



The Hashemite Kingdom of Jordan
Ministry of Water & Irrigation

Jordan's Water Strategy & Policies

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WATER STRATEGY FOR JORDAN

Background

1. The population pressure on the water resources of Jordan today has never been as intense. Measured by the per capita share of indigenous renewable water resources of 175 M3 in 1996, and an average share of 0.1 hectare per capita of rain fed agricultural land, the country can hardly yearn for a balance in the trade of food commodities, and can afford to allocate only a modest annual quantity of municipal water to its population that averaged in 1996 a share of 57 M3 per capita (156 liters per cap per day). The deficit in the foreign trade balance ran that year at \$ 475 per capita of which food trade deficit accounted for \$95 per capita that year. Present water use already exceeds the renewable freshwater resources by more than 20% . After the year 2005, freshwater resources will be fully utilized and there remain no more known resources within the country to develop.
2. The population increase of the country has not been normal, nor has the natural growth rate been commendable. Jordan has hosted several waves of refugees, displaced persons and returnees as a result of the prolonged conflict in the Middle East. The population centers sprang at locations distant from water resources. The result has been a high cost of projects for municipal water supply and wastewater collection and disposal, and another high annual cost for their operation and maintenance of which energy is responsible for 55%. Additionally, the toxicity index as measured by the pollution load compared to the renewable water resources is high compared to other countries in the region.
3. Water and energy are twins; sweet water is generated from salty waters with energy inputs, and energy is generated from water falls. Jordan is almost void of indigenous energy resources, is also below the water poverty line, and is managing a fragile environment.
4. The reaction to the abrupt surges in population levels, water wise, has been over abstraction from groundwater aquifers. This was exacerbated by relaxed controls on drilling operations, and the near absence of controls on licensed abstraction rates. Ground water aquifers are exploited at more than double their sustainable yield in the average.
5. The inhabited productive area of the country does not exceed 6% of its total area, and borders the Badia to the east, and the Jordan Valley to the west. Both regions are semi arid and agriculture is possible in them only through irrigation. The environment of the country is fragile, and the protection against desertification requires sustain-ability of agriculture.
6. The per capita share of the GDP in 1996 did not exceed the equivalent of \$ 1634, which was basically less than its level of \$1775 in 1980. The country suffered setbacks in its economic performance-due to regional and international economic downturns, and as such had incurred high external debt that amounted to the equivalent of \$2189 per capita in 1990. It had to undergo economic structural adjustment with austerity measures. The external debt level was brought down to \$ 1632 per capita in 1996.
7. A Peace Treaty was concluded between Jordan and Israel in October of 1994 by which the water dispute has been all but resolved. Water projects were envisaged, and their implementation will slightly relieve the population - resources imbalance. Still, the hoped-for economic development boom has not been initiated.
8. The marginal cost of water is high by world standards. The investment portfolios for water and wastewater projects are high and will be no the rise.

Rehabilitation of old water networks is needed and is highly challenging both technically and financially. Additional water resources that can be mobilized are modest. The current per capita share of the GDP does not allow full cost recovery before it is drastically improved

9. Cognizant of the above, the Jordan Government has adopted the following water strategy, and will supplement it with a set of policies and measures to help achieve its objectives.

The Water Strategy

On Resource Development:

10. Water is a national resource and shall be valued as such at all times. A comprehensive national water data bank will be established and kept at the Ministry of Water and Irrigation, and shall be supported by a decision support unit. It will be supported by a program of monitoring and a system of data collection, entry, updating, processing and dissemination of information, and will be designed to become a terminal in a regional data bank setup.

11. The full potential of surface water and ground water shall be tapped to the extent permissible by economic feasibility, and by social and environmental impacts.. Investigation works of deep aquifers shall be conducted to support development planning. The interactive use of ground and surface water with different qualities shall be considered. Assessment of the available and potential resources shall be conducted periodically.

12. Wastewater shall not be managed as "waste". It shall be collected and treated to standards that allow its reuse in unrestricted agriculture and other non-domestic purposes, including ground water recharge. Appropriate wastewater treatment technologies shall be adopted with due considerations to economy in energy consumption, and quality assurance of the effluent for use in unrestricted agriculture. Consideration shall be given to blending of the treated effluent with fresher water for appropriate reuse.

13. Marginal quality water and brackish water sources shall be enlisted to support irrigated agriculture. They shall be listed, along with sea water for desalination to produce additional water for municipal, industrial and commercial consumption. Technology transfer and the findings of advanced research in genetic engineering shall be introduced to the extent possible for this purpose.

14. A far horizon plan shall be formulated for the development of the resources, and a revolving five years plan shall be extracted from it and updated as necessary. The revolving plan shall be compatible with those formulated for the other sectors of the economy. A parallel investment plan shall accompany the development plan.

15. The priority criterion for project implementation, and for additional water allocation shall be based on economic, social and environmental considerations. A "critical path" shall be established for the allocation of each new source of water. Consideration shall be given to the sustainability of the allocation in the light of the national water balance situation and the economic, social and environmental opportunity cost of forgone alternative uses of water.

16. First priority will be given to allocation of the basic human needs; as such first priority is given to allocation of a modest share of 100 liters per capita per day to domestic water supplies. Expensive additional water has municipal purposes as a first priority in allocation, followed by tourism and industrial purposes.

On Resource Management:

17. Priority is given to the sustainability of use of the previously developed resources including resources mobilized for the irrigated agriculture in the Jordan Valley and other established uses. Special care shall be given to the protection against pollution, quality degradation and depletion.

18. Mining of renewable ground water aquifers shall be checked, controlled, and reduced to sustainable extraction rates. Mining of fossil aquifers shall be planned and carefully implemented.

19. Resource management shall continually aim at achieving the highest possible efficiency in the conveyance, distribution, application and use. It shall adopt a dual approach of demand management and supply management. Tools of advanced technology shall be adopted to enhance the resource management capabilities.

20. A dynamic regime of demand and supply shall be instated and updated. Minimum cost of operation and maintenance shall be targeted.

The cost of production of future industrial, commercial, tourism and agricultural projects shall be measured also in terms of their requirements of units of water flow.

21. Interactive use of multiple resources shall be targeted to maximize the usable flows, and maximize the net benefit from the use of a unit flow of water.

22. Human resources development shall occupy an advanced rank in the priority scale. Continuous education, on-the-job training and overseas training programs shall be organized and implemented. Over-employment shall be trimmed to reach optimum employment levels compatible with efficient management.

23. Management of waste water shall receive attention with due regard to public health standards. Industrial wastewater shall be carefully watched to avoid degrading the quality of the effluent of wastewater treatment plants destined for reuse.

On Legislation and Institutional Set-Up:

24. Periodically review institutional arrangements and legislation in effect to appraise adequacy of the status quo through the changing conditions and times. Institutional restructuring shall be made to match the changing needs.

25. Update legislation whenever necessary to respond to emerging needs including the needs for improving performance efficiency. Laws in effect shall be enforced with due diligence.

26. Introduce and enhance the participation of stake holders, and legislate for their involvement wherever necessary.

27. Assure co-operation and co-ordination among public and private entities involved in water development and management.

On Shared Water Resources:

28. The rightful shares of the Kingdom shall be defended and protected through bilateral and multilateral contacts, negotiations, and agreements. Peace water and wastewater projects, including the scheme for the development of the Jordan Rift Valley, shall be accorded special attention for construction, operation and maintenance.

29. Due respect will be given to the provisions of international law as applicable to water sharing, protection and conservation, and those applicable to territorial waters.

30. Bilateral and multi-lateral co-operation with neighboring states shall be pursued, and regional co-operation shall be advocated, preferably within the provisions of a Regional Water Charter.

On Public Awareness:

31. The public shall be educated through various means about the value of water for them and the well being of the country for the sustainability of life, and for the economic and social development.

32. Challenges in the water sector are to be faced not only by the water administration, but also equally by the public if not more. The roles in water conservation to be played by the different sectors of society shall be defined and assigned.

33. Facts about water in Jordan shall be disseminated along with the cost incurred to provide the service, and the mounting pressure of population on the water resources. Introduction, adoption and use of water saving and recycling systems and devices shall be promoted.

34. Economic measures shall be adopted to reinforce public awareness. Such measures as demand management, efficiency improvements within supply management techniques shall be employed.

On Performance:

35. Performance efficiency of the water and wastewater systems and the management thereof shall be monitored and rated, and the improvements on performance shall be introduced with due consideration to resource economics.

36. Human resources performance shall be continually appraised to upgrade capabilities and sustain excellence. Incentives for excellence shall be introduced in compliance with the needs for dedication.

On Health standards:

37. Setting and enforcing national health standards shall be enhanced and sustained, especially in regards of municipal water supply.

38. Concerns for public health and the health of workers shall be a focus in the programs of reuse of treated wastewater.

39. Laboratories for controls shall be maintained and properly equipped.

On Private Sector Participation:

40. The role of the private sector shall be expanded. Management contracts, concessions and other forms of private sector participation in water utilities shall be considered and adopted as appropriate.

41. The concepts of BOT/BOO shall be entertained, and the impact of such concepts on the consumers shall be continually assessed, and negative impacts mitigated.

42. The private sector role in irrigated agriculture shall also be encouraged and expanded. Emphasis shall be placed on the social benefits in conjunction with the private investments.

On Financing:

43. Recovery of the cost of utilities and the provision of services shall be targeted. Recovery of operation and maintenance cost shall be a standard practice. Capital cost recovery shall be carefully approached. The role of water tariffs shall be considered as a tool to attract private investment in water projects.

44. Cost recovery shall be linked to the average per capita share of the GDP and its level. It shall also be connected to the cost of living and the family basket of consumption. However, profitable undertakings in industry, tourism, commerce and agriculture shall be made to pay the fair water cost.

45. Until the cost recovery is full, and the national savings become at levels capable of domestic financing of development projects, project financing will depend on concessionary loans, private borrowing and/ or BOO and EOT arrangements.

On Research and Development:

46. Efforts to encourage and enhance indigenous water research targeted at the improvement of resource management, enhancing the understanding resource economics, and adapting the research findings in other environments to local conditions, including but not limited to, crop water requirements, minimizing evaporation and controlling evapo-transpiration and the like.

47. Emphasis will be placed on liaison with international institution to keep abreast with modern technological advances, and to facilitate technology transfer and adaptation.

GROUNDWATER MANAGEMENT POLICY

Background

Groundwater in the Hashemite Kingdom of Jordan occurs in a renewable and nonrenewable form in 12 distinct basins. The exploitation of groundwater in ancient times was done through the exploitation of springs where groundwater emerges to the ground surface, and through the artificial means of tapping the aquifers by drilling shafts. Archaeological remains in the Jordan Rift Valley indicate the sinking of such shafts at different angles. They date back to the Nabatean era (300 B.C - 106 A.C) and the Roman era thereafter. Jordanians continued to harness the benefits of the use of spring water for different purposes. In the Ottoman era (1516-1916), the use of water was regulated and water rights were kept by the district administration in an official register. Legislation for water acquisition and use in the Hashemite Kingdom started in 1938, and due consideration was taken of the prior water rights recognized by the previous Ottoman administration.

Modern technology to access groundwater aquifers was introduced to the Kingdom in the late fifties; legislation to regulate the exploitation of groundwater resources and to have it supervised by government was soon introduced. The country had its population doubled as it hosted the first wave of Palestinian refugees in 1948. It united with the West Bank in 1951 in one Hashemite Kingdom. Free movement of people, goods, and services was normal and added more to the population. The increase in population occurred in and around urban areas, which intensified the demand for urban water. Springs that had been the source of urban water could no more cope with the increased demand. Streams that emerged from them dried up with adverse environmental consequences. Tube wells were drilled to pump more water from the aquifers for urban supply purposes.

Demand also increased for food. Permits were also issued to interested developers to drill wells for agricultural development. The drilling and abstraction of groundwater were monitored and controlled until the outbreak of the 1967 war and its aftermath. Government control weakened, and many wells were drilled without permits. The relaxation of Government controls thereafter continued primarily because of the institutional instability and the shifting of institutional responsibilities.

Today, each of the 12 water basins has wells sunk in it and pumps installed in them capable of abstracting more water than the safe yield of each. The average annual abstraction from all basins exceeds the renewable average of recharge and currently stands at 159% of that average. The over pumping ratio ranges between 146% in minor aquifers to 235% in major ones. This situation could not be tolerated, and decisions were taken to treat the situation.

The desire to propagate agricultural development prompted Government to lease out lands in the southeast in 1984, and contracted with agricultural production companies lands in the southeast in 1984, and contracted with agricultural production companies to undertake such activities in those remote and arid areas. Fossil freshwater is being used for the purpose. The aquifers thus exploited have been identified as a primary source for urban water supply to Amman, and a major project has been designed to convey water to Amman at an average capacity of 100 MCM per year. Action has been taken to reduce agricultural usage from these aquifers.

The Water Strategy for Jordan, and the water supply - demand table indicate that a gradual reduction of pumping from the groundwater aquifers has to be effected so that the abstraction rate will be close to the annual recharge by the year 2005.

Current Institutional Set-Up

Government administration of the groundwater affairs formally started in the late fifties with the creation of a specialized agency, the Central Water Authority, CTA. This was amalgamated in 1965 into a newly founded organization, the Natural Resources Authority, NRA. In 1977, the newly created Jordan Valley Authority, JVA, was authorized by law to carry out groundwater investigation and development in the Jordan Rift Valley. In 1983, the Water Authority law was enacted and WAJ assumed the responsibility of groundwater administration, management and development. The concerned directorate of NRA and that of the JVA were transferred to WAJ in 1984. Both WAJ and JVA came under the umbrella of a newly founded Ministry, the Ministry of Water and Irrigation, MWI in 1988.

Currently, MWI/WAJ is in charge of groundwater administration and management in addition to its responsibilities in providing municipal water supplies to all population centers in Jordan, and the collection and treatment of their wastewater. MWI/WAJ receives application for drilling licenses and abstraction permits, and issues such licenses and permits in accordance with the effective groundwater legislation. MWI/WAJ also supervises the drilling, the abstraction, and makes arrangements for the lease of land and use of groundwater for agricultural purposes in remote arid areas. Recently, MWI has stepped up the activities of groundwater resources studies on a national scale.

Conditions of Groundwater Aquifers

There are eleven renewable groundwater reservoirs in the country. Their sustainable yields vary from one reservoir to another, and their combined sustainable yield is 275 million cubic meters per year.

The majority of the reservoirs are being utilized at rates exceeding their sustainable yields. The important ones are of particular concern because they are the most over utilized aquifers. The combined abstraction rate of all renewable reservoirs approaches 437 MCM per year, a rate equal to 159% of their sustainable yield. The over pumping ratio varies from 146% in minor aquifers to 235% in major ones.

The over pumping from one aquifer in the 1960's and 1970's caused its loss due to high salinity ratios. It is feared that this unpleasant experience will be repeated in some other aquifers if they are not rescued through proper management.

There are extensive non-renewable reservoirs in the sandstone formation underlying almost the entire area of the country. The water quality of these reservoirs varies and is known to be fresh in the Disi-Mudawwara area.

Qualities elsewhere have been sparsely investigated and preliminary findings indicate brackish water qualities. More work is needed to investigate these reservoirs.

The use of fresh fossil waters from the non-renewable reservoir in Disi-Mudawwara started in the early eighties for municipal and industrial purposes in the city of Aqaba. This was followed by the use of the same aquifer (Disi) for agricultural purposes. Future use of this aquifer is earmarked for municipal purposes for the city of Amman, and pumping for agricultural purposes is being reduced.

The Policy

Objective

The objective of this policy is to outline in more detail the statements contained in the document entitled: "Jordan's Water Strategy". The policy statements set out the Government's policy and intentions concerning groundwater management aiming at development of the resource, its protection, management and measures needed to bring the annual abstractions from the various renewable aquifers to the sustain-able rate of each.

On Resource Exploration

1. Plans and implementation measures for the exploration of ground-water resources shall be prepared and updated. Theoretical investigation and field operations in the form of drilling, sampling and logging shall be conducted continually.
2. Assessment and re-assessment of the sustainable yields of ground-water reservoirs shall be made in light of the accumulation of data and information
3. Monitoring of each reservoir shall be conducted through a network of observation wells. Such crucial data as the groundwater table, the draw down as a result of development, the physical, chemical and biological characteristics and their changes will be collected.
4. Implementation of groundwater exploration will be conducted by MWI/WAJ personnel as a priority. The service can be out-sourced when deemed necessary or required by any partnership with others in this activity.
5. Equipment, hardware and computer software needed for groundwater investigation and exploration shall be maintained by MWI/WAJ. Drilling services can be out-sourced when needed and so will be the maintenance of software packages.
6. Advanced methods and tools for investigation including landsat imagery shall be employed, and co-operation with other countries in this field will be promoted.
7. A comprehensive program to assess the potential of brackish groundwaters shall be conducted. Brackish groundwater will be used to augment water supply for domestic uses through desalination in due time and specified localities. They also may be used for agricultural purposes where appropriate.
8. Compilation of oil and gas drilling data as well as geophysical data shall be made to gain better understanding of the potential of the deep aquifers.

On Monitoring

9. A network of observation wells shall be installed in each of the groundwater reservoirs or parts thereof for the purpose of monitoring the conditions and performance of the reservoirs in response to development and abstraction.
10. A groundwater reservoir can be divided into sub-units for the purposes of monitoring and control of abstraction
11. Advanced technology shall be employed in the monitoring processes including the installation of water meters, remote control devices, telemetry, automation and field central controls.

12. Data collected in the monitoring process shall be formatted for storage in and retrieval from computer files. Hard copies and computer back up copies shall be maintained at all times.

13. Analysis and interpretation of data shall be made by a specialized group of professionals and their aides, and results published in special reports by MWI/WAJ.

14. Logistics for the field teams shall be secured, and their working conditions improved to the best affordable levels.

15. MWI/WAJ shall evaluate, update and redesign the groundwater-monitoring plan to cover all aquifers with emphasis on the overexploited and polluted aquifers.

16. A special monitoring network of industries and olive presses will be adopted and installed for those with potential pollution to groundwater.

On Resource Protection, Sustainability, and Quality Control

17. Recharge areas of aquifers shall be protected to the maximum extent possible. Conflicts arising out of urbanization shall be addressed, and mitigation measures specified for the urban planners to have them included in the urban planning process.

18. Recharge areas shall be protected against pollution caused by whatever means including solid and liquid waste disposal, mining, land fills, brine disposal, agricultural inputs and the like.

19. Drilling of wells and abstraction of groundwater from them shall be prohibited without a drilling license and an abstraction permit issued by WAJ.

20. Withdrawal from wells shall not exceed the abstraction permit rate under penalty of substantial fines and / or revoking the abstraction permit and the closure of the well. Over-abstraction from aquifers shall be reduced to sustainable levels in accordance with a time-phased plan.

21. The laboratories of the Water Authority of Jordan shall be equipped with the latest technologies and equipment to match the requirements of good quality controls and assurance. Monitoring of groundwater qualities shall be made, hazards identified and mitigation measures specified and implemented.

22. Withdrawal from non-renewable fossil aquifers shall be made carefully and after elaborate studies and investigations. A lifetime will be assigned for each of these aquifers and an abstraction rate specified accordingly.

23. The MWI will co-operate with planning and environmental authorities to have polluting industries and solid waste dumps located outside the protection zones of aquifers.

24. The MWI shall co-operate with the Ministry of Agriculture and its arm of extension service to regulate the type and application rate of fertilizers, pesticides, and sludge used within the area of aquifer recharge.

25. MWI/WAJ in liaison with other authorities will seek to restrict storage of chemicals, waste materials and sewage treatment works within the inner circle protection zone.

On Resource Development

26. Development of groundwater reservoirs shall be commenced only after careful studies are made of the potential of each, and observation wells installed in carefully chosen locations to monitor the reservoir during exploitation. Well

fields shall be distributed with a proper distance between wells to minimize sudden draw down of water levels.

27. Development of deep groundwater aquifers shall be carefully made. Abstraction from them shall be gradual with periodic assessment of quality and quantity.

28. Potentials of reservoirs shall be based on the natural rate of recharge. These can be augmented through means of artificial recharge induced through proper designs.

29. Natural rainwater and treated effluent of wastewater are considered primary sources for artificial recharge. Monitoring of recharge facilities and their maintenance shall be made periodically.

30. Development of groundwater reservoirs shall not be allowed without a license issued by MWI/WAJ. Private developers and public entities shall all be required to apply for any development they intend to undertake.

31. Inflow into and outflow from each groundwater reservoir shall be determined as accurately as possible before any permit is issued for the development of that reservoir.

32. Artificial underground storage, especially in the alluvial fans of the Jordan Valley shall be investigated.

33. Groundwater mathematical models shall be developed or updated for all regional aquifers of the basins to predict their yield under various pumping scenarios.

34. New nonrenewable groundwater sources shall be allocated to municipal and industrial uses as a first priority.

35. MWI/WAJ shall encourage the use of groundwater conjunctively with surface water in places where such joint management has the potential for increasing the benefits of water use.

36. MWI/WAJ shall encourage the use of marginal groundwater quality for agricultural uses especially when such use may relieve pumping from fresh groundwater aquifers.

On Priority of Allocation

37. Priority of allocation of groundwater shall be given to municipal and industrial uses, to educational institutes and to tourism. These purposes are deemed to have the higher returns in economic and social terms .

38. Priority shall also be given to the sustainability of existing irrigated agriculture where high capital investment had been made. In particular, trees irrigated from groundwater shall continue to receive an amount sufficient for their sustainability with the use of advanced irrigation methods.

39. Expropriation of use rights arising from legal use of groundwater, or of water rights established on springs rising from groundwater reservoirs shall not be made without clear higher priority need, and against fair compensation.

40. Priority shall be given to the use in irrigated agriculture of the reservoirs whose water quality does not qualify them for use in municipal and industrial purposes.

41. Priority for use in agriculture shall also be given to the cases where supplementary irrigation from the groundwater reservoir is possible.

42. A contingency plan shall be made and updated for the purpose of allocating the water from privately operated wells for use in the municipal networks.

On Regulation and Control

43. Campaigns shall be waged against illegal drilling of tube wells, and wells thus drilled shall be stopped, rigs confiscated and legal action taken against violators.

44. Comprehensive groundwater basin management plan for each aquifer shall be developed as part of the National Water Master Plan.

45. Water meters installed on groundwater wells shall be read on quarterly basis to make sure that abstraction from the wells do not exceed their allocations, specified in the permits.

46. Prohibition of well licensing for agricultural purposes will be sustained. Only high priority purposes shall be entertained for licensing.

47. Fees and charges will be used as an instrument to control ground-water over-pumping.

On Legislation and Institutional Arrangements

48. Legislation and institutional arrangements for the development and management of groundwater resources shall be reviewed from time to time. Shortcomings shall be addressed and institutional arrangements shall be updated, adjusted or restructured..

49. Effective laws shall be reviewed from time to time with the intention of updating their provisions to match the requirements of changing times. By-laws issued under the applicable laws shall also be updated to serve the purpose of performance efficiency. Institutional set-up shall be reviewed in parallel, updated, adjusted or restructured to improve performance.

50. Close co-operation will be maintained with the other organizations whose activities may directly impact the performance in the water sector.

On Research, Development and Technology Transfer

51. A study and research activity shall be entrusted with a specialized unit within MWI. The unit will be entrusted with technology transfer responsibilities.

52. Due emphasis will be made on the efforts targeting human resources development.

53. Training centers will be reinforced and upgraded. Cooperation with outside centers and agencies will be promoted.

54. International and regional cooperation shall be pursued in the fields of research, development and technology transfer in ground-water exploration, management, quality control, and economics shall be promoted. Exchange of information and experience shall be maintained with regional and international parties.

On Shared Groundwater Resources

55. Legal research shall be made on the sharing of groundwater aquifers and their protection.

56. Efforts shall be made and sustained to establish Jordan's rights in shared groundwater resources through international agreements.

57. Regional data exchange on shared groundwater resources shall be encouraged.

58. Cooperation with neighboring countries for the optimal and sustainable use and management of the shared groundwater resources, shall be sought.

59. Special attention will be paid to the monitoring, assessment and development of shared groundwater resources.

On Public Awareness

60. Workshops and seminars for well owners will be organized to promote groundwater conservation and raise efficiency of groundwater use.

61. Training programs for Ministry staff shall be conducted to build capacity for public awareness campaigns related to groundwater use and protection.

62. MWI/WAJ in cooperation with other concerned agencies shall maintain a program to educate farmers on the importance of groundwater protection and shall promote technology transfer related to groundwater use in irrigation.

63. Cooperation with other concerned agencies shall be maintained to encourage the reuse of groundwater in beneficial purposes.

On Private Sector Participation

64. The role of the private sector in the development of fresh ground-water resources shall be reduced where reduction of abstraction is sought. The private sector shall be encouraged to co-operate in the rehabilitation of aquifers where needed.

65. The Private sector shall be encouraged to develop aquifers of marginal water quality for use in irrigation. It shall also be encouraged to develop fossil and renewable aquifers in remote areas for agricultural uses with the intention of promoting technology transfer and the creation of job opportunities.

66. Desalination of brackish groundwater by the private sector shall be promoted. Care shall be given to the environmental impacts of such activities, particularly the safe disposal of brines.

WATER UTILITY POLICY

Introduction

Water is a scarce and precious resource that is of vital importance to the continued socio-economic development of the Kingdom. It requires careful planning based on long-term data of available water resources-surface water, groundwater including the deep aquifers, brackish water and appropriately treated wastewater generated from the urban areas. Limited available water resources must be used in an equitable way, taking into consideration various water rights, priority for reasonable domestic use, established socio-economic development and other uses such as agriculture, industry and tourism.

1. The Water Strategy

Securing a reliable supply of water, adequate in quantity and quality, is one of the most challenging issues facing Jordan today. Planning and policy formulation for the supply and utilization of water resources will be based on comprehensive and reliable data, including data on water quantity, quality and utilization. The supplies of surface water, groundwater, and treated wastewater, and their utilization will be carefully monitored. The importance of shared surface water supplies and groundwater aquifers demands careful and consistent assessment and monitoring of these resources. Other non-conventional water resources, particularly brackish water resources, will be assessed, as desalination becomes more economically feasible.

The full potential of surface water and groundwater shall be developed based on the economic feasibility and taking into consideration the relevant social and environmental impacts. Investigation works of deep aquifers shall be conducted to support development planning. The interactive use of ground and surface water with different qualities shall be considered, and assessment of the available and potential resources shall be conducted periodically.

A Water Strategy has been formulated by the Ministry of Water and Irrigation, and was adopted by the Council of Ministers on April 26th, 1997. The strategy stresses the need for improved resource management with particular emphasis being placed on the sustainability of present and future uses. Special care shall be given to protection against pollution, quality degradation and depletion of resources. Furthermore, the Ministry of Water and Irrigation shall continually aim at achieving the highest practical efficiency in the conveyance, distribution, application and use, and shall adopt a dual approach of demand management and supply management, with tools of advanced technology being increasingly utilized to enhance the resource management capabilities. The interactive use of multiple resources shall be targeted to maximize the usable flows, and maximize the net benefit from the use of a unit flow of water. In conjunction with this, there will be a targeting of the minimum cost of operation and maintenance with the cost of production of future industrial, commercial, tourism and agricultural projects being measured also in terms of their requirements of units of water flow. Performance efficiency of the water and wastewater systems and the management thereof shall be monitored and rated, and the improvements on performance shall be introduced with due consideration to resource economics.

The Water Strategy ensures that the rightful shares of the Kingdom's shared water resources shall be defended and protected through bilateral and multilateral contacts, negotiations, and agreements. Peace water and wastewater projects, including the scheme for the development of the Jordan Rift Valley, shall

be accorded special attention for construction, operation and maintenance. Due respect will be given to the provisions of international law as applicable to water sharing, protection and conservation, and those applicable to territorial waters. Bilateral and multi lateral co-operation with neighboring states shall be pursued, and regional co-operation shall be advocated.

As part of the Ministry's efforts to manage the water resources more efficiently a long-range plan shall be formulated for the development of the resources, and a revolving five-year plan shall be extracted from it and updated as necessary. The revolving plan shall be compatible with those formulated for the other sectors of the economy. A parallel investment plan shall accompany the development plan.

2. Institutional Development

The Government will adopt the most efficient and effective means for optimizing national objectives in the water sector. Among the main requirements for facilitating and accelerating this achievement is an institutional framework compatible with the complexities of water sector issues and a management system that best serves them. The performance of the water sector, like that of any other sector, depends heavily on the strength of its institutions. Institutional restructuring and the introduction of private sector involvement must, therefore, be supported by adequate legislation, efficient law enforcement, and strong human resources development.

A significant reorganization of the water agencies will be necessary to increase efficiency and responsiveness. In this context a thorough assessment of the institutional setting and constraint has been developed, and a program of implementation was adopted. The role of the Ministry of Water and Irrigation (MOWI) will be centered on planning, development of the sector, formulation of policy framework and on regulation of various activities related to the water sector. The restructuring program will produce an overall framework articulated by the following three entities:

The Ministry of Water and Irrigation (MOWI) will remain as a government entity responsible for sector governance. The role of the Ministry will center on providing policy formulation, decision making, centralized data collection. Geographic Information System, monitoring and national water planning for the water sector of Jordan. A comprehensive national water data bank will be established and kept at the Ministry of Water and Irrigation, and shall be aided by a decision support unit. Additionally, this data bank will be supported by a program of monitoring and a system of data collection, entry, updating, processing and dissemination of information, and will be designed to become a terminal in a regional data bank setup.

The Water Authority of Jordan (**WAJ**) is moving to separate its bulk water supply and retail functions. The majority of the retail water delivery functions in the Amman Governorate will be managed by the private sector. BOT or similar private sector mechanisms will be considered for new bulk water supply and wastewater treatment facilities. The role of WAJ will change with the expected separation of bulk water from the retail supply, and the adoption of cost accounting methods based on Generally Accepted Accounting Principles (GAAP). WAJ will monitor retail supply contracts, and will become a smaller organization of higher caliber with a major role in the operational monitoring of a number of management contracts with private sector utilities and BOT providers. WAJ will manage the resources as well as those bulk supplies, which are not privatized. Furthermore, it will provide support to smaller retail distribution units, which are not operated by the private sector. The intention is that these units will

be operated along commercial lines, with greater local autonomy and with higher stakes for the users.

The Jordan Valley Authority (JVA) has, over the past two decades, implemented a series of successive integrated social and economic development plans. Its activities, particularly in social infrastructure, have witnessed a slowdown over the past decade. The development of the Jordan Valley needs to be re-assessed, and the role of the JVA will be defined accordingly. Future development will have to take a course that builds on the achievements and charts new territories with more focus on such sectors as tourism, industry, manufacturing, advanced technologies, and others. The mandate of the JVA as stipulated in Law No. 19 of 1988 will be sustained. The private sector will be called upon to assume a proper role in development as well as operation and maintenance activities that are being restructured on a more commercial basis. Furthermore, cost accounting methods based on Generally Accepted Accounting Principles (GAAP), will be introduced. JVA's responsibilities will be enhanced as more momentum is gained by the integrated development of the Jordan Rift Valley (JRV) now being studied as a regional project.

3. Private Sector Participation

The Government is committed to securing water services at affordable prices and acceptable standards. It is also committed to extending these services to remote and less developed areas. Although in the future, demand and competition are expected to increase for the available limited water resources, the government intends, through private sector participation, to transfer infrastructure and services from the public to the private sector, in order to improve performance and ensure the delivery of services to the population.

The role of the private sector will be expanded with management contracts, concessions and other forms of private sector participation in water utilities being considered and adopted as appropriate. The concepts of BOT/BOO shall be entertained, and the impact of such concepts on the consumers shall be continually assessed, and negative impacts mitigated. The private sector role in irrigated agriculture shall also be encouraged and expanded. Emphasis will be placed on the social benefits in conjunction with the private investments.

4. Water Pricing and Cost Recovery

In view of the increasing marginal cost of supplying water in Jordan, the growing demand for water, the low rate of cost recovery and in line with the policy towards private sector participation and privatization, the Ministry will set municipal water and wastewater charges at a level which will cover at least the cost of operation and maintenance by the first quarter of 1998. The Ministry will also move towards the recovery of all or part of the capital costs of water infrastructure. Until the cost recovery is full, and the national savings reach levels capable of domestic financing of development projects, project financing will depend on concessionary loans, private borrowing and/or BOO and BOT arrangements.

The water tariffs mechanism shall be considered as a tool to promote cost recovery of water projects. However, profitable undertakings in industry, tourism, commerce and agriculture shall be made to pay the fair water cost. Moreover, the Ministry will attempt to set differential prices for water based on water quality, the end users, and the social and economic impact of prices on the various economic sectors and regions of the country. The Ministry will also attempt to regularly review and adjust water tariffs based on the costs of supply, operations, and the comprehensive analysis of economic data.

5. Human Resources

Although clear policies already exist concerning the terms of employment and benefit packages of government workers, more transparent procedures concerning recruitment and job's terms of reference are required. Further clarity is also needed concerning national priorities for technical and management skills and the means through which they will be transferred. In order to better prepare for the twenty-first century, a National Water Sector Training Strategy and implementable programs will be developed.

In light of the above, the Ministry of Water and Irrigation will endeavor to improve the capability of Jordan's human resources in the water sector and maximize their efficiency by giving priority to human resources development through continuous education, inservice training, career development, and short- and long-term training. In addition, the Ministry shall strengthen the existing national water training center and provide it with the necessary support in order to identify, encourage, promote, and organize human resources activities and training needs. Recruitment of new staff will be based on sound criteria thus ensuring that staff qualifications meet job requirements. Human resources performance will be continually appraised in order to upgrade capabilities, sustain excellence, and provide job security to qualified personnel. Incentives for excellence will be introduced in compliance with the needs for dedication, while over-employment will be trimmed to reach optimum employment levels compatible with efficient management.

6. Water Resource Management

Since the shortage of water resources in Jordan was first widely recognized in the early 1970s, many strategies and measures have been proposed to alleviate and overcome it. These have included supply augmentation measures involving the construction of various hydraulic structures and the development of groundwater. However, no single action can remedy the nation's water shortage. Rather, an integrated approach will be adopted to enhance water availability, suitability, and sustainability.

It is estimated that in the year 2000 the renewable freshwater resources available per capita in Jordan will be about 160 cubic meters per year. This is less than one third of the widely recognized "water poverty line" of 500 cubic meters per capita per year. This sobering observation requires that water be well managed and used as efficiently as possible, that demand be proficiently managed, that all available sources of water be developed, and that adverse impacts be mitigated through measures of environmental protection.

- **Surface Water**

Development of the country's remaining limited surface water potential can contribute to meeting rapidly increasing demands for all categories of water use in the country. Surface water supplies contribute substantially to Jordan's total water resources, and despite heavy investment in the construction of storage reservoirs, there are still opportunities for further investment in surface water facilities.

Surface water potential in Jordan is estimated at 692 Million Cubic Meters per year. Because of the aridity in the eastern, southeastern and southern basins, and because of other economic and geographic constraints, only about 475 Million Cubic Meters of this potential can be developed economically.

In order to enhance the surface water resources, the Ministry of Water and Irrigation is implementing a comprehensive monitoring and assessment program

for surface water quantity, quality, and uses, as well as establishing an integrated development and conservation program to increase the potential of surface water development in Jordan.

Since the surface water resources are extremely limited, the Ministry will optimize the development and use of this resource through supply-enhancing measures, including surface and subsurface storage, minimizing losses by surface evaporation and seepage, soil and water programs, and protecting surface water supplies from pollution.

The Ministry is also pursuing the development of sustainable management plans for surface water systems in the Jordan Valley, conversion of open canal systems to a pressurized pipe system, giving priority to modernizing and upgrading systems, and precedence to water projects which make significant contributions to meeting rising municipal and industrial demands.

- **Groundwater**

The unsustainable abstraction of groundwater and the depletion of groundwater aquifers is one of the major problems facing the water sector in Jordan. The reaction to the abrupt surges in population levels has been over abstraction from groundwater aquifers. This was exacerbated by the lack of enforcement of regulations on private sector drilling operations, and the near absence of controls on licensed abstraction rates resulting in the rapid depletion of aquifers and culminating in increased pumping costs due to the drastic drop in the water table, as well as increased salinity levels. Groundwater aquifers are exploited at more than double their sustainable yield in the average. The sustainability of irrigation in the highlands and the Badia areas will be greatly endangered unless strict measures are taken to address this issue. As such, the Ministry is implementing a program that sets out legal and financial measures aimed at controlling and gradually reducing groundwater withdrawals with the final objective of maintaining the safe yield of aquifers. Measures will also continue to be taken to protect the groundwater resources from all sources of pollution.

In order to improve the groundwater situation in the Kingdom, the Ministry of Water and Irrigation is establishing an integrated program to assess the availability and exploitability of all resources at rates that can be sustained over long periods of time. The mining of renewable groundwater aquifers will be checked, controlled, and reduced to sustainable extraction rates. In conjunction with this, the Ministry is pursuing planned and controlled groundwater mining from promising, extensive fossil aquifers as an option to secure incremental supplies for municipal and industrial uses. The groundwater use will take place conjunctively with surface water in places where such joint use has the potential for increasing the available supply. There will also be improvement and centralization of groundwater data collection, analysis, and monitoring, as well as the strengthening of the enforcement of groundwater legislation and regulations. The Ministry will further encourage the application of applied research activities, including artificial recharge to increase groundwater supplies, and the employment of new technologies that will optimize the operation and development of groundwater systems and promote its more efficient and feasible uses.

- **Wastewater**

The Ministry presently provides wastewater collection and treatment services to fourteen major populated areas. At present about 2 million people (about 50% of the population) are served by sewerage systems and the effluent quantity is

estimated at about 60 Million Cubic Meters per year, being reused primarily in agriculture.

In view of the increasing population and the social and economic development of the country, the amount of treated wastewater is increasing. It is estimated that by the year 2020 the volume of treated wastewater will be 200 Million Cubic Meters per year and as such, more wastewater projects are planned. As available freshwater resources become increasingly limited in Jordan, treated wastewater will play an ever more important role in the sector. To protect human health and the environment and to provide additional water supply that meets the approved standards for its use, the Ministry of Water and Irrigation will ensure that appropriate wastewater collecting systems and treatment facilities are provided for all sources of wastewater, wherever feasible. It will also ensure that wastewater is not managed as "waste" but is collected, treated, managed, and used in an efficient and optimized manner. The Ministry will also ensure that treated effluent complies with recently established national standards (JS893-1995) and that all treatment is to a quality appropriate for use in agricultural activities and other non-domestic purposes, including groundwater recharge. Appropriate wastewater treatment technologies shall be adopted with due consideration to sustainability, economy in energy consumption, and quality assurance of the effluent. Consideration shall also be given to the blending of the treated effluent with fresher water for suitable reuse.

In light of this, the Ministry is developing a wastewater master plan, which will establish targets for providing wastewater collection systems and treatment facilities to unserved areas throughout the country.

The Ministry is moving, through restructuring, towards establishing the institutional capability for monitoring, regulating and enforcing wastewater regulations. Industries will be encouraged to recycle part of their wastewater and to treat the rest to acceptable standards before it is discharged into the sewer systems or elsewhere. This will help to ensure that the treated effluent quality exiting wastewater treatment plants conforms to water quality standards for reuse.

Due consideration will be given to environmental issues and contamination of groundwater aquifers in the development of wastewater reuse systems, and standards will be set for the construction and management of septic tanks where it is not feasible to have sewerage collection systems and treatment facilities. In addition, the Ministry will establish a unit with well-qualified staff to be responsible for the planning, design, construction and management of sewerage system projects and for the reuse of treated effluent.

- **Brackish Water**

Besides wastewater reuse, brackish water, either for direct use or after desalination, appears to offer the highest potential non-conventional means of augmenting the country's water resources. Several brackish springs have been identified in various parts of the country. Tentative estimates of stored volumes of brackish groundwater for the major aquifers suggest immense resources, but not all of these quantities will be feasible for utilization. As such, when referring to statistics about brackish water, the quality, quantity and location of this resource need to be carefully studied in order to assess its potential for utilization.

In order to further pursue the brackish water option, the Ministry must first assess the potential of brackish water resources in terms of sound technical, economic and environmental feasibility in all groundwater basins within the Kingdom, and then conduct research and studies on desalination and on optimization of brackish water use in agriculture and industry. Brackish water resources will then

be allocated, either desalinated or in their natural condition, to their best uses in order to provide additional water supply and to ensure water productivity and sustainability. They shall also be listed, along with seawater, for desalination to produce additional water for municipal, industrial and commercial consumption.

The Ministry has consistently encouraged regional and international cooperation for the promotion of research, development, exchange of information as well as training in the field of desalination and other non-conventional sources. Therefore, technology transfer and the findings of advanced research in genetic engineering shall be introduced to the extent possible for this purpose.

7. Water Quality and the Environment

Jordan has witnessed some deterioration in its water quality in the last two decades due to industrial pollution, overuse of agrochemicals, drainage water, overloading of wastewater treatment plants, over-pumping of aquifers, seepage from landfills and septic tanks, and the improper disposal of dangerous chemicals by certain industries. The added population pressure, exacerbated by successive waves of refugees and displaced people, has further degraded the effluent from the khirbet As-Samra wastewater treatment plant and has resulted in the degradation of water quality in the King Talal Dam, requiring that its reservoir be closed to public access.

Water quality criteria are physical, chemical, and biological characteristics, which reflect tolerances and requirements for use of the resource in various sectors. For domestic uses, they reflect human health considerations and people's intangible sense of aesthetics. When these values are incorporated into enforced standards, the result will be water that is both aesthetically pleasing and reliably safe. Water of this standard is the right of all citizens and the responsibility of the Government. However, meeting these standards can be complex and difficult.

Treated effluent from wastewater plants offers a different set of challenges. The performance of many of the plants is inadequate, resulting in an effluent of low quality. This effluent may have an adverse effect on public health due to the presence of pathogens or the accumulation of toxins in soils irrigated using effluent. Furthermore, pollution of surface and groundwater due to seepage will result in the deterioration of the water quality of some water resources and will limit their use for drinking purposes.

The quality of treated effluent and the performance of the wastewater treatment plants are greatly affected by the influent water quality, which may be of domestic or industrial source. Thus, enforcing standards for wastewater discharges to sewers, treated effluent and water for other uses is essential

Jordan, as well as many other countries, has adopted international water quality standards or guideline values developed by the World Health Organization (WHO), the United States Environmental Protection Agency (EPA), and others. This acceptance has been a simple and safe way of setting water standards policy. However, these standards

are often stringent, based on "the worst case assumptions" or condition, which may not be relevant to local conditions, or even affordable in some instances. To achieve a desirable water quality, it is not always necessary to adopt these standards.

When water is extremely limited, as is the case in Jordan, water standards must be carefully examined to assure that available resources are fully and efficiently utilized. Thus, the standards adopted should consider national priorities, economics, and availability of water supplies, as well as health and other environmental implications.

Implementation of standards and their enforcement require facilities and expertise, which involve significant costs. Enforcement, particularly, requires commitment and coordination between many agencies and at many levels within the government. It should be emphasized that considerations of policy and convenience must never be allowed to jeopardize public health.

In developing standards for drinking water, it is intended that when these standards are implemented, the safety of drinking water supplies be ensured. Adopting and implementing standards for treated effluent will result in minimizing health hazards, as well as other environmental risks, such as biological and chemical pollution of surface and groundwater.

Adopting standards and guidelines for water used in irrigation, in cooperation with the Ministry of Agriculture, increases the availability of water that can be used in irrigation. Setting standards for treated effluent according to its end use will have an economic impact and makes the implementation of these standards easier. To ensure these standards are achieved, an effective monitoring program has been adopted. Such a program requires that analytical methodology equipped laboratories and qualified personnel be provided.

In order to ensure the safety of drinking water supplies, to prevent chemical, biological and physical pollution of water resources, and maintain efficient wastewater systems the Ministry of Water and Irrigation will survey and monitor all water resources for water quality, ensure that water quality standards are consistently being met. Furthermore, the Ministry will continuously evaluate and update standards guidelines for drinking water quality, while simultaneously strengthening the enforcement of standards so that water supplies and wastewater do not endanger the public health.

Particular attention needs to be focused on adopting and enforcing effluent and sludge standards for municipal and industrial wastewater treatment plants and for discharge from laboratories, hospitals, slaughterhouses, and other businesses. Concerns for public health and the health of workers shall be a focus in the programs of reuse of treated wastewater. Laboratories shall be maintained and properly equipped to provide reliable data needed to ensure safe supplies to the consumers.

8. Service Levels

Policy issues related to water distribution have to do primarily with questions of efficiency and investment. The general objective of any water distribution system is to distribute water to consumers in adequate quantity and quality and at the required time to meet the demand in the most efficient manner. National efforts are required in Jordan to improve existing systems, expand them to cover areas not being served, and to improve technical and managerial capabilities.

Specific improvements in Jordan's water distribution systems include the removal of inadequacies in the various components of the existing systems, such as operational problems, metering problems, supply interruptions, under design of pipes, high operation pressures, and absence of pressure zones.

In conjunction with the above, the Ministry of Water and Irrigation will continue with the enhancement of the operation and maintenance of the existing distribution systems and reservoirs, and the rehabilitation of old and damaged components. Conjointly, the Ministry will continue ensuring proper, safe, and high standards and specifications for pipe and other materials and for construction and operation and maintenance practices.

Since efficient water distribution systems are vital to conserve water, provide better services to consumers, and reduce water costs, the Ministry will improve the efficiency of water distribution through improved planning and strengthened

technical, managerial, and financial capability of concerned institutions. The Ministry will also endeavor to meet water demands in the most effective and efficient manner, focusing on proper planning, improving operation and maintenance, and private sector participation, whenever possible.

Investments in municipal networks are inadequate. Although the level of services in the water supply sector in Jordan is fairly high, with service to 97% of the population in the urban areas and 83% in the rural areas, distribution systems are still far from optimal and efficiencies are still low. The unaccounted for water in the municipal networks was estimated to be 55% of the quantity supplied in 1995.

The most important parameters developed for service level assessment include:

- * Maintaining water quality in the networks to be within the standards.
- * Frequency of summer water supply.
- * Frequency of winter water supply.
- * Response time for repair of network leakages, pressure loss, and sewer blockage.
- * Reduction in waiting times for water and wastewater connections.
- * Reduction in waiting times for the resolution of customer complaints.

In the Jordan Valley, the overall irrigation efficiency of 57% in 1994 was raised to 68% in 1995 after significant improvements. In addition, and because of operational problems and water shortages, about 16% of the total developed agricultural area is not regularly supplied with irrigation water.

The priority criterion for project implementation, and for additional water allocation shall be based on economic, social and environmental considerations. A critical path shall be established for the allocation of each new source of water. Consideration shall be given to the sustainability of the allocation in the light of the national water balance situation and the economic, social and environmental opportunity cost of forgone alternative uses of water.

First priority will be given to allocation of the basic human needs, and as such, first priority is given to the allocation of a modest share of 100 liters per capita per day to domestic water supplies. Expensive additional water has municipal purposes as a first priority in allocation, followed by tourism and industrial purposes.

9. Public Awareness

Public awareness is primarily a means of informing and educating water users about the seriousness of the water situation in Jordan. In so doing, it is a tool for managing water demand and can be used to help rationalize water consumption and encourage conservation at the household, business, or farm level. Public awareness programs could substitute for other demand management methods, including raising water prices, introducing water saving devices, and rationing water supply, which may be less acceptable to the general public. Public awareness is also a means of directly confronting the degradation of the resource by having end users understand its implications and seeing themselves as caretakers who can protect the quality of water, neither contaminating it themselves nor permitting others to pollute it. It also has critical institutional components, since public awareness must be carried out within some organizational setting, which involves budget allocations and determination of roles for government, nongovernmental organizations, and the private sector.

Carrying out public awareness programs is important to Jordan for a number of reasons. There is a general lack of understanding and concern about the value

and scarcity of water resources. Any significant changes in how water is conserved or protected will require public support and participation. Public awareness programs seek to conserve and protect water resources through understanding the water situation and the shortages and scarcity of the resource. They raise community understanding and support for water allocation among competing sub-sectors and improve the likelihood of the public's helping to develop and accept new policies. By providing information, which seeks behavioral modifications, these programs may assist in the reduction of illegal water connections and the general misuse and damage of water measurement devices. There is also a need to increase understanding of water conservation issues in Jordan among policy-makers and the private sector.

The Government believes that public awareness programs are a successful way of reaching the Jordanian populace as a way of modifying undesirable behavior and reinforcing positive efforts. By supporting public awareness programs that encourage the conservation and protection of the Kingdom's limited water resources and observation of its regulations, the Ministry of Water and Irrigation can better achieve the Government's objectives in the water sector through the direct involvement of the people.

Within the Ministry of Water and Irrigation, an active public awareness program is rapidly gaining acceptance. Policy implications are related primarily to how the Government will collaborate with nongovernmental and other organizations. Given the already collaborative relationships, at least at the policy level, it appears to be only moderately important. With regards to the public however, there needs to be an educational campaign put into effect to inform the public about the value of water for them and the well being of the country for the sustainability of life, and for the economic and social development. Likewise, facts about water in Jordan need to be disseminated such as the cost incurred to provide the service, and the mounting pressure of population growth on the water resources. Economic measures must also be adopted to reinforce public awareness .

10. Conservation and Efficiency Measures

The increasing gap between limited water supply and increasing demand in Jordan requires careful policies and programs to conserve and manage water properly. Water conservation is a means of enhancing water availability by managing both supply and demand. Generally, this can be addressed by enhancing the efficiency of use through the utilization of improved water saving technologies and management practices, and the behavior modification of current practices through, in part, public awareness programs. Water conservation by the Ministry of Water and Irrigation is expected to bring immediate and sizable water savings. Financially, conservation and efficiency measures will help to reduce the need for expensive water supply projects that are primarily designed to provide additional water.

Water conservation and efficiency improvement play a major role in mitigating the problem of water scarcity and shall be given the proper consideration in the Kingdom's water resources development and management programs. Therefore, the Ministry of Water and Irrigation will endeavor to undertake all the necessary measures leading to the establishment of comprehensive programs for water resources conservation, reduction of water losses, and improvement of water use efficiency in all sectors.

11. Investment

Nearly all of Jordan's available renewable water resources have been developed. Current use significantly exceeds the country's available renewable water resources, but still falls well short of meeting demand. Options for increasing the supply are limited, and development costs are increasing. Such options include rehabilitation and replacement of inefficient networks, wastewater reuse, shared water resources, and other non-conventional water resources, particularly brackish water desalination, and are all being considered. Development and implementation of these options will require large investments from the public and private sectors in the future.

Because of limited financial resources available in the water sector of Jordan, the process of setting investment priorities has taken on added importance. Criteria for prioritizing investments that take into account the current and expected needs of the country are currently being developed. There is also a need to expand domestic water supply and wastewater systems in urban areas and to expand water supply and provide wastewater systems to smaller towns and villages that are currently unserved. The same criteria must be applied to the integrated development of the Jordan Valley. New water schemes continue to be identified, and there is a serious need for periodic rehabilitation of existing schemes.

Traditionally, the public sector has invested heavily in the water resource development, and water investments comprise a major share of Jordan's external borrowing. Although public sector investments will continue, private sector investment will be sought. To the extent possible, private sector investments will be channeled to priority areas set by the Ministry. The investment criteria currently being developed are a means of assisting the Ministry in setting priorities for investment that will apply to both the public and private sectors. Economic evaluation methods such as cost-benefit analysis and rate of return analysis have traditionally been used to rank investment options. The Ministry of Water and Irrigation will also take into consideration environmental, health, social and other issues relevant to the water sector in Jordan.

Due to the strategic importance of water for the social and economic development of the country, and considering the scarcity of financial resources, the Ministry of Water and Irrigation will place a high priority on integrated planning and optimal investment in the water sector, by both the public and private sectors, and establish appropriate criteria for ranking and selecting water projects. The updating of the National Water Master Plan, currently being undertaken, will provide broad guidelines and the initial identification of future investments in the sector.

IRRIGATION WATER POLICY

Background

The Hashemite Kingdom of Jordan has been facing a chronic imbalance in the population - water resources equation, which imbalance is manifested by a substantial imbalance in the foreign trade in food commodities (\$110 per capita in 1997), and by rationing of municipal water that is serviced to the population twice a week. The total renewable freshwater resources of the country amount to an average of 750 MCM per year . The population of 1997 is around 4.4 million people, growing at an annual rate of 3.6%. The per capita share was 160 cubic meter per annum in 1997 and declines at a rate equal to that of the population increase .

The production of food in semi arid countries like Jordan is hardly possible without irrigation. The irrigated areas are located in the Jordan Valley (some 33,000 hectares), and in the Plateau (some 44,100 hectares). Some 400,000 hectares are fit for dry land farming, but it is practiced on half of this potential because of the insecurity associated with erratic rainfall and other reasons. Irrigated agriculture, however, provides most of the agricultural production in the Kingdom and offers the higher percentage of agricultural jobs and other jobs in support services.

Because of the huge imbalance in the population - water resources equation, the treated wastewater effluent is added to the water stock for use in irrigated agriculture. It will constitute a substantial percentage of the irrigation water in future years.

Development of Irrigated Agriculture

Irrigated agriculture has been practiced in the Jordan Valley since the dawn of human civilization. Archaeological remains tell of the construction of water storage facilities and irrigation networks by the Nabateans before the Christian era in the Jordan Rift Valley and elsewhere. Irrigation was developed in the Rift Valley by channeling the uncontrolled perennial flow of side wadis and rivers through well developed water conveyance systems and irrigation techniques.

Formal development and a rebirth of irrigated agriculture in Jordan started in the early fifties in the Zarqa Triangle with irrigation from the uncontrolled flow of the Zarqa River. The Deir Alia agricultural experimental station was established at that time. The more serious effort was planned in 1954 - 1955, and implementation commenced with grant assistance from the United States towards the East Ghor Canal Project, renamed in 1986 as the King Abdallah Canal Project. The Project was implemented between 1959 and 1966 with USAID grant funds, and between 1968 - 1970 with support from the Kuwait Fund, between 1975 and 1980 with loan funds from USAID, IDA and KFW, and between 1983 and 1988 with loan funds from KFW, and, south of the Dead Sea with loan funds from the Kuwait Fund, the Saudi Fund and the Government of Italy. The older parts of the project were upgraded by conversion of surface canal networks to pressure pipe distribution networks between 1986 and 1996 with loan funds from the Arab Fund and the Government of Japan.

Five storage dams have been built in the process; they serve as important feeders to the King Abdallah Canal. The Canal itself has been rehabilitated between 1994 and 1998 with funds from the EIB.

The total area thus developed in the Jordan Valley, under the responsibility and supervision of successive Government agencies, is about 33,000 hectares. About 8,000 more hectares of arable lands remain to be irrigated north of the Dead Sea,

and some 2,000 hectares south of the Dead Sea. A potential exists for irrigated agriculture in Wadi Araba with groundwater sources and surface water sources.

More development has taken place on the plateau using ground water sources. The private sector was behind all that development, with the exception of small and scattered irrigation projects supervised by Government agencies in the 1960's. The total area thus irrigated amounts to about 44,100 hectares.

The Policy

Objective

The following policy statements detail the long-term objectives outlined in the Water Strategy. It is to be noted that this policy addresses the irrigation water and does not extend to the issues of irrigated agriculture. It addresses in more detail water related issues of resource development: agricultural use, resource management, the imperative of technology transfer, water quality, efficiency, cost recovery, management and other issues. Linkages with energy and the environment are accorded a separate chapter. This policy is compatible with the Water Strategy and is in conformity with its long-term objectives. Most of the provisions of this policy are being exercised, and some others are needed to maximize the benefit from irrigation water, and improve the social returns from its uses.

While the policy is national, its implementation is vested in the respective Government agencies as stipulated by applicable laws. Of particular importance is the role of the Ministry of Water and Irrigation and the Ministry of Agriculture.

On the Role of Irrigated Agriculture:

1. Irrigated agriculture is a trade of Jordanian ancestry practiced in the Jordan Rift Valley and on its escarpment. Archaeological irrigation networks and facilities are standing evidence. Irrigated agriculture contributes to the production of food, and provides job opportunities in direct and indirect agricultural employment and supporting services. It also enhances the environment and helps arrest desertification.

On Sustainability of Irrigated Agriculture

2. Existing areas of irrigated agriculture shall be accorded the chances for sustainability. No diversion of its waters to other uses shall be allowed without providing a replacement source fit for agricultural use unrestricted by health and public health considerations, and unduly hampered by chemical constraints.

3. Sustainability of agriculture shall be compromised only if it threatens the sustainability of use of ground water resources. Potential pollution of underlying aquifers or the depletion thereof are among the reasons that can prompt such compromise.

4. Irrigation water sources shall be protected against pollution which degrades water quality, is hazardous to the environmental integrity of soils, or can endanger animal health, particularly livestock. In this regard the adoption of biological control methods shall be promoted in lieu of the use of pesticides. Where desalination of brackish water is practiced, particular attention will be paid to the disposal of brine; especially when such practice is done within the catchment area of dams.

5. Close co-ordination shall be maintained with the Ministry of Agriculture and its research and development arm and with other related institutions with the aim of

enhancing on-farm irrigation efficiencies and maximizing the agricultural output of a unit of land area per unit flow of irrigation water.

6. Surplus surface water during the wet season shall be provided to farmers through the irrigation networks free of charge to leach soils;

especially those farms that are irrigated with treated wastewater in the dry season.

7. Drainage networks shall be installed in irrigated areas where natural drainage is not sufficient to serve the purpose. Disposal of drainage water shall be made in an environmentally friendly manner. Maintenance of such networks shall be accorded attention similar to that paid to the maintenance of irrigation networks.

On Resource Development and Use

8. For irrigation purposes, and in light of the tight water situation, wastewater is considered a resource and can not be treated as "waste." It shall be collected and treated to standards that allow its reuse in irrigation unrestricted by health and public health considerations or unduly constrained by high salinity contents.

9. In remote sparsely populated areas, and after satisfying the local municipal and industrial needs from unallocated water resources, water resources shall be allocated to agricultural production including livestock. Such development shall be planned and implemented in an integrated social and economic fashion in order that communities can be formed, settled and developed.

10. Maximum use shall be made of rainfall for crop production, and supplementary irrigation shall be employed to maximize production including increasing cropping intensities.

11. The use of brackish water in irrigation shall be pursued with care. Soil salinity resulting there from shall be monitored and its buildup managed and mitigated. Land shall be managed with the attention it deserves as a non-renewable resource.

12. A revolving development plan for water resources, including irrigation resources, shall be adopted. The use of modern techniques made available by software development will be employed for the purpose.

On Technology Transfer and Adaptation

13. Despite the high percentage of agricultural water uses, the quantities used fall short of the needs. Higher agricultural yields shall be targeted and the transfer of advanced technology shall be endorsed and encouraged. The transformation of traditional irrigation and farming practices into modern methods shall be endorsed and promoted.

14. Such advanced methods as drip irrigation, spray irrigation, micro-sprinkler irrigation are favored over less efficient methods. Local manufacturing of these equipment will be encouraged.

15. Irrigation water conveyance and distribution shall be made through the installation of pressure pipe networks. Maximum use shall be made of gravity generated pressures to operate these systems.

16. Operation of the irrigation network will be improved to have the water filling the network for 24 hours. Such operation will enhance the benefits that accrue from drip irrigation. While in a rotation system the drip irrigation pipes act as on farm conveyor, the 24 hours operation has the advantage of operating the drippers as designed.

17. Plant varieties developed as a result of genetic engineering research shall be favored for introduction into Jordan's markets. Maximizing resistance to pests, salinity and adverse conditions are features that are needed. Additionally, the maximization of crop yields is another beneficial feature of such varieties.

18. Leasing of Government lands with permits to use water resources not earmarked for higher priority uses, especially in remote areas, shall be encouraged with the view of introducing advanced agricultural practices. Co-operation with advanced countries through technical co-operation shall be sought and promoted to advance technology transfer and adaptation .

On Farm Water Management

19. Crop water requirements in the various micro-climatic zones of the country shall be experimentally determined taking into consideration the prevailing different water qualities .

20. Farmers shall be encouraged to monitor soil moisture on their farms to determine the timing for irrigation water application. The rate and duration of the application shall be adjusted to match the crop water requirements .

21. In as much as is practical, investments on the farm to provide over-night water storage facilities shall be discouraged through providing a continuous supply of irrigation water in the distribution networks.

22. Along with water management, farmers should be able to manage such other agricultural inputs as chemical fertilizers with the irrigation water.

23. Night application of irrigation water, especially in the dry season, shall be encouraged to reduce evaporation losses.

24. Automation of on farm irrigation networks and their operation will be encouraged and training of farmers on advanced water management techniques shall be sought by co-operating with the research and extension service of the Ministry of Agriculture. Co-operation with other countries in this regard and in technology transfer in general shall be pursued.

25. *Programs shall be prepared to raise the public and farmer's awareness of the availability of irrigation water, its rational and economic use and on the impacts of its quality.*

On Irrigation Water Quality

26. Irrigation water quality shall be monitored through sampling at the sources and from the conveyance and distribution network. Farmers shall be alerted to any degradation of water quality. This is important so that they can plan the use of such water for the suitable farming purposes.

27. Where marginal quality water, such as treated wastewater effluent, is a source of irrigation water, care should be taken, to the maximum extent possible, to have the quality improved to standards that allow its use for unrestricted irrigation. This can be achieved through blending with fresher water sources.

28. The same applies to the potential use of drainage water or brackish water sources. However, farmers should be appraised of the potential quality of irrigation water so that their choice of crops is made with the necessary background information and knowledge.

29. Soil salinity and water chemical contents are also constraining factors. Where its salinity is combined with water salinity, the environment of the root zone can cause high stress. Care shall be taken in providing testing services to farmers,

and in promoting extension service in such zones where soil salinity and irrigation water salinity produce hostile roots environment.

On Management and Administration

30. Government agencies have been responsible for the development of water resources in the Jordan Valley and for the construction of the irrigation network. The Jordan Valley Authority (JVA) is the legal successor of these agencies and has been in operation since May 1977. It is the agency amongst them that has lived longest. The JVA is, as the predecessor agencies had been, responsible for the operation and maintenance of irrigation facilities, from the source (dams, rivers, springs..)to the destination (farm gate).

31. Piped irrigation networks shall be the standard method of irrigation conveyance and distribution. Where possible, gravity pressure shall provide the heads in the distribution networks. Supplementary pumping shall be used where needed.

32. Irrigation water shall be metered at the farm turn-out. Digital meters shall be installed at each farm unit for volumetric measurement of in-flowing water.

33. Government shall gradually phase-out of the business of irrigation water distribution, as is feasible, as soon as possible.

34. Pilot irrigation areas shall be designated to test the workability of Participatory Irrigation Management (PIM), where farmers will assume the responsibility of water delivery to their farms. When found successful, PIM will be extended to the Jordan Valley irrigation systems.

35. Development of water resources, including groundwater, outside the Jordan valley has been the responsibility of the Water Authority, WAJ which since 1983 has been the successor, among others, of the Natural Resources Authority. Private farmers are allowed, by license and abstraction permit from WAJ, to exploit groundwater for all purposes, including irrigated agriculture. These private farmers operate their irrigation systems, and have introduced advanced irrigation techniques to their operations.

36. Abstraction from all groundwater wells shall be metered, and monitoring of abstraction shall be made periodically to assure conformity with the provisions of the abstraction permits.

On Public Awareness

37. Public awareness campaigns shall be waged to urge the public to protect water resources against pollution, and to bring home the economic and social value of a unit flow of water.

38. The cost of irrigation water development shall be emphasized, and the importance of protection of structures and utilities against vandalism shall be advocated.

On Water Pricing

39. Irrigation water shall be managed as an economic commodity that has an immense social value. Like the rest of water resources, irrigation water is a national commodity owned by society at large without prejudice to existing water rights.

40. Agriculture provides service to society in the form of employment, population distribution, provision of food that will otherwise have to be imported, and

enhancing the environment. It is for this reason that agriculture enjoys support from society in the form of tax exemptions and subsidies.

41. The water price shall at least cover the cost of operation and maintenance, and, subject to some other economic constraints, it should also recover part of the capital cost of the irrigation water project. The ultimate objective shall be full cost recovery subject to economic, social and political constraints. Due consideration shall be made of any water rights as established by law.

42. Part of the capital cost shall be recovered through the application of a one time charge against irrigation rights. This is applied as a rate per unit area of the irrigated farm. The size of the portion thus recovered shall not be less than half the irrigation network development cost.

43. Differential prices can be applied to irrigation water to account for its quality.

On Regulation and Controls

44. Planting of crops with high water requirements shall be discouraged. Market forces shall be applied to discourage such plantations.

45. Planting of perennial crops shall be allowed only with permits until such time as the water balance and the operation system show no signs of water stress in any of the dry months.

46. Co-operation with other countries, regional and world wide, shall be promoted to enhance the marketing potential of Jordanian agricultural commodities and the products of its agro-industries.

On Irrigation Efficiency

47. Maximum overall irrigation efficiency shall be a standing target. Government agencies in charge of operation and maintenance shall endeavor to approach this target and maintain it.

48. Automation of irrigation networks shall be pursued, and electronic surveillance and monitoring of irrigation networks shall be employed to reduce losses through leakage and breaks.

49. Preventive maintenance of pumps, motors and valves shall be programmed and conducted periodically. Human resources for proper management of maintenance shall be secured to the maximum extent possible.

50. On-farm automation, although the responsibility of farmers, shall be promoted through extension service and demonstration farms.

51. Programs for manpower training to perform duties of irrigation operations, forecasts and scheduling of irrigation service shall be a standing objective.

On Linkages with Energy and the Environment

52. The use of herbicides that are environmentally friendly shall be encouraged. The savings in evapo-transpiration by unwanted plants is a positive outcome. Similar advantage is gained through the savings in plant nutrition that otherwise will be absorbed by unwanted vegetation.

53. Serious care shall be taken in choosing the technology of wastewater treatment. The treated effluent, considered part of the irrigation water stock, shall be maintained as an environmentally accepted resource that can be safely handled by agricultural labor. It shall not be harmful to wild life or to domesticated animals on the farms.

54. A trade-off shall be made between capital investment, energy requirements for operation, and the losses that will otherwise be incurred in the irrigation water resource. Choice of the optimal configuration shall be based on a thorough analysis of these factors.

55. Maximum use shall be made of the gravity head inherent in the irrigation water sources of the Jordan Rift Valley. Supplementary head shall be generated through pumping interventions to maintain a suitable pressure head at the farm gate.

On legislation and Institutional Arrangements

56. Legislation and institutional arrangements for the development and management of irrigation water resources shall be periodically reviewed. Gaps shall be filled, and updating of institutional arrangements with parallel legislation shall be made periodically.

57. The role of government shall be fine-tuned and its involvement reduced over time to regulation and supervision. Involvement of stakeholders and the private sector in irrigation management and support will be introduced and expanded.

58. The role of the private sector in the development of irrigated agriculture shall be promoted. Care will be taken to monitor and supervise the use of water resources in that regard.

On Scared Water Resources

59. Shared water resources occur in the Jordan River basin and in ground water resources to the south, east and north, and that are either used for irrigation or are mixed with irrigation water of the Jordan Valley. Priority shall be given to the development and management of shared water resources.

60. The quality and flow rates of water obtained by Jordan shall always be monitored and proper records kept of such data.

61. The establishment of Joint Water committees to co-operate with neighboring countries over issues affecting other riparians shall be promoted.

62. Regional co-operation will be proposed, promoted and sustained with the neighboring countries with whom Jordan shares international waters.

On Research and Development

63. *Applied research on water topics will be adopted and promoted.* Such topics as water economics, resource management crop *water* requirement, use of brackish water, irrigation technologies, farming practices, crop yields, moisture storage and the like are among favored topics.

64. Co-operation with specialized centers in the country and outside will be promoted, and raising of funds for this purpose will be supported.

65. Technology transfer and adaptation to local conditions will be a primary target for development activities and for adaptive research.

WASTEWATER MANAGEMENT POLICY

Background

The Hashemite Kingdom of Jordan is an arid to semi arid country, with a land area of approximately 90,000 km². Its topographic features are variable. A mountain range runs from the north to the south of the country. Land slopes gently to the east of this range to form the eastern deserts, but to the west the ground slopes steeply towards the Rift Valley, which extends from Lake Tiberias in the north, at an elevation of -220 m below sea level, to the Red Sea at Aqaba.

The growth of its population has not been natural over the past few decades. The more recent average population growth rate stands today at about 3.5% due to natural and non-voluntary migration. Although population growth rates are declining, the expanding population will continue to place enormous pressures on water resources. About 78 percent of the population is located in urban areas concentrated in four Governorates: Amman, Balqa, Zarqa, and Irbid. The influx of waves of refugees and displaced persons has resulted largely in fast and almost uncontrolled urbanization.

Jordan has been experiencing an imbalance in the population - water resources equation. Its per capita share of renewable water resources is among the lowest in the world, and is declining with time. It is projected to fall from 180 m³/capita/year at present to 90 m³/capita/year by 2025.

Water resources consist primarily of surface and ground water resources, with treated wastewater being used on an increasing scale for irrigation, mostly in the Jordan Valley. Renewable fresh water resources are estimated at about 850 million cubic meters (MCM) per year, including water added by the Peace Treaty. About 125 MCM/ year is expected to be available from fossil aquifers and through desalination by the year 2005, making the annual freshwater stock about 975 MCM per year.

Treated wastewater generated at sixteen existing wastewater treatment plants is an important component of Jordan's water resources. Due to the terrain and the concentration of the urban population above the Jordan Valley escarpment, the majority of treated wastewater is discharged into various watercourses and flows to the Jordan Valley where it is used for irrigation. About 60 MCM per year of treated wastewater are effectively discharged today into the watercourses or are used directly in irrigation.

Wastewater quantity is increasing with the increase of population, increase in water use and the development of sewerage systems. Thus, by the year 2020 when the population is projected to be about 9.9 million and when the percentage of the population with sewerage service will have increased from the current 50 percent today to percentages that will cover most of the townships and cities of the country, about 240 MCM per year of wastewater are expected to be generated.

Development and Status of Wastewater Sector

Wastewater collection has been practiced in Jordan in a limited way since 1930 in the town of Salt. Some treatment was achieved by utilizing primitive physical processes. Mostly, however, septic tanks and cesspits were used with gray water often discharged to gardens. This practice resulted in major environmental problems, especially ground-water pollution. The pollution problems were

complicated by the rapid urban growth. The population in the capital city of Amman, for example, increased from 50,000 in 1940 to 800,000 in 1985.

Modern technology to collect and treat wastewater was introduced in the late sixties when the first collection system and treatment plant was built at Ain Ghazal utilizing the conventional activated sludge process. The system consisted of a sewage network that runs by gravity to the lowest point in Amman, where the treatment plant was located and built. The treatment plant was designed to handle an average flow of 60,000 m³/d with a BOD₅ loading of 18,000 kg/d, for a population of 300,000. The design effluent standard was BOD₅ 20 mg/l. The treated effluent was discharged to Sell Zarqa.

However, due to the high strength of the raw sewage i.e. the BOD₅ of the incoming sewage was greater than 600 mg/l, the effectiveness of the activated sludge process was drastically reduced. Nevertheless, AGTP continued to operate under high organic overloading conditions, which resulted in major operational and environmental problems. As a result, AGTP produced odors that were a source of public nuisance to the surrounding areas. The quality of the effluent of AGTP deteriorated the quality of surface, ground and irrigation water in the region.

Since the year 1980 and during the International Drinking Water and Sanitation Decade (1980-1990), the Government of Jordan carried out significant and comprehensive plans with regard to the different issues of wastewater management primarily related to the improvement of sanitation. About 75% of the urban population and 52% of the total population (at that time) gained access to wastewater collection and treatment systems. This has raised the sanitation level, improved public health, and strengthened pollution control of surface and ground-water in the areas served by wastewater facilities. Presently, there are 16 treatment plants serving most of the major cities and towns in the country. Ten facilities are conventional mechanical treatment plants and six employ waste stabilization ponds. Another two treatment plants are under construction. About 2 million people (nearly 50% of the population) are served by sewerage systems and the effluent quantity is estimated at about 60 million cubic meters per year.

The characteristics of wastewater in Jordan are somewhat different from other countries. The average salinity of municipal water supply is 580 ppm of TDS, and the average domestic water consumption is low (around 70 l/c/d country wide). This results in very high organic loads and in a higher than normal salinity in wastewater. This is particularly applicable to wastewater treated in waste stabilization ponds (85% of the total generated wastewater), where part of the water is lost through evaporation, thus increasing salinity levels in the effluents. In addition, high organic loads impose operational problems where the plants become biologically overloaded with only a portion of their hydraulic loads.

Given the low level of industrial discharges to sewage treatment plants, wastewater in Jordan is comparatively low in toxic pollutants such as heavy metals and toxic organic compounds. It is estimated that 10% of the biological load comes from industrial discharges.

The major receiving streams for wastewater have very low flow with wastewater comprising a significant portion of stream flow. These streams are not used for bathing or fishing. Much of Amman's waste-water treated effluent is discharged in the Zarqa River and is impounded by the King Talal Dam where it gets blended with fresh flood water and is subsequently released for irrigation use in the Jordan Valley.

It is worth mentioning that the increased supply of water to Jordan's cities came about at the expense of spring flows discharging into such streams as the Zarqa River, Wadi Shueib, Wadi Karak, Wadi Kufrinja and Wadi Arab. The flow of freshwater in these streams dried up as a result of increased pumping from the

aquifers, and the flow was replaced with the effluent of treatment plants, a process that transformed the ecological balance over time.

Varieties of crops are grown using irrigated wastewater including citrus, vegetables, field crops and bananas. Soil characteristics vary widely from sand to clay. Principal concerns in the use of wastewater for irrigation include its salinity, chloride concentrations, and the presence of fecal Coliforms and nematode eggs. Concerns about heavy metals, has not been substantiated but is an area of public concern warranting monitoring.

The Jordanian standards and regulations which specify the quality of the treated effluents allowed to be discharged into wadis or destined for reuse in agriculture, require a secondary level of treatment. Quality specifications follow the WHO guidelines for the safe use of treated effluent in irrigation.

In order to develop a Wastewater Management Policy, the following represent the key issues under consideration:

1. Provision of adequate wastewater collection and treatment facilities for all the major cities and towns in Jordan.
2. Protection of the environment and public health in the areas affected by the proposed systems, especially, surface waters and ground waters.
3. Consideration of treated effluents as a source for irrigation reuse.
4. Improvement of the socio-economic conditions in the areas to be served by the proposed systems.

The Policy

On Resource Development

1. Wastewater is a perennial water source and shall form an integral part of renewable water resources and the national water budget.
2. Collection and treatment of wastewater is a necessity to circumvent hazards to the public health and the environment. It becomes imperative when contamination of freshwater resources with wastewater is eminent.
3. Collection and treatment of wastewater becomes mandatory to protect public health against water borne diseases, and where epidemics become a threat otherwise.
4. Existing levels of wastewater services shall be maintained and upgraded where necessary to enhance public health and the environment.
5. Treatment of wastewater shall be targeted towards producing an effluent fit for reuse in irrigation in accordance with WHO and FAO guidelines as a minimum. Reuse of treated wastewater in other purposes shall be subject to appropriate specifications.
6. Co-ordination shall be maintained with the official bodies in charge of urban development to account for the treatment and disposal of their liquid wastes. Central treatment plants shall be built to serve semi urban and rural communities, and collection of wastewater can be made initially through trucking until collection systems are justified.
7. Specifications and minimum standards shall be issued by the competent authorities for the use of septic tanks in rural areas. Particular attention shall be paid to the protection of underlying aquifers.

On Resource Management

8. It is highly imperative that a section in the Water Authority be responsible for the development and management of wastewater systems as well as the treatment and reuse of the effluent.

9. A basin management approach shall be adopted where possible. 'the use of treated wastewater in irrigation shall be given the highest priority and shall be pursued with care.

10. Effluent quality standards shall be defined based on the best attainable treatment technologies, and calibrated to support or improve ambient receiving conditions, and to meet public health standards for end users. Key factors will include the location of the discharge, its proximity to wells, the type of receiving water, and the nature and extent of end uses. Wastewater intended for irrigated agriculture will be regulated based on the soil characteristics of the irrigated land, the type of crops grown, the irrigation schedule and methods, and whether other waters are mixed with the treated wastewater.

11. Industries shall be encouraged to recycle part of its wastewater and to treat the remainder to meet standards set for ultimate wastewater reuse or to meet the regulations set for its disposal through the collection systems and/or into the receiving environment.

12. Wastewater from industries with significant pollution should be treated separately to standards allowing its reuse for purposes other than irrigation or to allow its safe disposal.

13. Consideration shall be given to isolating treated wastewater from surface and ground waters used for drinking purposes, and to the blending of treated effluent with relatively fresher water for suitable reuse.

On Wastewater Collection and Treatment

14. The existing level of services shall be sustained and promoted. Where it is necessary to meet public health and environmental objectives, treatment shall be improved. Wastewater shall be collected and treated in accordance with WHO and FAO Guidelines as the basis for effluent quality requirements for reuse in irrigation. However, final reuse options, type of crops to be irrigated, location of the reuse and the treatment plant location shall govern the level of treatment (effluent parameters), and the treatment technology to be adopted.

15. Priority shall be given to protecting public health and water resources from chemical and microbiological pollutants.

16. Where possible, gravity flow shall command the collection and conveyance lines.

17. Treatment plants shall be located away from any potential population growth. Location selection shall be coordinated and approved with the concerned governmental agencies. Due consideration shall be given to interact with landowners and adjacent communities.

18. The transfer of advanced wastewater treatment technologies shall be endorsed and encouraged. However, appropriate wastewater treatment technologies shall be selected with due consideration to operation and maintenance costs and energy savings, in addition to their efficiency in attaining and sustaining quality standards.

19. Innovative approaches to wastewater treatment, particularly for the small municipal systems have to be considered. Design criteria, performance specifications and guidelines for such systems shall be adopted and generalized.

20. Design and performance specifications of wastewater treatment plants shall be studied and standardized. Sufficient room in tendering for the construction of new plants shall be provided for competition to take place in both technologies and costs. However, deviations from standard designs shall be minimized and justified.

21. Septage from unserved areas shall be treated either in municipal or in well monitored and maintained facilities designed to receive septage.

On Reuse of Treated Effluent and Sludge

22. Treated wastewater effluent is considered a water resource and is added to the water stock for reuse. This is warranted and deemed feasible in light of the semi arid climate, the modest per capita share of freshwater resources, the high demand for municipal water, the per capita share of the deficit in the trade of food commodities, and of the marginal cost of resource development.

23. Priority shall be given to agricultural reuse of treated effluent for unrestricted irrigation. Blending of treated wastewater with fresh water shall be made to improve quality where possible. Crops to be irrigated by the treated effluent or blend thereof with freshwater resources shall be selected to suit the irrigation water, soil type and chemistry, and the economics of the reuse operations.

24. Crop nutrients requirements shall be determined taking into consideration the prevailing effluent quality. Overuse of nutrients shall be avoided.

25. Accumulation of heavy metals and salinity shall be monitored, managed and mitigated. Leaching of soils shall be advocated by the irrigation authorities.

26. Farmers shall be encouraged to determine the rate of water application needed for different crops, taking into consideration the value of nutrients in the treated water and other parameters.

27. *Farmers shall be encouraged to use modern and efficient irrigation technologies.* Protection of on farm workers and of crops against pollution with wastewater shall be ensured.

28. Treated effluent quality should be monitored and users be alerted to any emergency causing deterioration of the quality so that they will not use such water unless corrective measures are taken.

29. Studies should be conducted and projects designed and implemented to store the excess treated wastewater in surface reservoirs or in groundwater reservoirs through artificial recharge techniques. Due attention shall be given to the quality of treated and ground-water and the characteristics of the strata.

30. Plans and studies for power generation from sludge, if proven technically, economically and financially feasible, shall be made with due attention to environment impacts.

31. Sludge produced from the treatment process would be processed so it may be used as fertilizer and soil conditioner. Care shall be taken to conform to the regulations of public health and environment protection norms.

32. Whenever possible, other end uses of treated effluents; such as recycling, cooling, power generation, etc ... shall be considered.

On Pricing

33. In view of increasing marginal cost of wastewater collection and treatment, wastewater charges, connection fees, sewerage taxes and treatment fees shall be set to cover at least the operation and maintenance costs. It is also highly

desirable that part of the capital cost of the services shall be recovered. The ultimate aim is for a full cost recovery.

34. Appropriate criteria in order to apply the "polluter pays" principle shall be established.

35. Different charges for different areas may be applied. This shall be assessed for each geographical area as a function of end uses and effluent quality and will be subject to economic and social considerations.

36. Treated effluent shall be priced and sold to end users at a price covering at least the operation and maintenance costs of delivery.

On Selected Priority Issues

37. To the extent that design capacities of wastewater treatment plants permit, priority of collection and house connections shall be accorded to expansion of urban areas served by treatment facilities. Users willing to contribute to the cost of the services in addition to fees and charges set by laws and regulations shall also be given priority.

38. Where design capacities of treatment facilities and of conveyance systems are approached or exceeded, priority shall be given to the expansion of such capacities.

39. Priority shall be accorded to situations and locations where waste-water disposal practices threaten the environmental integrity of freshwater resources, and where performance of cesspools and percolation pits pollute underground water aquifers.

On Standards, Regulations and Quality Assurance

40. Jordanian Standards JS893/95, JS202/91, JS 1145/96, WAJ's regulations for the quality of industrial wastewater to be connected to the collection system and WAJ's specifications for sewerage works, have been, thus far, the benchmarks against which plans and specifications of treatment plants and wastewater reuse were evaluated. They were established to bring about relative uniformity throughout the country. Periodically, these standards and regulations should be reviewed and modified to reflect special ambient conditions or end uses. Other aspects shall also be considered, e.g. economic socio-cultural, environmental and regional aspects.

41. Particular attention shall be focused on adopting and enforcing effluent and sludge standards for municipal and industrial wastewater treatment plants and for discharges from industries, laboratories, hospitals, slaughterhouses and other businesses.

42. Extensive and comprehensive monitoring programs shall be developed. Influent to and effluent from the plants and throughout watercourses shall be measured and monitored against all appropriate parameters to ensure that public health objectives and treatment efficiency goals are attained.

43. All crops irrigated with treated or mixed waters shall be analyzed and monitored periodically.

44. Observation wells shall be installed near the treatment plants to monitor groundwater quality where necessary, and to mitigate adverse impacts where and when needed.

45. Data collected from the monitoring process shall be entered and stored, processed and analyzed through computer software, and results published periodically.

46. Roof and storm water connections to public sewers shall be prohibited. Collection of storm water shall be done separately and will be the subject of water harvesting.

47. Effluent and sludge standards for the disposal of hazardous liquid wastes shall be defined to ensure the safe disposal of such wastes.

48. Laboratories shall be maintained and properly equipped to provide services and reliable data needed to ensure enforcement of and adherence to standards and regulations.

On Legislation and Institutional Arrangements

49. Legislation and institutional arrangements for the development and management of wastewater shall be periodically reviewed. Gaps shall be filled, and updating of the institutional arrangements with parallel legislation shall be made periodically to cope with varying circumstances.

50. The role of the Government shall be fine-tuned and its involvement reduced with time to be regulatory and supervisory. Involvement of the stakeholders in wastewater management and support shall be introduced and expanded.

On Financing and Investment

51. Because of the limited financial resources available to Jordan, setting investment priorities in wastewater will be compatible with government investment plans.

52. Criteria for prioritizing investments in the wastewater sector shall take into account the current and future needs of the country, needs to expand wastewater systems in urban areas and to provide wastewater systems to smaller towns and villages that are not yet served.

53. Priorities of wastewater projects shall not be disconnected from water supply projects and urbanization in general. Decisions will be made concerning them to attain optimum solutions to the need for services, availability of finance and availability of trained manpower.

On Public Awareness

54. The public shall be educated through various means about the risks associated with the exposure to untreated wastewater and the value of treated effluents for the different end uses.

55. Programs on public and farmer's awareness shall be designed and conducted to promote the reuse of treated wastewater, methods of irrigation, handling of produce. Such programs shall concentrate on methods of protection of farmers health, animal and bird health and the environment.

56. Public awareness campaigns shall also be waged to educate the public on the importance of domestic hygiene, wastewater collection, treatment and disposal.

On the Role of Private Sector

57. It is the intention of the Government, through private sector participation, to transfer management of infrastructure and services from the public to the private sector, in order to improve performance and upgrade the level of service.

58. The role of the private sector will expand with management contracts, concessions and other forms of private sector participation in wastewater management.

59. The concepts of BOO/BOT shall be entertained, and the impact of such concepts on the consumers shall be continually addressed and negative impacts mitigated.

60. The private sector role in reuse of treated effluent shall be encouraged and expanded.

On the Human Resources Development

61. Capabilities of human resources in the management of wastewater shall be enhanced through training and continuous education. Work environment shall be improved and incentives provided.

62. The existing National Water Training Center shall be enhanced. It will be accorded adequate attention and provided with space, furniture and the necessary support in order to identify needs, promote and conduct human resources development activities and training needs.

63. Human resources performance will be continually appraised in order to upgrade capabilities, sustain excellence and provide job security and incentives to qualified individuals with excellent performance.

On Research and Development

64. Applied research on relevant wastewater management topics shall be adopted and promoted. Topics such as the transfer of wastewater treatment technologies, low cost wastewater treatment technologies, reduction of energy consumption and others will receive adequate support.

65. Cooperation with specialized centers in the country and abroad shall be advanced, and raising of funds for this purpose shall be supported.

66. Transfer of appropriate technology suited for local conditions will be a primary target for the development activities and for adaptive research.

67. Emphasis will be placed on liaison with international institutions to keep abreast with modern technological advances and to facilitate technology transfer and adaptation.