

The Study on Water Resources Management in the Hashemite Kingdom of Jordan

**FINAL REPORT VOLUME VI
SUPPORTING REPORT
FOR**

PART-A “WATER RESOURCES MANAGEMENT MASTER PLAN”

Chapter 6 Water Transfer/Supply System

Chapter 7 Institutional and Legislative Improvement

Chapter 8 Water Resources Management Master Plan

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SUPPORTING REPORT

FOR

CHAPTER 7

**Institutional and Legislative
Improvement**

Supporting Report for Chapter 7 “Institutional and Legislative Improvement”

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ANNEX to 7.1.2

**Institutional and Legislative
Improvement for Privatization**

7.1.2 Institutional and Legislative Improvement for Privatization

The related policies and strategy prepared by MWI in recent years include Water Utility Policy, Jordan's Water Strategy, Wastewater Management Policy, etc. The major points stressed across them are described below:

I. Wastewater Management Policy; MOWI

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. *Legislation and Institutional Arrangements to be Reviewed and Updated*
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. *Role of Government to be Regulatory & Supervisory*

On Financing and Investment

51. 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 *Priority in Wastewater Sector Investments*

On the Role of Private Sector

57. It is the intention of the Government, through private sector participation, to transfer management of the infrastructure and services from the public to the private sector, in order to improve performance and upgrade the level of service. *Transfer of Management of Infrastructure to the Private Sector*
58. The role of the private sector will expand with management contracts, concessions and other forms of private sector participation in wastewater management. *The Forms of Private 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. *The Concepts of BOO/BOT*
60. The private sector role in reuse of treated effluent shall be encouraged and expanded. *Private Sector Involvement in Wastewater Reuse*

II. Jordan's Water Strategy; MOWI

On Legislation and Institutional Set-up

26. Introduce and enhance the participation of stakeholders, and legislate for their involvement wherever necessary. *Involvement of Stakeholders*
27. Assure co-operation and co-ordination among public and private entities involved in water development and management. *Private Sector Participation*

III. Water Utility Policy; MOWI

2. Institutional Development

Institutional restructuring and the introduction of private sector involvement must, therefore, be supported by adequate legislation, efficient law enforcement, and strong human resources development. *Institutional Restructuring and Private Sector Involvement to be Supported by the Triple Pillars of Law, Enforcement and Human Resources*

The Water Authority of Jordan (WAJ)

..... 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).
... Private Sector Involvement to be Considered for Water Supply & Wastewater Treatment Facilities and WAJ's Role to be Changed by Separating Retail Supply & by Introduction of GAAP

The Jordan Valley Authority (JVA)

.... 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 GAAP will be introduced.
Private Sector Involvement to be Considered for Development and O & M Activities and GAAP to be Introduced to JVA

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. ... 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.
Transferring Infrastructure and Services to Private Sector

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.
Private Sector Involvement in Investments in the Form of BOT/BOO, etc. to be Promoted in Water Utilities and Irrigated Agriculture

ANNEX to 7.2
Treated Wastewater
Reuse in Agriculture

7.2 Institutional and Legislative Improvement for Treated Wastewater Reuse in Agriculture

There are three MWI policies/strategy related to wastewater reuse which were made public in recent years: Wastewater Management Policy, Jordan's Water Strategy and Water Utility Policy. Also, there are three related laws: the Water Authority of Jordan Law #18/1988, the Jordan Standard #202/1991 for Industrial Wastewater Discharge and the Jordanian Standard #893/1995 for Discharge of Treated Domestic Wastewater.

The three government policies/strategy and the three laws were summarized from the standpoint of wastewater reuse as described below:

I. Wastewater Management Policy; MOWI

On Resource Development

1. 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.

Following International Standards for Treatment of Wastewater for Reuse

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. *New Organization to Deal with Wastewater*
9. ... The use of treated wastewater in irrigation shall be given the highest priority and shall be pursued with care. *Highest Priority Given to Wastewater Reuse for Irrigation*
10. 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. *Conditions in Applying Wastewater for Irrigation*
11. Industries shall be encouraged to recycle part of its wastewater and to treat the remainder to meet standard set for ultimate wastewater reuse or to meet the regulations set for its disposal through the collection systems and/or into the receiving environment. *Recycling, Reuse & Disposal of Industrial Wastewater*
12. Wastewater from industries with significant pollution should be treated separately to standards allowing its use for purposes other than irrigation or to allow its safe disposal. *Separate Treatment of Industrial Wastewater with Significant Pollution*
13. Consideration shall be given to isolating treated wastewater from surface and ground waters used for drinking purposes, and to blending of treated effluent with relatively fresher water for suitable use. *Isolation of Treated Wastewater*

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. *Importance of Wastewater as a Water Resource*
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. *Priority Given to Wastewater Reuse for Irrigation and Conditions in Wastewater Application*
24. Crop nutrients requirements shall be determined taking into consideration the prevailing effluent quality. Overuse of nutrients shall be avoided. *Overuse of Nutrients to 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. *Leaching of Soils to be Required*

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. *Farmers' Knowledge on Rate of Wastewater Application to be Promoted*
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. *Farmers' Use of the Latest Irrigation Technologies to be Encouraged*
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. *Monitoring of Treated Effluent Quality*
29. Studies should be conducted and projects designed and implemented to store the excess treated wastewater in surface reservoirs or groundwater reservoirs through artificial recharge techniques. *Storing of Treated Wastewater and Recharging by Treated Wastewater*

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 full cost recovery. *Wastewater Cost Recovery Policy*
34. Appropriate criteria in order to apply the "polluter pays" principle shall be established. *PPP to be Established*
35. Different charges for different areas may be applied. *Different Charges for Different Conditions*

On Standard, Regulations and Quality Assurance

40. Jordanian Standard JS93/95, JS202/91, JS1145/96, 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 the treated plants and wastewater reuse were evaluated. ... Periodically, these standards and regulations should be reviewed and modified to reflect special ambient conditions or end users. ... *Related Laws and the Need for Review*
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. *Effluent Standards for WWTP and Discharges from Particular Businesses*
42. Extensive and comprehensive monitoring programs shall be developed. ... *Extensive Monitoring Programs to be Developed*
43. All crops irrigated with treated or mixed waters shall be analyzed and monitored periodically. *All Irrigated Crops to be Monitored*
44. Observation wells shall be installed near the treatment plants to monitor groundwater quality. ... *Ground water Quality to be Monitored near Treatment Plants*

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. *Legislation and Institutional Arrangements to be*

Reviewed and Updated

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. *Role of Government to be Regulatory & Supervisory*

On Financing and Investment

51. 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 *Priority in Wastewater Sector Investments*

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. *Public Education on Risk & Value of Wastewater*
55. Programs on public and farmers' 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 environment. *Awareness Promotion to Farmers on Reuse & Hazard of Wastewater*

On Pricing

On the Human Resources Development

.....

On Research and Development

.....

II. Jordan's Water Strategy; MOWI

On Resource Development

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 groundwater 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. *Wastewater as a Resource*

On Resource Management

23. Management of wastewater 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. *Management & Monitoring*

On Legislation and Institutional Set-up

26. Introduce and enhance the participation of stakeholders, and legislate for their involvement wherever necessary. *Involvement of Stakeholders*
27. Assure co-operation and co-ordination among public and private entities involved in water development and management. *Private Sector Participation*

On Health Standards

38. Concerns for public health and the health of workers shall be a focus in the programs of reuse of treated wastewater. *Concerns for Public and Workers' Health in Reuse of Treated Wastewater*

III. Water Utility Policy; MOWI

2. Institutional Development

Institutional restructuring and the introduction of private sector involvement must, therefore, be supported by adequate legislation, efficient law enforcement, and strong human resources development. *Institutional Restructuring and Private Sector Involvement to be Supported by the Triple Pillars of Law, Enforcement and Human Resources*

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..... 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). ... *Private Sector Involvement to be Considered for Water Supply & Wastewater Treatment Facilities and WAJ's Role to be Changed by Separating Retail Supply & by Introduction of GAAP*

The Jordan Valley Authority (JVA)

.... 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 GAAP will be introduced. *Private Sector Involvement to be Considered for Development and O & M Activities and GAAP to be Introduced to JVA*

3. Private Sector Participation

6. Water Resource Management

Wastewater

The Ministry presently provides wastewater collection and treatment services to 14 major populated areas. At present about 2 million people (about 50% of the population are served by sewerage systems and the effluent quality is estimated at about 60 MCM per year, being reused primarily in agriculture.

... It is estimated that by the year 2020 the volume of treated wastewater will be 200 MCM per year and as such, more wastewater projects are planned. ... the Ministry will ensure that appropriate wastewater collecting systems and treatment facilities are provided for all sources of wastewater, wherever feasible. It will ensure that wastewater is not managed as "waste" but is collected, treated, managed, and used in an efficient and optimized manner. (*Wastewater as a Resource*) The Ministry will also ensure that treated effluent complies with recently established national standards (JS893-1195) and that all treatment is to a quality appropriate for use in agricultural activities and other non-domestic purposes, including groundwater recharge.(*Standards to be observed for Wastewater Reuse*)

The Ministry is moving, through restructuring, towards establishing the institutional capability for monitoring, regulating and enforcing wastewater regulations. (*Institutional Restructuring to be Considered*) 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. (*Standards for Industrial Wastewater Discharges*)

7. Water Quality and the Environment

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. (*Enforcing Standards for Discharges to Sewers, Treated Effluent, etc. to be Required*)

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 Environment 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 conditions, which may not be relevant to local conditions, or even affordable in some instances. ... (*Following the International Guidelines in Setting Water Quality Standards*)

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. (*Setting Standards for Treated Effluent According to Its End Use to be Required*) To ensure that these standards are achieved, an effective monitoring program has to be adopted. Such a program requires that analytical methodology, equipped laboratories and qualified personnel be provided. (*Capacity of Monitoring to be Enhanced in Terms of Analytical Methods, Laboratory Equipment and Human Resources*)

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

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. (*Effluent Standards for WWTP and Discharges from Particular Businesses*) Concerns for public health and the health of workers shall be a focus in the programs of reuse of treated wastewater. (*Concerns for Public and Workers' Health in Reuse of Treated Wastewater*)

Laboratories shall be maintained and properly equipped to provide reliable data needed to ensure safe supplies to the consumers. (*Monitoring for Safe Supplies to Consumers*)

IV. Wastewater Reuse Law and Standards in the Kingdom of Jordan; MOWI

3.0 Current National Wastewater Standards

The Water Authority of Jordan Law #18/1988

The Jordan Standard #202/1991 for Industrial Wastewater Discharge

The Jordanian Standard #893/1995 for Discharge of Treated Domestic Wastewater

3.1 Water Authority of Jordan Law #18/1988

In 1987 and 1988 WAJ developed a comprehensive law, WAJ Law No. 18/1988, to control industrial discharges to the public sewers. The current law, the "Instructions for Commercial and Industrial Wastewater" provides the legal foundation for preventing the entry of toxic and damaging substances and liquids to Jordan's public sewer. The act provided specific prohibitions on toxic chemicals, petroleum products, dense slurries, and excessive hot, alkaline or acid discharges. Because of the necessity of agricultural reuse of some wastewater, a list of the maximum concentrations of heavy metals that could be disposed of was included in the rules. Recommendations for the maximum salinity of discharges to sewers were also included in the 1988 version of the law. *Standard for Industrial Wastewater to be Discharged to Public Sewers*

3.2 Jordan Standard #202/1991 for Industrial Wastewater

Standard 202 incorporated the World Health Guidelines for the reuse of industrial wastewater that included four categories:

Irrigation

Artificial Recharge of Groundwater

Discharge to the Sea

Discharge to Wadis, Rivers and Catchment Areas

Standard for Reuse of Industrial Wastewater

3.3 Standard #893/1995 – Discharge Standards for Treated Domestic Wastewater

The 1995 Standard #893 includes the following 7 categories of wastewater reuse standards depending on the fate of domestic wastewater after it is released from the wastewater treatment facility:

Recycling of water for irrigation of vegetables that are normally cooked.

Recycling of water used for tree crops, forestry and industrial processes.

Discharge to receiving water such as wadis and catchment areas.

Use in artificial recharge to aquifers.

Discharge to water bodies containing fish.

Discharge to public parks or recreational areas.

Use in irrigation of animal fodder.

Standard for Reuse of Treated Domestic Wastewater

3-2 Irrigation must be stopped two weeks before harvesting (fruit collection)...

3-3 In crop selection, the sensitivity of some crops to some elements or some characteristics in treated domestic wastewater must be taken into consideration as well as the negative effect on the soil properties.

3-5 Irrigation of crops eaten raw by treated domestic wastewater is prohibited. ...

3-7 It is prohibited to dilute the treated domestic wastewater on-site with fresh water for the sake of meeting the criteria of this standard.

Cautions & Prohibitions in Wastewater Reuse for Irrigation

ANNEX to 7.3
Restriction of Groundwater
Abstraction in Up/Mid Land

7.3 Institutional and Legislative Improvement for Restriction of Groundwater Abstraction in Up/Mid Land

Reduction of irrigated area is projected in the MWI/WB water balance model based on the institutional measures for more efficient irrigation methods and technologies coupled with the legal measures to be taken to reduce the over-abstraction of groundwater.

There are three policies concerned prepared by MWI in recent years: Irrigation Water Policy, Water Utility Policy and Groundwater Management Policy.

The points taken up and stressed in the above policies are summarized as follows:

1. Institutional Measures for More Efficient Irrigation Methods and Technologies Irrigation Water Policy of MWI, 1998

On Farm Water Management

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 encouraged 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 irrigation water.
23. Night application of irrigated 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 research and extension service of the Ministry of Agriculture. ...
25. Programs shall be prepared to raise the public and farmers' awareness of the availability of irrigation water, its rational and economic use and the impacts of its quality.

On Regulations and Controls

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

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 irrigated 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.

2. Legal Measures to be Taken to Reduce the Over-Abstraction of Groundwater Irrigation Water Policy of MWI, 1998

On Farm Water Management

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.

Water Utility Policy of MWI, 1997

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 on 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 set out legal and financial measures aimed at controlling and gradually reducing groundwater withdrawals with the final objective of maintaining the safe yield of aquifers. ...

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.

...

There will be ... the strengthening of the enforcement of groundwater legislation and regulations. ...

Groundwater Management Policy of MWI, 1998

Background

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 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

Currently, MWI/WAJ is in charge of groundwater administration and management ... MWI/WAJ receives application for drilling licenses and abstraction permits, and issues such licenses and permits in accordance with the effective groundwater legislation. ...

The Policy

On Resource Exploration

2. Assessment and re-assessment of the sustainable yields of groundwater 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.

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.
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.

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

On Resource Protection, Sustainability, and Quality Control

17. Recharge areas of aquifers shall be protected to the maximum extent possible. ...
18. Recharge area shall be protected against pollution caused by whatever means...
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.

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 reservoirs 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. Potential of reservoirs shall be based on the natural rate of recharge. These can be augmented through means of artificial recharge induced through proper designs.
30. Development of groundwater reservoirs shall not be allowed without a license issued by MWI/WAJ. Private developers and public entities shall be required to apply for any development they intend to undertake.

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 groundwater over-pumping.