

**The Kingdom of Saudi Arabia
The Ministry of Water and Electricity (MOWE)**

**THE STUDY ON MASTER PLAN
ON
RENEWABLE WATER RESOURCES
DEVELOPMENT IN THE SOUTHWEST REGION**

**IN
THE KINGDOM OF SAUDI ARABIA**

**FINAL REPORT
(SUPPORTING REPORT)**

OCTOBER 2010

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.
SANYU CONSULTANTS INC.

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Foreign Exchange Rate

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PREFACE

In response to a request from the Kingdom of the Saudi Arabia, the Government of Japan decided to conduct a study concerning the Master Plan Study on Renewable Water Resources Development in the Southwest Region, and entrusted the study to the Japan International Cooperation Agency.

JICA selected and dispatched a study team headed by Mr. Masatomo WATANABE of Yachiyo Engineering Co., Ltd. to the Kingdom of Saudi Arabia between June 2007 and June 2010.

The team held a series of discussions with the officials concerned in the Government of Saudi Arabia and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of further friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned in the Government of the Kingdom of Saudi Arabia for their close cooperation extended to the study.

October 2010

Mr. Izumi Takashima
Vice President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

October, 2010

Mr. Izumi Takashima,
Vice President
Japan International Cooperation Agency

Dear Sir

We are pleased to submit to you the final report of the Master Plan Study on Renewable Water Resources Development in the Southwest Region in the Kingdom of Saudi Arabia (KSA).

The final report deals with the basic policy, strategy and action plan for sustainable water resources development, utilization and management in the five regions (Makkah, Al Baha, Asir, Jazan and Najran Region) located in the southwest region in KSA and the Water Master Plan on renewable water resources development targeting the year of 2035, focusing for only the three regions (Al Baha, Asir and Jazan Region). In elaboration of the final report, the Study Team has taken into account the advices and suggestions of your Agency and the comments on draft final report made by the Ministry of Water and Electricity (MOWE).

The Water Master Plan proposes the water resources development facilities such as dams and wells which meet the water demand to the year of 2035. In order to overcome hydrological handicaps (scarcity of rainfall, annual and regional large fluctuation gap of rainfall, large potential evaporation) in the study area belonging to arid and semi-arid areas, the Water Master Plan also proposes the renewable water resources development by combining operations between large dams and aquifers in Wadi. It finally proposes the extension and construction of desalination plant hence water demand cannot be obtainable by only developing the renewable water resources in the three regions.

Based on economic and technical aspects it was taken into consideration the development of different water resources such as renewable water resources as well as desalinated seawater in three regions in order to secure less expensive water and necessary water sufficiency. Therefore, the Study Team planned the Red Sea Water Lifeline Project (REWLIP) that widely connects water resources with pipelines and supplies water to the mentioned three regions' major cities. As part of the water demand management plan, the Study Team promoted the reuse of reclaimed waste water for municipal greening, industrial cooling and agricultural water.

The proposed project components in the master plan can be evaluated as feasible from the viewpoints of technology, economy, and finance, and socio-environment. By the implementation of these projects proposed in the Water Master Plan, we are convinced that it will contribute to the socio-economic development of three regions and will achieve comfortable life for people.

We wish to take this opportunity to express our sincere gratitude to your Agency and the Ministry of Foreign Affairs. We also wish to express our deep gratitude to the MOWE and the related organizations for their close cooperation and extended assistance to us during the study period.

Very truly yours,

Masatomo WATANABE

Team Leader

The Master Plan Study on the Study on Renewable Water Resources Development in the Southwest Region in the Kingdom of Saudi Arabia

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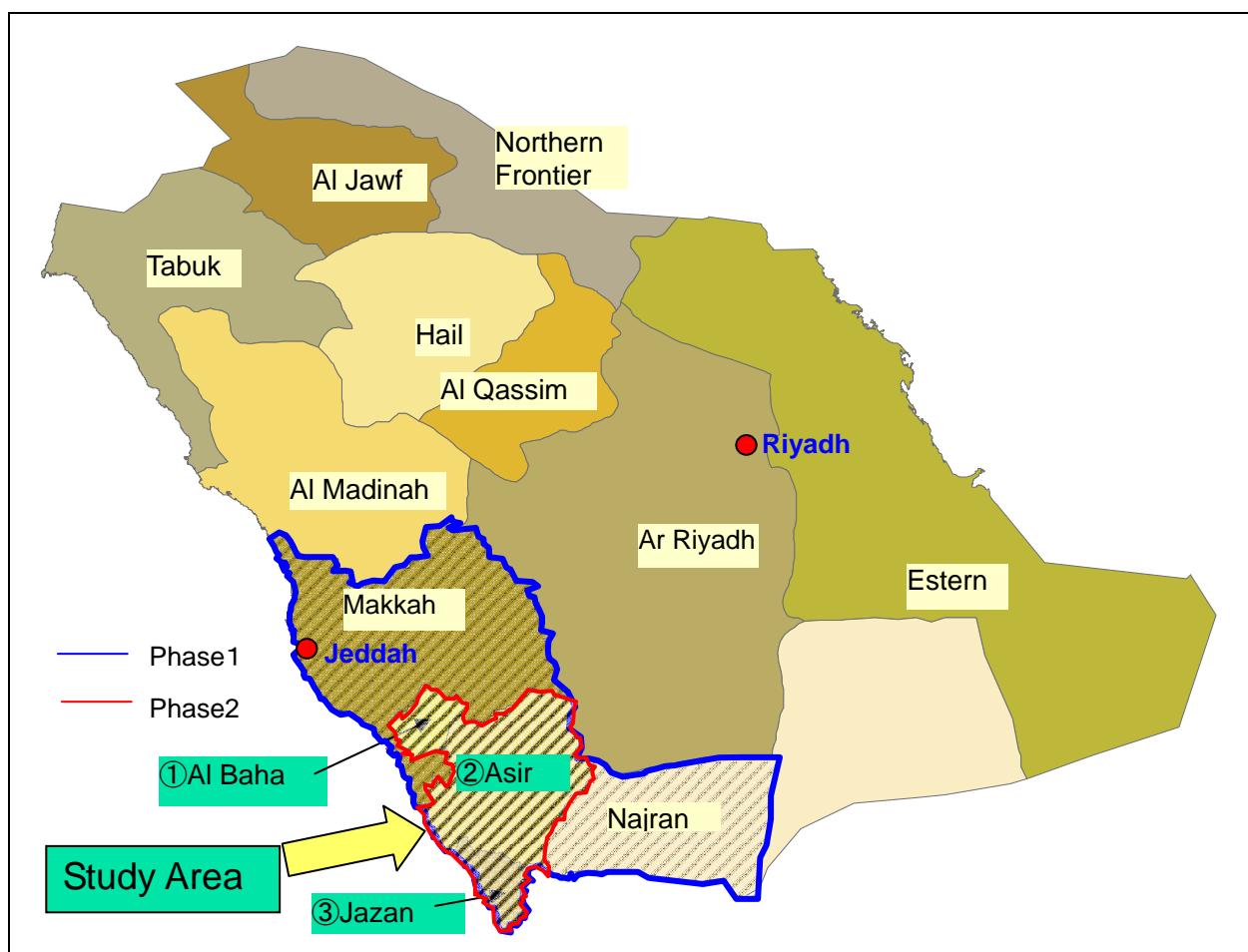
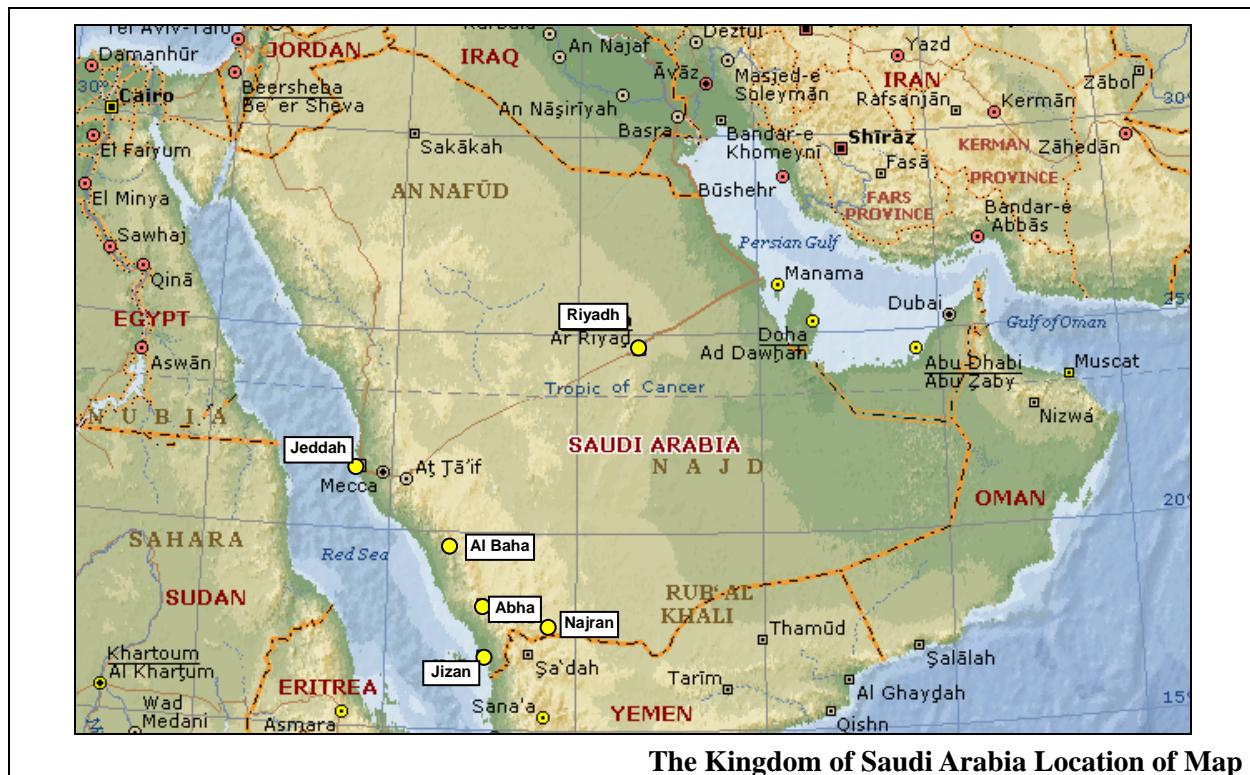
**A. WATER RESOURCES DEVELOPMENT AND
MANAGEMENT**

OCTOBER 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

SANYU CONSULTANTS INC.



**Final Report
Supporting Report (A)**

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List of Abbreviations

Abbreviation and Acronym	English	Arabic (عربى)	Japanese (日本語)
BCM	Billion Cubic Meters	مليار متر مكعب	10億立方メーター
CBD	Convention on Biological Diversity	اتفاقية التنوع البيولوجي	生物多様性保全条約
C/P	Counterpart	النظير	カウンターパート
EIA	Environment Impact Assessment	تقييم الآثار البيئي	環境アセスメント
ER	Effective Rainfall	الأمطار الفعالة	有効雨量
ET	Evapotranspiration	البخرة	蒸発散
FAO	Food and Agriculture Organization, United Nations	منظمة الأغذية والزراعة للأمم المتحدة	国連食料農業機関
GIS	Geographic Information System	نظام المعلومات الجغرافية	地理情報システム
GPS	Global Positioning System	نظام تحديد المواقع العالمي	グローバル・ポジショニング・システム
GDP	Gross Domestic Product	الانتاج المحلي الإجمالي	国内総生産
GDW	General Directorate of Water		地方水事務所
GNI	Gross National Income	الدخل القومي الإجمالي	国民総所得
GSMO	Grain Silos and Flour Mills Organization	صوامع الحبوب ومطاحن الدقيق	サイロ・製粉公団
GTZ	Deutsche Gesellschaft fur Technical Zusammenarbeit GmbH	الجمعية الألمانية للتعاون التقني المحدودة	ドイツ技術協力公社
IC/R	Inception Report	تقرير الإنشاء	インセプション・レポート
IEE	Initial Environmental Examination	الفحص البيئي الأولي	初期環境調査
IUCN	World Conservation Union	اتحاد التحويل العالمي	国際自然保護連合
IWPP	Independent Water and Power Project	المياه المستقلة وطاقة المشروع	独立水道・発電事業
IWRP	Integrated Water Resources Planning	التخطيط المتكامل للموارد المائية	総合水資源計画
JCCME	Japan Cooperation Center for Middle East	مركز التعاون الياباني للشرق الأوسط	財団法人中東協力センター
JICA	Japan International Cooperation Agency	الوكالة اليابانية للتعاون الدولي	独立行政法人国際協力機構
KSA	Kingdom of Saudi Arabia	المملكة العربية السعودية	サウジアラビア王国
LCD	Liter per Capita per Day	لتر للفرد يوميا	リッター/人/日
MAW	Ministry of Agriculture and Water	وزارة الزراعة والمياه	水・農業省
MEPA	Meteorology and Environment Protection Administration	ادارة الأرصاد الجوية و حماية البيئة	気象環境保護庁
MCM	Million Cubic Meters	مليون متر مكعب	100万立方メーター
M/M	Minutes of Meeting	ملخص الاجتماع	会議の議事録
MMW	Million Megawatt	مليون ميغواط	100万メガワット
NAS	National Agriculture Strategy	استراتيجية الزراعة الوطنية	国家農業戦略
NGO	Non-Governmental Organization	المنظمات غير الحكومية	民間公益団体
NMS	National Mining Strategy	استراتيجية التعدين الوطنية	国家鉱業戦略
NSS	National Spatial Strategy	استراتيجية العمران الوطنية	国家特別戦略
NWC	National Water Company	شركة المياه الوطنية	国家水会社
MWS	National Water Strategy	الاستراتيجية الوطنية للمياه	国家水戦略
MOA	Ministry of Agriculture	وزارة الزراعة	農業省
MOEP	Ministry of Economy and Planning	وزارة الاقتصاد والتخطيط	国家経済計画省
MOF	Ministry of Finance	وزارة المالية	財務省
MOI	Ministry of Interior	وزارة الداخلية	内務省
MOMRA	Ministry of Municipal and Rural Affairs	وزارة الشؤون البلدية والقروية	地方自治省
MOWE	Ministry of Water and Electricity	وزارة المياه والكهرباء	水・電力省
M/P	Master Plan	الخطة الرئيسية	マスター・プラン
MSR	Million Saudi Riyals	مليون ريال سعودي	100万サウジリアル

Abbreviation and Acronym	English	Arabic (عربى)	Japanese (日本語)
NCWCD	National Commission for Wildlife Conservation and Development	اللجنة الوطنية لحماية و تطوير الحياة البرية	国立動物保護開発協会
NIA	National Irrigation Authority	السلطة الوطنية للري	国家灌漑局
PME	Presidency of Meteorology and Environment Protection	الرئاسة العامة للأرصاد وحماية البيئة	国家気象環境保護
P/O	Plan of Operation	خطة العمل	プラン オブ オペレーション
PPP	Public Private Partnership	شراكة القطاعين العام والخاص	官民連携
RWPC	Renewable Water Production Corporation	شركة إنتاج المياه المتجددة	再生可能水生産公社
REWLIP	Red Sea Water Lifeline Project	شريان الحياة للمياه البحر الأحمر المشروع	紅海水ライフライン事業
OJT	On the Job Training	التدريب المهني	研修
SAGIA	Governor Saudi Arabian General Investment Authority	محافظ الهيئة العامة للاستثمار العربي السعودي	サウジアラビア総合投資庁
SAMA	Saudi Arabian Monetary Agency	مؤسسة النقد العربي السعودي	サウジアラビア通貨厅
SAR	Saudi Arabian Riyal	الريال السعودي	サウジアラビアリアル
SCT	Supreme Council for Tourism	المجلس الأعلى للسياحة	最高観光委員会
SEA	Strategic Environment Assessment	التقييم البيئي الاستراتيجي	戦略的環境アセスメント
SGS	Saudi Geological Survey	هيئة المساحة الجيولوجية السعودية	サウジ地質調査
SOIETZ	Saudi Organization for Industrial Estates and Technology Zone	الهيئة السعودية للمدن الصناعية و للمنطقة التكنولوجية	サウジ産業国家技術団体
SR	Saudi Riyals	الريال السعودي	サウジリアル
STP	Strategic Transformation Plan	خطة التحول الاستراتيجي	戦略的転換計画
STP	Sewerage Treatment Plant	محطة معالجة الصرف الصحي	下水処理プラント
S/W	Scope of Works	العمل نطاق	業務範囲
SWAT	Soil and Water Assessment Tool	أداة تقييم التربة والمياه	土壤水アセスメントツール
SWCC	Saline Water Conversion Corporation	المؤسسة العامة لتحلية المياه المالحة	海水淡水化公社
UFW	Unaccounted For Water	مياه غير محسوبة	無収水
UNDP	United Nations Development Programme	برنامج الأمم المتحدة للتنمية	国連開発計画
UN-ESCWA	United Nations Economic and Social Commission for Western Asia	اللجنة الاقتصادية والاجتماعية للأمم المتحدة لغربي آسيا	国連西アジア経済社会委員会
WB	The World Bank	البنك الدولي	世界銀行
WHO	World Health Organizations	منظمة الصحة العالمية للأمم المتحدة	世界保健機関
WMO	World Meteorological Organization	المنظمة العالمية للأرصاد الجوية	世界気象機関

A. LAWS AND REGULATIONS RELATED TO WATER RESOURCES DEVELOPMENT & MANAGEMENT

1. Laws and Regulations Related to Water Resources Development & Management

1.1 Current State on Development of Laws & Regulations in Water Sector

Table1-1 shows the summary on the current state on the development of the laws and regulations related to water resources development and management in the Kingdom of Saudi Arabia (KSA) by focusing the categories and issues in water sector.

Table1-1 Summary on Current State on Laws and Regulations in Water Sector

No.	Category / Issue	Corresponding Laws or Regulation
1. Water Resources Development and Management		
1.1	Middle-term Development on Water Resources Development and Management	<ul style="list-style-type: none"> • 8th National Development Plan • 9th National Development Plan (under preparation)
1.2	Overall Water Resources Management	<ul style="list-style-type: none"> • 8th National Development Plan • Royal Decree No M/34 dated 24/08/1400H (7 July 1980G) • The Council of Ministers' Resolution No. 62044 dated 07/07/1409H
2.	Reuse or Reclamation of Reclaimed Waste Water	<ul style="list-style-type: none"> • Royal Decree No. M/6 dated 13/02/1421H (18 May 2000G)
3.	Water Right (Priority Use on Water)	<ul style="list-style-type: none"> • Royal Decree No M/34 :Priority Use on Water • The Council of Ministers' Resolution No. 62044 :Priority Use on Water
4.	Legislation on Water Tariff	<ul style="list-style-type: none"> • the Council of Ministers' Resolution No. 125 dated 25/04/1422H (17 July 2001G): One of the key tasks of MOWE is to propose water tariffs for all consumers • The Council of Ministers' Resolution No.96 dated 26 Dec. 1994G
5.	License for Well Digging	<ul style="list-style-type: none"> • Royal Decree No M/34 • The Council of Ministers' Resolution No. 62044
6.	Monitoring (Water Quantity, quality, etc.)	<ul style="list-style-type: none"> • Royal Decree No M/34 • The Council of Ministers' Resolution No. 62044 • Royal Decree No. M/6
7. Institutional & Organizational Demarcations / Mandates of Relevant Agencies		
7.1	Set-up of Two Distinct Entities into Water and Agriculture Departments from the former Ministry of Water	<ul style="list-style-type: none"> • The Council of Ministers' Resolution No. 125
7.2	Delegation of Authority on Water Resources Development & Management to MOWE	<ul style="list-style-type: none"> • Royal Decree No 27472 dated 09/07/1423H (17 September 2002G)
7.3	Saline Water Conversion Corporation Law	<ul style="list-style-type: none"> • Royal Decree No M/49 dated 20/08/1394H (7 September 1974G) • Royal Decree No M/10 dated 27/02/1427H (27 March 2006G) (Revision of M/49)
7.4	The Saudi Geological Survey Regulation	<ul style="list-style-type: none"> • The Council of Ministers' Resolution No. 115 dated 16/07/1420H (26 October 1999G)
8. PPP (Private Public Partnerships)		
8.1	Lists of Projects to be privatized	<ul style="list-style-type: none"> • The Council of Ministers' Resolution No. 219 dated 16/07/1420H (26 October 1999G)

The policy on water resources development and management is currently executed based on the 8th National Development Plan, and it is expected to be applied by the year of 2009 and replaced with the new plan of 9th National Development Plan which is scheduled to commence its execution in 2010. 8th National Development Plan provides the basic policy on water resources development and management.

The Royal Decree No M/34 dated 24/08/1400H (corresponding to 7 July 1980G) is a fundamental law for the water resources management in addition to the 8th National Development Plan. The enforcement regulations relating to water resources management are provided in the Council of Ministers' Resolution No. 62044 dated 07/07/1409H. The Reclaimed Waste Water and Re-use of Waste Water Law were issued under Royal Decree No. M/6 dated 13/02/1421H (corresponding to 18 May 2000G).

The laws and regulations which clearly provide water right were not clearly identified, however, the

provisions on priority use of water were identified in above Royal Decree No M/34 and the Resolution No. 62044 as the enforcement regulations of the Royal Decree No M/34.

In relation to the provisions on water tariff, Ministry of Water and Electricity (MOWE) can set up water tariffs for all consumers according to the Council of Ministers' Resolution No. 125 dated 25/04/1422H (corresponding to 17 July 2001G). The regulations on the overall water tariff are in the process of restructuring its system in MOWE. The Council of Ministers' Resolution No.96 dated 26 Dec. 1994G provides the water tariff for municipal water.

The laws and regulations relating to the establishment, organizational demarcations and mandates of relevant agencies are provided in above Resolution No. 125 and the Royal Decree No 27472 dated 09/07/1423H (corresponding to 17 September 2002G).

1.2 Laws and Regulations on Water Resources Management

(1) Royal Decree No. M/34 dated 24/8/1400

This law is a fundamental law providing the overall water resources management in KSA, and the following provisions are regulated under the jurisdiction of the former Ministry of Water & Agriculture (MOA) (in which is currently delegated to the present MOWE).

Article 1: Water resources shall be considered as public property.

Article 2: MOWE shall have powers for maintaining water resources and regulating the utility of water. To perform these powers, MOWE shall i) lay down the necessary rules and procedures to maintain water resources and protect water from pollution, ii) regulate exploitation of water in a manner that ensures availability and fair distribution, iii) lay down the necessary instructions for digging wells and construction of dams and other water facilities, iv) determine and identify the capabilities of contractors conducting digging wells and classify them in categories based on their technical, administrative and financial capabilities, and v) supervise and inspect the compliance with the provisions of this law and its regulations.

Article 3: The priority use on water shall be i) first: human needs, ii) second: water use for animals' drinking and iii) third: water use for agriculture, industry, construction and other purposes. MOWE shall have the right to ban digging of wells for a limited period of time or permanently and fix water quantities for consumers, regulate methods and means for consumption and utilization of water and other necessary procedures to maintain available water levels and to distribute available supply fairly.

Article 4: In case of emergency or events of deficiency of water supply, MOWE shall be entitled to take the necessary technical and administrative procedures to achieve fair distribution of water among different categories of consumers pursuant to the preferences provided for in Article 5: MOWE is empowered to repair or fill up wells that expose water resources to loss or that cause damage to soil or pollution of water.

Article 6: MOWE is empowered to have the authority to dig wells and construct dams or any other water facilities.

Article 7: Well digging contractors shall obtain licenses from MOWE for starting up the digging business.

Articles 9, 10 and 11: The breaches of the law and execution of penalties shall be made pursuant to the procedures determined by the Minister for the Interior and MOWE, and penalties shall be decided by MOWE. Penalties may include fines and withdrawal of licenses.

Note: Text of each article explains contents of each article based on the translation of the Royal Decree No. M/34 in Arabic and does not necessarily show the text itself.

(2) Resolution No. 62044 dated 7/7/1409H

This resolution provides the regulations on the execution of above provisions of Royal Decree No M/34 relating to water resources management.

The major provisions are shown as below;

Chapter 2- Registration and Licenses

Article 2: Those who want to practice the profession of digging shall obtain the necessary license from MOWE by submitting an application attached with the documents that proves the availability of the necessary workers, technicians and the required digging machines for the digging.

Article 3: Digging contractors shall be registered in an authorized administration after submitting certificates and completing procedures which is provided in Article 2 within three months of the date of issuance.

Article 4: Digging contractors shall be classified by their technical, administrative and financial capabilities.

Article 8: Digging contractor shall provide a report of completing well digging works to MOWE's division in which his digging works are carried out within 15 (fifteen) days from completing its digging works and he shall inform the location and movements of his digging works to MOWE's division. After completing the well digging and making a report of digging completion, the contractor shall send a copy from the report to the ministry directly.

Chapter 3- Digging Contracts

Article 9: Digging contractors shall make and enter into a written contract with the well owner or his deputy.

Note: Text of each article explains contents of each article based on the translation of the Royal Decree No. M/34 in Arabic and does not necessarily show the text itself.

1.3 Reuse or Reclamation of Reclaimed Waste Water (Royal Decree No. M/6 dated 13/2/1422H)

The objective of this law is to set acceptable standards for dealing with different kinds of waste water in the public waste water network, as well as achieving safe standards for recycling reclaimed waste water for artificial irrigation, watering public gardens and recreations parks, refrigeration, industrial purposes and any other usage. The purpose of the law is also to ensure an adequate degree of protection from pollution and any resulting risk of disease through the control of the quality of reclaimed waste water and waste water treatment control plants.

The law regulates the following provisions;

Chapter 1 General Rule

The general objectives of the law are;

- To define the acceptable treatment method and allowable maximum effluent standards on waste water
- To define the safety standards for the reuse of reclaimed waste water
- To protect public health from the adverse effects to be caused by the waste water pollution
- To promote the reuse of Reclaimed waste water as non-conventional water resource
- To monitor the quality of the reclaimed waste water
- To control the waste water treatment plants

Chapter 2 Permits and Conditions

Article 4 Permits

It is mandatory to obtain a permit from MOWE to use the reclaimed waste water, or to use the sludge generated by the public or private treatment plants, or, to obtain a permit from the regulation body to use the water wells located in the urban areas of the towns and villages or water suspected of being polluted by waste water.

Article 6 Specific Conditions: Utilization of reclaimed waste water for irrigation use

The reclaimed waste water to be used for agriculture irrigation shall conform to the standards and conditions which are defined in the law. It is mandatory to conduct physical and chemical analysis of the farmland soil in order to use reclaimed waste water. These analyses shall be conducted at the laboratory of MOA or other certified laboratories to assess the impact level on the farm land. The Reclaimed waste water to be used for unrestricted irrigation (the irrigation method in which crop types are not restricted) shall meet the standards as shown in Table 3-4 which is set up for tertiary Reclaimed waste water. The reclaimed waste water to be used for restricted irrigation (the irrigation method in which crop types are restricted) shall meet the standards as shown in Table 3-5 which is set up for secondary reclaimed waste water. The farms using reclaimed waste water for restricted irrigation shall have a clearance at least 50 m from public drinking water wells and reservoirs. When the number of living eggs of intestinal worm is larger than 1 egg/l, only use of drip irrigation is allowed. In that case, however, it is prohibited to collect fallen fruits. When reclaimed waste water is used for irrigating the crops requiring higher water quality, a treatment unit shall be installed to enhance water quality after obtaining a permit from MOA.

Table1-2 Maximum Allowable Effluent Standards for Tertiary Reclaimed Waste Water

Item	Parameter	Maximum Allowable Effluent Concentration (Royal Decree M/6)	International Standards
Physical Characteristics	Floating Materials	ND (Not Detected)	
	TSS (Total Suspended Solid)	10 mg/l ¹⁾	US-EPA/USAID: 30 mg/l for agricultural use for food crops not commercially processed
	pH	6 – 8.5	
Chemical Characteristics, Organics	BOD ₅ (Biochemical Oxygen Demand)	10 mg/l ¹⁾	US-EPA/USAID: 30 mg/l for agricultural use for food crops not commercially processed
	Clarity	5.00 Clarity Unit	
	Oil & Grease	ND	
	Phenol	0.002 mg/l	
Microbiological Characteristics	Fecal Coliforms	2.2 / 100 ml ²⁾	US-EPA/USAID: No detectable for surface or spray irrigation of any food crops. 200 for surface irrigation of orchards and vineyards
	Number of Intestinal Worm Eggs	1 Live Egg (Count/l)	WHO Guidelines 1989: Less than 1 mg/l
Chemical Characteristics	Al (Aluminum)	5.0 mg/l	
	As (Arsenic)	0.1 mg/l	
	Be (Beryllium)	0.1 mg/l	
	B (Boron)	0.5 mg/l	
	Ba (Barium)	1.0 mg/l	
	Cd (Cadmium)	0.01 mg/l	
	Cr (Chrome)	0.1 mg/l	
	Co (Cobalt)	0.05 mg/l	
	Cu (Copper)	0.4 mg/l	
	Cn (Cyanide)	0.05 mg/l	
	F (Fluoride)	1.0 mg/l	
	Fe (Iron)	2.0 mg/l	
	Pb (Lead)	0.1 mg/l	
	Ag (Silver)	0.5 mg/l	
	Li (Lithium)	0.07 mg/l	
	Mn (Manganese)	0.2 mg/l	
	Hg (Mercury)	0.001 mg/l	
	Mo (Molybdenum)	0.01 mg/l	
	Ni (Nickel)	0.02 mg/l	
	Se (Selenium)	0.02 mg/l	
	Va (Vanadium)	0.1 mg/l	
	Zn (Zinc)	2.0 mg/l	
	N-NO ₃ ⁻ (Nitrates)	10.0 mg/l	
	Cl ₂ ⁻ (Chlorides)	1,000 mg/l	
	SO ₄ ²⁻ (Sulfate)	600 mg/l	
	NH ₃ -N (Ammonia)	5 mg/l	

Notes: ¹⁾ The monthly average for TSS & BOD5 shall not exceed 10 mg/l. The weekly average for TSS & BOD5 shall not exceed 15 mg/l.

²⁾ The reclaimed waste water is considered "Cleansed" to the non contagious level and suitable to for unrestricted irrigation, provided the maximum MPN (Fecal Coliforms) is 2.2/100ml or equivalent measurement according to the weekly microbiological analysis. The count shall never exceed 23/100ml for any sample.

Table1-3 Maximum Allowable Effluent Standards for Tertiary Reclaimed Waste Water

Item	Parameter	Maximum Allowable Effluent Concentration	International Standards
Physical Characteristics	Floating Materials	ND (Not Detected)	
	TSS (Total Suspended Solid)	40 mg/l	US-EPA/USAID: 30 mg/l for agricultural use for food crops not commercially processed
	pH	6 – 8.5	
Chemical Characteristics, Organics	BOD ₅ (Biochemical Oxygen Demand)	40 mg/l	US-EPA/USAID: 30 mg/l for agricultural use for food crops not commercially processed
	Clarity	5.00 Clarity Unit	
	Oil & Grease	ND	
	Phenol	0.002 mg/l	
Microbiological Characteristics	Fecal Coliforms	1,000 / 100 ml	US-EPA/USAID: No detectable for surface or spray irrigation of any food crops. 200 for surface irrigation of orchards and vineyards
Chemical Characteristics	Al (Aluminum)	5.0 mg/l	WHO Guidelines 1989: Less than 1 mg/l
	As (Arsenic)	0.1 mg/l	
	Be (Beryllium)	0.1 mg/l	
	B (Boron)	0.5 mg/l	
	Ba (Barium)	1.0 mg/l	
	Cd (Cadmium)	0.01 mg/l	
	Cr (Chrome)	0.1 mg/l	
	Co (Cobalt)	0.05 mg/l	
	Cu (Copper)	0.4 mg/l	
	Cn (Cyanide)	0.05 mg/l	
	F (Fluoride)	1.0 mg/l	
	Fe (Iron)	2.0 mg/l	
	Pb (Lead)	0.1 mg/l	
	Ag (Silver)	0.5 mg/l	
	Li (Lithium)	0.07 mg/l	
	Mn (Manganese)	0.2 mg/l	
	Hg (Mercury)	0.001 mg/l	
	Mo (Molybdenum)	0.01 mg/l	
	Ni (Nickel)	0.02 mg/l	
	Se (Selenium)	0.02 mg/l	
	Va (Vanadium)	0.1 mg/l	
	Zn (Zinc)	2.0 mg/l	
	N-NO ₃ ⁻ (Nitrates)	10.0 mg/l	
	Cl ₂ ⁻ (Chlorides)	1,000 mg/l	
	SO ₄ ²⁻ (Sulfate)	600 mg/l	
	NH ₃ -N (Ammonia)	5 mg/l	

1.4 Laws and Regulations Relating to Water Right

As mentioned before, the laws and regulations which clearly provide the water right were not identified. The priority use on water, however, was regulated in the Royal Decree No. M/34 and the Resolution No. 62044 of its execution rules.

Article 3, Royal Decree No. M/34:

The priority use on water shall be i) first: human needs, ii) second: water use for animals' drinking and iii) third: water use for agriculture, industry, construction and other purposes.

Article 11 and 12, Chapter4 of Resolution No.62044:

Article 11: The license in digging wells and water use for agriculture shall be in accordance with the priorities of: i) first: old farm lands, ii) second: the land which was farm land originally but is idle at present and iii) third: a newly designated farm land. The above priority is to be determined through the technical accreditation in terms of water saving in irrigation and water supply.

Article 12: In the case of equality in priorities mentioned in article 11, the priority shall be given to the owner of agricultural or animal production that supports the national food self-support policy.

1.5 Laws and Regulations Relating to Water Tariff

The water tariff for municipal water is regulated in the Council of Ministers' Resolution No.96 dated 26 Dec. 1994G. The tariff system for municipal use pursuant to Resolution No.96 is shown in Table1-4. The water tariff is below the current cost of providing water, which seems to be a weak incentive to water conservation.

Table1-4 Tariff System for Municipal Use

Consumed Volume (m ³ /Month)	Tariff per m ³ (in SR)
0 - 50	0.10
51 - 100	0.15
101 - 200	2.0
201 - 300	4.0
301 and over	6.0

1.6 Laws and Regulations Relating to Organizational Demarcations / Mandates of Relevant Agencies

The Council of Ministers' Resolution No. 125 is the fundamental regulation which provides the establishment of MOWE, and the water and agricultural departments which had been under the jurisdiction of the former Ministry of Water and Agriculture was divided separately. Afterwards, Royal Order No. 27472 dated 09/07/1423H (corresponding to 17 September 2002G), confirming Resolution No. 125, provides the establishment of MOWE and its mandate of the nationwide water resources development and management.

Royal Decree No M/49 dated 20/08/1394H (corresponding to 7 September 1974G) and Royal Decree No M/10 dated 27/02/1427H (corresponding to 27 March 2006G) of its amendment, provide the establishment of the Saline Water Conversion Corporation (SWCC). The Council of Ministers' Resolution No. 115 dated 16/07/1420H (corresponding to 26 October 1999G) provides the Saudi Geological Survey (SGS) with the mandate of the study of water resources potential.

The Council of Ministers' Resolution No. 125:

In accordance with Resolution No.125, the water directorates and departments of MOA and the water directorates and departments of the Ministry for Municipal and Rural Affairs (MOMRA), came under the jurisdiction of MOWE.

Pursuant to Resolution No. 125, the key tasks of MOWE in relation to the water sector include:

- Supervising, managing, observing and regulating the water sector and its utilities,
- Conducting studies relating to water to identify its sources and the available stored resources,
- Preparation of a national comprehensive plan for water, devising water policies, developing and maintaining water resources and urging the rationed use of water,
- Preparation of an integrated program to spread drinking water and waste water networks in the cities, provinces and centers of KSA,
- Development of water policies and proposing the necessary regulations for maintaining water resources and regulating proper utility of water,
- Preparation of a study of water tariff for all categories of consumers,
- Setting up an effective mechanism to improve the performance of collecting water revenues,
- Setting up the necessary mechanisms, frames and arrangements for the private sector to invest in the finance, implementation, operation and maintenance of the water, and
- Granting necessary permits for digging wells and determining the depth of such wells

Royal Order No. 27472:

Royal Order No. 27472 dated 09/07/1423H (corresponding to 17 September 2002G), confirming Resolution No. 125, provides that i) the water directorates shall become branches of MOWE as from the execution date of the Royal Order No. 27472 and that ii) the supervision, management, observing and regulation of the water sector and its utilities, including water and waste water directorates, shall be under the jurisdiction of MOWE.

SWCC Law, Royal Decree No M/49 and M/10 (Amendment of M/49):

SWCC is administratively related to MOWE as provided for in SWCC Law, which is equivalent to Royal Decree No M/49 and M/10 (Amendment of M/49). Article 3 of SWCC Law provides that

SWCC shall have all necessary powers to achieve its main objective, which is to support natural water resources through providing desalination in the nationwide of KSA in which natural resources are not sufficient for fulfilling their needs.

In particular, SWCC shall perform the following;

- Implement and manage desalination projects in KSA including expansion, operation and maintenance of these projects,
- Train Saudi nationals inside or outside the Kingdom with respect to implementation, management and maintenance of desalination projects,
- Conclude agreements and contracts for the sale of water and power with distribution entities, whether public or private,
- Fix water and power tariff and terms for sale in cooperation with competent government authorities in accordance with the instructions of the Council of Ministers

SGS Regulation, the Council of Ministers' Resolution No. 115 dated 16/07/1420H:

Article 3 of the Regulation provides that the tasks of SGS are to carry out survey and excavation works to identify water resources and water storage, determine the qualities and quantities to be dug out, and determine water suitability for the different purposes in consultation with MOA and MOWE.

1.7 Laws and Regulations Relating to PPP (Private Public Partnerships)

The Council of Ministers' Resolution No. 219 dated 16/07/1420H (26 October 1999G) listed the infrastructure projects such as; Water, sewage, desalination, telecommunications, air transport, railway, etc. including construction, operation and maintenance.

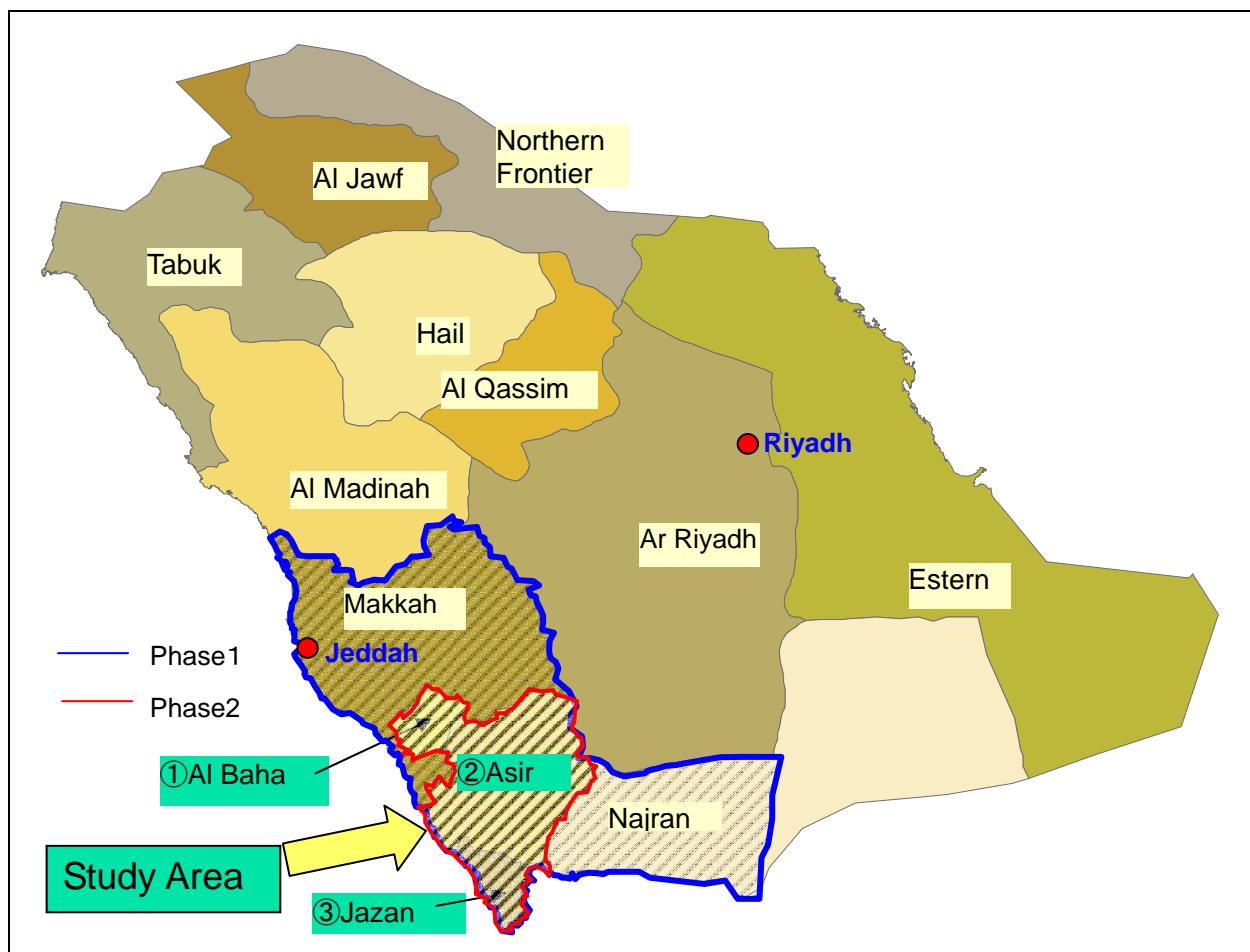
**The Kingdom of Saudi Arabia
The Ministry of Water and Electricity (MOWE)**

**THE STUDY ON MASTER PLAN
ON
RENEWABLE WATER RESOURCES
DEVELOPMENT IN THE SOUTHWEST REGION
IN
THE KINGDOM OF SAUDI ARABIA**

**FINAL REPORT
(SUPPORTING REPORT)
B. HYDROLOGY**

OCTOBER 2010

JAPAN INTERNATIONAL COOPERATION AGENCY
YACHIYO ENGINEERING CO., LTD.
SANYU CONSULTANTS INC.



**Final Report
Supporting Report (B)**

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List of Abbreviations

Abbreviation and Acronym	English	Arabic (عربى)	Japanese (日本語)
BCM	Billion Cubic Meters	مليار متر مكعب	10億立方メーター
CBD	Convention on Biological Diversity	اتفاقية التنوع البيولوجي	生物多様性保全条約
C/P	Counterpart	النظير	カウンターパート
EIA	Environment Impact Assessment	تقييم الآثار البيئي	環境アセスメント
ER	Effective Rainfall	الأمطار الفعالة	有効雨量
ET	Evapotranspiration	البخرة	蒸発散
FAO	Food and Agriculture Organization, United Nations	منظمة الأغذية والزراعة للأمم المتحدة	国連食料農業機関
GIS	Geographic Information System	نظام المعلومات الجغرافية	地理情報システム
GPS	Global Positioning System	نظام تحديد المواقع العالمي	グローバル・ポジショニング・システム
GDP	Gross Domestic Product	الانتاج المحلي الإجمالي	国内総生産
GDW	General Directorate of Water		地方水事務所
GNI	Gross National Income	الدخل القومي الإجمالي	国民総所得
GSMO	Grain Silos and Flour Mills Organization	صوامع الحبوب ومطاحن الدقيق	サイロ・製粉公団
GTZ	Deutsche Gesellschaft fur Technical Zusammenarbeit GmbH	الجمعية الألمانية للتعاون التقني المحدودة	ドイツ技術協力公社
IC/R	Inception Report	تقرير الإنشاء	インセプション・レポート
IEE	Initial Environmental Examination	الفحص البيئي الأولي	初期環境調査
IUCN	World Conservation Union	اتحاد التحويل العالمي	国際自然保護連合
IWPP	Independent Water and Power Project	المياه المستقلة وطاقة المشروع	独立水道・発電事業
IWRP	Integrated Water Resources Planning	التخطيط المتكامل للموارد المائية	総合水資源計画
JCCME	Japan Cooperation Center for Middle East	مركز التعاون الياباني للشرق الأوسط	財団法人中東協力センター
JICA	Japan International Cooperation Agency	الوكالة اليابانية للتعاون الدولي	独立行政法人国際協力機構
KSA	Kingdom of Saudi Arabia	المملكة العربية السعودية	サウジアラビア王国
LCD	Liter per Capita per Day	لتر للفرد يوميا	リッター/人/日
MAW	Ministry of Agriculture and Water	وزارة الزراعة والمياه	水・農業省
MEPA	Meteorology and Environment Protection Administration	ادارة الأرصاد الجوية وحماية البيئة	気象環境保護庁
MCM	Million Cubic Meters	مليون متر مكعب	100万立方メーター
M/M	Minutes of Meeting	ملخص الاجتماع	会議の議事録
MMW	Million Megawatt	مليون ميغواط	100万メガワット
NAS	National Agriculture Strategy	استراتيجية الزراعة الوطنية	国家農業戦略
NGO	Non-Governmental Organization	المنظمات غير الحكومية	民間公益団体
NMS	National Mining Strategy	استراتيجية التعدين الوطنية	国家鉱業戦略
NSS	National Spatial Strategy	استراتيجية العمران الوطنية	国家特別戦略
NWC	National Water Company	شركة المياه الوطنية	国家水会社
MWS	National Water Strategy	الاستراتيجية الوطنية للمياه	国家水戦略
MOA	Ministry of Agriculture	وزارة الزراعة	農業省
MOEP	Ministry of Economy and Planning	وزارة الاقتصاد والتخطيط	国家経済計画省
MOF	Ministry of Finance	وزارة المالية	財務省
MOI	Ministry of Interior	وزارة الداخلية	内務省
MOMRA	Ministry of Municipal and Rural Affairs	وزارة الشؤون البلدية والقروية	地方自治省
MOWE	Ministry of Water and Electricity	وزارة المياه والكهرباء	水・電力省
M/P	Master Plan	الخطة الرئيسية	マスター・プラン
MSR	Million Saudi Riyals	مليون ريال سعودي	100万サウジリアル

Abbreviation and Acronym	English	Arabic (عربى)	Japanese (日本語)
NCWCD	National Commission for Wildlife Conservation and Development	اللجنة الوطنية لحماية و تطوير الحياة البرية	国立動物保護開発協会
NIA	National Irrigation Authority	السلطة الوطنية للري	国家灌漑局
PME	Presidency of Meteorology and Environment Protection	الرئاسة العامة للأرصاد وحماية البيئة	国家気象環境保護
P/O	Plan of Operation	خطة العمل	プラン オブ オペレーション
PPP	Public Private Partnership	شراكة القطاعين العام والخاص	官民連携
RWPC	Renewable Water Production Corporation	شركة إنتاج المياه المتجددة	再生可能水生産公社
REWLIP	Red Sea Water Lifeline Project	شريان الحياة للمياه البحر الأحمر المشروع	紅海水ライフライン事業
OJT	On the Job Training	التدريب المهني	研修
SAGIA	Governor Saudi Arabian General Investment Authority	محافظ الهيئة العامة للاستثمار العربي السعودي	サウジアラビア総合投資庁
SAMA	Saudi Arabian Monetary Agency	مؤسسة النقد العربي السعودي	サウジアラビア通貨厅
SAR	Saudi Arabian Riyal	الريال السعودي	サウジアラビアリアル
SCT	Supreme Council for Tourism	المجلس الأعلى للسياحة	最高観光委員会
SEA	Strategic Environment Assessment	التقييم البيئي الاستراتيجي	戦略的環境アセスメント
SGS	Saudi Geological Survey	هيئة المساحة الجيولوجية السعودية	サウジ地質調査
SOIETZ	Saudi Organization for Industrial Estates and Technology Zone	الهيئة السعودية للمدن الصناعية و للمنطقة التكنولوجية	サウジ産業国家技術団体
SR	Saudi Riyals	الريال السعودي	サウジリアル
STP	Strategic Transformation Plan	خطة التحول الاستراتيجي	戦略的転換計画
STP	Sewerage Treatment Plant	محطة معالجة الصرف الصحي	下水処理プラント
S/W	Scope of Works	العمل نطاق	業務範囲
SWAT	Soil and Water Assessment Tool	أداة تقييم التربة والمياه	土壤水アセスメントツール
SWCC	Saline Water Conversion Corporation	المؤسسة العامة لتحلية المياه المالحة	海水淡水化公社
UFW	Unaccounted For Water	مياه غير محسوبة	無収水
UNDP	United Nations Development Programme	برنامج الأمم المتحدة للتنمية	国連開発計画
UN-ESCWA	United Nations Economic and Social Commission for Western Asia	اللجنة الاقتصادية والاجتماعية للأمم المتحدة لغربي آسيا	国連西アジア経済社会委員会
WB	The World Bank	البنك الدولي	世界銀行
WHO	World Health Organizations	منظمة الصحة العالمية للأمم المتحدة	世界保健機関
WMO	World Meteorological Organization	المنظمة العالمية للأرصاد الجوية	世界気象機関

B. HYDROLOGY

1. Location of Meteorological and Hydrological Stations

1.1 Meteorology (Meteorological Stations)

The study area has 10 Meteorological Stations under the control of Presidency of Meteorological and Environment (hereinafter referred to as PME) and 56 of them under the control of the Ministry of Water and Electricity (MOWE) as shown in Table1-1 and Table1-2 respectively. Figure1-1 shows the arrange data of 8 stations (Medina, Jeddah, Makkah, Taif, Al Baha, Bisha, Abha, Khamis Mushayt, Najran and Jizan) under the control of PME shown in Figure1-2. Meteorological Characteristics of the study area are summarized below based on this Figure.

(1)Temperature	<ul style="list-style-type: none"> The mean annual temperature at Abha and Khamis Mushayt located in highlands is approximately 25 degrees and that at other area is 30 to 35 degrees through June into August at maximum, and that at Jeddah and Jizan facing the Red Sea is 20 to 25 degrees and that at other area is 15 to 20 degrees through December into January. The maximum annual temperature at Abha and Khamis Mushayt is 30 to 35 degrees and that at other area is 35 to 45 degrees. The minimum annual temperature at Jeddah and Jizan is 15 to 20 degrees and that at other area is 5 to 10 degrees. There is a small difference in temperature, about 10 degrees, throughout the year at Jeddah, Abha, Khamis Mushayt and Jizan. On the other hand, there is a quite big difference in temperature, 15 to 20 degrees, at Medina, Al Baha and Najran.
(2)Relative Humidity	<ul style="list-style-type: none"> The mean annual relative humidity is 40 to 50 percent at Medina and Bisha, 75 percent at Jizan, 65 to 70 percent at other area, through December into January at maximum, and that at Jeddah and Jizan is 50 to 60 percent, 40 percent at Abha and Khamis Mushayt, 10 to 30 percent at other area, through June into July at minimum. The mean annual relative humidity at Jeddah and Jizan is rather high with 50 to 75 percent, and it shows a nearly constant value with small difference throughout the year.

Table1-1 Meteorological Stations under the Control of PME and Available Data

Station Name	Station No.	Longitude	Latitude	Available Data
ABHA	41112	42° 39'39``	18° 13'59``	1978 - 2007.10
AL BAHA	41055	41° 38'35``	20° 17'41``	1985 - 2007.10
BISHA	41084	42° 37'09``	19° 59'28``	1970 - 1974,1977 - 2003.2
JEDDAH	41024	39° 12'00``	21° 30'00``	1970 - 1975,1977 - 2002.2
JIZAN	41140	42° 35'05``	16° 53'49``	1970 - 1974,1977 - 2003.2
KHAMIS MUSHYT	41114	42° 48'23``	18° 17'58``	1970 - 1974,1977 - 2003.6
MAKKAH	41030	39° 46'08``	21° 26'16``	1985 - 2007.10
MEDINA	40430	39° 48'06``	22° 21'36``	1970 - 1974,1977 - 1983.10
NAJRAN	41128	44° 24'49``	17° 36'41``	1978 - 2007.09
TAIF	41036	40° 24'00``	21° 16'48``	1970 - 1970.10

Source:PME

Table1-2 Meteorological Stations under the Control of MOWE and Available Data

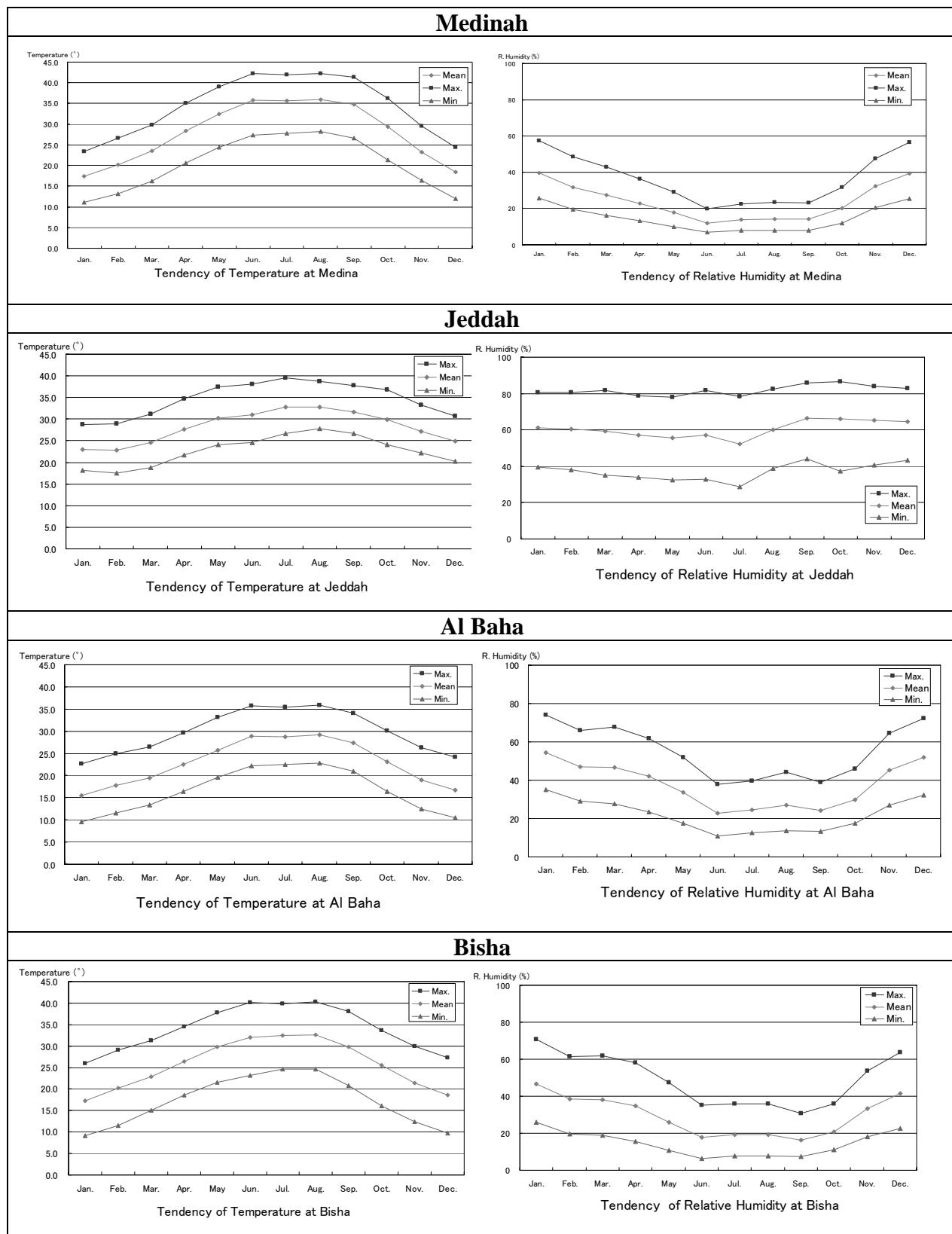
No.	Station Name	Elevation (EL.m)	Longitude	Latitude	Available Data
1	A004	2400	43° 06'00``	18° 10'00``	1975 - 2002
2	A005	2200	42° 29'00``	18° 12'00``	1975 - 2003
3	A006	2100	42° 36'00``	18° 15'00``	1975 - 2000
4	A007	2600	42° 09'00``	19° 06'00``	1975 - 2003
5	B001	2400	41° 17'00``	20° 06'00``	1975 - 2003
6	B004	1020	42° 36'00``	20° 01'00``	1975 - 2003
7	B005	1090	42° 32'00``	19° 52'00``	1975 - 2003
8	B006	975	43° 31'00``	19° 32'00``	1975 - 2003
9	B007	2400	41° 33'00``	19° 52'00``	1975 - 2002

No.	Station Name	Elevation (EL.m)	Longitude	Latitude	Available Data
10	B008	1230	42° 22'30``	19° 59'10``	1975 - 2001
11	D001	940	44° 22'00``	24° 29'00``	1970 - 1990
12	EP002	4.7	50° 00'00``	26° 30'00``	1975 - 2002
13	EP003	75	48° 23'00``	26° 59'00``	1975 - 2002
14	HU002	300	49° 01'00``	24° 04'00``	1975 - 2002
15	HU003	160	49° 34'00``	25° 30'00``	1969 - 2004
16	HU005	430	48° 08'00``	25° 05'00``	1975 - 2001
17	HU006	450	47° 22'00``	26° 22'00``	1975 - 2001
18	H001	1010	41° 38'00``	27° 28'00``	1975 - 2001
19	H002	985	41° 34'00``	27° 22'00``	1975 - 1992
20	H005	878	42° 30'00``	27° 16'00``	1975 - 1987
21	J001	53	41° 03'00``	19° 32'00``	1975 - 2001
22	J002	60	39° 20'00``	22° 09'00``	1975 - 2000
23	J003	90	40° 26'40``	20° 19'00``	1984 - 2002
24	M001	590	39° 35'00``	24° 31'00``	1975 - 2002
25	M002	840	40° 30'00``	24° 51'00``	1975 - 1981
26	M004	849	40° 31'00``	24° 50'00``	1982 - 2003
27	N001	1272	44° 15'39``	17° 34'00``	1975 - 1999
28	R001	564	46° 43'00``	24° 34'00``	1964 - 2003
29	R002	430	47° 24'00``	24° 10'00``	1975 - 2001
30	R003	539	46° 44'00``	22° 17'00``	1975 - 2002
31	R004	670	44° 48'00``	26° 17'00``	1980 - 2003
32	R005	665	45° 37'00``	25° 32'00``	1975 - 2003
33	R006	730	45° 15'00``	25° 15'00``	1975 - 2003
34	R007	600	46° 34'00``	24° 25'00``	1975 - 2001
35	R008	550	46° 28'00``	22° 33'00``	1975 - 2003
36	SA001	190	42° 57'00``	17° 03'00``	1975 - 2003
37	SA002	40	42° 37'00``	17° 10'00``	1975 - 2003
38	SA003	350	41° 53'00``	19° 00'00``	1975 - 2003
39	SA004	30	41° 24'00``	18° 44'00``	1975 - 2002
40	SA005	410	41° 48'08``	19° 13'34``	1975 - 2001
41	SK001	574	40° 12'00``	29° 58'00``	1975 - 2002
42	SK002	549	37° 21'00``	31° 20'00``	1975 - 2002
43	SK003	566	38° 17'00``	30° 31'00``	1975 - 2002
44	SU001	600	45° 34'00``	20° 28'00``	1970 - 1993
45	TA002	1500	40° 30'00``	21° 18'00``	1975 - 2000
46	TA003	1230	40° 25'00``	21° 37'00``	1975 - 2000
47	TA004	1530	40° 27'00``	21° 24'00``	1980 - 2003
48	TA005	1126	41° 40'00``	21° 11'00``	1975 - 1997
49	TA006	1450	41° 17'00``	20° 37'00``	1982 - 2001
50	TB001	737	36° 35'00``	28° 22'00``	1975 - 2003
51	TB002	820	38° 29'00``	27° 38'00``	1975 - 1995
52	U001	724	43° 59'00``	26° 04'00``	1980 - 2003
53	U002	740	42° 11'00``	25° 50'00``	1982 - 2003
54	W001	240	35° 01'00``	28° 28'00``	1975 - 2003
55	TA007	2200	41° 28'00``	19° 59'00``	1975 - 1992
56	B009	2011	41° 54'00``	19° 32'00``	1975 - 2003

Source:MOWE

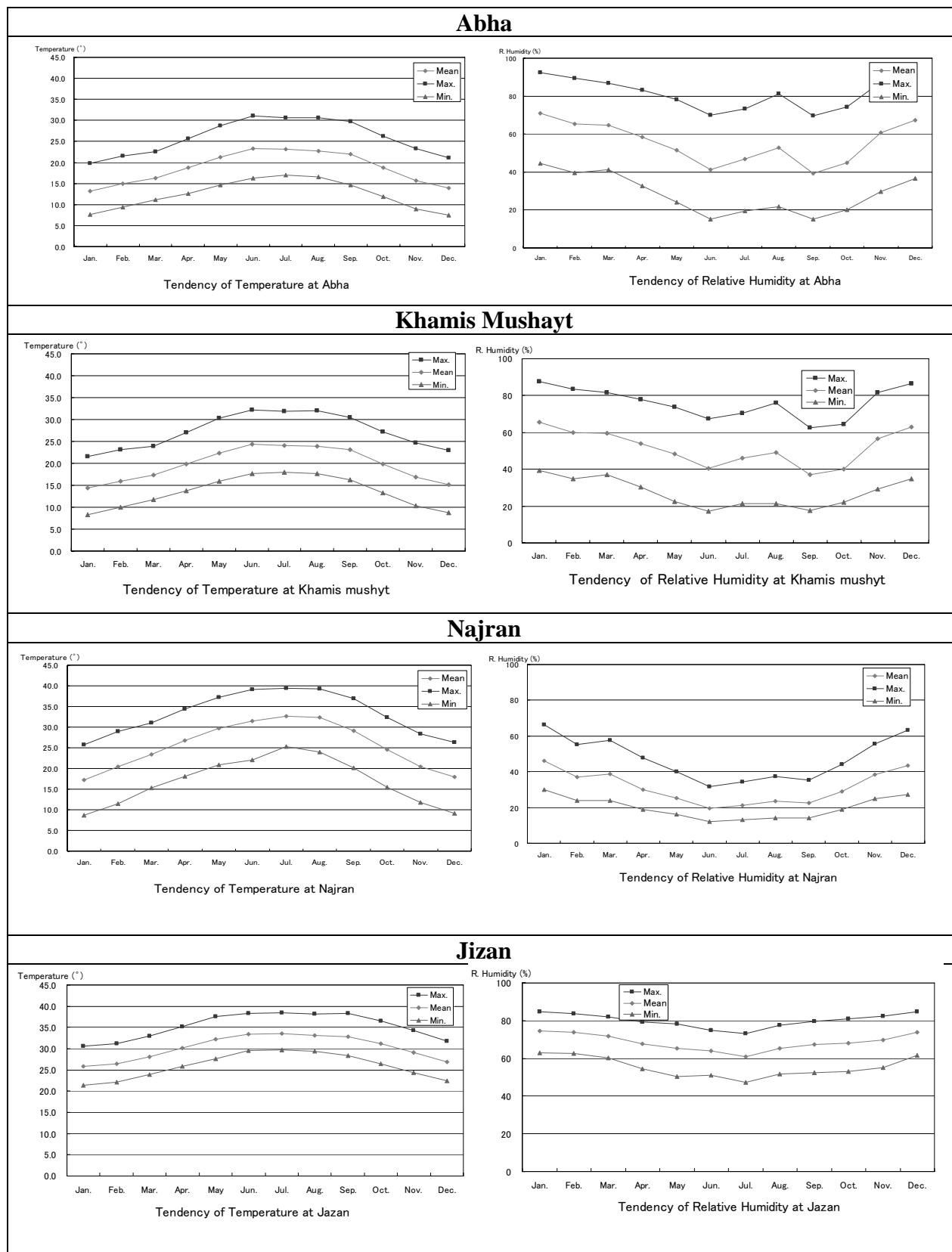


Figure1-1 Location Map of Meteorological Stations under the Control by PME



Source:PME

Figure1-2(1) Tendency of Temperature and Relative Humidity in the Study Area



Source:PME

Figure1-2(2) Tendency of Temperature and Relative Humidity in the Study Area

1.2 Hydrology (Rainfall Stations, Runoff Stations)

(1) Rainfall Stations

There are 105 Rainfall Stations under the control of MOWE as shown in Table1-3. Besides these stations, PME has 10 Rainfall Gauges in Meteorological Stations.

Location of the rainfall stations in each region are shown in Figure1-3~Figure1-7.

Table1-3(1) Rainfall Stations under the Control of MOWE in the Study Area

No.	Region	Station Name	Elevation (EL.m)	Longitude	Latitude	Available Data
1	Makkah	J111	55	38° 50'00"	23° 06'00"	1966 - 1988, 1991 - 2006
2		J140	8	39° 02'00"	22° 49'00"	1966, 1969 - 1979, 1982 - 1998, 2000 - 2003, 2005 - 2006
3		J116	317	39° 38'00"	22° 35'00"	1966 - 1979, 1985 - 1986, 1988 - 2006
4		J220	470	39° 49'00"	22° 22'00"	1966 - 1995, 1997 - 2004
5		J002	60	39° 20'00"	22° 09'00"	1972, 1994 - 2001, 2004
6		J106	60	39° 20'00"	22° 09'00"	1994 - 2001, 2005 - 2006
7		J219	125	39° 26'00"	22° 12'00"	1970 - 1995, 1997 - 2006
8		J221	90	39° 21'00"	21° 55'00"	1971 - 1995, 1997 - 2004
9		J239	350	39° 41'00"	21° 58'00"	1976 - 2002, 2004
10		J214	710	39° 59'00"	21° 59'00"	1966 - 2006
11		J134	11	39° 12'00"	21° 30'00"	1970 - 1979, 1984 - 2005
12		J102	116	39° 42'00"	21° 26'00"	1966 - 2003, 2005 - 2006
13		J114	280	39° 49'00"	21° 26'00"	1964 - 1965, 1969 - 1970, 1972, 1975 - 1976, 1979, 1981, 1995 - 1998
14		TA250	1465	40° 27'00"	21° 40'00"	1982 - 1992, 2001
15		J113	520	40° 07'00"	21° 22'00"	1966 - 1976, 1979 - 1997, 1999 - 2005
16		J204	720	40° 12'00"	21° 21'00"	1966 - 2005
17		J205	910	40° 13'00"	21° 21'00"	1966 - 2005
18		TA251	1900	40° 22'00"	21° 22'00"	1982 - 1992, 2001
19		TA206	1680	40° 24'00"	21° 17'00"	1966 - 2004
20		TA233	1650	40° 39'00"	21° 08'00"	1971 - 2005
21		J003	90	40° 26'00"	20° 19'00"	1994 - 1996, 2004 - 2005
22		J107	84	40° 27'00"	20° 19'00"	1966 - 1977, 1981 - 1982, 1986 - 1987, 1989 - 1992, 1994 - 2005
23		J108	6	40° 17'00"	20° 09'00"	1966 - 1975, 1977 - 1985, 1987 - 2003, 2005
24		J001	53	41° 03'00"	19° 32'00"	1970 - 1988, 1994 - 1995, 1997 - 1998
25		J131	370	41° 37'00"	19° 28'00"	1970 - 1988, 1990 - 1998, 2000 - 2006
26		SA120	580	41° 50'00"	19° 26'00"	1968 - 2005
27		SA005	410	41° 48'00"	19° 13'34"	1990 - 1999
28		SA122	450	41° 50'00"	19° 07'00"	1969 - 1996, 1999, 2001, 2002, 2004, 2006
29		SA147	85	41° 28'00"	19° 02'00"	1970 - 1976, 1978 - 1983, 1995 - 2000, 2003 - 2005
30		SA142	90	41° 35'00"	18° 46'00"	1966, 1970 - 2005
31		SA004	30	41° 24'00"	18° 44'00"	1973 - 1987, 1997 - 1998
32		B111	810	42° 51'00"	21° 15'00"	1965 - 1971, 1974, 1976, 1982, 1985 - 1986, 1991 - 1997, 2001 - 2002, 2004
33	Al Baha	B001	2400	41° 17'00"	20° 06'00"	1975 - 2003
34		B103	1470	41° 39'00"	20° 15'00"	1975 - 1976, 1978 - 1996, 2005
35		J139	80	41° 02'00"	19° 44'00"	1967 - 1987, 1992 - 1995, 1997 - 1999
36		J126	350	41° 26'00"	19° 46'00"	1966 - 1988, 1990 - 1997
37		B007	2400	41° 33'00"	19° 52'00"	1965 - 1981, 1983 - 2005
38		B101	2330	41° 35'00"	19° 54'00"	1960 - 1980, 1982 - 2005
39		J127	440	41° 32'00"	19° 40'00"	1970 - 2001, 2005
40	Asir	J137	398	41° 58'00"	19° 58'00"	1966, 1968, 1972 - 2002, 2004 - 2005
41		B114	1305	42° 14'00"	20° 01'00"	1966 - 1978, 1980 - 1997, 2001
42		B008	1230	42° 22'30"	19° 59'10"	1990 - 1997, 2000
43		B004	1020	42° 36'00"	20° 01'00"	1975 - 2003
44		B217	1715	41° 56'00"	19° 45'00"	1971 - 1976, 1985 - 1996, 2000 - 2002
45		B005	1090	42° 32'00"	19° 52'00"	1973 - 1999
46		B216	2000	41° 59'00"	19° 28'00"	1970 - 1998, 2002
47		SA003	350	41° 53'00"	19° 00'00"	1968 - 1988, 1991 - 1993, 2000 - 2006
48		SA105	390	41° 58'00"	18° 56'00"	1965 - 1988, 1991, 1993, 1998 - 2003
49		SA139	450	42° 02'00"	19° 03'00"	1970 - 2006

Sources: MOWE

Table1-3(2) Rainfall Stations under the control of MOWE in the Study Area

No.	Region	Station Name	Elevation (EL.m)	Longitude	Latitude	Available Data
50	Asir	SA120	580	41° 50' 00"	19° 26' 00"	1968 - 2005
51		A127	2250	42° 15' 00"	18° 47' 00"	1966 - 1979, 1981 - 2006
52		B208	1650	42° 44' 00"	19° 01' 00"	1967 - 1976, 1985 - 1996
53		A103	2100	42° 47' 00"	18° 06' 00"	1965 - 2006
54		B219	1480	42° 48' 00"	19° 20' 00"	1971 - 1997, 1999 - 2002, 2004 - 2005
55		B006	975	43° 31' 00"	19° 32' 00"	1983 - 1996, 1999 - 2002
56		SA138	570	42° 01' 00"	18° 38' 00"	1966, 1970 - 2005
57		SA113	450	42° 02' 00"	18° 32' 00"	1965 - 1999
58		A206	2480	42° 15' 00"	18° 41' 00"	1967 - 1995, 2002 - 2006
59		A117	2200	42° 16' 00"	18° 37' 00"	1966 - 1995, 1997 - 2006
60		A108	2300	42° 23' 00"	18° 31' 00"	1967 - 1983, 1985 - 2006
61		A107	2150	42° 34' 00"	18° 36' 00"	1968 - 1982, 1984 - 1994, 1998 - 2006
62		A113	1700	42° 41' 00"	18° 38' 00"	1966 - 2002, 2004 - 2006
63		B110	1650	42° 53' 00"	18° 48' 00"	1965, 1968, 1970 - 1976, 1978 - 1997, 2000 - 2005
64		A110	1880	42° 59' 00"	18° 41' 00"	1966 - 1983, 1985, 1990 - 1997, 2001 - 2005
65		SA108	420	41° 55' 00"	18° 20' 00"	1965 - 1966, 1968 - 2005
66		A130	2440	42° 19' 00"	18° 20' 00"	1982 - 2006
67		A124	2400	42° 20' 00"	18° 25' 00"	1965 - 1981, 1983 - 2006
68		A201	2030	42° 31' 00"	18° 25' 00"	1966 - 1996
69		A112	1980	42° 34' 00"	18° 22' 00"	1965 - 2006
70		A128	1800	42° 42' 00"	18° 28' 00"	1974 - 1993, 1996 - 2001
71		SA116	700	42° 12' 00"	18° 15' 00"	1968 - 1988, 1993 - 1994, 1998 - 2002, 2004 - 2006
72		SA144	408	42° 15' 00"	18° 10' 00"	1971 - 2000, 2004 - 2006
73		A118	2820	42° 22' 00"	18° 15' 00"	1965 - 2002, 2004 - 2006
74		A005	2200	42° 29' 00"	18° 12' 00"	1982 - 2003
75		A006	2100	42° 36' 00"	18° 15' 00"	1973 - 1976, 1978 - 1996
76		A123	1900	42° 52' 00"	18° 19' 00"	1965 - 1993, 1995 - 2001
77		SA115	20	41° 40' 00"	18° 00' 00"	1965 - 1979, 1982, 1987, 1990, 2000, 2005
78		A121	2300	42° 45' 00"	18° 02' 00"	1965 - 2006
79		A004	2400	43° 06' 00"	18° 10' 00"	1981 - 1999, 2003 - 2006
80		A105	2060	43° 11' 00"	18° 14' 00"	1968, 1970 - 2002, 2004 - 2006
81		A004	2400	43° 06' 00"	18° 10' 00"	1981 - 1999, 2003 - 2006
82		A104	2350	43° 22' 00"	17° 56' 00"	1966 - 2002
83	Jazan	SA102	65	42° 14' 00"	17° 42' 00"	1966 - 2005
84		SA204	200	42° 36' 00"	17° 34' 00"	1979 - 1985, 1998 - 2006
85		SA145	600	42° 48' 00"	17° 37' 00"	1966, 1968 - 1969, 1972 - 1976, 1980 - 1993, 1997 - 2006
86		SA106	70	42° 32' 00"	17° 22' 00"	1967 - 1994, 1997 - 2004
87		SA126	540	42° 53' 00"	17° 27' 00"	1966 - 2006
88		SA125	200	42° 27' 00"	17° 08' 00"	1967 - 1968, 1970 - 1977, 1979 - 2006
89		SA002	40	42° 37' 00"	17° 10' 00"	1965 - 1993, 1995, 1999 - 2002, 2005 - 2006
90		SA107	70	42° 47' 00"	17° 07' 00"	1966 - 2005
91		SA129	150	42° 54' 00"	17° 10' 00"	1967, 1969 - 1987, 1992 - 1999, 2005 - 2006
92		SA140	305	43° 02' 00"	17° 19' 00"	1967, 1970 - 1990, 1993, 1995, 1998 - 2006
93		SA110	860	43° 08' 00"	17° 16' 00"	1960 - 1984, 1988 - 2006
94		SA148	4	42° 32' 00"	16° 55' 00"	1984 - 1997, 2003 - 2005
95		SA132	73	42° 47' 00"	17° 01' 00"	1963, 1990 - 2006
96		SA101	69	42° 50' 00"	16° 58' 00"	1960 - 1976, 1978, 1980 - 1995, 1998 - 2005
97		SA001	190	42° 57' 00"	17° 03' 00"	1976 - 1993, 2000 - 2005
98		SA104	223	43° 05' 00"	17° 03' 00"	1960 - 2006
99		SA111	900	43° 07' 00"	17° 03' 00"	1960 - 2006
100		SA143	340	43° 08' 00"	16° 54' 00"	1971 - 1996, 2002 - 2005
101		SA135	240	43° 14' 00"	16° 48' 00"	1967 - 1974, 1982 - 1984, 1988, 1990 - 2006
102		SA136	90	43° 08' 00"	16° 41' 00"	1967 - 2006
103		SA137	40	42° 57' 00"	16° 36' 00"	1967 - 1979, 1982 - 1997, 2000 - 2002, 2004 - 2005
104	Najran	N001	1272	44° 14' 00"	17° 33' 00"	1969 - 1975, 1977 - 1978, 1980 - 2001
105		N103	2020	43° 38' 00"	17° 40' 00"	1966 - 2002, 2004 - 2006

Sources: MOWE

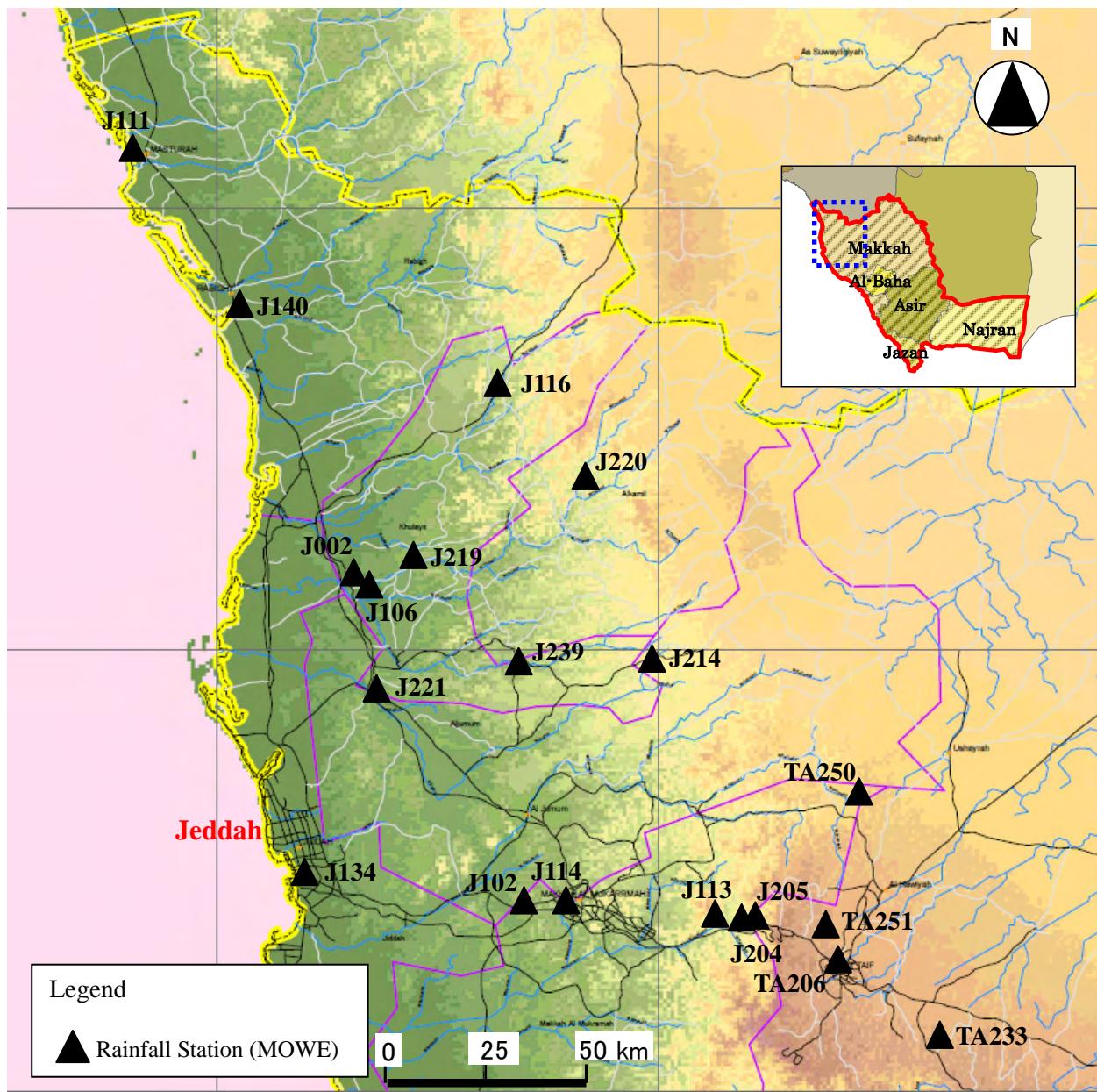


Figure1-3(1) Rainfall Stations in Makkah Region

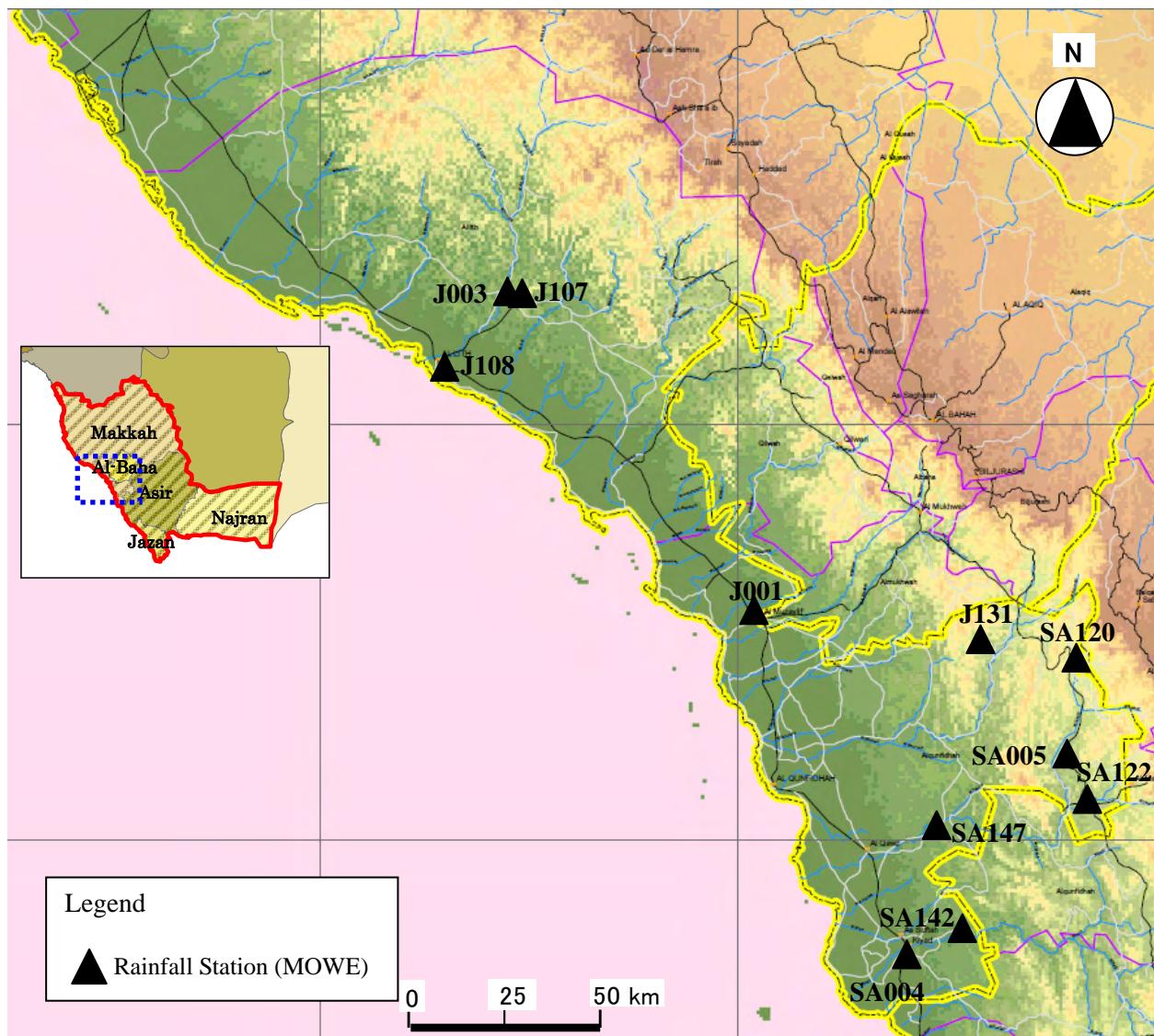


Figure1-3(2) Rainfall Stations in Makkah Region

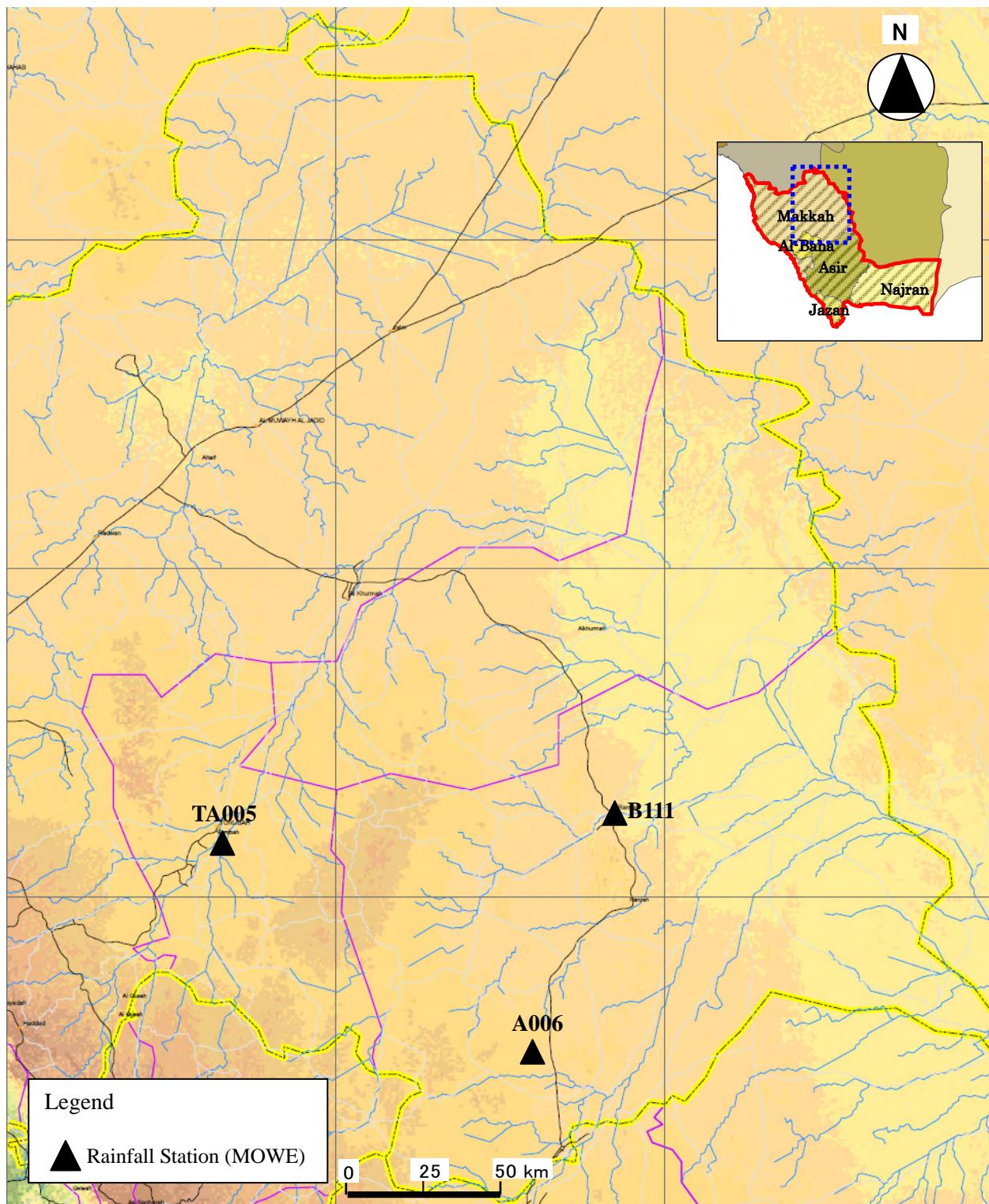


Figure1-3(3) Rainfall Stations in Makkah Region