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JORDAN VALLEY AUTHORITY

JORDAN VALLEY IRRIGATION PROJECT

STAGE II

FEASIBILITY STUDY

VOLUME IV

APPENDIX F
SOILS

APPENDIX G
AGRICULTURAL DEVELOPMENT

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(SHAIR & PARTNERS)

REPORT OUTLINE

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SOILS

Introduction

This Appendix describes the work associated with the reclassification and amelioration of the soils within the Project Area. A general location map, (Exhibit F-1) and six 1/50,000 scale Land Classification Maps (Exhibit F-2) are included. The Project includes a dam on the Yarmouk River at the Maqarin site and an irrigation system for a net area of 25,353 ha. This area, together with the areas that have irrigation systems under construction or at an advanced planning stage, brings the total net irrigated area in the Jordan Valley to 36,000 ha. Of the 25,353 ha for which sprinkler systems are proposed in this study, about 12,000 ha are presently under surface irrigation, and the balance is mostly unirrigated.

A soil survey and a land classification have been carried out previously for most of the area. The land classification was based on using surface irrigation. Under sprinkler irrigation, some areas previously classed as unirrigable may be irrigated. Furthermore, certain areas that were previously rejected as too high, distant, or small for surface irrigation schemes, and as such were not surveyed, are now considered as potentially irrigable areas and are recommended for detailed soil survey. These areas amount to 1,947 ha and are referred to as potential lands.

Scope of Work

The scope of work covered by this appendix is based on the agreement for this Feasibility Study entered into between the Jordan Valley Authority and Harza Overseas Engineering

Company in association with Dar Al-Handasah Consultants (Shair and Partners) in March 1976.

The scope of work for the soil investigation is summarized as follows:

a) Review all previous soils work.

b) Establish criteria for land classification considering sprinkler irrigation and carry out a reclassification of the area which has previously been classified for surface irrigation and which presently is not included under a sprinkler irrigation system plan.

c) Study the overall Project Area and select potentially irrigable areas for which no previous soil survey work has been carried out and prepare a reconnaissance land classification survey for these areas.

d) Prepare recommendations for the various soil amelioration practices which are considered to be necessary.

Method of Work

The soils work was carried out by utilizing all previous soil maps, land classification information, air photos, and reports as a basis for arriving at the criteria for land classification and the actual reclassification of the areas. The field work consisted of field visits for visual observation and study. No special aerial photography or photogrammetric work was carried out. Soil samples were collected and analyzed for spot checking certain areas and for the preliminary reconnaissance of a previously unstudied area in the Yarmouk gorge.

For the soil studies, a team was mobilized and established in Amman. Frequent consultations were made with the home-office staff and several meetings of the Consultants Project Technical Control Board were held in Amman.

Subsequent Stages

Following the approval of this report, and barring serious modifications to its basic concepts, the following tests or studies will be required for final design.

1. A semi-detailed soil survey of the potential area, using 1/6,000 air photos.
2. Correlation with design engineers to help in final design of farm units.

General Desciption of Soils

The Project Area is enclosed by natural boundaries: The Yarmouk River on the North, the Dead Sea on the South, the Jordan River on the West, and the escarpment on the East.

The agricultural lands of the Jordan Valley have been studied considerably over the past twenty five years.

The first study, which contained a detailed land classification, was carried out in 1953/54 by Baker-Harza[1/]. This study was based on a detailed survey carried out in accordance with the Bureau of Reclamation Manual - Volume 5, Irrigated Land Use, Part 2, Land Classification. Mapping was carried out on 1:2,500 scale photo mosaics, that were assembled and reduced to an approximate scale of 1:119,000 on one sheet and colored with respect to classes 1, 2, 3 and 4 in yellow, green, blue, and brown, respectively, in accordance with the standards of the U. S. Bureau of Reclamation. The

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1/ Yarmouk-Jordan Valley Project, Master Plan Report, Michael Baker, Jr., Inc., Harza Engineering Co., 1955.

first three classes are suitable for irrigated agriculture with various degrees of restriction. Class 4 lands, which are mainly in the southern part of the area, are presently unsuited for irrigated agriculture due to salinity. These class 4 lands are reclaimable to class 1, 2, or 3 by leaching the salts.

The second study was a Salinity/Alkalinity study conducted by the Institute of Pedology and Technology, Zagreb, Yugoslavia during 1964 and 1965. In this study, four leaching trial stations were built, each with an area of three hectares. One of these stations was located in the East Ghor 3.5 km east of the Jordan River and 5.5 km north of the Dead Sea (205.0E x 135.5N). It was recommended in this study that the Baker-Harza land classification be considered a basis for delineating the saline areas that need leaching.

The third study was carried out by Dar Al Handasah - Nedeco in 1969. The soil survey of this study followed the system established by the Soil Survey Staff, U.S.D.A. This soil survey was generally based on the Baker-Harza land classification and was produced on a 1:50,000 scale map. Based on extensive field work and soil sample analysis, the soils were classified according to their parent material, namely; lacustrine sediment, fluviatile-colluvial sediment on the Ghor terrace, and the alluvial sediment of the Jordan River and tributaries. These in turn were further sub-classified according to series, type, and phase.

Topography

The floor of the valley consists of a terrace, adjacent to the escarpment on the east, and the flood plain of the Jordan River on the west. The terrace and the flood plain are referred to as the Ghor and Zor, respectively. The Ghor is 30-60 m above the present level of the Jordan River and slopes toward the river at a rate of 15-25 meters per kilometer. The higher part is arbitrarily called the upper Ghor as contrasted with the lower Ghor down the slope and the middle Ghor in between. In the North, the Ghor is 2-4 km wide but toward the south it becomes 4-6 km wide. Toward its western edge, adjacent to the Zor, the Ghor is highly eroded and of "badland" appearance forming a transitional zone referred to as the Katar. The Zor is a minor valley 1-2 km wide and subject to a degree of annual flooding.

Sheet erosion, caused primarily by winter rains and sparce vegetation, has produced minor surface modifications. Cobbles and boulders scattered over certain areas indicate that sheet erosion and wind action have removed finer materials. Similarly, other localities appear to have recent deposits of wind and water-borne materials.

The North Ghor. A series of alluvial fans in the North Ghor give rise to slopes up to 10 percent. Complex slopes of short runs occur on the upper edges of the fans adjacent to the foot hills. Topography of the larger fans, such as those of Wadi Arab and the Zarqa River, is relatively smooth with long uniform slopes. The lands between the Wadi Rajib and the Zarqa River are indicative of the larger interfan areas which are of medium to heavy texture with long gentle slopes, (3-5%). The gentle slopes and the very gentle slopes (1-3%) occur most frequently and are described as normal slopes. When the slopes exceed three percent they were identified as slope phases. These occur almost exclusively in the North Ghor[2/]

2/ For complete description of slope phases, reference is made to Dar Al-Handasah-Nedeco Final Report, 1969 Vol. II Annex C page 8.

The South Ghor. The majority of the South Ghor area is characterized by long, gently sloping lands well adapted to irrigated agriculture. Major exceptions to this condition are found immediately south of the Zarqa River and north of Karama, where numerous small wadis cross the area. Levelling on some of the areas will be prohibited by shallowness to marl and rock in the profile. Less apparent, but of signficance, are small ridges formed on the Ghor by wave action as the old inland lake receded. These are found primarily near the Katar, south of the Ghor Nimrin area. Steeper gradients and rock cover are generally found above the Main Canal alignment. The rock cover was caused by outwash from the hills. A relatively insignificant area of vegetative cover composed mostly of small Christ-thorn trees, is located in the vicinity of Wadi Hisban.

The Zor. The Zor area is characterized by old stream channels which have been filled in by flood action. The resulting complex slopes would require a significant degree of land grading for surface irrigation. Some land grading and surface drainage will still be required. This is particularly true south of Grid 139 North, where flooding action of the Jordan River and outwash from the Ghor and Katar have left partially filled channels. Thick growths of cane and salt cedar are also prevalent and will require clearing.

General Description

Soils of the Jordan Valley are typical of low rainfall development, being relatively low in organic matter and highly calcareous and gypsiferous. The majority of these soils are relatively permeable.

According to the comprehensive soil survey system, (7th approximation), the soils of the Jordan Valley belong

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partly to the order Entisols, which comprises the Zor and part of the Ghor and partly to the order Aridosals, which comprises the other parts of the Ghor soils.

<u>North Ghor Soils</u>. The soils of the Ghor have been formed primarily from alluvial materials from streams and general outwash of the uplands.

In the North Ghor, the texture of the soil ranges from moderately fine to fine. The moderately fine-textured soils cover more than 75 percent of the North Ghor. The fine-textured soils occur exclusively in the North Ghor, and are found in the north end of this area. These soils are deep (more than 90 cm) or medium deep (ranging between 46 cm and 90 cm).

Rainfall, together with other weathering agents, has played a principal role in modification of the soils. The lake-laid materials have undergone changes to such an extent that it has become difficult in most cases to identify the original laminations. In many cases, the structure has even become softly consolidated. Marls were found to be present within 1.5 m of the surface in about 5 percent of the arable area.

The soils have good water holding capacity and are relatively fertile. Areas with salinity and alkalinity problems are not common, covering only about 5 percent of the arable area. Generally, they occur in association with drainage deficiencies. Adequate drainage and the addition of gypsum, where none is present in soil, will improve these lands.

<u>South Ghor Soils</u>. The most favorable soils are located on the broad, smooth, gently sloping alluvial fans of the three major wadis; Shueib, Kafrein, and Hisban.

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The texture of these soils ranges from moderately fine to moderately coarse. The moderately coarse-textured soils occur quite commonly around Suweima. The textures of soils on the Wadi Shueib fans are loams, clay loams and clays. Considerable surface rock is found in the area adjacent to Shunat Nimrin. Southward, the soils on the fans of Wadi Kafrein and Wadi Hisban are a little coarser in texture, with clay seldom being found. Soils on these fans are deep, porous, and relatively free of soluble salts and alkali. When irrigated, these soils produce good crops. Marl is seldom found within 1.5 m of the surface. Soils south of Karama, between the lower edge of the alluvial fans and the Katar, are grayish-brown to whitish-gray with identifiable marl occurring under most of the area within two meters of the surface. North of Karama, the lands become broken and soils are predominantly whitish-gray in color. Textures are predominantly clay loams, and the soluble salt content is relatively high. In much of the area, the irrigated soils are relatively salt free while the non-irrigated soils are saline. Soils with a high degree of salinity will require leaching. The permeability, gypsum content, and location of these soils make them favorable for reclamation.

Zor Soils. The Zor soils were developed in alluvial deposits of the Jordan River and its tributaries. In the Dar-Nedeco soil survey the criteria used was that the alluvium should be at least 90 cm thick to classify it as a Zor soil. The Zor soils have little profile development and are usually stratified with layers of different textures. This stratification is a common feature of alluvial soils. The shifting course and the variable regime of the stream causes stratification. This is especially true of the Jordan

River, where the course of the river is confined to a narrow flood plain.

Moderately fine textured soils occur on the flood plain of the Yarmouk River. Medium textured soils, such as silt loams, sandy loams and sandy clay loam, are also found. Due to stratified sedimentation, the variation within an area can be considerable.

<u>Parent Material of the Soils</u>

The parent materials of the soils of the Jordan Valley are the three main deposits: lacustrine sediments, fluviatile colluvial sediments, and alluvial sediments.

The deposition process started in the lakes which occupied the Valley during the Pliocene age. The Jordan Rift Valley was formed in the early Miocene age by down-faulting and other tectonic movements that continued through the Pliocene and Pleistocene ages. The latter age was characterized in the Jordan area by the occurrence of a series of alternating pluvial and interpluvial periods.

Filling of the rift valley started with sedimentary fresh-water limestones, sandstones, and clays, with deposition being more calcareous (calcareus sandstones and marls) towards the South. Overlying these fresh-water deposits are the Lisan marls, a type of lacustrine sediments deposited during Middle Pleistocene period. Prior to this deposition, the salinity of the lake had increased by evaporation during the previous periods.

Lisan marls are composed mainly of thinly laminated beds of alternating layers of white gypsiferous chalks (including anhydrite and rarely sulphur nodules) and gray calcareous clays (marls), representing sedimentation during dry and wet seasons, respectively. The upper layers are mostly highly calcareous, silty deposits. At places where wadis entered the lake, the deposits of the Lisan formation are inter-fingered with clastic sediments (sand, gravel). The water occuring in the clastic sediments is often saline and under artesian pressure.

During the interpluvial period of the upper Pleistocene age, the level of Lake Lisan began to recede under the effects of increased evaporation and reduced precipitation. During this recession to the present base level (Dead Sea) a series of shore lines were formed. Drainage waters from the north incised a channel through the Lisan Lake deposits as it flowed to the Dead Sea. The present Jordan River occupies and floods the lower level of this channel. There are, however, numerous places where channel erosion left intermediate terraces between the original surface of the lake sediments and the present flood plain of the Jordan River.

Some of the soils in the Zor have been influenced considerably by sediments which were produced during the formation of the Katar and by sediments carried across the Ghor by Wadi flows originating on the high lands to the east.

The fluviatile-colluvial sediments, being eroded material, reflect the mineralogical composition of the formations from which they originate. This reflection is most distinct for colluvial deposits. In fluviatile deposits, considerable variations occur, especially when watersheds cover areas occupied by many different types of rocks. The predominant rock type of the Eastern Uplands is limestone, which commonly occurs in association with sandstone. Small local areas of basalts also occur.

Sandstone in these areas generally has weathered mostly into sandy loams and sandy clays, rather than pure sand. The limestone has weathered under the higher rainfall conditions of the Uplands into strongly calcareous clay or silty clay, with a typical reddish-brown color.

The fluviatile-colluvial cover of the Ghor is mostly moderately fine to medium-textured. Relatively coarse-textured material occurs in the southeast corner of the valley and also along the valley borders, especially where wadis enter. The cover is thickest on the Upper Ghor (usually more than 5 m) and thins out towards the lower Ghor. In the Katar exposed Lisan marls occur. Lisan marl outcrops are also found higher up the Ghor. It appears that during the retreat of the Lisan lake (and probably thereafter) runoff water from the upper Ghor accomplished a considerable degree of surface sculpturing of the emerging Lisan formation.

The Lisan formation on the upper Ghor consists of highly calcareous silt loam with Gypsum crystals, but it is free of soluble salts. Most of the central and lower Ghor lisan marls are highly saline, laminated beds of calcareous silt loams and loams. This trend of salinity is found from north to south in the valley.

The difference may be partly due to the sedimentation process which took place on the Upper Ghor in a less saline environment. The salinity increased as the Lisan lake shrunk back first towards the river and then south towards the Dead Sea. The rainfall pattern may also be part of the cause of the salinity pattern. The Upper Ghor and the northern parts of the Valley which emerged first, as the lake receded, have been leached to a greater extent. The favorable natural drainage conditions on the Upper Ghor also added to this difference.

Recent fluviatile sediments are found in the Zor. They also occur in the flood plains of the Yarmouk and Zarqa Rivers, and locally in wadis. The origin of these sediments is mostly untraceable, as all the tributary watersheds have contributed sediments. In places, runoff from the Katar has resulted in a strong contribution of Lisan marls to the alluvial sediments.

Soil Fertility

Laboratory data on soil fertility were available from analyses conducted by Baker-Harza in 1953/54, the Institute of Pedology and Technology, Zagreb, in 1964/65 the Soil Laboratory of the National Resources Authority, which performed the analyses on soil samples taken during the survey conducted by Dar Al Handasah-Nedeco in 1969.

The values given in the following discussion were developed by Dar Al Handasah-Nedeco through a review of such data. The comparison between results was sometimes hampered by differences in the analytical methods applied.

Lacustrine Sediments. The lacustrine sediments have predominantly silt loam and loam textures. The silt content is mostly between 40 and 65 percent, the clay content is usually less than 20 percent, and the sand content between 25 and 40 percent (mostly very fine sand).

Carbonate equivalent, based on available data is higher on the upper Ghor and to the north (40-50%). Elsewhere, averages are between 30 and 35percent in Lisan marl.[3/]

The soils are mildy to moderately alkaline. The pH-H_2O[3/] is usually between 7.6 and 7.9. The pH-KCl[4/] is usually lower by 0.4 and 0.6 points.

3/ pH in 1:1 Soil suspension in Water.

4/ pH in 1:1 Soil suspension in 1N KCl solution.

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The Cation Exchange Capacity (CEC) data, presented by the Institute of Pedology and Technology, range from 15 to 25 me/100 g soil.

The nutrient status of the lacustrine sediments can be summarized as follows:

The organic matter content is almost always less than 1 percent and in about half the area it is less than 0.5 percent. These low organic matter contents are normal for a hot arid climate. Oxidation is intense under such conditions

Most N-values fall in the low to medium-low class (N=0.05-0.112%). Values higher than medium-low were not observed and many values classify as very low (N values less than 0.04%).

The C/N ratio of the soil organic material averages about 9 to 11 in the plough-layer. Very low C/N ratios occur in the sub-soil. A few topsoils have high C/N ratios, found generally with above average organic matter contents.

The available potassium content is mostly very high in the strongly saline soils and is also abundantly available in the lower salinity soils.

Available phosphorus of the lacustrine deposits classifies at present as sufficient (Olsen values higher than 0.002%). Data vary between 0.003 percent and 0.18 percent Meaningful trends of variation could not be detected.

Fluviatile - Colluvial Deposits on the Ghor Terrace. The trends in distribution of various textural types on the Ghor terrace are best illustrated by the change of soil texture from the North Ghor, where clay loam predominates, to those found in the South Gohr, where silt loams and loams appear most frequently.

Carbonate equivalent values on the Ghor are always high. They vary from 70 percent to approximately 25 percent. This is probably due to sediment contribution from watersheds with different parent material. On the North Ghor carbonate equivalent data mostly vary from 40 to 60 percent. The fine-textured soils north of Wadi Arab have somewhat lower values of 30 to 45 percent. Available data in the south range from 30 to 50 percent. Carbonate equivalent values below 20 percent were not found.

Carbonates are mostly uniformly distributed in the profiles in the south. In the north, carbonates tend to be higher in the C-horizon than in the A and AC-horizons.

The pH is always alkaline (i.e. above 7.4). Moderately alkaline, is the most frequently encountered (i.e. between 7.9 and 8.4). However, mildy alkaline (between 7.4 and 7.8) and strongly alkaline (between 8.5 and 9.0) can also be found. The pH-KCl is usually 0.5 to 1 unit below the pH-H_2O.

Exchange capacity of the soils tends to be higher on the North Ghor than on the South Ghor. The CEC on the North Ghor typically ranges from 25 to 40 me/100 g. While the average values for the moderately fine-textured soils on the South Ghor range from 15 to 40 me/100 g. Lower values occur in the upper Ghor and near the Dead Sea, where medium-textured soils (CEC= 15-20 me/100 g) and moderately coarse-textured soils (CEC= 5-15 me/100g) occur.

The variation in CEC seems to be mostly correlated with the texture. However, some of the variation is due to differences in organic matter content.

The organic matter content of the soils in the South Ghor is generally between one and two percent in the topsoil and between 0.25 and 0.75 percent at lower depths. Soils that have been used for irrigated agriculture for a long time have values in the upper part of the range. Other soils, mostly on the lower Ghor, that have never been used or have been used only for rain-fed agriculture, have organic matter contents in the lower part of the range.

In the North Ghor, the organic matter content of the soil is somewhat higher than in the South, with values between two and three percent in the topsoil and between one and two percent in the lower part of the root-zone. Higher rainfall and longer irrigation may explain this trend.

The N values in the topsoil on the South Ghor uniformly classify as low to medium low (N value between 0.05 and 0.12%). Similar trends as discussed for the variation in organic matter can be observed. N values in the North Ghor are only slightly higher than values for the topsoil which range from 0.08 to 0.20 percent. In both areas, N values decrease with depth.

The range in C/N ratio is from less than eight to greater than 13. The low values are usually correlated with a higher organic matter content as indicated for the lacustrine sediments.

Potassium is available in large quantities in the saline soils on the South Ghor (more than 200 mg/100g soil, available K_2O determined by the lactate potassium method). In non-saline soil K_2O is still abundant (50-200 mg/100g soils in the upper Ghor and the lower southern parts of South Ghor. Medium-textured types have lactate values from 30 to 60 mg/100 g soil. Moderately coarse-textured soils often have values ranging between 20 and 40 mg/100g soil. Typical K_2O data with 0.5N HCL extraction of the non-saline soil of the North Ghor are 1.0 to 1.5 percent (10,000-15,000 mg/100 g soil). Corresponding lactate data are 40 to 60 mg/100g soil.

Phosphate is considered to be sufficiently available when the lactate value is more than 20 mg/100g soil. Most soils on the Ghor have P_2O_5 lactate values between 5.0 and 25 mg/100g soil. Olsen P_2O_5 values for these soils vary from 0.005 to 0.02 percent. Here 0.002 percent can be considered as the lower adequate limit. According to the latter criterion, phosphate seems to be sufficiently available at present. As indicated, the Olsen method is adapted to calcareous soils. The latter values, therefore, are considered to be most indicative.

Alluvial Sediments of the Jordan River and Tributaries. The textural classes found in the Zor are loams. As indicated, finer-textured soils occur in the flood-plain of the Yarmouk River.

Carbonate equivalent content of the alluvial sediments mostly ranges from 30 to 40 percent.

The pH is mostly moderately alkaline (8.0-8.4). The pH-KCl is on an average 0.8 to 1.0 unit lower.

The CEC values are (taking the Zagreb laboratory data) 20-35 me/100g in the medium - textured soils and 5 to 10 me/100 g in sandy loam soils.

Organic matter content in the topsoil ranges from 1.25 to 2.25 percent. At lower depths the amount of organic matter is extremely variable.

Nitrogen content values vary between 0.05 and 0.11 percent in the topsoil (low to medium low).

C/N ratios range from 8 to 14.

Potassium is mostly available in large quantities. Lactate values range from 60 to 140 mg/100 g soil. Extraction with 0.5 n HCl gave results varying from 1 to 2 percent.

Available phosphorus, determined by the Olsen method vary between 0.008 and 0.018 percent.

Concluding Remarks. The analytical data show that the differences in the chemical properties of the various soils are small. The existing differences are too small to be taken into account in recommendations with respect to amounts of fertilizers to be used.

Normal, heavy nitrogen dressings are recommended. The Olsen P_2O_5 data show that the supply of phosphorus of these soils is sufficient at present. The application of phosphorus, therefore, has been based on maintaining the present level. Potassium fertilization is assumed to be unnecessary, at present, but should be monitored to guide future practices.

Soil Salinity and Alkalinity

Previous studies of the Jordan Valley have all considered salinity and alkalinity problems.

According to Dar Al Handasah-Nedeco study in 1969, salinity problems in the Valley are almost exclusively caused by fossil salts which were present in the underlying lacustrine sediments. These sediments still contain high amounts of salts. By upward moisture movement and diffusion, salts have locally penetrated into the fluviatile-colluvial cover. The salinity increases from the upper to the lower Ghor and from north to south in the valley.

Soluble salts in the valley are mostly chlorides. Soils high in salinity are almost always sodic (Alkaline) as well. High amounts of gypsum are also present.

The Institute of Pedology and Technology, Zagreb, based its classification maps of salinity/alkalinity in the Valley on criteria shown in Table F-1.

Table F-1

CRITERIA OF SALINITY AND ALKALINITY
USED BY THE INSTITUTE OF PEDOLOGY - ZAGREB

Salinity	Total Soluble Salts (TSS)	Alkalinity	Exchangeable Sodium Percentage (ESP)
Non-saline	0.25%	non-alkaline	5%
slightly saline	0.25 - 0.50%	slightly alkaline	5-10%
Moderately saline	0.50 - 1.00%	moderately to strongly alkaline	
Strongly saline	1.00%		10-30%
Solonchak	3.00%	solonetz	30%

It is noted that this classification differs from the system recommended by the Salinity Laboratory, Riverside (Handbook 60, USDA). In the latter system the EC of a saturated extract is used as a criterion for salinity.

The areas per class shown on the above mentioned salinity/akalinity maps are given in Table F-2.

Table F-2

AREAS OF VARIOUS SALINITY CLASSES
INSTITUTE OF PEDOLOGY - ZAGREB
(ha)

	Non-or slightly alkali	Moderately or strongly alkali	Total
Slightly saline	850	500	1,400
Moderately saline	200	1,400	1,600
Strongly saline	700	4,900	5,600
Solonchaks			100
Total			8,700

It is to be noted that except for a small area in the north, these soils are in the South Ghor.

The area affected by salinity according to Baker-Harza Master Plan Report of 1955 amounted to 8,450 hectares. (420 in North Ghor and 8,030 in the South Ghor). Some of this has been reclaimed by farmers. Primarily the soil textures and topography of these lands are favorable for leaching and in most instances there is an appreciable amount of gypsum present which materially aids in the leaching process.

Total soluble salt content ranges from 0.5 to greater than 3.0 percent in lands where soil, topography and drainage characteristics are favorable for leaching. The majority of this land occurs in large bodies primarily on the lower edge of alluvial fans, and is not irrigated.

The areas located on the fans of Wadis Shueib, Kafrein and Hisban are representative of soils leached by irrigation. Representative samples show the total soluble salt content in one irrigated field as less than 0.2 percent, as compared to samples showing greater than 2.0 percent in an adjacent field which has had no irrigation water applied, but which is comparable in soil texture, topography and drainage characteristics.

Soil Permeability

Field investigations were conducted by Baker-Harza in 1955 to obtain the infiltration rates of various soils under undisturbed field conditions. These infiltration studies were conducted in accordance with the method given in Salinity Laboratory Handbook No. 60. An additional guard ring, composed of earth, surrounded each infiltration cylinder to compensate for lateral water movement. A 15 cm depth of water was maintained in the cylinder and earthen ring, and the rate of subsidence of the water surface inside the cylinder was measured hourly or if fast subsidence occurred more frequently. Triplicate infiltrometers were continuously maintained until a uniform infiltration rate was established.

Thirty-eight sites were selected to represent typical areas. Three of these sites were excavated to the assumed restricting layer (primarily marl) and the infiltration tests were conducted and infiltration rates were determined for this restricting layer. In every instance these rates were higher than the surface rates indicating that flow divergence was negligible. A compact carbonate gypsiferous layer starting at 2.5 to 7.5 cm. below the surface and extending to a depth of 20 to 45 cm. is characteristic of some of the soils placed in Class 4, principally in the southern part of the Valley. Although a slow infiltration rate was evidenced at first, mechanical probing of this compacted gypsiferous zone greatly increased the permeability.

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Indications are that deep chiseling practices on these soils would aid in their reclamation. However, it might be possible that this layer would dissolve sufficiently in the leaching process so that no such mechanical treatment is necessary.

The effect of leaching on the soluble salt concentrations within the infiltration sites south of the Zarqa River is clear. In every instance appreciable salt displacement occurred during the infiltration test. It is remarkable that soils containing approximately 5.0 percent salt dropped to 0.1 percent salt during infiltration measurements. The magnitude of leaching in these soils was noticeable down to the 60 cm depth and, in some sites, extended as far down as the 120 cm depth before slight salt differentials were noted.

In general, investigations indicate that the soils comparise two broad groups non-saline in the area north of the Zarqa River, and saline in the area to the south. Infiltration rates for the non-saline soils were generally very satisfactory, with the exception of a few observed in the extreme northern sector, where drainage could be a problem. The saline soils, Class 4 land, will require reclamation in order to reach a productive state. Adequate drainage will be required to maintain productivity once the soils have been reclaimed.

The ranges of infiltration rates found by Baker-Harza, in 1955 for various soils in the Jordan Valley[5/], are summarized below.

5/ Yarmouk-Jordan Valley Project, Master Plan Report, Michael Baker, Jr., Inc., Harza Engineering Company 1955 Vol. III, Table 3.1.8, Page 47.

0.5 - 5 mm/hr for clay soils
5 -25 mm/hr for clay loams and silty clay loams
25 -40 mm/hr for silt loams and loams
60 -above 100 mm/hr for loams and sandy loams.

The detailed results of the infiltration tests show that the majority of the soils of Jordan Valley are permeable. Infiltration rates ranging between 5 and 25 mm/hr are the most frequently encountered.

Land Reclassification

Objective of Reclassification

Previous studies, and particularly the land classification by Baker-Harza and the soil survey by Dar Al Handasah-Nedeco, were based on assuming surface irrigation will be followed.

The land reclassification was carried out to suit sprinkler irrigation for all areas of the Jordan Valley that have not been considered, so far, in any sprinkler irrigation scheme.

Methodology

The reclassification was based on sprinkler irrigation land classification specifications followed by the U.S. Bureau of Reclamation, with certain modifications for local conditions. These specifications include both physical and economic characteristics and are reproduced as modified in Table F-3.

The reclassification was based on the Baker-Harza land classification photo-maps of 1:2,500 scale prepared in 1955 and the Dar Al-Handash-Nedeco Soil Map of 1:50,000 scale prepared in 1969. Occasional field checking was done where necessary. Samples were collected and analyzed, to check changes in salinity.

Table F-3

SPRINKLER IRRIGATION SUITABILITY LAND CLASSIFICATION
SPECIFICATIONS ADOPTED WITH MODIFICATION FROM BUREAU OF RECLAMATION

Land Characteristics	Symbol	Class 1 - Arable	Class 2 - Arable	Class 3 - Arable
SOILS				
Texture	l,m,h	Fine sandy loam to friable clay loam	Loamy sand to very permeable clay	Loamy sand to permeable clay.
Depth	D, M	Greater than 36 inches	Greater than 24 inches	Greater than 12 inches.
Water holding capacity (0 - 40 inches)		Greater than 6 inches	Greater than 4.5 inches	Greater than 3 inches
Salinity	a	Less than 4 mmhos	Less than 8 mmhos	Less than 12 mmhos
TOPOGRAPHY				
Slope	g	0.7% slope	Up to 12% smooth slope Up to 7% rough slope	Up to 20% smooth slope Up to 12% rough slope
Cover	c	Can be cleared at minimum cost	Can be cleared at moderate cost	Can be cleared at high cost
Erosion	e	Slightly eroded	Moderately eroded	Eroded
DRAINAGE	d	Can be provided with minimum cost	Can be provided with moderate cost	Can be provided with high cost.

The reclassification maps were produced on 1:50,000 scale. The fraction type symbol is used to designate the different land classes. The number in the numerator designates the land class; and the letters following the land class are the sub-classes and show the nature of the deficiencies. The sub-classes are "s", "t" and "d" and represent deficiencies in soils, topography or drainage respectively, and finally "A" to indicate that the arable land class is an association having 50-80 percent of land in that class and the rest being non-arable, Class 6, which was not possible to segregate from the arable land.

Land classes 1, 2 and 3 (arable), and Class 4, which is arable after reclamation, were mapped and differentiated by map symbols. Class 6 (non-arable) was mapped and differentiated by the Figure "6". The textures of the top soil and the sub-soil are represented by the first two letters in the denominator. They can be l m or h which stand for light, medium and heavy texture respectively. This means that when the letters hh or ll are encountered, they should mean that top soil and sub-soil are both heavy textured in the first instance (hh), and that top soil and sub-soil are both light tectured in the other instance (ll).

The following is a complete list of informative symbols:

Soils

Light	l
Medium	m
Heavy	h
Salinity	a
Soil Association	A
Deep	D
Medium deep	M

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Topography

Cover	c
Gradient	g
Undulation	u
Erosion	e
Drainage	d

Description of Land Classes in the Jordan Valley

Class 1. The lands of this class are the most suitable for irrigated agriculture. They are capable of producing relatively high yields for a wide range of crops adaptable to the Jordan Valley. They are smooth with gentle slopes.

The soils are deep and of medium textures having good water holding capacity yet good drainage conditions. These soils have high inherent fertility. They are non-saline or very slightly saline needing no extra care or cost.

Class 2. The lands of this class are less favorable for irrigated agriculture. They are lower in productive capacity for a narrower range of adaptable crops.

Any one of the following limitations is sufficient to reduce these lands to Class 2, but a combination of two or more is more frequently encountered. They may have topographic limitations of uneven surface and steeper slope. These limitations effect cropping practices but no levelling or grading would be required with the proposed sprinkler irrigation. The soils have moderate depth and have relatively coarser textures and lower water holding capacity than soils of class 1. They may have a slightly eroded surface or cover that needs clearing. They may be slightly to moderately saline requiring some leaching.

Class 3. The lands of this class are marginally suited for irrigated agriculture because of more severe conditions or deficiencies in the soils, topography and drainage than described for class 2. In this class, a combination of 2 or more deficiencies are more frequently encountered than in Class 2. Certain correctible deficiencies in this class involve relatively higher costs than in better classes.

Class 4. Class 4 lands, in the Baker-Harza land classification are presently unsuitable for irrigated agriculture, exclusively because of high salinity. Class 4 land would have been classified as class 1, 2, or 3 were it not for the salinity that is above the limits for these 3 classes. The suitable class without the salinity deficiency is mentioned between parentheses after class 4. Example: 4(3st). This means that this land is class 3 because of soil and topography deficiencies, (s and t respectively) but it is down-graded temporarily to Class 4 because of salinity.

Class 4 lands are reclaimable by sprinkler leaching of salts from the root zone. After leaching, class 4 lands will become class 1, 2 or 3. In the foregoing example, class 4 (3 st) will become class 3 after reclamation.

The majority of class 4 lands are in the southern part of the Valley, extending from the end of the 18-km extension to the Dead Sea.

Class 6. Class 6 lands are unsuitable for irrigated agriculture. The Katar represents the greater part of these lands. The remaining parts are scattered, small areas of very rough topography and areas of extreme conditions of salinity and drainage that are considered non-correctible.

Upgrading of Lands

Upgrading lands from one arable land class to another, and from non-arable land class to arable classes was done on the basis of the change in method of irrigation to be used. The U.S. Bureau of Reclamation land classification specifications for sprinkler irrigation, as modified for local conditions (Table F-3), was used.

The primary data source was the 1:2,500 scale land classification photo maps by Baker-Harza which included the fraction - type symbol with the deficiencies and characteristics in the denominator. The 1:50,000 soil map and the report by Dar Al Handasah - Nedeco also included the description of all soil mapping units.

The main characteristics used as criteria in the reclassification (i.e. upgrading) are texture, depth, soil salinity, drainage, slope and cover (vegetation or stones). The topography limitation was changed when the method of application was changed.

The following paragraphs describes the upgraded lands.

Upgrading of Class 6. A total area of 400 ha was upgraded from class 6 (non-arable) to class 3 (arable). Of this, an area of 150 ha was upgraded from subclasses 6H and 6I which were class 6 because of height and isolation respectively. The other 250 ha of this class 6 were upgraded from 6t and 6st which were class 6 because of topography and soil and topography deficiencies.

These 400 ha are located in the Conversion Area. About 175 ha located in the New Land area were upgraded to arable lands from the previously classified class 6.

Furthermore, of the area classified as class 6 in the East Ghor Canal Project lands, already distributed by the Natural Resources Authority, at least eight percent is upgradable to arable classes. This amounts to an area of approximate 600 ha.

Upgrading of Class 4. As mentioned previously, land class 4 is restricted to saline areas needing leaching, and that upon leaching class 4 will become class 1, 2 or 3.

Since the class 4 land is still saline, it has not been reclassified. However, the class shown in parenthesis on Table F-4 indicates the potential of the land after leaching. For example, Class 4 (3st) was upgraded to class 4 (2s). Areas of class 4 thus upgraded were not computed.

Upgrading of Classes 3 and 2. These two classes were also upgraded, whenever possible, to classes 2 and 1 respectively. The area of class 3, upgraded to class 2, was 400 hectares, and the area of class 2, upgraded to class 1 was 1,700 hectares.

Areas of Lands Classes

For ease of reference, the Project Area has been divided into the following groups according to their location and their stage of development. The location of these land groups is shown on Exhibit F-2.

Land Group A. This land group is located between the end of the 18-km extension of the EGMC and the Dead Sea.

This land group does not include the area in the Hisban Kafrein Project.

Group A lands are considered new lands because they have not been included in any previous irrigation scheme.

Land Group B. This group is located between the Zarqa Triangle Area and the Wadi Yabis, above the EGMC.

This area was not included in previous schemes because of its elevation above the EGMC.

Land Group C. This group includes the area that is to be converted from surface to sprinkler irrigation. It includes both the Ghor and the Zor land from the Yarmouk River to the end of the 8-km extension of the EGMC.

Land Group D. This group includes parcels of potentially irrigable lands some of which were not systematically classified in previous studies. Preliminary aerial photo interpretation and quick field checking found the areas to be potentially irrigable. Areas falling in this group, and referred to by an asterisk in Table F-4, were reported as estimated by the JVA.

Further soil survey and land classification are proposed to be carried out for these lands. Recent aerial photographs as well as new topographic maps will be needed.

Table F-4

LAND RECLASSIFICATION
AREA OF LAND GROUPS IN HECTARES (GROSS)

Land Class or Area	A By Dead sea	B Zarqa-Yabis	C Conversion	D Potential	Sub-total
Class 1	2,664	222	8,137		11,023
Class 1 Upgraded from Class 2	25	-	525		550
Class 2	2,109	541	2,376		5,026
Class 2 Upgraded from Class 3	100	-	300		400
Class 3	741	383	881		2,005
Class 3 Upgraded from Class 6	175	-	400		575
Class 3 Upgradable from Class 6			600		600
Class 4 (1)	2,020	-	225		2,245
Class 4 (2)	2,165	-	228		2,393
Class 4 (3)	108	-	-		108
SUB-TOTAL	10,107	1,146	13,672		24,925
Yarmouk Gorge				950	
Ziglab				52 a/	
In Group B				450	
Kufrinja				104 a/	
Zarqa				223 a/	
South of Zarqa				305	
Along 18 Km				546	
SUB-TOTAL				2,630	2,630
TOTAL	10,107	1,146	13,672	2,630	27,555

a/ As estimated by the JVA.

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Soil Amelioration

Leaching

Previous studies, have delineated the areas and have recommended leaching programs for the reclamation of the saline soils in the Jordan Valley.

These programs were designed assuming surface irrigation would be used. These recommended programs will continue to be important after sprinkler irrigation facilities are installed in the Valley. They give valuable information on areas needing leaching, limits of salinity, the quantity of water used and the reduction of salinity with leaching.

The Baker-Harza Report[6/] stated that approximately 8,450 ha (420 in the north and 8,030 in the south) require leaching of salts from the soils before a satisfactory degree of crop production can be expected. The Total Soluble Salt (TSS) percentage of these soils ranges upward from 0.2 percent with the average percentage somewhat greater than 3.0 percent. A TSS of 0.2 percent present within the upper meter of soil can be potentially damaging to crop yields.

Surface Irrigation Leaching. To establish a basis for leaching recommendations two trial areas were selected and prepared under normal field conditions. Each area was divided into four plots of equal size and each plot within an area was given a specified water treatment. One area was provided with subsurface drainage facilities while the other did not have such facilities. Results of the trials indicate that salts can be leached from the soil. An application of 15 cm of water followed by subsequent applications of the same amount, until a total of 80 to 100 cm have been applied, will remove the salts to a safe level for shallow rooted

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6/ See footnote 1.

crops Applications of additional irrigation water will maintain this level and complete the reclamation of the land when adequate subsurface drainage has been provided.

In 1965/66 four leaching experiments were conducted by the Institute of Pedology and Technology, Zagreb, one of which was in the East Ghor at coordinates 135 N/205 E. The salt content of all plots were lowered during the leaching. After the application of about two meters of water, 7 of the 12 plots were below the safe TSS level of 0.25 percent, two were still above 0.5 percent salt in the surface 60 cm and three plots were near but not below the safe limit. From this, it is evident that the soils are leachable. An examination of some of the plots the following year showed that resalinization had occurred on two of the three plots examined. The plots had not been irrigated and the upward movement of water had carried salt back into the surface layer.

These results point out the need for proper water management in the area. Sufficient downward movement of water must be maintained to keep the salts from returning to the surface. Where necessary additional drainage must be installed to keep the water table more than 1.5 meters below the surface.

Soils requiring leaching were classified into categories as follows:

1. Soils to be leached by normal farming methods, these include the slightly-saline soils (TSS 0.25-0.5%) and the moderately-saline soils (TSS = 0.5 -1.0%).

   The slightly-saline soils can be reclaimed after one winter of 20 percent over-irrigation and one pre-irrigation of about 25 cm applied depth.

The net leaching depth for the moderately saline soils requires a 20 percent over-irrigation and two pre-irrigations of an average of 25 cm applied depth per irrigation.

2. Soils to be leached by basin-flooding. These include the strongly saline soils (TSS = 1-3%) and the Solonchaks (TSS 3%). Net leaching depth for this category varies between 70-120 cm and 140-200 cm depending on type of soils. This required 30 percent over-irrigation and flooding with an average depth ranging between 105 cm and 150 cm.

Sprinkler Leaching. The procedures recommended and described in previous studies did not include the possibility of sprinkler leaching. However, the application of sprinkler irrigation in the Jordan Valley should facilitate the economical leaching of saline soils.

Some advantages of sprinkler leaching are as follows:

1. No land leveling or land forming will be required.
2. Ease of management of the soil-water regime is greatly improved over surface leaching.
3. Less water will probably be required.
4. Salt tolerant crops, such as barley, can be grown during the latter stages of leaching, thus providing an earlier income.

The intent is to reduce the salinity of the soil, as indicated by the electrical conductivity (E.C.) of the saturated paste extract, to the level of 4 mmhos/cm by passing excess water through the root zone. To achieve proper leaching, the water application rate must not exceed the soil intake race. The best time for leaching is during the rainy season, when the salt concentration in the rivers tend to be at its lowest, the soil has a higher initial water content (hence the salts are already dissolved), and water for leaching is more plentiful. The success of the leaching program will depend on the ability to bring the salts into solution and to move them below the desired root zone. The variable characteristics affecting leaching of different Jordan Valley soils, as indicated in Table 3.1.6 of the Baker-Harza Report of 1955, illustrates the difficulty of making a blanket recommendation for water application. Therefore a methodology is outlined which, if adhered to, will result in an economical leaching program which will conserve water and allow interim crops to be grown.

The following method is recommended for leaching the saline areas:

1. Limit individual leaching applications to 10 cm.
2. Leave a period of at least 24 hours between applications for salt to equilibrate with soil solution.
3. Make initial application after the onset of the rainy season if practicable.
4. Make determinations of conductivity prior to initiation and 24 hours after each successive application.
5. When the top 20 cm has an E.C. of 8 mmhos/cm or less, a barley crop may be planted. Salt tolerant crops which could follow the barley include such crops as wheat, garden beets, sugar beets, asparagus, spinach, tomatoes, broccoli, cotton, cabbage, bell

pepper, cauliflower, lettuce, sweet corn, carrot, and potatoes (white rose). When the salinity of the soil extract from the 30-60 cm zone drops to below 3 mmhos/cm., then all crops may be grown. Since leaching removes nutrients with the salts, a fertilization program to supply adequate nutrients will be required for each crop grown after leaching.

6. There should be an excess application of 20 percent over the crop water requirement until the salt content of the soil is lowered to the desired level of 3 mmhos/cm. Thereafter seasonal leaching should be done only during the rainy season or between crops when the water is most available.

7. Strict control should be kept on the water table so that it does not rise closer to the surface than 1.5 meters.

8. If it becomes necessary to fallow reclaimed land, a shallow dry zone should be formed by disking several times. This dry zone, or mulch, will serve to interrupt the flow of moisture and salt upward through the soil.

Drainage

Due to its importance in irrigated agriculture, drainage has been dealt with in almost all previous studies.

Good drainage practice, both surface and subsurface, is essential to the successful operation of any irrigation system. Drainage is a means of improving agriculture by removing excess water and dissolved salts from the soil.

Excess surface water has two different sources; irrigation water losses, and natural rainfall.

Removal of excess surface water from the Ghor terrace in the project area is generally rapid. Water moves by over-land flow with the natural slope until it is picked up by one of the branches of the natural surface drainage system. The main branches of this system have been formed and still discharge run-off water from the bordering uplands. Drainage water is thus disposed of further in an east-east direction through the Ghor and Katar to the Zor and eventually to the Jordan River.

Generally, there is no problem in the surface drainage system; however, a few areas occur where the functioning of this system is imperfect. This happens in shallow depressions, remains of old water courses, etc. The proposed plan includes provision to drain all areas and the costs are included in the Project costs.

The ground-water movement is very important as far as it is related to subsurface drainage problems. The main ground-water flow takes place through aquifers and cracks in the Lisan Marl. These aquifers consist mainly of lenses, tongues and wedges of sand and gravel which occur within the Lisan Marl. The aquifers are discontinuous, although some seem to be coalescent and extend over a considerable area.

When recharge exceeds lateral drainage, water tables are built up into the fluviatile - colluvial cover on top of the Lisan formation. The ground water thus formed flows into the ground water in the aquifers through cracks in the Lisan Marl.

Leakage from the underlying artesian aquifer upward through the semi-permeable substratum may act as another source which causes high water tables. High water tables occur due to upward flow; however, increased pumping in the last two decades has released sufficient pressure on some of these aquifers to reduce this problem.

Except for a few small areas having shallow water tables, natural subsurface drainage is adequate to prevent the building up of high water tables. In these areas with shallow water tables a subsurface drainage system is required and should be adequate to maintain water tables at the depth dictated by plant growth considerations. Considering the quality of the groundwater and also the nature of the soils, the safe depth on the Ghor has been set at 1.5 m below soil surface.

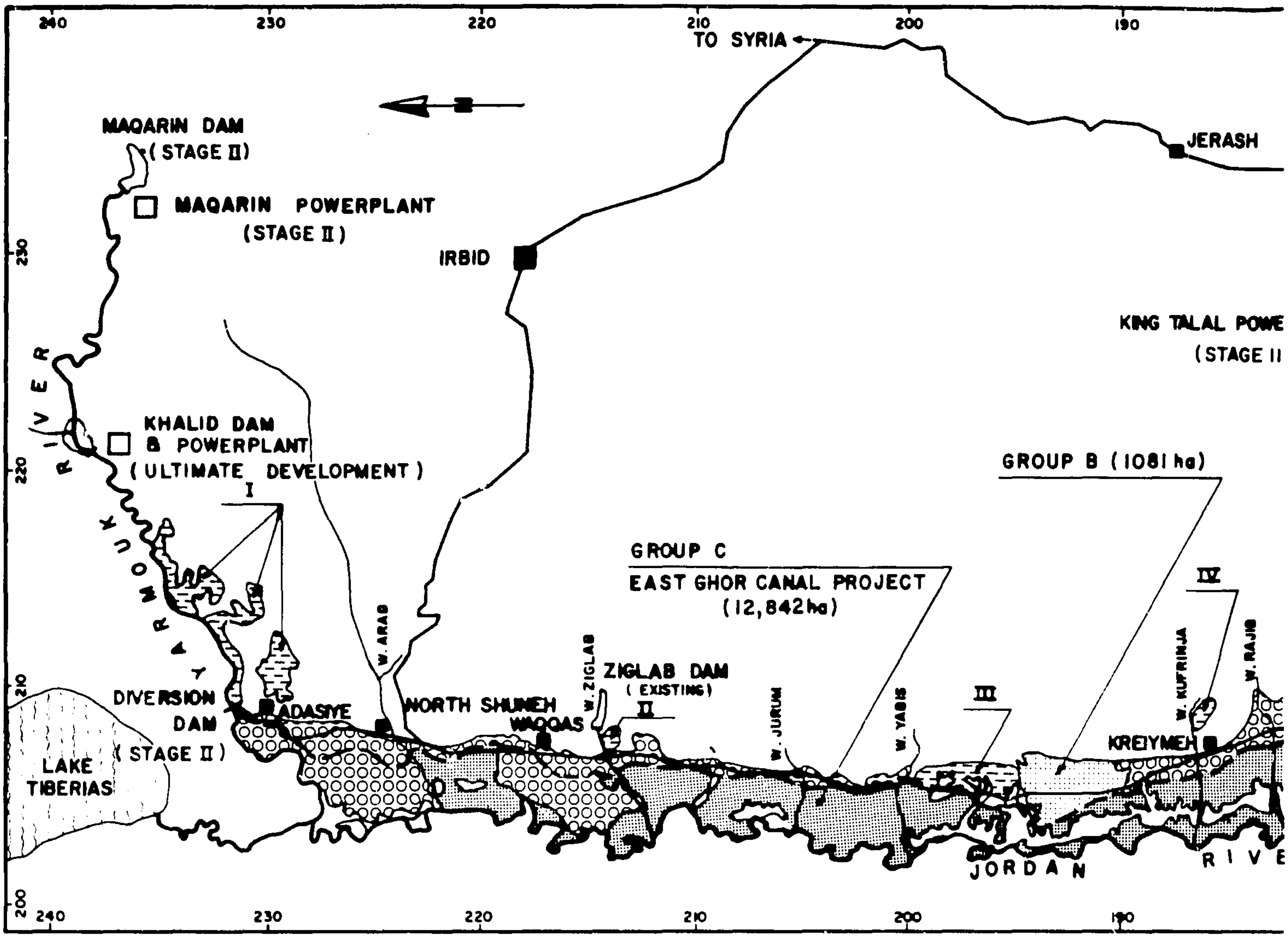
In the past, there have been many proposals for artificial subsurface drainage. The area to be covered by such a drainage system varied from the entire Ghor area to the saline (Class 4) area, and sometimes down to a few thousand hectares.

With the adoption of sprinkler irrigation throughout the Valley the need for subsurface drainage will be less than with surface irrigation. In the non-irrigated areas which are being included in this study it is difficult to say how much of a drainage problem will develop. The capacity of the natural subsurface system may be adequate in most areas. However there are areas where drainage is needed now and which are becoming worse under the present system. There will also be areas where drainage problems will develop as water is applied to the new lands of the project. There are an estimated 500 hectares of land which may develop a need for drainage as irrigation is established. The cost of this drainage system is included in the Project construction cost. Based on previous experience with similar lands, installation of subsurface drainage for approximately 200 to

300 hectares of new lands each year, over a period of 20 years, will be needed to control subsurface water problems which may develop. The cost of draining these lands is included in the annual operation costs. A water table monitoring program is recommended to avoid unncessary installation of drains where they are not needed and yet to be able to avoid the unnecessary loss of production from poor subsurface water conditions caused by high water table and associated salt accumulation. This system would constitute a minimum network of observation wells located in areas where problems are most likely to occur, such as in and near areas which have high water tables at present and where salty soils indicate that possible upward flow created shallow water tables at some time in the past.

Piezometers would be used in areas to be drained to evaluate the source of water and help in the design of a suitable drainage system.

The discussion of the planned observation well network is contained in Appendix K, Preliminary Design of Irrigation Facilities. The well locations are shown on the irrigation layout maps.



LEGEND

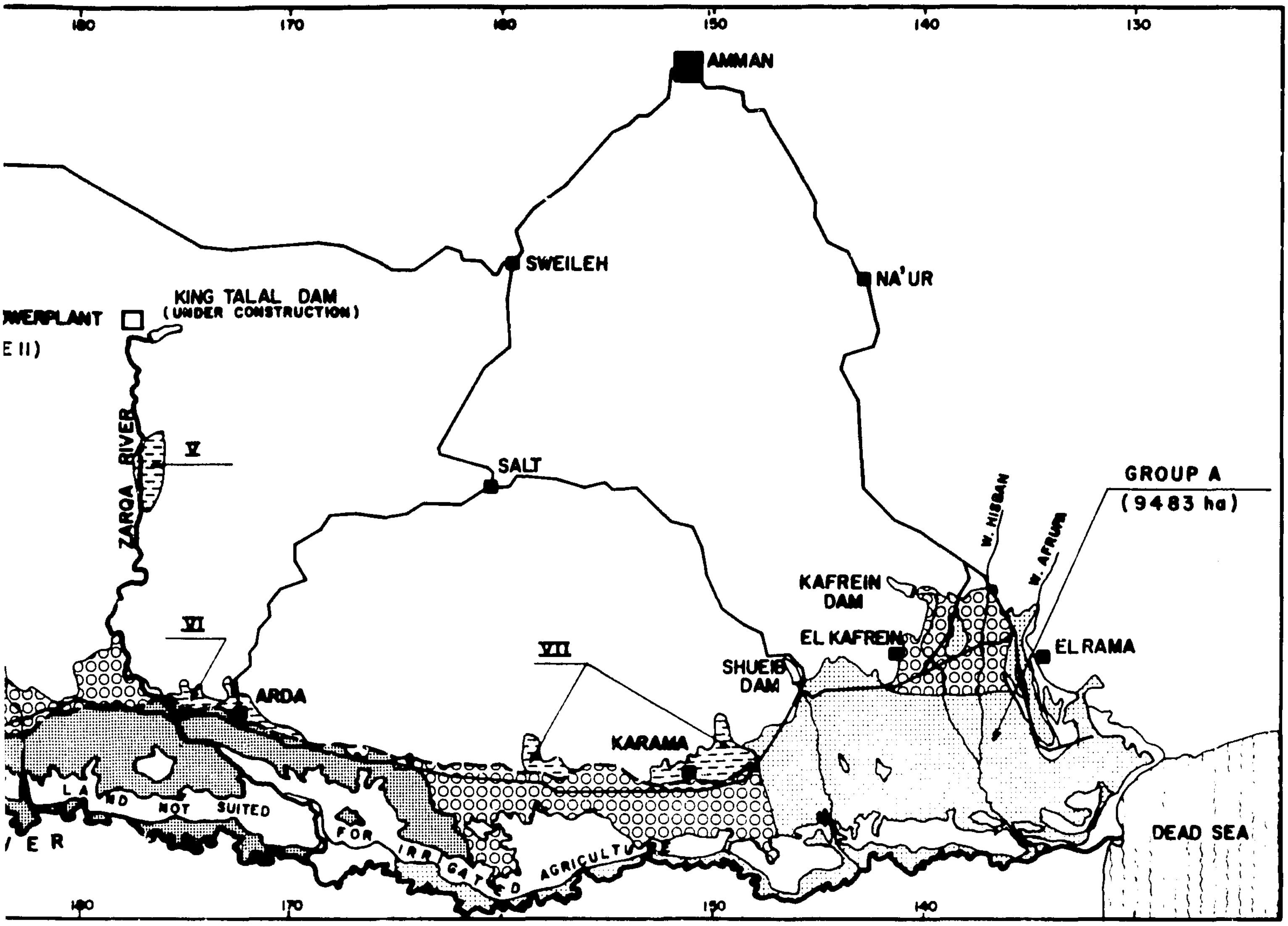
ROADS
EAST GHOR MAIN CANAL
RIVERS
STAGE I PROJECTS
STAGE II - NEW LANDS - GROUPS A & B
STAGE II - CONVERSION LANDS - GROUP C
STAGE II - POTENTIALLY IRRIGABLE LANDS - GROUP D

NOTES

1. - GRID FIGURES ARE KI
2. - POTENTIAL AREAS INC

I - YARMOUK GORGE
II - ZIGLAB GORGE
III - BETWEEN KUFRIN
IV - KUFRINJA GORGE
V - ZARQA GORGE
VI - SOUTH OF ZARQA
VII - ABOVE 18 Km EXTE

Dar Al - Handasah Consultants (Shair and Partners) January 1978



KILOMETERS

INCLUDE

	HECTARES
GE	331
E	50
INJA & YABIS	432
GE	100
	216
QA	293
TENSION	525
TOTAL	1947

STAGE II PROJECT AREA

	HECTARES
CONVERSION LANDS (INCLUDES UPGRADED AREAS)	12,842
NEW LANDS	10,564
POTENTIALLY IRRIGABLE LANDS	1,947
TOTAL	25,353

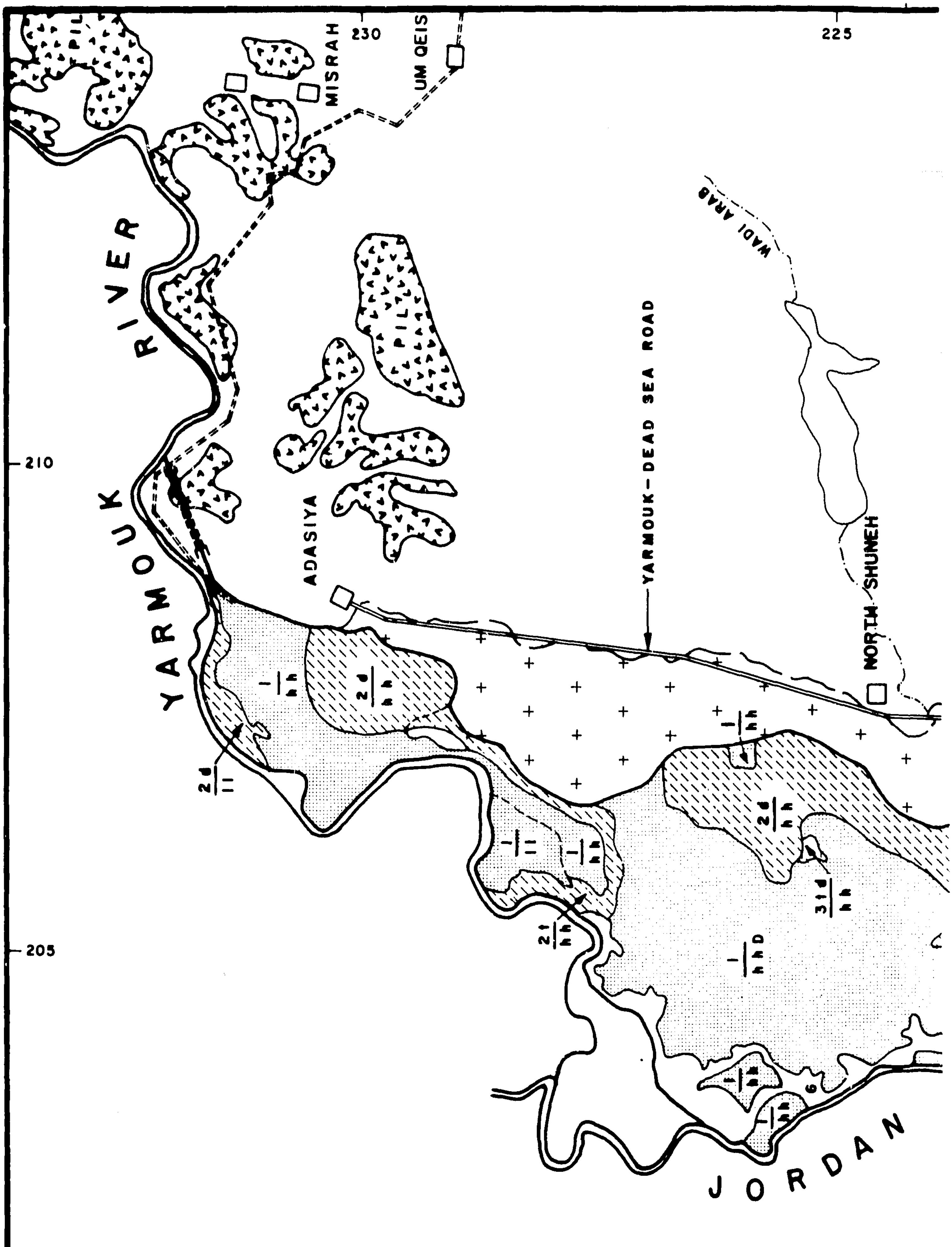
TOTAL AREA

ON GOING PROJECTS	9,397
JAPANESE PROJECT ON WADI ARAB	1,250
STAGE II LANDS	25,353
TOTAL	36,000

GENERAL PLAN OF DEVELOPMENT

JORDAN VALLEY IRRIGATION PROJECT

STAGE II



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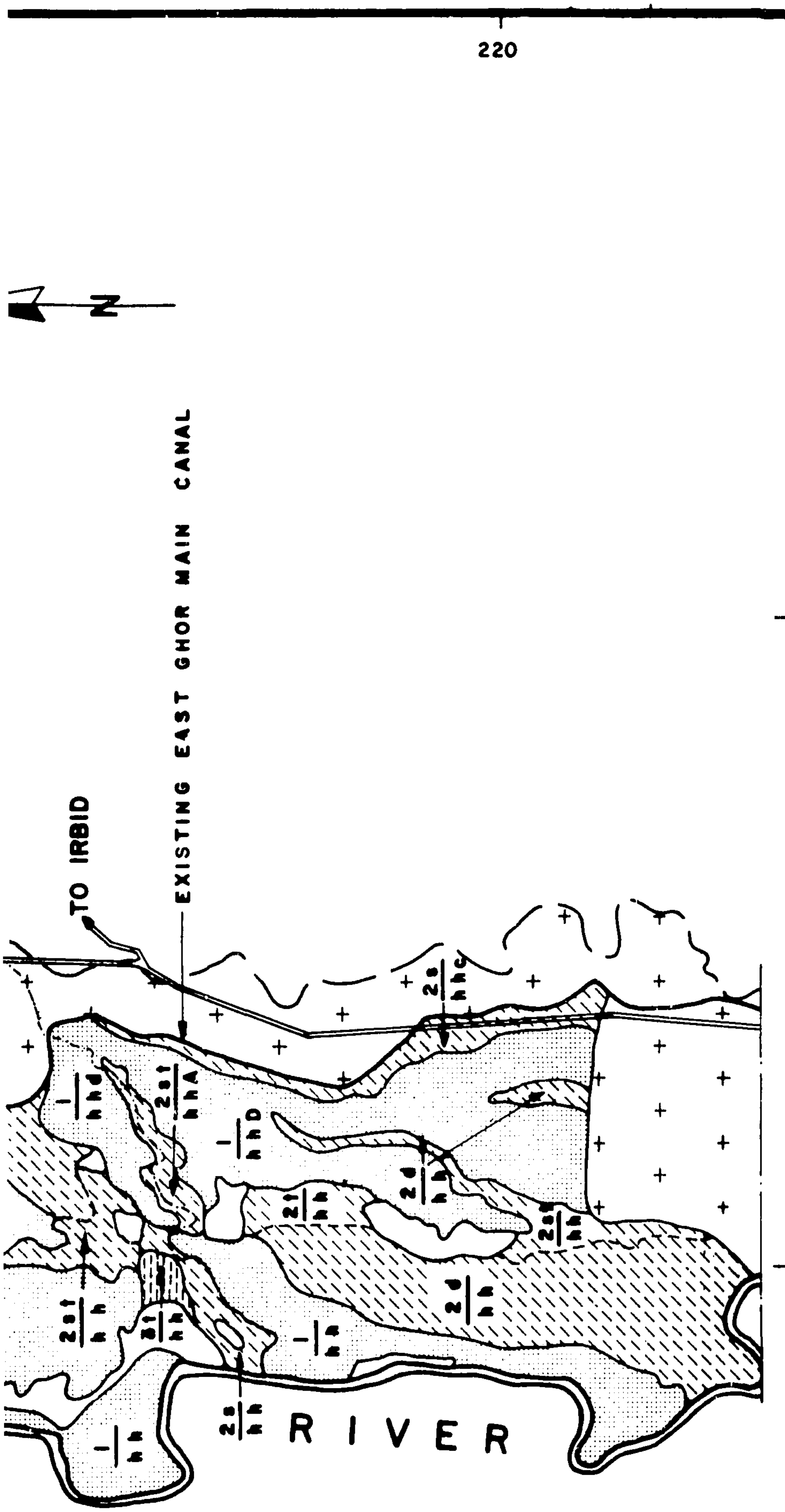

LEGEND

EXHIBIT F-2
SHEET 1 of 6

- E.G.M.C. CONSTRUCTED
- E.G.M.C. BEING CONSTRUCTED (18 km. EXTENSION)
- E.G.M.C. ENVISAGED UNDER CURRENT PLAN
- ROAD
- SECONDARY ROAD
- WADI
- TOWN
- BOUNDARIES BETWEEN LAND CLASSES
- BOUNDARIES BETWEEN LAND SUB-CLASSES
- BOUNDARIES OF AREAS ENVISAGED IN OTHER SPRINKLER IRRIGATION DEVELOPMENT PLANS.

LAND CLASSES

- LAND CLASS 1 – ARABLE
- LAND CLASS 2 – ARABLE
- LAND CLASS 3 – ARABLE
- LAND CLASS 4 – ARABLE AFTER RECLAMATION
- LAND CLASS 6 – NON ARABLE
- POTENTIALLY IRRIGABLE LAND

SOIL DEFICIENCY
LAND CLASS
TOPOGRAPHY DEFICIENCY
DRAINAGE

3 s t d
m h a c g e D A

TEXTURE OF TOPSOIL
TEXTURE OF SUB-SOIL
PRESENCE OF SALINITY
PRESENCE OF COVER
SOIL ASSOCIATION
DEEP SOIL
PRESENCE OF EROSION
GRADIENT

PRESENT CLASS
CLASS AFTER RECLAMATION

4(2 s / hhe)

SCALE 1/50,000

LAND CLASSIFICATION

SHEET INDEX

1	2	3	4	5	6

JORDAN VALLEY IRRIGATION PROJECT
STAGE II

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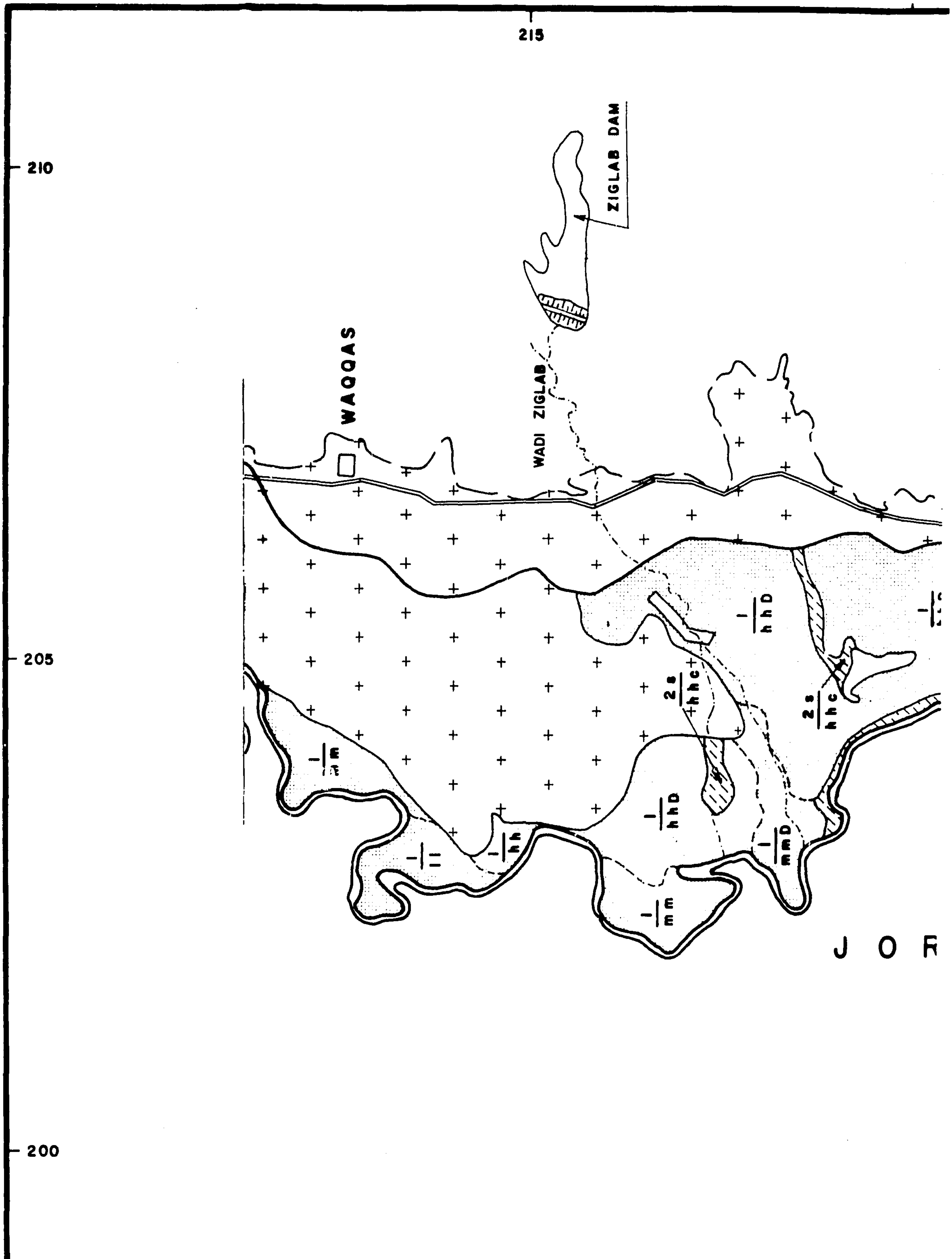

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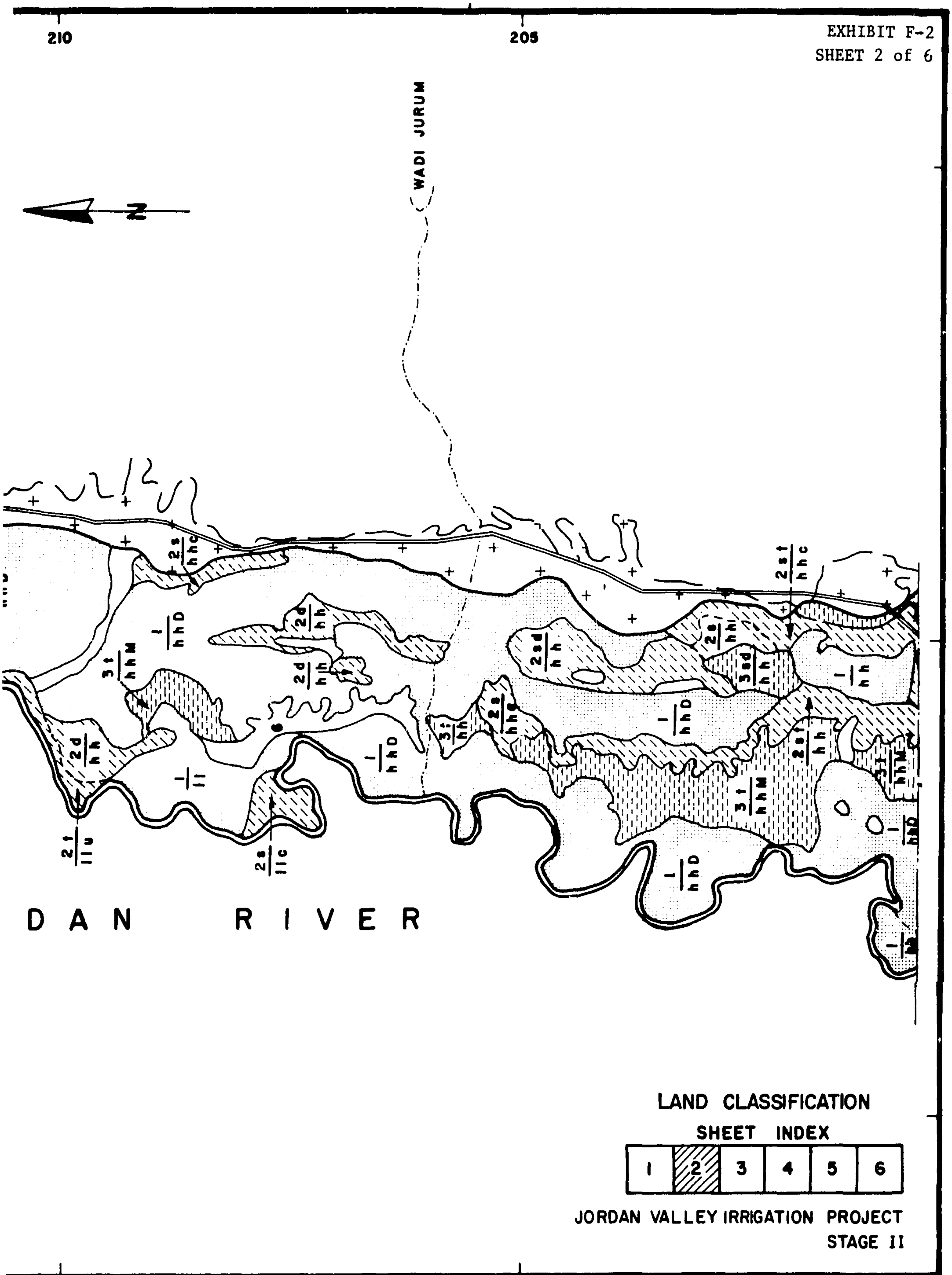
EXHIBIT F-2
SHEET 2 of 6



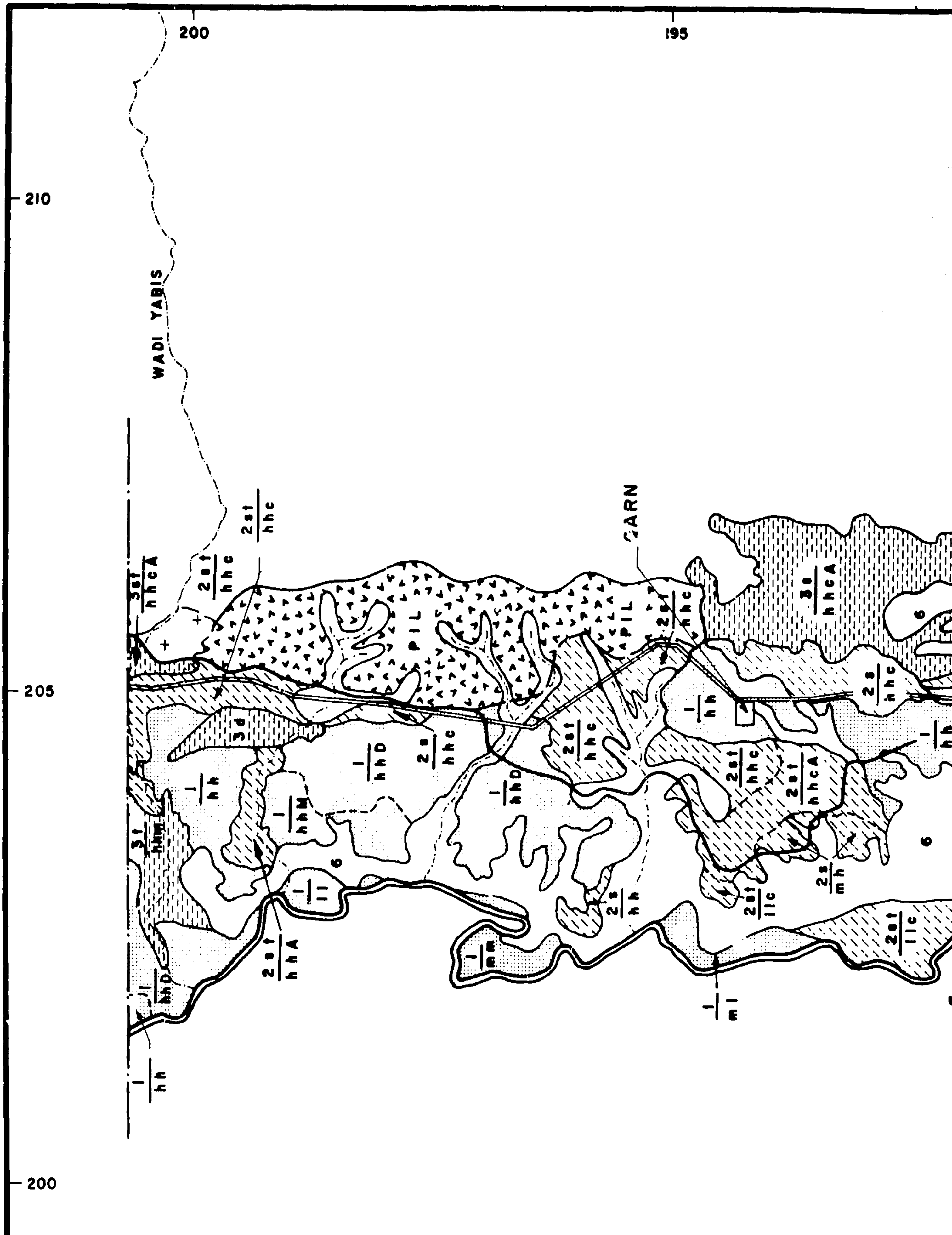


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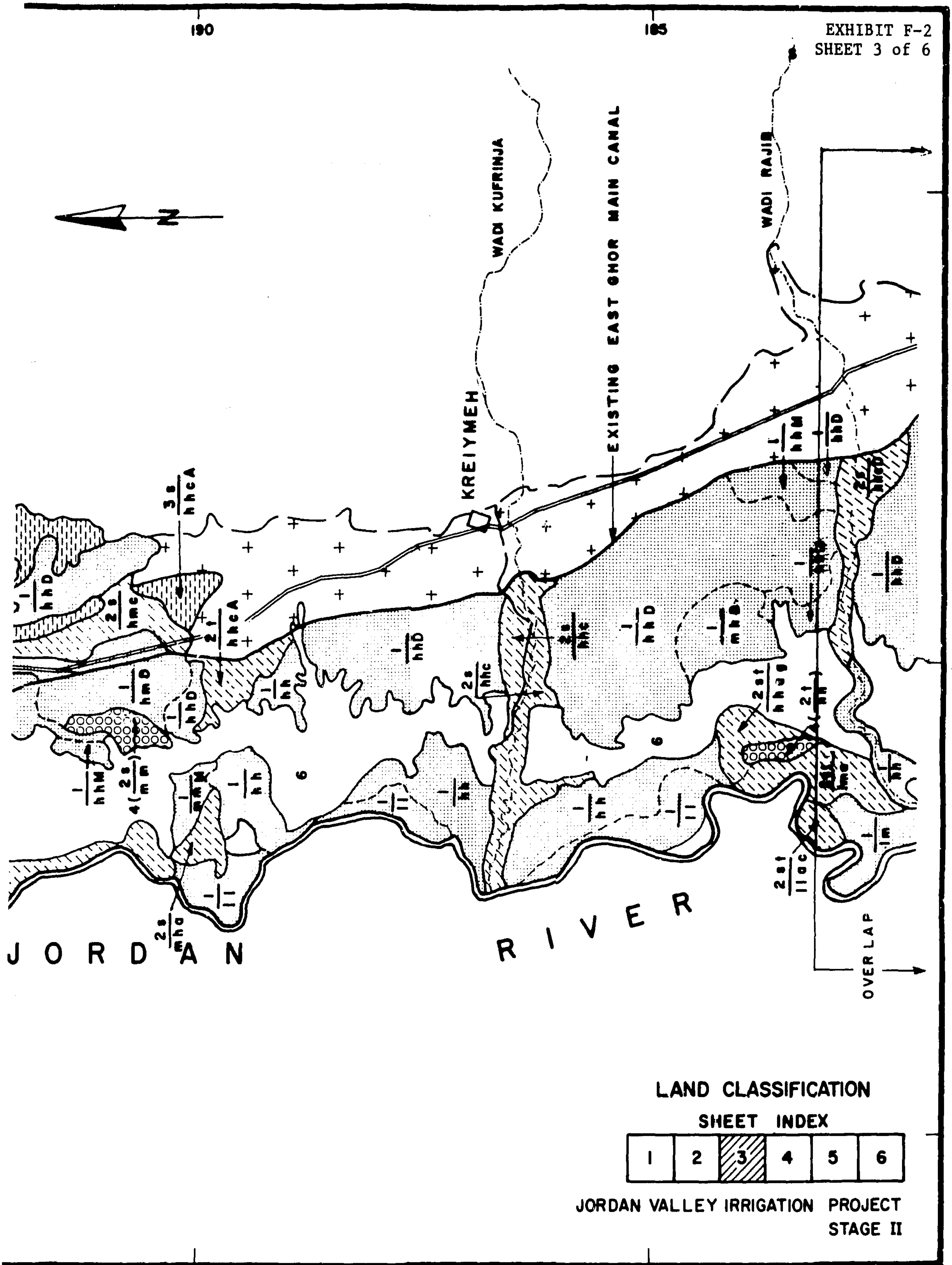
EXHIBIT F-2
SHEET 3 of 6



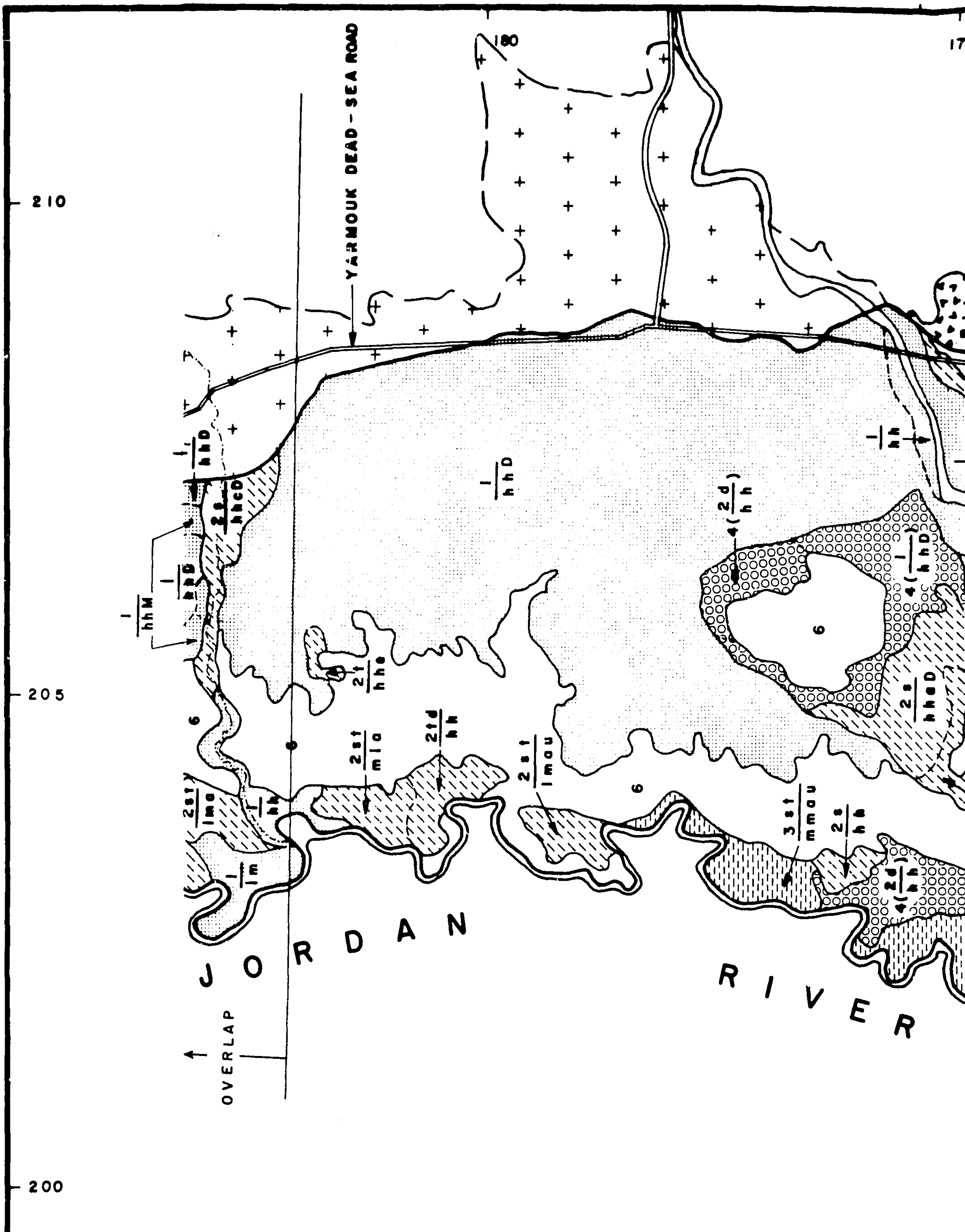


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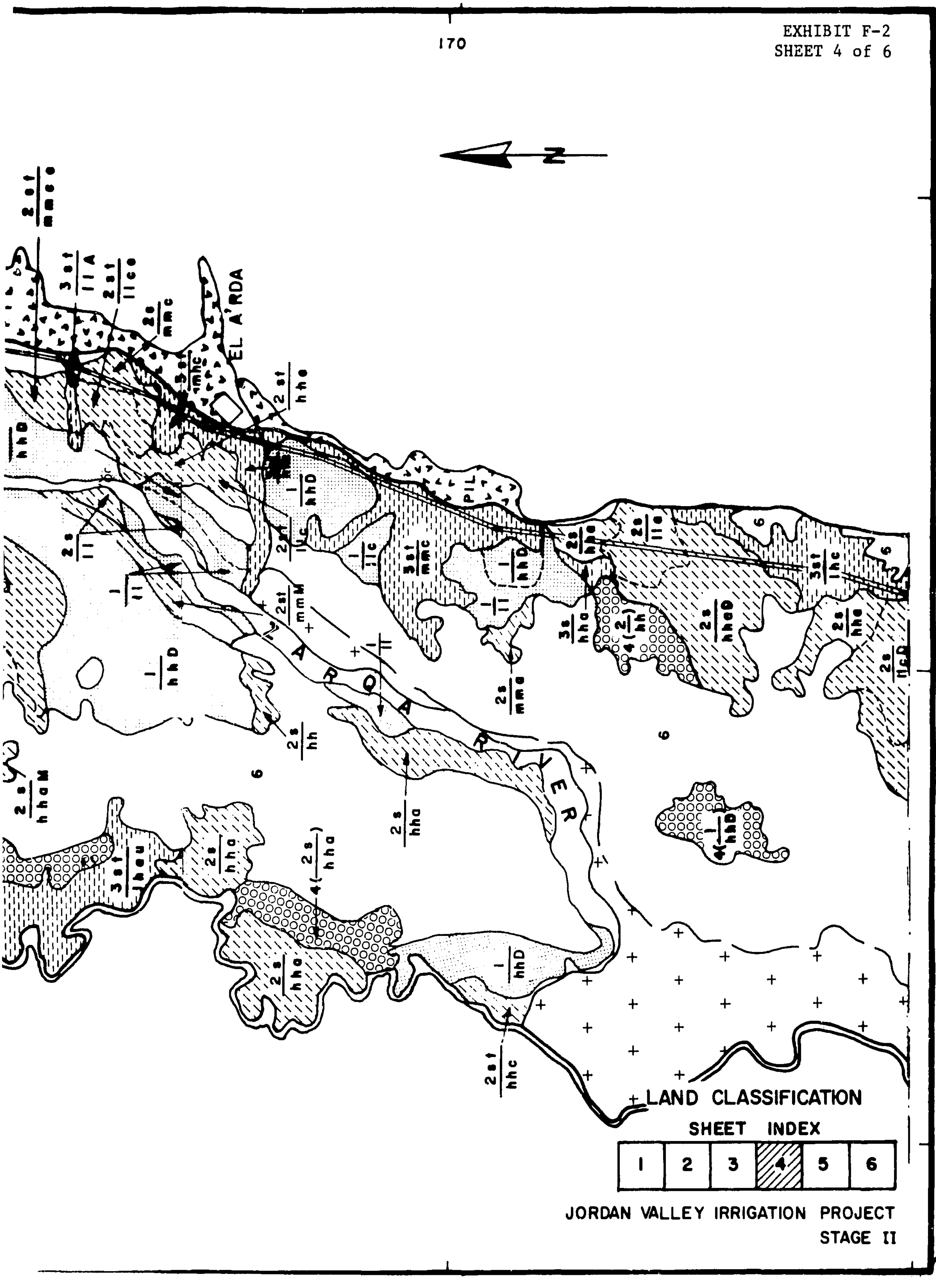
EXHIBIT F-2
SHEET 4 of 6



JORDAN VALLEY IRRIGATION PROJECT
STAGE II

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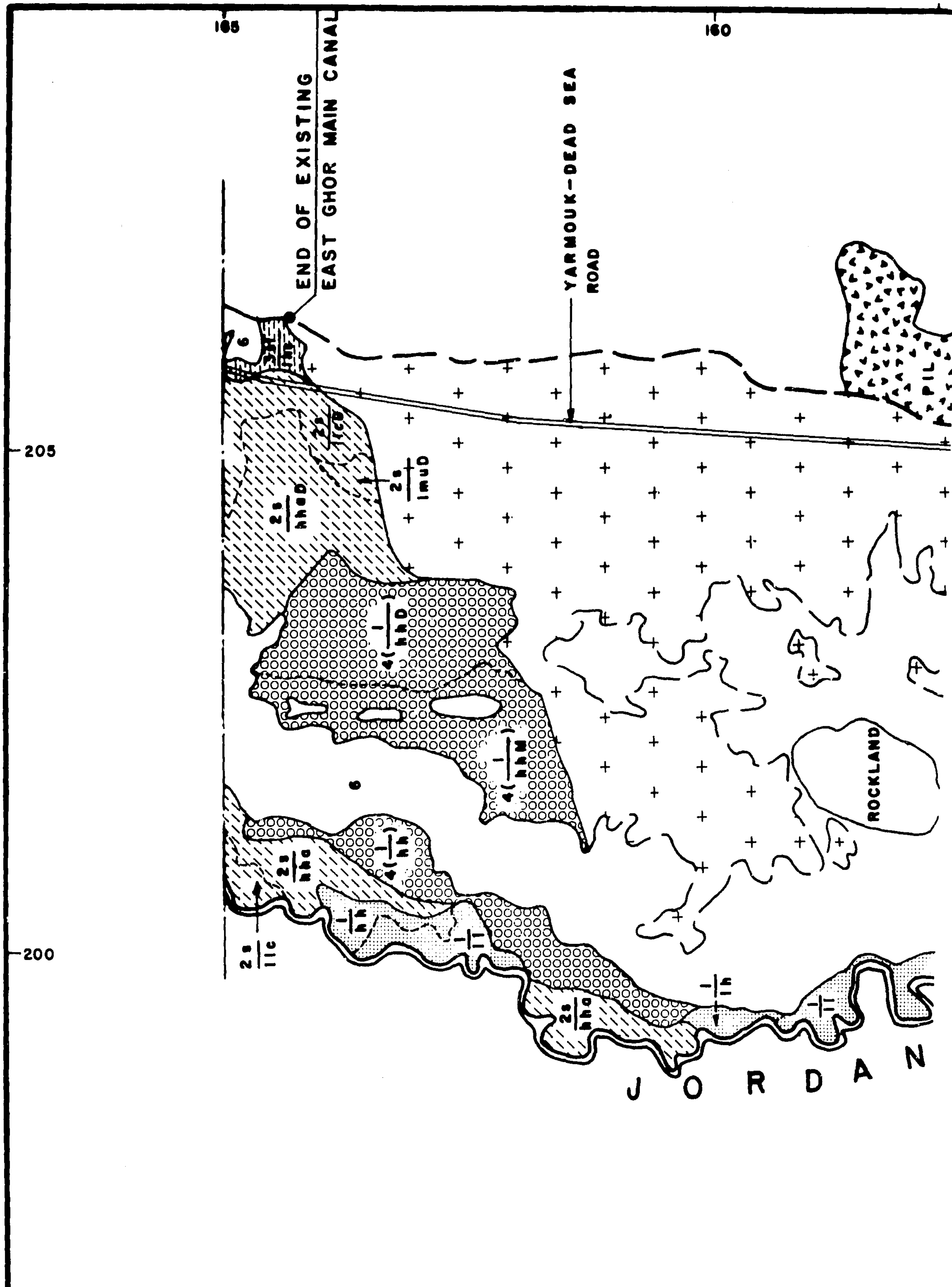
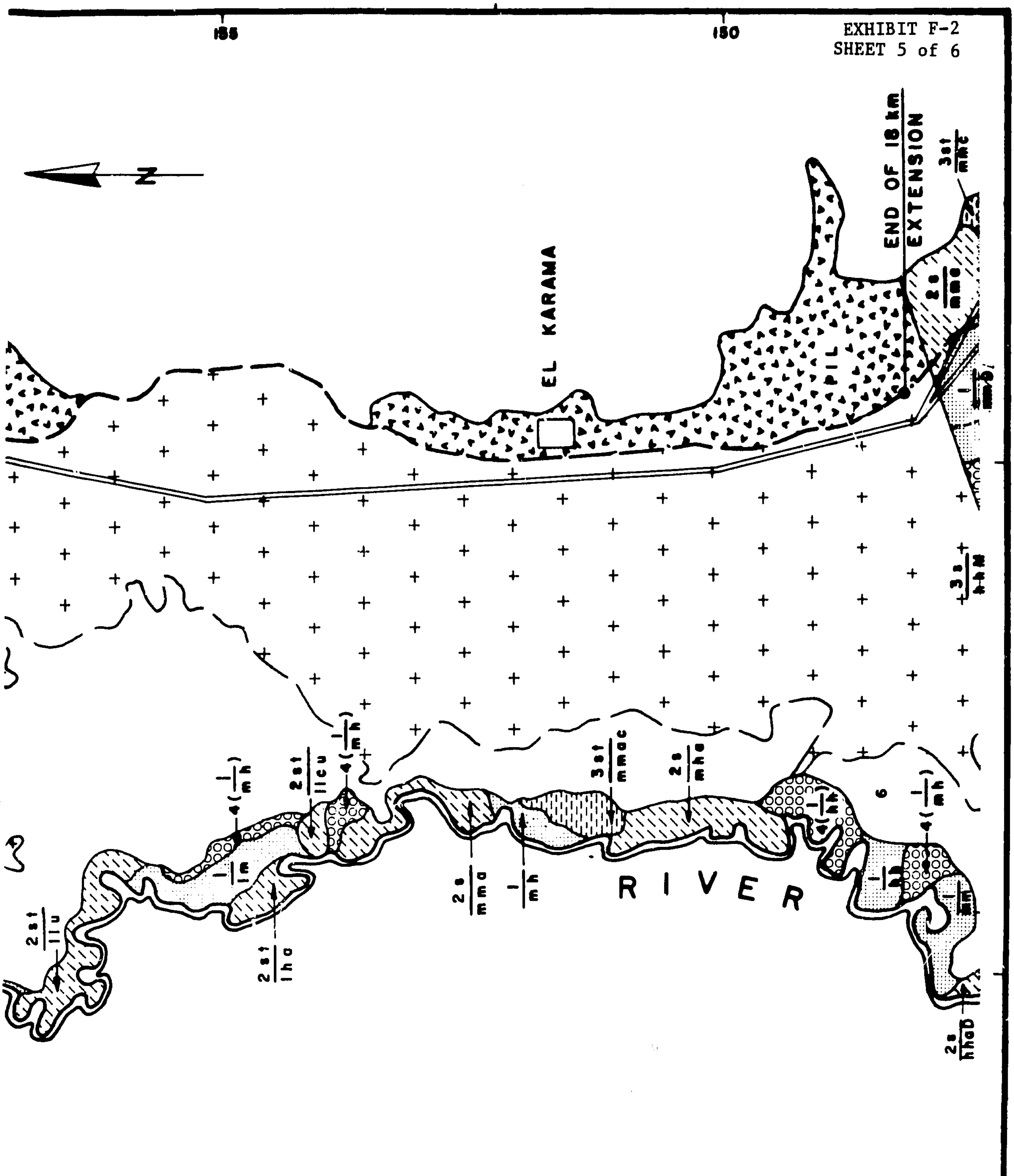

165
160
205
200
END OF EXISTING
EAST GHOR MAIN CANAL
YARMOUK-DEAD SEA
ROAD
PIL
ROCKLAND
JORDAN
6
2s/hhaD
2s/lmuD
4(1/hhD)
4(1/hhM)
4(1/hh)
2s/hha
2s/llc
1/hh
1/ll
1/lh

EXHIBIT F-2
SHEET 5 of 6

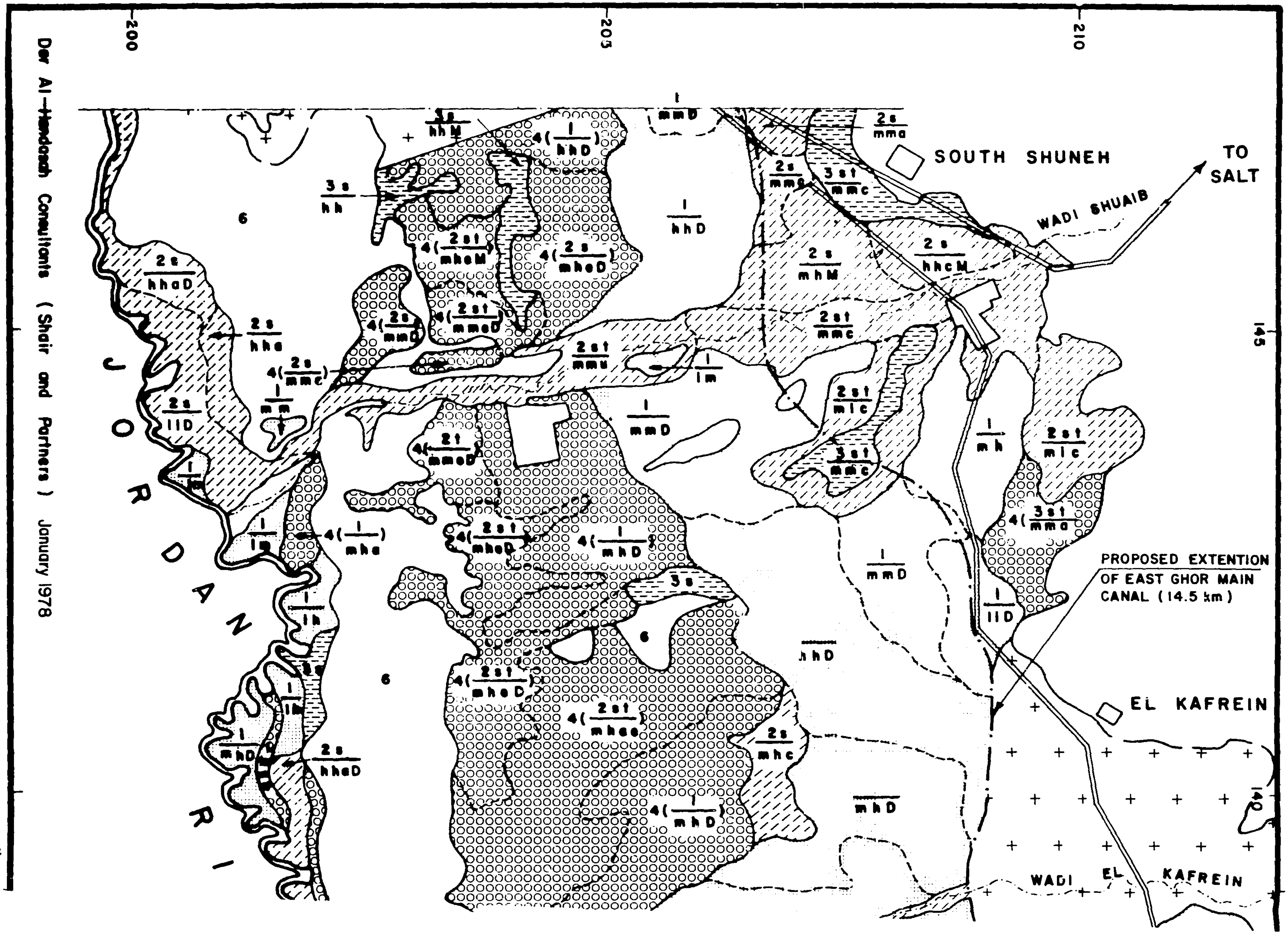


LAND CLASSIFICATION

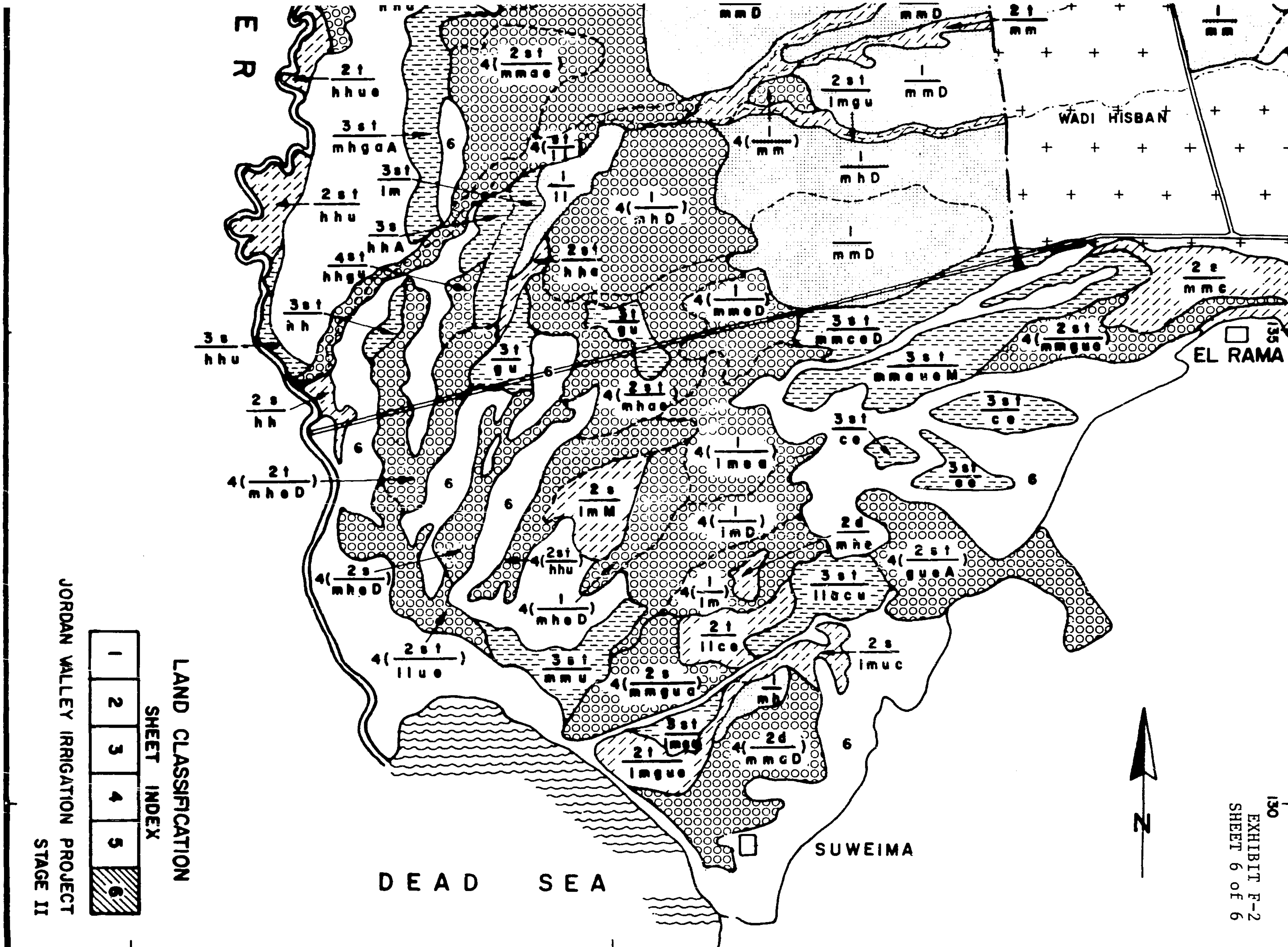
SHEET INDEX

1	2	3	4	5	6

JORDAN VALLEY IRRIGATION PROJECT
STAGE II



Dar Al-Handasah Consultants (Shair and Partners) January 1978
200
205
210
145
140
SOUTH SHUNEH
TO SALT
WADI SHUAIB
JORDAN RIVER
PROPOSED EXTENTION OF EAST GHOR MAIN CANAL (14.5 km)
EL KAFREIN
WADI EL KAFREIN



WADI HISBAN
EL RAMA
SUWEIMA
DEAD SEA
LAND CLASSIFICATION
SHEET INDEX
1
2
3
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5
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JORDAN VALLEY IRRIGATION PROJECT
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Appendix G

AGRICULTURAL DEVELOPMENT

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FOREWORD

General

This Appendix gives details of the agricultural development that is proposed in the areas that will be affected by Stage II of the Jordan Valley Development Plan. It is divided into five Chapters. The first chapter describes the present economy of the Jordan Valley and establishes the need for a comprehensive rural development scheme. Chapter II is devoted to demand considerations and showns that there will be ample opportunity to dispose of large quantities of fruit and vegetables on foreign and domestic markets in the next few decades. The third chapter outlines the changes that could take place in farm technology if the project is implemented, and quantifies the value of these changes. The fourth chapter gives irrigation water requirements. The fifth chapter gives a number of representative farm budgets and demonstrates the gains that could be made in farm incomes Finally, Chapter VI considers some of the assoicated developments that would be required to ensure the success of the project.

Scope of Work

The scope of work of this Appendix is based on the Agreement for a Feasibility Study entered into between the Jordan Valley Authority and the Harza Engineering Company, in association with Dar-Al Handasah Consultants in March 1976.

The agricultural work may be summarised as follows:

a) Recommend a suitable cropping pattern for the project, guided by the findings of previous studies. The pattern should be of sufficient flexibility as to permit modifications to reflect fluctuations in market demands, prices and other variable factors,

b) Summarise the expected benefits of the irrigation proposals per unit area of land,

c) Provide an economic and financial analysis of the project, giving sufficient detail to allow the evaluation of alternative developments.

The work given in the following Appendix goes well beyond the scope of work indicated above, and is designed to assist in the evaluation of the project by International Financing Agencies.

Method of Work

The recommendations contained in this Appendix are guided as far as is feasible by the findings of previous studies. Three documents have proved particularly useful in this regard, these are:

a) The Jordan Valley Project, Agro and Socio economic study. (Dar-Al Handasah and Netherlands Engineering Consultants, April 1969.)

b) The Northeast Ghor Irrigation and Rural Development Project Reports. (FAO July 1973 and IBRD May 1974)

c) The Jordan Valley Development Plan, 1975-1985 (Jordan Valley Commission, November 1975, with subsequent Summary May 1976.)

However, it has been necessary to undertake a considerable amount of new work. This has been based on extensive field work, library research and consultations with the International Financing Agencies. Nevertheless, the agro-aconomic proposals that are contained in this Report must be considered as tentative recommendations that may be subject to review. The existence of the Jordan Valley Authority, which is an autonomous government agency charged with the socio-economic development of the Jordan Valley, means that proposals can be tested, monitored and revised according to experience gained in the field. The aim of this report is therefore to present a coherent programme which establishes the broad order to magnitude of the costs that will be incurred and the benefits that will be gained in implementing the land development component of the project.

Chapter I

THE PRESENT ECONOMY

The Project and the National Economy

The Jordanian economy appears to be strong at present and well placed for sustained growth. In the past its performance has been marred by periods of stagnation, an over-dependence on tertiary activities, and a persistent balance of payments deficit. These difficulties can be eliminated or allieviated by the policies outlined in the 1976-1980 Year Plan. This emphasises investment in such basic activities as mining, agriculture and tourism to provide export income and generate employment. If the plan is successful, the economy will grow at an annual rate of 12 per cent between 1976 and 1980, and exports will rise by an average of 19 per cent per year. The Jordan Valley Development Plan is an integral part of the national strategy. Its implementation will bring the agricultural resources of the Valley into full production, while it will create employment and give rise to a substantial and valuable export surplus in fruit and vegetables.

The physical geography of Jordan is not favourable to rainfed agriculture. It is estimated that about 91 per cent of the total area of the East Bank receives less than 200 mm. of rainfall each year, can therefore be classed as arid. A further 8 per cent of the total area receives between 200 and 500 mm per year which makes it of marginal utility for continuous rainfed agriculture. This leaves about one per cent of the total (or around 100,000 hectares) which can be regarded as semi-humid and generally suited to cultivation without irrigation. These figures emphasise the fact that the basic agricultural resources of Jordan are both small and finite. These resources can be augmented substantially by the intensive use of irrigable land. Although it is estimated that only about 30,000 hectares of land are currently irrigated from artesian and surface water sources, this area accounts for the greater part of the nation's agricultural production. The project, which will develop 12,511 hectares of new land for irrigation, and permit the conversion of 12,842 hectares of land from surface to sprinkler irrigation, will therefore add considerable to the nation's effective land resources.

The necessity for the expansion of agricultural production is illustrated by the fact that food accounted for about 28 per cent of Jordan's total consumption expenditure in 1975 while the agricultural sector contributed only 10 per cent to the Gross Domestic Product. In the same year the total value of imported foodstuffs was about 50 million JDs which was greater than the total value of the nation's exports. This dificit is lidely to widen unless determined attempts are made to intensify agricultural production.

The population of Jordan (East Bank only) in 1975 was about 1,954,000. If it is assumed that the average annual growth rate will be 3.2 per cent between 1975 and 1995, the following forecasts are derived:

1980	2,298,000
1985	2,703,300
1990	3,133,100
1995	3,631,200

This means that the gross demand for foodstuffs in Jordan is likely to rise rapidly over the next 20 years, even if it is assumed that there will be no improvement in personal incomes during the period.

A more realistic forecast of future demands can be derived from the determination of probable changes in per capita incomes and the application of income eleasticity coefficients for different classes of food. This has been done for this report (see Chapter II). The analysis assumes that per capita incomes will rise by about 2.5 per cent per year over the next twenty years. For some commodities, such as wheat, the growth in consumption is relatively slow. It is estimated that the overall demand for wheat will rise from around 240,000 ton in 1975 to about 410,000 tons by 1995. However, the total annual consumption of vegetables is expected to rise by over 300 per cent over the same period (from about 281,000 tons to around 869,000 tons), while the demand for beef is likely to show a 260 per cent increase from about 5,000 tons to around 13,000. It is clear therefore that local sources of agricultural products must be developed to prevent the further deterioration of Jordan's balance of trade in foodstuffs.

While the Jordan Valley has a vital role to pay in import replacement, it also provides openings for the export of high value Spring crops. In 1975 exported fruit, nuts and vegetables worth nearly 10 million dinars. The main recipients were the neighbouring countries of Saudi Arabia, Syria and Lebanon. In the future these markets are likely to expand, but it is expected that Jordanian products will be distributed much more widely in the Middle East, as the demand for high quality goods increases. The population of the Middle East as a whole is rising at an annual rate of 2.6 per cent and expected to increase by 4 per cent per year as incomes rise, while total food production is likely to increase by only 3 per cent per year. Within the regional market, particular opportunities exist in the oil producing countries where the rate of economic development is spectacular. In the United Arab Emirates, for example, the total population rose from 350,000 to 650,000 in the three years from 1973 to 1975, and the average per capita income of the inhabitants is now estimated at about US $17,000 per year. Markets such as these can absorb increasing quantities of high quality, high value fruit and vegetables which can be air freighted by suppliers. In summary, Jordan is well placed to distribute its products throughout the Middle East where demand is likely to be strong in the future.

Additional market opportunities also exist in Europe. In the European Economic Community (EEC) total consumption of vegetables is rising at about 3 per cent per year, and the growth rate for fresh fruit is nearly double this figure. (see Chapter II). The demand for non-indigenous and off-season fruits and vegetables is particularly strong, and countries such as Morocco, Egypt and Israel are now supplying commodities such as avocadoes, melons, sweet peppers, peaches, citrus fruit, new potatoes and early tomatoes.

The Jordan Valley is virtually frost free and given a reliable source of water the farmers of the area should be able to compete effectively in producing fruit and vegetables for the European market. The potential value of this trade is substantial. A preliminary estimate suggests that at least 10 million dinars per year could be gained from exports by 1990, as the resources of the Valley are brought into use.

The implementation of Stage II of the Jordan Valley Development Plan will also make a significant contribution to the Jordanian economy by providing new jobs. Roughly half the Kingdom's population is under 15 years old and the population is increasing at about 3 per cent per year, which means that many new job opportunities will be required in the next twenty five years. Additional problems may arise as the oil rich states complete their development programmes. At present these countries are taking skilled and semi-skilled workers from Jordan and this has led to an overall reduction in the national workforce. However, these people will be seeking jobs and outlets for investment when they return. If the project area of 254,134 dunums is divided into farms which average 37 dunums, some 6,800 families can be settled on the land. Another 3,200 wage earners could be supported directly in the provision of hired labour and farm services. When due account is taken of the multiplier effects of the project, a total of about 17,400 jobs could be provided supporting about 97,000 people. The project will therefore add significantly to the range of opportunities for employment and investment in Jordan.

While the nation needs jobs of all types, any project which assists in diversifying the structure of economic activity is particularly valuable. In 1975 only 73,000 people, representing 19 percent of the total workforce, were employed in agriculture. Moreover, the number employed in this sector delined by one third between 1970 and 1975. In contrast, some 74 per cent of the workforce is involved in service activitites, which is exceptionally high for a developing country. It is therefore desirable to expand employment in such productive sectors as mining, agriculture

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and manufacturing. The project will contribute to this aim. A related characteristic of the Jordanian economy is the growing concentration of activity at a few locations. In particular, Amman is beginning to dominate the economic life of the country and around 70 per cent of all wage earners are employed in the capital. This is creating congestion and driving up costs. The expansion of the villages and towns in the Jordan Valley help to ease this problem to some extent.

The Project Setting

Physical Background

The Jordan Valley stretches for about 100 kilometres from Lake Tiberias to the Dead Sea. The physiography of the Valley can be characterised in terms of a series of land catenas stretching down-slope from the East Jordan Plateau to the river (see Land System Classification of Jordan, FAO, Rome, 1975). The first catena can be termed the Upper Ghor. It consists of the coarser outwash of the wadis which enter the Valley from the Plateau. Its soils are somewhat stony and are derived from the upslope rocks, such as the Ajlun Limestone and the Kurnub Sandstone. Most of this land is above the existing East Ghor Main Canal and cultivation has been restricted to the dry farming of cereals. The second catena, the Lower Ghor, is composed of finer alluvial material, much of which is loam. This catena occupies a greater proportion of this land has been intensively cultivated with water supplied by the East Ghor Main Canal. The third catena is usually known as the Katar and consists of the gullied and frequently saline margin of the Ghor. The fourth catena is the flood plain of the Jordan Valley which has silty, fertile soils. This area which is usually referred to as the Zor is subject to flooding and is covered by swamp vegetation in its natural state. When it is cultivated heavy yields are possible with irrigation. The fifth and final catena consists of the beaches of Lake Tiberias and the Dead Sea. These areas are stony, gravelly or sandy, and of little use for agriculture. This brief description of the physiography of the Valley is given to supply the context for the work that follows in this Appendix. For a complete discussion of the soils of the project area, the reader is referred to the Appendix on Soils and Irrigation.

The climate of the Valley can be classed as Mediterranean in its northern sections. Here the average annual rainfall varies from 300 to 400 mm per year. About 90 percent of this falls between November and March and 45 per cent falls in December and January. Average monthly temperatures range from about 15°C in January to around 30°C in August in this area. Frosts occur occasionally in the north but these have relatively little impact on agriculture. Generally there are clear skies and long periods of sunlight. The proportion daylight cloud cover varies from about 45 per cent in January down to 10 per cent in August. The high temperatures maintained in the winter make it possible to grow and mature vegetable crops for harvest in the early Spring. They also mean that fruit crops such as banana and citrus have a virtually uninterrupted growing cycle. In the summer, temperatures in the northern part of the Valley rarely reduce the potential for outdoor work or cause distress to livestock.

The climate of the southern part of the Valley puts it into the Desert Zone. Here the annual rainfall falls to less than 100 mm per year near the Dead Sea. The rain is restricted to winter months and is highly variable in incidence. Average monthly temperatures range from about 15°C in January to 33° or more in August. The southerly latitude and the general absence of cloud lengthen the potential growing season, but the high temperatures and low humidity experienced in the summer make it more difficult to maintain crops then. In this area human settlements and livestock enterprises are best located on the Upper Ghor to avoid the extremes of midsummer heat. Once again, the reader is referred to the Appendix on Soils and Irrigation for further details on the project area. In summary the soil and climatic resources of the Valley make it a uniquely favourable area in the Middle East for the production of early fruit and vegetables.

Human Background

Population. The population of the Jordan Valley has fluctuated widely over the last thirty years as a result of political events. In 1947 there were probably about 50,000 permanent residents in the Valley (East and West Banks), but as many as 80,000 refuges may have settled there following the events of 1948. By 1967, the population of the Jordanian area of the Valley had risen to about 250,000 at which time the West Bank passed out of Jordanian control. Between 1967 and 1971 extensive fighting devasted most of the settlements on the East Bank, and the area became virtually deserted. However, people have gradually returned to the East bank (refered to henceforth, for convenience, as the Valley), and the comprehensive Social & Economic Survey of the East Jordan Valley showed that the population was about 64,000 in 1973. It is estimated that it has now risen to somewhat over 70,000.

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It is difficult to assess the population that is supported at present by the project area. In 1973 it was estimated that there were about 25,000 people in the area covered by the North East Ghor Project which would leave around 40,000 people in the remainder of the Valley. However, many of the people in the North East Ghor area actually earned their livelihoods on land which was already surface irrigated downslope of the East Ghor Main Canal. This illustrates the problems that arise in relating particular groups of people to individual project areas. Where, as in Stage II of the Jordan Valley Development Plan, the project covers scattered areas with differing existing land-uses, these difficulties are multiplied. Given this, it seems reasonable to assume that the project will affect about 45,000 people directly, while all the inhabitants of the Valley will be influenced to some degree by the development programme.

Socio-economic conditions. The Social and Economic Survey of the East Jordan Valley, 1973, which was undertaken on behalf of the Jordan Valley Commission provides an excellent picture of conditions in that year. It is not feasible to update the information for this report, and the following section is simply designed to provide a background to the project appraisal. In 1973, the labour force participation rate was about 30.5 per cent which means that around 19,500 people were available for work. Although the proportion of the population that was employed is low by international standards, it is much higher than the Jordanian average. The national participation rate in 1975 was only 19.6 per cent. This suggests that the rate could fall in the Valley as additional family members, who took refuge elsewhere

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between 1967 and 1971, return to join the employed males. In 1973 only 1.5 per cent of the workforce could be considered out of work and there are complaints from farmers that it is difficult to obtain hired labour. Two developments are likely to solve this problem. First, females are being encouraged to work and some 18 per cent of all the females in the Valley have jobs. Second, the population is extremely youthful. Approximately 53 per cent of the population was under 15 years of age in 1973, which is close to the national average of 55 per cent. This means that the labour pool will expand rapidly in the next decade.

The existing economy of the Valley is dependent upon agriculture. About 80 per cent of the workforce are classed as farmers and farm labourers. Many of the remaining people work for the Government or for construction companies. The local economy is therefore as unbalanced as the national economy in its employment structure but the bias is towards primary rather than tertiary occupations. At present labourers appear to earn between 400 and 450 dinars per year, while skilled workers like tractor drivers earn over 600 dinars per year. About 55 per cent of all the farms are run on a share cropping or tenancy basis, and the landlords frequently take half of the returns in exchange for the use of land and the provision of inputs such as seed and fertiliser. It appears that the average annual return from one hectare of surface irrigated land is now about 500 dinars, which gives farmers operating units of 2.5 to 3.0 hectares, incomes of between 1,250 and 1,500 dinars per year. However, around 40 per cent of the existing farms are below 2.5 hectares in area, and there are many families of Palestinian origin that have no land. The local economy is therefore characterised by marked disparities in wealth and an absence of opportunities for personal advancment.

The general level of education of the inhabitants of the Valley is poor. The 1973 survey showed that 67 per cent of those over 12 years of age were illiterate and while the literacy rate among adult males was about 50 percent, it was only 15 percent among adult females. However, the standard of education is improving rapidly and over 82 per cent of the males and 37 per cent of the females between the ages of 15 and 19 years are now literate.

The existing residential development in the Valley is also substandard. There are 48 settlements which often consist of scattered groupings of houses with few amenities. North Shuneh was the largest settlement in 1973 with a population of around 7,700 followed by Kreiymeh with about 6,700 people. These towns and most of the smaller villages are spread along the main north-south road, at intervals of between 5 and 10 kilometers. Many of them are located on the Upper Ghor above the irrigated land. Most of the houses are constructed from mud bricks and there are an average of about 4 persons to every room. According to the 1973 survey, only 40 percent of all households had their own kitchens and only 10 percent had a separate bathroom. The overall picture is therefore one of overcrowded and insanitary conditions.

Moving to the provision of public services, these can generally be characterised as inadequate. Most of the population draws its water from open irrigation ditches and electric power has not yet been provided from the national grid. Many public and professional services are not available in the Valley, and the people have to travel to Amman, Salt

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or Irbid to obtain services such as dentistry. There is only one resident doctor in the Valley. On the positive side, the quality of road surfacing is high, though the steep slope of the Plateau edge is a deterrent to frequent contact with the rest of the country.

From this inventory of the existing socio-economic characteristics of the Valley, it can be seen that there is an obvious need for a comprehensive programmed of improvement such as could be supported by the implementation of the project.

Land Use

Existing Land Use in the Valley.

The areas devoted to particular crops in the Valley in 1975 are shown in Table G-1. This information, which is the latest available, is drawn from the 1975 Agricultural Census in the Ghors. In 1975 the total area cultivated in the Valley was 21,960 hectares. Of this, some 3.374 hectares was cropped with unirrigated field crops such as wheat. All of the remaining crops were irrigated with water drawn from three sources - the East Ghor Main Canal, side wadis such as the Zarqa and groundwater drawn from wells and bores. The total area of harvested vegetables was 11,437 hectares, but these crops were grown on 10,419 hectares of land. This indicates that 1,018 hectares were double-cropped with spring and summer maturing varieties. When the total harvested area is compared to the total cultivated area for the whole Valley, it can be seen that the former exceeds the latter by 6 per cent. According to the convention adopted in this Report, cropping intensity is defined as the margin between the area harvested and the area cultivated. This means that the average cropping intensity in the Valley in 1975 was 106 per cent.

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Table G-1

CROP GROUPS GROWN IN THE VALLEY, 1975

Crop Group	North (North Ghor)		South (Middle Ghor)		Valley Total	
	area (ha)	per cent	area (ha)	per cent	area (ha)	per cent
1. Field Crops	5,349	44	4,015	41	9,364	42
2. Vegetables	5,697	46	5,740	59	11,437	52
3. Fruit	1,977	16	595	6	2,572	12
Total Crop Area.	13,023	106	10,350	106	23,373	106
Cultivated Area	12,248	100	9,712	100	21,960	100

As can be seen from Table G-1, conditions vary between the northern and southern parts of the Valley. The northern area extends from Adasiye to Dara (north of El Arda). About 16 percent of the land cultivated in this area is under fruit. Citrus fruits predominated though some 181 hectares were devoted to bananas. The southern area, which is know locally as the Middle Ghor, has a greater proportion of recently irrigated land and a smaller share of its land under fruit. Here vegetables are relatively important.

An examination of the 1973 and 1975 Agricultural Sample Surveys in the Ghors and other sources of historical data suggested the following trends in production in the seven years from 1968 to 1975:

Crop Type	Area	Yield	Production
1. Field Crops:	decreasing,	higher	constant
2. Vegetables:	increasing,	improving,	increasing
3. Fruit :	up slightly,	constant,	up slightly

Total agricultural production almost doubled in the seven year period. This was mostly accounted for by the increase in vegetable production with a smaller contribution from the increased area under fruit.

The current yield and crop choice situation can be summarised as follows: In the field crops sector, wheat accounts for about 75 per cent of the crops area; barley takes about 18 per cent, and other crops, particularly maize, account for the remainder. About two thirds of the wheat area is currently irrigated and yields on this land were double those on unirrigated land in 1975.

Tomatoes dominate the vegetable sector making up 40 per cent of the harvested area. Eggplant are the second most common vegetable crop covering 20 per cent of the area, and

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watermelons take up 10 per cent. Green beans, pepper and cucumbers cover about 5 per cent each, followed by squash with 4 per cent, and cauliflower and cabbage with 3 per cent each. The remaining 5 per cent is devoted to a variety of other vegetables.

About 70 percent of the vegetables production comes from autumn sown crops. These have an advantage in terms of water usage, price and ease of cultivation but yields of tomatoes and eggplant were about 10 percent less for autumn sown crops than for crops sown in the spring. At least three quarters of the tomatoes, eggplant and peppers, and a higher proportion of the green beans, cauliflower and cabbage are now grown in the winter period. On the other hand, all of the watermelon and about 70 percent of the squash and cucumbers harvested are planted in the Spring.

In the fruit sector, oranges are the most important crop occupying roughly one third of the total area. Lemons cover a further 18 percent and other citrus fruits take up to 27 percent. Bananas are the most favored non-citrus fruit and occupy about one fifth of the total area. Only 4 percent is devoted to other forms of fruit. Banana yields appear to have increased steadily over the last seven years, while citrus yields may have declined to some extent.

<u>Land Use in the Project Area</u>

The project will supply water to eleven discrete areas of land, which range in size from 50 to 11,385 hectares. These areas adjoin or interlock with areas that will be irrigated under Stage I of the Jordan Valley Development Plan. In view of the small size of some of the areas that are included in the project, it is convenient and reasonable to summarise the agro-economic analyses in terms of four

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types of land, as differentiated by the problems associated witn supplying water for sprinkler irrigation. The first two types of land can be grouped together, and termed the "Conversion area". This is the area that is commanded at present by the East Ghor Main Canal. It is subdivided into 11,927 hectares which are currently surface irrigated, and 915 hectares which are now unirrigated but which could be supplied with water following the conversion from a surface to a sprinkler distribution system. The remaining 12,511 hectares of land that will be affected by the project can also be considered in two groups. This "New Land" consists of 10, 379 hectares of land that is currently unirrigated and 2,132 hectares of land that is irrigated from wells and side wadis.

A summary estimate of the current land-use pattern in the project area is given in Table G-2. This shows that about 44 percent of the total area can be classed as waste or grazing. Production on the remaining area depends upon access to water. On the 11,927 hectares that are irrigated from the East Ghor Main Central Canal, the average croppin intensity is 106 percent. On the land that is irrigated from the wells and side wadis, the overall cropping intensity is only 89 percent. Field crops such as wheat are most widely grown. In some areas these are grown without irrigation. Fruit growing is restricted to the Conversion Area, and vegetables form the main crop elsewhere.

To estimate the current magnitude and value of agricultural production in the project area it is necessary to identify the crop mix in some detail for the lands irrigated from the East Ghor Main Canal. The crop mix can be expressed in terms of coefficients which show the proportion of the

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Table G-2

ESTIMATED 1975/6 LAND USE IN THE PROJECT
AREA (hectares)

Crop Group	"Conversion Area"		"New Lands"		Total
	Irrigated EGMC	Unirri-gated	Unirri-gated	Irrigated wells & wadis	
1. Field Crops	5,248	300	-	1,050	6,598
2. Vegetables	5,486	-	-	850	6,336
3. Fruit	1,908	-	-	-	1,908
4. Total Crop Area	12,462	300	-	1,900	14,662
5. Cultivated Area	11,927	300	-	1,900	14,127
6. Waste/Grazing	-	615	10,379	232	11,226
7. Total Land Area	11,927	915	10,379	2,132	25,353

cultivated area that is reserved for any crop during the year. A simple example will explain the concept. Suppose there is a general farm where all the land is devoted to spring vegetables during the winter and half the land is double-cropped with summer vegetables. In this case the coefficient for the spring harvested crops is 1.0 and the coefficient for the summer harvest crops is 0.5. The cropping intensity for the whole farm is therefore 1.50 or 150 percent. Using this concept the present crop mix for the cultivated land in the Conversion Area can be listed as follows:

Crop	Cropping Intensity
Wheat	0.36
Barley	0.08
Tomato	0.17
Eggplant	0.09
Pepper	0.01
Squash	0.07
Cucumber	0.02
Beans	0.03
Cauliflower & Cabbage	0.02
Other Vegetables	0.01
Watermelon	0.04
Oranges	0.05
Lemons	0.04
Grapefruit	0.04
Bananas	0.02
Other Fruit	0.01
Overall Total	1.06

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Agricultural Economy

Present Yields and Production

Yields on the cultivated land in the project area are generally low at present. On the irrigated land in the Conversion Area, the following yields can be taken as representative:

Crop	Average Yield (T/ha)
Cereals	1.5
Tomatoes	20.0
Eggplant/Pepper	17.5
Cucumber/Squash	14.5
Other Vegetables	16.0
Citrus Fruit	17.50
Bananas	22.0
Other Fruit	20.0

On the additional cultivated areas, average yields are lower. Taking this into account a composite estimate can be derived for the existing production of the whole project area. This is shown in Table G-3.

Table G-3

ESTIMATED 1975/6 GROSS PRODUCTION IN THE PROJECT AREA (10^3 metric tons)

Commodity	Conversion Area	New Lands	Total
Cereals	7.50	0.08	7.58
Tomatoes	40.50	0.25	40.75
Eggplant/Pepper	22.70	0.25	22.95
Squash/Cucumber	15.90	0.25	16.15
Other Vegetables	19.20	0.10	19.30
Citrus Fruit	27.20		27.20
Bananas	5.30		5.30
Other Fruit	2.40		2.40

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Production Costs and Net Returns

Summary figures for the present gross and net value of production in the project area have been derived from field enquiries and previous project appraisals in the Jordan Valley. The 11,927 hectares that are now irrigated from the East Ghor Main Canal account for about 85 per cent of the present output of the project area, so that it is necessary to consider conditions there in more detail. Estimates have therefore been made of current average yields, farmgate prices and production costs for the major crops grown. This information is summarized in Table G-4 below:

Table G-4

ESTIMATED EXISTING NET RETURNS ON LAND IRRIGATED FROM THE EGMC

Crop	Sales Revenue		Production Costs		Net Returns	
	Per ha (JDs)	Total (10^3 JD)	Per ha (JD)	Total (10^3JD)	Per ha (JD)	Total (10^3JD)
Cereals	82.4	432.4	29.7	155.7	52.7	276.7
Tomatoes	1,250.0	2,534.5	273.0	553.5	977.0	1,981.0
Eggplant & Peppers	1,017.3	1,213.3	287.0	342.3	730.3	871.0
Squash & Cucumbers	852.8	915.4	215.0	230.8	637.8	684.6
Other Vegetables.	568.5	678.0	185.5	221.6	382.7	456.4
Citrus Fruit	1,230.8	1,908.4	380.5	590.0	850.3	1,318.4
Bananas	2,745.6	654.9	570.0	135.9	2,175.6	519.0
Other Fruit	1,400.0	167.0	350.0	41.8	1,050.0	125.2
Average	713.0		190.5		522.5	
Total		8,503.9		2,271.5		6,232.3

The parameters are defined as follows. Sales Revenue is the net farmgate value of the products that are sold, or consumed by the farmer and his family. The net farmgate prices received in the Jordan Valley have been determined by substracting transportation and handling costs from representative prices on the derivation of the figures is given in Chapter II of this Appendix. The production cost figures include all payments all payments for machinery, seeds, fertilisers, plant protection and hired labour. Machinery costs have been standardised at contractors charge rates. No allowances are therefore necessary for the depreciation of equipment. The costs exclude payments for housing and irrigation water and do not assign values for the labour and management skills supplied by the farmers and their families. General taxation is also exluded. Net Returns are the margin between Sales Revenue and Production Costs. As defined, Net Returns correspond to the Value Added to the regional economy through agricultural production.

The figures given in Table G-4 indicate that cereals only contribute about 4 per cent of the Net Returns earned throughout the area. Fruit makes up about 31 percent of the total and the remaining 65 per cent is accounted for by vegetables. Net Returns per hectare appear to be particularly high for tomatoes, citrus fruit and bananas. The average Net Return per hectare on the land that is now surface irrigated from the Eash Ghor Main Canal is estimated at 522.5 JDs.

Net Returns on the remaining areas that will be affected by the project have been estimated more simply. It appers that Net Returns on the 2,132 hectares that are currently irrigated from wells and side wadis, are about 200 JDs per

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hectare. On the unirrigated land a value of 50 JDs per hectare per year has been adopted to cover the returns that will accrue from dryland cultivation and pastoral use. In summary, the current annual value of Net Returns on the whole project area is estimated at 7,223,435 JDs. This figure forms the base for the estimation of the net benefits that will arise from the implementation of the irrigation and land development elements of the project.

Land Tenure and Farm Credit

Over the Valley as a whole, the following farm plot distribution obtains:

Size of Plot	Percentage of holdings
0-1.9 ha	24.4
2.0-2.9 ha	12.1
3.0-3.9 ha	31.8
4.0-4.9 ha	9.4
Over 5.0 ha	22.3

In the irrigated areas smaller plots predominate and it appears that at least 75 per cent of the land that is irrigated from the Eash Ghor Main Canal is held in plots that are within the range of 3 to 6 hectares.

The best available information on land tenure and credit in the Valley is contained in the report Agro-Economic Aspects of Tenancy in East Jordan Valley (Royal Scientific Society of Jordan, 1975). The tenure pattern shown in the report is as follows:

Type of Tenure	Percentage of Farm Land	
	1961	1973
Owner Operator	32.5	35.9
Sharecropper	39.0	47.2
Cash-rent	1.8	2.7
Mixed Tenure	26.7	14.2

It can be seen that the sharecropped land, the most prevalent form of land tenure, increased from 39 per cent in 1961 to 47 per cent in 1973. The percentage of land ower-operated or cash-rented rose only slightly in the period. The decrease occured in the mixed tenure category which declined by almost one half in the 12 year interval.

Four factors help to explain the prevalence of share cropping. First, 37 per cent of the landlords were not residents of the Valley (48 per cent in the Northern section), and the proportion is higher for the larger farms. Secondly, 15 per cent of the landlords did reside in the Valley but were non farmers. These were employees, merchants, or women who have inherited farm lands. Another 16 per cent of the landlords leased part of their farm holdings because the size of their holdings exceed the amount they could cultivate using family labour. Leasing the land was more profitable than hiring labour to farm the excess land, as labour is both scarce and expensive. On the average the holdings were large in the southern portion of the Valley: many exceed 50 hectares. The remaining 33 per cent of the landlords wanted to be relieved of cultivation due to inability to work (10 per cent), labour reasons (6 per cent), finding leasing more profitable (5 per cent) and other reasons (12 per cent). Most landlords could be eliminated by legislation confining land ownership to farming residents of the Valley, and limiting farm size.

Of the tenants, 63 per cent originated outside the Valley, 67 per cent were illiterate, and 33 per cent received six years or less of schooling. There are no laws or regulations in Jordan relating to lease agreements. Oral agreements existed in 84 per cent of the tenancies and only one percent of the leases were for a duration exceeding one year. In general the agreements ran well in spite of the short duration and non-formal documentation. One year leases were favoured by 92 per cent of the landlords and 65 per cent of all tenants.

Cash rentals account for only five per cent of the lease agreement with sharecropping the most prevalent form existing in 95 per cent of the leases. A 50:50 sharecropping system was the most comon arrangement. In most cases inputs are also split evenly with the exception of hired labour, which is generally paid for by the sharecropper; and irrigation water which was paid for by the landlord in one third of the instances. The majority of the sharecroppers indicate a preference for a cash rent. Most of the decision making is made by mutual agreement between the landlord and tenant. The sharecropper made the decision pertaining to planting date and harvesting date and methods in more than half of the cases.

About 56 per cent of the tenants had obtained credit. Commission agents were the most important source of credit, supplying about one-half of the tenants requiring credit. Relatives and friends, and landlords, supplied the remaining credit requirements in equal proportions. The credit is generally not officially recorded, is for short-term seasonal use, and is not guaranteed by mortgage of real estate. Due to the last fact, governmental agencies do not generally lend to tenants. About 71 per cent of the tenants interviewed stated that they had not received any assistance from extension agents. Most landlords maintain close contact with their tenants which may account for the fairly good relationship which exists.

In summary, the Royal Scientific Society's report indicates that limited structural reforms may be needed in the organisation of farming in the Valley. This could include land reform and the improvement of credit and extension facilities.

Conclusion

The Jordanian economy is becoming more mature and more diverse. However, there are problems due to an adverse balance of trade in foodstuffs and a general lack of employment and investment opportunities in primary industry. The project, which forms Stage II of the Jordan Valley Development Plan, should make a major contribution to the solution of these problems. It offers the prospect of expanding the irrigated area by 11,294 hectares and upgrading irrigation practices on a further 14,059 hectares.

The Jordan Valley provides a highly favourable natural environment for the production of off-season fruits and vegetables. In the past the development of the resources of the Valley has been hampered by political uncertainty and under-investment. Socio-economic conditions reflect this fact. The existing land use pattern on the surface irrigated area shows a low level of double-cropping and an emphasis on traditional crops such as cereals. Yields and net returns on the irrigated land can also be considered low and sub-optimal. The evidence therefore suggests that there is a need for a comprehensive rural development programme. The project could provide the basic infrastructure for such a programme.

The following chapter examines the market for the commodities that can be produced if the project is implemented. It looks at domestic and foreign demand. This provides the background to the selection of a more intensive and productive cropping pattern in the proposed agricultural economy.

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Chapter II

DEMAND CONSIDERATIONS IN PROJECT PLANNING

Domestic Demand

The primary determinants of total domestic demand are the level of population and the amount of expenditure that is available for personal consumption. These elements can be estimated with varying degrees of certainty. In the past there have been significant changes due to political events. Between 1965 and 1970, for example, the population of Jordan (East Bank only) rose by 63 percent following an influx of refugees from the West Bank. However the population increased from 1,568,000 in 1970 to 1,954,000 in 1975, at an annual rate of 3.2 percent, almost entirely as a result of natural increase. If this rate is maintained over the next twenty years, the population of the East Bank will rise as follows:

1975	1,953,800
1980	2,298,000
1985	2,703,300
1990	3,133,100
1995	3,631,200

From this fairly conservative estimate, it appears that the gross demand for food in Jordan will increase by 85 percent in the twenty year period, even if it is assumed that there will be no effective improvement in personal incomes.

The 1976 - 80 Five Year Plan aims for an annual increase of 4 percent in per capita incomes at constant prices. This is a highly ambitious target and will demand an annual growth in the Gross Domestic Product of 12 percent. In the recent past the following growth rates have been observed for GDP per capita:

1962 - 1966	+ 3 per cent
1967 - 1972	- 3 per cent
1973 - 1975	+ 3 per cent

It therefore seems reasonable to assume that the per capita income growth rates given in the Five Year Plan will not be sustained between 1975 and 1995. More modest figures were assumed as the basis of the consumption elasticity coefficients developed for Jordan by FAO in 1971 (see Agricultural Commodity Projections, 1970 - 1980, FAO, Rome, 1971, Table B), which gives a growth of 2.5 percent per year for per capita incomes. For the purposes of the present report the lower FAO rate has been applied for the twenty year period of 1985. It should be noted however, that this is a relatively conservative view which may understate the expansion of domestic demands for foodstuffs.

It is obvious that dietary preferences change as incomes rise. In estimating shifts in demand for individual commodities three sources of information have been used: the 1969 Dar Nedeco Report, the 1971 FAO projections, and a report prepared on vegetable marketing in 1976 by the Royal Scientific Society of Jordan. Table G-5 shows the composite figures. According to the estimates, the gross demand for wheat in Jordan will increase by 73 percent between 1975 and 1995, while demand for all forms of vegetables is likely to rise by over 300 percent from 281,000 to 869,000 tons per year. Large increases are also expected in the demand for fruit, meat and milk. Beef demand should increase 260 percent from 5,000 tons to 1,300 tons per year by 1995.

To assess the overall impact of the implementation of the project on domestic supplies, it is necessary to estimate the possible contribution of agriculture outside the Jordan

Table G-5

ESTIMATED LEVELS OF DOMESTIC DEMANDS FOR VARIOUS FOODSTUFFS 1975 - 2000 (10^3 TONS)

Commodity	1975	1980	1985	1990	1995
Wheat	236	276	319	363	410
Tomato	93	159	208	254	329
Eggplant	17	51	62	74	87
Pepper	4	7	10	14	18
Squash & Cucumber	25	37	47	58	73
Beans and Peas	12	14	19	25	33
Cauliflower & Cabbage	19	28	36	46	54
Onions	23	28	32	40	47
Potatoes	25	36	43	53	65
Melons	53	69	87	110	134
Other Vegetables	10	12	18	22	29
Citrus	48	62	76	91	109
Banana	12	14	17	21	25
Grapes & Other Fruit	58	69	81	94	109
Milk	49	72	93	112	135
Beef and Veal	5	6	8	10	13

Valley over the next twenty years. Table G-6 gives the required figures. These are derived from a variety of sources which include Ministry of Agriculture census material and a number of background papers that have been collected by the consultants. The projected growth rates follow those given in the 1969 Dar-Nedeco Report.

According to the estimates, agricultural production outside the Jordan Valley will only be able to supply about 20 percent of the wheat, around 30 percent of the vegetables and less than 10 percent of the bananas and citrus fruit that will be required by the nation at the end of the century. This is a reflection of the fact that only about one percent of the country can be cultivated successfully under dryland agriculture.

The present contribution of the Jordan Valley to national demand can be judged from Table G-7. This illustrates the importance of the existing irrigated area to the national economy. In 1975 the Valley provided about half of the nation's supplies of vegetables, and permitted substantial exports of commodities like tomatoes, eggplant, squash, cauliflower and water melons. However it is also obvious from the table that there was a significant national deficit in grain, fruit and animal products. The financial dimensions of this imbalance can be seen in Table G-8 which shows that the total value of agricultural exports in 1975 was only one fifth of the total value of food imports.

In planning the future development of the Jordan Valley it seems sensible to first consider the potential for replacing the most costly imports by local production. Some of the imported products, such as tea, coffee and cocoa, could not be produced in Jordan. In other cases, such as cereals, the cultivated areas that would be needed to gain self-sufficiency

Table G-6

ESTIMATED PRODUCTION OF SELECTED COMMODITIES OUTSIDE
THE JORDAN VALLEY 1975 - 2000
(10^3 TONS)

Commodity	1975	1980	1985	1990	1995
Wheat	56	61	68	75	83
Tomato	79	91	105	118	127
Eggplant	6	7	7	8	9
Pepper	2	2	2	2	2
Squash	5	5	6	6	7
Cucumber	10	11	11	13	13
Beans and Peas	9	10	10	11	11
Cauliflower	9	10	11	12	13
Cabbage	15	15	16	16	18
Onions	7	8	9	10	10
Potatoes	2	2	2	2	2
Melons	32	32	32	33	33
Other Vegetables	3	4	4	4	5
Citrus	3	3	4	4	4
Banana	-	-	-	-	-
Grapes	14	14	14	14	14
Milk	21	23	26	29	32
Beef and Veal	2	2	2	2	3

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Table G-7

CONTRIBUTION OF THE JORDAN VALLEY TO DOMESTIC DEMAND, 1975 (10^3 TONS)

Commodity	Jordan Valley Supplies	Other Jordanian Supplies	National Demand	Balance
Wheat	8	56	236	- 172
Tomato	67	79	93	+ 53
Eggplant	33	6	17	+ 22
Pepper	4	2	4	+ 2
Squash & Cucumber	21	15	25	+ 11
Beans and Peas	5	9	12	+ 2
Cauliflower & Cabbage	4	24	19	+ 9
Onions	2	7	23	- 14
Potatoes	4	2	25	- 19
Melons	21	32	53	0
Other Vegetables	5	3	10	- 2
Citrus	12	3	48	- 33
Banana	3	-	12	- 9
Grapes & Other Fruit	-	14	58	- 44
Milk	-	-	-	-
Beef and Veal	-	-	-	-

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Table G-8

VALUES OF TRADE IN EDIBLE COMMODITIES,
JORDAN 1971 - 1975 (10^3 JDs)

Commodity	1975	1974	1973	1972	1971
xports					
ruit and nuts	6,377	4,274	1,716	1,578	1,005
Vegetables	3,236	4,886	2,471	2,500	2,056
Olive Oil	365	464	82	277	275
Other	634	415	505	715	667
Total	10,612	10,039	4,774	5,070	4,003
Imports					
Live Animals	3,185	2,373	2,955	1,182	778
Dairy products and eggs	4,822	3,880	3,311	3,235	2,451
Wheat and flour	6,824	7,137	7,037	6,099	3,843
Rice	1,867	4,276	1,396	1,289	1,306
Sugar	11,534	6,758	1,779	5,186	2,186
Fruit, vegetables, nuts	9,570	8,669	6,439	3,887	3,961
Coffee, tea, cocoa	2,923	2,347	2,523	1,958	2,084
Oils and fats	1,255	1,153	1,514	1,096	795
Other	8,695	7,300	5,373	4,460	3,516
Total Value	50,675	43,893	32,327	28,392	20,920

Source: Department of Statistics, Jordan. External trade Statistics, Amman, 1975.

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exceed the nation's agricultural land resources. It therefore appears inevitable that the country will continue to depend upon imports for its wheat and rice. There is a prima facie case for considering the cultivation of industrial crops like sugar beet and oil seeds. The problem here is that it would be necessary to reserve large areas of land for these crops to support refineries and mills which were of economic size. The problems associated with collecting small quantities of raw materials from thousands of 3 to 4 hectare farms would also be significant. A recent study on the economics of growing sugar beet in the Valley illustrates these difficulties (Feasibility Study on Sugar Beet Cultivation and Sugar Production in Jordan, Agrar and Hydrotechnik GMBM, 1974). This report suggests that the smallest economic plant would require 5,000 hectares of beet each year. A plant of this type would therefore command about 14 percent of the total area of the Valley. It would, however, only meet 40 percent of the existing national demand.

Taking into account the physical characteristics of the Valley, and its division into small farms, it seems reasonable to recommend that the future cropping pattern should aim for self-sufficiency and exportable surpluses, if possible, in vegetables, fruit and dairy products. As can be seen from Table G-9, fruit exports are becoming particularly important to the economy, while significant gains have also been made from vegetable exports in recent years. The potential for including dairy products in the future production programme arises from the advisability of including field crops in intensive cropping sequences. If barley, maize, sorghum, alfalfa and berseem can be grown at relatively little cost between crops of vegetables, it seems sensible to recommend

Table G-9

EAST JORDAN VEGETABLE EXPORTS TO NEIGHBORING
ARAB COUNTRIES 1968-75 (Tons)

	1968	1969	1970	1971	1972 1/	1973	1974	1975
Syria								
Tomatoes	9,777	9,999	19,080	25,575	8,228	18,443	44,872	21,716
Eggplants	4,808	3,754	6,944	5,573	7,287	11,369	13,260	12,735
Cauliflowers	2,235	512	162	135	71	897	2,021	3,031
Watermelons	2,802	876	1,537	555	1,174	827	653	1,465
Total	20,033	18,431	28,745	33,721	17,137	36,810		
Lebanon								
Tomatoes	7,904	5,827	8,564	9,913	851	4,046	14,994	9,059
Eggplants	2,337	2,680	3,160	2,606	717	2,327	4,991	4,445
Cauliflowers	842	331	66	33	7	148	466	455
Watermelons	1,720	4,765	1,844	339	--	376	7,074	1,292
Total	12,793	14,012	13,886	13,089	1,632	7,451		
Iraq								
Tomatoes	30,493	20,794	18,603	7,013	1,342	--	4,893	--
Eggplants	643	882	195	16	559	0.3	404	--
Cauliflowers	5	14	3	--	3	--	3	--
Watermelons	--	--	--	--	--	--	--	--
Total	31,353	21,798	18,874	7,029 2/	1,940 2/	0.7	--	--
Saudi Arabia								
Tomatoes	2,422	2,035	1,277	3,098	5,712	5,426	7,461	9,323
Eggplants	237	213	238	254	--	444	463	705
Cauliflowers	149	86	63	125	291	269	318	460
Watermelons	627	145	189	742	830	67	290	217
Total	3,635	3,336	1,920	4,479	6,906	6,715		
Kuwait								
Tomatoes	11,015	8,382	4,766	7,827	10,849	9,676	10,839	11,566
Eggplants	3,029	2,934	3,303	3,478	3,407	3,733	3,749	3,896
Cauliflowers	1,077	750	2,941	886	2,034	1,406	2,238	2,079
Watermelons	907	141	13	13	147	158	703	126
Total	17,631	13,531	12,882	14,012	17,938	17,419		

1/ Syrian border closed most of the year, consequently affecting Syrian and Lebanese markets.

2/ Vegetable imports subject to quotas.

Source: Kingdom of Jordan, Department of Statistics, External Trade Statistics, 1968-73 (annual volumes).

their inclusion. They can then provide the fodder for stall-fed dairy cattle. The final choice of crops must obviously include agronomic and supply considerations as well as those of demand. These factors are dealt with in Chapter III of this report. Having considered domestic demand, it is necessary to examine foreign demand and the apparent margin on different commodities before recommending changes to the present cropping pattern.

Foreign Demand

The Arab World

In 1975 Jordan exported fruit, nuts and vegetables worth nearly 10 million dinars. The main recipients were the neighbouring countries of Syria, Saudi Arabia and Lebanon, and the Gulf States. Serious difficulties arise in forecasting the potential for Jordanian exports in these markets. Over the last decade trade embargoes and restrictions have been common. In 1968, for example, Iraq received over 36 percent of Jordan's exports, but this trade terminated in 1973 as a result of political factors. The border with Syria has also been closed at different periods, while the Lebanese Civil War disrupted the trade with Beirut in 1975 and 1976. An additional complication arises from the fact that the Jordanian Government sometimes imposes a blanket ban on exports to safeguard local supplies (as in December 1976).

Despite the irregularities, certain trends can be observed from the statistics given in Table G-9. In the case of tomatoes, a strong growth has taken place in exports to Saudi Arabia, while Syrian imports of eggplants rose sharply between 1968 and 1975. Taking the picture as a whole, it appears that after 1967, Jordanian exports declined for a number of seasons as a result of the political and economic problems of the whole of the Middle East. By the early 1970's economic recovery was underway and increases in oil prices since 1973 have given an added stimulant to demand. The impact of all these factors has been taken into account in the statistical models developed by the Consultants in the special report on marketing recently prepared for the Jordan Valley Authority (Supply and Demand for Jordanian Fruits and Vegetables Harza Overseas Engineering Company, Chicago, 1977). These models estimate the tonnages that can be absorbed by each market at existing prices. Some of the results of the work are given in Table G-10.

The forecasts indicate that gross demand for Jordanian tomatoes is likely to rise by 36 percent in neighbouring Arab countries between 1975 and 1995. Bigger percentage increases are expected for eggplants, squash, cauliflower and citrus products. These figures are encouraging and suggest that there will be sufficient demand to absorb the levels of increases in production that will follow the implementation of the project. However, it is important to note that the figures are based on statistical procedures which cannot take full account of the dramatic changes that are taking place in the Middle East. According to the Middle East Economic Digest (vol 20:34,1976), the population of the region is rising at an annual rate of 2.6 percent and will reach about 260 million in 1985. Food requirements are expected to increase by 4 percent per year as incomes rise, while total food production is likely to increase by only 3 percent per year. Within this regional market particular opportunities exist in the Gulf States. In the United Arab Emirates, the total population rose from about 350,000 to 650,000 between 1973 and 1975. Similar developments are taking place in Qatar, Bahrain and Kuwait, and the combined population of these states is now about 3 million. These people have an average per capita income of at least US $10,000 per year. Markets such as these can absorb increasing quantities of high quality, high value fruit and vegetables. Already Jordan is sending supplies by road, and opportunities should develop for air-freight consignments. There are therefore good grounds for believing that the Middle East

Table G-10

PROJECTED EXPORT DEMAND IN THE MIDDLE EAST FOR SELECTED JORDANIAN COMMODITIES 1980 - 1995 (10^3 TONS)

Commodity	1975	1980	1985	1990	1995
Tomatoes	52	60	65	68	71
Eggplant	22	29	33	37	41
Peppers	2	2	3	3	3
Squash	4	6	7	8	10
Cauliflowers	6	11	16	20	24
Watermelon	4	4	4	4	4
Citrus Fruit	-	116	166	217	270

Source: Supply and Demand for Jordanian Fruits and Vegetables. Tables IV-15 and VI-3

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could absorb any surplus production from Jordan.

Europe

Trends in the European Economic Community. The member states of the EEC have all benefited from substantial economic growth over the last thirty years, and this has led to higher per capita incomes and a strengthening of demand for off-season and non-indigenous fruits and vegetables. In the original six countries of the EEC, per capita consumption of vegetables increased from 92 kilograms to 109 kilograms per year between 1958 and 1972, while per capita consumption of fresh fruit rose from 52 kilograms to 80 kilograms over the same period. Within the fruit category, consumption of citrus products almost doubled from 13 to 24 kilograms per head. In Great Britain imports of non-indigenous fruits and vegetables grew by 4 percent per year between 1964 and 1969. As far as Jordan is concerned non-indigenous vegetables like eggplants, pepper and avocado, and citrus fruits merit intensive study.

Table G-11 shows the pattern of imports for the three selected vegetables in 1974. Two points may be noted from the statistics. First, the EEC is drawing supplies from a wide variety of countries. Some of these, for example, Ethiopia and Kenya are further from the market than Jordan and have less developed economies. Second, there are attractive price premiums for off season and more exotic vegetables. This is shown clearly in the prices paid for sweet peppers where the off-season producers received more than double the rate paid to European suppliers in the summer. Here, it is interesting to note the excellent price that was paid for a small consignment of peppers from Jordan.

Table G-11

SELECTED VEGETABLES IMPORTS INTO THE EEC, 1974

Commodity	Source	Tonnage ('000 Tons)	Value ('000 JDs)	Delivered price/ton (JDs)
1. Eggplant	Spain	14.04	1,243	88.53
	Morocco	8.67	961	110.84
	Kenya	4.73	961	203.17
	Israel	3.59	515	143.45
	Others	16.39	2,700	164.73
Total		47.42	6,380	134.54
2. Sweet Peppers	Hungary	7.31	514	70.31
	Bulgaria	7.00	498	71.14
	Romania	6.29	442	70.27
	Ethiopia	5.58	867	155.38
	Israel	5.07	818	161.34
	Jordan	0.19	35	184.21
	Others	19.71	2,902	147.23
Total		51.15	6,076	118.79
3. Avocadoes	Israel	11.55	2,526	218.70
	South Africa	3.59	1,045	291.09
	Others	1.96	263	134.18
Total		17.10	3,834	224.21

Source: Foreign Trade - Analytical Tables, 1974 - Volume A, The Statistical Office of the European Communities.

From a further analysis of the source statistics, it is evident that a large portion of EEC imports for one commodity are taken by a single country, which eases transportation arrangements. For instance, Germany regularly takes about three quarters of the peppers imported into the EEC, while France accounts for 45 percent of the eggplant imports. Table G-11 is limited to higher value crops, but large quantities of lower value vegetables are exported to Europe and some of these may be suitable for production in Jordan. Early potatoes are an example. In 1974 Egypt exported 47,000 tons and Morocco exported 58,000 tons, at an average price of 52 Jordanian dinars per ton.

As far as citrus fruit is concerned, demand continues to strengthen. In Germany, for example, per capita consumption of citrus fruit rose from 13.4 kilograms per year in 1957 to 23.4 kilograms per year in 1972. Lower but comparable rates of growth were also recorded in France, Holland and Belgium. The present range of demand is shown in Table G-12. This shows that substantial premiums can be gained from the sale of the more unusual fruits like clementines and mandarins. However, the biggest trade openings are for eating oranges of the conventional varieties.

The Scandinavian Market. The Scandinavian countries represent a prosperous market that has little natural potential for growing high quality vegetables and fresh fruit. Table G-13 shows the pattern of imports into Norway and Sweden for 1970 - 73.

Time series data shows that per capita consumption has increased steadily over the last 15 years. Imports have probably risen fairly rapidly since 1973 because the rise in the price of oil has reduced the profitability of hot-house horticulture.

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Table G-12

FRESH CITRUS IMPORTS INTO THE EEC, 1974

Type of Fruit	Tonnage ('000 tons)	Value ('000 JDs)	Delivered Price/ton (JDs)
1. Sanguines	569	25,300	44.46
2. Navels, Valencias, Shamoutis	1,490	74,013	49.67
3. Other oranges	48	2,835	59.06
4. Satsumas	219	12,962	59.19
5. Mandarins	31	2,100	64.74
6. Clementines	280	24,575	87.77
7. Grapefruit	362	21,126	58.36
8. Lemons	297	24,636	82.95
Total	3,296	187,547	56.90

Source: Same as Table G-11.

Table G-13

FRUIT AND VEGETABLE IMPORTS, NORWAY AND SWEDEN, 1970 - 73

Commodity	Consumption (kgm/caput /year	Imports (10^3 tons)	Consumption (kgm/caput)	Imports (10^3 tons)
Citrus Fruit	16.8	69	14.7	124
Fresh non-Citrus Fruit	44.0	91	38.4	197
Tomatoes	2.5	4	4.9	30
Other Fresh Vegetables	32.3	12	23.2	71

Source: *Food Consumption Statistics, 1975 - 73* OECD, 1975.

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The Israeli Example. In 1974 Israel exported over 600,000 tons of fresh produce to the EEC countries, worth in excess of 33 million Jordanian dinars. The composition of these exports is shown in Table G-14.

Citrus accounts for 90 percent of the total weight and seventy five percent of the total value. Most of the other crops are luxury items. With a comparable climate, and similar transportation costs, Jordan should be able to compete effectively for these markets. In addition to the crops listed, shipments of other products like tomatoes, dates, nuts and grapes were made which amounted to 50,000 tons in 1974. Additional opportunities may exist for processed products, and the time is approaching when it may become feasible to export fresh products from the Middle East to the United States. Recently, the Israeli Ministry of Transport have authorized a flat rate for air freight to Europe to 100 Jordanian dinars per ton. This compares to the 200 to 300 dinar charges that have been levied in Israel in the past, and to the current rate from Amman to Frankfurt of 240 dinars per ton. If charges in Jordan could be reduced to the recently announced Israeli rate, the opportunities for trade within Europe would be much increased.

The Future Supply - Demand Balance

Demand is obviously a crucial element in the justification of the project, and the choice of crops, cropping intensities and levels of factor inputs. A thorough analysis has therefore been undertaken to ensure that markets will be available for the commodities that will be produced in the project area. The economic analysis relates to normative cropping pattern for the project at full development, which is designed to satisfy the available domestic and foreign markets for crops

Table G-14

SELECTED ISRAELI AGRICULTURAL EXPORTS TO THE EEC, 1974

Commodity	Tonnage ('000 tons)	Value ('000 JDs)	Delivered Price/ton (JDs)
1. Citrus	563.09	25,650	45.55
2. Onions -sets	7.41	405	54.66
-other	15.88	581	36.59
3. Avocadoes	11.55	2,526	218.70
4. Melons	9.61	1,349	140.37
5. Sweet Peppers	5.07	818	161.34
6. Strawberries			
-early	1.28	538	420.31
-late	2.20	797	362.27
7. Eggplant	3.59	515	143.45
8. Peaches	0.55	96	174.54
9. Apricots	0.40	56	140.00
Total	620.62	33,331	53.71

Source: Same as Table G-11

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which can be grown at a comparative advantage. The choice depends upon a series of interlocking assumptions. A major element is the Consultants' forecast of crop yields at full development, and the background to the figures used in the report is discussed in the following chapter. However, the attainment of these yields also depends upon the availability of resources. The most important resource is water. A comprehensive study has therefore been undertaken to ensure that the intensity and mix of cultivation throughout a normal twelve month period optimises, as far as possible, the use of stored water and the capital equipment that is required to impound and distribute the water. A second constraint is imposed by the availability of labor. Another series of analyses have therefore been provided to show that sufficient labor will be available in the Valley to support the forecast levels of production. A third budget has been calculated for machinery use. Care has also been taken to ensure that the chosen land use pattern is agronomically sound, such that practices and rotations can be derived which minimise the incidence of plant disease and maintain soil fertility. Finally, it is also important to note that future commodity shipments from the Valley will also depend to some extent upon the availability of back-up services, improved infrastructure facilities and institutional reforms. All these factors and their influence on project definition are discussed at length in the remaining chapters of this Appendix.

At this point it is reasonable to concentrate upon demand and its relationship to future supplies. Table G-15 summarizes the forecasts that have been made for the target date of 1995. The origin of the domestic and Middle Eastern

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Table G-15

PROJECTED SUPPLY - DEMAND BALANCE FOR JORDANIAN PRODUCTION FOLLOWING FULL DEVELOPMENT OF THE JORDAN VALLEY (10^3 tons)

	Demand		Supply		
Commodity	Domestic	Middle Eastern	Jordan Valley	Other	Balance
Wheat	410	-	9	83	- 318
Tomato	309	71	275	127	+ 22
Eggplant	87	41	115	9	- 4
Peppers	18	3	22	2	+ 3
Squash & Cucumber	73	10	58	20	- 5
Beans and Peas	33	-	22	11	0
Cauliflower-Cabbage	58	24	54	31	+ 3
Onions	47	-	36	10	- 1
Potatoes	65	-	65	2	+ 2
Melons	134	4	108	33	+ 3
Other Vegetables	29	-	22	5	- 2
Citrus	109	270	158	4	- 217
Bananas	25	-	25	-	0
Grapes & Other Soft Fruit	109	-	97	14	+ 2
Milk	135	-	66	32	- 37
Beef and Veal	13	-	2	3	- 8

demand figures has already been discussed. The estimate of the supplies that will be available outside the Jordan Valley are drawn from Table G-7. The production figures for the Jordan Valley are based on the cropping patterns and yield forecasts discussed in the following chapter. These coefficients have been applied to the total irrigable area in the Valley of 36,000 hectares. This can be done for two reasons. Firstly, the project area of 25,353 hectares constitutes 70 percent of the irrigable land, while, secondly, the cropping patterns provided by the other Consultants and the Jordan Valley Authority for the ongoing projects were not formulated with a detailed regard for demand. The overall results show a close fit between supply and identified demands, at current prices, in 1995.

The strategy behind the proposed cropping pattern is the maximization of revenues from the sale of fresh vegetables and fruit. In an average year about 24,000 hectares of vegetables, 8,000 hectares of fruit and 14,000 hectares of field crops will be harvested. In this report cropping intensity is defined as the relationship between the total area harvested and the land area available, which means that the proposed cropping intensity is 1.28. About 22 percent of the area is reserved for perennial fruit crops, leaving 78 percent in the general farming category. In the latter area, it is assumed that about 36 percent of the land will be double cropped in an average year.

Given the assumptions outlined in this Appendix, the project should make it possible for Jordan to fulfill its own needs for fresh vegetables and make substantial export shipments to Middle Eastern markets by 1995. Tomatoes will be the main crop occupying 17 percent of the harvested area.

These will be grown in three seasons with planting in August, October and May. Melons occupy the next largest area as a summer crop. Eggplants will take up about 8 percent of the harvested area, having a good export potential, while potatoes have been allocated 6 percent of the area which will be sufficient to eliminate imports. At full development Jordan should be self-sufficient for all fresh vegetables between 1990 and the end of the century, including commodities like okra, mo lo khia, asparagus, lettuce, spinach and turnips which are included in the 'other vegetables' category. Beyond the end of the century exports are likely to disappear and a trade imbalance will develop once more if Jordan's population continues to grow at the current rate. As far as fruit is concerned, it is apparent that there is a very large export potential in the Middle East. However over-dependence on fruit crops is not recommended on two grounds. In the first place, the necessity for continuous watering during the summer increases the amount of storage that must be provided in Lake Maqarin; this raises capital costs rapidly as the fruit area is expanded. Secondly, a large investment in fruit growing ties up capital in maturing trees and offers little scope for adaptation to changing market conditions.

The areas reserved for field crops have a strong agronomic justification. They make it possible to rotate vegetables of similar families, such as the solanaceae, to reduce the incidence of disease and pest infestation. About 5 percent of the crop area has been reserved for wheat which is a traditional subsistence crop, particularly among share croppers. The remaining field crop area is designed to support livestock projects, which will also make available valuable quantities of animal manure. It is assumed that the area reserved for barely will provide about 19,000 tons at full development. This will be sufficient to supply concentrates to about 18,750 milking cows and their followers in the Valley. The bulk fodder part of the ration will be provided by green cut or silaged maize, sorghum and berseem, at a ratio of one ton of concentrates to 13.33 tons of forage. It is estimated that the dairy herds could provide about 65,600 tons of milk per year and about 1,500 tons of meat per year. As Table G-15 illustrates there is likely to be more than sufficient domestic demand to absorb this output.

In summary, considerable attention has been paid in this work to matching potential production to potential demands. However, it is important to recognize that the marketing and cropping strategy must be kept under constant review. If farmers are allowed to respond gradually to market forces with the assistance of bodies such as the Agricultural Marketing Orgnaization, within the physical constraints imposed by the project area, the results should be satisfactory. The proposed cropping pattern is based on a normative analysis which could be superseded by events. In particular there seem strong grounds for believing that the demand for good quality, off season fruits and vegetables in the Middle East will grow at an increasing rate, while there also appear to be opportunities for Jordanian products on European markets. If this proves to be the case, Jordan may have more flexibility in stressing high value crops. These could include fruits like strawberries, avocadoes and guavas. This means that further research will be required on the agronomy and market potential for new varieties and new forms of production.

Prices

Base Farmgate Prices

The prices recorded on the Amman wholesle market provide the basis for the calculation of contemporary net farm prices for vegetables and fruit. The records held by the Department of Agriculture, Economic Research Section give the quantities sold in each month, together with the highest, lowest and most representative prices. Taking the quantities and representative prices it is possible to drive weighted prices on a quarterly or annual basis. Tables G-16 and G-17 give this information for selected commodities in 1975 and 1976. It is apparent from the figures that there was a distinct overall rise in prices over the two year period. Tomatoes, for example, rose from an average price of 54.5 JDs per ton in 1975 to 75.6 JDs per ton in 1976; a rise of nearly 40 percent. It is also interesting to note the seasonal variations that take place. This indicates the potential that exists for crops which can be delivered to the market outside the main selling season. In 1976, for example, prices for eggplants in the second quarter were more than double those offered for crops delivered between October and December.

In view of the large price rises that are taking place as a result of inflation, it seems sensible to derive the base farmgate price series from the statistics available for 1975 and 1976. The first step is the calculation of the weighted average price for each commodity for the 24 month period. This is given in the first column on Table G-18. The second step is the subtraction of transportation, marketing an handling fees. These have been derived from information given in the Jordan Valley Development Plan. The

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Table G-16

QUARTERLY WEIGHTED AVERAGE PRICES AMMAN WHOLESALE MARKET 1975 (JDs/ton)

Commodity	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Whole Year
Tomato	66.8	69.4	24.0*	75.5	54.5
Eggplant	42.6	47.3	31.3	40.4*	42.6
Peppers	44.8	110.2	45.8	62.3*	60.2
Squash	106.0	47.5*	53.8	59.1	54.7
Cucumbers	217.1	94.2*	66.9	85.7	86.0
Green Beans	107.3*	48.5	235.0	241.4	90.8
Cauliflower	17.7*	58.8	67.2	63.5	33.8
Cabbage	12.3*	28.0	42.0	38.2	26.0
Onions	27.5	44.8	35.1*	92.5	46.0
Potatoes	67.2	66.3	60.4*	60.3	63.5
Watermelon	-	24.0	26.3*	58.0	26.5
Oranges	71.0	62.7*	77.6	78.6	68.9
Lemons	76.2	87.7	101.8	70.9*	79.4
Bananas	121.8	131.2*	134.0	131.2	129.4
Grapes	N.A.	N.A.	N.A.	N.A.	N.A.

* Maximum quarterly clearance

Source: Department of Agriculture, Agricultural Economic and Research Section (Data from Amman wholesale Market Authority).

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Table G-17
QUARTERLY WEIGHTED AVERAGE PRICES AMMAN WHOLESALE MARKET 1976 (JDs/ton)

Commodity	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Whole Year
Tomato	65.7	90.4*	56.5	88.0	75.6
Eggplant	73.8	89.1	30.4	41.2*	53.9
Peppers	50.9	124.0	81.3	82.0*	82.1
Squash	132.5	62.7*	112.1	81.8	73.9
Cucumbers	197.7	108.6*	94.7	128.8	111.9
Green Beans	170.3	137.1	104.8	131.6*	137.9
Cauliflower	35.7*	82.5	118.0	81.6	60.6
Cabbage	34.1	32.3	72.5	46.4*	42.4
Onions	131.7	74.4	70.1*	108.6	91.5
Potatoes	87.7*	80.8	96.6	102.9	93.0
Watermelon	-	35.0	41.2*	39.8	40.1
Oranges	80.4*	79.4	112.6	114.9	83.8
Lemons	73.6*	82.1	103.6	85.2	82.3
Bananas	140.9	147.7*	158.1	160.0	149.2
Grapes	206.0	-	100.6*	125.6	107.1

* Maximum quarterly clearance

Source: Same as Table G-16.

Table G-18

DERIVATION OF THE BASE FARMGATE PRICE SERIES (JDs/ton)

Commodity	1975-76 Weighted Average Price	Marketing Costs	Base Farmgate Price
Tomato	66.9	9.4	57.5
Eggplant	48.7	7.2	41.5
Peppers	72.6	9.4	63.2
Squash	64.8	7.4	57.4
Cucumbers	100.3	10.6	89.7
Green Beans	118.1	10.3	107.8
Cauliflower	45.6	5.0	40.6
Cabbage	34.4	5.0	29.4
Onions	73.3	5.8	67.5
Potatoes	77.8	7.9	69.9
Watermelon	34.5	3.3	31.2
Oranges	76.0	8.0	68.0
Lemons	80.8	9.3	70.8
Bananas	139.2	11.4	127.8
Grapes	107.1	7.1	100.0

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resulting farmgate price series therefore gives the average prices received by farmers between January 1975 and December 1976. To some extent therefore, the prices understate returns in terms of the base date for the economic analysis of the project which is December 1976. Although it is possible to adjust the figures to take account of the price drift, the calculations can lead to peculiar results for individual crops because the official consumer price indices are also affected by seasonal variations in the demand for commodities (see Consumer Price Index for Amman, Zarqa, Aqaba and Civil Servants, January 1976 and January 1977). Therefore the unadjusted figures were used in the economic studies, though it should be remembered that the series is relatively conservative.

Prices for field crops have been derived from enquiries in the Jordan Valley and reports as the Project Proposal: Development of 100 Cow Units in the Jordan Valley supplied by JVA. The base farmgate prices for these commodities can be listed as follows:

Wheat	60 JDs/ton
Barley	50 JDs/ton
Straw	12 JDs/ton
Green Maize	13.5 JDs/ton
Green Sorghum	10.0 JDs/ton
Green Berseem	10.0 JDs/ton

These prices enter the evaluation because it is assumed that the livestock industry will be developed through ancillary projects. The proposed dairy units will buy their fodder from the general farmers and yard or stall feed their stock. However, for the sake of completeness it may be noted that the average farmgate prices assumed for livestock products

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are 90 JDs per ton for milk, and about 550 JDs per ton liveweight for animals culled for meat.

Variations from the Base

Premiums for Quality. The existing prices for fruit and vegetables on the Amman market reflect to some extent the rather low standards of packaging and presentation that currently apply in Jordan. Given the implementation of the marketing proposals discussed in Chapter VI of this Appendix, it should be possible to reduce waste and to increase the average value of sales. A ten percent increase in prices from this source would not be unreasonable.

Premiums for Off-Season Supply. As previously discussed, there are significant opportunities for adjusting production more closely to monthly variations in market prices. The average margin between the prices realized in the highest price quarter and the year as a whole in 1976, was in the region of 40 percent. Clearly it would not be possible to eliminate seasonal variations without increasing production costs, while large supplies would tend to reduce prices. However, it seems possible that a net margin of between 5 and 10 percent could be gained by the co-ordination of planting dates on a co-operative basis.

Future Price Trends. Over the longer term it seems likely that foodstuff prices will rise in relation to the price of other goods. This is part of a world trend which is resulting from population growth, rising incomes and an increasing shortage of cultivable land. Jordan's geographical position will intensify the effects of these changes. The country stands between the large and wealth European market, and the rapidly growing market provided by the oil-rich states of the Middle East. As previously stated, the base

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farmgate price series refers to the period 1975-1976, and no attempt has been made to forecast basic price shifts over the life of the project. The possibility of a relative rise in the terms of trade for agricultural commodities should therefore be considered as an additional but non-quantifiable element in the project evaluation.

Price Distortions. Where domestic costs or prices are inflated by tariffs, taxes, trade bans or monopoly profits, they should be adjusted to reflect the true economic value of a good to the nation. The adjusted figures are frequently termed shadow prices. Ideally these prices should be calculated by the national or international agencies that are involved in macroeconomic planning. Standard accounting prices and conversion factors are not available for Jordan, and no previous report on an agricultural project has employed them to value output. The general assumption in the past has been that prices on the Amman wholesale market reflect fully the current opportunities that are available to farmers and the value of their produce to the nation.

In Jordan, tariffs on foodstuffs are generally low or uncollected so that there is no element of protection in local prices. However, there are some factors which tend to depress price levels, and these will now be discussed. First, transportation facilities for exports are rather limited. Goods are generally shipped via Aqaba, Beirut or Latakia and all these ports have suffered congestion during the past few years. Steps are being taken, particularly at Aqaba, to remedy this. Similarly, the difficulties now experienced at Amman airport will be alleviated when the new airport is completed. Second, the market system in the Middle East is still relatively underdeveloped. There is

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some evidence of collusion between middlemen, for example, in the export of vegetables to Saudi Arabia where retail prices can be three times greater than prices in Amman. This difference is not fully reflected on the Jordanian wholesale market. Third, exports have been inhibited in the past by border closures, as with Iraq and Syria. Given the favorable political climate that now exists with Syria these difficulties should be reduced. Fourth, the Jordanian Government sometimes imposes a blanket ban on fruit and vegetables (as in December 1976). When this happens it represents a subsidy to consumers. Taking all these points into account it appears there may be sound reasons for an upward adjustment in wholesale prices to characterize the true value of farm production to the national economy, at present and in the immediate future. It is not possible to estimate this adjustment with any accuracy, but it could be in the region of a twenty percent premium on the prices given in Table G-18

Conclusion

The cropping pattern recommended for the project has been developed with particular reference to the changes that are likely to be encountered in the domestic and foreign markets for Jordanian fresh fruits and vegetables over the next twenty years. From the analysis given in this Appendix and the supporting data contained in the recently completed report Supply and Demand for Jordanian Fruits and Vegetables, it appears that there will be ample opportunities for the disposal of the future production of the project area even though the proposed developments will lead to a large extension of the irrigable area, the intensification of cropping, and the attainment of higher yields. From the data given in

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Tables G-10 and G-15, and G-18, it is possible to quantify the potential value of exports from the project area in terms of 1975-1976 prices. Table G-19 gives the results of the exercise on the assumption that all export surpluses are due to the expansion of production in the Jordan Valley and that the project area will account for 70 percent of the output of the Valley. If the exports are valued in terms of the composite wholesale price index derived for this study, they will be worth about 10,500,000 JDs to the nation in 1995. If a twenty percent premium is allowed for the improvement of quality, shipping dates and the elimination of price distortions, they will be worth a total of about 12,600,000 JDs per year. The project will therefore make a significant contribution to Jordan's balance of payments position. Fundamentally, however, it is important to realise that the project is crucial to the satisfaction of domestic demands. Given the fairly modest increases in population and personal incomes forecast for Jordan in this report, it is clear that immediate steps must be taken to expand the nation's agricultural production. The project offers the only sound opportunity for this expansion.

Table G-19

ESTIMATION OF THE VALUE OF EXPORTS FROM THE PROJECT AREA, 1995

Commodity	Exports (10^3 tons) Middle East	Elsewhere	Value (10^3 JDs) 1976 Prices	Plus 20%
Tomato	50	2	3,479	4,175
Eggplant	26	-	1,266	1,519
Peppers	2	2	290	348
Squash	4	-	259	311
Cauliflower & Cabbage	17	5	880	1,056
Melons	3	2	173	207
Citrus	53	-	4,155	4,986
Total	155	11	10,502	12,602

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Chapter III

PROJECTED AGRICULTURAL ECONOMY

Farm Technology

Cultivation and Irrigation Practices

The slow but steady increases in productivity that have been demonstrated in the Jordan Valley over the last few decades have been obtained under traditional agronomic practices. However, there now appears to be an opportunity to adopt new techniques which could lead to a much more intensive form of land use. The climate of the Valley is conducive to the production of early spring and late autumn corps which command high prices. This together with the potential for double cropping makes it economic to apply factor inputs at high levels. The change involves the adoption of some horticultural techniques, the incorporation of a pasture-livestock element in the rotation and the improvement of commodity marketing. The essential catalyst for these changes is the provision of a reliable source of irrigation water and this will be guaranteed by the Maqarin Dam storage and the controlled application of water under sprinkler irrigation.

It is estimated that the average efficiency of water application will rise from 55 per cent under surface irrigation to 70 per cent under a sprinkler system. This will conserve water and allow the farmers to apply water in a more flexible and controlled manner. The adoption of sprinkler irrigation will also obviate the need for extensive land leveling, which, it may be noted, can also cause damage to the structure of the soil. A further advantage lies in the fact that sprinklers can be used to leach excessive salts from reclaimed land without the installation of leaching basins. The leaf yellowing that is observed in tree crops in the Valley, which is thought to be caused by excessive watering may be eliminated. Finally under some conditions sprinkler irrigation may assist in certain farm operations, such as the provision of humid conditions for seedlings and the spraying of blossoms for frost protection. These advantages should raise yields and reduce costs directly.

The availability of a regular supply of water from the dam storage, and the use of sprinklers, will permit and encourage theintensification of cropping. Measures to avoid problems with pests, diseases, and soil exhaustion will also be required. It is necessary to devise a fairly intricate crop rotation to ensure that similar crops are not repeated, thus, helping to control diseases and pests. Pasture fallows and green manure can be used to maintain the structure and nitrogren content of the soil. The availability of fodder will make it possible to include a livestock element which will provide supplies of farmyard manure. The farmers must also increase their use of bagged fertilizers and crop protection chemicals. Further changes are expected in the future which will lead to higher yields and cost economics. Some preliminary calculations on the costs of producing tomatoes are given in the case study that follows.

In this report it is not feasible or relevant to consider in detail the improvements that could be made to cultivation practices for the complete range of crops. Such recommendations should be made by local agronomists and agricultural economists following laboratory experiments and field trails. At this stage it is only necessary to identify the overall margin that exists for improvements.

Tomato Production a Case Study

Introduction. This section analyses tha available information on the economics of cultivating tomatoes in the Jordan Valley as an example of the methodology that has been adopted in estimating production costs for the whole crop range. The section is divided into three parts. The first examines historic data on yields, costs and returns. The second looks at previous forecasts, while the third sets out the elements of the crop budget for tomato production at 'full development' following the completion of the Maqarin Dam and its associated works.

Production Cost Survey Data. The 1969 Dar-NEDECO Report included the results of a comprehensive interview survey which covered over 300 farms in the Jordan Valley. Although the tabulations give costs and returns by farm, rather than by crop, some of the results are relevant to the present study. In 1965/66 about 31 per cent of the farmers obtained yields of over 20 tons per hectare and 10 per cent obtained yields of over 35 tons to the hectare. In the Zor where yields were highest, typical inputs per hectare were 2 ton of farmyard manure, 400 kilograms of sulphate of ammonium, 500 kilograms of superphosphate and 300 kilograms of mixed fertilizers. About 20 surface irrigations were given to the plants. The ratio between total production costs and the farmgate value of the crop in Zor was 0.350.

More detailed figures are available from subsequent samples. Table G-20 presents data from the survey conducted by the United Nations Development Programme Marketing Centre in 1974, and the Royal Scientific Society's investigation into tenancy conditions in the Valley, which was made in the same year. The results have been adapted to a common

Table G-20

SAMPLE SURVEY RESULTS FOR TOMATO CROPS IN THE VALLEY, 1974 (JDs/hectare)

Item	UNDP Marketing Centre Survey		RSS[a/] Survey[b/]	
	North	South	North	South
A. Costs				
1 Materials				
a. Seeds	10.9	12.1	9.9	6.7
b. Fertilizer	44.2	27.2	85.8	68.0
c. Chemicals	17.9	14.7	30.1	19.4
d. Water	8.0	40.0	7.4	11.1
2 Hired Labour	44.7	52.0	37.7	57.7
3 Services				
a. Machinery	6.6	12.2	7.3	7.5
b. Other	-	-	-	-
Total Costs	132.3	158.2	178.2	170.4
B. Returns				
1 Yield (tons)	15.07	16.02	18.3	18.5
2 Farmgate Price (JDs/ton)	27.5	27.9	27.5	27.9
3 Sales Revenues	414.4	447.0	503.2	516.2
4 Net Return[c/]	282.1	288.8	325.0	345.8
C. Inputs-Output Ratio	0.319	0.354	0.354	0.330

a/ Royal Scientific Society.
b/ Mean for Tenants and owners.
c/ After Water Charges.

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format which itemizes variable input costs. The ratio between Total Costs and Sales Revenue at the farmgate, has been termed the Input-Output Ratio. It excludes charges for capital, family labour and management, and represents a simple measure of farming efficiency. The figures show a remarkably consistent trend with total variable costs ranging from 132.3 to 216.0 Jordanian Dinars per hectare and Input-Output ratios which cluster closely around a mean of 0.339.

Previous Forecasts. There have been a number of previous reports which have given detailed budgets for tomato cultivation following the implementation of comprehensive development proposals in the Valley. Table G-21 summarizes the forecasts made in the 1969 Dar-NEDECO Report, the 1974 North East Ghor Study, and the 1975 Jordan Valley Development Plan. The figures have been adjusted where necessary to make the categories compatible. The Dar-NEDECO figures relate to development with surface irrigation, and show an input-output ratio which is similar to those recorded in the UNDP and RSS surveys. The North East Ghor and Jordan Valley Development Plan figures relate tothe use of sprinkler irrigation equipment. They show a widening of the ratio between Sales Revenue and Production Costs. Part of this change is due to recent improvements in the prices received for tomatoes, and part is ude to the yield and cost adjustments that accompany the use of sprinklers. In particular it is assumed that the more effective use of water will be accompanied by marked increase in the use of fertilizers and plant protection chemicals. Despite these changes, the cost profiles indicate that there has been no fundamental change in crop husbandry. The shift towards a more intensive form of land-use depends primarily on the application of local

Table G-21

FORECASTS OF TOMATO CROP PRODUCTION COST
AT FULL DEVELOPMENT
(JDs/hectare)

Item	Dar-Nedeco Report	NE Ghor Project	Jordan Valley Development Plan	
			North	South
A. Costs				
1 Materials				
a. Seeds	8.5	10.0	26.0	26.0
b. Fertilizer	64.0	40.4	85.0	85.0
c. Chemicals	25.0	20.0	53.0	53.0
d. Water	42.9	25.7	26.5	33.00
2 Hired Labour	32.0	15.3	87.2	87.2
3 Services				
a. Machinery	23.1	35.0	27.5	27.5
b. Other	9.4	-		
Total Costs	204.9	146.4	305.2	311.7
B. Returns				
1 Yields (tons)	28.0	25.0	25.0	25.0
2 Farmgate Price (JDs/tons)	20.0	30.0	48.3	48.3
3 Sales Revenue	560.0	750.0	1,207.5	1,207.5
4 Net Return	355.1	603.6	902.3	895.8
C. Input-Output Ratio	0.366	0.195	0.253	0.258

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methods. In the following section, revised estimates are given which show the adjustments that will be associated with the use of a more advanced farming technology.

Revised Estimates with Improved Technology. To evaluate the benefits that will follow from the implementation of the project, it is necessary to estimate production costs in the Valley under three conditions. These are the existing state of affairs, the maximum level of development that is possible without the project, and the level of development that will be attained if the project is completed. Table G-22 sets out the relevant figures for tomato cultivation. The first column gives the existing structure of costs in the Conversion Area. It can be seen that hired labour is a major item at present in the absence of adequate mechanisation. Water use is based on the net irrigation requirement for tomatoes in the north of the Valley, as given in the Dar-NEDECO Report. A net requirement of 4110 cubic metres per hectare results in a metered use of 5871 cubic metres per hectare with a conveyance efficieny of 70 per cent on the surface distribution system. This water is costed at 0.003 JDs per cubic metre, at present. Expenditure on seeds, fertilizer and plant protection chemicals can be considered low and inadequate. However, it appears from the relatively favorable input-output ratio that the farmers use the available resources well.

Moving to the level of development that could eventually be attained with surface irrigation, it can be seen that yields could be raised from about 20 tons per hectare to around 35 tons per hectare. This would require the substitution of transplants for seeds, the use of greater quantities of fertilizer and plant protection chemicals, and other

Table G-22

FORECAST TOMATO CROP PRODUCTION COSTS
USED IN THIS STUDY (JDs/hectare)

Item	Conversion Area 1976 Base	Conversion Area Max Without Project	At full Development 'Conversion Area'	At full Development 'New Lands'
A. Costs				
1. Materials				
a. Seeds	22.5	100.0	120.0	120.0
b. Fertilizer	90.0	105.0	105.0	105.0
c. Chemicals	37.5	65.0	100.0	100.0
d. Water	17.6	17.6	61.0	69.8
2. Hired Labour	100.0	80.0	128.0	128.0
3. Services				
a. Machinery	23.0	60.0	95.0	95.0
b. Sprinklers	-	-	27.0	18.9
c. Other	-	-	40.0	40.0
Total Costs	290.6	482.6	676.0	676.7
B. Returns				
1. Yields (tons)	20.0	35.0	45.0	45.0
2. Farmgate Price (JDs/ton)	62.5	62.5	57.5	57.5
3. Sales Revenue	1,250.0	2,187.5	2,587.5	2,587.5
4. Net Return	959.4	1,704.9	1,911.5	1,910.8
C. Input-Output Ratio	0.232	0.221	0.261	0.262

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services (notably improved packaging, input storage and insurance). Further mechanization would also improve tillage and weed control. It is estimated that these changes might take place gradually over 15 year period if the project is not implemented. It can be seen that net returns (valued in 1976 prices) would rise by about 77 per cent from the present base, with little change in the input-output ratio.

While it seems probable that radical but gradual improvements will take place without the project, it must be recognized that more rapid and profound changes would accompany the completion of the Jordan Valley Development Plan. It is estimated, for instance, that tomato yields could rise to an average of 45 tons per hectare with the adoption of modern horticultural methods. The background to this potential gain is the continued improvement of yields elsewhere in the world. In the United States of America nationwide yields of fresh and canned tomatoes rose from the equivalent of 32.5 tons per hectare in 1965 to about 39 tons per hectare in 1975. These national averages conceal some marked regional variations, and the productivity of farms in states like California, where conditions are similar to Jordan is much higher. For instance, yields averaged 64 tons per hectare in Fresno County in 1975. Among the measures which would be necessary to ensure these yields in Jordan are the use of purpose bred transplants from high quality strains, soil fumigation, skilled pruning, the more intensive application of fertilizers and farmyard manure, and the undoubted advantages of sprinkler irrigation in ensuring constant water availability and controlled humidity. The effects of these changes on individual costs are discussed below.

Seeds/Plants. Under current practices seed is sown at rates of about 1.5 kilograms per hectare. At a delivered cost of 15 JDs per kilo, the existing cost is 22.5 JDs per crop. Under more intensive cultivation, seedlings would be bought from central nurseries where they had been raised under glass or plastic frames to strict quality standards. It is estimated that the total cost of the seedlings would be about 120 JDs per hectare.

Fertilizer. Expenditure on fertilizers varies with the natural quality of the soil and the position of the crop in the rotation. Applications for tomatoes now reach 1 ton per hectare for sulphate of ammonia and 1 ton of single superphosphate. At current prices, these treatments would cost 92 JDs per hectare. In the future it is assumed that 20 tons of farmyard manure will also be applied at a cost of 13 JDs per hectare. With the controlled application of water it is assumed that fertilizer response with be much improved.

Chemicals. The main disease control chemicals that are used in the Valley are Zineb, Dudex, Calthene, Malathion or their equivalents. Minimum quantities cost about 37.5 JDs per hectare. To obtain full protection and make provision for soil sterilization as required, expenditure on these items and weed control could be raised to 100 JDs per hectare.

Water. The net crop water requirement for tomatoes varies according to the planting date of the crop and its location in the Valley. In this study, three crops have been defined according to their planting dates, and each has been allocated a share of the total cultivated area. The crops are further differentiated in their water use according to whether they are in the northern (Conversion Area) or southern (New Lands) parts of the Valley. For the purposes of the present analysis, it is reasonable to calculate the weighted average use in the two areas. These figures are an average net requirement of 4574 m^3 per hectare in the Conversion Area and 5239 m^3 per hectare in the New Lands. Assuming a farm application efficiency of 75 per cent, the metered flows will be 6097 m^3 and 6983 m^3 respectively. These have been costed at 0.010 JDs per cubic metre. It follows that farmers in the New Lands will pay relatively more for the water required to produce their crops. However, this difference will be offset by the higher cost of providing sprinkler equipment on the irregularly shaped holdings of the Conversion Area. It is estimated that the capital cost of the portable equipment required for one hectare will be 161.08 JDs in the Conversion Area and 112.75 JDs in the New Lands. The annual payments that will be required to repay loans for these sums, with a compound interest of 7 per cent on the unpaid balances, have been calculated using standard tables of capital recovery factors.

Labour. The typical labour input for tomatoes under surface irrigation is about 1,300 man-hours per hectare. This breaks down into 680 hours for cultivation and plant care, and around 620 hours for harvesting. If just under half of this labour is performed by hired labourers, the cost is 100.0 JDs per crop hectare, assuming a day-rate of 1.25 dinars. In the United States, the average labour input is equivalent to 450 hours per hectare from planting to harvest. It is expected that total labour inputs in the Jordan Valley will not be much reduced under the project, though labour will be transferred from land preparation and irrigation to plant care and harvesting. The suggested

Table G-23

ESTIMATED LABOUR REQUIREMENTS BY CROP AT FULL DEVELOPMENT (hours/ha)

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wheat		12		18	36							30	96
Barley		12		12	30							30	84
Maize					24	24	12	36	48	36			180
Sorghum					24	24	12	24	24	36			144
Berseem	12	20	20	20						24	12	12	120
Tomatoes I	300							120	72	72	204	288	1,056
Tomatoes II	204	288	300							120	72	72	1,056
Tomatoes III					120	72	72	204	288	300			1,056
Eggplant I	84	72	204	240	192				144	108	72	72	1,188
Eggplant II		144	108	72	72	84	72	204	240	192		1,188	
Peppers I	72	108	144	240				108	84	72	72	72	972
Peppers II		108	84	72	72	72	72	108	144	240			972
Squash	240								96	96	84	144	660
Cucumber		96	96	84	144	240							660
Beans I	300								108	78	78	192	756
Beans II		108	78	78	192	300							756
Cabbage								96	24	24	180	300	624
Cauliflower		96	24	24	180	300							624
Onions	420							96	36	24	24	84	684
Potatoes I	384								72	12	12	24	504
Potatoes II		72	12	12	24	384							504
Melons			96	24	36	36	252						444
Other Vegetables	240	180							108	84	84	84	780
Citrus	150	150	250	170	50	50	50	50	70	70	100	150	1,310
Bananas	70	100	180	200	250	130	80	80	100	200	200	180	1,770
Other Fruits	200	100	70	100	100	100	400	150				30	1,250

figure for tomato cultivation at the full development of the project is 1,056 man-hours per hectare. The phasing of this labour demand is given in Table G-23 along with figures for the other crops suggested for the project area. It has been assumed that farmers will hire labour when the requirement for any crop rises about 100 hours of hired labour will be needed for one hectare of tomatoes. If it is assumed that the quality and value of labour will improve, the average value of labour will improve, the average value of male and female labour can be costed at 2 JDs per day or 0.25 JDs per hour.

Machinery. The current cost of the hire of a tractor and implements is about 2 JDs per hour. Typical usage of hired machinery at present is around 11.5 hours per hectare and most of this is incurred in ploughing and the preparation of the seed bed. Under more intensive cultivation it is expected that machinery usage will rise to about 38 hours per hectare. This will include such operations as weed control, the application of farmyard manure, and the cartage of the various pickings of the crop. It is assumed in this study that machinery will be provided from central pools which serve 1,000 hectares of land. The cost of hiring the equipment is estimated at 2.50 JDs per hour, which should be sufficient to cover its purchase, maintenance and operation. Details of the proposed organization of the machinery pools are given in Chapter VI of this appendix.

Other Costs. A sum of 40 JDs per hectare has been added to total costs to cover miscellaneous items. Of this up to 35 JDs could be allocated to packaging materials, insurance and book-keeping. Other costs could include minor items of farm equipment, postage, and technical advice.

It should be noted that none of the budgets cover transfer payments such as taxes and rents.

Conclusion. The case study has illustrated the scope that exists for the application of improved technology in the cultivation of vegetables in the Valley. It also demonstrates the approach that has been used to determine the levels of factor inputs given for the complete crop range in the following section. Detailed estimates of the structure of production costs for the full crop range are given in Table G-24.

Land Management at the Project Level

Following the implementation of the project, it is expected that the overall intensity of land-use in the irrigated areas will rise rapidly. The water storage capacity of Lake Maqarin should alleviate shortages and reduce supply uncertainties, while the installation of a sprinkler system will conserve water and permit more accurate and flexible applications to individual crops. For these reasons, it is expected that the overall cropping intensity on the Conversion Area will rise from the present level of 106 per cent to 128 per cent. In the absence of the project, it is assumed that farmers in this area will be unable to raise the average level of land-use intensity. On the New Lands it should be possible to incorporate double-cropping at an early stage of development, given the provision of the back-up services outlined in Chapter VI of this Appendix.

As previously discussed, the cropping pattern chosen for the project has been based on a detailed analysis of the potential market for Jordanian fruits and vegetables. It has also been determined with respect to the constraints imposed by the availability of water, labor, machinery and

Table G-24

AVERAGE LEVELS OF EXPENDITURE ON INPUTS REQUIRED FOR FULL DEVELOPMENT WITH PROJECT (JDs/hectare)

Crop	Seeds & Plants	Fertilizer	Plant Protection	Hired Labour	Machinery	Other	Total
Wheat	6.0	29.9	10.0		53.7		99.6
Barley	6.0	29.9	10.0		51.2		97.1
Maize	5.0	57.5	13.0		75.0	10.0	160.5
Sorghum	5.0	57.5	5.0		57.5		125.5
Berseem	25.0	18.4	25.0		76.3		144.7
Tomatoes	120.0	105.0	100.0	128.0	95.0	40.0	588.0
Eggplant	120.0	124.4	125.0	97.0	108.0	20.0	595.2
Pepper	200.0	82.5	140.0	50.0	82.5	30.0	584.5
Squash	15.0	70.5	60.0	35.0	81.3	30.0	291.8
Cucumber	15.0	70.5	50.0	35.0	81.3	30.0	291.8
Beans	16.0	59.0	48.0	75.0	80.0	10.0	288.0
Cabbage	24.5	77.4	20.0	70.0	85.0	10.0	286.9
Cauliflower	24.5	77.4	20.0	70.0	85.0	10.0	286.9
Onions	20.0	70.5	30.0	80.0	85.0	30.0	315.5
Potatoes	90.0	105.0	30.0	71.0	90.0	30.0	416.0
Melons	7.5	47.5	30.0	38.0	67.5		190.5
Other Veg	60.0	74.0	55.0	57.0	78.5	20.0	344.5
Citrus	173.8	104.2	125.0	92.5	37.5	25.0	558.0
Bananas	610.5	131.5	120.0	160.0	32.5	40.0	1094.5
Other Fruit	107.5	115.0	100.0	112.5	66.5	15.0	516.5

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ancillary services. The recommended land allocations and planting dates for field crops and vegetables are not differentiated by area. However, a differentiation has been made for fruit crops, which relects the greater potential for bananas in the more southerly New Lands. The composite list is given in Table G-25. The pattern is also illustrated in Figure G-1.

The suggested overall cropping intensity for both areas is 128 per cent compared to 106 per cent on the Conversion Area at present. As explained in Chapter I, the intensity figures are calculated on the basis of harvested crops. If any piece of land yields two different crop harvests during the year, its cropping intensity is 200 per cent. If only one crop is harvested, as with fruit orchards, the land has a cropping intensity of 100 per cent. The pattern assumes that 22 per cent of the actual land area will be devoted to fruit crops, and 78 per cent will be reserved for general farming. About 36 per cent of the general farming area will be double-cropped in any one year.

The intensity of cropping has been related to the pattern of water release that will be possible from Lake Maqarin, and the availability of labor and machinery. These issues are discussed in the following sections.

As far as land-use is concerned, the following percentages of the total area will be covered by crops over an average twelve month period:

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Table G-25

SUGGESTED CROPPING INTENSITY FACTORS AT FULL DEVELOPMENT

Crops: Field and Vegetables	Planting Date	Intensity
Wheat	1 Dec - 31 May	0.05
Barley	1 Dec - 31 May	0.15
Maize	1 May - 30 Oct	0.03
Sorghum	1 May - 30 Oct	0.03
Berseem	1 Oct - 30 Apr	0.13
Tomato I	1 Aug - 31 Jan	0.07
Tomato II	1 Oct - 31 Mar	0.07
Tomato III	1 May - 31 Oct	0.03
Eggplant I	1 Sep - 31 May	0.04
Eggplant II	1 Mar - 30 Nov	0.04
Peppers I	1 Aug - 30 Apr	0.02
Peppers II	1 Feb - 31 Oct	0.02
Squash/Cucumber I	1 Sep - 31 Jan	0.02
Squash/Cucumber II	1 Feb - 30 Jun	0.03
Beans I	1 Sep - 31 Jan	0.02
Beans II	1 Feb - 30 Jun	0.02
Cabbage/ Cauliflower I	1 Aug - 31 Dec	0.03
Cabbage/ Cauliflower II	1 Feb - 30 Jun	0.02
Onions	1 Aug - 31 Jan	0.04
Potatoes I	1 Sep - 31 Jan	0.03
Potatoes II	1 Feb - 30 Jun	0.03
Melons	1 Mar - 31 Jul	0.12
Other Vegetables	1 Sep - 28 Feb	0.02

Crops: Fruit	Intensity Conversion Area	Intensity New Lands
Citrus	0.11	0.11
Bananas	0.01	0.03
Other Fruit	0.10	0.08
Overall Totals	1.28	1.28

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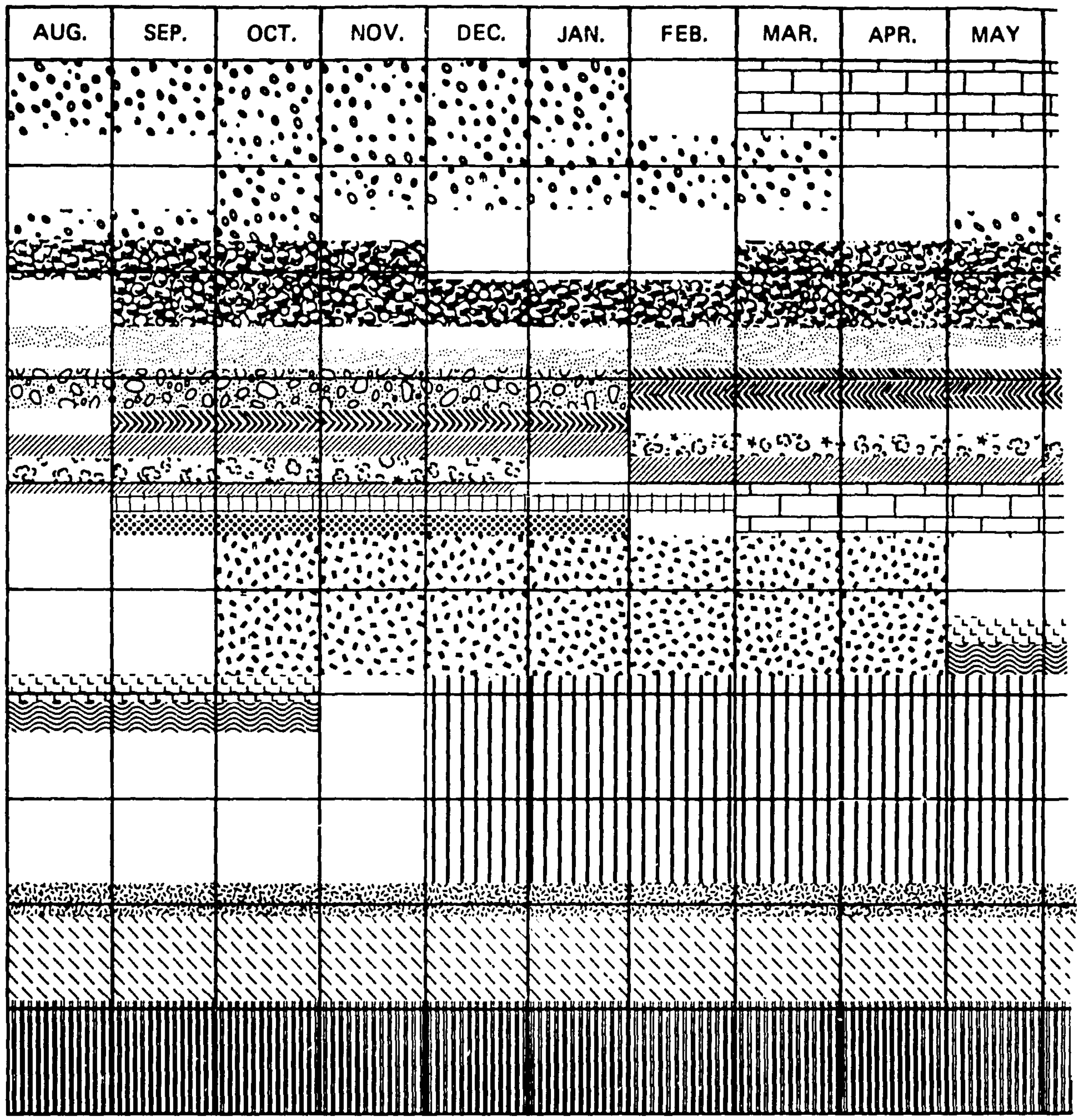
AUG.
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MAR.
APR.
MAY

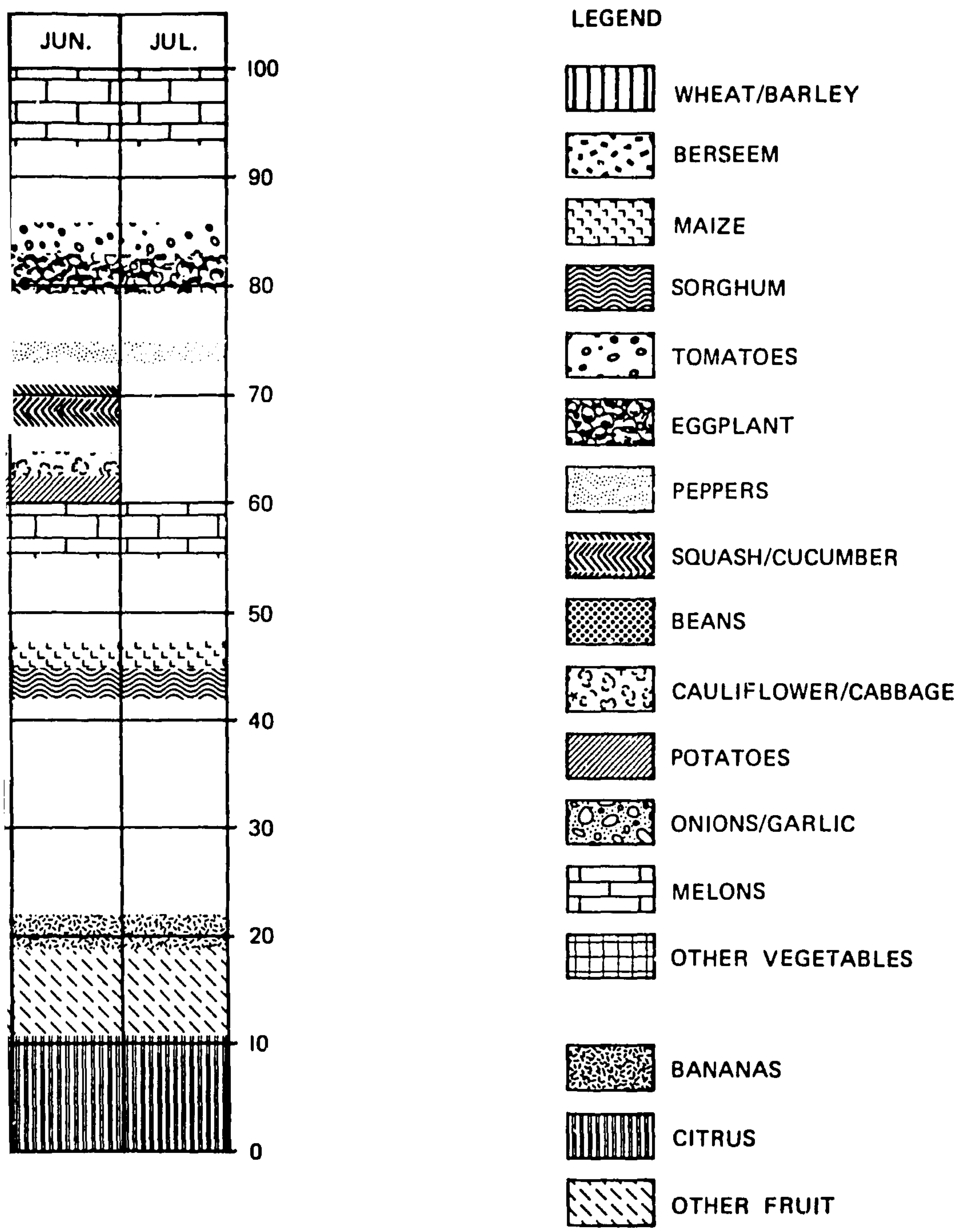

FIGURE 1
PROPOSED CROPPING PATTERN AT FULL DEVELOPMENT
JORDAN VALLEY IRRIGATION PROJECT
STAGE II

Jan	88
Feb	82
Mar	96
Apr	89
May	83
Jun	59
Jul	49
Aug	53
Sep	66
Oct	86
Nov	75
Dec	91

Land-use is most intensive between October and May. Cultivation in this semester conserves water and maximizes the advantages that the Valley offers for the production of early vegetables. In the height of the summer less than half of the land will be covered, and crops like melons and summer fodder, which have low water requirements, will be emphasized.

Within the proposed pattern it is expected that a number of rotations will be employed by farmers. In the general farming area substantial areas have been allocated for field crops to support a livestock industry. A representative rotation might be barley-potatoes-squash and cucumber-green fodder grown over a three year period, giving an average land-use intensity of 1.33. This makes it possible to separate plantings of crops like solanaceae by two-year periods. This should minimize the incidence of disease and pest infestation. This rotation is discussed in Chapter V. where attention is given to economic structure of model farms.

The proposed cropping pattern and the land management procedures discussed above should be regarded as models and not prescriptions. Adaptations will inevitably be made according to local experience and changing circumstances. The range of possibilities is wide, and several different crop mixes have been considered in this study. Among these are the 1969 Dar Nedeco pattern which has an overall intensity of 119.6 per cent, a preliminary model pattern with an overall intensity of 140.0 per cent, and a low crop yield pattern with an overall intensity of 163.0 per cent. For the sensitivity testing conducted in this Report, patterns were determined which stressed two elements; the reduction of water use during the summer and the intensification of vegetable production to meet heavier foreign demands. The Low Summer Water Use pattern has an overall intensity of 126.0 per cent, with land coverage ranging from 96 per cent in December to 41 per cent in July. The Vegetable Intensive pattern has an overall intensity of 122.0 per cent but restricts field crops to 13 per cent of the harvested area, while maintaining fruit at 22 per cent.

It should be noted therefore that the central pattern is based on a short-term, low risk marketing strategy. In the long term, it may be expected that the intensity of land use will increase gradually to reflect changes in agricultural technology and the growth of domestic demand. The impact of these trends cannot be forecast with any degree of accuracy, but they are likely to exert a positive effect on the economic viability of the project.

Production Costs

General

The forecast structure of production costs for the crop range at full development is given in Table G-24. These figures have been derived from comparative studies and field enquiries, as described in the case study on tomatoes. Details for the full crop range are given in the Technical Coefficients Annex. The summary table shows representative costs for 4 hectare general farms and 3 hectare fruit farms, and these costs form a major element in the economic evaluation of the project. The following sections offer comments on the derivation of the figures for each set of inputs. A preliminary discussion on the cost of water, which varies according to the location and date of planting of the crop, is also provided to complete the production cost list.

Seeds and Plants. For the most part, it is assumed that vegetables will be grown from seed or transplants prepared by farmers in the traditional manner on nursery plots. However, an allowance has been made in the case of tomatoes, eggplant and peppers for the purchase of transplants grown at central nurseries. These would be capable of producting seedlings from good quality strains with maximum potential for healthy growth. A recent study by the Department of Research and Extension confirms that sufficient material could be grown at 5 central nurseries to supply all the farmers in the Valley. It also suggests the use of transplants for cauliflower, cabbage and onions, and estimates the average cost of production at about 0.005 JDs per plant. This costing does not take account of the opportunity cost of the land required for the nurseries, and tends to under-estimate operating, research, transportation, and packaging costs. Taking due account of these points and the inevitable wastage that will occur, it seems likely that the average cost will be about 0.01 JDs per plant and this figure has been used in the production cost schedules for tomatoes, eggplants and peppers. It should be noted, however, that new forms of technology such as the use of plastic frames, plastic cones and special mulches may make it more economic to grow plants from seed in situ.

The figures given for fruit trees have been derived as follows. For citrus it has been assumed that budded stocks will be bought at a cost of 2.50 JDs per tree and that the costs of the 6 year establishment phase will be spread over 24 years of crop harvests. For bananas, the establishment period is two years followed by three years of annual harvests. Grapes are the most important member of the 'other fruit' category and here it is assumed that barley will be cultivated to provide green manure during the establishment period which is expected to last for 5 years.

Fertilizer. The costs of fertilizers for each group have been derived from estimates of the amounts of farmyard manure, sulphate of ammonia, single superphosphate, potash and special compounds that will be required. The main elements in most cases are sulphate of ammonia and single superphosphate which are costed at an average of 46 JDs per ton. Quite obviously, actual applications will depend upon extension advice and the experience gained by farmers on the range of soils found in the project area.

Plant Protection. A wide variety of plant protection chemicals will be required and these cannot be itemized at this level of analysis. The figures given in Table G-24 have been derived from previous studies, field enquiries, and model costings. The main incidence of costs will fall on the early vegetable and fruit crops.

Water. The cost of water to farmers will depend in part upon the net irrigation requirements of the crops grown and the efficiency of the distribution system. These issues are considered in detail in the Irrigation Appendix. Given the proposed cropping pattern, the average monthly net irrigation requirements of the project area can be listed as follows in terms of cubic metres per hectare:

	Conversion Area	New Lands
Jan	240	389
Feb	370	490
Mar	545	716
Apr	714	787
May	747	849
Jun	778	824
Jul	700	727
Aug	723	775
Sep	762	799
Oct	748	824
Nov	457	557
Dec	288	464
Total	7,072	8,201

Assuming a conveyance efficiency of 94 per cent and a farm efficiency of 75 per cent, the gross requirements will be 10,103 cubic meters per hectare in the New Lands. The metered uses chargeable to farmers will not include conveyance losses and will be 9,427 and 10,932 cubic metres per hectare for the Conversion Area and New Lands, respectively.

The farm portable sprinkler equipment is described in detail in the Irrigation Appendix. On a 4 hectare farm there will be three sprinkler sets. The two inch diameter pipes will deliver water over a period of 22 hours, and the sets will be available for use every day of the week at peak requirement. The capital cost of the equipment is estimated at 161.08 JDs per hectare in the Conversion Area and 112.76 JDs per hectare in the New Lands. The annual costs amortized over 8 years with 7 per cent interest are 18.88 and 29.98 JDs per hectare respectively. The incidence of double cropping makes it difficult to allocate these values to particular crops, and they have been added to production costs at the aggregate level. As far as the cost of water is concerned, the existing charge is 0.003 JDs per cubic metre. It is expected that this will be raised when the scheme is implemented. These charges do not, however, enter the economic appraisal as they represent a transfer of money from the farmers to JVA.

While the project has been defined in terms of the provision of portable sprinklers, it should be noted that attention has also been given to alternative irrigation methods. These are described in the Irrigation Appendix, and include surface irrigation with gated pipes, hose and hose-basin irrigation, and trickle and drip systems. All these forms can be operated from the conveyance facilities that will be provided, and it is expected that they will be used in some cases. For example, hose-basin and trickle irrigation may be preferred by citrus growers, while drip irrigation is likely to be used for the cultivation of early vegetables under plastic frames. No problems are envisaged in matching these methods to the proposed farm layouts, but costs are not available at present for the provision and operation of alternative systems.

Labour. It is important to ensure that there will be sufficient labour available to implement the cropping proposals that have been made for the project. Estimates have therefore been prepared of the amount of labour that will be required to cultivate and harvest each crop at full development. These figures are given in Table G-23, from the farm survey results and forecasts given in the 1969 Dar Nedeco Report, and data from the United States as reported by Ware and McCollum (Producing Vegetable Crops, Danville Illinois, 1968). The identification of the future trend of labour usage is difficult and depends in part on the availability of machinery. The wide range in requirements is illustrated by the case of green peppers. The Dar Nedeco survey reported an actual usage of 1,260 man hours per hectare, but the Consultants suggested that this could be reduced to 1,100 man hours at full development with surface irrigation. Data from the U.S.A. indicates that the average usage in 1959 was only 494 man hours per hectare. The new forecast for the valley of 972 man hours per hectare was therefore determined primarily from existing reports on Jordan confirmed by field enquiries. However, some reduction is expected from the Dar Nedeco figure as a result of the switch to sprinkler irrigation and the introduction of a higher level of mechanization.

The incidence of labour demand can be as important as the overall quantities required. Table G-26 shows the results of the calculation of the annual labour use regimes of the different areas in the scheme. The demands can be compared to supply if it is assumed that 3,000 man hours per year will be available from each farm family. This is assumed to be made up of 2,400 man hours from the farm operator (300 eight-hour days), and 600 hours from other

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Table G-26

ESTIMATED MONTHLY INCIDENCE OF LABOR DEMANDS
AT FULL DEVELOPMENT (man hours/hectare)

Month	General Farming Area	Fruit Farms	Whole Project Area
Jan	110 a/	163 a/	121 a/
Feb	58	125 a/	73 a/
Mar	75 a/	170 a/	96 a/
Apr	43	144 a/	65
May	51	89 a/	60
Jun	55	78	60
Jul	49	196 a/	81 a/
Aug	39	94 a/	51
Sep	57	44	55
Oct	71 a/	53	67 a/
Nov	57	68	59
Dec	75 a/	104 a/	81
Total	740	1,328	869

Jan	2.98	1.67	2.69
Feb	4.26	1.67	3.69
Mar	5.68	2.68	5.02 a/
Apr	2.51	2.29	2.46
May	4.92	1.84	4.24
Jun	1.84	1.07	1.67
Jul	1.06	1.48	1.15
Aug	3.60	1.89	3.22
Sep	4.49	0.40	3.59
Oct	4.40	0.72	3.59
Nov	2.59	0.78	2.19
Dec	4.01	3.85	3.97
Total	42.34	20.34	37.48

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a/ Indicates possible shortfall

members of the household. In the general farming area, where the farms average 4 hectares, this means that an average of 250 hours per farm or 62.5 hours per hectare will be available. From the figures given in Table G-26, it can be seen that although the overall supply exceeds demand, there are likely to be shortages in the general farming area in January, March, October and December. These shortages must be filled by hired labour.

In the fruit area which covers 22 per cent of the total land, the farms will average 3 hectares, which means that 83 man hours will be available from the farm family in an average month. Here shortages could occur in 8 months of the year. For the scheme as a whole, however, there are only 5 deficit months which indicates that there is room for labour sharing between the general farming and orchard enterprises.

Despite the detail given in the tabulations, it is difficult to calculate the amount of hired labour that will be required. Taken overall, the requirement will be 250 man hours per farm. Spread over the 6,700 farms planned for the project area, this gives a gross requirement of 1,675,000 man hours which could be supplied by about 700 labourers. However, it is obvious that the peaking of usage will increase the overall demand. For the purposes of the study, it is assumed that farmers will use hired labour when the labour demand for any crop exceeds 100 man hours per month. This assumes that farmers will break their holdings into fields having compatible crops where possible, and also takes account of the fact that the actual range of planting dates will be much wider than that assumed in this study. On this basis the total requirement will be for about 7,750,000 man hours, which could be supplied by about 3,230 labourers.

The hired labour figures have been costed at 2 JDs per day or 0.25 JDs per hour. This figure is a composite which includes male, female and child labor. The latter will be employed mainly during the harvesting of the vegetable and fruit crops. Family labor is costed at 0.33 JDs per hour which amounts to family living allowance of 1,100 JDs per year. In the economic analysis, this element has been given a shadow price of zero to reflect the fact that the provision of opportunities for farmers is a national priority. This assumption has been made in all the previous feasibility reports prepared by consultants and international agencies on agricultural development in the Valley.

Machinery. To some extent labour and mechanisation are substitutes in agriculture. The machinery usage figures used in this analysis are therefore complementary to the labour usage figures that have been discussed above. They have also been derived from similar sources. The detailed figures are given in Table G-27. The cultivation of tomatoes provides an example. At present farmers use about 11.5 hours per hectare which is almost entirely absorbed by ploughing and the preparation of zig-zag furrows for surface irrigation. The Dar Nedeco Report estimated that usage could increase to 25 hours per hectare at full development but this figure does not include allocations for planting, fertilizer application, and harvesting. The current figure for Cypriot farms is similar, at 22.5 hours per hectare. In the present study, it is assumed that average machinery use will rise to 36 hours per hectare which will permit farmers access to equipment at all phases of production.

As with labour, the incidence of usage is as important as the overall amount in assessing requirements. It is possible

Table G-27
ESTIMATED MACHINERY REQUIREMENTS BY CROP AT FULL DEVELOPMENT (working hours/ha)

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Wheat	3.0		1.5		10.0							7.0	21.5
Barley	2.0		1.5		10.0							7.0	21.5
Maize					7.5	8.0	1.5		3.0	10.0			30.0
Sorghum					4.5	3.0		3.0	6.5	6.0			23.0
Berseem	3.0	5.5	5.5	6.5						4.0	4.0	2.0	30.5
Tomatoes I	5.0							15.0	4.3	4.2	4.5	5.0	38.0
Tomatoes II	4.5	5.0	5.0							15.0	4.3	4.2	38.0
Tomatoes III					15.0	4.3	4.2	4.5	5.0	5.0			38.0
Eggplant I	3.4	3.4	4.5	4.0	3.0				15.0	3.4	3.4	3.4	43.5
Eggplant II			15.0	3.4	3.4	3.4	3.4	3.4	4.5	4.0	3.0		43.5
Pepper I	2.0	3.0	4.0	2.0				13.0	2.5	2.5	2.0	2.0	33.0
Pepper II		13.0	2.5	2.5	2.0	2.0	2.0	3.0	4.0	2.0			33.0
Squash	4.5								17.0	3.5	3.5	4.0	32.5
Cucumber		17.0	3.5	3.5	4.0	4.5							32.5
Beans I	4.5								16.0	3.5	3.5	4.5	32.0
Beans II		16.0	3.5	3.5	4.5	4.5							32.0
Cabbage								14.5	4.5	4.5	5.0	5.5	34.0
Cauliflower		14.5	4.5	4.5	5.0	5.5							34.0
Onions	5.0							16.0	4.0	3.0	3.0	3.0	34.0
Potatoes I	5.5								20.0	3.0	3.5	4.0	36.0
Potatoes II		20.0	3.0	3.5	4.0	5.5							36.0
Melons			15.0	3.0	2.5	2.5	4.0						27.0
Other Vegetables	5.5	4.0							15.0	3.5	3.5	3.5	34.5
Citrus	1.7	1.7	3.0	2.3	0.5	0.5	0.5	0.5	0.8	0.8	1.0	1.7	15.0
Bananas			3.0	2.0	2.0					3.0	1.5	1.5	13.0
Other Fruits	2.0	2.0	2.0	2.0	3.0	3.0	4.0					7.0	27.0

to estimate monthly demands for machinery at the project level by relating the figures given for individual crops to the proposed cropping pattern. This information is given in Table G-28. For the purposes of this analysis the requirements can be evaluated in terms of wheeled tractors. The maximum monthly demand arises in March when an average of 5.02 machinery hours per hectare will be required. If it is assumed that an average tractor can supply 900 working hours per year, or 75 working hours per month, it follows that a tractor would be needed for every 15 hectares at the peak season, giving a gross demand for about 1,690 tractors in the project area. In practice tractors can usually provide at least 100 working hours per month at periods of maximum demand. The overall project requirement has therefore been set at 1,250 tractors which will provide an average of 3.7 working hours per hectare per month. At this level, March will be the only month in which difficulties could arise in organizing the supply of equipment.

In this study, it has been assumed that the machinery required in the project area will be provided from central pools at an average cost to the farmer of 2.50 JDs per working hour. Details of the equipment that will be needed and the structure of the proposed machinery pools are given in Chapter VI of this volume.

Other Inputs. Figures in this category in Table G-25 cover items such as packaging insurance and other overheads. These figures take into account the fact that product presentation and farm management are expected to improve following the implementation of the project.

Conclusion. The figures that have been presented above represent the final set in a series of calculations of

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Table G-28

ESTIMATED MONTHLY INCIDENCE OF MACHINERY DEMANDS AT FULL DEVELOPMENT (working hours/hectare)

Month	General Farming Area	Fruit Farms	Whole Project Area
Jan	2.98	1.67	2.69
Feb	4.26	1.67	3.69
Mar	5.68	2.68	5.02[a/]
Apr	2.51	2.29	2.46
May	4.92	1.84	4.24
Jun	1.84	1.07	1.67
Jul	1.06	1.48	1.15
Aug	3.60	1.89	3.22
Sep	4.49	0.40	3.59
Oct	4.40	0.72	3.59
Nov	2.59	0.78	2.19
Dec	4.01	3.85	3.97
Total	42.34	20.34	37.48

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a/ Indicates possible shortfall

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alternative farm management strategies. The feasibility of the proposed strategy has been demonstrated under the stated assumptions. However, it should be remembered that the figures are normative rather than prescriptive, and that a wide range of approaches are likely to be followed by farmers in practice.

Yields

It is difficult to forecast the level of crop yields that could be gained in the Jordan Valley with modern farm technology. The project provides a unique opportunity to exploit a large area of fertile alluvial soil from a low base. Given the climatic and land quality characteristics of the Valley, it should be possible to reach and surpass the yields that are recorded from comparable irrigation schemes in the United States of America, if the requisite inputs are made available. These will be made available through the implementation of the project and other socio-economic elements of the Jordan Valley Development Plan. However, it seems probable that yields will continue to improve on the Conversion Area if surface irrigation is retained and the farmers are left to their own devices. Estimates are therefore required of yields, at the time of full development, with and without the project. These are given in Table G-29.

Table G-29

PROJECTED YIELDS WITH AND WITHOUT THE PROJECT

Crop	Conversion Area without Project (tons/ha)	Project Area With Project (tons/ha)
Wheat	3.0	5.0
Barley	3.0	5.0
Maize	6.5	7.5
Fodder Sorghum	35.0	40.0
Berseem	50.0	60.0
Alfalfa	50.0	60.0
Tomato	35.0	45.0
Eggplant	32.0	40.0
PepperS	12.5	15.0
Squash	32.0	35.0
Cucumber	20.0	30.0
Beans	12.5	15.0
Cauliflower & Cabbage	27.0	30.0
Onions	20.0	25.0
Potatoes	25.0	30.0
Watermelon	22.0	25.0
Other Vegetables	25.0	30.0
Oranges	30.0	40.0
Lemons	30.0	35.0
Grapefruit	40.0	50.0
Bananas	30.0	35.0
Other Fruit	25.0	30.0

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The two yield series have been based on local experience and international comparisons. The yields projected for the Conversion Area without the project are already quite common in the Valley. It is assumed, however, that it will take 13 years (to 1990) for these to become the area-wide average if surface irrigation is maintained. The yields that can be gained following the implementation of the project have been determined with reference to comparable schemes in the United States, Israel and Cyprus. Data was collected from 27 sources by a consultant agronomist to confirm the forecasts and his report has been produced as a limited edition Appendix Table G-30 gives a selective summary of the results. Here it can be seen that the study estimates are frequently below those thought attainable by experts in the Departments of Agriculture of Jordan and Israel, and the normative yields reported from Cyprus. Generally yields now obtained in the United States are lower than those reached under intensive cultivation in the Middle East. This observation does not however apply to grains and fodders. Taking the figures as a whole, the forecast yields are thought to give a reasonable estimate of the potential that exists for improvement in the immediate future if the project is implemented.

As the agronomist notes in his report there are certain necessary conditions for the achievement of higher yields in the Jordan Valley. These include:

(1) Comprehensive project planning, including attention to marketing, mechanization, research, extension and complementary investments in infrastructural and social facilities. Recommendations on these subjects are given in Chapter VI of this appendix.

Table G-30

COMPARATIVE ESTIMATES OF POTENTIAL CROP YIELDS (tons/ha)

Crop	Jordanian[1] Panel	Israeli[2] Panel	Cypriot[3] Data	El Centro[4] U.S.A.	Assumed Project Potential
Wheat	3.0	4.0	1.8	5.3	5.0
Barley	3.5	2.0	2.3	4.9	5.0
Maize[5]	27.5	N.A.	N.A.	42.3	35.0
Sorghum[5]	46.6	21.7	N.A.	42.0	40.0
Berseem[5]	55.0	N.A.	N.A.	N.A.	60.0
Tomato	50.0	75.0	45.0	39.0	45.0
Eggplant	40.0	60.0	67.5	13.2	40.0
Peppers	30.0	35.0	45.0	13.2	15.0
Squash	30.0	25.0	26.3	22.5	35.0
Cucumber	30.0	25.0	30.0	14.3	30.0
Beans	22.5	N.A.	18.7	26.5	15.0
Cauliflower	30.0	25.0	28.5	N.A.	30.0
Cabbage	40.0	35.0	26.3	29.2	30.0
Onions	40.0	45.0	26.3	30.5	25.0
Potatoes	30.0	45.0	33.8	N.A.	30.0
Watermelon	30.0	40.0	37.5	21.2	25.0
Other Vegetables	N.A.	N.A.	N.A.	N.A.	30.0
Grapefruit	50.0	65.0	56.3	53.5	50.0
Lemon	35.0	25.0	37.5	49.6	35.0
Orange	40.0	45.0	33.8	25.8	40.0
Banana	45.0	45.0	22.5	N.A.	35.0
Grapes	17.5	20.0	15.0	N.A.	30.0

1/ Colloqium held 29/8/77, Amman
2/ Colloqium held 7/9/77, Tel Aviv
3/ Data from Norm Input-Output Data of the Main Crops of Cyprus, by S. Papachristodoulou, Nicosia, 1976
4/ For field crops and vegetables, averages of data collected from El Centro, 15/9/77: for fruits, averages of data collected from Yuma, 17/9/77
5/ Green Feed

(2) An effective land reform programme to give the land to owner operators. This should include a law against the fragmentation of holdings, the elimination of absentee landowners and limitations on the aggregation of farms.

(3) The formation of co-operatives for the supply of farm supplies like seeds, chemicals and fuels, and where possible the provision of machinery on an individual farm or farmer co-operative basis.

(4) The institution of positive extension and research programs designed to provide specialist advice which is directed towards showing farmers how they can increase their incomes.

For the purposes of this project analysis, it is assumed that the forecast yields will be reached within 4 years of the completion of the sprinkler system on the Conversion Area, and over a period of 7 years in the New Lands. These targets are thought to be feasible if the conditions described in this report are met. However, the assumption of a static ceiling on yields at full development is unrealistic and this point should be borne in mind when evaluating the economic value of the project over its full life. Experience from the United States supports this view. Agronomists in California estimate, for example, that average yields of processing tomatoes are likely to rise from 47 tons per hectare in 1961-65 to 75 tons per hectare in 1980 and 85 tons per hectare by the end of the century, on the basis of past trends (see Projections of California Agriculture to 1980 and 2000, California Agriculture Experiment Station Bulletin 847, Table 4). The potential rises for other vegetable crops are equally dramatic and suggest that the long-term potential of the Jordan Valley may be understated in this report.

The Estimation of Irrigation Benefits

The data that has been presented on prices, yields and production costs makes it possible to estimate the Net Returns that will be gained in the project area when the land development programme has been completed. As defined in the Chapter I of this Appendix, net returns are the margin between Sales Revenue at the farmgate, and basic Production Costs. The cost figures do not include payments for housing and irrigation water and do not assign values for the labour and management skills supplied by the farmers and their families. General taxation is also excluded, so that the Net Return figures can be regarded as a measure of the Value Added to the local economy through agricultural production.

For the purposes of this analysis, it it necessary to give separate figures for the 12,856 hectares included in the Conversion Area, and the 12,506 hectares which make up the New Lands. Tables G-31 and G-32 provide the relevant information. On the Conversion Area, Net Returns at full development with the project will total about 19,240,500 JDs per year, which is equivalent to an average of about 1,498 JDs per hectare per year. Field crops will generate about 8 per cent of the total; vegetables will contribute about 57 per cent, and fruit will be slightly more important since a larger area will be allocated to bananas. Total Net Returns for the New Lands are estimated at 19,066,800 JDs per year at full development, which is equivalent to an average of 1,524 JDs per hectare.

Table G-31

ESTIMATED NET RETURNS ON THE CONVERSION AREA AT FULL DEVELOPMENT - WITH PROJECT

Crop/Item	Sales Revenue Per ha. (JDs)	Sales Revenue Total (1,000 JD)	Production Costs Per ha. (JDs)	Production Costs Total (1,000 JD)	Net Returns Per ha. (JDs)	Net Returns Total (1,000 JD)
Wheat	360.0	231.1	99.6	63.9	260.4	167.2
Barley	310.0	597.1	97.1	187.0	212.9	410.0
Maize	472.5	182.0	160.5	61.8	312.0	120.2
Sorghum	400.0	154.1	125.0	48.2	275.0	105.9
Berseem	600.0	1,001.7	144.7	241.6	455.3	760.1
Tomato	2,587.5	5,648.9	588.0	1,283.7	1,999.5	4,365.2
Eggplant	1,660.0	1.705.4	595.2	611.5	1,064.8	1,093.9
Pepper	948.0	487.0	584.5	300.2	363.5	186.8
Squash/Cucumber	2,350.0	1,508.9	291.8	187.4	2,058.2	1,321.5
Beans	1,617.0	830.0	288.0	147.9	1,329.0	682.7
Cauliflower/Cabbage	1,050.0	674.2	286.9	184.2	763.1	490.0
Onions	1,687.5	866.8	315.5	162.1	1,372.0	704.7
Potatoes	2,097.0	1,615.7	416.0	320.5	1,681.0	1,295.2
Watermelon	780.0	1,202.0	190.5	293.6	589.5	908.4
Other Vegetables	1,500.0	385.3	344.5	88.5	1,155.5	296.8
Citrus	2,720.0	3,842.3	558.0	788.2	2,162.0	3,054.1
Banana	4,473.0	574.4	1,094.5	140.6	3,378.5	433.8
Other Fruit	3,000.0	3,852.6	516.5	663.3	2,483.5	3,189.3
Portable Sprinkler Equipment	-	-	26.9	345.4	-	-
Average/Total	1,974.7	25,360.1	476.5	6,119.6	1,498.2	19,240.5

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Table G-32

ESTIMATED NET RETURNS ON THE NEW LANDS AT FULL DEVELOPMENT - WITH PROJECT

Crop/Item	Sales Revenue Per ha. (JDs)	Sales Revenue Total (1,000 JD)	Production Costs Per ha. (JDs)	Production Costs Total (1,000 JD)	Net Returns Per ha. (JDs)	Net Returns Total (1,000 JD)
Wheat	360.0	225.1	99.6	62.2	260.4	162.9
Barley	310.0	581.6	97.1	182.1	212.9	399.5
Maize	472.5	177.3	160.5	60.2	312.0	117.1
Sorghum	400.0	150.1	125.0	46.9	275.0	103.2
Berseem	600.0	975.7	144.7	235.3	455.3	740.4
Tomato	2,587.5	5,502.0	588.0	1,250.3	1,999.5	4,251.7
Eggplant	1,660.0	1,661.1	595.2	595.2	1,064.8	1,065.5
Pepper	948.0	474.3	584.5	292.4	363.5	181.9
Squash/Cucumber	2,350.0	1,469.7	291.8	182.5	2,058.2	1,287.2
Beans	1,617.0	809.0	288.0	144.0	1,329.0	665.0
Cauliflower/Cabbage	1,050.0	656.7	286.9	179.4	763.1	477.3
Onions	1,687.5	844.3	315.5	157.9	1,372.0	686.4
Potatoes	2,097.0	1,573.7	416.0	312.2	1,681.0	1,261.5
Watermelon	780.0	1,170.7	190.5	285.9	589.5	884.8
Other Vegetables	1,500.0	375.3	344.5	86.2	1,155.5	289.1
Citrus	2,720.0	3,742.4	558.0	767.7	2,162.0	2,974.7
Banana	4,473.0	1,678.9	1,094.5	410.8	1,378.5	1,268.1
Other Fruit	3,000.0	3,002.6	516.5	516.9	2,483.5	2,485.7
Portable Sprinkler Equipment	-	-	18.9	235.2	-	-
Average/Total	2,003.8	25,070.5	479.8	6,003.7	1,524.0	19,066.8

To complete the data requirements for a full project appraisal it is necessary to estimate the level of Net Returns that would be attainable in the future in the Conversion Area if the project does not go ahead. Implementing improved farming methods, as described in this chapter, will likely produce a slow but steady increase in yields with surface irrigation. Such increases are estimated to raise the returns from about 522 JDs per hectare in 1977 to about 908 JDs per hectare in 1990. As previously discussed, it has been assumed that Net Returns cannot be improved elsewhere in the Valley without the project.

It is now possible to summarize the likely incidence of direct irrigation and land development benefits in the project area. By definition, the difference between annual net returns with and without the project gives the incremental level of Value Added that can be attributed to the development programme. This excludes any transfer payments that are made by the farmers to the Government, such as water charges and general taxes. As far as family labour is concerned it is assumed that no production will be foregone as a result of the labor of farm families in the project area. To a large degree the farmers will be drawn from labourers and farmers' sons who already live in the Valley. Where immigrants are concerned, it is assumed that they will be drawn from upland and desert irrigation schemes where there are few opportunities for agricultural workers. In addition some 35,000 to 40,000 individuals are expected to join the national work force between 1976 and 1982, which is likely to worsen the level of unemployment in Jordan in the near future.

The summary Net Return figures are given in Table G-33. This information can be used to draw up a schedule of the

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incidence or irrigation benefits, when due account is taken of the phasing of land development and the build up of productivity on the farms. The land development programme stretches over 5 years. In the Conversion Area the peak year for the installation of sprinklers is likely to be 1979, when some 4,152 hectares will be serviced. In the New Lands, the peak year will be 1982 when 3,615 hectares will be developed. The whole program is discussed in more detail in the Appendix H, Economic Analyses. As previously discussed, it is assumed that farms in the Conversion Area will reach full development four years from the installation of the sprinkler system. In the New Lands a period of seven years is allowed for the build up of soil fertility and the maturation of fruit trees.

The full schedule for direct net irrigation benefits is given in the Appendix H, Economic Analyses. This shows that benefits will rise from zero to about 12,750,000 JDs in year 5, and about 29,540,000 JDs in year 10. The total annual value of the irrigation benefit stream is expected to stabilize at about 31,087,000 JDs in Year 13.

The sensitivity tests described in the Economic Analyses have been based on 2 additional cropping patterns. The first is termed the Low Summer Water Use Pattern. This concentrates vegetable production between November and April. Using the basic yield and crop net return forecasts discussed in this Chapter, the average value for net returns at full development with this pattern would be 1,496 JDs per hectare in the Conversion Area and 1,522 JDs per hectare in the New Lands. This indicates that it would be possible to conserve water and maintain farm incomes in a dry spell with good management.

Table G-33

SUMMARY ESTIMATES OF THE ANNUAL VALUE OF NET RETURNS IN THE PROJECT AREA

Present Status of Land	Net Returns without Project	Net Returns with Project	Incremental Value Added
A. Conversion Area			
(1) Irrigated EGMC	522 1/ to 908	1,498	590
(2) Unirrigated	50	1,498	1,448
B. New Lands			
(1) Unirrigated	50	1,524	1,474
(2) Irrigated Wells and Wadis	200	1,524	1,324

1/ Returns rise from 522 to 908 JDs per hectare between 1978 and 199

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However the use pattern is not recommended because it would lead to unacceptable shortages of vegetable produce on the domestic market during the summer. This fact would of course be reflected in price distortions which cannot be predicted at this level of analysis.

The second alternative hase been termed the Vegetable Intensive Pattern. Under the central yield and net return forecasts, the implementation of this pattern would give average net returns of 1,747 JDs per hectare at full development, for the project area as a whole. Here problems could arise in disposing of all the vegetables that would be grown, at least until 1995. However this alternative may give a guide to returns in the longer term, when it may prove profitable to either reduce the dairy element in the rural economy or let it become increasingly dependent on imported concentrates and fodder.

Conclusion

Considerable scope exists for the improvement of crop husbandry in the Jordan Valley. The implementation of the project will make it possible to introduce new forms of land-use and farming technology on the areas that are now irrigated by surface methods. The storage of water in Lake Maqarin will alleviate shortages and reduce water supply uncertainities, while the installation of a sprinkler system will permit its more accurate and flexible application at the farm level. On the New Lands it will be possible to apply the lessons of past experience to ensure that the tull potenital of the land is reached. Given the changes in farm technology that have been outlined so far in this report and the ancillary developments discussed in Chapter VI the implementation of the project is likely to yield agricultural benefits worth 31 million JDs per year by 1990.

Chapter IV

IRRIGATION WATER REQUIREMENTS

General

The crop water use values used as a basis for the design of the sprinkler network and appurtenances are based on the work reported in the Dar Al Handasah-Nedeco study of the Jordan Valley Project.[1/] The Consultants do not have any evidence or reason to modify the previously developed values. Therefore, these crop water use values were applied to the cropping patterns developed for the Project to arrive at net irrigation requirements.

Crop Water Use Determination

Various methods to determine the amount of water consumed by crops are available. Direct methods, involving tank and lysimeter experiments or soil moisture studies, are not suited for project planning in developing areas as they require several years of growing the anticipated crops. Indirect methods attempt to relate data on temperature, humidity, wind and radiation to potential water use of crops. When the potential use is multiplied by the appropriate crop factor it provides the expected crop water use. Of these indirect methods, the most widely known are those of Blaney-Criddle, Evaporation Index (Shallow Lake) and Penman. The Penman method uses the most complete theoretical and rational approach but its limitation is that it requires climatic data that are not usually available. The Evaporation Index method requires actual pan evaporation data or climatic data similar to that of Penman, and this also limits its use. Blaney-Criddle is a simplified relationship using temperature and daylight-hours data which are usually available.

1/ Jordan Valley Project, Agro-and Socio-Economic Study, Final Report, Dar Al-Handasah Consulting Engineers, NEDECO, April, 1969.

To convert potential water use to specific crop use, individual crop factors are required. Very few crop factors are published for the Penman method, a moderate amount for the Shallow Lake method, while for the Blaney-Criddle method, available data is extensive. The Blaney-Criddle method provides reasonable total annual use when carefully selected crop coefficients are used while the Penman method provides better short-period estimates required to determine peak use values for design. Comparisons between the two methods, with data for similar climatic areas and with limited data obtained from the project area during the 1967-69 study period, indicated a close agreement when using the modified crop factors shown in Chapter III. The modified Blaney-Criddle method, using adjusted crop factors that seem to compensate for its lack of consideration of humidity and wind, was used for the following reasons:

1. Availability of the requisite long-term climatic data for all parts of the project area,
2. Availability of crop factors,
3. Agreement with actual crop water use data obtained in the field.

The primary arguments against using Penman or the Shallow Lake method are the lack of sufficient climatic data, the consequential error in estimates resulting from approximations, and the fact that many crop factors would have to be assumed. The consequence of using Blaney-Criddle is to have very nearly the same total seasonal amount as the other methods but slightly lower peak values.

Net Irrigation Requirements

The Blaney-Criddle method with modified crop factors was used for determining the crop water use. Crop Water Use, also referred to as Consumptive Use or Evapotranspiration, is the actual amount of water used by a crop in transpiration and building up of plant tissue and that evaporated from adjoining soil surfaces. The basic relation is:

$$U = K \frac{P}{100} (45.7t + 813) = Kf, \text{ where}$$

U = Monthly crop water use, in millimeter depth,

K = Empiricial water use crop coefficient which is a function of climate and stage of growth,

P = Monthly percentage of the annual daylight hours for the locality, and

t = Mean monthly air temperature in °C.

When K is assumed to be one, the value of U is f and this is approximately equal to potential evapotranspiration.

The environmental factors used for calculating water use and the f-factor in the Blaney-Criddle relation are tabulated in Table G-34 for both north and south zones. The separation between the north and south zones is assumed to be the Zarqa River. The modified crop factors selected by the Consultants are given in Table G-35. The cropping dates are shown in Table G-36 and a sample calculation of the net irrigation requirements for the amount of water, exclusive of precipitation, required to grow a crop, is shown in Table G-37.

The crop selected for the sample calculation is tomatoes II. The top two lines of the table give the crop factor during each month of growth after being modified for both temper-

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Table G-34

ENVIRONMENTAL FACTORS - BLANEY CRIDDLE FORMULA - JORDAN VALLEY

	(P) Percentage Daytime hours 32°N	Mean Temperature in °C N(1)[a/] Zone	Mean Temperature in °C S[b/] Zone	Precipitation - mm North Zone Mean[c/]	Precipitation - mm North Zone Effective	Precipitation - mm South Zone Mean[d/]	Precipitation - mm South Zone Effective	f Factor in BC Relation mm North Zone	f Factor in BC Relation mm South Zone
January	7.20	14.1	14.6	68.6	39	37.9	20	105	106
February	6.97	15.1	15.6	56.7	31	26.8	14	105	106
March	8.37	17.4	18.4	43.3	27	18.9	10	134	138
April	8.75	21.3	22.1	16.2	10	7.8	4	156	159
May	9.63	25.6	26.6	5.7	4	2.7	1	190	195
June	9.60	29.0	29.9	-	-	-	-	205	209
July	9.77	30.5	31.3	-	-	-	-	216	219
August	9.28	31.0	31.7	-	-	-	-	207	210
September	8.34	29.2	29.6	-	-	-	-	179	180
October	7.93	26.6	27.1	9.8	6	3.4	2	159	163
November	7.11	21.2	21.9	41.2	26	19.7	11	127	129
December	7.05	16.3	16.6	75.4	45	34.0	19	110	111
Total	100.00			316.9	188	151.2	81	1,893	1,925

a/ Weighted Average of North Shunah, Ziglab, Jurum, Yabis and Deir Alla Station.

b/ Weighted Average of Faria (Ag. St.) Faria (C.W.A.) Jericho, South Shunah, Hisban and Dead Sea North Station.

c/ Weighted Average of Adassiya, Baqura, North Shunah, Ziglab, Jurum, Yabis, Wahadina Gaging Sta. Kufrinja, Deir Alla E.G.C.A. and Deir Alla Agr. Exp. Stations.

d/ Weighted Average of Deir Alla. Faria, Auja, South Shunah, King Hussein Br. Jericho. Er-Rameh, Kafrein and Dead Sea North Stations.

Table G-35

MODIFIED CROP FACTORS JORDAN VALLEY
(Percent)

Annual Crops	Months of Growth I	II	III	IV	V	VI	VII	VIII
Tomatoes	48	72	96	88	80			
Cabbage-Cauliflower	48	72	96	88				
Egg Plant/Sweet Peppers	48	72	96	88	80	80	80	80
Melons/Beans	48	80	88	80				
Cucumber/Squash	48	72	80	80				
Potatoes	48	88	96	96				
Onion/Garlic	52	76	84	76	60			
Wheat/Barley	48	72	96	96	80	80		
Maize	48	76	92	92	88			
Berseem	52	72	72	80	84	92		
Sorghum	48	64	80	92	96			

Calendar Month

Perennial Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Bananas	70	80	80	90	100	110	115	115	115	100	90	80
Citrus	48	48	48	56	56	60	60	60	60	56	56	40
Other Fruits			32	48	60	68	68	68	56	40	32	

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Table G-36

CROPPING DATES

	Planting	Harvesting
Wheat/Barley	1/12-31/12	31/ 5-30/6
Berseem	1/10- 1/11	30/ 4-31/5
Maize	1/5 - 1/6	30/10-30/11
Sorghum	1/5 - 1/6	30/10-30/11
Tomatoes I	1/8 - 1/9	31/ 1-28/2
Tomatoes II	1/10- 1/11	31/ 3-30/4
Tomatoes III	1/5 - 1/6	31/10-30/11
Eggplant I	1/9 - 1/10	31/ 5-30/6
Eggplant II	1/3 - 1/4	30/11-31/12
Peppers I	1/8 - 1/9	30/ 4-31/5
Peppers II	1/2 - 1/3	31/10-30/11
Squash/Cucumber I	1/9 - 1/10	31/ 1-28/2
Squash/Cucumber II	1/2 - 1/3	30/ 6-31/7
Cabbage/Cauliflower I	1/8 - 1/9	31/12-31/1
Beans I	1/9 - 1/10	31/ 1-28/2
Beans II	1/2 - 1/3	30/ 6-31/7
Melons	1/3 - 1/4	31/ 7 -31/8
Potatoes I	1/9 - 1/10	31/ 1 -28/2
Potatoes II	1/2 - 1/3	30/ 6 -31/7
Onion/Garlic	1/8 - 1/9	31/1 -28/2
Other Vegetables	1/9 - 1/0	28/2 -31/3
Banana		
Citrus	Perennials	
Other Fruits		

Table G-37

SAMPLE CALCULATION OF CROP WATER REQUIREMENT - TOMATOES II

		Sept	Oct	Nov	Dec	Jan	Feb	Mar
Month of Growth			1	2	3	4	5	6
Modifiied Crop Factor			48	72	96	88	80	
Actual Growing Period		Sept	Oct	Nov	Dec	Jan	Feb	Mar
For indicated % of Area	25		12	18	24	22	20	
	50		12	12 18	18 24	24 22	22 20	20
	25			12	18	24	22	20
Weighted factor, %			24	60	84	92	84	40
Mean Monthly Temp. °C (t)			26.2	21.2	16.3	14.1	15.1	17.4
Monthly Daylight Hours % (P)			7.93	7.11	7.01	7.20	6.97	8.37
Potential Evapo-Transpiration, mm a/			159	127	110	105	105	134
Water Use, mm/month b/			39	77	93	97	89	54
Pre-Irrigation		+15	+45	+	+	+	+	+
Modifications (Soil Moisture Depletion		+	+	+		-10	-20	-10
Eff. Precipitation c/		+	-3	-26	-45	-39	-31	-13
Net Crop Irrigation Requirements d/		15	81	51	48	48	38	31

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a/ Potential E.T. = $(45.7t + 813) \frac{P}{100}$

b/ Water Use = Potential E.T. x Crop Factor

c/ Effective Precipitation determined as follows:

	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Mean monthly, mm	-	9.8	41.2	75.4	68.6	56.7	43.3
Eff. 8 out of 10 years	-	6	26	45	39	31	27
Weighted Eff. Ppt.	-	3	26	45	39	31	13

d/ In mm per month

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ature and growth state. The lower four lines show how the weighted crop factor during each month is calculated. The weighting is due to the variations in planting and harvesting dates. For the example, 25 percent of the area is planted at the beginning of October, 50 percent at mid-October, and 25 percent at the end of October. Thus during the month of October, 25 percent of the area will be under crop for the whole month and an additional 50 percent of the area will be under crop for half of the month. Since, for the first growing month the modified crop factor is 48 percent, then the weighted modified crop factor will be 24 percent as shown on the fourth line. Similarly for November 25 percent of the area will be in the second growing season month for the whole month; 50 percent of the area will be in its first growing month for two weeks and in its second growing month for the balance of the month; 25 percent of the area will be in its first month of growth during the whole month.

By multiplying the mean temperature and the daylight hours ratio, the monthly potential evapotranspiration is obtained. Multiplying this by the weighted crop factor, gives the monthly use in mm.

Three modifications were applied; pre-irrigation, soil moisture depletion, and effective precipitation. Each modification was weighted in proportion to the ratio of the area under crop during the month of its application. A pre-irrigation of 60 mm is assumed two weeks before planting. Moisture depletion is assumed at 20 mm per month during the last two months of growth. Mean effective precipitation was assumed equal to 90 percent of the mean monthly precipitation when the mean value was less than 50 mm and 80 percent when the mean monthly precipitation was more than 50 mm. The mean effective precipitation was multiplied by a probability

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factor to obtain the effective precipitation expected to be equalled or exceeded 8 years out of 10.

The monthly net requirement is the algebraic summation of monthly use and the modifications.

The modified and weighted crop factors are shown in Table G-38, and the monthly net irrigation requirements for each crop considered in the cropping pattern for both zones of the project area are shown in Table G-39 and Table G-40.

Net monthly crop irrigation requirements were calculated by multiplying the net crop irrigation requirements by the crop intensities shown elsewhere in this appendix. The resultant net monthly crop irrigation requirements for a representative cropping are shown in Table G-41 and G-42 for the north and south zones of the Valley. A summary of monthly irrigation requirements for two other cropping patterns is shown in Table G-43.

The irrigation design modules, are obtained by applying efficiency figures to the net irrigation requirements developed in the previous section.

Based on the physical features and operational aspects of the recommended irrigation system, the operation and management efficiency is predicted to be 94 percent. This prediction reflects the fact that excluding the EGMC, the distribution of water is through a closed conduit. In addition, it is anticipated that the water levels and releases to the closed distribution system will be carefully controlled. The field application efficiency is estimated to be 75 percent for the proposed portable on-farm sprinkler irrigation system. The estimate of application efficiency is based on a study done for similar irrigation facilities in California.

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Table G-38

MODIFIED AND WEIGHTED CROP FACTORS
in percent
JORDAN VALLEY

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Wheat/Barley		68	90	88	60	10	-	-	-	-	-	-	26
Berseem		76	82	88	46	-	-	-	-	-	26	62	72
Maize		-	-	-	-	22	60	84	92	90	44	-	-
Sorghum		-	-	-	-	20	52	72	86	94	48	-	-
Tomato	I	40	-	-	-	-	-	-	24	60	84	92	84
	II	92	84	40	-	-	-	-	-	-	24	60	84
	III	-	-	-	-	24	60	84	92	84	40	-	-
Eggplant	I	84	80	80	80	40	-	-	-	24	60	84	92
	II	-	-	60	84	92	84	80	80	80	80	40	-
Peppers	I	80	80	80	40	-	-	-	24	60	84	92	84
	II	-	24	60	84	92	84	80	80	80	40	-	-
Squash/Cucumber	I	40	-	-	-	-	-	-	-	24	60	76	80
	II	-	24	60	76	80	40	-	-	-	-	-	-
Cabbage/Cauliflower	I	-	-	-	-	-	-	-	24	60	84	92	44
	II	-	24	60	84	92	44	-	-	-	-	-	-
Beans	I	40	-	-	-	-	-	-	-	24	64	84	84
	II	-	24	64	84	84	40	-	-	-	-	-	-
Melons		-	-	24	64	84	84	40	-	-	-	-	-
Potato	I	48	-	-	-	-	-	-	-	24	68	92	96
	II	-	24	68	92	96	48	-	-	-	-	-	-
Onion/Garlic	I	30	-	-	-	-	-	-	26	64	80	80	68
Other Vegetable	1	68	30	-	-	-	-	-	-	26	64	80	80
Banana		70	80	80	90	100	110	115	115	115	100	90	80
Citrus		48	48	48	56	56	60	60	60	60	56	56	48

Table G-39

NET CROP IRRIGATION REQUIREMENTS - NORTH ZONE
JORDAN VALLEY
(mm)

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Wheat/Barley		33	62	75	69	17	-	-	-	-	-	15	52	323
Berseem		41	46	72	58	-	-	-	-	15	84	53	35	404
Maize		-	-	-	15	85	124	182	181	142	58	-	-	787
Sorghum		-	-	-	15	82	108	156	168	149	64	-	-	742
Tomato	I	13	-	-	-	-	-	15	95	108	128	81	28	468
	II	48	38	31	-	-	-	-	-	15	81	51	48	312
	III	-	-	-	15	89	123	182	181	131	51	-	-	772
Eggplant	I	50	53	71	95	64	-	-	15	88	80	81	57	664
	II	-	15	65	84	156	189	182	166	134	70	28	-	1,089
Peppers	I	45	43	61	48	-	-	15	95	108	128	91	48	682
	II	15	56	54	121	167	173	173	156	124	54	-	-	1,093
Squash/Cucumber	I	13	-	-	-	-	-	-	15	88	90	74	23	303
	II	15	56	54	99	128	72	-	-	-	-	-	-	424
Cabbage/Cauliflower	I	-	-	-	-	-	-	15	95	108	118	71	17	424
	II	15	56	54	121	151	81	-	-	-	-	-	-	478
Beans	I	13	-	-	-	-	-	-	15	88	96	71	38	321
	II	15	56	59	111	136	72	-	-	-	-	-	-	449
Melons		-	15	65	90	108	153	77	-	-	-	-	-	508
Potato	I	22	-	-	-	-	-	-	15	88	103	81	41	350
	II	15	56	65	124	159	79	-	-	-	-	-	-	498
Onion/Garlic		3	-	-	-	-	-	15	99	115	122	66	10	430
Other Vegetables		13	7	-	-	-	-	-	15	92	96	76	33	332
Banana		35	53	80	130	186	226	248	238	206	153	88	43	1,686
Citrus		11	29	37	77	102	123	130	124	107	83	45	8	876
Other Fruit		-	-	17	63	111	144	152	133	98	62	29	-	809

Table G-40

NET CROP IRRIGATION REQUIREMENTS -SOUTH ZONE
JORDAN VALLEY
(mm)

Crop		Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Wheat/Barley		53	81	96	75	18	-	-	-	-	-	15	55	393
Berseem		62	64	93	62	-	-	-	-	15	87	69	61	513
Maize		-	-	-	15	89	126	185	185	143	61	-	-	803
Sorghum		-	-	-	15	85	110	159	171	151	68	-	-	759
Tomato	I	23	-	-	-	-	-	15	96	108	135	98	55	530
	II	68	55	41	-	-	-	-	-	15	84	67	75	405
	III	-	-	-	15	91	126	184	184	132	55	-	-	787
Eggplant	I	69	71	91	104	67	-	-	15	89	96	98	84	784
	II	-	15	74	92	163	193	184	168	134	109	36	-	1,168
Peppers	I	65	61	81	52	-	-	15	96	108	135	108	75	796
	II	15	64	73	130	179	176	176	158	124	55	-	-	1,150
Squash/Cucumber	I	23	-	-	-	-	-	-	15	89	96	77	50	350
	II	15	64	73	107	135	74	-	-	-	-	-	-	468
Cabbage/Cauliflower	I	-	-	-	-	-	-	15	96	144	125	88	29	497
	II	15	64	73	120	159	82	-	-	-	-	-	-	513
Beans	I	23	-	-	-	-	-	-	15	89	103	88	55	373
	II	15	64	79	120	143	74	-	-	-	-	-	-	495
Melons		-	15	74	98	153	166	78	-	-	-	-	-	584
Potato	I	31	-	-	-	-	-	-	15	89	109	98	68	410
	II	15	64	84	133	167	91	-	-	-	-	-	-	554
Onion/Garlic		12	-	-	-	-	-	15	100	116	129	83	37	492
Other Vegetables		32	15	-	-	-	-	-	15	92	103	93	60	410
Banana		54	71	100	139	194	230	252	242	207	161	105	70	1,825
Citrus		31	37	56	85	108	125	131	126	108	89	61	34	991
Other Fruits		-	-	25	68	118	145	153	161	99	67	9	-	845

The report on this study is in Attachment 2 of this appendix. The overall project water use efficiency is estimated to be 70 percent.

This irrigation efficiency is real and obtainable but is higher than that which is currently taking place in the Jordan Valley. The efficiency is higher because it reflects a closed distribution system to the farm unit and farm application with portable sprinklers. To allow effective development of the irrigable lands, it is essential that efficient water use be achieved in the Jordan Valley Project. Using these high irrigation efficiencies in planning and design will assist the water users in being more effective in their water use and will limit operational waste in the irrigation operation.

It is noted in this report that these efficiencies will require good on-farm water management and effective reservoir and distribution system operation to assure their realization.

Table G-44 gives the average monthly diversion requirement for each of the two zones of the project and the design modules, at 75 percent efficiency, for the sprinkler network for each of the two zones.

Table C-41

NET MONTHLY CROP IRRIGATION REQUIREMENT
NORTH ZONE - JORDAN VALLEY
PROPOSED CROP PATTERN
(mm)

Crop		Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Wheat/barley		6.60	12.40	15.00	13.80	3.40	-	-	-	-	-	3.00	10.40	64.60
Berseem		5.33	5.98	9.36	7.54	-	-	-	-	1.95	10.92	6.89	4.55	52.52
Maize		-	-	-	.45	2.55	3.72	5.46	5.43	4.26	1.74	-	-	22.61
Sorghum		-	-	-	.45	2.46	3.24	4.68	5.04	4.47	1.92	-	-	22.26
Tomato	I	.91	-	-	-	-	-	1.05	6.65	7.56	8.96	5.67	1.96	32.76
	II	3.36	2.66	2.17	-	-	-	-	-	1.05	5.67	3.57	3.36	21.84
	III	-	-	-	.45	2.67	3.69	5.46	5.43	3.93	1.53	-	-	23.16
Eggplant	I	2.00	2.12	2.84	3.80	2.56	-	-	.60	3.52	3.60	3.24	2.28	26.56
	II	-	.60	2.60	3.36	6.24	7.56	7.28	6.64	5.36	2.80	1.12	-	43.56
Peppers	I	.90	.86	1.22	.96	-	-	.30	1.90	2.16	2.56	1.82	.96	13.64
	II	.30	1.12	1.08	2.42	3.34	3.46	3.46	3.12	2.48	1.08	-	-	21.86
Squash/Cucumber	I	.26	-	-	-	-	-	-	.30	1.76	1.80	1.48	.46	6.06
	II	.45	1.68	1.62	2.98	3.84	2.16	-	-	-	-	-	-	12.72
Cabbage/Cauliflower	I	-	-	-	-	-	-	.45	2.85	3.24	3.54	2.13	.51	12.72
Beans	I	.26	-	-	-	-	-	-	.30	1.76	1.92	1.42	.76	6.42
	II	.30	1.12	1.18	2.22	2.72	1.44	-	-	-	-	-	-	8.98
Melons		-	1.80	7.80	10.80	12.96	18.36	9.24	-	-	-	-	-	60.96
Potato	I	.66	-	-	-	-	-	-	.45	2.64	3.09	2.43	1.23	10.50
	II	.45	1.68	1.95	3.72	4.77	2.37	-	-	-	-	-	-	14.94
Onion/garlic		.12	-	-	-	-	-	.60	3.96	4.60	4.88	2.64	.40	17.20
Other Vegetables		.26	.14	-	-	-	-	-	.30	1.84	1.92	1.52	.66	6.64
Banana		.35	.53	.80	1.30	1.86	2.26	2.48	2.38	2.06	1.53	.88	.43	16.84
Citrus		1.21	3.19	4.07	8.47	11.22	13.53	14.30	13.64	11.77	9.13	4.95	.88	96.36
Other Fruits		-	-	1.70	6.30	11.10	14.40	15.20	13.30	9.80	6.20	2.90	-	80.90
Total		24.02	37.00	54.47	71.43	77.81	69.96	72.29	76.21	74.79	74.79	45.66	28.84	707.19

Table G-42

NET MONTHLY CROP IRRIGATION REQUIREMENT
SOUTH ZONE - JORDAN VALLEY
PROPOSED CROP PATTERN
(mm)

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Wheat/barley		10.60	16.20	19.20	15.00	3.60	-	-	-	-	-	3.00	11.00	78.60
Berseem		8.06	8.32	12.09	8.06	-	-	-	-	1.95	11.31	8.97	7.93	66.69
Maize		-	-	-	0.45	2.67	3.78	5.55	5.52	4.29	1.83	-	-	24.09
Sorghum		-	-	-	0.45	2.55	3.30	4.77	5.13	4.53	2.04	-	-	22.77
Tomato	I	1.61	-	-	-	-	-	1.05	6.72	7.56	9.45	6.86	3.85	37.10
	II	4.76	3.85	2.87	-	-	-	-	-	1.05	5.88	4.69	5.25	28.35
	III	-	-	-	0.45	2.73	3.78	5.52	5.52	3.96	1.65	-	-	23.61
Eggplant	I	2.76	2.84	3.64	4.16	2.68	-	-	0.60	3.56	3.84	3.92	3.36	31.36
	II	-	0.60	2.96	3.68	6.52	7.72	7.36	6.72	5.36	4.36	1.44	-	46.72
Peppers	I	1.30	1.22	1.62	1.04	-	-	0.30	1.92	2.16	2.70	2.16	1.50	15.92
	II	0.30	1.28	1.46	2.60	3.58	3.52	3.52	3.16	2.48	1.10	-	-	23.00
Squash/Cucumber	I	0.46	-	-	-	-	-	-	.30	1.78	1.92	1.54	1.00	7.00
	II	0.45	1.92	2.19	3.21	4.05	2.22	-	-	-	-	-	-	14.00
Cabbage/Cauliflower	I	-	-	-	-	-	-	0.45	2.88	4.32	3.75	2.64	0.87	14.91
	II	0.30	1.28	1.46	2.40	3.18	1.64	-	-	-	-	-	-	10.26
Beans	I	0.46	-	-	-	-	-	-	0.30	1.78	2.06	1.76	1.10	7.46
	II	0.30	1.28	1.58	2.40	2.86	1.48	-	-	-	-	-	-	9.90
Melons		-	1.80	8.88	11.76	18.36	19.92	9.36	-	-	-	-	-	70.08
Potato	I	0.93	-	-	-	-	-	-	.45	2.67	3.27	2.94	2.04	12.30
	II	0.45	1.92	2.52	3.99	5.01	2.73	-	-	-	-	-	-	16.62
Onion/garlic	I	0.48	-	-	-	-	-	0.60	4.00	4.64	5.16	3.32	1.48	19.68
Other Vegetables	I	0.64	0.30	-	-	-	-	-	0.30	1.84	2.06	1.86	1.20	8.20
Banana		1.62	2.13	3.00	4.17	5.82	6.90	7.56	7.26	6.21	3.83	3.15	2.10	54.75
Citrus		3.41	4.07	6.16	9.35	11.88	13.75	14.41	13.86	11.88	9.79	6.71	3.74	109.01
Total		38.89	49.01	71.63	78.67	84.93	82.34	72.69	77.52	79.94	82.36	55.68	46.42	820.08

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Table G-43

NET MONTHLY ZONE IRRIGATION REQUIREMENT
ALTERNATE CROPPING PATTERNS
(mm)

Month	Low Summer Use North Zone	Low Summer Use South Zone	Vegetable Intensive North Zone	Vegetable Intensive South Zone
January	31.94	48.21	19.87	31.71
February	38.73	52.67	27.90	36.91
March	54.03	71.86	42.48	56.38
April	69.69	76.97	62.62	69.05
May	66.20	73.63	79.60	90.05
June	64.88	68.62	85.77	90.52
July	58.68	61.53	77.52	80.34
August	65.01	68.11	79.78	85.49
September	68.29	71.07	86.10	89.88
October	73.69	79.91	85.01	93.24
November	54.98	65.02	50.72	61.91
December	26.42	48.94	22.86	42.12
TOTAL	672.72	786.54	720.23	827.60

Table G-44

IRRIGATION REQUIREMENTS DESIGN MODULES
FOR RECOMMENDED CROPPING PATTERN (in mm)[a]
JORDAN VALLEY

	Net Requirements		Sprinkler System Design Module - 75% Efficiency		Overall Project Diversion Requirements - 70% Efficiency	
	North Zone	South Zone	North Zone	South Zone	North Zone	South Zone
January	24.02	38.89	32.0	51.9	34.3	55.6
February	37.00	49.01	49.4	65.4	52.9	70.0
March	54.47	71.63	72.6	96.8	77.8	102.3
April	71.43	78.67	95.3	105.0	102.0	112.4
May	74.71	84.93	99.6	113.2	106.7	121.3
June	77.81	82.34	103.7	109.8	111.7	117.7
July	69.96	72.69	93.3	96.9	99.9	103.9
August	72.29	77.52	96.4	103.4	103.3	110.8
September	76.21	79.94	101.6	106.6	108.9	114.2
October	74.79	82.36	99.8	109.8	106.9	117.7
November	45.66	55.68	60.9	74.2	65.2	79.6
December	28.84	46.42	38.5	61.9	41.2	66.3
TOTAL	707.19	820.08	943.1	1,094.9	1,010.3	1,171.8

a/ Multiply given figures by 10 to obtain cubic meters per hectare.

Chapter V

REPRESENTATIVE FARM BUDGETS

Introduction

This chapter examines the economic and financial structures of representative farm units, with and without the proposed project. For simplicity, the analyses have been restricted to model 4 hectare general farms, growing field crops and vegetables; and 3 hectare fruit farms. These farm sizes have been determined primarily by the requirements of Natural Resources Authority Law No. 12 (1968) which states that land holdings in government developed irrigation areas in the Jordan Valley should be allocated in 3 hectare holdings of Class I and Class II land, and 5 hectare holdings of Class III land. In practice these requirements will not be applied rigidly because some account has to be taken of the constraints imposed by the water distribution system, and the desirability for some degree of uniformity in farm investment and net returns per holding. The cropping patterns which have been chosen illustrate the average level of net returns that will be reached when the project is completed. The budgets that follow should therefore be viewed as examples drawn from a very wide range of possible farm types. Additional models can be built up as required from the data presented in Chapter III.

The third section of this chapter considers the economic structure of the model 100 cow dairy units which have been proposed by the Jordan Valley Authority. These units will stall feed their cattle, and the general farming area will supply their fodder needs on a contract basis. From an economic viewpoint these units are therefore ancillary to the main project and represent one source of secondary benefits. The primary gains will accrue to the farmers from the sale of concentrates, green fodder and crop residues.

4-Hectare General Farms

Background

According to the proposed project cropping pattern, 78 per cent of the irrigated area will be reserved for field crops and vegetables. It is proposed that most of these crops should be grown on specially designated blocks of land, segregated to some degree from the orchards. The typical field crop - vegetable units have been termed general farms. The separation of the two main crop types will make it easier to provide specialist services and will promote co-operation among farmers with similar problems and skills.

Land-Use

A large number of considerations enter into the determination of farm cropping patterns. At the industry scale these include general climatic conditions, foreign and domestic demand, and government policy towards agriculture. At the farm scale they include local microclimatic and soil conditions, the compatibility of crops and crop sequences, and the availability of the various factors of production that are required by the enterprise. The best patterns are either the result of intensive agronomic research, or the consequence of the collective experience of the farming community. It is therefore important for the reader to remember that the cropping pattern that is discussed in this section should be regarded as an example rather than a specific recommendation. It is obvious that further research should continue in Jordan on the agronomy and agricultural economy of alternative cropping patterns, and that this work may further raise the development potential of the project area.

Model cropping patterns for a 4 hectare general farm in the Conversion Area with and without the project, are given in Table G-45. For the purposes of this analysis it is assumed that only one per cent of the area will be lost to pathways and drains. The farmers house and any additional buildings will be located in planned villages above the irrigated land as described in Chapter V of this Appendix. At present the average cropping intensity in the Conversion Area is 106 per cent. Typically, farmers divide their land between a cereal crop and two vegetables crops. In the example the crops are wheat, tomatoes and mixed vegetables. There is only a small amount of double-cropping due to the difficulty that arises in guaranteeing the supply of water. The structure of returns with surface irrigation is given in Table G-46 which shows that about 2,108.5 JDs per year remains when the cost of materials, hired labour and other services is subtracted from the revenue earned by farm sales. From this residual farmers must meet the cost of irrigation water, taxes and loan repayments, and draw a suitable reward for the labour and managerial skills supplied by the family.

Following the implementation of the project it is expected that the average land-use intensity in the general farming area will rise to about 136 per cent. A model crop sequence which gives an intesity of 132 per cent and net returns near the project average is shown in Table G-45 and illustrated in Figure 2. The farm is divided into 3

Table G-45

MODEL CROP MIX: 4 HECTARE GENERAL FARMS

Crop	Existing Pattern Conversion Area		Proposed Pattern	
	Crop Factor	Area Cropped (ha)	Crop Factor	Area Cropped (ha)
Wheat	0.40	1.60		
Barley			0.33	1.33
Tomatoes	0.33	1.33		
Potatoes			0.33	1.33
Squash/Cucumber			0.33	1.33
Fodder Maize			0.33	1.33
Other Vegetables	0.33	1.33		
Total	1.06	4.26	1.32	5.33

Table G-46
ECONOMIC BUDGET: 4 HECTARE GENERAL FARM, CONVERSION AREA

Crop	Production (tons)	Farmgate Price (JDs/ton)	Sales Revenue (JDs)	Production Costs (JDs)	Net Returns (JDs)
Without Project					
Wheat Grain	2.40	60.00	144.00	47.52	
Wheat Straw	2.40	12.00	28.80	-	
Tomatoes	26.60	57.50	1,529.50	363.09	
Other Vegetables	21.28	50.00	1,064.00	247.11	
Total			2,766.30	657.72	2,108.58
With Project					
Barley Grain	6.65	50.00	332.50	129.14	
Barley Straw	6.65	12.00	79.80	-	
Potatoes	39.90	69.90	2,789.01	553.28	
Squash/Cucumber	43.20	72.31	3,125.50	388.09	
Fodder Maize	46.55	13.50	628.40	213.47	
Sprinkler Equipment a/				107.92	
Total			6,955.21	1,391.90	5,563.33
Increment due to Project					3,454.75

a/ Costs per year for eight years.

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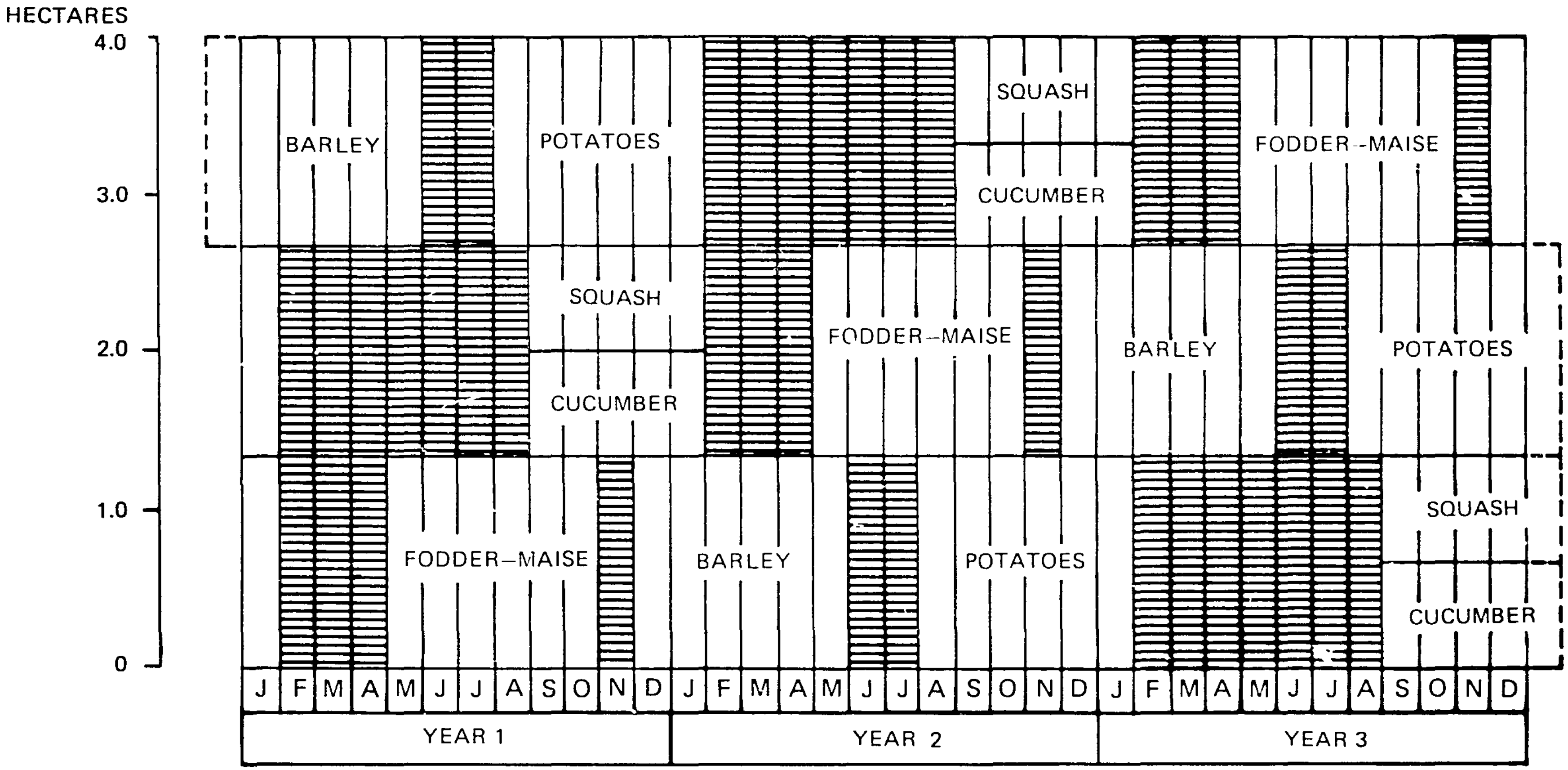

FIGURE 2
MODEL CROP ROTATION FOR 4 HECTARE GENERAL FARM

JORDAN VALLEY IRRIGATION PROJECT
STAGE II

Dar Al-Handasah Consultants JANUARY 1978 fields each of which is 1.33 hectares in area. One of these fields will be double-cropped each year. The rotational sequence is barley-potatoes-squash/cucumber-fodder maize. This avoids sequential cropping with plants of the same family and disease risk (e.g. solanacea), and minimises water and labour requirements at the height of the summer. If sufficient water is available, much more intensive rotations can be implemented. An example is shown in Figure 3 where barley-tomatoes-melons-cauliflower/cabbage-fodder maize are rotated over a three year period to give an overall intensity of 166 per cent. The scope for further variations is considerable and the land use pattern that eventually develops in the Valley will reflect a wide range of agronomic and agro-economic factors. The following sections discuss the expected incidence of resource use and costs for the model pattern, which presents a conservative view of the opportunities that will be open to farmers when the project is completed.

Materials

The average per hectare levels of expenditure that will be required to produce field crops and vegetables under the proposed system have already been summarized in Table G-25. These figures relate to resource usage on farms varying from 3 to 5 hectares in size. The gross materials requirements of the model 4 hectare farm can therefore be listed as follows:

	JDs
Seeds and Plants	154
Fertilizer and Manure	350
Plant Protection	150
Other Materials	93
Total	747

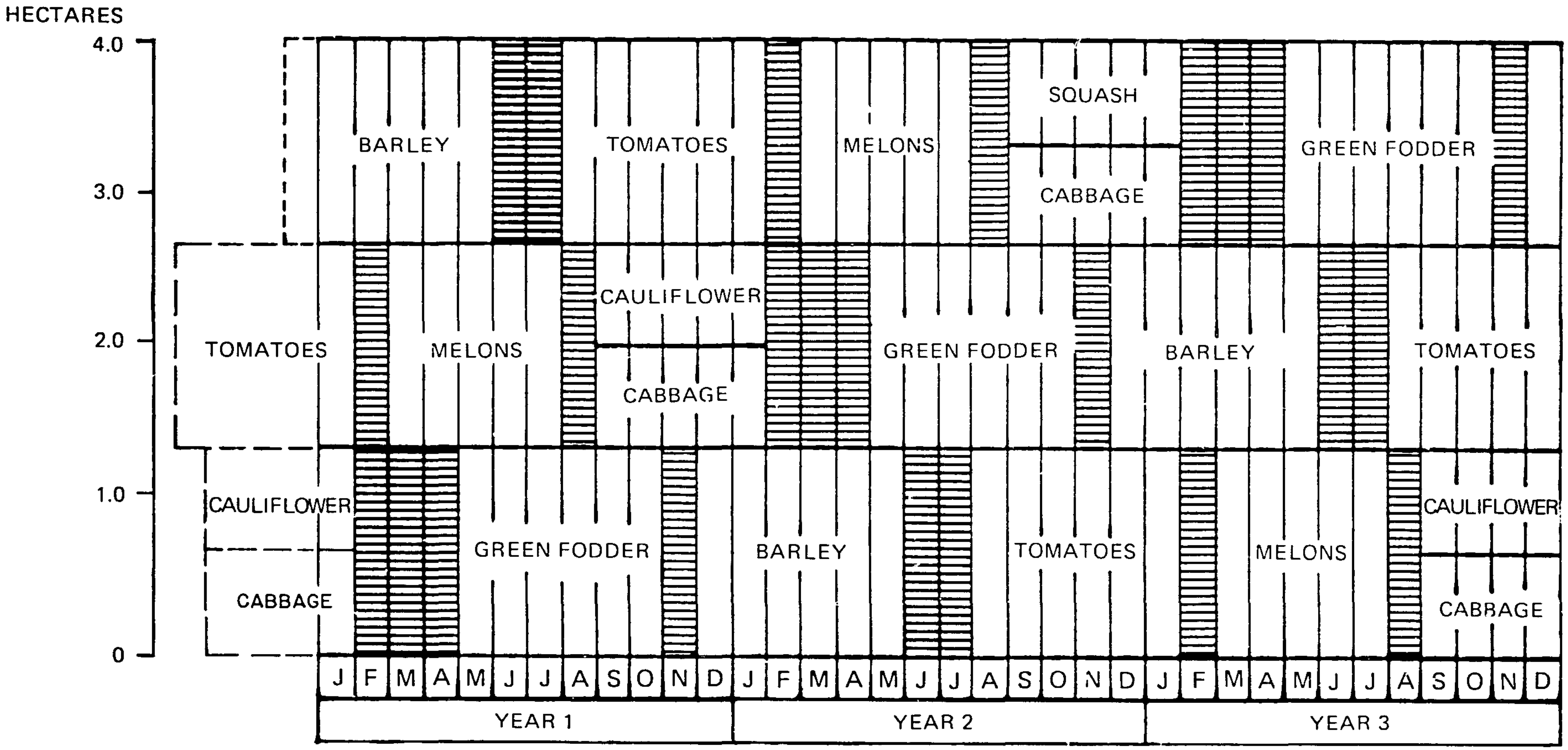

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FIGURE 3

ALTERNATIVE CROP ROTATION FOR 4 HECTARE GENERAL FARM

JORDAN VALLEY IRRIGATION PROJECT
STAGE II

Dar Al-Handasah Consultants JANUARY 1978

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The main item in the seeds and plants category is the purchase or reservation of seed potatoes for planting in August at a cost of 90 JDs per hectare. The fertilizers consist of 53 tons of organic manure, 3 tons of single superphosphate and 4 tons of sulphate of ammonia. The other items include a wide range of materials which will vary according to the crop and the nature of the season.

Water

The water applications that will be needed for farms in the Conversion Area are based on the north zone net irrigation requirements given in the Irrigation Appendix. The total net requirement for the model cropping pattern shown in Figure 2 will be about 23,450 cubic metres per farm or 5,863 cubic metres per hectare. With a farm system efficiency of 75 per cent, the farmer will pay charges on the 7,817 cubic metres per hectare that will be recorded as reaching his farm. At full development this water will be charged at 0.01 JDs (10 fils) per cubic metre, giving a farm cost of about 313 JDs per year. Overall, the system efficiency is estimated at 70 per cent so that about 33,500 cubic metres will be released from the reservoir for the farm.

The peak use will occur in September with an average net irrigation requirement of about 1,057 cubic metres per hectare. The lowest usage will occur in February with a net requirement of 206 m^3 per hectare. As discussed in Chapter III the cropping pattern for the whole project is designed to conserve water during the summer, though this is not immediately obvious from the figures for the model farm. Here the growth of fodder maize between April and October is responsible for a September peak. This points up the fact that high crop net irrigation requirements in the summer

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semester will act as a constraint on the expansion of activities like dairying. This will be relatively more important in the New Lands of the southern part of the Valley. For farms in this area, for example, it will be necessary to release about 36,000 m^3 to support the proposed crop rotation on a 4 hectare farm.

The annual cost of the portable sprinkler equipment required on the farms is estimated at about 108 JDs in the Conversion Area and about 75.5 JDs in the New Lands. The differential reflects the additional costs that arise in providing equipment for the irregularly shaped holdings of the Conversion Area. The capital cost estimates for the two areas which are 644.0 and 451.0 JDs per farm respectively have been derived from model costings. Ideally, the 4 hectare farms will be dimensioned 336 by 120 metres giving 28 sprinkler line settings or 420 by 96 metres giving 35 settings. This will result in farms with gross areas of 4.032 hectares.

Labour

Using the data generated on future labour demands, the total requirement for the model cropping pattern is estimated at 1,901 man-hours per year, or an average of about 158 man-hours per month. As previously described, it is assumed that about 250 hours per month will be available from the farm family, made up of 200 hours per month from the operator and 50 hours per month from dependents. However, the incidence of labour usage over the year shows a peak requirement of 846 hours in January during the harvesting period for early potatoes and cucumbers. At this time it will be necessary to hire a fairly large amount of seasonal labour. Hired labour could also be needed in September and December though the extra inputs in these months could be met quite easily by overtime from the farm family. The budget figure however is estimated on the gross requirement, which is for 564 hours, costing about 141 JDs.

As far as the project as a whole is concerned the incidence of labour demand is fairly even throughout the year. The average farm requirement is also much nearer to the amount of labour available from a farm family than the example that has just been quoted. This is because some high value crops such as tomatoes, eggplant and peppers are best grown by labour intensive methods. However, there do appear to be opportunities to increase labour usage through the intensification of cropping if sufficient water can be supplied.

Machinery

The estimated machinery requirements for the model pattern is 63.7 working hours per year. This has been costed at 2.50 JDs per hour on the assumption that all the work will be done on a custom or contract basis. The cost therefore includes an allowance for the salary of the tractor driver, and all other necessary inputs. The peak demand for the representative farm will arise in September when land preparation will be taking place on two fields and the fodder maize is being harvested on the third. This demand will be for 53 hours for the month, which is relatively modest. During the other months of the year, usage will not exceed 25 hours per month. Detailed suggestions on the organisation of tractor pools for the project area are given in the following chapter.

Production Cost Summary

The annual production costs that will arise on representative 4 hectare general farms can be summarised as follows:

Item	Conversion Area (JDs)	New Lands (JDs)
Seeds and Plants	154	154
Fertilizer and Manure	350	350
Plant Protection	150	150
Other Materials	93	93
Water	313	336
Family Labour	1,000	1,000
Hired Labour	141	141
Machinery	396	396
Sprinkler Equipment	108	76
Total	2,705	2,696

These figures form the basis of the analysis that follows of the project payment capacities of model farms.

Farm Payment Capacity

A clear distinction must be drawn between transfer payments and development costs. The economic budget that has already been presented in Table G-46, shows the impact of the project on Value Added at the farm level. The annual increment in returns that can be attributed to the project on a model farm in the Conversion Area at full development is shown as 3,455 JDs per year. This is equivalent to 864 JDs per hectare, and compares to an estimated average gain in the Conversion Area of 976 JDs per hectare (see Table G-33) At this level the production cost figures exclude water charges, which are a transfer payment, and the value of family labour which is shadow costed at zero.

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The figures must be viewed in a different context to assess the problems that farmers may face during the development period and to estimate the contribution that they can make towards the repayment of the capital borrowed by JVA for the implementation of the project. A financial analysis of this type must consider phasing of costs and must attempt to allocate returns to land, labour and management. Table G-47 gives a development budget for the model farm that has already been described. The assumptions that have been made can be listed as follows:

(1) the farm will reach full development 4 years after the installation of sprinklers,

(2) the term Basic Production Costs covers the items listed in Table G-25,

(3) family labour is valued at 1,000 JDs per year,

(4) a return to management is identified which is equivalent to 10 per cent of Sales Revenue, less Basic Production Costs and the Value of Family Labour,

(5) the cost of the portable sprinkler equipment is estimated by amortizing the capital outlay over 8 years with 7 per cent interest on the outstanding balances,

(6) water charges in the early years of the project rise on a scale determined by JVA, from 0.006 JDs/m^3 in Years 1 to 3, to 0.008 JDs/m^3 in Years 4 to 6, and to 0.010 JDs/m^3 in Year 7,

(7) the farmer is expected to pay 250 JDs per hectare to JVA for the ownership of his land, and the equity accumulation figure is calculated as the annual cost of repaying a 1,000 JD loan from JVA at 10 per cent interest over 20 years.

Table G-47

DEVELOPMENT BUDGET AND PAYMENT CAPACITY: 4 HECTARE GENERAL FARM, CONVERSION AREA (JDs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales Revenue	2,766	4,162	5,558	6,955	6,955	6,955	6,955
Less							
Basic Production Costs	657	866	1,075	1,284	1,284	1,284	1,284
Value of Family Labour	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Management Allowance	110	230	348	467	467	467	467
Basic Payment Capacity	999	2,066	3,135	4,204	4,204	4,204	4,204
Less							
Sprinkler Equipment Cost	108	108	108	108	108	108	108
Water Charges	94	188	188	250	250	250	313
Equity Accumulation	117	117	117	117	117	117	117
Residual Income/Farm	680	1,653	2,722	3,729	3,729	3,729	3,666
Residual Income/Hectare	170	413	680	932	932	932	916

As the table shows, a residual will exist from the earliest years of the scheme in the Conversion Area, and this will rise to about 3,666 JDs per year, per farm by Year 7. A comparable budget has been prepared for holdings in the New Lands and is given in Table G-48. Here deficits are likely to occur in the Years 1 and 2, and repayment capacity will remain below 2,000 JDs per farm up to Year 5.

The budgets raise two very important points. First JVA will need to provide developmental credit to farmers on the New Lands. Second, it is apparent that the implementation of the project will give farmers in both areas substantial wind-fall gains at full development. From a theoretical point of view, the residual income figures can be regarded as a return to land. The project makes it possible to apply irrigation water in a controlled manner and this changes the potential of the land. Thus the residual income stems directly from the capital investment that will be made to provide water storage and water distribution facilites. There is therefore a good case for arguing that JVA should be entitled to take this money as a betterment levy to assist in the repayment of international debts incurred during the construction period.

The justice of this argument can be appreciated by examining the response of land values to the project. Between 1974 and 1976 land values in the Conversion Area are estimated to have risen from 2,000 to 5,000 JDs per hectare in anticipation of its commencement. When the project is completed, values could rise to 7,500 JDs per hectare or beyond. These sums are very different to the charge of 250 JDs per hectare that JVA intends to make on farm sales in the New Lands. The difference will be a windfall gain to

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Table G-48

DEVELOPMENT BUDGET AND PAYMENT CAPACITY: 4 HECTARE GENERAL FARM, NEW LANDS (JDs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales Revenue	994	1,988	2,982	3,975	4,969	5,963	6,955
Less							
Basic Production Costs	900	964	1,028	1,092	1,156	1,220	1,284
Value of Family Labour	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Management Allowance	-	2	95	188	281	374	467
Basic Payment Capacity	(906)	22	859	1,695	2,532	3,369	4,204
Less							
Sprinkler Equipment Cost	76	76	76	76	76	76	76
Water Charges	202	202	202	267	267	267	336
Equity Accumulation	117	117	117	117	117	117	117
Residual Income/Farm	(1,301)	(373)	464	1,235	2,072	2,909	3,675
Residual Income/Hectare	-	-	116	309	518	727	919

the farmers unless JVA takes steps to recover some of this moeny. This can be done by instituting either higher water charges or a system of betterment levies. From the figures given in Tables G-47 and G-48, charge 0.020 JDs per hectare per cubic metre for water, and about 700 JDs per hectare for land without empoverishing the farmers. The institution of charges on this scale would obviously have social and political implications, and these will have to be evaluated by JVA and the Jordanian Government before a new policy is formulated.

3-Hectare Fruit Farms

Background

The recommended cropping pattern for the project allocates about 5,578 hectares to fruit. It is assumed that this area will be taken up by specialized fruit farms averaging 3 hectares in size. At an earlier stage in the project formulation, thought was given to grouping fruit farms of about 12 hectares into 50 hectare orchards run on a cooperative basis. This remains a possibility, though the 3 hectare independent units conform more closely to the provisions of Natural Resources Law 12. However, the planting of relatively large areas of fruit in one location would have a number of advantages. First, locations could be chosen which particularly favour fruit; these might be the relatively high areas of the Valley, which are less prone to frost. Second, areas could be selected where water could be drawn from more than one source. Third, advantages could be gained in the establishment of the orchards. The Jordan Valley Authority or the Farmer's Association could plant the groves in batches and hand over the farms to individual

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small holders when the trees began to bear fruit. Fourth, on a large area of land, it would be possible to plant a variety of fruit for planting and harvesting. This would spread the workload over the year. Finally, a range of economies could be gained in the use of specialist machinery, the bulk buying of chemicals and the packing and sale of the produce.

The economic and financial analyses for the 3 hectare units follow the methodology established in the previous section, and use the same data sources. This makes it possible to present the information in a concise form.

Land Use

The land allocated to fruit in the recommended cropping pattern amounts to 22 per cent of the project area. This proportion remains constant throughout but the shares allocated to different crops vary between the Conversion Area and the New Lands. In the former area, half the land will be devoted to citrus crops, 4.5 per cent will be devoted to bananas and the remainder will be reserved for a variety of fruits, the most common of which will be grapes. In the more southerly New Lands about 13.6 per cent of the fruit area will be devoted to bananas and this will be offset by a reduction in the area allocated to non-citrus fruits. This differentiation reflects the climatic advantages of the southern lands.

For the purposes of farm appraisal, a simple crop mix of 2.5 hectares of citrus fruit, and 0.5 hectares of bananas per farm has been adopted in both areas. This gives a net return structure close to the average for the fruit growing part of the project. In practice a wide range of cropping patterns are possible, including the mixture of vegetable and fruit production. Preliminary estimates for average production costs for alternative units can be derived from the data presented in Table G-49.

For the model pattern net returns in the Conversion Area at present are estimated at 3,144.55 JDs per farm as shown in Table G-49. Following the implementation of the project the provision of a reliable and controlled source of water is expected to lead to significant advances in orchard management. These changes are discussed in the following sections which consider each cost item in turn.

Establishment and Materials Costs

At full development, the annual cost of the material resources that will be used on a model 3 hectare fruit farm can be listed as follows:

	JDs
Plant Establishment	740
Fertilizer and Manure	326
Plant Protection	372
Other Materials	83
Total	1,521

The plant establishment costs used for the citrus element are based on model estimates for oranges. They include all the inputs that are necessary to produce 7 year old bearing trees, such as the expenditure of 1,000 JDs per hectare on budded stocks and 250 JDs per hectare on hired labour. Compound interest is charged on these items at 10 per cent per year during the establishment phase. The total capital outlay over 6 years is estimated at 1,391 JDs per hectare. This cost has then been annualised by assuming that the trees will have a 24 year bearing life. A similar procedure has been followed for bananas which indicates that a total capital outlay of

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Table G-49

ECONOMIC BUDGET: 3 HECTARE FRUIT FARM, CONVERSION AREA

Crop	Production (tons)	Farmgate Price (JDs/tons)	Sales Revenue (JDs)	Production Costs (JDs)	Net Returns
Without Project					
Bananas	11.00	127.80	1,405.80	285.00	
Oranges	43.75	68.00	2,975.00	951.25	
Total			4,380.80	1,236.25	3,144.55
With Project					
Bananas	17.50	127.80	2,236.50	547.25	
Oranges	100.00	68.00	6,800.00	1,395.00	
Sprinkler Equipment				80.94	
Total			9,036.50	2,023.19	7,013.31
Increment due to Project					3,868.76

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1,831 will be incurred over a two year establishment phase. This has been annualised over a 3 year bearing life.

At full development, it is estimated that about 104 JDs per hectare per year will be spent on fertilizers and manure for oranges, while about 131 JDs per hectare will be needed for this item for bananas. Considerable expenditures are likely to be incurred on plant protection for both kinds of fruit. It is assumed that the orchards will be sprayed on a contract basis with machinery supplied from central pools. The values in the 'Other Cost' category cover preliminary packaging, but do not include such other lifting expenses as the disinfection of fruit.

Water

Using a 12 by 12 metre sprinkler coverage, a typical farm could be dimensioned 168 metres by 180 metres, giving a gross size of 3.024 hectares. The capital cost of the portable equipment is expected to be about 483 JDs per farm in the Conversion Area and 338 JDs per farm in the New Lands. The annual cost of the equipment is therefore estimated at 81 JDs and 57 JDs per farm respectively.

The net water requirements of 0.5 hectares of bananas and 2.5 hectares of oranges are estimated at 30,330 cubic metres per year in the north zone and 33,905 cubic metres per year in the southern zone of the Valley. With a farm efficiency of 75 per cent, and a water charge of 0.01 JDs per cubic metre, farmers will therefore pay 404 and 452 JDs per farm for their irrigation water. The peak application on the fruit farms occurs in July when the orchards in the New Lands will need an average net requirement of 1,512 cubic metres per hectare.

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As previously discussed, it may prove desirable to modify the farm system design in the fruit growing area. Hose basin and trickle irrigation may prove preferable to sprinklers in the orange groves, and gated pipe has been suggested as a suitable form for the irrigation of banana stands. The capital cost of investment in equipment of this type is unlikely to exceed the sums reserved for the portable sprinkler lines.

Labour

The total annual demand for labour on the model fruit farm is estimated at 4,160 man hours per year per farm. This much exceeds the 3,000 man hours per year which will be available from the farm family. The highest demand is likely to occur in the harvesting period for Valencia oranges which mature between March and May. At this time a considerable amount of hired labour will be required. The total annual requirement for the farms is estimated at 1,245 man hours which will cost the farmers about 311 JDs per year.

The labour budget figures for the model farms suggest that scope might exist for the reduction in the average size of fruit holdings and the formation of co-operatives. As previously mentioned, the grouping of 2 hectares small holdings into 50 hectare groves, offers one solution to the problem. Opportunities will also develop for the diversification of the range of citrus crops grown on the farms and this could spread labour demands more evenly throughout the year. A mix of shamouti oranges which mature in February, Valencia oranges which mature in April, and lemons which are harvested at the end of the year is one possibility.

Machinery

A comparatively small amount of machinery will be required on fruit farms at full development. The average requirement for the model holdings is estimated at about 44 working hours per farm or around 15 working hours per hectare. This will largely consist of crop spraying and harvest transportation. The cost of hiring the machinery is estimated at 110 JDs per year.

Production Cost Summary

The annual costs that will arise on representative 3 hectare fruit farms can be summarised as follows:

Item	Conversion Area (JDs)	New Lands (JDs)
Plant Establishment	740	740
Fertilizer and Manure	326	326
Plant Protection	372	372
Other Materials	83	83
Water	404	452
Family Labour	1,000	1,000
Hired Labour	311	311
Machinery	110	110
Sprinkler Equipment	81	57
Total	3,427	3,451

These figures form the basis of the analysis that follows of the project payment capacities of the model farms.

Farm Payment Capacity

The economic budget for a representative fruit farm in the Conversion Area that has been presented in Table G-49 shows that the annual increment in returns that can be attributed to the project at full development is about 3,869 JDs per farm or 1,290 JDs per hectare. The margin between

Sales Revenue and Basic Production Costs at full development is 7,013 JDs per farm. To assess the financial viability of the enterprise it is necessary to subtract values for water, management and family labour, and to examine the incidence of costs over the development period. Table G-50 gives the relevant data. Here it can be seen that few problems are likely to arise in the payment of the water charge increases recommended by JVA. It will also be easy for the farmers to pay for the land at the nominal value of 250 JDs per hectare set by the Authority. As previously argued, there is a good case for increases in both types of charges.

In the New Lands, smallholder fruit farmers are likely to face problems in the early years of the project. The figures presented for farms in the Conversion Area assume that the cost of establishing new fruit stocks can be subsumed in annual production cost. This is obviously not true in the New Lands where heavy establishment costs will be met at the outset. Table G-51 illustrates the fact that farms here are likely to run deficits until the citrus trees reach half of their full potential in Year 6. This suggests that it might be sensible for the Farmers Association and the Jordan Valley Commission to establish the orchards and carry the initial debt. The fruit stands could then be gradually transferred to the smallholders as they mature. The sale of the bearing trees would safeguard the farmers, and might allow the JVA to recoup an additional portion of the gain that will arise from the implementation of the project.

100 Cow Dairy Units

Background

This section summarises and revises the findings of a recent Jordan Valley Authority report on the potential for

Table G-50

DEVELOPMENT BUDGET AND PAYMENT CAPACITY: 3 HECTARE FRUIT FARM, CONVERSION AREA (JDs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales Revenue	4,381	5,933	7,485	9,037	9,037	9,037	9,037
Less							
Basic Production Costs	1,236	1,498	1,760	2,023	2,023	2,023	2,023
Value of Family Labour	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Management Allowance	315	343	473	601	601	601	601
Basic Payment Capacity	2,830	3,092	4,252	5,413	5,413	5,413	5,413
Less							
Sprinkler Equipment Cost	81	81	81	81	81	81	81
Water Charges	121	242	242	323	323	323	404
Equity Accumulation	88	88	88	88	88	88	88
Residual Income/Farm	2,540	2,681	3,841	4,921	4,921	4,921	4,840
Residual Income/Hectare	847	894	1,280	1,640	1,640	1,640	1,613

Table G-51

DEVELOPMENT BUDGET AND PAYMENT CAPACITY: 3 HECTARE
FRUIT FARMS, NEW LANDS (JDs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Sales Revenue	-	1,118	2,236	2,236	2,236	5,636	9,036
Less							
Basic Production Costs	5,148	1,369	1,394	1,457	1,572	1,667	1,174
Value of Family Labour	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Management Allowance	-	-	-	-	-	297	686
Basic Payment Capacity	(6,148)	(1,251)	(158)	(221)	(336)	2,672	6,176
Less							
Sprinkler Equipment Cost	57	57	57	57	57	57	57
Water Charges	136	271	271	362	362	362	452
Equity Accumulation	117	117	117	117	117	117	117
Residual Income/Farm							
Residual Income/Hectare	(1,458)	(1,696)	(603)	(757)	(872)	(2,136)	5,550

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dairying in the Valley, (Project Proposal: Development of 100 Cow Units in the Jordan Valley JVA, April, 1976). The project proposal represents one of a large number of possible options in the livestock sector which can be related to Stage II of the Jordan Valley Development Plan. It is quoted here as an illustrative example, since a comprehensive survey of the livestock industry is beyond the scope of the present study.

The report states that the consumption of fresh milk and milk substitutes in Jordan is about 57,000 tons and that consumption could rise to about 97,000 tons by 1980. At least twenty-five per cent of total demand is now met by imports giving a substantial potential for local production. Alternative projections made for the present study (see Chapter II) suggest a rather lower level of consumption (49,000 tons in 1975, and 72,000 tons in 1980) but the margin is still very significant. The National Plan (1975-1980) provides for the import of 3,500 Friesian cattle which could provide around 14,000 tons of milk, but it is obvious that additional units will be required if the increased consumption is to be met by the local industry.

Land-Use

The implementation of Stage II of the Jordan Valley Development Plan will make it possible to irrigate a substantial area throughout the summer and this in turn will make it feasible to develop a local dairy industry. The introduction of fodder crops into the rotation will diversify the farm system and improve soil fertility, while the application of animal manure will improve crop yields. In addition, the tending and milking of the cattle, which will be kept in yards near the re-grouped villages in the Valley, will provide valuable employment for youngsters and women.

The JVA proposal was based on the reservation of 40 hectares of land to provide the total feed requirements of 100 dairy cows and their followers (i.e. 164 stock units). About 26 hectares was reserved for a double crop of fodder (berseem from September to April with a yield of about 50 tons per hectare, and green sorghum from May to September with a yield of 35 tons per hectare). A second section of 14 hectares was allocated to a double crop of grains (barley from November to May with a yield of 4 tons per hectare, and maize from June to October with a yield of about 4.6 tons per hectare). This pattern would give about 1,860 tons of green feed and 121 tons of grain in a year. Though the forecast yields seem reasonable it is doubtful whether the land could be continuously double-cropped in the manner that is suggested. It also appears that some concentrates would have to be purchased to maintain the herd.

The estimated quantities of feed that would be required to support the herd are listed as follows:

Concentrates	144 tons
Hay	143 tons
Green Fodder	1,192 tons
Chaff	97 tons

These quantities allow an average of 3 kilograms of concentrates, 3 kilograms of hay and 25 kilograms of green fodder per milking cow per day, and additional allowances for youngstock and heifers. These rations are judged to be satisfactory for the production of milk in the Jordan Valley. The general relationship between concentrates and green fodder equivalent is 0.075:1.000. However, as previously noted, some purchase of concentrates (wheat bran and vetch) would be needed to maintain the rations.

The amount of feed that will be produced in the general farming area if the recommended cropping pattern is adopted can be calculated from the data given in Table G-24 and the discussion on future yields. The gross quantities are:

Barley	19,015 tons
Fodder Maize	26,621 tons
Fodder Sorghum	30,424 tons
Berseem	197,753 tons

This pattern gives a broad relationship between concentrates and green fodder equivalent which is comparable to that made in the JVA proposal. Of course, additional quantities of wheat bran, straw, and crop residues will also be available. It is assumed that a proportion of the green fodder (say about 40 per cent) will be stored in the form of hay or silage. Taking the JVA feed ration as a guide, the quantities that will be produced in the project area will make it possible to support about 132,000 milking cows and their followers at full development.

Herd Structure

The costings that are given in the following sections assume that the fodder grown on the general farms will be supplied to independent 100 cow dairy units located near the villages. This means that there will be about 132 units when the project is complete. These units will care for herds consisting of:

100 cows
20 mated heifers
20 heifers 12 to 20 months old
20 heifers 6 to 12 months old
28 heifers 1 to 6 months old
49 bull calves 1 to 6 months old

A herd with this structure assumes that mortality in the first year of the lives of the animals will be 4 per cent, that mortality among 12 to 20 month old heifers will be negligible, and that it will run at 2 per cent among milking stock. Cows will be replaced after 5 years which means that 18 culled cows will be available for sale every year. Calculated in terms of cow units, the total feed requirements of the herd will be equivalent to the requirement of 169 animals.

Capital Investment

JVA assumed that the initial capital investment for a 100 cow dairy unit would be 80,571 JDs, allocated as follows:

	JDs
Cows	35,000
Sheds	7,074
Yards	3,409
Fences	840
Troughs	1,548
Milking Parlour	1,200
Milk Tank	320
Stables	1,080
Fodder Storage	5,400
Offices	1,200
Manager's House	3,000
Labourer's Houses	2,400
Other Structures	3,600
Tractor	3,300
Trailers	1,400
Generator	2,500
Milking Machines	3,000
Pick-up	3,200
Other Machinery	1,100
Total	80,571

The cost of the foundation herd is notable. Pregnant heifers cost 350 JDs a piece in Jordan. A reinvestment in machinery of 14,500 JDs will be required in the eleventh and twentieth years of the enterprise. Under the proposals, the machinery will be supplied from central machinery pools. However, this is not likely to affect the overall level of costs. It merely means that the livestock unit would contract its harvesting and haulage operations to a machinery pool which could lower the cost of this input.

Operating Costs

Over the twenty-five year life of a dairy unit, operating costs are assessed at around 33,500 JDs per year. In an average year these costs would be distributed as follows:

	JDs
Labour	3,720
Calf Feed	786
Medical Care (incl. AI)	600
Fuel, Oil, Electricity	800
Concentrates	6,839
Fodder	18,131
Miscellaneous	2,600

The labour item covers the cost of a manager, 2 labourers, 1 driver and additional labour from the families of the employees. The feed is costed as follows:

	JDs/ton
Grain Maize	70
Vetch	60
Barley	50
Berseem Hay	35
Green Feed	10

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These figures are close to the prices that have been assumed in the general farming area for the fodder that will be produced on contract.

Yields and Returns

In the JVA report the average yield per milking cow is estimated at 3.5 tons per cow per year. This seems rather conservative as yields of 4.0 tons per cow should be possible with good management. The milk is valued at 90 JDs per ton ex-farm. Since the current retail price of milk in Jordan is about 200 JDs per ton, this figure is also conservative. The estimated sales revenue of 31,500 JDs per year from a 100 cow herd therefore provides a base figure for the returns that will be generated. An additional 1,151 JDs per year could be realised from the sale of youngstock and culls. The total revenue in an average year at full development is therefore derived as follows:

	Quantity	Value/Unit (JDs)	Total Return
Milk	350 tons	90.00	31,500
Bull Calves	49	130.00	6,370
Heifers	28	150.00	4,200
Culls	18	200.00	3,600
Manure	1,500 tons	0.65	981
Total			46,651

Once again these estimates have been confirmed by field enquiries. Further, overall returns have been phased to take account of the problem of stabilising herd numbers. Full production is reached in the eighth year.

Economic Appraisal

Under the system outlined in the JVA report, a 100 cow dairy unit shows an internal rate of return of 14 per cent

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over a 25 year period. The benefit-cost ratio, at a discount rate of 10 per cent, is 1.07 over the same period. If the life of the units is extended, as seems reasonable, the rate of return improves. The adaptation of the concept to the agricultural system proposed in this project is feasible, and this will have a favourable impact on costs. At full development the project should be capable of supporting 132 dairy units producing about 46,200 tons of milk and 1,085 tons of meat per year. A further 56 units could be supported in other areas of the Valley if the proposed cropping pattern is adopted there. The estimated capital cost of the 132 units associated with the project is about 10,635 JDs. As previously explained, this expenditure can be regarded as ancillary to the investment programme costed in this report, but it is nevertheless important to note the level of finance that could be required. Finally it is important to bear in mind that the livestock industry development proposals that have been detailed above offer one possibility for the use of the fodder potential of the project. Alternative schemes will no doubt be evaluated by JVA before any large scale investments are made.

Conclusion

A relatively simple farm system has been outlined for the project area which consists of 4 hectare general farms, 3 hectare fruit farms and ancillary 100 cow dairy units. These elements are complementary and the system as a whole observes the constraints which are imposed by product demand, water availability and government policy. However, there is obviously scope for much greater diversity within the project area, and this will inevitably occur as farmers and institu-

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tions adjust to the opportunities that will arise. However, the JVA will need to monitor developments to discourage waste and inequity. One problem that could arise is the allocation of too much land to fruit. The water resources of the Valley are finite and fruit growing depends upon the release of water throughout the summer months. An excessive area of fruit could therefore reduce the amount of land that could be cultivated as a whole. At the farm level the potential returns on crops such as bananas are so high that even controlled planting could lead to income inequality and dissension among the farmers. This provides a further reason for suggesting that fruit growing in the Valley should be undertaken on a co-operative basis.

The JVC and Government will be faced with the task of recouping the operations and maintenance costs associated with the project, and as much of the capital investment as is practical. This could be done through the imposition of uniform water charges as has been done in the past. However, it may be sensible to consider alternative ways of raising revenue. Possibilities include betterment levies on the New Lands, the sale of fruit area quotas and differential water charges. From the data provided in this report, it can be seen that very substantial windfall gains are likely to accrue to farmers on the land which will be irrigated for the first time as a result of the project. It seems only fair that these people should bear a greater proportion of the costs. As far as water charges are concerned, it is interesting to relate Net Returns to the amount of water that will be required in different areas. At full development, Net Returns per cubic metre of water (Diversion Requirement) will be 0.15 JDs in the Conversion Area and 0.13 JDs in the New Lands. This reflects the higher requirements of the southern part of the Valley. At the farm level, Net Returns per cubic metre of water will vary from a low of 0.12 JDs on the general farms of the south to a high of 0.19 JDs for fruit farms in the Conversion Area. These figures suggest that it may be necessary to devise a fairly complex water charge schedule to maximise the use of resources and avoid injustice.

Chapter VI

ASSOCIATED DEVELOPMENTS

Back-Up Services

General Introduction

The Jordan Valley Development Plan 1975 - 1982 sets out a comprehensive series of investment proposals, which together form a complex integrated rural development programme. Stage II of the Jordan Valley Irrigation Project (the project under study) is one component of this programme. As defined in the Plan, the project comprises the following elements:

(i) a dam and power plant at Maqarin

(ii) a water conveyance system to carry water from the Maqarin Reservoir to The East Ghor Main Canal.

(iii) the relocation of the Himma Railway.

(iv) the construction of a sprinkler irrigation system for 12,511 hectares of presently unirrigated land.

(v) the Conversion of the existing surface irrigation network on 12,842 hectares to a sprinkler system.

Machinery Pools

Introduction. This section considers the agricultural machinery that will be required to support the intensive land development proposals that have been described in the previous chapters of this Appendix. First, the current availability of machinery is discussed. The following section then describes the function and structure of the specialist machinery pools that are recommended for the areas that will be affected by the project. Suggestions are made on the numbers, cost and location of different items of equipment. Finally, some consideration is given to the servicing of machinery and the staffing of the pools.

The Current Availability of Machinery. Some consideration must be given to the equipment now available in the Valley and the additions that might be made even if the project is not implemented. A Ministry of Agriculture inventory reveals that the Northern and Middle Ghors had the following equipment in 1975. There were 282 wheeled tractors, 88 chain tractors, four self-propelled combines, five combines pulled by tractors, 29 mobile thrashers and a range of smaller items. It is difficult to determine what proportion of the equipment is used in the project area, since the tractors travel long distances to perform custom work. A large proportion of the farm machinery is operated by the Ministry of Agriculture including a fleet of 45 Fendt spraying tractors which service agricultural areas throughout Jordan providing both vehicle and driver at no charge. Much of the equipment, such as this spraying fleet provided under German aid, are under assistance programmees and their replacement may be rather difficult. The equipment is primarily used for ploughing and hauling services, and specialized spraying activity. In relation to the area of farmed land the equipment numbers are low. Without the project, machinery stocks will probably only rise slightly. However, the implementation of the project will vastly extend the cultivable area in the Valley and increase the intensity of cropping on land that is now surface irrigated to a significant degree. These changes will require a new approach to the provision of agricultural machinery.

The Recommended Structure. The only tasks which are presently done by tractors are the preparation of the land for planting and the hauling of produce to markets. The main reason for the minimal amount of mechanized work on the farm is that the surface - irrigated land is grooved with zig-zag channels for water flow, which prohibit the use of tractors. Therefore, most of the tasks required to be done during the growing season are accomplished using expensive and scarce hired labour. With the advent of the sprinkler irrigation system planned in Stage II, it will be possible for equipment to be used in the fields during the growing season since the zig-zag furrows will be unnecessary. A more intensive agricultural pattern will evolve, since cropping intensities are planned to increase dramatically. To reach the forecast yields and to offset any possible ill-effects from the sprinkler system causing a more humid environment for plant pathogens and weeds, intensive use of modern agricultural chemicals will be required. The proposed increases in the livestock sector will create a demand for forage crops, which are best harvested mechanically. It is planned that most of the livestock will be maintained away from the agricultural area, so that transportation will be required to move the field crops to the livestock units. All these changes will increase the demand for machinery. The projected incidence of machinery usage for each crop at full development has been detailed in Table G-28.

The organization of the supply of farm equipment is still uncertain. There are many alternatives, but based on the success of equipment pools in the Valley and elsewhere, and the fact that the farm size is not sufficient to warrant individual farm ownership, co-operative equipment pools are suggested. Many economies of scale would exist in such aspects as equipment purchase, and spare part stocks, while professional mechanics and services staff could be employed. The cost of specialized equipment could be spread over many farms, making economic use of such items as combines, forage harvesters, bailers, fertilizer spreaders and herbicide and pesticide spraying aparatus. Back-up irrigation equipment could be held at the center and machinery that is needed for the maintenance of the irrigation network (for instance bulldozers) could be made available to farmers at low cost as required. A range of sizes of machinery would also be available to match work requirements.

The responsibility for these equipment pools could be borne by a number of possible candidates. In the existing situation about 90 percent of the farmers use tractors provided by commercial or co-operative sources. This system seems to work fairly effectively, but the tasks are generally limited to ploughing and hauling services. The increasing demands which will be placed on the equipment pools due to the size of the area cropped and the intensity of cropping will call for a more sophisticated organization. One solution is to give the organization and management responsibility to the Farmer's Association. This task is contained in the list of Farmer's Association responsibilities in Article 12, which includes provision of agricultural inputs including equipment such as tractors, machinery and spraying equipment. In the costings given in the following sections it is assumed that the pools will be run by specialists who are either members of a machinery co-operatives or employees of the Farmers Association. However, it is possible that the pools could be run by the farmers themselves and this option should also be explored.

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Two important points must be made concerning the machinery pools. First, the type of equipment to be purchased must be determined after a careful consideration of work requirements. One of the prime advantages of a machinery pool is the possibility of building up a stock of spare parts. Wherever possible a single type of equipment should be purchased. The second point is that the mechanics are one of the key factors in making an equipment pool function reliably. The mechanics must be suitably trained, paid enough to keep them from leaving for more lucrative employment, and be given the necessary tools and transportation to allow them perform their duties. The training of mechanics is an expensive and long-term effort, and it is suggested that a centre be set up at one of the machinery pools in the Valley to offer formal training. In some cases more complex facilities could be provided, which would require specialist operators. An activity of this type which could well be handled by the machinery pools is the contract spraying of herbicides and pesticides. In this operation, the facility could provide the equipment and a trained individual who can assess the correct mix and dilution. The storage of materials in a special building at the central location would act as a safety precaution.

The machinery pools should be located where they can command the maximum area of land for a minimum of travelling. The obvious locations in the Valley are the 36 settlements that are being constructed under the Jordan Valley Development Plan. Each pool would therefore serve 1,000 hectares of irrigated land. On this basis 25 machinery pools can be allocated to the areas that will be affected by the project. The settlement hierarchy suggested in the Plan would also

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serve as a convenient framework for the distribution of specialist functions. For example, a major repair might be undertaken in the four Type 'A' settlements, where the infrastructure will be of higher standard. If these suggestions are accepted, the layout of the settlement pattern will be an important determinant of the supply of machinery to individual farms. In some cases, particularly in the southern part of the Valley, there may be holdings which would be ten or more kilometers form one of the sites selected in the Jordan Valley Development Plan. This suggests that further consideration should be given to locating some of the new settlements in the Katar in this area.

Capital Costs. Table G-52 gives a preliminary estimate of the quantity of equipment that will be needed in the project area, on the assumptions outlined in Chapter III of this Appendix. The basic element in the calculation is the number of tractor hours that will be required for the project area during the peak season. Under the proposed cropping pattern, the maximum monthly demand arises in March when an average of 5.02 tractor hours per hectare will be needed. If it is assumed that an average tractor can supply 900 working hours per year, or 75 working hours per month, it follows that a tractor would be required for every 15 hectares during the peak, giving a gross demand for about 1,690 units. However, tractors can usually provide at least 100 working hours per month in periods of heavy use, and the overall requirement for the project area has been set at 1,250 units. This is equivalent to 1 tractor to 5.5 farms or 20.3 hectares. This allows sufficient capacity to cover peak demands, and takes account of the fact that a considerable amount of travelling will be required in moving from

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Table G-52

ESTIMATED QUANTITIES AND COST OF EQUIPMENT REQUIRED
FOR 25,000 HECTARES IN THE VALLEY

Item	Number Required	Approximate Cost (10^3 JD)
Tractors (wheeled)	1,250	3,750,000
Chisel Ploughs	125	33,750
Disc Ploughs	500	207,000
Disc Harrows	250	100,000
Cultivators	378	138,726
Seed/Fertilizer Drills	100	120,000
Maize Planters	50	38,350
Fertilizer Spreaders	150	41,250
Mower Bars	200	64,000
Rakes	150	85,050
Bailers	150	357,150
Silage Chopper-blowers	200	127,000
Trailers	500	403,500
Forage Planters	80	66,800
Trailer Sprayers	150	111,750
Combines	35	408,345
Tracked Tractors	30	101,010
Land Rover/Utilities	60	174,000
Equipment Trailers	30	30,000
Potato Diggers	30	25,500
Soil Fumigators	40	36,000
Knapsack Sprayers	2,500	62,500
Total		6,481,681

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one small plot to another. Estimates of the number of pieces of equipment that will be needed have been derived from previous reports on the Jordan Valley, and international comparisons. The costings are based on field interviews with machinery suppliers in Amman in August 1976 and competitive tenders by British manufacturers in May 1977.

Tractors are the most important item in the list. They account for well over half of the necessary investment. Given the large numbers that will be required, it should be possible to operate a range of tractor sizes while still maintaining economies in the holding of spare parts. Tractors in the 40 to 50 horse power range would be the most common form, but smaller vehicles could be used for such tasks as fertilizer distribution. Diesel powered units are recommended for economy. The list includes a wide variety of ancillary equipment but it does not represent a complete schedule. Special machines could be used to advantage in the harvesting of some fruits and vegetables. Nevertheless, the estimated capital cost of about 6,500,000 dinars gives the broad order of magnitude of the expenditure that will be required. While much of this will be in the form of foreign exchange, two recent developments which will assist in the implementation of the programme, may be noted. First, special arrangements have been made recently for the construction of agricultural machinery in Syria for Jordanian use. Second, an engineering plant is being located at Jerash which will be capable of making the simpler types of equipment.

Operation and Depreciation Costs. The average operating lives of different types of agricultural implements are well documented. In Jordanian conditions the expected life of a tractor, for example, is six years. The gross cost of maintaining the equipment detailed in Table G-52 is estimated at about 1,500,000 dinars per year. An additional 750,000 dinars might be kept tied up in spares and working capital to some extent the cost of maintaining the machinery will depend upon the size of the local pools.

Manpower. A rough estimate of the numbers of workers that will be employed in the machinery pools can be derived from the previous estimates. They can be classified as follows -

managers	25
clerks	50
senior mechanics	40
trainee mechanics	125
drivers	1,050
others	210
Total	1,500

During peak periods considerable amounts of overtime may be necessary. However, it may be possible to bring in labour and machinery from other parts of Jordan at such times. Nevertheless, the figures point up the need for a training programme for mechanics. The wage cost of the drivers is estimated at 600 JDs per year per employee, or about 625,000 per annum for the whole project. The wages of the mechanics and other pool staff are estimated at about 200,000 JDs per year, but this figure has been included in the equipment operation budget. If the machinery pools are organized as farmer co-operatives there could well be some savings on labor. Summarizing the available information on costs, it appears that the machinery pools will have annual costs of about 2,125 000 JDs. This can be set against the revenue that could be earned from about 1,125,000 tractor operating hours per year. At a charge of 2.5 JDs per hour, this would be about 2,812,500 Js which is sufficient to make the program viable. If the number of working hours available from each tractor could be raised from 900 to 1,200 by efficient management, the scheme would be even more favourable. Advice on managing machinery pools is given in publications such as Multifarm Use of Agricultural Machinery, (by H. Lonnemark), FAO, Rome 1967. A detailed project appraisal will obviously be required before any investment decisions are taken.

Marketing

Introduction. The Jordan Valley has or will have the resources to grow excellent quality produce for both the domestic and export markets. It is imperative that adequate marketing and transportation facilities should be provided to ensure that a high quality product is received by the consumer. Recognizing this fact JVA commissioned the Consultants to undertake a special study on marketing to make detailed forecasts and suggestions for the future. This work is now available as a 2 volume report entitled Supply and Demand for Jordanian Fruits and Vegetables, Harza, Chicago, 1977. The reader is referred to these volumes for a comprehensive treatment of the topic. The following section is designed to present a complementary programme of capital investment. The section is divided into three parts. The first considers the existing grading and marketing facilities; the second gives some guidance on export standards; and the final part gives an approximate estimate of the costs that may be incurred in improving the system.

The Present Situation. At present most of the fruits and vegetables that are grown in the Jordan Valley are rough - graded on the farms and sold through the wholesale markets located at Amman, Irbid and Zarqa. About 85 percent of all sales pass through these markets and the remaining 15 percent of the crop is exported directly from the growing areas. The trade is organized by middlemen termed commissionaires. At present they handle about 80 percent of the turnover at the markets. They receive a five percent commission on sales. In addition, a two percent levy is paid by both sellers and buyers to the marketing authority. A further charge of one quarter of a per cent of the sale value is incurred if a professional auctioneer is employed, though the commissionaires can and often do sell the goods themselves. The existing system appears to work well for the domestic market where retail standards are not particularly high. However, fruits and vegetables consigned for export must frequently be regraded and repackaged in Amman and this causes additional deterioration through delay and double handling.

Noting the problems associated with the existing wholesaling system, the Northeast Ghor Irrigation and Rural Development project appraisal suggested that further efforts should be made to operate assembly markets and packing stations in the Jordan Valley. The packing houses built at Wadi Yabis and North Shuneh in 1966 have been relatively unsuccessful. Both suffered damage due to hostilities and the equipment at Wadi Yabis was removed. The North Shuneh facility, which is primarily designed for packing citrus, has been affected by competition from West Bank produce and inadequate management. The Northeast Ghor project allocated about 10,000 dinars to make both facilities operational in 1974, but comparatively little progress appears to have benn made. Properly organized these stations could handle an average of 80 tons of produce per day, rising to 120 tons per day in peak periods. This would make a moderate contribution to the solution of the marketing problems of growers in the areas that will be converted from surface to sprinkler irrigation as part of the project under study.

Desirable Standards. The first requirement for the maintenance of export standard is sound crop selection. Varieties should be chosen which have visual appeal with attractive colors and shapes. The standardisation of fruit and vegetable forms has been a notable trend in Europe and the United States in the last few decades, and will become increasingly desirable elsewhere. The second requirement is careful handling in the field. In the Jordan Valley, where high temperatures often occur, picking may have to be done more frequently than usual to avoid overripening. To reduce wilting, crops should be picked in the early morning in the summer. Where contract labor is used, payments should be designed to discourage bruising and waste. Since the fields in the project areas will be small, there will be little opportunity for the use of picking machinery, though some forms of equipment, like potato pickers, could be used to advantage. The general trend will be towards the adoption of market gardening techniques and the packaging of relatively small quantities of produce on the farm. Rapid transportation to the assembly markets is essential and it is possible that refrigerated collection vehicles could be run on a cooperative basis for some crops.

At the packing stations, operations such as trimming, washing, grading, preservation and packing should be carried out. There may be complex procedures for individual crops. The treatment of citrus fruit, which are not generally considered highly perishable, provides an example. Leaves and stalks should be carefully removed and the fruit should be fumigated with a preparation such as Decco to prevent stem end rot. The fruit should then be immersed in a borax solution, dried and waxed. Finally, individual fruits should be wrapped in diphenyl paper to eliminate fungus growths. Measures such as these can reduce losses in shipment to about two per cent. More perishable vegetables may be prepackaged in cellophane and kept under cold storage. Vacuum cooling is generally recommended. While cold storage facilities could be located in the Valley when it is fully developed, it would be possible to collect the produce into cool rooms and move it in bulk to central facilities in Amman.

Future Requirements. If the project is implemented, and the forecast yields are obtained, the following quantities of fruits and vegetables will be produced -

	Vegetables (10^3 tons)	Fruits (10^3 tons)
Conversion Area	277	100
New Lands	270	98
Total	547	198

Facilities will therefore be required to process an average of about 1,500 tons of vegetables per day, and around 540 tons of fruit per day. The peak requirements would obviously be much higher than these average figures.

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The assembly markets at Wadi Yabis and North Shuneh are capable of handling a maximum of 800 tons per day each. Their original design capacity is 300 to 400 tons per day. On this basis an additional five markets will be needed to deal with produce from the areas affected by the project. Judging, however, from the success of the large Amman market it would be possible to centralize facilities to some degree. In the long run it might prove desirable to build up four centers to serve the whole Valley. This would conform to the proposals outlined in the national _Five Year Plan for Economic and Social Development_, 1976-1980 (see page 205).

The present capacity of the packing stations at Wadi Yabis and North Shuneh is about 80 tons per day (40 per station). This means that a substantial investment will be required to meet the throughputs forecast in this study.

A good start has been made in this regard with the recent agreement between the Dutch and Jordanian governments on the construction of a large new grading and packing station in the Valley. This will have an average daily capacity of 650 tons per day and will cost about 675,000 dinars. Taking the Valley as a whole, about four of these stations may eventually be required. If it is assumed that assembly market facilities could be provided very cheaply as an adjunct to the stations, a gross investment of between 2,800,000 and 3,000,000 dinars will be required for the Valley. About 70 per cent of this expenditure can be allocated to the areas that will be affected by the project, giving a capital requirement of about 2 million dinars.

The management of the new centers would eventually be entrusted to the Farmer's Association, in collaboration with the Agricultural Marketing Organization, which would provide

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the necessary technical services. If the middlemen were eliminated, charges of up to 10 per cent of the wholesale value of the produce could be levied without loss of income to the farmers. In practice, a levy of between 2 and 5 percent would probably be sufficient to cover the costs of the service. This would therefore tend to increase farmgate prices. Assuming average wholesale prices of 70 dinars per ton for fruit, a levy of 2 percent of the value of sales would bring about 1 million dinars per year. This should be sufficient to cover the costs associated with the new facilities. Obviously, detailed feasibility studies will be needed to confirm this very preliminary assessment.

Demonstration Farms

The development of the technical capabilities to operate the farms of the project will be a major problem to be solved. There is a need for both technical information and methods to extend this information to the farm operators.

Sprinkler irrigation is not at present being used in the project area. Because of this and the fact that many of the potential farmers have had little or no irrigation experience, there is a lack of understanding about the use of sprinkler irrigation. Demonstration farms can fill at least a part of this need in the program of development. They will provide centers for the application of improved techniques of agricultural production on a scale which the farmers must use and to which they can easily relate. The demonstration farms will thus provide the essential link between the research stations, such as Deir Alla, and the farmer. They will serve as centers to which the farmers can go to obtain the technical information provided by the stations. The success of these demonstration farms in filling this role will be greater if they are planned on the following criteria. Each demonstration farm should:

1. Be located so that it is easily accessible to the farmers of the area.
2. Be planned to have the same size of productive area as the farm units.
3. Include facilities to handle visiting farmers so they can easily see what is going on.
4. Include and maintain an Irrigation Management Service (IMS) weather station.
5. Be planned so that the operation of the farm will be carried out as much as possible with facilities which will be available to the farmers.
6. Grow crops which are planned for farmer production.

Demonstration Farm Location. The farms should be located on land which is typical of the area represented and where the farmers of the area can easily see them. They should be located immediately adjacent to farm-to-market roads. The distance between demonstration farms should recognize the transportation available to the farmers so that they can visit the farms frequently and without undue expense.

The final locations of the farms will be coordinated during the design phase of the work with on-going programs of AID supported demonstration farms and any programs of the farmer associations.

Demonstration Farm Size. The actual productive farm area should be the same as the regular farm units. Some additional land will be required to permit the farm to be seen easily without changing the representativeness of the farm. Extra land should also be included for additional facilities needed for "open house" or field day activities and for the IMS weather station or any other special facilities which will not be included on regular farms.

Demonstration Facilities. The demonstration farm should, as much as possible, be planned to have the same facilities as the regular farm it represents. The only modifications should be for those special facilities which are required to permit visiting farmers to view the farm and to be given the technical information they desire. These should be well-prepared walkways past the significant areas of the farm and an area where meetings can be held in relative comfort; such as an open shelter which could also double as a storage or parking area most of the time. There must also be extra sanitary facilities for any such group meetings, as well as for routine visitors.

Informative signs should be maintained at all times to give appropriate information about the operations and items or crops of the demonstration.

Special Facilities. The inclusion of special facilities such as the IMS weather station will have two advantages. One is to provide an additional point of interest to attract visitors to the station. A second more practical point is to provide additional information to help in the interpretation of experiment station data so that it can be applied with better confidence to the area in which the demonstration farm is located.

A complete list of needed equipment is given in Table G-53.

Table G-53

WEATHER STATION COST ESTIMATE

Item	Description	Cost for Source	Source
Fencing	Chain Link, Gate Posts & Hardware	US$ 140.00*	Hardware Store
Redwood Posts	Two 10' 4x4	7.00*	Lumber Yard
Solar Meter	MK 14E	696.40	Matrix Inc.
Shelter	IS-1	191.00	Weather Measure Corporation
Hygrothermograph	H311-S	227.00	-do-
Max-Min Thermometer	TM-2F	56.00	-do-
Sling Psychrometer	WI64-B/E	22.50	-do-
Contact Anemometer	WI64-B/E	273.00	-do-
Rain Gauge	P561	137.00	-do-
Rain Gauge Steel	P561-S	25.75	-do-
	Total	$1,775.65	

ADDRESS:

Matrix, Inc.
537 South 31st Street
Mesa Arizona 85204
PH. 602-832-1380

Weather Measure Corp.
P. O. Box 41257
Sacramento, CA 95841
PH. 916-481-7565

* Price will vary with location and source.

Farm Operation

The farming operation of each demonstration farm should have no more physical facilities available for use than would be available for the regular farms. The only exception may be such special equipment as water-measuring devices to obtain detailed information on the amount of water actually used on each crop on the farm. This will help to provide the basis for water management recommendations. The major difference in the demonstration farm and the regular farms would be the level of technology available in the operation. The demonstration farm should have the best available technical supervision and receive top level of technical advice from the experiment station staff.

The staff of each demonstration farm should maintain an "open door" policy to all farmers to visit the farm at any time to watch the operation and to learn more about "how to do it."

Research and Extension

The Jordan Valley's unique climatic environment and the innovatory nature of the developments that are proposed will make it necessary to expand the current research and extension programmes. Research will be needed on -

(i) The agronomic and marketing characteristics of new crops and new plant varieties.

(ii) The benefits of alternative crop rotations and systems of farm management.

(iii) The problems associated with leaching and irrigating the new land areas of the southern part of the Valley.

(iv) The determination of optimum applications for such inputs as water, fertilizer and plant protection chemicals.

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Agricultural research is the responsibility of the Department of Research and Extension of the Ministry of Agriculture. Fundamental agronomic research is undertaken at the Deir Alla experimental station and a sub-station at Wadi Yabis. The Northeast Ghor Study recommended considerable increases in the staffing of Wadi Yabis, so that trials could be undertaken which would reflect the physical conditions of the northern part of the Valley. Bearing this in mind, it seems obvious that a new experimental station will be required in the south to undertake field trials on the new lands that will be developed as part of the project under study. The staff of this facility could tackle such problems as the leaching of salts, water application techniques, drainage requirements and the determination of suitable cropping sequences. This work should commence as soon as possible. The national staffing of the station, which could be located near Ghor Nimrin, might be 2 irrigation engineers, 5 agronomists and 12 research assistants. It is not feasible to put a detailed cost to this proposal without further study.

One of the persistent problems associated with agricultural research is the difficulty of applying the findings under commercial conditions. There is always a need for demonstration farms and the monitoring of farm businesses. Wherever possible, experiments on crop rotations and management systems should be undertaken on commercial farms. This may require the payment of incentives to selected farmers. If is also desirable to conduct regular agro-economic surveys to assess the effects of changes in input and product prices. Some work has been done in teh past on applying Linear Programming techniques to the determination of optimal cropping patterns. This work should be continued. Further insights could be given by the application of various forms of Production Function Analysis to farm survey data, and construction of mathematical models of resource use. The Agricultural Economics Department of the University of Jordan could be encouraged to undertake this work.

The Northeast Ghor Study recommended that the number of extension agents in the Northeast Ghor project area should be increased from two to eight. The recommended allocation is one extension agent to about 1,000 hectares of land. This seems a reasonable objective. On this basis about 25 extension agent would be needed in the areas that will be affected by the project under study. Each agent might take charge of the land tilled by the inhabitants of one of the 36 new settlements planned for the Valley. The resident agents would be backed by specialists in fieldcrops, vegetables, fruit trees, livestock and soils irrigation. Particular emphasis should obviously be given to vegetables and fruit if the suggested cropping pattern for the project areas is accepted. A total of about 10 specialists may be required.

The agricultural extension agents could work through the Farmers Association wherever possible. This should make it easier to identify and assist problem farms and problem areas. The existing extension agents have been hindered by the prevalence of sharecropping. A report on Agro-Economic Aspects of Tenancy in the East Jordan Valley, 1975 found that only 29 per cent of the sharecroppers in the Valley had received advice on improved farming practices. Institutional and land reform must therefore form part of the programme. The National Five Year Plan (1976-1980) emphasis on-farm

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demonstrations, extension work and the negotiation of purchasing contracts to encourage the production of clover, maize and oil seeds in the Valley. It would now appear that these objectives should be reveiwed and that the resources should be devoted to fruit and vegetable production. However, new challenges will arise in the promotion of the kind of crop rotation given in Figure 2 of this report, which will be necessary to support the dairy industry. Further extension problems may develop on particular farms in the project area as a result of the terrain or the presence of accumulated salts. This suggests that a highly flexible service, will be needed which can co-operate with the Jordan Valley Authority in providing temporary subsidies or debt relief to farmers who run into unavoidable difficulties during the early years of the project.

Substantial progress has already been made in providing an efficient research and extension programme in the Valley. There are now 17 trainee agricultural engineers and 100 laborers at Deir Alla and 4 engineers and 40 labourers at Wadi Yabis. Appointments have been made for 30 of the 36 posts that have been created for village Extension Officers. Specialists are provided from the Agricultural Research and Extension Department's headquarters in Amman. In the future the number of trainee agricultural engineers at Deir Alla could rise to 30 and plans have been made for the intensification of the extension programme. It is therefore difficult to identify the cost of schemes which are specifically related to the project. However, pending further studies, the following estimates are offered to establish a broad order of magnitude:

Capital Investment	JDs
Ghor Nimrin Research Station	95,000
Improvements Deir Alla	35,000
Improvements Wadi Yabis	15,000
Extension workers housing & vehicles	100,000
Total	245,000

Annual Costs	
Staff Ghor Nimrin	40,000
Staff Extension Workers and Specialists	57,500
Operating Costs and Depreciation	65,000
Total	162,500

Both the proposals and the costings will need to be checked by a competent agency and it is recommended that JVA should approach FAO or IBRD for assistance on these points. A recent publication Agricultural Extension: The Training and Visit System, (by D. Benor and J.Q. Harrison), IBRD, Washington, 1977, provides some interesting examples of the results of applying intensive farmer orientated methods which could serve as a model for Jordan.

Farm Credit

In 1975 medium term loans worth about 190,000 JDs were registered with the Agricultural Credit Corporation (A.C.C.) Details of these loans are given in Table G-54, which shows that fruit establishment accounted for about 45 percent of the money borrowed in the northern part of the Valley, while pipes motors and pumps were very important in the south where ground water resources are being exploited.

Though the A.C.C. is likely to remain an important source of medium (5 to 10 year), and long term credit in the future, the Jordan Valley Farmers Association will become the major source of finance for farmers. The first Board of

Table G-54

A.C.C. MEDIUM TERM LOANS TO JORDAN VALLEY FARMERS, 1975 (JDs).

Purpose	Wadi Yabis Area	Madda-Dead Sea	Other
1. Fruit Establishment			
citurs	27,942	9,935	400
bananas	780	6,700	
other	4,200	500	
2. Farm Development			
cement channels	10,360	4,170	
sand channels	120		
irrigation pipes	550	30,035	
terraces		40	
fences	14,395	2,815	500
deep ploughing	245		
land levelling	6,495	4,940	
farm houses	3,880	5,150	
plastic frames	2,740	12,000	
reservoirs	300	7,600	
motors		14,635	
pumps		16,835	
Total	72,007	115,355	900

Source: Agricultural Credit Corporation

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the JVFA was elected in 1976 and the Association is divided into 5 Departments, namely: Credit; Farm Management; Supply; Research; and Farm Relations and Training. These 5 functions overlap to some extent and recent activities undertaken by the JVFA include the purchase of 4,000 tons of superphosphate for distribution to its members, co-operation with JVA on establishing a new marketing center at El Arda and the institution of a sprinkler irrigation training programme.

By June 1978, the JVFA should be able to extend credit to its members, who consist of the whole farming population of the Valley. It will also establish an insurance fund to protect farmers against bad harvests. The sums that could be required to implement the proposals outlined in this report are substantial. For example, the capital outlay involved in planting 1,376 hectares of citrus in the New Lands is estimated at about 1,914,000 JDs spread over 6 years. A preliminary estimate of the total requirements of the project area are about 1,400,000 JDs short term credit and 3,500,000 JDs medium and long-term loans. This will certainly place a heavy burden on the JVFA and the A.C.C. Further studies will obviously be required to ensure that the various agencies involved in land development co-operate effectively, and that the loan programmes are administered

The Social Infrastructure

General Introduction

As described in Chapter I of this Appendix there is considerable potential for the improvement of socio-economic conditions in the Jordan Valley. In some cases changes may be essential to the success of the project under study. The Jordan Valley Authority recognizes this fact and measures are outlined in the Jordan Valley Development Plan to upgrade or reform a wide variety of institutions and services. It is not feasible to consider each item in great detail as the whole Jordan Valley Development Plan constitutes an intricate and comprehensive planning exercise. However, comments are offered in the following sections on the general adequacy of the proposals. The first section discusses the land reform programme, while the second section is devoted to more general infrastructural and social developments.

Land Reform

Natural Resources Authority Law 12(1968) requires that land holdings on government developed irrigation areas should be allocated in 3 hectare holdings on the best quality land, and 5 hectare holdings on the poorest quality land. The maximum holding that can be held by the existing landlords is 20 hectares. Under these provisions, it is estimated that only about 6 percent of the land will remain in farms bigger than 7 hectares. The future farm size distribution is forecast as follows:

Size of holding (hectares)	Percentage of Holding
2.6 to 4.0	87.1
4.1 to 7.0	10.7
over 7.0	0.2
Total	100.0

The representative farms considered in Chapter V of this Appendix fit this pattern fairly well. However two points are relevant here. First, it is important that the law should be administered in a flexible way. It should permit the formation of co-operatives and it should reflect local environmental conditions. secondly, it may prove necessary to recognize that the quantity of water that can be made available to a farmer may be more important, than the amount of land that he farms, in determining his income. In this case, it seems reasonable to restrict the size of the farms that are designated for fruit growing.

The Jordan Valley Development Plan assumes that many of the new holdings will support both a sharecropper and a landlord. This form of organization cannot be recommended for the project area for three reasons. First, sharecropping makes it difficult to pursue crop rotations and other forms of long-term crop husbandry. An owner can make sacrifices in the short term to maintain fertility over a long period. A sharecropper cannot afford to follow policies of this type. Secondly, the temporary nature of the relationship between operator and farm results in the loss of accumulated experience and the dissipation of the extension effort.

Finally it is important to allow some freedom of action to the man who actually works the land. Directives and advice are likely to be handed down by bodies such as the Farmers Association, the Jordan Valley Authority and the Ministry of Agriculture. This will constrain the freedom of owner operators. If these then pass on further commands to their sharecroppers, the latter will be reduced to the status of laborers paid in kind who have no opportunity for initiative or enterprise.

Infrastructural and Social Development

The project under study forms Stage II of the Jordan Valley Development Plan, 1975 - 1982 (Jordan Valley Commission, Amman, November 1975, with subsequent Summary, Amman, May

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1976). This plan covers all aspects of the economic and social development of the Valley. The summary gives the following estimates of the cost of the main components of the Plan -

	JDs
Stage I	29,000.00
Stage II	86,000.00
Associated infrastructural and Social Development	58,810.00
Overall Total	173,810.00

The estimates of the capital costs of the two stages in the irrigation and land development programme have now been outdated, but figures given for the cost of associated investments form a basis for discussion.

The project covers 25,353 hectares or about 70 percent of the total cultivable area in the Valley. The irrigation proposals relate to eleven distinct land areas, but these are not geographically discrete. They interlock with each other and with the four project areas covered by Stage I of teh Plan. This makes it difficult to relate the various elements of the infrastructural and social development programme to individual irrigation areas. Further problems arise in dealing with the renovation of facilities that already exist. The project area includes over 90 percent of the land that will be converted from surface to sprinkler irrigation. Here, there may be opportunities to save money by upgrading the present settlements. In view of this, it seems reasonable to discuss the adequacy of the proposals at the Valley scale, and to allocate costs on a fairly simple set of assumptions. For this report it has been assumed that the investment necessary for one hectare of newly developed land will be fifty percent greater than that required in the Conversion Area. In this case, the total cost of 58,810,000 dinars can be apportioned at about 1,900 JDs per hectare of the New Lands, and about 1,250 JDs per hectare on the Conversion Area. Individual costs have been apportioned in the same way. Table G-55 summarizes the expenditure that will be required in the project area, according to the programme set out in the Summary of the Jordan Valley Development Plan. On this basis, about 39.8 million dinars will be needed between 1976 and 1982.

The scale and distribution of this investment was determined by the need to ensure that there will be sufficient labor to develop the agricultural potential of the Valley. The JVA assumed that the total irrigable are (36,000 hectares) would be divided into farms which would average 3 hectares. On this estimate, there would be about 12,000 farm families in the Valley. According to the JVA forecast, about 7,200 full-time laborers would be required. A further 7,000 families could be supported by service and administrative jobs. Taking 5.6 people as the average family size, this gives a target population of 147,000 people for the Valley as a whole. The Project covers about 70 percent of the irrigable land which means that it would support about 103,000 people on the assumptions given above.

The form of agricultural development recommended in this report is relatively economical in its use of labor, and some adjustments must be made to take account of this fact. Estimates have been given in the previous sections of this report of the numbers of people that will work on the land. These are

Table G-55

BROAD COST ESTIMATES FOR INFRASTRUCTURAL & SOCIAL DEVELOPMENT

Facility	Conversion Area		New Lands	
	Per ha (JDs)	Total (10^3 JD)	Per ha (JDs)	Total (10^3
A. Public Utilities				
Water supply	71	911.8	107	1,338.
Electricity	64	821.9	97	1,213.
Telecommunications	72	924.6	110	1,376.
Roads	45	577.9	68	850.
B. Housing	763	9,798.4	1,163	14,550.
C. Social Services				
Schools	79	1,104.5	120	1,501.
Health Centers	22	282.5	33	412.
Administration	28	359.6	42	525.
Community Centers	9	115.6	13	162.
Business Centers	17	218.3	26	325.
Streets	80	1,027.4	121	1,513.
Total	1,250	16,052.7	1,900	23,770.

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general farmers	4,944
fruit farmers	1,859
labourers	3,230
dairy unit workers	528

The numbers that will be employed in related fields are estimated as follows:

machinery pools	1,500
marketing and packing	300
other(including veterinary, extension and maintenance	500

This suggests that there will be about 12,900 basic jobs in the project area. Using the JVA job multiplier to relate service jobs to basic employment, there would be about 17,400 jobs in the project area at full development. Assuming an average of 5.6 dependants to one worker, this gives a total population of about 97,400. This is slightly lower than the JVA estimate, but it is likely that the general trend of inflation in Jordan will offset any apparent savings that could be made on this score.

The Jordan Valley Development Plan aims to regroup the population of the Valley into 36 settlements. These stretch along the north-south road at intervals of between 3 and 5 kilometers. They are usually located on the stony areas of the Upper Ghor on land which is unsuitable for agriculture. All the people who are directly employed on the land, both farmers and other workers, will live in the settlements. This means that they will frequently have to travel five or more kilometers to the fields. While there appear to be good reasons for locating many settlements on the eastern edge of the Valley, it might be advisable to re-examine the possibility of locating more of the settlements on the Katar in the southern part of the project area. A secondary road from Damiya to Suweima (via Ghor Nimrin) would open up this part of the Valley and provide additional settlement opportunities. However, this suggestion requires further detailed study, since the cost of constructing infrastructural facilities in the relatively rugged terrain of the Katar might outweight the benefits.

The 36 settlements can be placed in three categories, on the basis of the sizes of their populations, as follows -

Type 'A'(population above 10,000, 4 in number).
Type 'B'(population 5,00 to 10,000 9 in number).
Type 'C'(population under 5,000 23 in number).

While these categories provide a useful framework for the allocation of social service facilities, it is understood that no attempt will be made to adhere rigidly to the hierarchy. Indeed there have been recent changes in emphasis in the programme. In the latest proposals, a regional capital will be located at El Arda with a population of between 15,000 and 20,000. This would be a suitable site for the industrial developments that might be associated with the project, which could include the production of fruit juices, the canning of fruit and vegetables, the processing of dairy products, and the manufacture or repair of components for the irrigation system. As far as can be judged without detailed study, the proposed locations and functions of the new settlements seem appropiate to the agricultural developments that have been discussed in this report. The following paragraphs summarise the sectoral investment programme, and offer some comments on their adequacy.

(i) Domestic Water Supplies. Three separate water supply districts were identified. In the north ten settle-

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ments were to have been supplied from small concrete reservoirs, while settlements in the middle and southern parts of the Valley were to have drawn their supplies from well fields at Wadi Rajeb and Wadi Jaria. These plans have now been superseded and it is proposed that 17 MCM of the Maqarin Dam Storage will be allocated annually for domestic livestock, municipal and industrial use in the Valley. Further engineering studies will therefore be required to prepare plans for the treatment and distribution of this water.

(ii) Electricity Supply. The original plan called for the construction of a 33 KV network which would draw from the national grid at Adasiya, El Arda nd South Shuneh. A review suggested that a central power station might be built at South Shuneh. Further work must not be undertaken to take account of the possibility that hydroelectric power may be available from the project. The generators could be located at Maqarin, or at the lower end of a pressure tunnel to Wadi Arab; the latter site would obviously favor the development of the Valley.

(iii) Telecommunications. The plan calls for a telephone exchange located in the Type 'A' settlements. Microwave links would be provided between the exchanges, and Amman, and local facilities would be installed for all of the 36 settlements. These proposals are phased for 1976-1982. A review of the likely growth in the demand for telecommunications services is recommended. This may show that the programme should be phased over a longer period.

(iv) Roads. The expenditure allocated for roads in the plan is reserved for the Yarmouk-Dead Sea road. This is being widened and upgraded. The plan includes the reconstruction of the Zarqa bridge and the construction of new road sections at the northern and southern ends of the Valley. In the future, additional money may be required for new projects. These could include the construction of a road from Damiya to Ghor Nimrin, and the widening of the road from Salt to the proposed regional capital at El Arda.

(v) Sewerage. No money was allocated in the original plan for sewage treatment and disposal. This topic requires immediate attention. The uncontrolled discharge of waste from livestock units and human settlements could affect crop quality, soil fertility and ground water supplies.

(vi) Housing. The Jordan Valley Development Plan is based on the assumption that 18,000 houses will be built between 1976 and 1982. Each of these was to have 2 bedrooms, a kitchen and a bathroom. Families were to receive twenty year loans of up to JD 2,000 per family at 7 percent interest. Taking both private and public investment into account JVC estimated that about 36 million dinars would therefore be required for housing. If the revised manpower estimates that are given in this report prove correct, fewer houses will be needed. The programme could also be phased over a longer period, as farmers may judge it unwise to incur additional debts during the early years of land development.

(vii) Schools. The regional education programme provides for separate boy's and girl's elementary and preparatory schools in every village neighborhood. Nine secondary schools will be constructed in the type 'B' settlements. The area requirements were calculated according to standards laid down by the Ministry of Education. However, adjustments may be necessary if the population stabilises at the level suggested by this report.

(viii) Health Centers. The original plans for health facilities were based on the settlement hierarchy. Type 'A' settlements were to have a comprehensive range of facilities for preventive medicine, dentistry, emergencies and child care. Type 'B' settlements were to have outpatient and maternity/child care units, while provision was made for first aid centers in the Type 'C' settlements. More recent plans appear to centralize facilities on five district centers. Each of these is to be staffed by 2 doctors. Both sets of proposals appear highly ambitious and could be subject to review.

(ix) Municipal Facilities. The Jordan Valley Development Plan contains proposals for administrative buildings, community centers, business centers and street paving. These suggestions appear sensible, although it may prove necessary to extend the phasing beyond 1982. In many instances, the facilities might be constructed by local taxation or cooperative effort, which would reduce the pressure on central government funds.

Existing Loans for the Development of the Jordan Valley

A large number of international loans have already been made for development projects in the Jordan Valley. Some of these cover schemes that can be regarded as complementary or ancillary to the project under discussion. This point should be considered in evaluating the total level of finance that will be required. The following sections discuss the range of assistance that has already been granted by foreigh governments, with particular reference to loans and grants made by USAID (AID).

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(1) Loans for Irrigation Schemes

Initial planning to develop the irrigation potential of the East Ghor began with the "Yarmouk-Jordan Valley Master Plan Report" of 1955. An outgrowth of the Study was the construction of the East Ghor Canal designed to irrigate about 12,000 hectares of land from the unregulated flow of the Yarmouk Rivers and smaller streams. The project, which began in 1958 and was completed in 1966, included a tunnel one kilometer long and main canal approximately 69 Km (42 miles) in length, plus a distribution system of 400 Km (250 miles) of small concrete-lined lateral canals. The agency for International Development (AID) contributed over $12 million while the Government of Jordan contributed the equivalent of $9 million in cash and in kind.

With the help of the Arab League Fund, the Government of Jordan later extended the canal 8 Km (5 miles) and raised the sides of the entire canal to enable it to carry additional quantities of water. A number of water development projects are currently underway, most of them designed to utilize the second major water source in the Jordan Valley, the Zarqa River, which has a drainage area lying entirely in Jordan. Current projects are:

(i) King Talal Dam. Financed by the Kuwait Fund, the Abu Dhabi Fund and the Government of Jordan at a total estimated cost of $36 million, this dam was begun in mid-1971. Construction was often interrupted, but began again in earnest in 1976 and is continuing. Impounding of water began in March 1977. This earth-fill dam is vitally important

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for East Ghor and Zarqa Triangle projects described below.

(ii) East Ghor Canal Extension Project. This 18 km extension (and its attendant works) is expected to irrigate 3,600 hectares of land with water from the King Talal Dam and from unregulated flows of the Yarmouk River. A $10 million AID loan was extended in 1973. Work began in March 1975, and the project is expected to be completed by the end of 1977.

(iii) Zarqa Triangle Irrigation Project. The term "Zarqa Triangle" refers to areas above the main canal in the Zarqa River area, about 1,400 hectares of which will be irrigated through a pressure pipe network with water from the King Talal Dam. A $4.5 million AID loan was extended in 1974. Expected project completion is late 1977.

(iv) North East Ghor Irrigation Project. This project will irrigate nearly 2,700 hectares of land from waters of the Wadi Arab, Wadi Jurum and the Ziglab Dam. A $5 million International Development Association (IDA) loan was extended in 1976. Work began in August 1974 and is expected to be completed toward the end of 1978.

(v) Hisban - Kafrein Scheme. About 1,550 hectares will be irrigated with water from Wadi Hisban and the Kafrein Reservoir. A $4.6 million loan from Kreditanstalt fur Wiederaufbau (KFW) was extended in 1976, and work began the same year. Scheduled completion is February 1978.

(vi) Sprinkler Supply Project. This project will supply portable aluminum pipes and sprinklers for use in all four of the irrigation projects currently under construction in the Valley. Originally each irrigation project called for its own distinct sprinkler system, but JVA decided (and donors agreed) to utilize a single system in order to standardize equipment, thus permitting more efficient maintenance and stockpiling of equipment and allowing farmers to purchase replacement through loans from the Agricultural Credit Corporation. An $8 million AID loan was extended in August 1976. Procurement is expected to be completed by the end of 1978.

(vii) Wadi Arab Dam and Irrigation Project. Under this project, a storage dam will be constructed on the Wadi Arab, and a gravity sprinkler system will irrigate 1,250 hectares. A $30 million loan was extended by the Japan International Coopertion Agency in May 1977. Work is expected to begin by the end of 1977.

(viii) Sub-surface Drainage Project. The JVA plans to organize a "drainage team" of engineers and scientists to study drainage requirements for lands to be irrigated and monitor the situation to be able to provide drainage facilities if problems develop. With USAID financing of $120,000, a drainage expert is being recruited to train this team.

(ix) Equipment for Operation and Maintenance. This project supplies equipment and vehicles required to operate and maintain the irrigation system and farm roads under, an IDA loan of $461,000.

(2) Loans for Agricultural Development

A number of agricultural projects underway and planned by the JVA are important to ensure that the benefits promised by the substantial capital development can actually be realized. They are also necessary to promote equity for farmers throughout the Valley.

(i) Agricultural Research and Extension. The Ministry of Agriculture, with assistance from IDA and the UNDP/FAO in previous years, is involved in research to increase yields, reduce production costs, introduce new crops, improve farming and irrigation techniques, gear production to market demands, and relay results and information to farmers through the extension service. Extension agents are being trained, and a farmers training center has been established at the Deir Alla Agriculture Station.

(ii) Agricultural Marketing. Four grading and packing centers are being constructed or improved andput into operation in four different sections of the Valley. IDA and KFW are the major financing organizations.

(iii) Jordan Valley Farmers Association. This organization, formally established in 1974, is expected to be a farmer-owned and controlled enterprise which will develop agriculture in the Valley, enable farmers to participate in formulating and carrying out government agricultural policies, promote equitable returns for farmers, and increase food production through efficient utilization of land and water resources in the Valley. Eventually, the Association plans to provide loans and agricultural inputs, undertake various agricultural operations common to the members (such as pest control, transportation of produce, etc.), and market crops at wholesale markets in and out of Jordan. Through a technical services grant, AID assisted the newly formed organization in the development of a variety of operations. AID plans further assistance to the Association in future years.

(3) Loans for Transportation Improvements

The construction of roads in the Jordan Valley has had a large impact on accessibility to the farming areas and has provided ready market outlets and access to production imputs such as improved seeds, fertilizers and pesticides. Current projects include:

(i) Yarmouk-Dead Sea Road. This project upgrades the Valley north-south road to a primary highway with a uniform carriage way 7.2 meters wide. A $2.9 million AID loan was extended in 1974, and an addition $1 million loan was authorized in May 1977. Completion is expected in late 1977.

(ii) Farm Roads. Improvement of the farm road system in the Valley provides ready access to farms and facilitates the transportation of agricultural produce. It also allows for maintenance of the irrigation system in all types of weather. AID assisted the Government of Jordan in the improvement of farm roads in the 1960's and, under the village Development Loan (see below) is providing funds for continued upgrading.

(4) Loans for Social Services Development

To make the Valley a desirable place to live, improve the quality of life for current inhabitants and attract the population necessary to make optimum use of the newly irrigated lands, the JVA has undertaken an ambitious Village Development program with AID assistance.

The project aims to provide all 36 villages with the facilities necessary for carrying out programs in education, health and community and local government employees; and provide basic village infrastructure such as streets, commercial facilities, etc. An $8.65 million AID loan was extended in 1975, and an additional $5.5 million was added through an amendment authorized in May 1977. Other donors in this undertaking include KFW and the IDA.

Assisted by an AID $290,000 grant, town planning studies and designs were carried out for the villages and were completed in early 1977. AID also provided a $335,000 grant in 1975 to provide supporting technical advisory services.

The housing mortgage program, for which AID is providing $2 million under the Village Development loan, was blocked by land title problems until recently. When the new JVA law went into effect May 16, 1977, it provided authority (among many other powers) for the JVA to acquire areas within village boundaries, implement land parcellation in accordance with town plans, and distribute land to eligible beneficiaries. The program began moving in summer 1977.

(5) Loans for Public Utilities

Projects in this sector also aim to make the Jordan Valley a better place to live and improve the quality of life of its inhabitants. Current projects include:

(i) Domestic (Potable) Water Supply. At an estimated cost of more than $3.5 million, the 36 Valley villages will be provided with potable water. AID KFW, and IDA are donors in the project, with KFW the primary contributor. The project is divided by areas into three sub-projects, and work has already begun or is expected to begin before the end of 1977.

(ii) Electrification. A north-south high tension line will travel along the Valley adjacent to the Yarmouk Dead Sea Road and connect three feeder lines transmitting current from electrical energy sources in the Plateau. Transformers will be set up at an estimated 54 locations to form a low voltage electrical distribution network to serve the villages. Total cost is expected to be $5.5 million. A $3.9 million KFW loan was extended in 1975.

(iii) Telecommunications Project. The JVA plans to link the Valley with major cities in the Plateau and from there to the rest of the world. Consultants have completed a feasibility study, but no financing has yet been made available and no starting date has been set for the project.

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Conclusion

The project forms part of a complex integrated plan for the development of the land, water and human resources of the Jordan Valley. It is extremely difficult to sift out the capital requirements that will arise in ancillary and associated fields. however, it is possible to make estimates of the broad order of magnitude of the sums that will be needed. Table G-56 sets out this information. Under the assumptions used in this Report a total of about 67,600,000 JD's could be required in the long-term. As has been explained some of this money has already been spent, while loans for other elements of the programme have been advanced by international lending agencies. Taken overall, the cost of these secondary investments should be related to the value of the stemming, induced and public benefits that will arise at the secondary level as a result of the implementation of the project.

Table G-56

SUMMARY OF CAPITAL REQUIREMENTS FOR ANCILLARY AND ASSOCIATED DEVELOPMENTS (10^3 JDs).

Item	Capital Cost
Agriculture	
Dairy Units	10,600
Farm Machinery Pools	6,500
Marketing Facilities	2,000
Research and Fxtension	300
Portable Sprinkler Equipment	3,500
Farm Credit	4,900
SUB TOTAL:	27,800
Social Infrastructure	
Public Utilities	8,000
Housing	24,300
Social Services	7,500
SUB TOTAL	39,800
TOTAL:	67,600

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ATTACHMENT 1

CROP YIELDS STUDY

BY JOHN K. BLACK, HARZA CONSULTANT

August - September 1977

INTRODUCTION

The primary objective of this study was to gather data on yields, from areas similar in climate to the Jordan Valley, to serve as a basis for projections of project yields. The method used in this study was to obtain data from areas which are climatically similar to the Jordan Valley. Crop yield data were obtained where available. A second and equally important type of data on the probable yields was obtained from knowledgeable specialists in the various areas. These yields are those that should be obtained under the conditions presented with the Jordan Valley project.

The areas of study included Jordan, Cyprus, Israel and the desert valleys of the Southwestern United States including, the Welton Mohawk Valley, Yuma Mesa, and Imperial Valley areas of Arizona and California.

Preparation for the visits to the above areas was made by discussions at the Jordanian Embassy, the World Bank and the U.S. Bureau of Reclamation offices in Washington D.C., and the F.A.O. offices in Rome.

Acknowledgements

Greatful appreciation is expressed to all who gave valuable assistance in supplying suggestions for contacts and in arranging for conferences, and especially to those who participated in the conference and who so willingly gave information. The names of all participants are in Exhibit A.

Data Presentation

The areas visited will be discussed in the order they were visited. The order of presentation within an area is to present the information from panel discussion, then estimates from individual government officials and then data from private farms.

The information obtained is summarized in a general table, Exhibit B.

Jordan

A conference with Ministry of Agriculture specialists was held in Amman. The crops were individually discussed and the concensus of probable project yields was taken. Other information and recommendations were willingly presented in the conference. Information, from the conference are given in Exhibit C and the probable yields with sprinkler irrigation are entered on line three of Exhibit B.

The first two lines of Exhibit B give the projected crop yields for the Jordan Valley without and with the Jordan Valley Project. The rest of the lines contain the information obtained in this study.

Information on yields was obtained from the staff at the Experiment Station at Deir Alla. These are presented on line four of Exhibit B.

The information on line five was obtained on a private farm near Deir Alla. The farm is owned and operated by a former director of the Deir Alla Experimental Station. The citrus yields from this farm give a good example of the production potential of the Valley.

Cyprus

In cyprus, no panel was assembled but information was obtained indvidually from various specialists of the government. Published data by Mr. Stelios Papachristodoulou[1/], Agricultural Ecomomist of the Agricultural Research Institute Ministry of Agriculture and Natural Resources, are given in line six of Exhibit B.

1/ Norm input-output data of the main crops of Cyprus Stelios Papachristodoulou Agric. Econ. Report No 6, Min Ag. and Nat. Res. Nicosia, Cyprus. Nov., 1976.

Data from the Paphos Irrigation Project Feasibility Report[2/] are given on line seven of Exhibit B. Data for reported yields from the Paphos Project Experimental Farm near Paphos, are given on lines eight and nine of Exhibit B.

The Paphos Project Feasibility Report was completed in April, 1973. Shortly thereafter, a loan for project construction was approved by the World Bank, and actual construction began.

The vine culture specialist, with the Department of Agriculture at Paphos, expects the project to reach the projected grape yield of 18.75 T/ha within five years.

Data from the Lanitis Farm is given on line 10 Exhibit B. This 1000-acre farm was reclaimed from swamp land about 100 years ago. It is highly productive, and the fruit is processed in farm facilities for both local and export markets.

The estimate of the average farm yield of tomatoes was quoted as 37.5 T/ha. This figure is entered on line 11 of Exhibit A. The value is the same as the yield for the experimental farm.

Israel

In Israel two panels of specialists were consulted to obtain a concensus on the probable yields under the Jordan Valley Project Conditions. The data from the first panel, consisting of staff of the Faraa experiment station, are listed on line 12 of Exhibit B. The second panel in, Tel Aviv, was from the Ministry of Agriculture. The data obtained from this Panel is given on line 13 of Exhibit A.

2/ Paphos Irrigation Project Cyprus Feasibility Report Volume 1, Main Report Sir MacDonald and Partners and Hunting Technical Service, April, 1973.

The entries on line 14, Exhibit A were from published data by the Volcani Center[3/].

No individual farm yields were obtained, but the staff at the Faraa Station stated that farmer yields near the station were close to those obtained on the station. The station and many of the old farms in the area are operated by Arabs. There is a ready acceptance of the technical information by these Arab farmers. The appearance of the farm was evidence to support the high yields stated by the Faraa staff. It was noted that these farmers respond well to the profit motive in the adoption of new techniques to obtain efficient and abundant production when markets are available. The staff of the Settlement Study Center at Rehovot emphasized the need for planned and developed infrastructure in a project so that the farmers will have access to the markets.

Southwestern U.S. Valleys

Data were obtained from the University of Arizona Extension Service for average yields for Yuma County and for The State of Arizona[4/]. These are given on line 15 and 16 of Exhibit B.

Data were also obtained from the University of Arizona Experiment Farm. These were taken from station statistics and supported by yields of nearby farm yield as well. The data are entered on line 17 of Exhibit B.

Data were also obtained from the Mellowland Station or the Imperial Valley Field Station. The yields obtained on the station are given on line 18, and those for near by farms are given on line 19 of Exhibit B. Yield data from

3/ Irrigation of Field & Orchard Crops Under Semi-Arid Conditions, Edited by J. Shalhevet, A. Mantell, H. Bialorgi and Deshimgh III Publication No. 1, International Irrigation Information Center, Bet Dagan, Israel 1976.

4/ 1976 Arizona Agricultural Statistics, Arizona Crop and Livestock Reporting Service Bulletin 912. March, 1977.

circular 464[5/] are included on line 20 of Exhibit B. These are representative of both Imperial and Coachella Valleys. A second source of published data on yields for California is circular 142[6/]. These are given on line 21 of Exhibit B Fruit yields on the same line were obtained from the Annual Crop Report of Imperial County[7/]. Data on yields of various vegetable crops in Imperial County were obtained from the manager of The Harry Newman Seed Company. These are given on line 22 of Exhibit B.

Data were obained from Spencer & Spencer, Snyder Ranch and Interharvest on yields of crops on these Welton-Mohawk Project Farms. They are given on lines 23, 24 and 25 of Exhibit B. This project is noteworthy in that every effort is being made to overcome return flow problems by increasing water application efficiencies. The yields given are for marketed produce and may be low in some instances where the prices in the market were too low to justify harvesting the fruit.

5/ California Desert Agriculture. N.L. McFarlane, R.S. Ayer, C.L. Wainwright, University of California Circular 464. Nov., 1957.

6/ Vegetable production trends Imperial Valley K.S. Mayberry AF Van Marrem, Hunter Johnson Jr., Circular 142 University of California April 1977.

7/ Annual Crop Report 1976 Imperial County Claude M. Finnel Agriculture Commissioner Imperial County Board of Supervisors.

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Interpretation of data obtained from farms in the Yuma areas is subject to this same problem. Data from the Jacoby Farm Management Service of Somerton, Arizona, are given on line 26 of Exhibit A. Data from the Didier Farms, as given on lines 27 and 28 of Exhibit B, show the range of production from various farms operated for absentee owners. The low values are the result of: (1) technological breakdown, such as failure to use adequate fertilizers fitted to the needs of the crop; (2) Economic prices too low at time of harvest to justify harvest; (3) Absentee owners put pressure on to pick the fruit or leave it on the trees depending on the effect the income will have on their income tax returns; (4) normal vagaries of weather.

Exhibit A

List of Participants

Washington

Mr. Kent Bebb, Chief of the Division of Foreign Activities Bureau of Reclamation U.S.G.I.

Mr. James O'Brien, Engineer for East Asia, World Bank (IBRD).

Mr. Guy M. LeMoigne, Chief Irrigation Division Middle East Countries, IBRD.

Mr. Eddie Quicke, Economist, IBRD.

Mr. Mahmud Hasan Tirmazi, Economist, IBRD.

Mr. Arthur Schwenneker, Contracts Engineer. Far East Area, IBRD.

Mr. Horst Von Oppenfeldt, Economist, IBRD.

Mr. Leslie Shanan, Engineer, IBRD.

Mr. John Hyslop, Argricultural Officer, For AID/Jordan.

Rome

Dr. Neal R. Carpenter, Chief Agricultural Services Division, Farm Management and Production Economics, Service, F.A.O.

Mr. James Punnel, Economist, F.A.O.

Jordan

Mr. Ashgar Abidi, Engineer, FAO.

Mr. Robmatullah Shahida, Head Horticulture Research Section, Research & Extension Dept of Agriculture Amman. (Panel participant).

Mr. Zaki Nassar, Head Vegetable Research Section, Research and Extension, Department of Agriculture, Amman (Panel Participant).

Mr. Zulkifl Ghosheh, Head Agronomy Division, Research and Extension Department of Agriculture Amman (Panel Participant).

Mr. Adman A.R. Dadden, Agricultural Economist, Jordan Valley Authority, Amman (Panel Participant).

Mr. Tom Pearson, Chief Capital Development Section, USAID/Jordan.

Mr. Abu Mamoon, Director, Experiment Station, Deir Alla.

Mr. Marwan Al Hamood, Private Farmer, Deir Alla, Former Director Expt. Sta. Deir Alla.

Cyprus

Dr. Christo Konteatis, Director Department of Water Development, (DWD) Ministry of Agriculture and Natural Resources, MANR Nicosia. Mr. Christakis Harodotou Agricultural Economist, DWD MANR, Nicosia.

Dr. Vlasios Krentos, Director Agriculture Research Institute, MANR Nicosia.

Mr. Stelios Papachristodoulou, Director Agricultural Economics Section, Agricultural Research Institute MANR Nicosia.

Mr. Aris J. Chisistodolou, Farm Namager, Lanitis Farms Ltd, Nicosia.

Mr. Papana Stasiou, Director, Paphos Project Experimental Farm, Paphos.

Mr. Michael Mbekris, Vine Culture Specialist, Dept of Agriculture and Natural Resources at Paphos.

Mr. Danayiotis, District Agriculture Officer, Department of Agriculture Paphos.

Dr. Auraam Louka, Director, Department of Agriculture and Natural Resources Nicosia.

Israel

Mr. Yaacov Vardi, Vice President, Tahal Consulting Engineers, Ltd., Tel Aviv.

Mr. Yore Artsi, Agricultural Economist, Ministry of Agriculture, West Bank Planning.

Mr. Levy Moshe, Min Ag, West Bank Planning. (Panel Participant).

Mr. Maxen H. Risheh, Director, Farah Experiment Station FARAA.

Mr. Yeghay Hou Novm Ministry of Agriculture Tel Aviv (Panel Participant).

Mr. Herzel Aviolon Min Ag Tel Aviv (Panel Participant).

Mr. Thkloneoitz Sysmdea Min Ag Tel Aviv (Panel Participant).

Dr. I. Arnon. Settlement Study Center, Rehovot.

South Western U.S.

Mrs. Wilma West, Statistician, Welton-Mohawk Irrigration and Drainage District, Yuma Arizona.

Mr. Abraham Bodderig, Farm Manager, Spencer and Spencer Incorporated, Yuma, Arizona.

Mr. Bill Wootton, Manager, Snyder Ranch, Yuma Arizona.

Mr. Greg McCleery, Manager, Interharvest Produce Farms Yuma Arizona.

Dr. James H. Clark, Sept., Yuma Experimental Station, University of Arizona, Yuma Arizona.

Dr. Jackson, Chief Agronomist, Yuma Expt Sta., Univ of Arizona Yumes, Arizona.

Dr. George F. Worker, Jr., Supt and Agronomist Imperial Valley Field Station University of Calif, Holton, Calif.

Mr. Keith Mayberry, Vegetable specialist, Agricultural Extension Univ. of Calif, Imperial County, El Pentro, Calif.

Mr. Harry Newman, Manager, Harry Newman Seed Co, El Centro, Calif.

Mr. Rogers, Manager, Jacoby Farm Management Service, Somerton, Arizona.

Mr. Jerry Didier, Owner and Operation, Didier Farms, Yuma, Arizona.

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EXHIBIT B
Sheet 1/3

COMPARATIVE CROP YIELDS
Tons/ha

	Name of Study	A Barley	B Maize	C Sorgum	D Wheat	E Alfalfa	F Berseem	G Beans	H Cabbage	I Cauli-flower	J Cucum-ber
1.	Estimated JVP w/o Proj.	3.0	6.5	35.0	3.0	50.0	50.0	12.5	27.0	27.0	20.0
2.	Estimated JVP with Proj.	5.0	7.5	40.0	5.0	60.0	60.0	15.0	30.0	30.0	30.0
3.	Suggested by Jordan Panel	3.5	x	x	3.0	x	x	22.5	40.0	30.0	30.0
4.	Dier Alla Exp. sta.	4.0	5.0	70.0	4.0	60.0	60.0	x	x	x	22.5
5.	Commercial farm J.V. (Dier Alla)	x	x	x	1.3	x	x	x	x	x	x
6.	Cyprus Study	x	2.3	x	1.8	x	x	18.8	26.2	28.5	30.0
7.	Cyprus Paphos proj.	1.5	x	x	1.5	x	x	13.1	26.2	26.2	26.2
8.	Cyprus Expo Farm	x	x	x	x	x	x	15.0	x	x	22.5
9.	Cyprus Expo Farm	3.0	x	x	2.0	x	x	x	x	x	x
10.	Cyprus Lanitis Farm	x	x	x	x	x	x	x	x	x	x
11.	Cyprus Average Farmer	x	x	x	x	x	x	x	x	x	x
12.	Israel - Faraa Exp. sta.	x	x	x	6.0	x	x	30.0	x	x	30.0
13.	Israel Pannel Min. of Agricul.	2.0	x	3.2	4.0	x	x	x	35.0	25.0	25.0
14.	Israel Volcani Center	x	6.8	4.0	5.2	6.6	x	x	x	x	x
15.	Yuma County Wide	3.4	3.7	4.2	5.1	17.2	x	x	x	x	x
16.	Arizona State	4.0	3.7	4.5	5.0	15.4	x	x	x	x	x
17.	Yuma Experiment Farm	4.4	x	6.6	6.1	15.4	x	x	x	x	x
18.	El Centro - Imp. Val. Field Station	6.7	x	8.1	8.6	19.8	33.1	x	16.5	x	x
19.	El. Centro Valley Yields	4.8	x	5.5	5.5	16.5	x	x	x	x	x
20.	El Centro - Newman Seed	x	8.8	8.8	6.6	18.8	x	x	44.1	x	x
21.	El Centro - Pub. 464	4.4	3.7	3.3	1.9	13.2	x	26.5	21.0	x	14.3
22.	El Centro - Imperial County	5.2	x	5.8	5.0	17.0	x	x	35.4	x	x
23.	Yuma - Spencer & Spencer	x	x	x	x	x	x	x	x	x	x
24.	Yuma Snyder Ranch	x	5.1	x	7.0	19.T	x	x	x	x	x
25.	Yuma Interharvest Ranch	x	x	2.5	6.1	x	x	x	x	x	x
26.	Yuma - Jacoby Farm Mgt.	x	x	x	x	x	x	x	x	x	x
27.	Yuma Didier Farms High Range	9.4	x	4.4	3.1	18.8	x	x	x	x	x
28.	Yuma Didier Farms - Low Range	1.6	x	1.6	x	x	x	x	x	x	x
	Average of all Yields	4.1	5.8	5.1	4.6	16.2	50.8	19.2	30.2	29.5	25.1
	Excessive Yields Projected	.9			.4					.5	

Note:

Columns C, E and F, Forage. In Jordan yields of Sorghum (lines 1, 2 and 4) are expressed in green weights since the sorgum is cut green and fed to the dairy cattle in that form. The same holds true for alfalfa and berseem. Notice that all other recordings in these columns are in dry weights.

EXHIBIT B
Sheet 2/3

COMPARATIVE CROP YIELDS
Tons/ha

	K	L	M	N	O	P	Q	R	S	T	U	V
Source of Yield Data	Eggplant	Onion	Pepper	Potato	Squash	Tomato	Water-melon	Grape-fruit	Lemon	Orange	Banana	Grapes
1. Projected JVP w/o Proj.	32.0	x	12.5	x	32.0	35.0	22.0	40.0	25.0	30.0	30.0	x
2. Projected JVP with Proj.	40.0	27.0	15.0	40.0	35.0	45.0	25.0	50.0	35.0	40.0	35.0	20.0
3. Suggested by Jordan Panel	40.0	40.0	30.0	30.0	30.0	50.0	30.0	50.0	35.0	40.0	45.0	17.5
4. Dier Alla Exp. Station	x	65.0	10.0	25.0	20.0	35.0	50.0	x	x	x	x	x
5. Commercial farm J.V. (Dier Alla)[1/]	20.0	x	x	x	x	24.0	x	97.0	61.7	61.7	x	x
6. Cyprus Ag Econ Report No. 6[1/]	67.3	26.2	45.0	33.8	26.2	45.0	30.0	56.2	37.5	33.8	22.5	15.0
7. Cyprus Paphos Proj.[2/]	28.1	26.2	23.4	23.4	22.5	30.0	18.8	44.0	21.6	30.4	18.8	18.8
8. Cyprus Expo Farm	82.5	18.8	37.5	37.5	22.5	37.5	22.5	64.1	54.4	40.2	x	x
9. Cyprus Expo Farm											19.5	10.8
10. Cyprus Lanitos Farm	x	x	x	x	x	x	x	51.2	x	34.2	x	16.9
11. Cyprus Average Farmer	x	x	x	x	x	37.5	x	x	x	x	x	x
12. Israel - Faraa Exp. sta.	85.0	40.0	30.0	x	30.0	85.0	55.0	x	30.0	x	22.0	25.0
13. Israel Panel Min. of Agricul.	60.0	45.0	35.0	45.0	25.0	75.0	40.0	65.0	25.0	45.0	45.0	20.0
14. Isreal Volcani Center[3/]	x	x	x	x	x	64.7	x	54.0	63.0	47.0	55.0	x
15. Yuma County Wide[4/]	x	39.0	x	x	x	x	x	x	x	x	x	x
16. Arizona State	x	x	x	x	x	x	x	26.5	15.8	13.2	x	x
17. Yuma Experiment Farm	x	x	x	x	x	x	x	70.6	39.7	39.7	x	x
18. El Centro - Imp. Val. Station	x	23.5	x	x	25.4	x	x	x	x	x	x	x
19. El. Centro Valley Yields	x	23.2	x	x	16.5	23.2	15.4	x	x	x	x	x
20. El Centro - Pub. 464[5/]	13.2	41.4	13.2	x	x	22.0	21.0	x	x	x	x	x
21. El Centro - Imperial County[6/7/]	x	23.1	x	x	25.7	55.7	15.3	7.9	14.0	4.3	x	x
22. El Centro - Newman Seed	x	41.4	x	x	x	55.0	33.0	x	x	x	x	x
23. Yuma - Spencer & Spencer	x	x	x	x	x	x	x	99.2	66.2	82.7	x	x
24. Yuma Snyder Ranch	x	x	x	x	x	x	x	x	x	x	x	x
25. Yuma Interharvest Ranch	x	x	x	x	x	x	x	x	x	x	x	x
26. Yuma - Jacoby Farm Mgt.	x	x	x	x	x	x	x	48.5	46.3	27.6	x	x
27. Yuma Didier Farms High Range	x	x	x	32.2	x	x	x	97.0	66.9	41.5	x	x
28. Yuma Didier Farms - Low Range	x	x	x	21.5	x	x	x	15.4	36.4	8.3	x	x
Excessive Yields Projected	46.8	34.5	26.2	32.0 8.0	25.9 9.1	45.0 .0	29.1	55.1	39.6	36.4 3.5	33.6 1.4	18.0 2.0

EXHIBIT B
SHEET 3/3

1/ Norm input-output data of the main crops of Cyprus Stelios Papachristodoulou Agric. Econ. Report No. 6, Min Ag. and Nat. Res. Nicosia, Cyprus. Nov., 1976.

2/ Paphos Irrigation Project, Cyprus Feasibility Report Volume 1, Main Report Sir MacDonald and Partners and Hunting Technical Service, April, 1973.

Paphos Project from Exhibit IV table 15.3 for vegetables, table at 15.3.2 for grapes, and table 15.2 for citrus. Please note here that yields indicated are "Exported" citrus. Actually yields for total production run, oranges 38 t/ha, grapefruit 55 t/ha and lemons 27 t/ha. The yields used were projected by government officals and their consultants and were accepted by IBRD.

The Paphos project feasibility report did not project cereals or fodder. But the Paphos Project Agricultural Economist said that if they had done so, wheat and barley would have been projected at 1.5 t/ha. This figure was inserted for these cereals.

3/ Irrigation of Field & Orchard Crops Under Semi-Arid Conditions, Edited by J. Shalhevet, A. Mantell, H. Bialorgi and Deshimgh III Publication No. 1, International Irrigation Information Center, Bet Dagan, Israel 1976.

4/ 1976 Arizona Agricultural Statistics, Arizona Crop and Livestock Reporting Service Bulletin 912. March, 1977.

5/ California Desert Agriculture. N.L. McFarlane, R.S. Ayer, C.L. Wainwright, University of California Circular 464. Nov., 1957.

6/ Vegetable production trends Imperial Valley K.S. Mayberry AF Van Marrem, Hunter Johnson Jr. Circular 142 University of California April 1977.

7/ Annual Crop Report 1976 Imperial County, Claude M. Finnel, Agriculture Commissioner Imperial County Board of Supervisors.

EXHIBIT C

Yields Suggested by Panel of Experts
at meeting, JVA, 29/8/77 (tons/ha.)

	Obtained Now		Max. Surface Irrigation	Max Sprinklers	
Wheat	1.5		3.0	3.0	Rust
Barley	2.2		3.5	3.5	resistant
Maize	5.0	to	6.0	need high sprinklers	
Fodder Sorghum	6.0	to	8.0	sprinklers not	
Beseem			50 - 60.0	favored	
Alfalfa	Crop not favored for project area.				
Tomatoes	19.0			50.0	
Eggplants	19.0	- 20.0		40.0	
Peppers	9.0			30.0	
Squash	11.0			30.0	
Cucumbers	7.0			30.0	
Beans (snap)	4.0			20.0	
" (broad)	9.0			25.0	
Cauliflower & Cabbage	21.0			40.0	
Potatoes	13.0			30.0	
Onions	11.0			40.0	
Watermelon	10.0			30.0	

Fruits - Ag Appendix estimates accepted as reasonable (including bananas).

Oranges	40.0
Lemons	35.0
Grape Fruit	50.0
Bananas	45.0
Grapes	15-20.0

Attachment 2

Irrigation Application Efficiencies

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Introduction

Harza Engineering Company, in association with Dar Al-Handasah Consultants has contracted with the Government of Jordan to provide engineering services for development of an irrigated agriculture project in the Jordan Valley. Since irrigation system designs are based on farm irrigation application efficiencies, it is important that the farm irrigation application efficiency selected for the design of the Jordan Valley Irrigation Project be realistic. To assist in the selection of a farm application efficiency, this study of irrigation systems, and their field and farm irrigation application efficiencies was undertaken.

The objective of this study was to collect information on current field and farm irrigation application efficiencies in the vicinity of Fresno, California. Sprinkler, furrow, and border irrigation systems were investigated. Sprinkler irrigation with portable farm systems was the major subject of this study.

Although the primary focus of this investigation was farm irrigation application efficiency, an attempt also was made to show the effect of water and fertility management on crop yields.

Irrigation application efficiency can be based on a field or a farm. In this study, both field and farm efficiencies were studied. The definition of field and farm irrigation application efficiency used in this study may be expressed in the form of an equation as shown below:

$$E_a = \frac{ET - R_e + L + Sm_e - Sm_s}{W_d} \times 100$$

Where:

E_a = irrigation application efficiency in percent,

ET = consumptive use of crop,

R_e = effective rainfall,

L = leaching requirement,

Sm_e = soil moisture in the root zone at the end of the study period,

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Sm_s = soil moisture at the beginning of the study period established at the same depth as the Sm_e and

W_d = water delivered.

Operational irrigation data available at Harza Agricultural Services (Harza) in Fresno, California was collected and analyzed to achieve the objectives of this study.

Fields and Farms Selected

Basis for Selecting Fields and Farms

The following information was required for each field and farm selected for this investigation.

1. Total amount of water delivered to the field or farm during the study period.

2. The consumptive use of the crops during the study period.

3. The soil moisture prior to the first irrigation of the study period and at the end of the selected consumptive use period.

4. The effective precipitation that occurred during the study period.

The above requirements extremely restricted the selection of farms and fields that could be examined in this investigation. Because portable sprinkler systems are being planned for use in the Jordan Valley, emphasis was placed on finding farms using this type of system.

Description of Fields Selected

Listed below are the farms selected for the investigation along with the type of irrigation system used. A more detailed description of each field is given in Tables 1, 2, 3, 4, 5, and 6.

Table 1

SK RANCH

12/26/75 to 9/22/76

Irrigation System: portable sprinkler

Soil: Panoche loam, fine sandy loam, silty clay loam

Water Intake Rate: exceeds sprinkler rate

Topography: gently sloping to gently undulating

Field	Area (acres)	Crop	Water holding Capacity (in/ft root zone)
2	160	barley	4.9/2.5
3	155	barley	5.1/2.5
9	151	barley	5.0/2.5
11	155	barley	5.1/2.5
13	155	barley	5.2/2.5
15	158	barley	5.1/2.5
4	158	barley	5.1/2.5
12	155	barley	4.7/2.5
1	57	alfalfa hay	10.2/5.0
6	92	alfalfa hay	9.9/5.0
17	155	alfalfa hay	10.2/5.0
7	150	cotton	3.6/2.0
8	140	cotton	3.6/2.0
5	150	cotton	3.7/2.0
16	158	cotton	3.7/2.0
10	155	cotton	3.7/2.0
14	160	cotton	3.9/2.0

Table 2

VALLE VERDE FARMS, INCORPORATED

12/29/76 to 7/13/77

Irrigation System: portable sprinkler

Soil: fine sandy loam and loam

Water Intake Rate: exceeds sprinkler rate

Topography: slightly undulating

Field	Area (acres)	Crop	Water holding Capacity (in/ft root zone)
17-SW	150	onion	4.4/2.5

Table 3

ALLEN RANCH

6/2/77 to 8/27/77

Irrigation System: portable sprinkler

Soil: silt loam and sandy clay loam

Water Intake Rate: exceeds sprinkler rate

Topography: very gently sloping

Field	Area (acres)	Crop	Water holding Capacity (in/ft root zone
21-4	155	cotton	7.0/3.5

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Table 4

CLARK BROTHERS

12/1/75 to 10/21/76

Irrigation System: furrow with tailwater reuse Soil: Panoche, Oxalis and Lethent silty clays

Water Intake Rate: good

Topography: gently sloping

Field	Area (acres)	Crop	Water holding Capacity (in/ft root zone)
4-3-1	20	barley	9.0/4.0
"		lettuce	3.5/1.7
4-3-2	20	barley	9.0/4.0
"		lettuce	3.5/1.7
4-3-3	20	barley	9.0/4.0
"		lettuce	3.5/1.7
4-3-4	20	barley	9.0/4.0
"		lettuce	3.5/1.7
4-3-5	20	barley	9.0/4.0
"		lettuce	3.5/1.7
4-3-6	20	barley	9.0/4.0
"		lettuce	3.5/1.7
4-3-7	20	barley	9.0/4.0
		lettuce	3.5/1.7
34-2	155	barley	8.6/4.0
35-1W	20	barley	7.9/3.5
35-1E	20	barley	7.9/3.5
4-1	140	barley	9.0/4.0
35-3	155	barley	8.1/3.5
35-2	155	barley	9.1/4.0
34-3	155	seed alfalfa	12.8/6.0
2-1	150	seed alfalfa	12.8/6.0
35-1	115	sugar beets	8.7/3.5
34-4	155	sugar beets	8.3/3.5
4-2	155	tomato	9.0/4.0
4-4	155	tomato	9.1/4.0
3-2N	75	tomato	7.9/3.5
3-2S	75	tomato	7.9/3.5
3-3	155	cotton	10.5/4.5
3-4	155	cotton	11.1/4.5
34-1	155	cotton	11.0/4.5
35-4	155	cotton	9.5/4.5
3-1	155	cotton	10.7/4.5

Table 5
CARVALHO BROTHERS

1/16/77 to 8/16/77

Irrigation System: furrow

Soil: Panoche silt loam

Water Intake Rate: moderate to good

Topography: gently sloping

Field	Area[a/] (acres)	Crop	Water holding Capacity (in/ft of root zone)
3N	80	cotton	12.5/6.0
3S	80	cotton	8.3/4.0
5N	40	cotton	12.6/6.0
5S	40	cotton	12.6/6.0
2N	75	cotton	8.5/4.0
2S	75	cotton	8.5/4.0

a/ The cotton was skip-row planted so only 66 percent of the area listed was actually planted.

Table 6

BORBA

1/12/77 to 5/3/77

Irrigation System: border

Soil: Ponoche clay loam

Water Intake Rate: moderate

Topography: gently sloping

Field	Area (acres)	Crop	Water holding Capacity (in/ft of root zone)
31-3	105	Kumbar barley	10.5/5.0

Irrigation System	Farm
Portable sprinkler	SK Ranch
Portable sprinkler	Valle Verde Farms, Incorporated
Portable sprinkler	Allen Ranch
Furrow with tail-water reuse	Clark Brothers
Furrow	Carvalho Brothers
Border	Borba

Source of Data

Water Delivery

Borba, Clark Brothers, and the SK Ranch received their water from the Westlands Water District. The water was metered at each turnout, and once a month each farm was billed according to the water delivered. Thus, for these three farms, a copy of each farm's monthly water bill was used to determine the amount of water applied on the fields. In the case of the Carvalho Brothers farm, the water applied to each field was metered and recorded by the farmer. The water delivered to the Allen Ranch study area was estimated. This estimate was determined by multiplying the number of sprinklers operating each hour, by the product of the average sprinkler discharge and the total hours of operation. The water delivered to the Valle Verde Farms, Incorporated study area also was estimated. The estimate was made by the Harza Agricultural Service fieldman responsible for the area. The estimate was based on water records and the fieldman's knowledge of the change in the soil moisture profile after each irrigation.

Consumptive Use

Harza Agricultural Services has provided a water management program to agricultural organizations in the San Joaquin Valley, California since 1973. This management program is based on irrigation scheduling and uses a consumptive use model for determining the timing of irrigation amounts. The calculations required to apply the consumptive use model are carried out by use of a computer. This consumptive use model and associated crop coefficients have been adjusted and calibrated on 150,000 acres of irrigated land in the San Joaquin Valley.

The consumptive use (ET) of a particular crop is determined by multiplying the potential evapotranspiration (ETP) by a crop coefficient. The data required for calculation of ETP are maximum and minimum temperatures, dew point temperature, wind travel, and solar radiation. This data was collected at four Harza weather stations located in the San Joaquin Valley. ETP was calculated using a modified Penman equation. The crop coefficient is related to the growth period of the crop and, therefore, changes with time.

The ET for this study was calculated using Harza's irrigation scheduling consumptive use model.

Soil Data

The soil type and water holding capacity for each field in this study was determined by Harza fieldmen. This information was frequently supported by laboratory gravimetric and pressure plate analyses.

Procedure for Calculating Farm and Field Irrigation Efficiency

Assumptions

The following assumptions were made to determine the application efficiencies of the farms and the fields evaluated during this study.

1. Rainfall that occurred prior to the consumptive use period was considered ineffective.

2. No leaching requirements were added to the calculated irrigation requirements.

3. The crops were never purposely water stressed during the farm water management period.

Consumptive Use Calculations

The ET for the fields in this study was determined from Harza's 1975, 1976 and 1977 irrigation scheduling computer printouts. Because the 1975 and 1976 irrigation scheduling program differs from the 1977 program, two slightly different procedures were used to calculate ET.

1975 and 1976 Program. Exhibit A is an example of a 1975 and 1976 irrigation scheduling computer printout. Listed on this printout are the daily ETP's for the days indicated. Also shown on the printout is an average crop coefficient for each of the fields being scheduled. This crop coefficient is the average crop coefficient for the time interval covered by the daily ETP's.

The ET, for the time period covered by each printout, is calculated by multiplying the average crop coefficient by the sum of the ETP's.

1977 Program. Exhibits B and C are two examples of the 1977 irrigation scheduling computer printout. Listed on these printouts are the daily ETP's for the days indicated. Shown under the heading of crop coefficient are the crop coefficients for each of the fields. These are not average coefficients, but are daily coefficients for the last day of the ETP indicated on the printout.

The first step in determining a field's ET was to determine an average crop coefficient for a specific time interval. This was achieved by averaging, for a specific field, the crop coefficients listed on two consecutive irrigation scheduling printouts. The time interval, covered by the average crop coefficient, started and ended on the days of the daily crop coefficients concerned. The second step was to sum up the daily ETP's that were within the average crop coefficient's time interval. The final step was to multiply the sum of the ETP's by the average crop coefficient. This product yielded the ET that occurred during the time interval of the average crop coefficient.

Soil Moisture

The soil moisture at the beginning and end of the study period was estimated by the Harza fieldmen. The fieldmen frequently checked the soil moisture level of each field during the irrigation scheduling period.

Effective Rainfall

The rainfall that occurred during the irrigation scheduling period was recorded on the irrigation scheduling computer

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printout. The soil moisture depletions are also shown on the computer printout (see Exhibits A, B, and C). By examining the change in soil moisture and discussing the rainfall with the fieldmen responsible for each field, it was possible to estimate the effective rainfall.

Net Consumptive Use

The net consumptive use (Net ET) as used in this study may be expressed as an equation as shown below.

$$\text{Net ET} = ET + L + Sm_e - Sm_s - R_e$$

Where:

- Net ET = net consumptive use (inches),
- ET = consumptive use (inches),
- L = leaching requirement (inches),
- Sm_e = soil moisture in root zone at the end of the selected ET period (inches),
- Sm_s = soil moisture at the beginning of the study period established at the same depth as the SM_e (inches), and
- R_e = effective rainfall (inches),

Irrigation Application Efficiency

Irrigation application efficiency can be calculated at the field level or the farm level. In this study, both field and farm irrigation application efficiencies were used. The efficiency was calculated as follows:

$$E_a = \frac{\text{Net ET}}{12\ W_a} \times 100$$

Where:

- E_a = irrigation application efficiency in percent,
- Net ET = net consumptive use (inches), and
- W_a = water delivered (ac-ft).

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Farm and Field Descriptions and Irrigation Application Efficiencies

Six ranches (farms) were studied during this investigation. An attempt was made to describe the farms and fields investigated to lend support to the calculated irrigation efficiencies. The level of water management for the farms investigated was rated using the following scale: very poor, poor, below average, average, above average, good, and excellent. The degree of water management for the farms in this study was rated relative to other farms in the Fresno area.

SK Ranch

An irrigated area of 2,464 acres from the SK Ranch was selected as an example of portable sprinkler irrigation. The time period considered was from December 26, 1975 to September 22, 1976. Shown in Table 7 are the dates each field was irrigated during the study period.

Irrigation System. This portable sprinkler system was approximately three years old. The main lines and laterals were surface aluminum pipe. Weather-Tee model No. 10-20 sprinkler heads with 7/64-inch diameter nozzles on 24-inch risers were used. The sprinklers were spaced 30 feet apart on the laterals, and the laterals were moved at 45-foot spacings. From four to six laterals were used on each irrigation set. All irrigations were nominal 24-hour sets. The average sprinkler pressure was 55 pounds per square inch (psi) with a sprinkler discharge of 2.7 gallons per minute (gpm). The entire system shown schematically on Figure 1, was a closed pipeline from farm turnout to sprinkler.

Soil and Topography. The predominant soil types for this area were Panoche loam, fine sandy loam, silty clay loam, and clay loam. The water intake rates for all soil types exceeded the sprinkler application rate. The topography varied from very gently sloping to gently undulating.

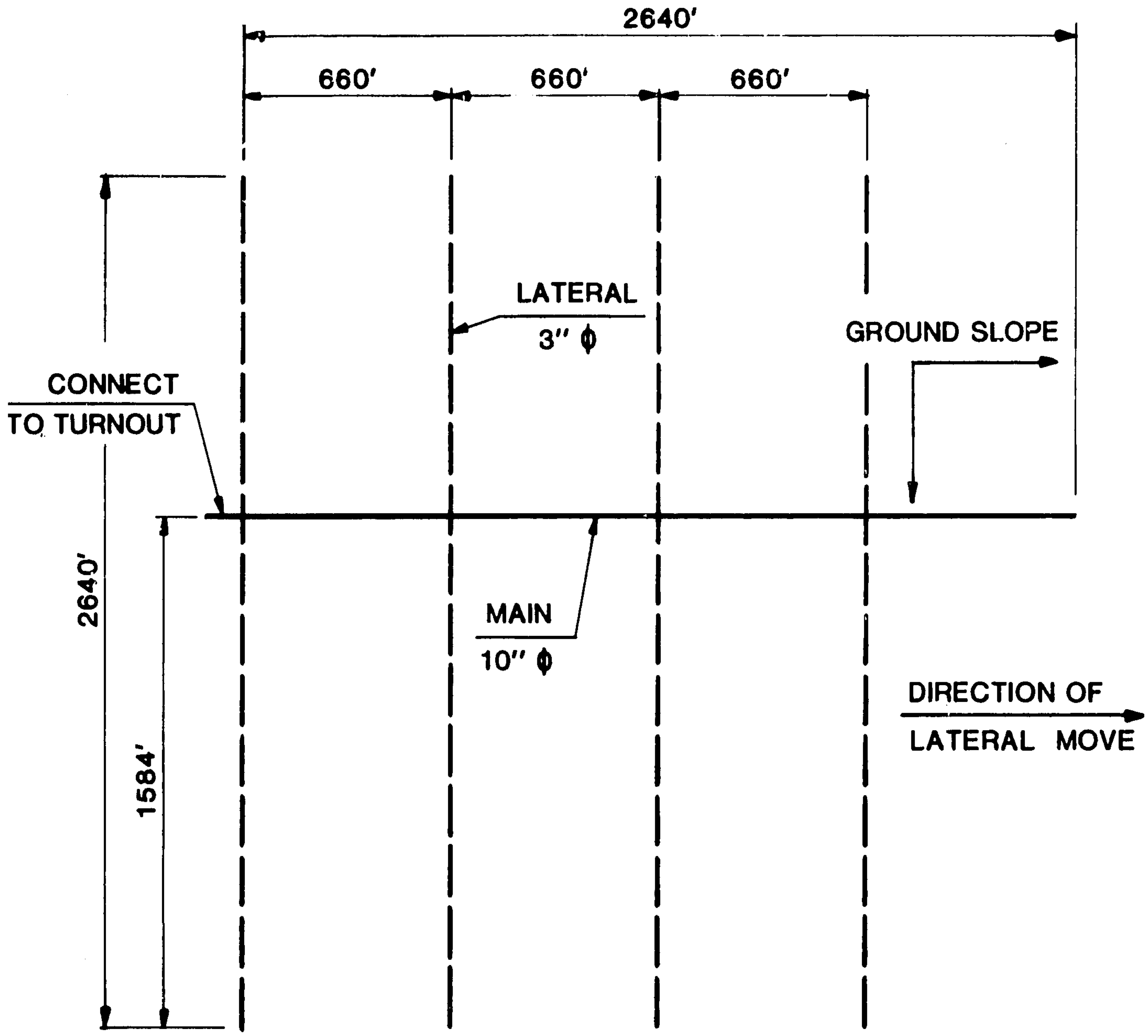
Crop. The average crop yields and approximate seed germination dates for the SK Ranch study area are listed below.

Table 7

IRRIGATION DATES FOR THE SK RANCH

From 12/26/75 to 9/22/76

Field No.	Crop	Irrigation Number 1	2	3	4	5	6	7	8	9
2	barley	12/26/75	2/25/76	3/29/76						
3	barley	12/26/75	2/25/76	3/29/76						
9	barley	12/26/75	2/25/76	3/29/76						
11	barley	1/ 6/76	4/ 3/76	4/24/76						
13	barley	1/ 6/76	3/ 1/76	4/19/76						
15	barley	1/ 6/76	3/ 7/76	4/24/76						
4	barley	1/17/76	3/ 7/76	4/13/76						
12	barley	1/17/76	3/ 7/76	4/13/76						
1	alfalfa hay	3/ 9/76	3/29/76	4/ 3/76	5/ 5/76	6/ 2/76	6/ 7/76	7/ 3/76	8/ 4/76	9/ 2/76
6	alfalfa hay	1/28/76	3/ 1/76	5/ 5/76	5/31/76	6/ 5/76	7/ 4/76	8/ 2/76	9/ 2/76	
17	alfalfa hay	1/28/76	3/13/76	4/19/76	5/24/76	6/18/76	7/22/76	8/26/76		
7	cotton	1/15/76	6/ 2/76	6/28/76	7/16/76	7/27/76	8/ 8/76	8/21/76		
8	cotton	1/14/76	6/ 2/76	6/28/76	7/16/76	7/28/76	8/11/76	8/24/76		
5	cotton	1/17/76	5/28/76	6/27/76	7/15/76	7/26/76	8/ 8/76	8/21/76		
16	cotton	1/24/76	5/28/76	6/28/76	7/15/76	7/26/76	8/ 7/76	8/16/76		
10	cotton	1/24/76	5/31/76	6/30/76	7/28/76	8/ 9/76	8/22/76			
14	cotton	1/24/76	5/28/76	6/30/76	7/15/76	7/26/76	8/ 7/76	8/20/76		



TYPICAL SPRINKLER LAYOUT FOR SK RANCH

FIGURE 1

Crop	Yield	Area (acres)	Germination date
barley	5,200 lbs/ac	1,247	early January 1976
cotton	1,500 lbs lint/ ac	913	late April 1976
alfalfa hay	8 tons/ac	304	early January 1976

The barley was mechanically (drill) planted and irrigated up. Cotton was pre-irrigated and planted into moist soil on 40-inch row spacings. The alfalfa hay was drill planted in moist soil in late December 1975.

Water Management and Irrigation Efficiency. The SK Ranch's level of water management during the investigation period was considered to be excellent relative to other farms in the Fresno area. The total water delivery to the SK Ranch during the study period was 5,770 acre-feet. As can be seen from Table 8, the Net ET was 4,380 acre-feet which resulted in a farm irrigation application efficiency of 76 percent.

Valle Verde Farms, Incorporated

Field 17-SW was a 150-acre field owned by Valle Verde Farms, Incorporated. This field was irrigated with portable sprinklers. The investigation period for this field began on December 29, 1976 and ended on July 13, 1977. Table 9 shows the dates this field was irrigated during the study period.

Irrigation System. This portable sprinkler system was approximately four years old during the period of investigation. The main-line and four laterals were surface aluminum pipe. Weather-Tec Model No. 10-20 sprinkler heads with 1/8-inch diameter nozzles on 30- inch risers were used. The sprinklers were spaced 30 feet apart on the laterals, and the laterals were moved at spacings of 33 to 47 feet. The spacing of the lateral move depended on the growth stage of the crop, weather, and other management factors. The sprinkler pressures ranged from 55 to 65 psi with an average sprinkler discharge of 3.5 gpm. The irrigations took place during daylight hours and the sets lasted from three to 12 hours. The entire system, shown schematically on Figure 2, was a closed pipeline from farm turnout to sprinkler.

Table 8

FIELD CONSUMPTIVE USE DATA

Study Period: 12/26/75 to 9/22/76

FARM: SK RANCH

Field	Crop	Irrigated Acres	Period of ET Start	Period of ET End	ET (inch)	Rainfall actual (inch)	Rainfall effective (inch)	Root zone soil moisture Sm_s (inch)	Root zone soil moisture Sm_e (inch)	Net ET a/ (ac-ft)
2	barley	160	12/26/75	5/19/76	13.45	2.37	0.88	3.3	0.3	127.60
3	barley	155	12/26/75	5/19/76	13.45	2.37	0.72	3.3	0.7	130.85
9	barley	151	12/26/75	5/19/76	13.45	2.37	0.77	3.3	0.5	124.32
11	barley	155	1/6/76	5/19/76	13.36	2.37	0.61	5.1	5.0	163.40
13	barley	155	1/6/76	5/19/76	13.36	2.37	0.71	5.2	2.3	124.65
15	barley	158	1/6/76	5/19/76	13.36	2.37	0.71	5.1	5.0	165.24
4	barley	158	1/17/76	5/19/76	13.68	2.37	0.71	4.2	1.0	128.64
12	barley	155	1/17/76	5/19/76	13.68	2.37	0.7	3.9	0.4	122.32
1	alfalfa hay	57	1/ 1/76	9/22/76	43.51	3.64	2.46	6.1	8.3	205.44
6	alfalfa	92	1/1/76	9/22/76	43.91	3.64	2.35	6.0	8.1	334.73
17	alfalfa hay	155	1/1/76	9/22/76	45.77	3.64	2.86	6.1	5.4	545.21
7	cotton	150	4/19/76	9/9/76	25.35	0.37	0.28	0	4.4	368.38
8	cotton	140	4/21/76	9/9/76	24.86	0.37	0.28	0	5.4	349.77
5	cotton	150	4/23/76	9/9/76	24.41	0.37	0.28	0	4.2	354.13
16	cotton	158	4/25/76	9/9/76	24.54	0.37	0.28	0	4.6	379.99
10	cotton	155	4/28/76	9/9/76	24.04	0.37	0.28	0	5.2	274.07
14	cotton	160	5/3/76	9/9/76	23.54	0.37	0.28	0	5.3	380.80
	TOTAL	2,464							TOTAL	4,379.59

a/ Net ET (ac-ft) = (ET - effective rainfall + Sm_e - Sm_s) x (irrigated acres ÷ 12)

Soil and Topography. About one-half of the field was fine sandy loam soil and the other half was loam soil. The water intake rate of the soil exceeded the sprinkler application rate. The topography of the field was slightly undulating

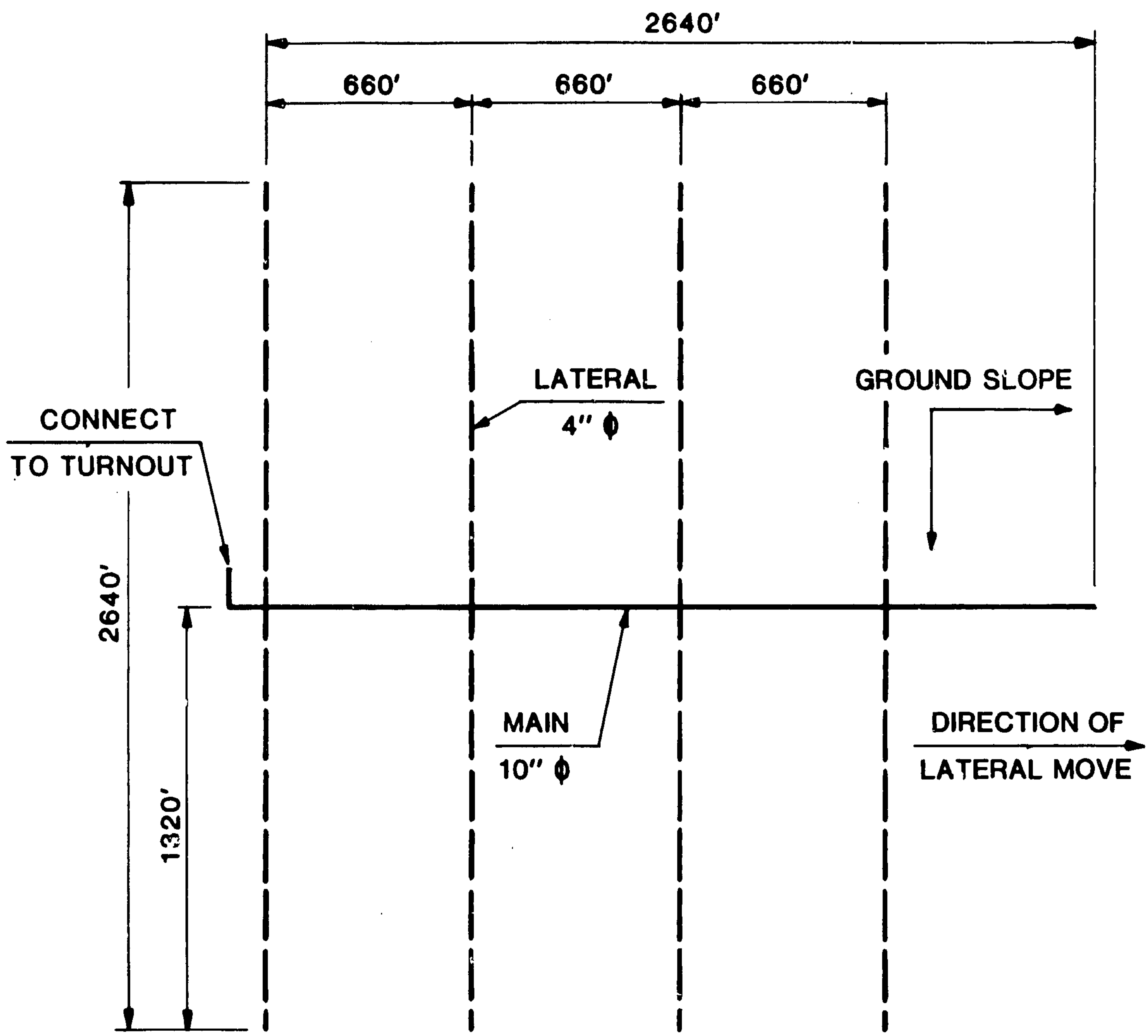
Crop. Field 17-SW was planted to onions with six rows planted on a 40-inch bed. The field was irrigated for the purpose of germination which occurred early in January, 1977 This study started on the second irrigation of the season and ended before harvest, thus the yields were not available.

Water Management and Irrigation Efficiency. The level of water management for this field, during the investigation period, was considered above average relative to other farmers in the Fresno area. The total amount of water delivered to the field was estimated to be 540 acre-feet. As can be seen in Table 10, the Net ET was 318 acre-feet which resulted in a field irrigation application efficiency of 59 percent. The major cause of this low efficiency was the shallow root zone of the onion. Water management is more difficult when working with shallow root zones.

Allen Ranch Field 21-4.

Allen Ranch field 21-4 had an irrigated area of 155 acres and used a portable sprinkler system. The investigation period for this field began on June 2 and ended on August 27, 1977. This field was continuously irrigated with an irrigation cycle of 20 days, during the period of this study.

Irrigation System. This portable sprinkler system was approximately five to 10 years old during the investigation period. The main-line and three laterals were portable aluminum pipe. Weather-Tee Model No. 10-20 sprinkler heads with 7/64-inch diameter nozzles placed on 33-inch risers were used. The sprinklers were spaced 30 feet apart on the laterals, and the laterals were moved at 45-foot spacings. Three laterals were used on each irrigation set. All irrigations were 24-hours sets. The average sprinkler pressure was 55 psi with a sprinkler discharge of 2.7 gpm. The entire system, shown on Figure 3, was a closed pipeline from the well to the sprinkler.



SPRINKLER LAYOUT FOR VALLE VERDE FIELD 17-SW

FIGURE 2

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Table 9

IRRIGATION DATES FOR VALLE VERDE FARMS, INCORPORATED

From 12/29/76 to 7/3/77

Field No.	Crop	Irrigation Number	
17-SW	Onions	1	11/ 5/77
		2	1/11/77
		3	1/17/77
		4	3/ 2/77
		5	3/ 7/77
		6	3/31/77
		7	4/14/77
		8	4/27/77
		9	5/16/77
		10	5/25/77
		11	5/31/77
		12	6 7/77
		13	6/18/77
		14	6/26/77
		15	7/ 5/77

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Table 10

FIELD CONSUMPTIVE USE DATA

Study Period: 12/29/76 to 7/13/77

FARM: VALLE VERDE FARMS, INC.

Field	Crop	Irrigated Acres	Period of ET Start	Period of ET End	ET (inch)	Rainfall actual (inch)	Rainfall effective (inch)	Root zone soil moisture Sm_s (inch)	Root zone soil moisture Sm_e (inch)	Net ET[a/] (ac-ft)
17-SW	onion	150	12/29/76	7/13/77	27.72	1.38	0.7	3.1	1.5	318

a/ Net ET (ac-ft) = (ET - effective rainfall + Sm_e - Sm_s) X (irrigated acres ÷ 12)

Table 11

FIELD CONSUMPTIVE USE DATA

Study Period: 6/2/77 to 8/27/77

FARM: ALLEN RANCH

Field	Crop	Irrigated Acres	Period of ET Start	Period of ET End	ET (inch)	Rainfall actual (inch)	Rainfall effective (inch)	Root zone soil moisture Sm_s (inch)	Root zone soil moisture Sm_e (inch)	Net ET[1/] (ac-ft)
21-4	cotton	155	6/2/77	8/27/77	21.58	0.17	0	7.6	2.5	213

1/ Net ET (ac-ft) = (ET - effective rainfall + Sm_e - Sm_s) X (irrigated acres ÷ 12)

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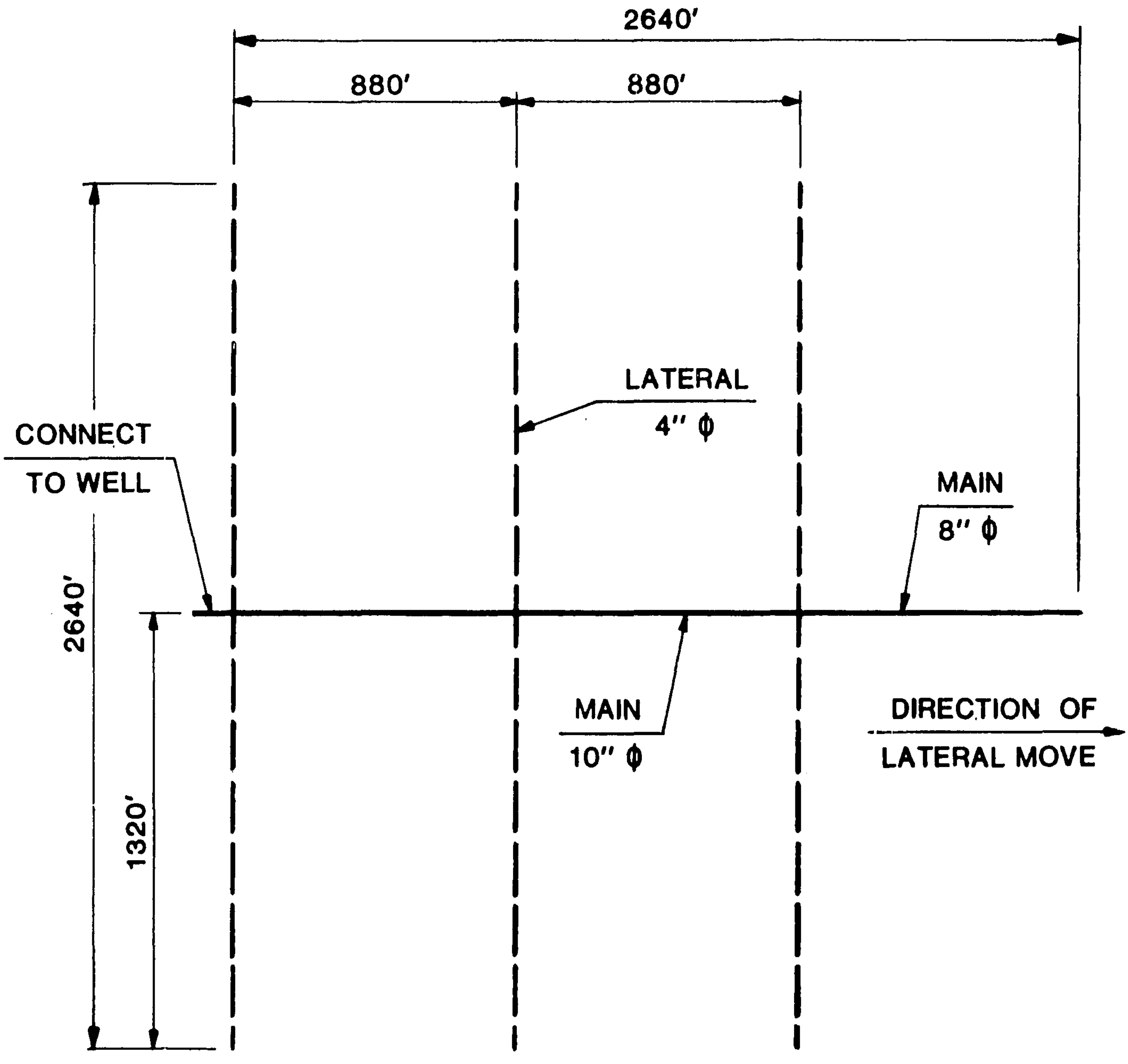

SPRINKLER LAYOUT FOR ALLEN RANCH FIELD 21–4

FIGURE 3

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Soil and Topography. The predominant soils of this area were silt loam and sandy clay loam. The water intake rate of the soil exceeded the sprinkler application rate. The topography of the field was very gently sloping.

Crops. Field 21-4 was planted to cotton which germinated early in April. The row spacing of the cotton was 40 inches. The estimated average crop yield for this field was 1,000 to 1,200 pounds lint per acre.

Water Management and Irrigation Efficiency. The level of water management for field 21-4, during the investigation period, was considered to be excellent relative to other farms in the Fresno area. The total water delivery to field 21-4 during the study period was estimated to be 277 acre-feet. As can be seen from Table 11, the Net ET was 213 acre-feet, which resulted in a field irrigation application efficiency of 76 percent.

Carvalho Brothers Ranch

Six fields totaling 395 acres were selected from the Carvalho Brothers Ranch as an example of furrow irrigation. The study period was from January 16 to August 16, 1977. Shown in Table 12 are the dates these fields were irrigated during the study.

Irrigation System. The fields were furrow irrigated with 12-inch diameter gated pipe. The length of the furrows was 1,320 feet and the furrow spacing was 40 inches. Typical irrigation sets lasted 24 hours. The system was a closed pipeline from the well to the furrow.

Soil and Topography. Panoche silt loam was the predominant soil type for this area. The water intake rate of the soil varied from moderate to good, and the topography was gently sloping.

Crop. All six fields studied were skip-row planted to cotton which germinated late in April. Normally six rows of cotton are planted in each individual bed, but under skip-row planting only four rows were planted. Thus, only 66 percent of the total 395 acres were actually planted. The estimated average yield of all 6 fields, based on 66 percent of the total areas, was 1,000 to 1,100 pounds lint per acre.

Table 12

IRRIGATON DATES FOR THE CARVALHO BROTHERS RANCH

From 1/16/77 to 8/16/77

Field No.	Crop	Irrigation Number 1	2	3	4	5	6	7	8
3N	cotton	6/ 6/77	7/ 2/77	7/24/77	8/11/77				
3S	cotton	6/ 9/77	7/ 6/77	7/28/77	8/16/77				
5N	cotton	6/ 1/77	7/ 1/77	7/20/77	8/ 9/77				
	cotton	6/ 4/77	6/30/77	7/22/77	8/ 9/77				
	cotton	6/13/77	7/11/77	8/ 1/77					
	cotton	6/17/77	7/14/77	8/ 5/77					

Table 13

FIELD CONSUMPTIVE USE DATA

Study Period: 1/16/77 to 8/16/77

FARM: CARVALHO BROTHERS RANCH

Field	Crop	Irrigated Acres	Period of ET Start	End	ET[a/] (inch)	Rainfall actual (inch)	effective (inch)	Root zone soil moisture Sm_s (inch)	Sm_e (inch)	Net ET[b/] (ac-ft)
3N	cotton	80	1/16/77	8/16/77	17.32	0.68	0	6.5	6.3	114.1
3S	cotton	80	1/16/77	8/16/77	17.32	0.68	0	6.5	6.3	114.1
5N	cotton	40	3/ 4/77	8/16/77	16.57	0.68	0	6.5	7.6	58.9
5S	cotton	40	3/ 4/77	8/16/77	16.57	0.68	0	6.5	5.8	52.9
2N	cotton	75	4/ 1/77	8/16/77	15.47	0.68	0	6.5	6.3	95.4
2S	cotton	80	4/ 1/77	8/16/77	15.00	0.68	0	6.5	6.9	102.7
	TOTAL	395								

a/ The ET was reduced by 1/6 due to skip raw planting.

b/ Net ET (ac-ft) = (ET - effective rainfall + Sm_e - Sm_e) X (irrigated acres ÷ 12)

Water Management and Irrigation Efficiency. The level of water management for all six fields was good, relative to other farms in the Fresno area. The total amount of water delivered to these fields during the study period was 734 acre-feet. As can be seen from Table 13 the Net ET was 538 acre-feet which resulted in a farm irrigation application efficiency of 73 percent.

Clark Brothers Ranch

An irrigated area of 2,595 acres was selected from the Clark Brothers Ranch as an example of furrow irrigation with tail-water reuse. Actually about four percent of this area was sprinkler irrigated, but the effect of this small area on the irrigation efficiency was assumed to be negligible. The time period considered in this study was from December 1, 1975 to October 21, 1976. Shown in Table 14 are the dates each field was irrigated during the study period.

Irrigation System. The fields were furrow irrigated with tail-water reuse. The furrows were 2,640 feet long on all the fields except for the tomato fields where the furrows were 1,320 feet long. The slopes of the furrows generally ranged between 0.10 and 0.15 percent. The furrows were spaced 40 inches apart for cotton, lettuce, and alfalfa; 30 inches apart for sugar beets and barley; and 60 inches apart for tomatoes. Furrow flows were normally 15 to 20 gpm. About 70 percent of the area was served by gated pipe which was supplied by surface aluminum pipe. The remaining area used unlined open ditches with siphon tubes to supply the furrows. The irrigation sets were either 12 or 24 hours because of the labor and delivery schedules.

Soil and Topography. The predominant soil types for this area are Panoche silty clay, Oxalis silty clay, and Lethent silty clay. The water intake rate of the soil was good and the topography was gently sloping.

Crop. The average crop yields and germination dates for the study area are listed below.

Table 14

IRRIGATION DATES FOR THE CLARK BROTHERS RANCH

From: 12/1/75 to 10/21/76

Field No.	Crop	Irrigation Number 1	2	3	4	5	6	7	8	9	10
4-3-1	barley	12/ 1/75	3/17/76								
"	lettuce			8/10/76	9/ 3/76	9/22/76	9/25/76				
4-3-2	barley	12/ 1/75	3/17/76								
"	lettuce			8/ 9/76	8/15/76	9/ 4/76	9/25/76	10/20/76			
4-3-3	barley	12/ 1/75	3/17/76								
"	lettuce			8/17/76	9/10/76	9/26/76	10/13/76				
4-3-4	barley	12/ 1/75	3/17/76								
"	lettuce			8/16/76	8/18/76	9/11/76	9/26/76	10/19/76			
4-3-5	barley	12/ 1/75	3/17/76								
"	lettuce			8/20/76	9/12/76	10/12/76					
4-3-6	barely	12/ 1/75	3/17/76								
"	lettuce			8/20/76	8/22/76	9/18/76	10/12/76				
4-3-7	barley	12/ 1/75	3/17/76								
"	lettuce			8/22/76	8/24/76	9/20/76	10/12/76				
34-2	barley	12/ 9/75	3/23/76								
35-1W	barley	12/ 8/75	1/ 8/76	4/ 7/76							
35-1E	barley	12/ 8/75	1/ 8/76	4/ 5/76							
4-1	barley	12/14/75	3/17/76	5/ 1/76							
35-3	barley	12/23/76	3/22/76	4/24/76							
35-2	barley	12/14/75	3/24/76								
34-3	seed alfalfa	4/29/76	6/16/76								
2-1	seed alfalfa	7/10/76	9/14/76								
35-1	sugar beets	12/ 8/75	3/15/76	5/15/76	6/ 8/76	6/23/76	7/ 9/76	7/23/76	8/ 6/76	8/28/76	9/28/76
34-4	sugar beets	2/ 2/76	4/27/76	5/17/76	6/ 4/76	6/22/76	7/24/76	7/24/76	8/10/76	8/31/76	9/18/76
4-2	tomato	2/25/76	4/28/76	5/18/76	6/ 4/76	6/16/76	6/27/76				
4-4	tomato	2/25/76	5/ 5/76	5/20/76	6/116/76	6/24/76	7/ 5/76	7/19/76			
3-2N	tomato	2/25/76	4/ 1/76	5/ 6/76	5/26/76	6/ 3/76	6/14/76	6/28/76	7/ 7/76		
3-2S	tomato	2/25/76	4/ 1/76	5/ 6/76	5/26/77	6/ 3/76	6/14/76	6/28/76	7/ 7/76		
3-3	cotton	12/22/75	6/ 2/76	7/11/76	8/ 1/76						
3-4	cotton	1/ 1/76	5/26/76	7/ 8/76	7/30/76						
34-1	cotton	1/ 4/76	5/28/75	7/15/76	8/12/76						
35-4	cotton	12/28/75	6/10/75	7/11/76	8/ 6/76	8/15/76					
3-1	cotton	1/ 7/76	6/ 3/76	7/11/76	8/ 3/76	8/16/76					

Crop	Yield	Area (acres)	Germination date
Barley	5500 lbs/ac	785	early January
Seed Alfalfa	700 lbs/ac	305	established stand
Tomato	35 ton/ac	460	late February
Sugar Beets	38 ton/ac[a/]	270	mid-January
Cotton	1350 lbslint/ ac	775	mid-April
Lettuce	not available	170	mid-August

a/ 12 percent sugar

The barley was aerially seeded. After the seed was on the fields, 30-inch seed beds were formed and then irrigated. The sugar beets were planted in moist soil on 30-inch beds and then irrigated to obtain uniform germination. Double rows of tomatoes were planted on dry 60-inch beds and then irrigated once or twice for germination. The cotton fields were pre-irrigated before seed was planted in 40-inch beds. The alfalfa was planted in rows 40-inches apart, however, the stand was established prior to this study.

Water Management and Irrigation Efficiency. The Clark Brothers Ranch had good water management relative to other farms in the Fresno area. The total water delivery to the study area was 7,695 acre-feet. As can be seen from Table 15 the Net ET was 4,966 acre-feet which resulted in a farm irrigation efficiency of 65 percent.

A perched water table existed over 10 to 15 percent of the study area at an average depth of five feet. This condition tended to influence the irrigation efficiency. Also, the irrigations used to germinate seed tended to lower the farm irrigation efficiency.

Borbo Brothers

Field 31-3 from the Borbo Brothers farm was selected as an example of border irrigation. The area of the field was 105 acres. The time period used for this study was from

Table 15

FIELD CONSUMPTIVE USE DATA

Study Period: 12/1/75 to 10/21/76

FARM: CLARK BROTHERS

Field	Crop	Irrigated Acres	Period of ET Start	Period of ET End	ET (inch)	Rainfall actual (inch)	Rainfall effective (inch)	Root zone soil moisture Sm_s (inch)	Root zone soil moisture Sm_e (inch)	Net ET[a/] (ac-ft)
4-3-1	barley	20	12/1/75	5/9/76	14.35	2.98	1.5	4.2		
"	lettuce		8/4/76	10/21/76	7.37	3.32	1.9		6.2	33.87
4-3-2	barley	20	12/1/75	5/ 9/76	14.35	2.98	1.5	4.2		
"	lettuce		8/9/76	10/21/76	6.47	3.32	1.8		8.0	35.53
4-3-3	barley	20	12/1/75	5/ 9/76	14.35	2.98	1.5	4.2		
"	lettuce		8/14/76	10/21/76	5.53	3.32	1.7		8.0	34.13
4-3-4	barley	20	12/ 1/75	5/ 9/76	14.35	2.98	1.5	4.2		
"	lettuce		8/19/76	10/21/76	5.13	3.32	1.9		8.7	34.30
4-3-5	barley	20	12/ 1/75	5/ 9/76	14.35	2.98	1.5	4.2		
"	lettuce		8/24/76	10/21/76	4.85	3.32	2.0		7.9	32.33
4-3-6	barley	20	12/ 1/75	5/ 9/76	14.35	2.98	1.5	4.2		
"	lettuce		8/29/76	10/21/76	3.62	3.01	1.2		8.0	31.78
4-3-7	barley	20	12/ 1/75	5/ 9/76	14.35	2.98	1.5	4.2		
"	lettuce		9/ 3/76	10/21/76	4.24	3.01	1.4		7.9	32.32
34-2	barley	155	12/ 9/75	5/13/76	14.23	3.61	2.8	3.8	2.0	124.39
35-1W	barley	20	12/ 8/75	5/13/76	14.33	2.98	1.3	2.3	0.8	19.22
35-1E	barley	20	12/18/75	5/13/76	14.25	2.98	1.0	2.3	0.9	19.75
4-1	barley	140	12/12/75	5/13/76	15/46	2.98	0.6	4.3	4.1	171.03
35-3	barley	155	12/26/75	5/13/76	14.76	2.98	2.7	2.8	1.6	139.63
35-2	barley	155	12/14/75	5/13/76	14.10	2.98	1.9	3.1	1.1	131.75
34-3	seed alfalfa	155	1/ 8/76	8/ 4/76	31.47	2.98	2.6	10.8	0.1	234.70
2-1	seed alfalfa	150	1/ 8/76	9/23/76	35.62	3.92	2.9	10.1	7.3	374.00
35-1	sugar beets	115	3/ 4/76	10/ 7/76	37.13	3.32	0.7	3.5	5.6	369.25
34-4	sugar beets	155	1/27/76	10/ 7/76	41.85	6.30	3.7	4.3	6.8	525.06
4-2	tomato	155	2/25/76	8/ 5/76	25.50	0.30	0.1	3.6	2.3	311.29
4-4	tomato	155	2/25/76	8/ 5/76	26.27	0.30	0.1	3.6	2.9	328.99
3-2N	tomato	75	2/25/76	8/ 5/76	23.98	0.30	0.1	3.2	0.2	130.50
3-2S	tomato	75	2/25/76	8/ 5/76	24.91	0.30	0.1	3.2	2.3	149.44
3-3	cotton	155	4/10/76	9/ 2/76	24.73	0.31	0.1	4.2	6.2	349.97
3-4	cotton	155	4/10/76	9/ 2/76	25.16	0.31	0	4.4	6.1	346.94
34-1	cotton	155	4/13/76	9/ 2/76	24.41	0.31	0.2	4.4	7.1	347.59
35-4	cotton	155	4/15/76	9/ 2/76	22.79	0.31	0.2	3.8	6.4	325.37
3-1	cotton	155	4/18/76	9/ 2/76	24.14	0.31	0.2	4.3	6.6	338.93
	TOTAL	2,595							TOTAL	4,966.06

a/ Net ET (ac-ft.) = (ET - effective rainfall + Sm_e - Sm_s) X (irrigated acres ÷ 12)

Table 16

IRRIGATION DATES FOR THE BORBA BROTHERS FARM

From 1/12/77 to 5/ 3/77

Field No.	Crop	Irrigation Number 1	2	3	4	5	6	7	8
31-3	Kumbar barley	3/11/77	4/14/77						

Table 17

FIELD CONSUMPTIVE USE DATA

Study Period 1/12/77 to 5/3/77

FARM: BORBA BROTHERS

Field No.	Crop	Irrigated Acres	Period of ET Start	End	ET (inch)	Rainfall actual (inch)	Rainfall effective (inch)	Root zone soil moisture Sm_s (inch)	Sm_e (inch)	Net ET[a/] (ac-ft)
31-3	Kumbar barley	105	1/12/77	5/3/77	13.31	0	0	10.2	6.2	81.46

a/ Net ET (ac-ft) = (ET - effective rainfall + Sm_e - Sm_s) X (irrigated acres ÷ 12)

January 12 to May 3, 1977. Shown in Table 16 are the dates this field was irrigated during the study.

Irrigation System. Field 31-3 was border irrigated. Water was conveyed from the farm turnout to each border through a closed pipe system. The length of run was 2,640 feet with 40 feet between borders. Each irrigation set lasted 24 hours.

Soil and Topography. Panoche clay loam was the predominant soil type for this area. The water intake rate of the soil was moderate and the topography was gently sloping.

Crop. The Kumbar barley, which was aerially seeded, germinated late in November of 1976. The average yield was 3.73 tons per acre.

Water Management and Irrigation Efficiency. The level of water management for this field was good relative to other farms in the Fresno area. The total amount of water delivered was 131 acre-feet. As can be seen from Table 17, the Net ET was 82 acre-feet which resulted in a field irrigation efficiency of 62 percent.

Effect of Water and Fertility Management

During the 1976 crop year, Harza Agricultural Services in Fresno, California provided a water and fertility service for the Newhall Land and Farming Company whose office is located in Valencia, California.

The two ranches that received the service were the New Columbia and Gill Ranches. Harza provided services for these two ranches on 2,777 acres out of a combined acreage of 9,843 acres. No significant differences in irrigation systems, soil characteristics, or management practices existed between similar crop areas. Thus the differences in crop yields shown on Table 18 can be attributed chiefly to Harza's water and fertility management.

Table 18

1976 CROP YIELDS
NEW COLUMBIA RANCH

Crop	Area (acres)	Yield	Yield/Acre	Yield Difference
Wheat	Harza 535	2,368,300 lbs	4,427 lbs	+ 330 lb
	New Col. 1964	8,045,540	4,097 lbs	
Cotton	Harza 560	553,793 lbs lint	989 lbs lint	+ 42 lb
	New Col. 1504	1,423,934	947 lbs lint	
Beets	Harza 703	20,722.52 tons	29.48 tons	
	New Col. 608	17,194.87	28.28 tons	+ 1.2 tons

GILL RANCH

Crop	Area (acres)	Yield	Yield/Acre	Yield Difference
Wheat	Harza 318	1,524,260 lbs	4,793 lbs	+ 560 lb
	Gill 872	3,691,060	4,233 lbs	
Barley	Harza 66	234,680 lbs	3,556 lbs	+ 906 lb
	Gill 681	1,804,586	2,650 lbs	
Cotton	Harza 299	301,948 lbs lint	1,010 lbs lint	+ 86 lb
	Gill 737	681,146	924 lbs lint	
Beets	Harza 296	10,015.56 tons	33.84 tons	- 2.33 tons
	Gill 700	25,318.79	36.17 tons	

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Summary

Listed in Table 19 are the farms investigated during this study and their corresponding field or farm irrigation application efficiencies.

The level of water management for the fields investigated ranged from above average to excellent. It should be noted that these ratings were selected relative to other farms in the Fresno area. Fresno farmers are very progressive and innovative and probably have some of the highest irrigation efficiencies in the world.

For the purpose of estimating water requirements in the Stage II development of the Jordan Valley Irrigation Project, to be irrigated by sprinklers with good management, a value of 75 percent is suitable for application efficiency.

Table 19

Irrigation Application Efficiencies

Farm	System	Area (acres)	Field Efficiency (percent)	Farm Efficiency (percent)	Water Management
SK Ranch	portable sprinkler	2,464		76%	Excellent
Valle Verde Farms, Inc.	portable sprinkler	150	59%		Above average
Allen Ranch	portable sprinkler	155	76%		Excellent
Carvalho Brothers	furrow (gated pipe)	395		73%	Good
Clark Brothers	furrow (with tail-water reuse)	2,595		65%	Good
Borba	border	105		62%	Good

EXHIBIT A

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HARZA AGRICULTURAL SERVICES SOIL MOISTURE REPORT

S-K RANCH(THREEROCKS)

UPDATE NUMBER 40
FARM CODE 2
8/12/76

DAILY CLIMATIC DATA FOR UPDATE NUMBER 40 CLIMATIC REGION 1

DATE	TEMPERATURE MAX	TEMPERATURE MIN	DEW PT.	SOLAR RADIATION	WINDRUN MI./DAY	RAIN FALL	ETP
805	85.	54.	56.	614.	99.	0.00	0.27
806	84.	51.	54.	620.	109.	0.00	0.28
807	84.	52.	56.	618.	101.	0.00	0.27
808	89.	53.	53.	627.	75.	0.00	0.28
809	95.	54.	56.	629.	49.	0.00	0.27
810	95.	58.	58.	616.	65.	0.00	0.29
811	96.	57.	57.	620.	71.	0.00	0.30

FORECAST ETP NEXT 7 DAYS 0.26
FORECAST ETP NEXT 14 DAYS 0.26
AVERAGE ETP LAST UPDATE 0.29
AVERAGE ETP THIS UPDATE 0.28

FIELD CODE	FIELD NAME	ACRE	CROP	PLNT DATE	COV DATE	LAST IRR DATE	CROP COEF	RT ZN	HOLD CAP.	ALLW DEPL	AVE DAILY ET	DEPLETIONS DATE 805	DEPLETIONS DATE 811	IRR EFF	TOTAL IRR TO DATE NO.	TOTAL IRR TO DATE AMT	IRRIGATION SCHEDULE LAST DATE	LAST AMT	NEXT DATE	NEXT AMT
9	1	57.	AL.HAY	624	724	1001	0.87	5.0	10.2	7.0	0.24	1.3	2.7	0.75	7	34.4	804	7.0	829	9.5
10	6	92.	AL.HAY	624	724	1001	0.87	5.0	9.9	7.0	0.24	0.7	2.5	0.75	7	34.4	802	7.0	830	9.5
11	17	155.	AL.HAY	709	811	1001	1.00	5.0	10.2	7.0	0.28	10.8	12.8	1.10	6	22.4	722	1.8	812	11.7
12	5	150.	COTTON	506	720	815	0.94	5.0	9.3	5.6	0.27	5.0	3.3	1.40	6	23.3	808	3.2	822	****
13	7	150.	COTTON	501	720	815	0.94	5.0	9.2	5.6	0.27	4.8	3.1	1.40	6	23.3	808	3.2	823	****
14	8	140.	COTTON	505	720	815	0.94	5.0	9.8	5.6	0.27	4.0	2.7	1.40	6	23.3	811	3.2	825	****
15	10	155.	COTTON	506	720	815	0.94	5.0	9.6	5.6	0.27	4.3	2.6	1.40	6	23.3	809	3.2	825	****
16	14	160.	COTTON	506	720	815	0.94	5.0	9.8	5.6	0.27	4.4	2.7	1.40	6	23.3	807	3.2	825	****
17	16	158.	COTTON	503	720	815	0.94	5.0	9.6	5.6	0.27	4.9	3.2	1.40	6	23.3	807	3.2	822	****

HARZA AGRICULTURAL SERVICES
SOIL MOISTURE REPORT

Update No. 20
8/18/77
Farm 91

THE ALLEN RANCH--COALINGA

Daily Climetic Data For Region 3

Average ETP This Update: 0.325
Forecast ETP Next 7 Days: 0.298
Forecast ETP Next 14 Days: 0.293

---DATE---		---TEMPERATURES---			SOLAR	WIND RUN	RAIN	-ETP-
Jul	MoDa	Max	Min	Dew Pt	RADIATION	Miles	In	In
208	727	99	57	43	686	79	0.00	0.256
209	728	99	58	50	588	87	0.00	0.335
210	729	99	58	59	586	110	0.00	0.342
211	730	104	60	53	580	64	0.00	0.310
212	731	104	61	55	475	95	0.00	0.328
213	801	104	66	58	509	90	0.00	0.321
214	802	105	72	66	552	77	0.00	0.303
215	803	104	65	53	534	91	0.00	0.352
216	804	104	65	58	551	76	0.00	0.327
217	805	102	58	56	626	100	0.00	0.380
218	806	102	56	63	481	120	0.00	0.338
219	807	93	53	53	480	104	0.00	0.314
220	808	93	55	55	540	76	0.00	0.282
221	809	96	56	56	543	79	0.00	0.288
222	810	96	59	55	530	89	0.00	0.295

------FIELD------			-CROP-	----KEY DATES----			----FUTURE----			---PROFILE--			DEPLETIONS		TOTAL IRR		----IRRIGATION SCHEDULE---				
						Final	Crop		Daily	S	Root	Hold			To	810	Irr	Latest		Next	
Code	Name	Acres		Emerg	Cover	Irr	Coef		ET	T	Zone	Cap.	Allow	810	No.	Amt	Eff	Date	Amt	Date	Amt
28	20-1	140	COTT	4107	8107	8207	1.00	0.96	0.25	2	5.0	10.7	7.49	2.34	4	25.0	1.00	801	7.0	831	*****
29	21-4	160	COTT	4107	8107	8207	1.00	0.96	0.11	2	5.0	10.0	7.00	7.30	4	24.3	1.00	817	4.3	831	*****
30	22-3	153	COTT	4107	8107	8207	1.00	0.97	0.25	2	5.0	9.8	6.86	2.77	5	26.6	1.00	802	6.0	827	*****
31	28-1	168	COTT	4107	8107	8207	1.00	1.00	0.30	2	4.0	8.0	5.60	7.15	5	24.3	1.00	712	4.2	811	* 7.1
32	27-4	130	COTT	4107	8107	8207	1.00	0.96	0.25	2	5.0	10.8	7.56	1.01	4	23.9	1.00	805	9.0	906	*****
33	26-2	153	COTT	4107	8107	8207	1.00	0.96	0.14	2	5.0	10.5	7.35	6.72	4	20.8	1.00	813	4.0	901	*****
34	35-1	105	COTT	4107	8107	8207	1.00	0.99	0.23	2	5.0	10.9	7.63	6.91	3	26.0	1.00	716	6.0	814	7.8
35	23-1	153	COTT	4107	8107	8207	1.00	0.95	0.17	2	5.0	11.1	7.77	4.88	5	23.3	1.00	812	4.0	909	*****
36	30-1	89	COTT	4107	8107	8207	1.00	0.99	0.24	2	5.0	11.0	7.70	6.32	3	36.0	1.00	718	10.0	816	7.7
37	30-5	72	COTT	4107	8057	8207	0.98	0.95	0.07	2	5.0	9.6	6.72	7.66	3	22.5	1.00	811	7.0	906	*****

EXHIBIT B

321

EXHIBIT C

322

HARZA AGRICULTURAL SERVICES
SOIL MOISTURE REPORT

Update No. 21
8/18/77
Farm 91

THE ALLEN RANCH--COALINGA

Daily Climatic Data For Region 3

Average ETP This Update: 0.309
Forecast ETP Next 7 Days: 0.288
Forecast ETP Next 14 Days: 0.282

---DATE--- Jul	MoDa	---TEMPERATURES--- Max	Min	Dew Pt	SOLAR RADIATION	WIND RUN Miles	RAIN In	-ETP In
215	803	104	63	53	534	91	0.00	0.352
216	804	104	65	58	551	76	0.00	0.327
217	805	102	58	56	626	100	0.00	0.360
218	806	102	56	63	481	120	0.00	0.338
219	807	93	53	53	480	104	0.00	0.314
220	808	93	55	55	540	78	0.00	0.282
221	809	96	56	56	543	79	0.00	0.288
222	810	96	59	55	530	89	0.00	0.295
223	811	99	60	52	540	68	0.00	0.289
224	812	100	59	60	524	88	0.00	0.300
225	813	100	57	57	524	87	0.00	0.311
226	814	101	55	55	525	87	0.00	0.322
227	815	101	53	53	527	85	0.00	0.326
228	816	100	52	61	406	101	0.00	0.285
229	817	100	74	64	277	99	0.00	0.227

------FIELD------ Code	Name	Acres	-CROP-	----KEY DATES---- Emerg	Cover	Final Irr	----FUTURE---- Crop Coef		Daily ET	---PROFILE--- S T	Root Zone	Hold Cap.	DEPLETIONS Allow	817	TOTAL IRR To No.	817 Amt	----IRRIGATION SCHEDULE---- Irr Eff	Latest Date	Amt	Next Date	Amt
28	20-1	140	COTT	4107	8107	8207	0.97	0.95	0.23	2	5.0	10.7	7.49	4.28	4	25.0	1.00	801	7.0	831	*****
29	21-4	160	COTT	4107	8107	8207	0.97	0.95	0.23	2	5.0	10.0	7.00	4.17	5	28.6	1.00	817	4.3	831	*****
30	22-3	153	COTT	4107	8107	8207	0.97	0.96	0.23	2	5.0	9.8	6.86	4.69	5	26.6	1.00	802	6.0	827	*****
31	28-1	168	COTT	4107	8107	8207	0.97	0.95	0.10	2	5.0	10.0	7.00	7.63	5	28.5	1.00	618	4.2	904	*****
32	27-4	130	COTT	4107	8107	8207	0.97	0.95	0.23	2	5.0	10.8	7.56	3.01	4	23.9	1.00	805	9.0	906	*****
33	26-1	153	COTT	4107	8107	8207	0.97	0.95	0.23	2	5.0	10.5	7.35	4.49	5	24.8	1.00	813	4.0	830	*****
34	35-1	105	COTT	4107	8107	8207	0.97	0.97	0.28	2	5.0	10.9	7.63	8.41	3	26.0	1.00	716	6.0	818	* 8.4
35	25-1	153	COTT	4107	8107	8207	0.97	0.94	0.23	2	5.0	11.1	7.77	2.83	6	27.3	1.00	812	4.0	908	*****
36	30-1	89	COTT	4107	8107	8207	0.97	0.97	0.28	2	5.0	11.0	7.70	7.94	3	36.0	1.00	718	10.0	818	* 7.9
37	30-5	72	COTT	4107	8057	8207	0.95	0.94	0.23	2	5.0	9.6	6.72	2.50	4	29.5	1.00	811	7.0	905	*****