sellers understand and accept this new system.

A bulk weighing system will not be successful unless the equipment can be maintained in correct working order. At present, truck scales and facilities for their servicing are available in many major cities. A sufficient number of personnel will need to be trained in scale maintenance in order to keep the system operative.

It should be understood by all participants in the system that scales designed to weigh grain in bulk have an inherent degree of variance. The larger the capacity of the scale, the greater this variance will be in terms of absolute weight. Therefore, it should not be expected that the weight of a given quantity of grain recorded at the procurement center will be exactly the same as the weight for the same quantity of grain recorded at the storage center. The weight of the same quantity of grain loaded out of the storage center may again show a variance. The total system should be designed so as to make allowances in recordkeeping for these variances.

Handling and Storage. Pakistan's present system consists of storing the grain in bulk, while receiving and shipping in bags. This process is inefficient, labor-intensive, slow, and expensive. If the benefits of a bulk system are to be realized completely, the entire postharvest chain must consist of bulk grain only. This will increase the speed of operation and reduce operating costs.

Current grain storage activities using silos, exterior bulkheads, interior bulkheads, and hexagonal bins imply that the system is ready to accept more advanced and correct procedures of bulk wheat handling and storage. The facilities being used at present will serve as the foundation on which to build the pilot project. As described in Section II, the existing bulk storage facilities have many technical and operational problems which need to be solved. Existing operational facilities will be modified so as to be incorporated into the pilot project.

However, in order to make the total system work as a whole, the correct use of bulk storage procedures must be accompanied by the conversion to bulk handling as well. The change from bag handling to bulk handling will require a power source to be available at the storage facilities. Power sources, though not reliable according to developed-country standards, are available even in some rural areas.

The technical results of the PASSCO experiment with the Khanewal hexagonal bins indicate that some equipment types, layouts, and designs are not technically suited to the bulk handling of wheat due to spillage and debris in wheat as well as maintenance problems. These results reinforce the need for a pilot project before implementing any permanent modifications in the present system.

Quality Control. Fumigation is currently practiced in both bag and bulk storage. Warehouse cleaning and insecticide spraying are also practiced to some extent. Inspection procedures seem to be clearly lacking. Nonetheless, these practices can serve as the basis for improvements in quality control measures to be carried out under the pilot project. These measures will be concentrated on sanitation, inspection, and fumigation by qualified personnel. The bulk handling and storage system will also facilitate the process of cleaning the wheat.

Transport. Pakistan's grain transportation system is almost equally divided between road and rail. In some areas, one mode of transport may be more important than the other. Rail operations are under the sole authority of Pakistan Railways. Road transport is mainly handled by the private sector, where a strong trucking business exists. However, regardless of whether road or rail transport is used, all grain is transported in bags.

Achieving bulk transportation by road will require two changes in the current trucking system. The first is the introduction of bulk trailers, including the type that could be easily converted to flat-bed trailers so as to be able to carry other kinds of merchandise. Although the project design calls for these trailers to be used initially by PASSCO, this agency's involvement in trucking is intended solely for demonstration purposes and to encourage the participation of the private sector. Once the private sector has become involved in these trucking activities, PASSCO must completely withdraw from them.

The second modification involves the current straight-bed trucks. It appears that slight modifications to the beds will allow bulk handling of wheat. As described in Section III, this will be accomplished by working with private-sector truckers. Therefore, development of a fleet of multipurpose trucks capable of handling grain in bulk seems to be a relatively simple problem that can be solved with the help of the local private sector.

Rail transportation for grain in Pakistan currently consists of unit trains composed of 30 cars, each with a 50-MT capacity, which move bagged grain from surplus to deficit provinces. Current conditions have imposed size limits on these unit trains. Because of the grade over which the cars must be pulled, each train is limited to a maximum of 30 cars. The condition of the tracks limits the weight capacity of each car to 50 MT.

Box railcars and their components are locally manufactured, as are top-loading, bottom-discharge bulk cars for gypsum, stone, and gravel. These top-loading, bottom-discharge railcars are suitable for hauling bulk grain.

As outlined in Section III, the use of dedicated unit trains composed of bulk railcars is preferable because transporting bulk grain via boxcar requires that the boxcar be fitted with special partitions, repaired if necessary, and

thoroughly cleaned each time the boxcar is used for bulk grain transport. Loading and unloading bulk railcars is simple and easy as compared to loading and unloading bulk grain transported in boxcars. The use of multipurpose railcars has been known to create bottlenecks in grain movement due to unavailability at the proper time.

With the introduction of bulk railcars and with the help of technical assistance and funding, Pakistan Railways should be able to develop suitable bulk carriers for wheat and other grains.

Summary. Based on the above factors involved in the analysis of the technical factors, it can be seen that a large number of supporting systems and practices in different stages of development are already in place to provide a foundation for the technical feasibility of the bulk pilot project. Among the supporting systems which have been initiated are the use of mechanical threshers and combines to harvest grain in bulk, which indicates the willingness of the private sector to accept new concepts that will lead to greater efficiency in operations; the use of tractors and trolleys for local transportation of bulk grain, and the ability of the private sector to manufacture and service this equipment locally; the availability of electrical power sources to enable the implementation of bulk handling systems, and the availability of service for these power supplies; the local industrial base for manufacturing, construction, and maintenance of bulk handling systems in the private sector, again indicating the ability of the private sector to provide local goods and services; the ability to provide maintenance on trucks used for bulk transport, with locally-available service and the availability of fumigants, chemicals, and other materials needed to carry out current fumigation practices in an efficient manner, with the participation of the private sector in the trade and transport of these materials.

Analysis of Project Costs

Since this is a pilot project whose purpose is to test the feasibility of introducing commercial bulk grain storage systems into Pakistan, the requirement for initial investment is greater than for establishing commercial grain operations in a system which already has existing bulk handling. The cost of the pilot project as detailed in Section VI encompasses construction of new facilities, conversion of and additions to existing facilities, storage facilities and equipment for flour mills, specialized transport equipment, training, technical assistance, data collection and analysis, and planning.

All of the components of collection, transportation, handling, and storage of grain in bulk, from the farm to the flour mill, are included in this project. High-capacity equipment has been selected for the project so that the rapidity of bulk grain handling can be tested in Pakistan and so that the facilities thus equipped can expand their storage capacity in the future without having to install new higher-capacity equipment. The facilities are designed as high-capacity handling terminals, not as long-term storage terminals. All equipment is to be imported, including safety equipment, spare parts, tools, and portable generators. These items should have been included in the initial construction of the facilities that are scheduled to be converted, but since they were not, these expenses must be added to the capital costs of the project.

Capital Cost. The statistics most widely used for cost comparisons are cost per ton of storage capacity or cost per ton of handling capacity. In a cost comparison, the purpose and nature of the operations being analyzed must be taken into consideration. For example, a port grain facility may be more than 20 times as expensive as a farm grain storage facility in terms of cost per ton of storage capacity. However, these two types of facilities serve different purposes. When all factors such as end use, investment cost, operating cost, benefits, and volume of grain handled are included in the analysis, the resulting costs per unit of grain handled in each facility may be nearly identical.

To analyze the capital costs of the pilot project, the facilities within the pilot project must be categorized by their primary function, either storage or transshipment.

The storage facilities within the pilot project are Dipalpur Bulk Dispatch Terminal, Sukhpur Bulk Reservoir, Pipli Pahar Bulk Reservoir, 40/D Bulk Reservoir, Chichawatni Silo, Khairpur Silo, and Quetta Silo. The primary purpose of these facilities is the storage of wheat production. The Quetta Silo, while intended as a transshipment facility in the pilot project design, is listed in this category because its size would allow it to easily be used for wheat storage during procurement periods as well as for wheat distribution to the mills.

The capital cost per MT of storage capacity for the storage facilities is as follows:

Dipalpur Bulk Dispatch Terminal	$254.47
Sukhpur Bulk Reservoir	63.40
Pipli Pahar Bulk Reservoir	69.43
40/D Bulk Reservoir	63.40
Chichawatni Silo	74.00
Khairpur Silo	74.00
Quetta Silo	83.33
Average, all storage facilities	91.10

Due to the equipment to be initially installed in the Dipalpur Bulk Dispatch Terminal, the storage capacity of this facility could easily be increased by at least 15,000 MT when needed without a large capital outlay. Based on the estimate for this expansion, the cost per MT of storage capacity would decrease to $145.59. A further expansion of 15,000 MT to a total of 45,000 MT would reduce the cost per MT of storage capacity to $111.49. These costs are equivalent to costs for similar storage facilities in the U.S. (Table 5, Appendix II).

The investment in the new bulk reservoirs at Sukhpur, Pipli Pahar, and 40/D represents a lower cost per MT of storage capacity than rectifying the deficiencies in the existing concrete silos at chichawatni, Khairpur, and Quetta. The projected capital costs for these reservoirs are equivalent to the cost calculations as presented in Tables 4 and 5, Appendix II.

The capital costs involved in the Chichatwani, Khairpur, and Quetta silos are required to correct the deficiencies outlined in Section II and to rehabilitate these silos as outlined in Section III.

The transshipment terminals within the pilot project are the Peshawar Hexagonal Bin Bulk Terminal, the Peshawar Bulk Dispatch Terminal, and the Quetta Silo which was also listed under the storage facility category. The primary purpose of these facilities is one of transshipment of grain, and they are specifically designed for rapid distribution of wheat.

The capital cost per MT of handling capacity is as follows:

Peshawar Hexagonal Bin Bulk Terminal	$ 70.50
Peshawar Bulk Dispatch Terminal	98.15
Quetta Silo	83.33

The annual turnover rate is eight times for the Peshawar Hexagonal Bin Bulk Terminal, ten times for the Peshawar Bulk Dispatch Terminal, and one time for the Quetta silo. These turnover rates could easily be increased without the addition of new equipment. Increased grain flows would decrease the capital costs per MT of handling capacity for these facilities. These capital costs are equivalent to U.S. costs as shown in Table 5, Appendix II. Because these are transshipment facilities, there are no comparable costs in Table 4, Appendix II.

The capital costs for MPCs, flour mill facilities, and other bulk handling and storage improvements can not be analyzed because they are a required part of the bulk handling design and must fit the current system of wheat procurement and distribution practiced in Pakistan. The additional requirements of bulk transport tests, technical assistance, and training are not subject to capital cost analysis since they are a part of the investment required to correctly implement and operate the pilot project.

The trade-offs involved in the investment outlay for the pilot project bulk handling and storage facilities are the benefits of labor cost reduction; bag cost elimination; value of rapid receiving, handling, and shipping of grain; reduction of handling losses; and basis for development of a commercial bulk handling and storage system.

Operational Costs. The operational cost estimate for the bulk test corridors as presented in Table 14, Section VI, includes operational costs for the handling, storage, and transport of wheat from procurement centers to flour mills. These estimated operational costs are based upon the best available data. Based on these estimates, crude comparisons have been presented to allow the reader to understand the potential savings resulting from conversion to a bulk wheat handling and storage system.

PASSCO costs for receiving, storage, and shipping in 1985 are detailed in Table 15. These costs are for wheat stored not only in bagged form, but also in various types of bulk facilities such as exterior bulkheads and bagged bulkheads in warehouses. The first set of costs indicates the GOP-approved cost for PASSCO operations as compared to the actual costs. Based on the GOP-approved costs, a second set of figures was calculated to reflect direct expenses for receiving, storage, and shipment of wheat once PASSCO operational overhead costs are eliminated. These direct costs are then regrouped into bagging costs, handling and storage costs (handling labor, godown expenses, unforeseen expenses, and management), and transport costs to provide the basis for comparison with the costs incurred in the bulk test corridors.

An analysis of estimated annual operating costs is given in Table 16. Comparisons indicate that due to the operation of the bulk test corridors, a probable savings of Rs 319/MT will accrue for the projected 156,000 MT of wheat to be handled by the pilot project, or a total of $2.9 million.

Loss Factors. Although the GOP has directed that there shall be a "no loss" policy in the government grain procurement sector, quantity losses will occur in the process of handling and storing grain. Four types of losses will occur: (1) shrinkage due to moisture reduction, (2) handling losses, (3) weight loss due to insect damage, and (4) quality deterioration due to insect or mold damage. All of these types of losses have an economic impact.

Given the low moisture content of wheat during procurement (in the range of 10 to 12 percent moisture), shrinkage should be less than 1 percent for a 12-month storage period based on the moisture data compiled in the loss assessment report of the Pakistan Agricultural Research Council (PARC).

Handling losses can not be accurately calculated, given the current lack of reliable information. Crude estimates based on extremely limited data show that the percent of damaged bags ranges from slightly less than 2.5 percent to nearly 6 percent at any one loading or unloading time. Crudes estimates of direct handling losses vary from 0.01 to 0.5 percent. Using two assumptions--first, that the 0.5 percent loss is somewhat realistic given the current methods of bagged grain handling, and second, that bags of grain will be handled at least seven times in the movement from farm to flour mill--it can be estimated that the average handling loss will be approximately 3.5 percent of the volume of grain moving through the system. In comparison, the use of bulk handling and storage should reduce direct handling losses to 0.5 percent or less of the volume of grain moving through the system. Therefore, it should be possible to realize a savings of some 3 percent of the grain moving through the pilot project system, grain which would be lost under the current system.

Weight loss due to insect damage is well documented for public storage facilities. Quantity loss for Pakistan was determined to be 3.6 percent for a 5.4-month storage period, with a range of losses by province from 2.2 to 6.2 percent. Stocks of wheat held for longer periods had higher losses. It was found that losses in 2-year old wheat averaged 8.9 percent, and in certain individual cases the losses were as high as 15 percent.

The above quantity loss percentage of 3.6 percent for a 5.4-month storage period does not seem like a significantly large number. However, when applied to the volume of wheat moving through the system, a large monetary loss has been incurred. For example, 3.9 million MT of wheat was shipped within Pakistan in 1984-85, with a resulting quantity loss of 141,600 MT due to insect and mold damage. The monetary loss was therefore in excess of Rs 240 million.

The use of bulk handling and storage facilities alone will not solve the above loss problem. This can be shown by the PARC loss assessment study which reveals that wheat stored in bulk in HTGs in Punjab had a higher percentage of quantity loss than wheat stored in bags in HTGs, as illustrated in Figure 32. Bulk handling and storage facilities must be accompanied by adequate administrative and technical training for managing such facilities. Otherwise, it will not be possible to realize any reduction in losses. However, if all

these measures are applied, the average savings accruing to the pilot project is expected to be a reduction in grain losses of 6 percent, with a value of $1.1 million.

In addition to an evaluation of quantity losses, the PARC loss assessment study also addressed quality losses. Quality deterioration is important because the wheat is to be milled into flour. As wheat quality deteriorates, milling percentages and the quality of the end product decline. The most important finding was that foreign material was the most important factor responsible for the downgrading of wheat below the FAQ grade, followed by insect-damaged kernels. Another important finding was that these quality downgrading factors were already present in the grain at the time of procurement. The fact that a large number of samples were downgraded during the study is evidence of the seriousness of insect infestation in the storage facilities sampled.

The use of bulk handling and storage will not automatically solve the quality deterioration problem related to insect damage of grain. Resolution of this problem will require the reduction of insect infestation through the correct application of insect control procedures, which will result from training all personnel and implementing sound management supervision practices.

The problem of quality as related to foreign material in wheat can be alleviated to a large extent by the proper application of buying standards in a total bulk grain system where no bagging or rebagging occurs. The need for bagging and rebagging of grain, as pointed out in the loss assessment study, is one of the major reasons for this problem.

Transportation Factors. Since no grain has been moved commercially in bulk form in Pakistan to date, no actual comparison can be made between the cost of transporting bagged grain versus bulk grain until investigations are conducted under the pilot project. However, it is expected that variable grain transportation costs per MT/km such as fuel, truck maintenance, and tires will not show major differences for hauling bulk grain as opposed to bagged grain.

Private-sector data in Pakistan indicate that the smaller 13-MT trucks average 80,000-90,000 km per year. The average rate of movement is 288 km per workday. This indicates that 300 workdays are utilized per year. At an average speed of 50 km/hr, road time per workday is less than 6 hr. For 35-MT trucks, the average annual mileage is 60,000 km, with an average of 192 km driven per workday. This indicates that 312 workdays are utilized per year. At an average speed of 50 km/hr, road time per workday is slightly less than 4 hours. The above low road time per workday indicates that there are great delays in the loading and unloading of cargos. Such delays in grain cargo handling can be eliminated with bulk grain transportation systems, thereby increasing the utilization rate of trucks. Increased utilization can result in increased tonnages hauled. Since increased tonnages can be hauled in the same time frame, fixed costs are spread over greater tonnages, therefore resulting in lower fixed costs per MT/km hauled. Since fixed costs, as compared to variable costs, usually make up a larger part of total costs, transporting grain in bulk allows for an overall reduction in transport costs.

Payback Period. A payback period for the bulk test corridors can be calculated based on estimated investment outlays and probable potential operational

savings. Investment outlay in the bulk test corridors amounts to $38 million. Potential savings resulting from annual bulk handling and storage of 156,000 MT of wheat amount to $2.9 million annually. The payback period in this case is 13 years. If the expected 6-percent grain loss reduction is attributed to the operations of the bulk test corridors, then this additional savings of $1.1 million annually would reduce the payback period for the bulk test corridors to 9 years. However, the pilot facilities have a capacity to handle more than 156,000 MT of wheat per year. If the amount of wheat handled in the bulk test corridors is doubled, then the payback period would be 7 years based on potential operational savings, and 5 years if the additional benefits of grain loss reduction are considered.

Summary. Since the 156,000 MT of grain projected to be handled under the pilot project is well below the capacity of the system, the project is underutilized at the present time, but will be able to easily accomodate future increases in grain volume. Due to this underutilization, the total cost of the project may seem to be quite extravagant, depending on the methods utilized to analyze these costs. However, based on the factors presented above, capital costs of the pilot project are not excessive.

Analysis of Labor and Marketing Impacts

The civilian labor force in Pakistan as a percentage of population ranged from 29.9 percent in 1971-72 to 30.2 percent in 1982-83. The percentage of the labor force distributed among various sectors of the economy is illustrated in Table 17. The obvious trend is the movement of labor from agriculture to other sectors of the economy. However, the area of transport, storage, and communications, and the area of services and others show no increase in the percentage of labor force utilized in these sectors. The 1981 census enumerated the labor force as 27.6 percent of the population. In the case of males, the labor force was 50.6 percent of the population for the country as a whole, with rural labor force being 52.8 percent and urban labor force being 45.2 percent.

Historical unemployment percentage rates for the total labor force are given in Table 18. It is obvious that unemployment has nearly doubled over a period of 10 years. However, the rates of unemployment are quite low compared to many other developing countries as well as to industrial countries. The frictional unemployment rate for Pakistan should be approximately 2.0 percent, resulting in true unemployment rates of 1.9, 1.3, and 3.7 percent for total, rural, and urban work force.

The unemployment rates determined by the 1981 census and illustrated in Table 19 indicate that male labor unemployment is always about 5 to 7 percent below the total labor force unemployment percentage. Removing frictional unemployment from the male work force in Punjab and Sind provinces in Table 19 leaves relatively no true unemployment in rural areas and only 2.8 and 3.8 percent unemployment in the urban areas for Punjab and Sind, respectively.

General comments by administrators and managers in the government grain procurement sector indicate that there are constraints in the availability of unskilled labor for the handling of bagged grain. Given the statistics presented, unemployment levels of unskilled common labor such as required for the handling of bagged grain seem to be extremely low and this verifies the

comments made by administrators and managers of the government grain procurement sector as to the constraints faced in using labor to handle bagged grain.

Based on the criterion that a working week of less than 35 hours constitutes part-time employment, the rates for total underemployment in Pakistan and underemployment for the three industry categories most likely to contain common labor are shown in Table 20. The rate of underemployment for the total work force has increased by 64 percent in 10 years. However, the largest part of this increase has come from the agriculture sector which shows a progressive increase in underemployment rates. Underemployment in the transport, storage, and communications sector has decreased. While there is a notable increase in the construction sector, this may be an anomaly due to the seasonal and yearly nature of this industry. The increase in the rate of underemployment in agriculture, when considered in relation to low rural unemployment rates, indicates either that there is a lack of full-time job opportunities in rural areas, that the frictional unemployment rates is higher than 2 percent, or that the statisical data gathering process is not sound.

The percentage of the work force in agriculture is declining and it is increasing in the industrial sectors, although the work force as a percentage of a highly-increasing population has remained stable. These factors, in conjunction with the relatively low rates of unemployment and underemployment, indicate no huge unskilled labor surplus. Therefore, the pilot project will have a negligible impact on the displacement of common unskilled labor used in handling bagged grain.

While bulk systems require less labor than bagged grain systems, the personnel required for bulk systems must be technically trained to operate and manage such a system. The use of common unskilled labor in bulk systems is very minimal. The pilot project will require training of personnel in physical operations of facilities, maintenance of equipment and buildings, inventory management and control, and overall management and supervision. Therefore, there will be an increase in the requirement for skilled labor in manufacturing, construction, maintenance, and operation of the pilot project and subsequent commercial systems.

Training of unskilled common labor to perform skilled tasks is dependent on the general level of education in the group. Because of the nature of the technology used in bulk systems, workers will need to be able to write, understand verbal and written directions, and read and comprehend technical and other instructional manuals. If unskilled common laborors do not have the above educational skills, they can not be technically trained. It appears that most unskilled common laborers in Pakistan do not meet this educational criterion and therefore there is little potential for upgrading their abilities.

A secondary impact of the introduction of bulk handling and storage will be the need for a change in the approach to marketing of wheat. Reports and observations reveal that the so-called quality standard of FAQ is little adhered to. Since bulk storage commingles grain, a system that functions without quality standards and related price incentives penalizes producers and traders who market a high-quality product, and rewards those who market a low-quality product. Overall quality of wheat can be improved by bulk handling and storage, but it can not be dramatically increased or maintained without a

mechanism which rewards those who produce and/or maintain high-quality products. As the pilot project is introduced and the bulk system expanded, a new marketing process must be developed involving grades and standards and suitable price rewards. This will require extensive education of producers, operating personnel, merchandisers, and millers so as to change habits and thought processes in the wheat marketing process.

Private-Sector Linkages

As of 1986, the total off-farm food grain storage capacity in Pakistan was estimated at 3.98 million MT, of which 97 percent was in the public sector. Because of GOP grain policies and the lack of incentives in the area of grain handling and storage, the private sector in general has not been involved in operating commercial facilities. With the implementation of the pilot project, the potential for increasing private-sector participation in grain storage activities will be enhanced.

The activities under the pilot project can serve as a model for private-sector operators concerning the applicability of different types of storage facilities and equipment. With government policies that create incentives for the private sector to handle and store large amounts of grain, the pilot project activities will give private-sector operators the experience to learn form this model and gain the technical understanding and economic knowledge needed to be able to carry out these activities on their own.

In order to implement future commercial systems, fabricators and manufacturers will be needed, as well as construction firms. This will create business for these organizations and help them increase their skills in building these types of facilities and manufacturing these types of equipment.

Outside maintenance assistance from machine shops, welders, parts fabricators, and electricians will be required in the long-term maintenance of the facilities in the pilot project. This will create business for these organizations and help them increase their skills through experience with these types of facilities.

Since millers are involved in the pilot project and since all mills are currently private-sector operations, the pilot project offers the opportunity for millers to increase their technical capabilities in the handling of wheat.

Private-sectors truckers can also benefit from the pilot project since a portion of the bulk transport tests in the corridors involve experimental work with private transportation. As previously mentioned, the utilization rate of trucks will be increased, thus providing additional opportunities for truckers to haul commodities in their vehicles.

TABLE 15

ANNUAL COSTS FOR RECEIVING, STORAGE, AND SHIPMENT OF WHEAT
PASSCO
1985

Rupees per MT

Expense	GOP-Approved Cost	Actual Cost
Bags	162.74	152.79
Delivery Charges	9.85	8.65
Taxes and Duties	2.95	3.83
Transportation	31.66	31.33
Handling	19.94	14.40
Godown Expenses	53.40	26.51
Unforeseen Expenses	8.00	-1.89
Departmental Charges	55.00	77.30
Financial Charges	256.46	280.68
TOTAL	600.00	593.60*

*Procurement of 655,009 MT

Source: PASSCO

After elimination of taxes and duties, departmental charges, and financial charges considered as PASSCO operational overhead, the following direct costs are calculated:

Bags	172.59
Transport of Grain	31.66
Handling Labor	19.94
Godown Expenses	53.40
Unforeseen Expenses	8.00
Management*	16.50
TOTAL	302.09

*Calculated at 30 percent of departmental charges to account for management and supervisory costs in receiving, storage, and shipment of wheat.

The above costs were then regrouped to reflect the following three expense categories:

Bagging	172.59
Handling and Storage	97.84
Transport	31.66
TOTAL	302.09

TABLE 16

ANALYSIS OF ESTIMATED PROJECT OPERATIONAL COSTS
BULK TEST CORRIDORS VERSUS CURRENT METHODS

Rupees per MT

	Estimated Costs			
	PASSCO	PFD and Miller	Bulk Test Corridor	Savings
Punjab Procurement Areas	302		84	218
Quetta and Peshawar Distribution Areas		350	249	101
Total	302	350	333	319

Sources: Tables 14 and 15
Majeed
Unpublished Data

TABLE 17

LABOR FORCE DISTRIBUTION

Percent of Work Force

Category	1971-71	1982-83	1983-84	1987-88 Projections
Agriculture	57.27	52.14	51.93	51.01
Manufacturing, including mining	12.91	14.85	14.92	15.84
Electricity, gas, and water	0.37	0.70	0.72	0.70
Trade, hotels, and restaurants	9.67	11.55	11.63	12.11
Transport, storage, and communications	4.83	4.66	4.72	4.83
Construction	3.41	5.72	5.70	6.04
Services and others	11.24	10.38	10.38	9.46

Source: Akhtar

TABLE 18

RATES OF UNEMPLOYMENT

Percent of Work Force

	1971-72	1981 Census	1982-83
Total	2.0	3.1	3.9
Rural	1.6	2.3	3.3
Urban	3.7	5.2	5.7

Source: Akhtar
Economic Advisor to GOP

TABLE 19

UNEMPLOYMENT RATES
1981 CENSUS

Percent of Work Force

	Pakistan#	NWFP	Punjab	Sind	Baluchistan
Both Sexes	3.1	2.2	3.2	3.3	3.1
Rural	2.3	2.0	2.5	1.6	3.0
Urban	5.2	3.7	5.0	5.8	4.8
Male	2.9	2.1	3.0	3.2	2.9
Rural	2.2	1.9	2.4	1.5	2.8
Urban	5.1	3.5	4.8	5.8	4.0
Female	7.5	6.5	7.7	7.1	8.6
Rural	7.2	5.3	7.2	6.8	9.4
Urban	8.2	7.2	8.8	7.3	5.1

#Excludes FATA

Source: Statistics Division
Economic Advisor to GOP

TABLE 20

PERCENT OF EMPLOYED PERSONS WORKING LESS THAN 35 HOURS PER WEEK

Percent of Work Force

Category	1971-72	1978-79	1982-83
Total Pakistan	7.68	12.47	12.56
Agriculture sector	8.20	19.10	18.60
Transportation, storage, and communications sector	4.30	2.10	3.30
Construction sector	4.27	3.90	9.40

Source: Statistics Division

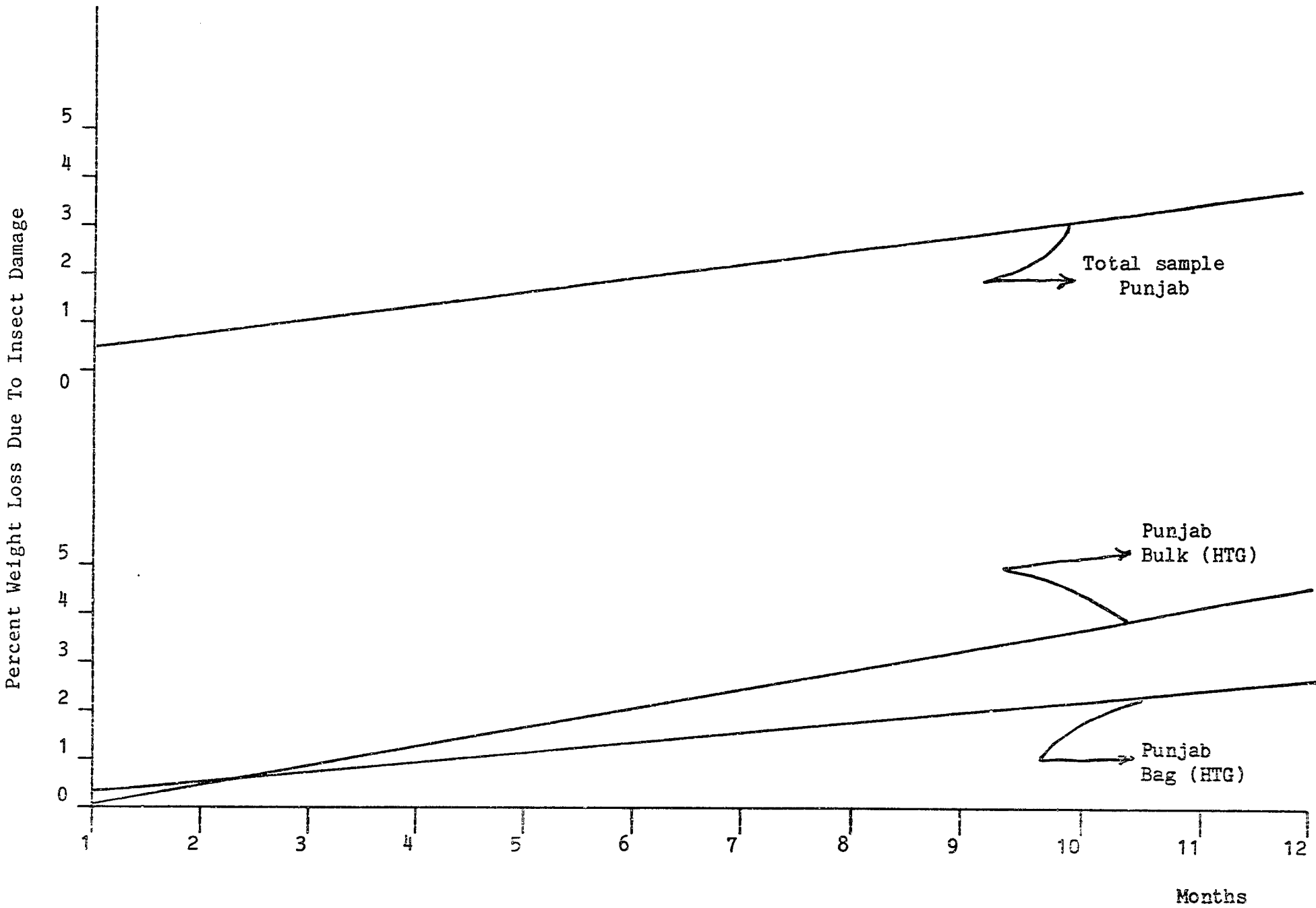


FIGURE 33. Weight Loss Due to Insect Damage

Source: PARC

APPENDIX I

STATEMENT OF WORK

To fulfill the objectives of planning in detail the implementation and operation of a pilot project, a team of engineers and an economist will undertake activities which are divided into three phases.

Phase I of the planning activities will include, but not be limited to, the following tasks:

1. Define the scope of the pilot project. The pilot project will be clearly defined as to its objectives, features, impact on future development, benefits, and risks. The conceptual design of the pilot project will be specified.

2. Define the pilot project areas. The areas the project are intended to serve will be clearly identified in terms of procurement, transportation, and marketing. Public and private sector groups to participate in the pilot project will be identified.

3. Conduct preliminary survey of sites. Suitable general locations based on collection, storage, transportation, and marketing considerations will be evaluated and selected. Complete engineering surveys will be performed during the implementation of the project.

4. Collect information on existing facilities. Various information related to grain procurement, transportation, storage, handling, inventory, and quality control in the existing facilities will be evaluated.

5. Plan for the retrofit of existing bulk storage facilities. Measures to remove the operation constraints in existing bulk storage facilities in the identified project areas will be detailed so as to integrate such facilities into the pilot project. This will assist in increasing the utilization rate of the existing facilities. This will include not only recently constructed bulk storage facilities, but also hexagonal bins, flat storage, and bulkheads.

6. Define throughput targets. The optimum throughputs of the handling, storage, transportation, and processing facilities will be determined.

7. Concept design of modifications of existing facilities. Measures to the removal or reduction of operation constraints in the existing facilities will be evaluated.

8. Concept design of new facilities required. Proposed new facilities at various locations, such as procurement centers, reservoirs, intermediate storage, distribution centers, and mills will be evaluated.

9. Collect local cost data. Cost data related to materials, labor, equipment, services, construction, grain storage, grain handling, grain transport, and quality control will be collected to the greatest extent possible.

10. Collect information on available personnel and identified public and private sector participant organizations. Information to be collected will include experience, education, and job category. This information will be used in constructing required training programs.

11. Collect information on current quality and inventory control programs in use. This information will be used to develop systems for collecting data for analysis.

12. Collect information on transport systems. This information will be used to determine what options exist for bulk handling of grain in transport.

13. Investigate the availability of a Pakistani Agency to conduct systems analysis and planning. Such an agency will be responsible for analysis of data collected in the pilot project and the use of the analyzed information in formulating a comprehensive plan for the introduction of a commercial bulk handling and storage system.

Phase II of the planning activities will include, but not be limited to, the following tasks:

1. Determine technical and various other needs of the pilot project. Such needs as related to project engineering, project implementation, project supervision, and project operation. This will also include such needs as inventory and quality control, facility maintenance, personnel training, and project data collection and analysis.

2. Determine technical assistance requirements. Because of Pakistan's relative inexperience in bulk grain system, specific technical assistance requirement will be assessed.

3. Prepare work plan and schedule. Define various phases of project implementation and operation as well as time schedules.

4. Prepare project cost estimate. Determine the various costs of engineering, construction, supervision, operation, personnel training, data collection, and systems analysis and planning.

5. Construct a comparison between existing bag storage system and the pilot bulk storage project. Depending on the availability, quantity, and quality of data collected for the existing bag storage system, make a cost comparison between existing bag systems and the pilot bulk system. This comparison will be based upon the project cost estimates as derived in above activity number 4.

Phase III of the planning activities will include, but not limited to, the following tasks:

1. Draft final detailed project plan.

2. Discuss detailed project plan with all involved parties.

3. Finalize work plan and time schedule based on series of discussions.

APPENDIX II

COMMENTS ON ISSUES RAISED DURING PROJECT PROPOSAL PRESENTATION

During the presentation of the report on the Bulk Wheat Handling and Storage Pilot Project in Pakistan, November 16-18, 1987, in Islamabad, specific questions and issues were raised by PASSCO, MINFA, and PFD officials. These questions and issues were addressed in the presentation sessions. The questions and the responses given are summarized as follows:

1. The financial project analysis does not aptly justify the budget of $48.382 million for bulk handling and storage of 156,000 MT of wheat. This high cost is not replicable for future expansion.

As pointed out in the pilot project concept, Section I of the report, the pilot project is not merely a handling and storage project, but a specific pilot project concept with stated objectives. The need for such a specific concept and the related objectives is the result of prior findings as set forth in Section I.

Since the pilot project's overall purpose is to test the technical and economic feasibility of bulk handling and storage systems, only limited financial analysis can be applied to such a pilot project. Capital cost comparisons, operational cost comparisons, and payback periods have been presented in the report. Also, as described in the report, the pilot project has a unique set of physical requirements which are necessary to test the technical and economic feasibility of different bulk wheat handling and storage subsystems and configurations so as to achieve the stated objective of the pilot project.

Based on the objectives, the financial analysis of the pilot project in terms of project capital costs, operating costs, and payback period does justify the project to be financially sound. The payback period for the pilot project, using the minimum amount of wheat expected to be handled (156,000 MT annually), is 13 years, considering only operating cost reduction. If loss reductions are considered as additional savings, then the payback period is reduced to 9 years. The facilities in the pilot project are designed to handle at least three times the minimum amount calculated as the base (156,000 MT annually). If the amount of wheat handled is increased to 312,000 MT annually (twice the minimum base), then the payback period is reduced to 7 years using only operating cost reductions, or 5 years using operating cost reduction and loss reduction.

As to replication of the pilot project, the pilot project itself is not designed to be replicated in total as a commercial system. It is designed to generate results which will indicate the technical and economic feasibility of different handling or storage subsystems and configurations. These results will be the basis on which least-cost commercial bulk wheat handling and storage systems can be introduced into Pakistan.

2. How much savings would a bulk system have over the present bag system? What is the payback period?

As set forth in the report, comparisons indicate that due to the operation of the bulk test corridors, a probable savings of Rs 319/MT will accrue for the projected 156,000 MT of wheat to be handled annually by the pilot project, or a total of $2.9 million.

A payback period for the bulk test corridors is calculated in the report based on estimated investment outlays and probable potential operational savings. Investment outlay in the bulk test corridors amounts to $38 million. Potential savings resulting from bulk handling and storage of wheat amount to $2.9 million annually. The payback period in this case is 13 years. If the expected 6-percent grain loss reduction is attributed to the operations of the bulk test corridors, then this additional savings of $1.1 million annually would reduce the payback period for the bulk test corridors to 9 years. However, the pilot facilities have a capacity to handle more than 156,000 MT of wheat per year. If the amount of wheat handled in the bulk test corridors is doubled, then the payback period would be 7 year based on potential operational savings, and 5 years if the additional benefits of grain loss reduction are considered.

3. The items not directly required by the pilot project may be excluded in the scheme to reduce the budget cost.

The secondary component of the pilot project, Other Storage Improvements, could be deleted from consideration without any direct impact on the bulk test corridors. However, as pointed out in the report, if the bulk test corridors prove to be successful and a decision is made to implement changes in the entire wheat handling and storage system, it will be necessary to understand how best to improve and modify the existing bag and bulk storage facilities. The technical and economic information gathered from the above activities can be used to verify the information gained in operating the bulk test corridors, and to provide an additional set of information on facilities outside the bulk test corridors. The compilation of this information will provide the System-wide Implementation Plan with a better set of data with which to develop a comprehensive plan for countrywide bulk wheat handling and storage.

Any reduction in the design for the bulk test corridors will drastically reduce the ability of the pilot project to meet the objectives as stated in the report. The bulk test corridors are designed to include all facets of a complete bulk handling and storage system from farm to flour mill, as well as to test different subsystems and configurations. Results drawn from inadequately-sized bulk test corridors run a very high risk of being invalid, incomplete, and biased. In this case, the results would not be useful for the future development of commercial bulk handling and storage systems.

4. The improvement cost for the silos at Chichawatni, Khairpur and Quetta is too high and it does not lead to increased storage capacity. Why not build new facilities within this cost which will increase storage capacity?

The silos at Chichawatni, Khairpur, and Quetta are situated at desirable locations served by both road and railways within the proposed bulk test corridors. However, because of the technical problems pointed out in the report, these silos need conversions which will solve the equipment deficiencies and therefore enable each facility to attain its full operational potential.

The objective of the pilot project is to test the technical and economic feasibility of bulk handling systems as well as various types of bulk storage methods. Concrete silos are a type of storage which should be included in the

project. It would not be logical to construct new concrete silos and leave the existing units out of the program. The costs associated with the improvements to the three silos are necessary to convert them into efficient bulk terminals. These costs would be required for new facilities as well. Furthermore, the improvements to the silos are of lasting value beyond the end of the pilot project.

5. Why have terminal facilities? Why not supply wheat directly to mills by increasing storage capacity at the mill sites?

It is highly likely that for relatively long-distance movements, transport of bulk wheat by large trucks or by railcars will be most economical. Small trucks will be inefficient. Providing rail and high-quality road connections to all mills would be impractical. In addition, the cost of providing facilities for receiving and unloading large trucks and railcars at each mill would be prohibitive. A terminal, equipped to efficiently transfer bulk wheat from large long-distance carriers to small short-distance carriers, can be positioned to serve many mills. The terminal provides the economy of efficient handling to many mills and also provides a point of logistics control of the distribution process.

The movement of wheat over long distances directly to large storage units at mills will possibly be a future development. If some mills develop into very large units, they may find it economical to construct their own terminal facilities adjacent to the mills. At this point in time, however, it is impractical to expect the mills to invest in these facilities.

6. Why have mobile procurement centers? It may be examined if additional storage capacity could be provided at the procurement centers.

In the present system, procurement centers are located at close intervals to facilitate easy access by farmers. Under the pilot project, bulk procurement equipment will be placed at the same sites as these existing centers. In many instances, these sites are rented only for the harvest period. In some cases the centers are the village streets. Storage will be located at three of the bulk procurement centers in the Dipalpur area. The cost of providing storage facilities at all procurement centers would be prohibitive. Furthermore, it is desirable to encourage more of the procurement to take place at fewer centers in the future.

The mobile procurement centers provide the transport equipment to move the wheat throughout the year. A major portion of the cost is associated with providing trucks which are themselves a part of the bulk handling system tests.

7. The provision has been made for long haulages which need costly equipment. To start with, the arrangements could be made for the short hauls to local mills in the surplus wheat-producing areas.

The bulk test corridors have been designed in accordance with historical grain flows, and therefore they have facilities, handling systems, and transport that are of sufficient size to simulate full-scale farm-to-market operations. The bulk test corridors encompass all handling, storage, and transport operations, subsystems, and configurations from the farm to final destination at flour mills.

Long-distance hauls are an important and integral part of Pakistan's wheat handling system. It will not be possible to eliminate long hauls from the project design since that would eliminate a major subsystem and as a result no data could be collected for decision-making for future commercial systems. Long hauls as a percentage of total transported wheat volume may even increase in the future. Wheat will continue to be moved from port to inland, and surplus areas to deficit areas, all of which require long-haul transport.

The pilot project is intended to provide an answer as to the technical and economic feasibility of systemwide adoption of bulk wheat handling and storage. To eliminate a segment of the project design will result in biased conclusions about technical factors and costs.

8. All the equipment should not necessarily be imported. The equipment specially related to transportation which can be made available or can be manufactured locally, should be provided locally.

Correctly-designed and adequately-constructed high-capacity equipment for bulk grain handling and storage will have to be initially imported. Such equipment, specifically designed for high-capacity grain movement within a storage facility, will be a new introduction in Pakistan. Once such equipment is installed and operational, the basic prototype exists for local manufacturing firms to understand the needed design criteria and necessary construction details required in the fabrication of high-capacity and long-life equipment.

Local modifications of transportation equipment such as trucks and trolleys have been included in the project and are described in the report. Required long-haul transport equipment such as bulk semi-trailers and bulk hopper railcars which are specially designed for high-capacity grain movement will be a new introduction in Pakistan. Again, when such equipment is operational, the basic prototype exists for local manufacturing firms to understand the needed design criteria and necessary construction details required in the fabrication of high-capacity and long-life equipment.

9. The provision of $7.2 million for the technical assistance and training is too high. Such comprehensive training might not be needed. The high amount of technical assistance indicates this project is not replicable.

The pilot project is quite comprehensive and very complex. It involves all elements of a complete countrywide wheat handling system from farm to mill. The facilities to be developed and operated are quite diverse with different subsystems and configurations. Duplication is minimal.

The technical assistance component spans a period of 5 years and includes planning, detailed design, procurement, construction management, operations consulting, and training. The technical assistance is a comprehensive technical exchange. Proper application of technical assistance will in fact make it possible to replicate the successful bulk handling and storage subsystems and configurations with minimal or no technical assistance cost in the future.

The success of the project should not be jeopardized by incomplete engineering and management. The successful extension of the bulk systems beyond the pilot project depends in fact on the training and technical exchange provided by the technical assistance component.

Comprehensive training in all aspects of management and operations will be required since the pilot project is a high-capacity bulk handling and storage system.

As stated previously, the pilot project itself is not designed to be replicated in total as a commercial system. It is designed to generate results which will indicate the technical and economic feasibility of different handling or storage subsystems and configurations. These results will be the basis on which least-cost commercial bulk wheat handling and storage systems can be introduced into Pakistan. Therefore, proper application of technical assistance will in fact make it possible to replicate the successful bulk handling and storage subsystems and configuration with minimal or no technical assistance cost in the future.

10. Is one unit train enough for two corridors?

The recommended project includes one unit train composed of 30 specialized bulk grain railcars of 50-MT capacity each. The railcars are to be imported. They will be joined with a dedicated locomotive provided by the railway authority to form a unit train. This unit train is intended to transport 25.000 MT annually between the Chichawatni silo and the Peshawar Bulk Dispatch Terminal, plus 50,000 MT annually between the Khairpur and Quetta silos.

Relative to the effect of operational time constraints on the turnaround time for the unit train, it is pointed out that the calculated turnaround time does not allow for unusual railroad operational problems. Such operational delays would reduce the amount of wheat which the unit train could handle. A second unit train would assure that the planned rail movement of wheat could be handled even in the event of railroad operational problems. However, a second unit train would represent an additional investment cost of $3.2 million. Two unit trains would be underutilized in transporting only 75,000 MT of wheat annually in the two corridors. If additional wheat were handled in the Chichawatni to Peshawar corridor or if additional corridors were considered, the second unit train could be justified. Both the Peshawar Bulk Dispatch Terminal and the Quetta silo would be capable of handling substantially more rail throughput than planned in the pilot project. Additional quantities of wheat to be moved could be originated from the Khairpur silo. Furthermore, Port Quasim could be added as a rail loading point.

11. Why can't the five bagged wheat procurement centers in the project design for the Dipalpur area be replaced with additional mobile procurement centers?

This could easily be accomplished by equipping these four centers (Qila Jarind Singh, Shah Yakka, Budla Ram, and Dharma) as type MPCB facilities with 10-MT capacity trucks and farm-to-procurement center trolleys. The estimated capital cost of this addition is $2,274,000.

12. Why can't the bulk storage facilities at Multan and Khanewal be equipped with mobile procurement centers?

This could be done. The harvest process in the production area that serves the Multan silo is partially mechanized by the use of combine harvestors. The silo is served by purchase centers generally located between 5 to 15 miles

from the silo. The average amount of grain procured from each center is 4,400 MT annually. The silo could be equipped with five type MPCB facilities, each with ten 10-MT capacity trucks and necessary farm-to-procurement center trolleys. The estimated capital cost of this addition is $4,403,500.

In the case of the Khanewal Hexagonal Bins, in addition to the conversion as specified in Section IV, three type MPCB facilities each with ten 10-MT trucks and necessary farm-to-procurement center trolleys could be provided. The estimated capital cost of this addition would be $2,641,000.

However, if the pilot project design is expanded to include bulk handling and storage operations at these locations, which are outside of the current geographical design, then additional technical assistance and training requirements will be incurred. The estimated cost of such assistance is $825,000.

13. The question of normal shrinkage (losses) in a bulk handling and storage system.

The question of normal shrinkage (losses) composed of normal handling losses and moisture shrinkage arose during discussions. The bulk wheat handling and storage pilot project will require a grain accounting system specially adapted to bulk handling and storage of wheat. As pointed out in the report, losses will occur in handling processes in all types of systems. To account for normal handling losses and moisture shrinkage factors, grain accounting systems in the U.S. use a loss factor of 1/2 to 3/4 of one percent. This percentage factor is deducted from the amount of incoming grain recorded in the grain accounting system. At least once annually, a physical inventory of grain in a facility is conducted. The physical inventory is used to adjust the balances in the grain accounting system. If this adjustment reflects shrinkage greater than the rate automatically entered into the grain accounting system, then the management of the facility is poor. Therefore, management procedures need to be improved to prevent sloppy management and the excess shrinkage of grain. Theft of grain in a system is a management failure and has no relationship to normal or abnormal handling losses and normal moisture shrinkage.

APPENDIX III

DATA

TABLE 1

CHICHAWATNI SILO SITE
1987 Data

Mode	Item	Rate
Truck	Carrying charge	RS 380 per MT
	Round trip time	6 days per truck
Rail	Siding capacity	35 railcars
	Railcar capacity	43 MT per car
	Carrying charge	Rs 240 per MT
	Demurrage rate	Rs 2 per MT per hr
	Allowable loading time for 35 railcars	6 hr
	Minimum loading time per train	18 hr
	Minimum amount of demurrage	Rs 24 per MT paid to railway
	Waiting time for the locomotive to arrive in siding for haulage to Peshawar	7 days

TABLE 2

MULTAN SILO

Receiving

Truck size - 10 MT
Time - 20 min/truck
Labor - 5 persons/truck
Capacity - 4 trucks simultaneously

Labor Costs

Loading - Rs 25 per 100 bags
Unloading - Rs 25 per 100 bags
(Operations include opening, emptying, filling, and stitching of bags)

Problems

The general condition of this facility is fair but many improvements will be needed to make the facility efficient. Technical and operational problems make it costly and difficult to improve the efficiency of the plant.

Design

Bin emptying consideration in the design was inadequate. Provision of only one discharge hole in the center of flat-bottomed bins as large as 60 ft and 80 ft in diameter is inappropriate. Consequently, a large quantity of grain cannot be unloaded by the unloading conveyor. The residual grain is removed by manual labor.

Operational

Receiving and dispatching facilities are inadequate. The area is not protected by any roof. There is no provision for truck hoist and bulk grain loadout spout. There is no insecticide application equipment. Out of ten storage bins, only three are equipped with aeration systems.

Maintenance

Spouts need replacement or repair. A few bin roofs leak. The bin temperature monitoring system does not work. The grain cleaner does not work. The motor control center is not satisfactory. Equipment is rusting. Bin top u-trough conveyors have developed holes and show signs of inadequate maintenance and repair. Bin discharge conveyors are in poor condition. The workshop facility is almost nonexistent.

Manpower

Inadequate technical manpower.

TABLE 3

QUETTA FLOUR MILLS

S.No.	Name of Mill	Capacity per 24 hr (MT)	Capacity of Covered Storage (MT)	Capacity of Un-covered Storage (MT)
1	Madina	144.000	500	500
2	Ghaznavi	144.000	500	500
3	Bolan	108.000	300	800
4	Jamal	108.000	300	1000
5	Adil	108.000	500	400
6	National	84.000	500	800
7	Rehmat	84.000	300	700
8	Quetta	108.000	400	1600
9	Pak Baluchistan	60.000	200	-
10	Syed	60.000	200	-
11	Wazir	60.000	200	-
12	Khan	60.000	200	-
13	Noor	60.000	200	-
14	Ishaque	60.000	100	-
15	Nadeem	60.000	300	-
	TOTAL	1308.000	4700	6300

Source: PFD, Baluchistan

TABLE 4

ANALYSIS OF INVESTMENT OUTLAY FOR GRAIN STORAGE FACILITIES BY STATED SOURCE

20-YEAR LIFE SPAN

Rupees per MT

Facility	Investment Outlay			Maintenance Cost
	Structure	Equipment	Total	
Bagged Storage				
Open Platform Storage (1)	573	N/A	573	23
HTG, 1,100 MT (1,2)	640-712	N/A	640-712	13-20
Bulk Storage				
Open Bulkhead Storage (1,3)	373	60	433	3-4
Flat: Modified HTG for Bulk Grain, 1,700 MT (3)	674	100	774	9
Silo, Storage, Concrete, 50,000 MT (4)	600-850	400	1000-1250	1

Data Source: (1) PASSCO, (2) PASSCO, NLC, Experience Inc, Hoff and Overgaard A/S, (3) Hoff and Overgaard A/S, (4) NLC, PASSCO

Investment outlay for grain storage facilities per MT of storage capacity as stated above varies depending on the data source utilized and the particular size and type of facility in question. This summarization is based on needed investment outlays over a 20-year facility life span.

Initial investment outlay for exterior bagged storage on platforms is Rs 78 per MT of capacity. However, due to the limited life of some of the components of this type of storage, additional investment outlay amounting to Rs 8, Rs 70, and Rs 22 per MT of capacity must occur every 1, 5, and 8 years, respectively.

Investment outlay for bagged grain HTG storage varies from Rs 640 to Rs 712 per MT of capacity, depending on the data source. PASSCO constructed its 1,100-MT warehouses for approximately Rs 640 per MT of capacity.

Initial facility investment outlay for open bulkheads for bulk grain storage is stated at Rs 138 per MT of capacity. Additional investment outlay of Rs 49 and Rs 39 per MT of capacity must occur every 5 and 10 years, respectively, because of the life span limitations of some of the components of the open bulkhead.

The flat and silo bulk storage facilities listed above are assumed to required no additional capital investment over a 20-year life span.

The stated investment outlays for bulk storage facilities are inconsistent with the generally accepted norms for such facilities. The total capital costs for bulk storage facilities should predominantly represent equipment costs for bulk handling of grain, in the approximate ratio of 60 percent of total facility cost for equipment, including installation and erection, and 40 percent of total facility cost for structure and civil work. The above-stated costs imply that inadequate equipment for handling bulk grain is intended to be installed in these facilities. This implication is supported by findings detailed in Section II and by the needed rehabilitation set forth in Section III on the Chichawatni, Khairpur, and Quetta silos. Rather than the stated cost of Rs 1,000-1,250/MT of storage capacity for a 50,000-MT concrete silo, the true capital cost for such a facility--if correctly designed, constructed, and equipped--should be approximately Rs 2,400-2,800/MT of storage capacity. The same argument applies to the above-stated outlay for open bulkhead storage. If the facility were properly equipped to rapidly handle bulk grain, the investment outlay would be approximately Rs 950/MT of storage capacity rather than the Rs 433/MT stated.

TABLE 5

AVERAGE INVESTMENT OUTLAY FOR GRAIN STORAGE FACILITIES

UNITED STATES

Dollars per MT[1]

Facility Type	Cost
Farm Storage Steel bins with handling equipment Average size of 1,500 MT Purpose: storage	55.00
Country and Subterminal Elevators Concrete construction with handling equipment Average size 50,000 to 250,000 MT Purpose: storage	110.00
Port Elevator Concrete construction with handling equipment Average size 80,000 MT Purpose: transshipment	575.00

[1]Facility costs do not include land, rail spur, or road costs.

APPENDIX IV

TERMINOLOGY

Approximate material take-offs	Estimates made on the basis of experience without knowing the final project design
bu	Bushel, 60 pounds
Budget-level quotations	Estimates from equipment suppliers as to what they would quote if they were to supply equipment, but these are not competitive quotations
Exchange Rate	Standard exchange rate of Rs 17 per $U.S. in this report
Ft	Feet
Float Time	Available extra time in which a given project activity can take place prior to achieving a target completion date (milestone) without affecting the completion date of the overall project
Milestone	Target completion date or that date by which certain activities must be completed so as not to delay future project activities
MT	Metric ton
MT/day	Metric ton capacity during standard operating day
MT/24-hr day	Metric ton capacity per 24 hours of continuous operation
MT/hr	Metric ton capacity per hour of operation
MT/km	1 metric ton transported 1 kilometer
Payback period	Number of years required for profits or savings to return capital invested
o	Degree

APPENDIX V

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