3. The Current status of the Environment/Social Conditions

3.1 Environmental Quality

(1) Water Quality (Surface Water)

Currently there has no water quality investigation conducted at the two (2) dam project sites due to scarcity of water. Besides, there is insufficiency in other water quality result from wadi, reservoir and oceanic zone. Due to scarcity of the source of pollution in mountain regions, it is believed the inflow water quality to reservoir is in good condition.

(2) Water Quality (Groundwater)

The groundwater quality is in general observed when new wells are developed. However, since the majority of the wells are utilized for agricultural purpose, there is no intensive groundwater quality monitoring programme established in the Kingdom.

(3) Air Quality

There has been no survey conducted for examination of air quality at the site for proposed project. However, there is no artificial source for generation of air quality at the site for proposed project. Therefore, it is considered that the air quality is at the natural background level.

(4) Soil Contamination

There has been no survey conducted for examination of soil contamination at the site for proposed project. However, since there is no land use observed at the site, it is considered soil contamination unlikely exists.

(5) Noise and Vibration

There has been no survey conducted for examination of noise and vibration at the site for proposed project. However, there is no artificial source for generation of noise and vibration at the site for proposed project. Therefore, it is considered that the noise and vibration are at the natural background level.

(6) Odour

There has been no survey conducted for examination of odour at the site for proposed project. However, there is no artificial source for generation of odour at the site for proposed project. Therefore, it is considered there is no offensive odour existing at the site for the proposed project.

3.2 Natural Environment

(1) Climate Change

According to the Fourth Assessment Report (AR4) (2007) prepared by the Inter-Governmental Panel for Climate Change (ICPP), the global average temperature in the past 100 years (1906 ~ 2005) raised 0.6 ºC. It is predicted the mean global temperature may rise 0.1 ~ 0.2 ºC in the next two decades and 0.3 ~ 6.4 ºC at the end of the twenty-first century if the emission of green house gas follows the scenario in the ICPP's Special Report on Emission Scenario (SRES) (2000).

(a) Past Climate Change in Saudi Arabia (1970 ~ 2003)

The Kingdom of Saudi Arabia ratified the United Nations Framework Convention on Climate Change (UNFCCC) on December, 1994. The First National Communication of the Kingdom of Saudi Arabia (Presidency of Meteorology and Environment, 2005) prepared by the Kingdom in accordance to the Article 12 of the treaty, the mean national temperature in the past 33 years (1970 ~ 2003) raised 0.4 ºC. The precipitation decreased 50% in the northern part of the Kingdom and 14% in the eastern hill of Asir Ridge whereas it raised 92% in the western coast including Jeddah city, 45% in the central region including Riyadh and 109% in the southern region. It is reportedly hypothesized increase precipitation is largely owing to an increase of local intensive rainfall.

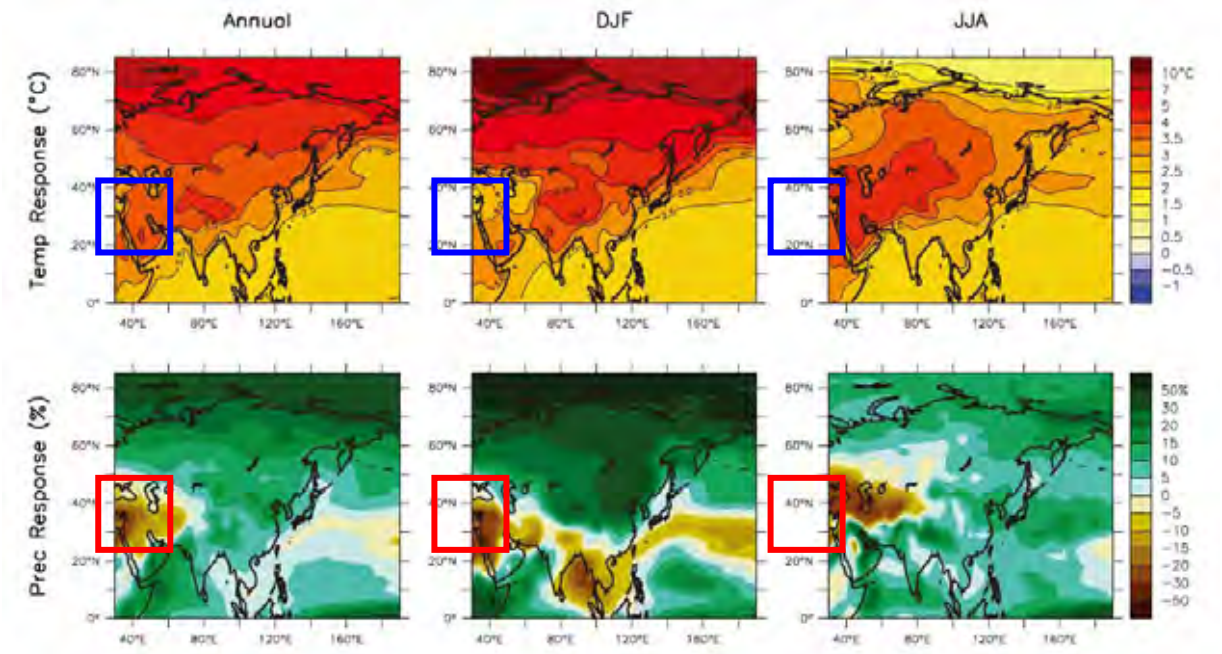
(b) Future Climate Change Projection in Saudi Arabia (late twenty-first century)

There has been some future climate change projection in the Middle East region conducted. All global simulation model predict that the raise of both average temperature and precipitation in the southwestern part of the Kingdom.

Table 3-1 Future Climate Change in the Southeastern Part of the Kingdom

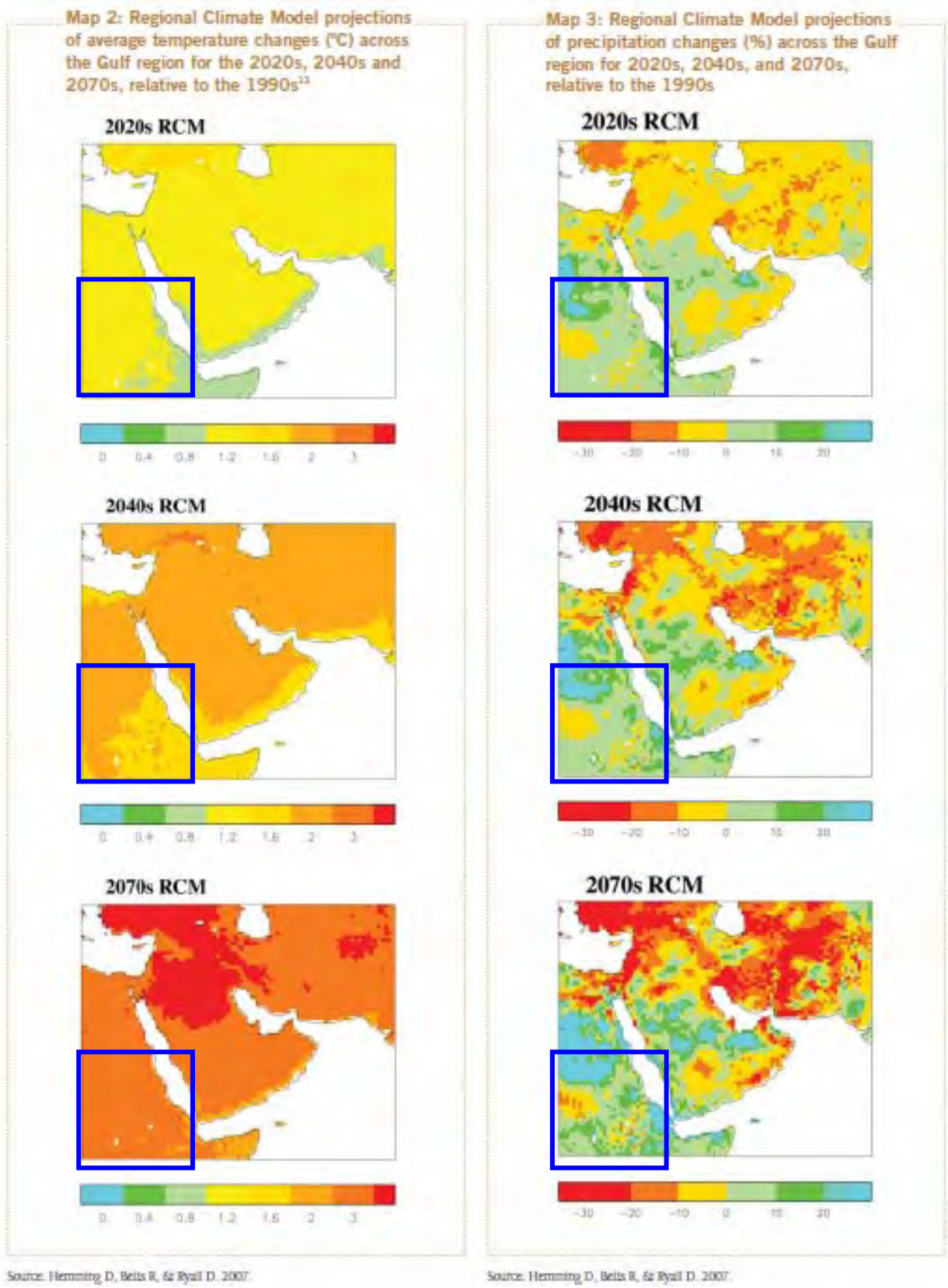
Sources	Year	Temperature	Precipitation	Remarks
AR4 Note1	2090s	0.3~6.4ºC↑ (Annual)	>5 ~ 10%↑	Figure3-1
First National Communication Note2	2041	0.4ºC↑ (Summer) 1.8ºC↑ (Winter)	66%↑	
Hemming D, Betts R & Ryall D Note3	2070s	2.5~3.7ºC↑ (Summer) 2.0~3.1ºC↑ (Winter)	>10%↑	Figure3-2

Note 1: ICPP, 2007, *Fourth Assessment Report*
Note 2: Presidency of Meteorology and Environment of the Kingdom of Saudi Arabia, 2005, *First National Communication of the Kingdom of Saudi Arabia*
Note 3: Hemming D, Betts R, & Ryall D., 2007, *Environmental stresses from detailed climate model simulations for the Middle East and Gulf region. Report (ref. MOEN/04/04/02/02b)* completed by the Met Office Hadley Centre for UK Ministry of Defense project Defense and Security Implications of Climate Change'.



Note 1: The change is the comparison from the year 1980 ~ 99. The figure shows the average of 21 major models.
Note 2: Top: Temperature, Bottom: Precipitation.

Figure 3-1 Climate Change Projection in the late 2090s in the AR4

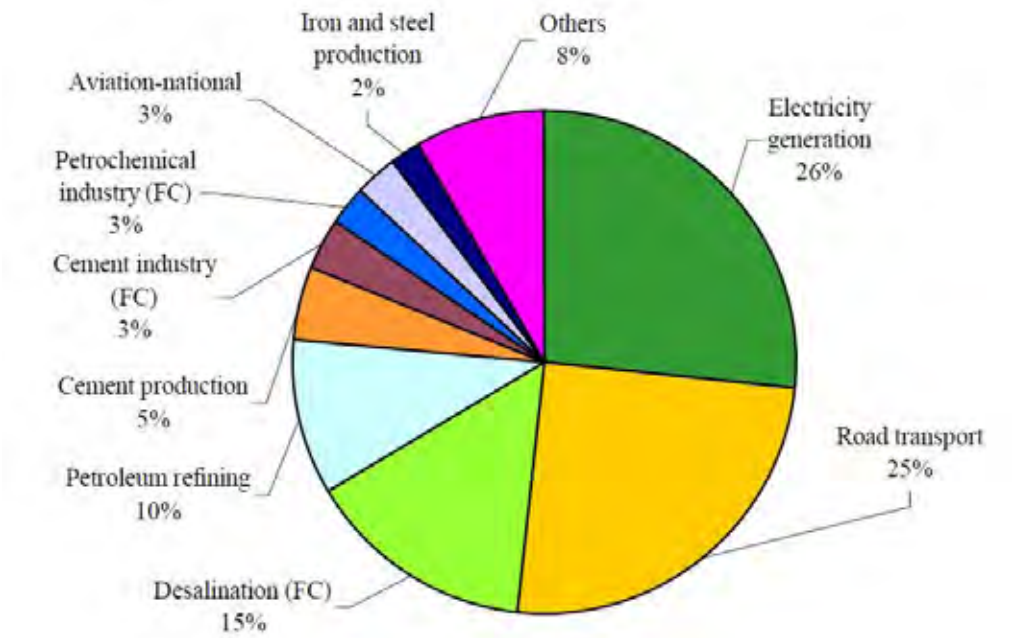


Note 1: The change is the comparison from the year 1990 ~ 99. The figure shows the result of Met Office Hadley Centre model.
Note 2: Left: Temperature, Right: Precipitation.

Figure 3-2 Climate Change Projection in the late 2070s by Hemming D, et.al.

(c) Major Green House Gas Emission Sources

According to the First National Communication of the Kingdom of Saudi Arabia (Presidency of Meteorology and Environment, 2005), the total emission of Carbon Dioxide (CO_2) in the year 1990 was estimated at 140,058 Gg (Giga Gram). Approximately a quarter of CO_2 was emitted from electricity generation (26%) followed by road and transport (25%). Desalination was ranked at third highest (15%). The majority of the emission from desalination was due to combustion of fuel for the plant.



Source: Presidency of Meteorology and Environment, 2005, *First National Communication of the Kingdom of Saudi Arabia*

Figure 3-3 Emission of CO2 per Sector in 1990

(d) Impact and Risk of Climate Change

Some literature cited the impact of the climate change in the Kingdom. According to the Government of Saudi Arabia (Presidency of Meteorology and Environment, 2005, *First National Communication of the Kingdom of Saudi Arabia*), Arab Forum for Environment and Development (AFED), which is a not-for-profit regional non-governmental organization in the Middle East (AFED, 2009, *Arab Environment: Climate Change, Impact of Climate Change in Arab Countries*) and International Institute for Sustainable Development (IISD), an international not-for-profit regional non-governmental organization (International Institute for Sustainable Development (IISD), 2009, *Rising Temperatures, Rising Tensions and the Risk of Violet Conflict, Climate Change in the Middle East*), the impact and risks of climate change in the Kingdom are summarized asTable 3-2.

Table 3-2 Impact and Risk of Climate Change in Saudi Arabia

Impact of Climate Change	Risk and Projection
Scarce of Water Resources	Due to an increase of temperature, increases in evapotransportation and drinking & domestic water demands are projected. Therefore, management of the water resources becomes more significant issue.
Desertification	Due to increase in temperature, evapotransportation increases. This may lead to expansion of desertification and arid areas.
Soil Environment	Global warming triggers sea level rising. This may lead to intrusion of saline water in the soil on the coastal line. Additionally, an increase in evapotransportation lead to salination of surface soil Therefore, there may be impact on the agricultural sector.
Flood	It is predicted that precipitation in the southwestern region would increase. However, it is also reportedly projected the main factor on the precipitation increase is owing to an increase of intensive local rainfall. Therefore, the local risks of flood may rise

Impact of Climate Change	Risk and Projection
	depend on the area.
Pestilence	Due to increase in both temperature and precipitation, the risk of Malaria in the southwestern region may increase
Ecology	It is anticipated an Increase of 2 ^{o}C in temperature may extinct approximately 40% of flora and fauna in the Middle East. In particular, the flora and fauna inhabiting in mountain areas are reportedly sensitive to the change of climate.
Conflict	Shortage and scarce of drinking and domestic water may lead to local and regional conflict on water and food. This may obstacle the public security and regional economic development.

(2) Topography and Geology

(a) Topography

The Study Area lies on the south-western part of the Kingdom that rises abruptly from the Red Sea in the west and dips gently towards the Najd in the east. In the trunk of the project area, Hijaz-Asir highlands rises up to about 3,000 meters in the south near Abha, while at northern boundary of the area near Tailf, the elevation is about 1,500 meters. There is a distinct coastal plain, locally known as Tihama, separated from the hills by an imposing scarp wall that runs parallel to the Red Sea along 700 km in the project area. Toward east form the peak of Hijaz-Asir highlands, hills peter out further east to the interior, and give way to an extensive plateau covered with lava flow (Harrat) of the area, and very thin veneer rock debris and alluvium over a basalt and crystalline basement, which is frequency outcrop as knolls and low hills.

(b) Geology

The Study Area is underlain by tightly folded, regionally metamorphosed volcanic-clastic, and epi-clastic rocks and many mafic to felsic plutons all of late Proterozoic age. It is called as 'Arabian Shield-Nubian Shield' and is exposed with concealed by the sedimentary cover rock that dips gently toward the east. As covered rock, in the Study Area, Palaeozoic sandstones, comprising the Cambrian-Ordovician Wajid sandstone, are found on the southeastern range of the Study Area and overlie Proterozoic rocks.

In the Study Area, several episodes of volcanism are recognized in the geologic age. Of those events, older volcanic activity occurred in Precambrian age and formed a volcano-clastics and subordinate flow rocks, complexly inter-layered with volcanically delivered and epi-clastic sedimentary rocks. While the younger rocks, Tertiary and Quaternary basalt-flows and gabbro-dikes are found in particular the north of the Study Area. Both are associated with Red Sea rifting: the basalt is part of a large area of a flow rocks and volcanic cones resulting from volcanic activity, whereas the gabbro dikes were intruded into tension fractures.

Overlying the bedrock are unconsidered Quaternary deposit that included wadi alluvium, fanglomerate delivered from the Red Sea escarpment, terrace gravels, coastal-plain silt and eolian sand. These formed during the period of active erosion following the uplift of the region and the opening the Red Sea, which caused the development of wadi system draining to the east and west and the erosional retreat of the Red Sea escarpment.

(3) Biodiversity, Flora and Fauna

According to "the National Strategy for Conservation of Biodiversity in the Kingdom of Saudi Arabia (2005)" prepared by NCWCD for the Convention of Biological Diversity.

(a) Flora

The 2,250 species of flora in Saudi Arabia belong to 132 families and 837 genera. Approximately 105 species inhabit sand dunes, 90 are halophytes, 75 are trees and 12 are aquatic plants. Out of these species 40 are considered endemic, the influence of the floras of neighboring countries, particularly Yemen and Oman, is high on the flora of Saudi Arabia. Approximately 20% of the flora, that include the rare and endemic species, are present in small populations in their respective niches.

(b) Mammal

A checklist of 98 species of mammals has been recorded from the Arabian Peninsula. Of these, 76 species occur in Saudi Arabia. Lion was the first large mammal species known to have become extinct from the Arabian Peninsula in the early 1900s. The cheetah was probably extinct with the last authentic records from the 1950s.

(c) Birds

About 444 bird species have been recorded in Saudi Arabia, of which about 185 species are known to breed in the Kingdom. Of the breeding species, 45 are believed to be of Ethiopian origin, 30 of Asiatic origin with the remainder Palearctic.

The Arabian Peninsula is functionally very significant for migrating birds from Asia, Europe and Africa. Thus a second source of colonization is from those migratory birds, a number of whom are now over wintering and even breeding in Saudi Arabia - rather than migrating further south due to the existence of extensively irrigated areas and the incidence of treated sewage water ponds around the major cities of Saudi Arabia.

In particular, Houbara Bustard (Chlamydotis undulata) (VU: Vulnerable in IUCN Red List) and Arabian Bustard (Ardeotis arabs) (LC: Least Concern in IUCN Red List) are under serious threat for extinction from the Arabian Peninsula. In some protected areas in the Kingdom, there are reintroduction projects for these rare species undertaken.

(d) Amphibians and Reptiles

All of Saudi Arabia's seven native amphibian species are restricted to freshwater seeps and ephemeral pools. They are the Tihamah toad, Dhofar toad, Green toad, Arabian toad, Savigny's tree frog, Arabian water frog and Arabian skittering frog.

There are 45 species of terrestrial snakes in Saudi Arabia, of which 23 species are poisonous and 10 species of sea snakes that are all poisonous. Because of the desert nature of the country, none of the terrestrial snakes are found in great numbers. Some species may be abundant in localized places

There are 67 species of lizards known from Saudi Arabia. The small-scaled species is under pressure from hunting for its flesh.

(e) Insect

There are no complete studies on the insect species of Saudi Arabia. Zoological analysis of Arabian and Middle Eastern butterflies reveals species with Palearctic, Afro-tropical and oriental affinities. Recorded are 8 endemic species in the Asir region and 23 sub-species in the Hijaz, Central Arabia, Eastern Arabia and Asir regions.

3.3 Social Environment

(1) Economy

Table 3-3 represents value added changes from 1999 to 2004. The average annual growth rate of the GDP in the period is 3.4%. In 2004, the share of non-governmental services sector was about 30%, crude oil and natural gas sector was about 28%, and productive sector was about 25% to the GDP.

Trade, Restaurants and Hotels, Other manufacturing, Real estate, and Construction occupy more than 6.0% of the GDP. The sub-sectors whose average annual growth rates are over 5.0% are Electricity, Gas and Water (6.3%), Other Manufacturing (5.9%), Finance, insurance and business services (5.8%), and Transport and Communications (5.6%). These figures show that the manufacturing sector and non-governmental services sector are leading the national economy.

Table 3-3 GDP by Sector (1999 prices)

Sectors	Value added		Average annual growth rate	Share in GDP	
	1999 (SR Million)	2004 (SR Million)	(%)	1999 (%)	2004 (%)
1. Productive	147,318	178,250	3.9	24.4	24.9
1.1 Agriculture, Forestry and Fishing	34,443	38,005	2.0	5.7	5.3
1.2 Non-Oil Mining and Quarrying	2,464	2,723	2.0	0.4	0.4
1.3 Oil Refining	18,021	20,508	2.6	3.0	2.9
1.4 Petrochemicals	6,000	7,352	4.1	1.0	1.0
1.5 Other Manufacturing	38,779	51,616	5.9	6.4	7.2
1.6 Electricity, Gas and Water	8,174	11,085	6.3	1.4	1.6
1.7 Construction	39,437	46,961	3.6	6.5	6.6
2.Non-Governmental Services	169,086	211,953	4.6	28.0	29.6
2.1 Trade, Restaurants and Hotels	45,992	57,299	4.5	7.6	8.0
2.2 Transport and Communications	27,893	36,674	5.6	4.6	5.1
2.3 Real estate	42,221	48,822	2.9	7.0	6.8
2.4 Finance, insurance and business services	31,603	41,902	5.8	5.2	5.9
2.5 Community and Personal Services	21,377	27,256	5.0	3.5	3.8
3. Government Services	116,789	135,064	3.0	19.3	18.9
4. Crude Oil and Natural Gas	173,102	196,696	2.6	28.7	27.5
5. Other Items	-2,706	-7,063	21.2	-0.4	-1.0
GDP	603,589	714,900	3.4	100.0	100.0

Source: The Eighth Development Plan
Note: "Other Items" is import duties less imputed bank service charges.

(2) Land Use

As shown in the section of this report, a major portion of the Study Areas is uncultivated area with some arable and cultivated areas. Despite the fact that there are some urbanized areas in the Study Area, there is no major industrial zone existing. Reflecting the high amount of precipitation in the mountain regions, particularly some juniper forest observed.

(3) Cultural Heritage

There is no World Heritage site, registered under the United Nations Educational, Scientific and Cultural Organization (UNESCO) existing in the study areas.

(4) Waste

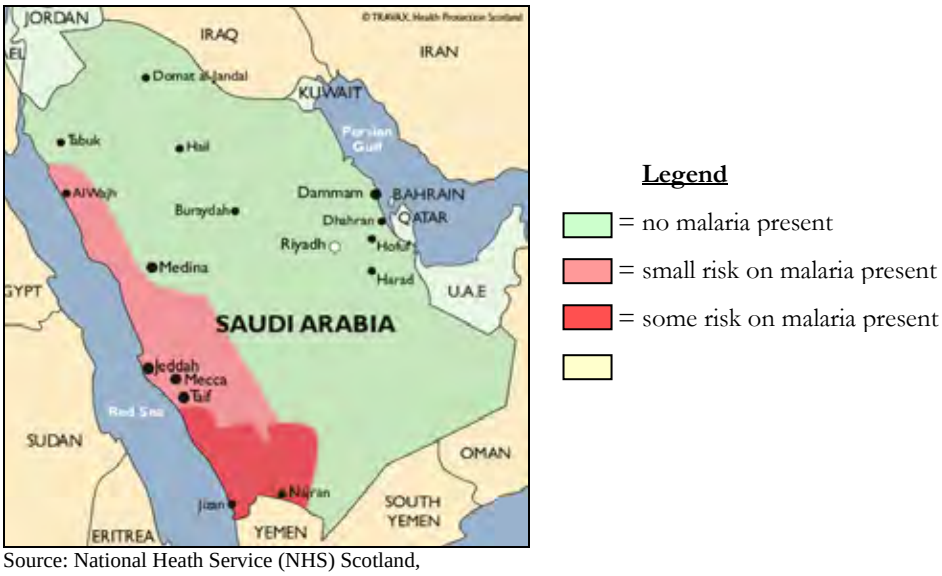
There is no landfill site at and around the project areas.

(5) Public Health Condition

Saudi Arabia has achieved substantial improvements to its healthcare system in the past 20 years or so, with infant mortality rates dropping from 85 per 1000 births to 22 per 1,000 births, and average life expectancy increasing from 61 years to 72 years. Access to healthcare of pregnant women increased from 86.8% in 1999 to 98% in 2003.

Nationally, incidences of disease have been reducing in parallel with increasing coverage and standard of the public health system. Tuberculosis incidence rates are currently of the order of 41 per 100,000 people per year, and Human Immunodeficiency Virus (HIV) infection is an extremely low 0.01%, due to the strong enforcement of Islamic teachings with respect to promiscuity, in conjunction with the law that dictates that all foreign nationals diagnosed with HIV are deported. The most common cause of death for males aged 16-36 in Saudi Arabia is currently road accidents and not disease.

The study area, in particular Jazan and parts of Najran and Asir, is host to the greatest concentration of incidences of malaria due to comparatively high rainfall in conjunction with warm temperatures and the occurrence of irrigation schemes, reservoirs, ditches, and dykes. Figure 3-4 shows the prevalence of malaria nationwide (Scotland National Health Service NHS Scotland).



Source: National Heath Service (NHS) Scotland, http://www.fitfortravel.scot.nhs.uk/destinations/middle-east/saudi-arabia/saudi-arabia-malaria-map.aspx

Figure 3-4 Prevalence of Malaria in KSA

According to the Saudi Statistical Yearbook (2006), access to the public potable water supply system in the study area currently stands at around 31% of the population (compared to 44% in 2000). Table 3-4 shows the percentage access to the public system for all five regions.

The remaining potable water needs are provided by water truck, private wells, public taps, and "catchment tanks." In common with the ratio of homes connected to the public potable water supply system, the national coverage of household connections to the sewerage network currently stands at around 30%.

Table 3-4 Access to Potable Water Supply in the Study Area

Region	% Access to Public Potable Water Supply	
	2000	2004
Makkah	53	64
Al Baha	12	7
Asir	24	17
Jazan	56	55
Najran	15	13
Average for all 5 regions	44	31

Source: Saudi Statistical Yearbook (2006)

4. The Existing Environmental Problem in the Study Area

4.1 Water Right and Shortage

The subject chapter in the M/P describes the current issues. The water right has not been systematically established in the area. This situation leads to the future water shortage and uneven distribution of water for each sector.

4.2 Groundwater Level

The groundwater table particularly in Jazan Region has been reportedly lowered due to extensive groundwater use for agricultural activity. The Study Team observed the current conditions of the Region yet no particular symptom such as blasted trees or salt accumulation on the agricultural area was not observed in general except the cultivated lands near the coastal line. However, it is anticipated that the uncontrolled use of groundwater may lead to further groundwater level lowering in Jazan and other regions in the future. Such groundwater lowering affects on groundwater quality, surface vegetation including agricultural products, hygiene condition, water right, etc.

4.3 Protected Area, Fauna and Flora

The southwestern part of the Kingdom is rich with precipitation. High rainfall in the area flourishes variety and unique ecosystem. Although no extensive study in the whole area has not been conducted, it is known that a number of endemic and endanger species inhabiting in the region such as Arabian Leopard (*Panthera pardus nimr*), Caracal (*Caracal caracal*), Arabian Oryx (*Oryx leucoryx*), Genet (*Genetta genetta*) and Baboon (*Papio*).

It is known that several species encounter extinction from the area. According to NCWCD in the National Strategy for Conservation of Biodiversity in the Kingdom of Saudi Arabia (2005), the main reason of such crisis is owing to development of urban and agricultural area and decrease in natural land, extensive forest and shrub harvesting for fuel wood, occurrence of periodic drought years, application of modern agricultural practice (use of pesticides), over hunting and pollution of water.

In some protected area as Mahazat as-Sayd protected area, reintroduction programme for such species as Arabian Oryx (*Oryx leucoryx*) and Houbara Bustard (*Chlamydotis undu*) has been undertaken.

Source: National Commission for Wildlife Conservation and Development (http://www.ncwcd.gov.sa/)

Figure 4-1 Endangered Animals (Houbara Bustard (Left) and Arabian Oryx (Right))

5. Projection of the Impact of the Project and Mitigation Plan

The M/P consists of the following components;

- Integrated Water Resources Development and Management through utilization of the facilities (which have already existed, been under constructed and been under planning by the Kingdom.
- Construction of two new dams, pipelines and desalination plants

The first item, the integrated water resource development and management, itself does not adversely impact on the society and the environment. However, the second item, construction of new facilities, may affect on the society and the environment. Therefore, the following section will discuss the impact on the society and the environment owing to construction of the new dams, pipeline and desalination plant together with possible mitigation programmes and suggestion of further studies.

As a part of the activity of the M/P survey, a social and environmental consideration study at initial environmental examination (IEE) level was conducted. This study was conducted for (i) impact projection and evaluation on the social and natural environment and pollution by the execution of the M/P, and (ii) proposal of mitigation measures for adverse impacts. This study also examined the impacts of the M/P in a point of view of strategic environmental assessment (SEA). The social and environmental factors were set with referring to the JICA's environmental guidelines.

5.1 Projection of the Impact

(1) Dams

The M/P proposes two new dams namely (i) Hirjab dam located in the centre of Asir Region with the total capacity of 4,800,000 m^3 and (ii) Ranyah dam located along the eastern border between Al Baha region adjacent to Asir Region with the total capacity of 213,800,000 m^3.

In accordance to the laws and regulation, Environmental Impact Assessment (EIA) is compulsory for any dam construction project. On the other hand, according to MOWE, there has been no record that the Kingdom has conducted any EIA for dam construction project.

MOWE conducted an environmental study for Hirjab Dam and concluded that construction of dams does not give significant adverse impact on the environment. Since the study was conducted as a part of dam location selection process for dams in Asir Region, the study was not an official EIA. There has been no environmental study taken place for Ranyah dam.

Table 5-1 ~ Table 5-3 shows the result of the projection on social and natural environments and pollution. The following describes the main impacts anticipated to be caused by execution of the project at IEE level.

(a) Groundwater and Hydrological Condition

The planned sites for both dams locate on the existing wadi. Therefore, except flood season, there is no water flowing. Although no groundwater use is identified in the reservoir areas, there are small scale cultivated areas scattering in the downstream. It is possible groundwater may be utilized for agricultural activity in these lands.

Due to appearance of the dams, the water flown at flood occasions will be checked. Therefore, it is projected hydrological condition at flood occasion will be altered. Additionally, it is identified that wadi is one of the important recharging sources of groundwater. Therefore, appearance of the dams may impact on the groundwater recharges and levels.

(b) Water Quality

The planned sites for both dams locate on the existing wadi. Therefore, except flood season, there is no water flowing. The land use of the upstream for both dams is mainly barren land. There are no potential pollution sources such as industrial, commercial and agricultural land extends in the upper basins.

Due to scarcity of the river water in wadi, there has been no water quality survey conducted at the sites for the wadi water (i.e. inflow water).

Due to appearance of the dams, the water flown at flood occasions will be checked at the reservoir. Based on the calculation with the estimated annual inflow volume, the annual turnover rate for Hirjab dan is 3.5 and Ranyah dam is 0.5. In general, those dams with such low rate turnover rate tends to form thermocline in the reservoir. Therefore, it is possible the dams potentially cause cold and warm water discharges as well as high turbidity water discharge upon flood occasion. Additionally, if the inflow water is rich with phosphate and nitrogen, eutrophication may occur in the reservoir.

At this stage, there is difficulty to project the precise future phenomenon in the reservoir due to lack of water quality data. However, water quality of the areas may potentially alter due to appearance of the dams.

Table 5-1 Simplified Leopold Matrix for the Construction of Dams (Social Environment)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Involuntary Resettlement	No houses located at the dam and reservoir sites. According to the EIA report, 140 people live around Hirjab dam site whereas the number of residents at Ranyah dam site is unknown.	Since the precise locations as well as the muck disposal yard and quarry sites are not decided, it may cause adverse effects.	D	Construction Operation
Local Economy	Grazing and agriculture are the major local industry	Local employment opportunity increase during the construction phase.	B	Construction
		Appearance of reservoirs may attract tourism and enhance local economy	B	Operation
Land Use	Hirjab dam site is currently used for grazing. Ranyah dam site is mainly composed of barren land.	Some areas sink in the reservoir. However, such areas are small portion and the rest of the area have no negative impact	C	Operation
Local Community	140 people live around Hirjab dam site whereas the number of residents at Ranyah dam site is unknown.	There are few impacts on the community (split of the community) due to small scale of the proposing facilities.	C	-
Existing Infrastructure	There is no major infrastructure around the proposing project sites.	Any impacts due to execution of the proposing project are not expected.	C	-
Poor, Indigenous and ethnic people	There are no indigenous and ethnic people inhabiting the areas.	Any impacts due to execution of the proposing project are not expected.	C	-
Cultural Heritage	There is no cultural official heritage in the proposing project sites. However, there are some old houses extends along pipeline route.	The pipeline will not destruct the monuments. Therefore, the impact is considered as minor.	C	Construction Operation
Local Conflict	There is no conflict in the proposing project sites.	Any impacts due to execution of the proposing project are not expected.	C	-
Water Right	The M/P of the Study examines the water rights and allocations.	The execution of the M/P will give positive impact.	B	Operation
Sanitation	There is no major issue relating to sanitation due to little population.	Increase in water supply will improve local sanitation	B	
Hazard & Infection	The HIV infection rate in the Kingdom is less than 0.01%.	Due to the Kingdom's strong policy on HIV, there is little impact foreseen for HIV infection among workers during the construction phase.	C	Construction

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

Table 5-2 Simplified Leopold Matrix for the Construction of Dams (Natural Environment)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Topography and Geology	There is no remarkable topography and geology.	Any impacts due to execution of the proposing project are not expected.	C	-
Soil Erosion	There is no information available on soil erosion in the proposing project sites.	Any impacts due to execution of the proposing project are not expected.	C	-
Groundwater	Groundwater is used in the downstream.	Due to change in the hydrology, the production rate of the groundwater in the downstream may alter.	E	Operation
Hydrological condition	Wadi runs the proposing project sites.	Due to change in the hydrology, the production rate of the groundwater in the downstream may alter.	E	Operation
Coastal Zone	Wadi running the proposing project sites flow toward inland (i.e. not toward coastal line)	Any impacts due to execution of the proposing project are not expected.	C	-
Flora and Fauna	Low biodiversity is expected due to scarce of vegetation in the areas. Currently, no information on flora and fauna is available in the proposing project sites.	Construction may lead to destruction of local flora and fauna community. Thus, it may affect on the local ecosystem.	D	Construction
		Appearance of reservoir may attract some fauna.	B	Operation
Meteorology	The areas belong to arid zone.	Any impacts due to execution of the proposing project are not expected.	C	-
Landscape	There is no landscape point near the proposing project sites.	Any impacts due to execution of the proposing project are not expected.	C	-
Global Warming	Raise of temperature is expected in accordance to the Fourth Assessment Report (AR4) by ICPP	Any impacts due to execution of the proposing project are not expected.	C	-

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

Table 5-3 Simplified Leopold Matrix for the Construction of Dams (Pollution)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Air Pollution	There is no information available on air pollution in the proposing project sites. However, since there is no source seen around the sites, significant air pollution is unlikely expected.	Generation of air pollution (SO_2, NO_2, etc) and dust may be expected during the construction due to mobilization of heavy equipments and construction work itself. However, there is no reception near the project site.	D	Construction
Water Pollution	No permanent water available at wadis in the proposing project sites. However, since there is no source seen around the sites, significant water pollution is unlikely expected.	Generation of high turbidity water is anticipated. However, there is no reception near the project site.	D	Construction
		Appearance of the reservoir may change water temperature and water quality. However, there is no reception near the project site.	E	Operation
Soil Contamination	Since there is no source seen around the sites, significant air contamination is unlikely expected.	Construction of dams will not lead to soil contamination.	C	-
Noise & Vibration	Since there is no source seen around the sites, significant noise and vibration contamination are unlikely expected.	Noise and vibration may occur due to heavy equipments and construction work itself. However, there is no reception near the project site.	D	Construction
Odour	Since there is no source seen around the sites, significant offensive odour is unlikely expected.	Construction of dams will not lead to generation of offensive odour.	C	-
Sediment	There is natural flow of sediments in wadi upon flooding.	Sediment is expected to be trapped at the reservoirs. However, MOWE considers these sediments may be effectively utilized as new topsoil.	D	Operation
Accident	There is no information on accident at the proposing project site.	Any impacts due to execution of the proposing project are not expected.	C	-

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

(2) Pipeline

The M/P consists of establishment of water distribution pipeline network with utilizing the existing, under construction and under planning pipelines. In addition to these pipelines, the Study Team proposed two new pipeline routes namely;

- Ras Mouhesan – Al Baha Line (approximately 100 km)
- Al Baha – Bisha / Al Alayah Line (approximately 180 km)

It is expected the construction facilities consist of pipelines and associated facilities such as booster pumps.

Since the pipelines are newly constructed and more than 50 km in length, environmental impact assessment (EIA) is required in accordance to the General Environmental Law and Rules for Implementation (2001).

Table5-4 ~ Table5-6 show the result of the projection on social and natural environments and pollution. The following describes the main impacts anticipated to be caused by execution of the project at IEE level.

(a) Flora and Fauna

The pipeline route between Ras Mouhesan and Al Baha lies approximately 20 km off in the southwest from the Jabal Shada protected area. Since there has been no biological surveys conducted, the flora and fauna inhabiting in the pipeline planning area is not known. However, the pipeline route is adjacent to the protected area and there is possibility that some similar environment may exist in the project site. In such occasion, some fauna may migrate to the area from the conservation zone. Despite uncertainty of the nature of the area, placement of the pipeline may potentially impact on the flora and fauna.

(b) Noise and Vibration

There have not been any noise and vibration survey conducted in the project site. Therefore, the noise and vibration level are not known. Pipeline itself does not generate noise and vibration. However, booster pump station which is required to pump the water to the mountain region is expected to be a source of noise and vibration. Since there are some villages and resident areas scattering around the project site, operation of the booster pump station may impact on the local environment.

Table 5-4 Simplified Leopold Matrix for the Construction of Pipelines (Social Environment)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Involuntary Resettlement	There are some towns and houses along the road. The precise routes of the pipelines have not been fixed.	Depending upon the routes of the pipelines, the lines may pass the housing areas and private owner's land.	D Unknown	Construction Operation
Local Economy	There are no large scale industrial and commercial areas along the proposing routes.	Construction works may lead to increase employment opportunities during the construction phase.	B	Construction
		Any impacts due to execution of the proposing project are not expected.	C	-
Land Use	The routes are along the existing roads.	Any impacts due to execution of the proposing project are not expected.	C	-
Local Community	There are some towns and houses scattering along the roads.	Any impacts such as split of local community due to execution of the proposing project are not expected.	C	-
Existing Infrastructure	There are some towns scattering along the roads.	Construction of water supply pipelines will contribute to improve local water supply networks	A	Operation
Poor, Indigenous and ethnic people	There are no indigenous and ethnic people inhabiting in the project sites.	Any impacts due to execution of the proposing project are not expected.	C	-
Cultural Heritage	There is no cultural heritage along the proposing routes.	Any impacts due to execution of the proposing project are not expected.	C	-
Local Conflict	There is no local conflict along the proposing routes.	Any impacts due to execution of the proposing project are not expected.	C	-
Water Right	The M/P of the Study examines the water rights and allocations.	The execution of the M/P will give positive impact.	A	Operation
Sanitation	There is no major issue relating to sanitation due to little population.	There is no major issue relating to sanitation due to little population.	C	-
Hazard & Infection	The HIV infection rate in the Kingdom is less than 0.01%.	Due to the Kingdom's strong policy on HIV, there is little impact foreseen for HIV infection among workers during the construction phase.	C	Construction

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

Table 5-5 Simplified Leopold Matrix for the Construction of Pipelines (Natural Environment)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Topography and Geology	The altitude of the proposing pipelines route consists of sea level till the top of Asir mountains.	The pipelines will be constructed on the surface on the ground along the existing roads. Thus, the impact on the topography and geology is considered as minor.	C	-
Soil Erosion	There is no information on soil erosion along the proposing project sites.	Construction of pipelines and booster pump stations will unlikely lead to soil erosion.	C	-
Groundwater	There is no information on groundwater along the proposing project sites.	The pipelines will be constructed on the surface on the ground or at a shallow depth. Therefore, the impact on the groundwater by the construction of pipelines is expected as minor.	C	-
Hydrological condition	There is no information on hydrology along the proposing project sites.	The proposing pipelines will be constructed along the existing roads. Therefore, the impact on the hydrological condition by the construction of pipelines is expected as minor.	C	-
Coastal Zone	Ras Mouhesan is a location along the coastal line. The area is barren land.	The proposing pipelines will unlikely impact on the coastal lines.	C	-
Flora and Fauna	There is Jabal Shada protected area extending on the route between Ras Mouhesan and Al Baha.	Since the protected areas and the adjacent areas, if the environment is similar, are rich with flora and fauna and there are some endemic and endangered species inhabiting in the area, construction works may affects on the behaviour on the creatures. Besides, placement on the pipelines on the surface of the ground may affects on migration of some small animals.	E	Construction
Meteorology	The areas belong to arid and semi-arid zone.	The proposing pipelines will not affect on the meteorology	C	-
Landscape	There is no landscape point near the proposing project sites.	Considering the scale of the pipelines, there will be minor impact on landscape	C	Operation
Global Warming	Raise of temperature is expected in accordance to the Fourth Assessment Report (AR4) by ICPP	It is expected there may be CO_2 emitted from the booster pump stations. However, considering the capacity, there will be minor impact on global warming.	C	Operation

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

Table 5-6 Simplified Leopold Matrix for the Construction of Pipelines (Pollution)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Air Pollution	There is no information available on air pollution in the proposing project sites. However, since there is no source seen around the sites, significant air pollution is unlikely expected.	Heavy equipments during the construction emit pollutants. However, the impact is minor.	D	Construction
		It is expected there may be pollutants emitted from the booster pump stations. Considering the capacity, there will be minor impact on air pollution.	D	Operation
Water Pollution	There is no water along the proposing pipeline routes in most of the areas.	Generation of high turbidity water is anticipated. However, there is no reception near the project site.	D	Construction
		The pipelines carry water, therefore, there will be no soil contamination expected from leakage.	C	Operation
Soil Contamination	Since there is no source seen around the sites, significant air contamination is unlikely expected.	Construction activity is unlikely generate contamination.	C	Construction
		The pipelines carry water, therefore, there will be no soil contamination expected from leakage.	C	Operation
Noise & Vibration	Since there is no source seen around the sites, significant noise and vibration is unlikely expected.	Construction activity generates noise and vibration. Special attention in resident areas is necessary.	D	Construction
		The booster pumps generate noise and vibration.	E	Operation
Odour	Since there is no source seen around the sites, significant offensive odour is unlikely expected.	The proposing pipelines unlikely generate offensive odour.	C	-
Sediment	There are no sediments deposited along the pipeline routes.	The proposing pipelines will not generate sediments.	C	-
Accident	There is no information on accident at the proposing project site.	Any impacts due to execution of the proposing project are not expected.	C	-

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

(3) Desalination Planted

One unit of desalination plant is expected to be constructed in Ras Mouhesan and at the northern area of Jizan City.

It is expected the proposing facility consist of the main plant with reverse osmosis membrane method, intake and drainage culvert/pipelines and fuel storage tanks.

In accordance to the General Environmental Law and Rules for Implementation (2001), environmental impact assessment (EIA) is required for construction of all desalination plant.

Table 5-7~ Table 5-9 shows the result of the projection on social and natural environments and pollution. The following describes the main impacts anticipated to be caused by execution of the project at IEE level.

(a) Water Pollution

The desalination plant is planned to be constructed along the coastal zones. There has been no sea water quality survey conducted, thus the water quality in the surrounding sea is not known. The plant intakes sea water and produces fresh water through separation of salt and fresh water by osmosis process. The separated salt water during the osmosis process is normally discharged into the sea as effluent. Yet, the recent academic studies revealed the effluent contains rather high concentration of salt and carbon dioxide than the ones in the sea. The exact impact of the brine water has been still under academic research and is not certain. The proposing facility is expected to generate similar brine water as effluent. Therefore, there may be some potential impact diffusing on aquatic biota and the marine environment.

(b) Pollution

The desalination plant is basically a factory to produce fresh water and consumes fuels. Therefore, the plant potentially emits air pollutants. However, such air pollution may be eased by introduction of anti air pollution devices. Additionally, there is no villages and residential areas in the adjacent area of the plant. Since there is no reception exists, the impact of the pollution may be limited.

Table 5-7 Simplified Leopold Matrix for the Construction of Desalination Plant (Social Environment)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Involuntary Resettlement	There is no resident area existing around the proposing construction site. The nearest town locates approximately 60 km in south.	Depending upon the location of the plant, it may locate in private owner's lands.	D	Construction Operation
Local Economy	There are no large scale industrial and commercial areas along the proposing sites.	Construction works may lead to increase employment opportunities during the construction phase.	B	Operation
		Operation of the plant may lead to increase employment opportunities of the local residents.	B	Operation
Land Use	The proposing area is barren land along coastal line.	Any impacts due to execution of the proposing project are not expected.	C	-
Local Community	The nearest resident area located approximately 60 km in south.	Any impacts such as split of local community due to execution of the proposing project are not expected.	C	-
Existing Infrastructure	There is no existing infrastructure near the proposing site.	Any impacts due to execution of the proposing project are not expected.	C	-
Poor, Indigenous and ethnic people	There are no indigenous and ethnic people inhabiting in the project site.	Any impacts due to execution of the proposing project are not expected.	C	-
Cultural Heritage	There is no cultural heritage along the proposing site.	Any impacts due to execution of the proposing project are not expected.	C	-
Local Conflict	There is no local resident in the proposing site.	Any impacts due to execution of the proposing project are not expected.	C	-
Water Right	The M/P of the Study examines the water rights and allocations.	The execution of the M/P will give positive impact.	A	Operation
Sanitation	There is no major issue relating to sanitation due to little population.	Improvement of water supply lead to improvement of sanitation	B	-
Hazard & Infection	The HIV infection rate in the Kingdom is less than 0.01%.	Due to the Kingdom's strong policy on HIV, there is little impact foreseen for HIV infection among workers during the construction phase.	C	Construction

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

Table 5-8 Simplified Leopold Matrix for the Construction of Desalination Plant (Natural Environment)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Topography and Geology	The proposing site is at the coastal line.	Considering the scale of the plant, the construction work unlikely impact on the topography and geology.	C	-
Soil Erosion	There is no information on soil erosion along the proposing project sites.	Construction of the proposing facility will unlikely impact on soil erosion.	C	-
Groundwater	There is no information on groundwater along the proposing project sites. However, since the location is along the coastal line, shallow water table and saline intrusion are expected.	The proposing project will not plan to intake or discharge into underground. Therefore, the impact due to the execution of the project is considered as minor.	C	-
Hydrological condition	There is no information on hydrology along the proposing project sites. The plant is located along the coastal line.	Considering the scale of the plant, the discharge from the plant will not effect on the oceanic currency.	D	Operation
Coastal Zone	Ras Mouhesan is a location along the coastal line. The area is barren land.	Considering the scale of the plant, the proposing plant will not significantly change the shape and nature of the coastal zone.	D	Construction
Flora and Fauna	There has no extensive investigation on both terrestrial and aquatic flora and fauna conditions.	Though the site is barren land, construction of the plant may impact on the local flora and fauna.	D	Construction
		It is known that the discharge water contains high concentration of CO_2 and salt. Nevertheless the impact on the brine water is academically under still investigation, it is anticipated brine water may effect on the behaviour of aquatic flora and fauna.	E	Operation
Meteorology	The areas belong to arid and semi-arid zone.	The proposing plant will not affect on the meteorology	C	-
Landscape	There is no landscape point near the proposing project sites.	Considering the scale of the plant, there will be minor impact on landscape	C	Operation
Global Warming	The First National Communication of the Kingdom of Saudi Arabia (Presidency of Meteorology and Environment, 2005) pointed desalination plant is the third largest source of CO_2 emission in the Kingdom in 1990.	It is expected there may be CO_2 emitted from the plant due to combustion of fuel. However, considering the capacity as a plant, there will be minor impact on global warming.	C	Operation

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

Table 5-9 Simplified Leopold Matrix for the Construction of Desalination Plant (Pollution)

Item	Current Condition	Nature of Impact	Impact & Magnitude	Duration Phase
Air Pollution	There is no information available on air pollution in the proposing project sites. However, since there is no source seen around the sites, significant air pollution is unlikely expected.	Heavy equipments during the construction emit pollutants and appropriate measures are required.	D	Construction
		It is expected there may be pollutants emitted from the plant and appropriate measures are required.	D	Operation
Water Pollution	The proposing plant is located along the coastal line.	Generation of high turbidity water is anticipated during the construction phase.	D	Construction
		It is known that the discharge water contains high concentration of CO_2 and salt. It is anticipated brine water may effect on the local oceanic water quality. However, such effect may be dismissed by mixing with the main oceanic currency.	E	Construction
Soil Contamination	Since there is no source seen around the sites, significant air contamination is unlikely expected.	Construction activity is unlikely generate contamination.	C	Construction
		Storage tanks for heavy oils may be equipped at the plant.	D	Operation
Noise & Vibration	Since there is no source seen around the sites, significant noise and vibration are unlikely expected.	Construction activity generates noise and vibration.	D	Construction
		The plant generates noise and vibration.	D	Operation
Odour	Since there is no source seen around the sites, significant offensive odour is unlikely expected.	The proposing plant unlikely generate offensive odour.	C	-
Sediment	There are no sediments deposited along the pipeline routes.	The proposing plant will not generate sediments.	C	-
Accident	There is no information on accident at the proposing project site.	Any impacts due to execution of the proposing project are not expected.	C	-

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

5.2 Mitigation Measures for Potential Adverse Impacts

(1) Mitigation Measures for Main Adverse Impacts

Table 5-10 shows the mitigation measures for main adverse impacts for those items high or medium adverse impact projected.

Table 5-10 Mitigation Measures for Main Adverse Impacts

Item	Dam	Pipeline	Desalination	Possible Mitigation Measures
Involuntary Resettlement	D	D	D	・ Selection of detour pipeline route ・ Mining the pipeline ・ Compensation of the land
Groundwater	**E**	C	C	・ Appropriate recharge into the underground from dam site.
Hydrological condition	**E**	C	C	・ Appropriate discharge from dam site
Coastal Zone	C	C	D	・ Examination of minimization of land reform at the design stage
Flora and Fauna	D	**E**	**E**	・ Understanding of the biodiversity at the project sites through biodiversity study ・ Selection of detour pipeline route from the protected and high biodiversity areas ・ Mining the pipeline
Air Pollution	D	D	D	・ Sprinkling for dust ・ Introduction of low air pollution type of heavy equipments ・ Encouragement of appropriate operation of heavy equipments ・ Examination of introduction of low air pollution types of facilities for booster pump stations and desalination plants
Water Pollution	**E**	D	**E**	・ Extension of effluent pipeline to the offshore for desalination plant ・ Surface water discharge or introduction of selective intake facility for dam
Soil Contamination	C	C	D	・ Installation of appropriate storage facility for oils and liquids.
Noise & Vibration	D	**E**	D	・ Selection of appropriate site ・ Compliance of the construction hours ・ Install of noise barrier ・ Selection of appropriate wall materials.
Sediments	D	C	C	・ Appropriate measures for prevention of sedimentation in the reservoir shall be examined in the detailed design stage.

A~E indicates likely causing A:: significant favourable impact, B: slight favourable impact, C: no or little impact, D: slightly adverse impact and E: significant adverse impact

(a) Involuntary Resettlement (Pipeline)

Since the concrete project sites for all components in the M/P have not been fixed at this stage, many unknown factors remain and magnitude of the impact is unpredictable. However, pipelines with the length of approximately 280 km in total may pass through some urban areas and private owner lands.

Primarily selection of detouring route for those areas should be considered. In case if detouring route is not economically, financially and environmentally feasible as well as appropriateness from engineering point of view, mining of the pipelines underground shall be selected as a mitigation measure. The compensation of the land shall be chosen as a last choice.

(b) Groundwater and Hydrological Condition (Dam)

Although there is no permanent water flow available at the dam sites, it is believed that the wadi functions as a source for groundwater recharge upon flood occasion. Therefore, construction of the dams obstacles these natural recharging and may lead to groundwater lowering at the downstream as well as natural flow in wadi.

In a part of the M/P, effective utilization of water in dam reservoir is examined. Under the current status, the groundwater recharge is limited to the flood occasion. In this examination, continuous flow regime of the wadi by controlled discharge from the stored water in the reservoirs was simulated. Controlled discharge from the reservoir to the downstream may enable permanent flow of water in wadi. If recharging wells are installed at the downstream of the dams under such condition, it is expected that discharging water from the dam continuously recharge groundwater at the present or further level. Therefore, controlled discharge from the dam is recommended as a mitigation measure for improvement of groundwater and hydrological environment.

(c) Flora and Fauna (Pipeline)

It is expected that the pipeline between Ras Mouhesan and Al Baha with an approximately length of 100 km may pass the area adjacent to a protected area, Jabal Shada, located in the south of Al Baha city. This isolated mountain massif supports an exceptionally rich flora; with approximately 500 plant species recorded, including 63 key plant taxa including endemics and Afro-tropical relicts, it is the single site of highest botanical diversity known in Saudi Arabia. The exceptional floral diversity of Jabal Shada al- A‘la, together with the presence of griffon vultures and endemic birds of the southwestern mountains and carnivores, including the rock fox, caracal, striped hyena, wolf, genet, and reportedly the Arabian leopard, makes this small protected area a unique treasure of biological diversity. Small communities on the mountain grow a distinctive variety of coffee and other crops in terraced fields.

The pipeline is expected to be placed in parallel to the existing road. A part of the pipeline route between Ras Mouhesan and Al Baha City passes the adjacent area of Jabal Shada Protected area. Since the behaviour of the resident fauna is not fully understood, prior to commencement of elaboration of countermeasures, it is recommended to conduct an intensive biodiversity survey. Key countermeasures considered at this stage are (i) Selection of detour route if mechanically, engineering point of view, financially and environmentally feasible, and (ii) Mining of the pipeline under the ground if any animal paths exist for their migration.

(d) Air Pollution (Dam, Pipelines and Desalination Plant)

It is expected that execution of construction works may generate temporary air pollution such as dust, NOx and SOx during the construction period. For reducing the impact of dust, the contractors shall comply the environmental protection and management including sprinkling water for reducing the generation of dust, encouragement of introduction of low pollution types of heavy equipments and appropriate operation of these equipments. Besides, operation of booster pump stations in pipelines and desalination plants may lead to cause of air pollution. For these facilities, introduction of low emission types of the facilities shall be examined during the detailed design stage.

(e) Water Pollution (Dam and Desalination Plant)

Appearance of reservoir is known to cause change in water quality including cold water discharge, eutrophication and high turbidity water discharge due to creation of a closed water area. Currently no water quality survey has conducted at both planned sites. Therefore, the precise impact of the water quality after appearance of the dam is not projected. However, construction of the dams possibly affects on the water quality. Therefore, an EIA study conducted during the feasibility study phase shall carefully examine the water quality of the dam sites. If significant adverse impact is expected, necessary countermeasures including installation of selective intake facility and its operation rule shall be examined.

The effluent from desalination plant contains high concentration of salt and carbon dioxide (CO_2). This effluent occurs due to the result of osmosis process. Recent academic researches indicate there

may be potential impact of the brine water on the marine biology, especially benthos, aquatic plants, etc.

Despite the fact the precise impact on the aquatic environment is still under discussion in academic world, it may be necessary to conduct appropriate countermeasures as; (i) extensive aquatic biodiversity research prior to commencement of the project and understanding the environment, (ii) extension of discharge pipes till the offshore, where the current is strong enough for mixing and diluting the effluent, and (iii) introduction of reclaimed waste water into the effluent to dilute the concentration of the salt and CO_2.

(f) Soil Contamination (Desalination Plant)

It is expected that some oils for fuel may be stored at the desalination plant for its operation of the facility. Since storage of such liquids may become a potential source of contamination, appropriate storage facility shall be designed and constructed.

(g) Noise and Vibration (Pipeline)

The pipeline itself will not generate noise and vibration. However, since the pipeline extend from the coastal line up to the top of the Asir Mountain with approximately 2,000 m in altitude, it is necessary to install a booster pump station before elevation. The pump station potentially becomes the source of noise and vibration.

The location of the booster pump station shall be at least 100 m off set from the residential area. The distance of 100 m reduces approximately 28 dB of power level owing to attenuation. Additionally, appropriate wall material for the architecture shall be considered.

(h) Sedimentation (Dam)

Sedimentation or accumulation of sediments in the reservoir is the common issue for dam. Although the rocks near the proposing dams are consolidated and generation of issue of sedimentation may be minor, appropriate sedimentation measures such as construction of sediment traps or sabo dam at the inflow of the reservoir, construction of selective intake facility, etc. shall be examined during the detailed design stage if sedimentation is forecasted based on the detailed topographical and geological surveys. Furthermore, the effective use of trapped sediments in the reservoir shall be studied.

(2) Mitigation Measures for Other Impacts

(a) Involuntary Resettlement (Dam and Desalination Plant)

The proposing project sites are barren land. There is no resident area at the sites. However, prior to commencement of the projects, the ownership of the land shall be inspected.

(b) Land Use (Dam)

According to the study for Hirjab Dam in the Environmental Impact Assessment for Asir Dams, the proposing area is utilized as a grazing area. Considering the nature of the land, it is estimated the land is not frequently used for grazing activity. However, the executing agency shall socialize with the local residents utilizing the area prior to the commencement of the project.

(c) Hazard and Infections, and Accident (Dam, Pipeline and Desalination Plant)

Conduction of construction works may lead to accident. Furthermore, construction works assemble a number of workers. The executing agency is strongly encouraged to put articles of safety and infection education in the contract document and supervise the contractor’s activity.

(d) Landscape (Pipeline)

The proposing pipelines are placed in parallel to the existing roads. Considering the size of the pipelines, the impact of the landscape is minor in comparison to the existing roads. However, the executing agency shall put maximum effort to align the pipeline in match with the skylines.

(e) Global Warming (Pipeline and Desalination Plant)

The booster pump stations and the desalination plant itself become the source of emission of carbon

dioxide (CO_2). In particular, desalination plant is categorized as one of the major source of green house gas in the Kingdom.

For mitigating the impact on global warming, the executing agency shall employ the recent pump and plant technology for minimizing the emission of carbon dioxide (CO_2).

(f) Flora and Fauna (Dam and Desalination Plant)

Since there has been no intensive flora and fauna studies conducted at the proposing project sites, the current status of the biodiversity condition is unknown. However, considering the proposing project sites are currently barren land and no particular vegetation group observed from satellite image and topographical maps, it is deemed the biodiversity in the sites are low. Nevertheless, although there is no protected area at the proposing project sites, special attentions shall be paid for flora and fauna. Upon the commencement of feasibility study, a survey for biodiversity shall be conducted. Based on the key findings of the survey, further mitigation measures shall be elaborated.

(g) Air Pollution (Dam, Pipeline and Desalination Plant)

The proposing project sites are relatively isolated from the resident areas. At least, there are no concentrated resident areas in radius of 1 km around the sites for all components. Nevertheless, it is expected construction works may lead to emission of air pollutant such as gasses (SOx, NOx, CO, CO_2, etc) and dusts, it may be concluded there is no reception of the pollution and the impact of the environment is minor. Yet, considering the current raise of concern on the environment and protection of the natural environment, the contractors are encouraged to introduce low emission types of heavy machinery for conduction of construction works.

(h) Water Pollution (Pipeline and Desalination Plant)

During the construction works, high turbidity water may occur. The contractor shall set a sedimentation pond or equivalent device to settle the suspended particle in the effluent before discharge into the environment from the construction site. The executing agency shall monitor the contractor's measures.

(i) Noise and Vibration (Dam, Pipeline and Desalination Plant)

Construction works generate noise and vibration. Nevertheless each proposing project site except pipeline is off set from the resident areas, the executing agency shall maximum attention on generation of noise and vibration through encouraging the contractors to introduce low noise and vibration types of the heavy machinery. Such point shall be written in the contract document.

6. Alternative Scenarios

6.1 Selection of Scenarios

The JICA Guidelines describes "*JICA introduces the concept of Strategic Environmental Assessment (SEA) when conducting Master Plan studies, etc.*" whereas there is no description on SEA in the Kingdom's regulations. The following section will discuss the alternative scenarios and their evaluation in respect to social and environmental consideration. However, due to uncertainty of the functions, scale and exact locations of the proposing facilities, and the limitation of available data and information, it should be noted the result of the evaluation will contains a number of uncertainty.

As alternative case, the following scenarios are considered.

Table 6-1 Selection of the Alternative Scenarios

Scenario	Zero Option	M/P Scenario	Desalination Scenario
Facility	N/A	2 Dam 2 lines of Pipeline 2 Desalination Plant	Pipelines Desalination Plants (No. not set)
Description	No facility will be constructed and the social and environmental conditions will proceed as natural	As on the M/P	A number of desalination plants will be constructed. The treated water will be delivered by pipelines which are connected to individual town/city and plants.
Justification	As on the definition of SEA	As on the M/P	Saudi Government reportedly plans to increase the number of desalination plant at 150% in comparison to the present number.

6.2 Evaluation of the Alternative Scenarios

The result of the evaluation of the alternative scenarios are shown in Table 6-2 ~Table 6-7. The followings are the summary of the comparison.

(1) Zero Option

(a) Social Environment

The current main issues relating to water attribute to non-systematic water distribution balance and water right. Under this scenario, this situation will continue. It is anticipated some regions may face to severe water shortage. Such condition may trigger to local conflict and deterioration of the hygiene conditions.

(b) Natural Environment

Despite the fact the current condition continues, it is expected groundwater lowering may be observed in some region. Such condition is not favourable not only for the human use (domestic, agricultural and industrial use) but may affects on regional vegetation. Therefore, potentially lowering of groundwater may lead to deterioration of natural environment.

(c) Pollution

Under this scenario, no pollution is projected because no artificial structures would be constructed.

(2) M/P Scenario

(a) Social Environment

The M/P was elaborated to establish the future appropriate water distribution. A component of the plan describes the water allocations and water right. If the M/P is applied, water right and allocation will be established. Under such conditions, some positive impact on local water use and economy is expected.

(b) Natural Impact

Due to the construction of dams, pipelines and a desalination plant, some adverse impacts are anticipated. However, appropriate mitigation measures as described in 5.2 Mitigation Measures for Potential Adverse Impacts mitigate the magnitude of the adverse impact. Yet, since a part of the pipeline is potentially passed through the protected area despite the fact the pipeline is planned to be placed along the existing road, special attention for conservation of flora and fauna is necessary. Besides, execution of the M/P may affect positive impact on groundwater environment.

(c) Pollution

Due to the construction of dams, pipelines and a desalination plant, some adverse impacts are

anticipated. Considering the capacity of the facilities planned under the M/P, the adverse impacts such as air pollution, noise and vibration, are expected to be minor. Appearance of reservoirs may potentially alter the water quality. Further studies may be required in prior to elaborate mitigation measures.

(3) Desalination Scenario

(a) Social Environment

Under this scenario, water distribution capacity increases in comparison to the present condition. This may give positive impact on such as local hygiene conditions. However, the issues relating to water right, in particular natural water and groundwater, will remain as present.

(b) Natural Environment

The natural environment will continue as projected under the zero option. Since desalination plant is one of the major emission sources for green house gas due to combustion of fuel in the Kingdom, it should be noted that construction of a number of plants may adversely impact on climate change although individual plant emission scale is minor.

(c) Pollution

Such pollution including air pollution due to combustion of fuel, noise and vibration due to operation of the plants and water pollution due to brine water, potentially affects on the local social and natural environment.

Table 6-2 Evaluation of Scenarios (Social Environment 1/2)

Item	Zero Option	M/P Scenario	Desalination Plant Scenario
Involuntary Resettlement	No Resettlement occurs. However, shortage of water may lead to resettlement.	Impact and magnitude depends on the precise location of the project sites.	Impact and magnitude depends on the precise location of the project sites.
	C	Unknown	Unknown
Local Economy	Lack of water distribution may deteriorate local economy	Increase in stable water supply will encourage the local economy development.	Increase in stable water supply will encourage the local economy development. However, those sectors relying on groundwater may deteriorate.
	D	A	B
Land Use	Current land use and some urbanization will continue.	Considering the scale of the project, impact on the land use is minor.	Considering the scale of each plant, impact on the land use is minor.
	C	C	C
Local Community	Local community will remain as present.	The projects do not have nature to split local community.	The projects do not have nature to split local community.
	C	C	C
Existing Infrastructure	Existing infrastructures will remain as present	The projects do not have nature to impact on the existing facilities.	The projects do not have nature to impact on the existing facilities.
	C	C	C
Poor, Indigenous and ethnic people	Current conditions remain.	No indigenous and ethnic people stays at the project sites	Impact and magnitude depends on the precise location of the project sites.
	C	C	Unknown
Cultural Heritage	Current conditions remain.	The projects do not have nature to impact on cultural heritage	Impact and magnitude depends on the precise location of the project sites.
	C	C	Unknown
Local Conflict	Currently no conflict observed. However, shortage of water may potentially lead to water conflict in the future.	The projects do not have nature to impact on local conflict	The projects do not have nature to impact on local conflict
	D	C	C

A: High positive impact, B: Medium or Low positive impact, C: No impact, D: Medium or Low adverse impact, E: High adverse impact

Table 6-3 Evaluation of Scenarios (Social Environment 2/2)

Item	Zero Option	M/P Scenario	Desalination Plant Scenario
Water Right	Currently no systematic water right exists. This situation is expected to continue and may lead to shortage of water and local conflict in the future.	The M/P focus on the water distribution among domestic, agricultural and industrial use. Appropriate water distribution is essential for prevention of water shortage.	Domestic water is expected to be supplied. However, water distribution problems for agricultural and industrial use remains. This may lead to shortage of water in some regions.
	E	A	B
Sanitation	Shortage of water may potentially lead to deterioration of sanitation environment.	Appropriate water distribution is believed to improve local sanitation conditions.	Appropriate water distribution is believed to improve local sanitation conditions.
	D	A	A
Hazard & Infection	Current conditions remain.	The projects do not have nature to impact on hazard and infection.	The projects do not have nature to impact on hazard and infection.
	C	C	C

A: High positive impact, B: Medium or Low positive impact, C: No impact, D: Medium or Low adverse impact, E: High adverse impact

Table 6-4 Evaluation of Scenarios (Natural Environment 1/2)

Item	Zero Option	M/P Scenario	Desalination Plant Scenario
Topography and Geology	Current conditions remain.	The projects do not have nature to impact on topography and geology	The projects do not have nature to impact on topography and geology
	C	C	C
Soil Erosion	Current conditions remain.	The projects do not have nature to impact on topography and geology	The projects do not have nature to impact on topography and geology
	C	C	C
Groundwater	Groundwater lowering is reported in some regions. This situation is expected to continue under zero option and some regions may face to shortage of water due to lack of groundwater resources.	A part of the M/P examines and concluded the measures for prevention of groundwater lowering. Execution of M/P will lead the groundwater conservation and appropriate groundwater use.	This scenario will not effect on the conservation of groundwater. Therefore, as zero option, some regions may face to shortage of water due to lack of groundwater resources.
	E	A	B
Hydrological Condition	Current conditions remain	The projects do not have nature to hydrological condition	Current conditions remain
	C	C	C
Coastal Zone	Current conditions remain	The projects do not have nature to impact on the existing facilities.	Construction of individual plant will not significantly affect on the coastal zone.
	C	C	C
Flora and Fauna	Current conditions remain. However, groundwater lowering may lead to deterioration of regional flora and fauna.	Construction and facilities may effect on the project sites' natural environment. Such impact may be mitigated by execution of mitigation measures.	Construction of many pipelines directly destructs the natural environment. Additionally brine water is anticipated to adversely impact on aquatic environment.
	D	D	D
Meteorology	Current conditions remain	The projects do not have nature to impact on meteorological condition.	The projects do not have nature to impact on meteorological condition.
	C	C	C

A: High positive impact, B: Medium or Low positive impact, C: No impact, D: Medium or Low adverse impact, E: High adverse impact

Table 6-5　Evaluation of Scenarios (Natural Environment 2/2)

Item	Zero Option	M/P Scenario	Desalination Plant Scenario
Landscape	Current conditions remain.	The projects do not have nature to impact on the change in landscape with considering the size of the projects.	The projects do not have nature to impact on the change in landscape with considering the size of the projects.
	C	C	C
Global Warming	Current conditions remain.	Considering the capacity of the booster pump station and the desalination plant, the projects do not have nature to impact on global warming.	Emission of carbon dioxide from individual plant is minor and does not contribute to global warming significantly. However, as a group of construction of desalination plant, the emission of green house gas may become considerable. It should be noted the Government of Saudi Arabia described desalination plant is the third largest source of green house gas emission in 1990 level.
	C	C	E

A: High positive impact (+2 points), B: Medium or Low positive impact (+1 point), C: No impact (0 point), D: Medium or Low adverse impact (-1 point), E: High adverse impact　(-2 points)

Table 6-6 Evaluation of Scenarios (Pollution 1/2)

Item	Zero Option	M/P Scenario	Desalination Plant Scenario
Air Pollution	Current conditions remain.	Considering the capacity of the emission from the booster pump station and the desalination plant, the projects do not have nature to impact on air pollution.	Emission of air pollutant from individual plant is minor and does not contribute to global warming significantly. However, as a group of construction of desalination plant, the emission of pollutants may become considerable.
	C	C	D
Water Pollution	Current conditions remain.	Operation of desalination plant may lead to deterioration of aquatic environment due to discharge of brine water. Additionally, appearance of reservoir may alter the water quality. Therefore, appropriate measures are required.	Operation of desalination plant may lead to deterioration of aquatic environment due to discharge of brine water. Therefore, appropriate measures are required.
	C	D	D
Soil Contamination	Current conditions remain.	The projects do not have nature to impact on the soil environment with considering the nature of the projects.	The projects do not have nature to impact on the soil environment with considering the nature of the projects.
	C	C	C
Noise & Vibration	Current conditions remain	The booster pump and the desalination plant generate noise and vibration. Therefore, appropriate measures are required.	The desalination plant generates noise and vibration. Therefore, appropriate measures are required.
	C	D	D
Odour	Current conditions remain	The projects do not have nature to impact on odour with considering the nature of the projects.	The projects do not have nature to impact on odour with considering the nature of the projects.
	C	C	C

A: High positive impact (+2 points), B: Medium or Low positive impact (+1 point), C: No impact (0 point), D: Medium or Low adverse impact (-1 point), E: High adverse impact (-2 points)

Table 6-7 Evaluation of Scenarios (Pollution 2/2)

Item	Zero Option	M/P Scenario	Desalination Plant Scenario
Sediment	Current conditions remain.	The projects for the pipeline and the desalination plant do not have nature to impact on sedimentation with considering the nature of the projects. However, operation of dam may lead to issue of sedimentation in the future unless appropriate measures are taken.	The projects do not have nature to impact on sedimentation with considering the nature of the projects.
	C	C	C
Accident	Current conditions remain.	The projects do not have nature to impact on accident with considering the nature of the projects.	The projects do not have nature to impact on accident with considering the nature of the projects.
	C	C	C
Overall Evaluation	**-8 points**	**+5 points**	**-3 points**
	3rd rank	**1st rank**	**2nd rank**

A: High positive impact (+2 points), B: Medium or Low positive impact (+1 point), C: No impact (0 point), D: Medium or Low adverse impact (-1 point), E: High adverse impact (-2 points)

6.3 Alternative Route for Pipeline (Ras Mouhesan – Al Baha)

(1) Selection of Alternative Route for Pipeline (Ras Mouhesan – Al Baha)

It is expected the pipeline route between Ras Mouhesan and Al Baha with the distance of approximately 100 km passes nearby a protected area, Jabal Shada Protected Area. Despite the fact that the planned route does not intrude the protected area and the pipeline is expected to be constructed along the existing road, alternative route was examined. Considering the construction environment, the alternative route was selected from those areas where an existing road extends from Ras Mouhesan to Al Baha city.

(2) Evaluation of the Pipeline Route (Ras Mouhesan – Al Baha)

The summary of the comparison is shown in Table 6-8. Considering the total length, social and natural environment, the M/P route is superior to the alternative route.

Table 6-8 Evaluation of the Pipeline Route

Item	M/P Route	Alternative Route
Approx. Length	100 km	165km
Protected Area	The route will no invade the protected area.	The route may graze the northern edge of the area.
Social Environment	Three villages exist on the route. However, detouring route on the wadi or foot of hills is available.	Several villages scatter. It is inevitable to pass the cultivated and residential area on the top of the hill near Al Baha City. Additionally, though there is no cultural reservation area, several old houses and castles locate along the route.
Natural Environment	There are some trees and grass scatter near the route. Yet, there is no intensive grass or forest land exists on the course of the line due to existence of the road.	There are some trees and grass scatter near the route. Yet, there is no intensive grass or forest land exists on the course of the line due to existence of the road.

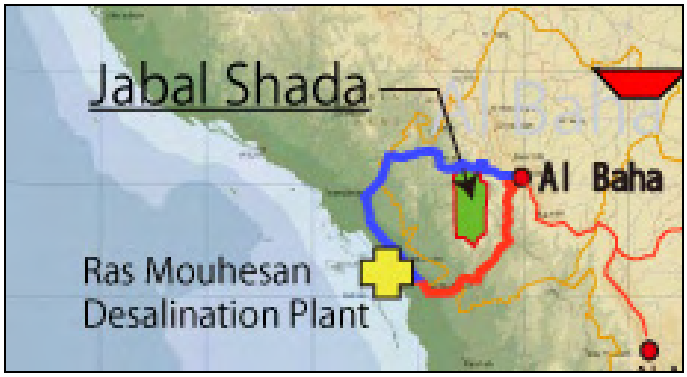


Figure 6-1 Routes of Pipeline between Ras Mouhesan and Al Baha City

7. Recommendations

- The integrated renewable water resources development programme itself will not adversely affect on the socio-environmental condition.
- The M/P itself was prepared for improvement of “sustainable development and management of renewable water resources” and “good governance on water resources”. Therefore, the M/P will cause favourable impacts on comprehensive water allocation and establishment of water right. Increase in available water is expected to diffuse to development of local economy and local community, hygiene and sanitation condition, groundwater and hydrological environment.
- The M/P, prepared by the Study Team, consists of utilization of the existing, under construction and planned facilities by MOWE and new facilities including the new dams, pipelines and

desalination plants proposed by the Study Team. It is anticipated that the newly proposed facilities including dams, pipelines and desalination plants, potentially cause some adverse impacts including temporary water pollution, noise and vibration, flora and fauna, etc.).

- Therefore, the mitigation measures for the possible adverse impact were considered as one the activities of this M/P study. The concrete construction locations or scale of the proposing facilities are not precisely identified yet at the M/P phase. Additionally, due to limitation of the information, the projection was conducted at IEE level. Therefore, the Kingdom of Saudi Arabia shall evaluate more detail social and environmental impacts and their affected area by the proposing facilities after the completion of this study by JICA Study Team.
- In accordance to the Article five (5) of the General Environmental Law and Rules for Implementation (2001) and Appendix-2 of its associated regulation on the Environmental Standard, Environmental Impact Assessment are required for all newly proposed facilities (i.e. dams, pipelines and desalination plants) at Feasibility Study Stage.
- It is recommended that the Kingdom shall conduct EIA and prepare social and environmental considerations particularly for the items that adverse impacts are possibly projected.

Attachment-1 Category for Environmental Assessment

Source: Environmental Standard in the General Environmental Law and Rules for Implementation (2001)

First Category

- Textile and ready made clothing factories located inside industrial parks, which do not have dyeing processes.
- Rubber and plastic factories located inside industrial parks, which rely on heating processes which do not produce hazardous emissions (as furan gas is emitted by heating raw PVC).
- Foodstuff and beverage processing and canning factories located inside industrial parks.
- Leather, shoe and bag factories located inside industrial parks, which do not involve any tanning processes.
- Minor expansions of power lines not exceeding 10% of their total lengths.
- Expansion of existing roads not exceeding 15% of the existing length or width.
- Modification or expansion of an existing marine berth which does not involve any pollution impact or effective dredging of the site.
- Expansion of irrigation and drainage installations by not more than 10% of the installation.

Second Category

- Steel and iron mills and metal foundries whose production is less than 150 tons per day.
- Metal and iron treatment and galvanization plants with a production of less than 25 tons per day.
- Engine shops, machine, pipe and boiler works.
- Auto and vehicle fabrication and assembly works.
- Glass factories.
- Block, brick, ceramic, china and porcelain factories.
- Chemical, drug, paint, detergent and adhesive plants with capacities of less than 25 tons per day.
- Quarry, crushing, asphalt and batching and mixing and prefab. Concrete plants.
- Chemical blending and packing works outside industrial parks.
- Paper and carton factories.
- Fabric dyeing works at less than 10 tons per day.
- Fabric, weaving and cellulose factories located outside industrial parks.
- Rubber and plastic plants located outside industrial parks.
- Foodstuff and vegetable canning plants with a capacity in excess of 1000 tons per year.
- Livestock and poultry abattoirs and butchery shops.
- Broiler poultry breeding projects and abattoirs of less than 20000 birds per cycle.
- Tannery works producing less than one million square feet annually or 750 animal hides per day.
- Fish and marine product processing plants producing more than 1000 tons per year.
- Animal fodder production projects.
- Non petroleum based chemical production and storage sites.
- Leather, bag and shoe factories not involving tannery operations located outside industrial parks.
- Industrial and petroleum waste recycling and reuse facilities.
- Offshore and onshore pipeline projects, less than 50 km in length.
- Petroleum, gas and petroleum product storage facilities (other than gasoline stations).

Third Category

- Steel and cast iron plants with a production capacity in excess of 150 tons per day.
- Metal electroplating plants with a capacity in excess of 25 tons per day.
- Cement plants.
- Metal extraction.
- Major chemical and petrochemical industries, such as fertilizers, petroleum products, drugs…etc.
- Paint, solvent and detergent industries which produce in excess of 50 tons per day.

- Pesticide and insecticide plants.
- Major paper production plants.
- Textile dyeing works producing in excess of 10 tons per day.
- Tannery works producing in excess of a million square feet per year.
- Lead smelting plants.
- Vegetable and animal oil and fat refining processes.
- Exploration, extraction, petroleum and gas development operations.
- ***Offshore and onshore pipeline in excess of 50 km in length.***
- Oil and gas separation and treatment facilities.
- Petroleum and petroleum product storage facilities in excess of 15000 cubic meter capacity.
- Oil refining installations.
- Petrochemical industries.
- Thermal power stations, in excess of 30 megawatts capacity.
- Nuclear power plants.
- Solar power villages and plants
- International trans-boundary power transmission lines and stations.
- ***Water desalination plants.***
- Major conveyance systems, such as causeways, underground transport, railways, express ways and roads in excess of 50 km in length.
- Civilian and military airports.
- Ports, expansions in berths, yards…etc.
- Tourist resorts and projects in the vicinity of sensitive ecosystems, archeological sites, sanctuaries, residential developments and the coastline.
- ***Public irrigation and sanitary drainage systems and their expansion, including dams …etc.***
- Waste water treatment plants.
- Waste water treatment plant discharges in to seas and valleys.
- Model cities and industrial zone construction projects.
- Urban development projects, their expansion and public residential complexes.
- Consolidated crushers, cement and asphalt batching complexes in cities and provinces.
- Municipal public waste liquid waste disposal and storage facilities (in the absence of processing plants in the area).
- Medical waste disposal projects (transportation, collection, treatment and disposal).
- Domestic waste treatment and municipal disposal facilities.
- Toxic and hazardous waste storage, treatment and disposal facilities.
- Sugar refineries.

Attachment-2 Ambient Air Quality Standard

Source: Environmental Standard in the General Environmental Law and Rules for Implementation (2001)

Item	Standard
SO_2	・ During any 30 day period, one hour average SO_2 shall not exceed 730 μg/m^3 (0.28 ppm) more than twice ・ During any 12 months period, 24 hour average SO_2 shall not exceed 365 μg /m^3 (0.14 ppm) more than once at any location. ・ During any 12 months period, the annual average SO_2 shall not exceed 80 μg /m^3 (0.03 ppm) at any location.
SPM	・ During any 12 month period, 24 hour maximum inhalable suspended particulate concentration shall not exceed 340 μg /m^3 more than once ・ During any 12 month period, the average annual inhalable suspended particulate concentration shall not exceed 80 μg /m^3
O_3	・ During any 30 day period, one hour average concentration of Photochemical oxidants shall not exceed 295 μg / m^3 (0.15 ppm) more than twice
NO_2	・ During any 30 day period, one hour average NO_2 concentration shall not exceed 660 μg /cubic meter (0.35 ppm) more than twice ・ During any 12 months period, the annual NO_2 concentration shall not exceed 100 μg / m^3
CO	・ During any 30 day period. One hour average Carbon monoxide concentration shall not exceed 40 μg / m^3 (35 ppm) more than twice ・ During any 30 day period. Eight (08) hour average Carbon monoxide concentration shall not exceed 10 μg / m^3 (09 ppm) more than twice
H_2S	・ During any 12 months period, One hour average H_2S concentration shall not exceed 200 μg / m^3 (0.14 ppm) more than once ・ During any 12 months period, 24 hour average H_2S concentration shall not exceed 40 μg / m^3 (0.03 ppm) more than once
F	・ During any 30 day period, the monthly average fluoride concentrations shall not exceed 1.0 μg / m^3 (0.001 ppm)

Attachment-3 Effluent Standard

Source: Environmental Standard in the General Environmental Law and Rules for Implementation (2001)

Item	Standard		Japanese Standard (Reference)
	Open Water	Sewerage System	
Applicable Facility	No Description => All facilities		Facilities discharging more than 50 m^3/day in average
pH	6 ~ 9	5 ~ 10	5.8 ~ 8.6 (except sea water)
TSS	15 mg/l	2,000 mg/l	200 mg/l
Temperature	Case by Case	60°C	N/A
Turbidity	75 NTU	N/A	N/A
BOD	25 mg/l	N/Al	160 mg/l
COD	150 mg/l	1,500 mg/l	160 mg/l
TOC	150 mg/l	1,000 mg/l	N/A
Kjeldahl Nitrogen	5 mg/l	N/A	N/A
Total Chlorinated Hydrocarbons	0.1 mg/l	N/A	N/A
Oil and Grease	8 mg/l	N/A	5 mg/l (incl. minerals)
Phenols	0.1 mg/l	N/A	5mg/l
NH_4	1.0 mg/l	N/A	100 mg/l
As	0.1 mg/l	1.0 mg/l	0.1 mg/l
Cd	0.02 mg/l	0.5 mg/l	0.1 mg/l
Chlorine (residual)	0.5 mg/l	N/A	N/A
Cr	0.1 mg/l	2.0 mg/l	2 mg/l
Cu	0.2 mg/l	1.0 mg/l	3 mg/l
Cn	0.05 mg/l	1.0 mg/l	1 mg/l
Pb	0.1 mg/l	1.0 mg/l	0.1 mg/l
Hg	0.001 mg/l	0.01 mg/l	0.005 mg/l
Ni	0.2 mg/l	2.0 mg/l	N/A
P	1.0 mg/l	N/A	16 mg/l
Zn	1.0 mg/l	10.0 mg/l	2 mg/l
Total Coliform	100 MPN/100 ml	N/A	3,000 MPN/cm^3

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)

H. SOCIAL / ORGANIZATION /INSTITUTION

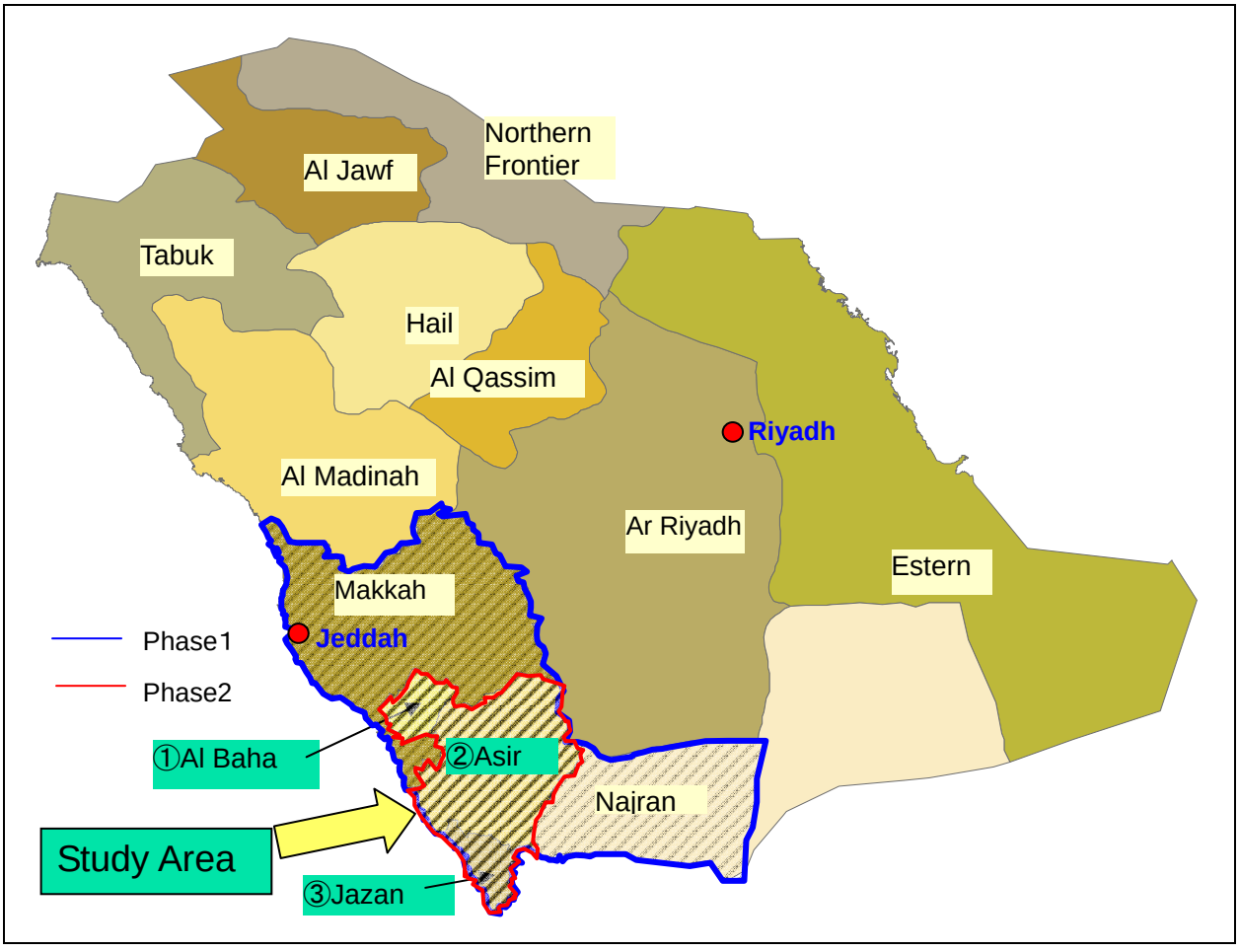
OCTOBER 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

SANYU CONSULTANTS INC.

The Kingdom of Saudi Arabia Location of Map



Final Report
Supporting Report (H)

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List of Abbreviations

Abbreviation and Acronym	English	Arabic (عربي)	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 الأثر البيئي	環境アセスメント
ER	Effective Rainfall	الأمطار الفعالة	有効雨量
ET	Evapotranspiration	البخرنتح	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 Conversion 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	ادارةالأرصاد 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 ميغاوات	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

Abbreviation and Acronym	English	Arabic (عربي)	Japanese (日本語)
MSR	Million Saudi Riyals	مليون ريال سعودي	100 万サウジリアル
NCWCD	National Commission for Wildlife Conservation and Development	اللجنة الوطنية لحماية و تطويرالحياة 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庁
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	العملنطاق	業務範囲
SWAT	Soil and Water Assessment Tool	أداة تقييم التربة والمياه	土壌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

H. SOCIAL CONDITION, ORGANIZATION AND INSTITUTIONS

1. Introduction

This supporting report mentions the following items concerning the part of "Social condition, organization and institutions" in "The Study on Master Plan on Renewable Water Resources Development in the Southwest Region in the Kingdom of Saudi Arabia".

1) Socio-economical situation
2) National plan, strategy, and low on water resources development and management
3) Recommendation for improvement of organization and institutions
4) Stakeholder meeting and work shop record

1.1 Objectives of the Study

The objectives of the Study are shown below.

1) To formulate a basic policy, strategy and action plan for sustainable water resources development and management in the southwest region of the Kingdom of Saudi Arabia (KSA)
2) To formulate a master plan (M/P) for sustainable water resources for the selected Regions
3) To transfer relevant skills and technologies mainly to personnel of the Ministry of Water and Electricity (MOWE)

1.2 Study Area

The study area for the phase 1 cover the following five (5) Regions, Makkah, Al Baha, Asir, Jazan and Najran which located in the southwest area of the KSA.

The study area for the phase 2 focuses on Al Baha Region, Asir Region and Jazan Region.

Study Schedule and Study Flow.

1.3 Study Schedule, Member and Assignment

The study consists of two (2) phases as follows.

Phase 1 : Basic study and formulation of basic policy, strategy and action plan on integrated water resources development and management (June 2007 to March 2009)
Phase 2 : Formulation of a M/P for integrated water resources development and management in the Selected Priority Regions (April 2009 to July 2010)

The member of this part and their assignment period is as follows.

Mr. Sanpei Nakanishi (Social, Organization and Institutions in Phase 1); 17th January 2008 to 25th February 2008

Mr. Hisashi OURA (Social, Organization and Institutions in Phase 2); 14th October 2008 to 27th November 2008, 22nd December 2009 to 22nd January 2010, 7th May 2010 to 3rd June 2010

2. Socio-economic Situation of the Study Area

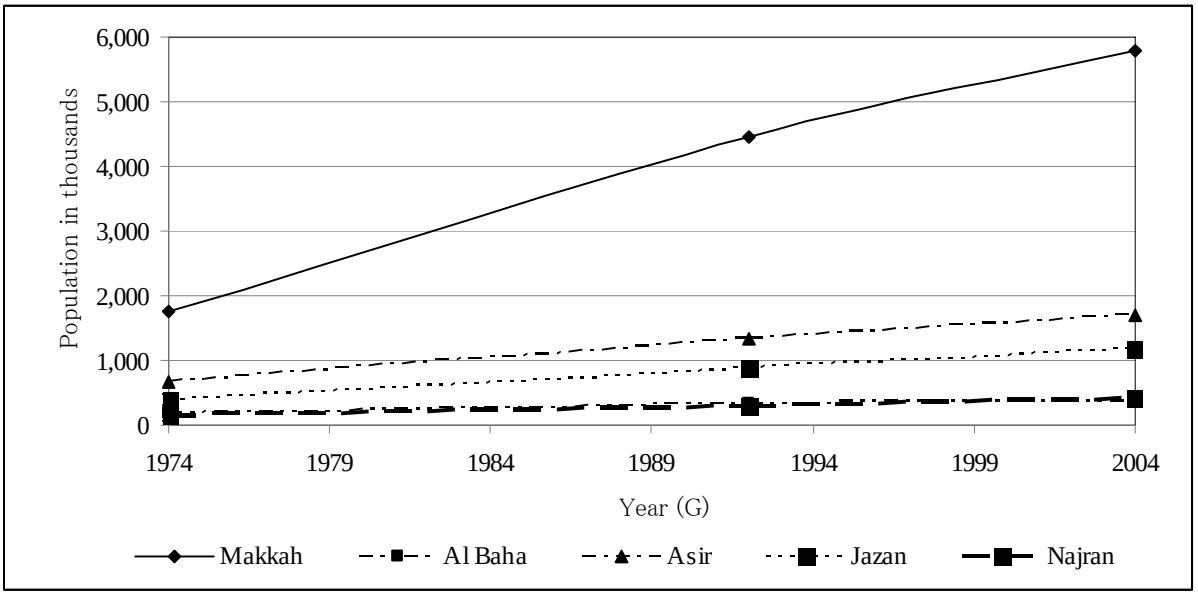
2.1 Sub-division and Population

Table 2-1 shows population changes in the five regions and all 13 regions in the country from 1974 to 2004 (see Figure 2-1). The population of the five regions made up about 40% of the KSA's population in 2004 and increased three-fold in the 30 years from 1974 to 2004. In addition, the annual population growth rate was 6.9% from 1974 to 1992 and decreased to 2.3% from 1992 to 2004. Both of these rates were lower than the KSA national average.

Table 2-1 Population Growth in the Five Regions from 1974 to 2004

Regions	1974	1992	2004	Growth Rate per Year in 1974-1992 (%)	Growth Rate per Year in 1992-2004 (%)
Makkah	1,754,108	4,467,670	5,797,971	8.1	2.3
Al Baha	185,905	332,157	377,739	4.1	1.1
Asir	681,361	1,340,168	1,688,368	5.1	2.0
Jazan	403,106	865,961	1,186,139	6.0	2.8
Najran	147,970	300,994	419,457	5.4	3.0
5 Regions total	**3,172,450**	**7,306,950**	**9,469,674**	**6.9**	**2.3**
13 Regions total	**6,729,642**	**16,948,388**	**22,673,556**	**8.0**	**2.6**

Source: The Eighth Development Plan
Note: Population growth rates were re-calculated.



Source: The Eighth Development Plan

Figure 2-1 Population Growth of the Five Regions from 1974 to 2004

The five regions of the study area are further divided into governorates as shown in Table 2-2. 73 cities are designated for urbanization in the 53 governorates as shown in Table 2-3. About 73% of the population in the five regions lives in urban areas. Makkah has the most urban population (88% urban) and Jazan has the least urban population (66% rural).

Table 2-2 Census Population of the Five Regions in 2004

Governorate	Households	Total	Rate of Governorate Pop.	Average size of household	Governorate	Households	Total	Rate of Governorate Pop.	Average size of household
Makkah Region									
Makkah al mukarramah	257,054	1,338,341	23.1%	5.21	Dahran Al janub	7,986	55,528	3.3%	6.95
Jeddah	635,001	2,883,169	49.7%	4.54	Balqarn	11,573	66,675	3.9%	5.76
Al taif	155,042	885,474	15.3%	5.71	Al majardah	16,028	89,655	5.3%	5.59
Al qunfudah	46,385	240,938	4.2%	5.19	**12 Governorates Total**	**287,853**	**1,688,368**	**100%**	**5.87**
Al lith	17,386	110,449	1.9%	6.35	**Jazan Region**				
Rabigh	14,605	68,966	1.2%	4.72	Jiazan	38,940	252,488	21.3%	6.48
Al jamoom	15,365	75,993	1.3%	4.95	Sabya	32,000	198,029	16.7%	6.19
Khelees	10,448	49,955	0.9%	4.78	Abu Arish	19,096	123,823	10.4%	6.48
Al Kamel	4,053	18,547	0.3%	4.58	Samtah	18,643	128,906	10.9%	6.91
Al Khurmah	6,860	39,053	0.7%	5.69	Al harth	5,665	47,791	4.0%	8.44
Ranyah	7,118	44,276	0.8%	6.22	Damad	9,818	62,465	5.3%	6.36
Turbah	8,140	42,810	0.7%	5.26	Al rith	1,405	13,406	1.1%	9.54
12 Governorates Total	**1,177,457**	**5,797,971**	**100%**	**4.92**	Baysh	8,883	58,326	4.9%	6.57
Al Baha Region					Farasan	2,346	13,972	1.2%	5.96
Al baha	17,317	93,128	24.7%	5.38	Bany malik (al daeer)	6,887	49,265	4.2%	7.15
Baljurashi	11,586	61,354	16.2%	5.30	Ahad Al masarha	10,243	69,976	5.9%	6.83
Al mandaq	7,505	45,666	12.1%	6.08	Al edabi	6,931	52,783	4.4%	7.62
Al mekhwat	10,607	64,365	17.0%	6.07	Al ardah	7,484	62,934	5.3%	8.41
Al Oqiq	4,727	28,606	7.6%	6.05	Al darb	8,625	51,975	4.4%	6.03
Qilwah	7,989	55,511	14.7%	6.95	**14 Governorates Total**	**176,966**	**1,186,139**	**100%**	**6.70**
Al qurah	5,254	29,109	7.7%	5.54	**Najran Region**				
7 Governorates Total	**64,985**	**377,739**	**100%**	**5.81**	Najran	45,171	263,537	62.8%	5.83
Asir Region					Sharorah	10,794	72,804	17.4%	6.74
Abha	63,390	350,694	20.8%	5.53	Habawnah	4,352	24,204	5.8%	5.56
Khamis Mushyt	75,290	446,467	26.4%	5.93	Bader al janub	1,632	9,521	2.3%	5.83
Bisha	32,185	188,668	11.2%	5.86	Yadmah	2,382	13,879	3.3%	5.83
Al namas	9,114	47,783	2.8%	5.24	Thar	2,037	12,912	3.1%	6.34
Mahael	28,305	176,377	10.4%	6.23	Khibash	2,995	18,805	4.5%	6.28
Serat Abeedah	9,215	59,546	3.5%	6.46	Al kharkher	409	3,795	0.9%	9.28
Tathlith	7,500	48,765	2.9%	6.50	**8 Governorates Total**	**69,772**	**419,457**	**100%**	**6.01**
Rijal Almah	10,020	58,952	3.5%	5.88					
Ahad rifidah	17,247	99,258	5.9%	5.76	**53 Gov. Grand Total**	**1,777,033**	**9,469,674**		**5.33**

Source: 2004G Population Census

Table 2-3 Population of the Five Regions by Urban (Cities) and Rural in 2004

Regions	Entire population of region (A)	Number of cities	City (Urban) population of region (B)		Other (Rural) population (C)=(B)-(A)	
Makkah	5,797,971	23	5,077,777	87.6%	720,194	12.4%
Al Baha	377,739	6	177,186	46.9%	200,553	53.1%
Asir	1,688,368	16	886,617	52.5%	801,751	47.5%
Jazan	1,186,139	23	403,756	34.0%	782,383	66.0%
Najran	419,457	5	331,966	79.1%	87,491	20.9%
Total	**9,469,674**	**73**	**6,877,302**	**72.6%**	**2,592,372**	**27.4%**

Source: 2004G Population Census

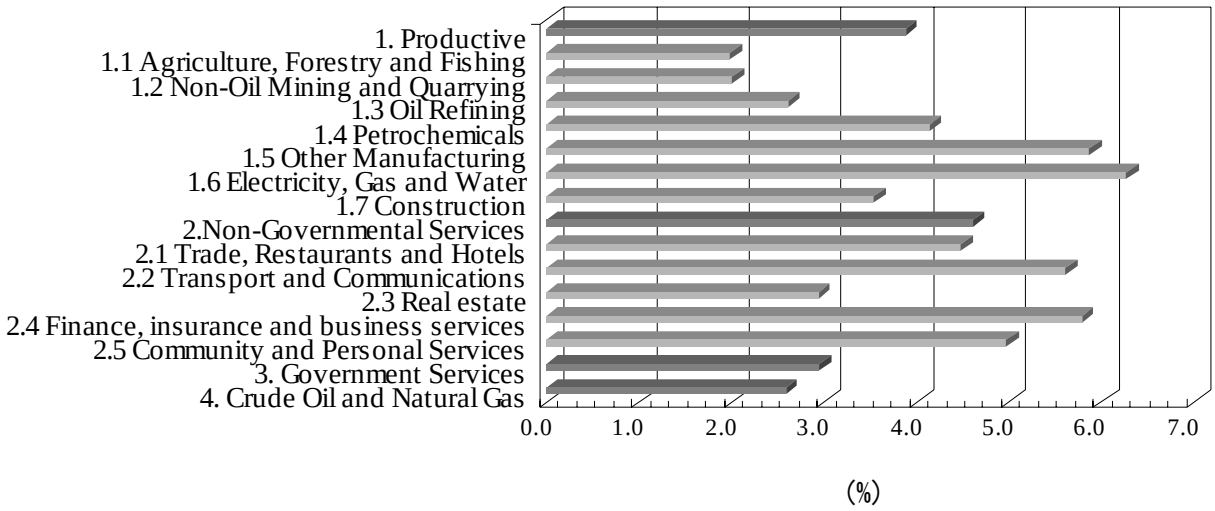
2.2 Economy

Table 2-4 represents value added changes from 1999 to 2004. The average annual growth rate of the GDP in the period is 3.4%. The growth rate of non-governmental services sector and productive sector are higher than the average growth rate of GDP. In 2004, the share of non-governmental services sector was about 30%, crude oil and natural gas sector was about 28%, and productive sector was about 25% to the GDP.

Table 2-4 GDP by Sector, Constant 1999 Prices

Sector	Value Added		Average Annual Growth Rate (%)	Shara in GDP	
	1999 (SR Million)	2004 (SR Million)		1999 (%)	2004 (%)
1.Productive	147,318	178,250	3.9	24.4	24.9
1.1 Agriculture, Forestry and Fishing	34,443	38005	2.0	5.7	5.3
1.2 Non-Oil Mining and Quarrying	2,464	2,723	2.0	0.4	0.4
1.3 Oil Refining	18,021	20,508	2.6	3.0	2.9
1.4 Petrochemicals	6,000	7,352	4.1	1.0	1.0
1.5 Other Manufacturing	38,779	51,616	5.9	6.4	7.2
1.6 Electricity, Gas and Water	8,174	11,085	6.3	1.4	1.6
1.7 Construction	39,437	46,961	3.6	6.5	6.6
2. Non-Governmental Services	169,086	211,953	4.6	28.0	29.6
2.1 Trade, Restaurants and Hotels	45,992	57,299	4.5	7.6	8.0
2.2 Transport and Communications	27,893	36,674	5.6	4.6	5.1
2.3 Real Estate	42,221	48,822	2.9	7.0	6.8
2.4 Finance, Insurance and Business Services	31,603	41,902	5.8	5.2	5.9
2.5 Community and Personal Services	21,377	27,256	5.0	3.5	3.8
3. Government Services	116,789	135,064	3.0	19.3	18.9
4. Crude Oil and Natural Gas	173,102	196,696	2.6	28.7	27.5
5. Other Items	-2,706	-7,063	21.2	-0.4	-1.0
GDP	603,589	714,900	3.4	100	100

Source: The Eighth Development Plan
Note: "Other Items" is import duties less imputed bank service charges.



Source: The Eighth Development Plan

Figure 2-2 Average Annual Growth Rate of GDP 1999 - 2004

The productive sector and non-governmental services sector are divided into some sub-sectors as shown in the above table. Trade, Restaurants and Hotels, Other manufacturing, Real estate, and Construction occupy more than 6.0% of the GDP. The sub-sectors whose average annual growth rates are over 5.0% are Electricity, Gas and Water (6.3%), Other Manufacturing (5.9%), Finance, insurance and business services (5.8%), and Transport and Communications (5.6%). These figures show that the manufacturing sector and non-governmental services sector are leading the national economy.

2.3 Agriculture

The crop planted area and production for last five years are as shown in Table 2-5. Since the Makkah region is holding the big consuming city Jeddah, agriculture in suburban type cultivation is popular in it. Moreover, mountainous Al Baha, Asir and Najran regions are active in the fruit trees and vegetable cultivation based on the geographical feature and climate of high elevation. On the other hand, the cereals represented by the sorghum and wheat are grown on the flat plain of Asir and Jazan regions. In the southwest region, although modern irrigation systems, such as drip irrigation and micro jet irrigation, are adopted as for vegetables and fruit trees and irrigation efficiency is rather high, in cultivation of cereals, such as a sorghum and wheat, traditional irrigation systems, such as flood

irrigation system, are generally adopted, and irrigation efficiency is rather low.

In addition, the percentage of occupying the agricultural population in 2001 in whole Saudi Arabia to overall population by 1,930,000 people is 9.2%. Moreover, the percentage that a working population occupies to the total working population by 580,000 people is 9.1% (source: FAOSTAT). If the agricultural population of the South West region is estimated at this rate, it become about 178,000 and 53,000 people respectively.

Table 2-5 Planted Area and Production in the Southwest Region

Region/Crops	2002		2003		2004		2005		2006		2007	
	ha	**Production**	ha	**Production**	ha	**Production**	ha	**Production**	ha	**Production**	ha	**Production**
Makkah	45,311	**377,845**	41,941	**389,345**	37,697	**396,010**	38,237	**399,221**	39,912	**404,417**	42,077	**408,982**
Cereal	12,588	19,212	10,467	21,365	8,128	18,513	7,608	16,392	7,708	17,085	8,386	18,998
Fodder	9,732	87,956	7,883	74,353	4,885	51,661	5,262	60,604	5,698	59,838	5,761	70,747
Fruits	11,396	108,282	11,343	102,567	12,005	130,079	13,201	115,532	13,930	106,484	15,447	109,270
Vegetable	11,595	162,395	12,249	191,060	12,680	195,757	12,166	206,693	12,576	221,010	12,483	209,967
Al Baha	2,769	**31,154**	2,927	**29,308**	3,459	**28,074**	3,584	**30,421**	5,023	**46,172**	4,450	**38,864**
Cereal	549	1,478	443	1,425	713	2,212	608	1,916	604	2,011	532	1,763
Fodder	168	2,272	139	2,091	136	2,285	94	1,585	147	2,255	185	2,982
Fruits	1,788	20,896	2,075	19,533	2,280	16,091	2,603	20,089	3,974	35,227	3,457	28,005
Vegetable	264	6,508	271	6,259	330	7,486	278	6,831	298	6,679	276	6,114
Asir	22,508	**221,898**	22,695	**203,806**	22,038	**203,205**	21,023	**178,885**	20,368	**209,778**	21,054	**206,243**
Cereal	6,477	14,192	7,318	16,731	8,159	24,027	7,550	20,497	6,780	20,573	7,744	23,587
Fodder	2,796	39,896	1,930	24,089	1,581	20,518	1,680	22,778	1,644	28,466	2,001	34,567
Fruits	10,159	102,679	10,644	103,088	9,633	92,610	9,220	74,156	9,334	73,584	8,579	65,252
Vegetable	3,076	65,131	2,803	59,898	2,664	66,050	2,572	61,454	2,610	87,155	2,730	82,837
Jazan	186,350	**557,840**	157,747	**455,250**	148,450	**513,797**	120,268	**449,714**	117,032	**503,187**	113,558	**504,303**
Cereal	159,461	229,467	136,609	225,736	128,551	275,667	101,302	197,261	97,484	230,382	92,204	217,924
Fodder	18,095	258,079	12,956	174,588	12,204	168,897	10,552	173,548	10,852	187,499	12,247	203,018
Fruits	4,151	19,451	3,843	18,292	4,322	23,646	4,786	30,783	5,049	28,252	5,525	32,365
Vegetable	4,643	50,843	4,339	36,634	3,373	45,587	3,629	48,122	3,647	57,054	3,582	50,996
Najran	13,212	**180,304**	12,286	**156,140**	12,185	**147,184**	13,107	**155,084**	11,747	**145,694**	11,430	**141,119**
Cereal	984	2,129	708	1,631	1,001	2,597	1,019	2,448	659	2,544	908	3,491
Fodder	3,237	35,718	2,520	26,421	2,479	36,690	2,879	44,838	2,435	37,266	2,287	35,916
Fruits	5,962	66,321	6,682	70,445	7,007	62,412	7,272	65,782	6,658	57,985	6,311	57,868
Vegetable	3,029	76,136	2,375	57,643	1,698	45,485	1,937	42,016	1,995	47,899	1,924	43,844
Total	270,150	**1,369,041**	237,596	**1,233,849**	223,829	**1,288,270**	196,219	**1,213,325**	194,082	**1,309,248**	**192,569**	**1,299,511**
Cereal	180,059	266,478	155,545	266,888	146,552	323,016	118,087	238,514	113,235	272,595	109,774	265,763
Fodder	34,028	423,921	25,428	301,542	21,285	280,051	20,467	303,353	20,776	315,324	22,481	347,230
Fruits	33,456	317,629	34,587	313,925	35,247	324,838	37,082	306,342	38,945	301,532	39,319	292,760
Vegetable	22,607	361,013	22,037	351,494	20,745	360,365	20,582	365,116	21,126	419,797	20,995	393,758

Data Source: Agriculture Statistical Year Book Twenty Issue by MOA

2.4 Industry

The ten main industries operating factories in the KSA are shown in Table 2-6. The total number of factories remarkably increased eight-fold in the 30 years from 1971.

There were 1,176 factories in the five regions in 2006, making up around 30% of the national total, a percentage that remained unchanged from 1999.

Table 2-6 The Number of Operating Factories in KSA

Sectors	1971	1999	2004	2005	2006
Food and Beverages	73	504	577	597	603
Textiles, readymade clothes and leather	12	141	174	190	191
Wood, wooden products and furniture	25	145	190	189	189
Paper, printing and publication	46	195	226	227	227
Chemical industries and plastic products	63	630	795	855	869
Building materials, glass, ceramic and metal basic industries	91	545	585	808	611
Basic Metallic		11	16		610
Manufactured metals, machines and equipment	159	893	993	847	453
Other industries	3	78	80	79	79
Transportation & Warehouse		21	16		16
Total	**472**	**3,163**	**3,652**	**3,792**	**3,848**
5 regions	**-**	**999**	**1,120**	**-**	**1,176**
% in 13 regions	**-**	**31.6%**	**30.7%**	**-**	**30.6%**

Sources: Saudi Organization for Industrial States & Technology Zone, and the Eighth Development Plan

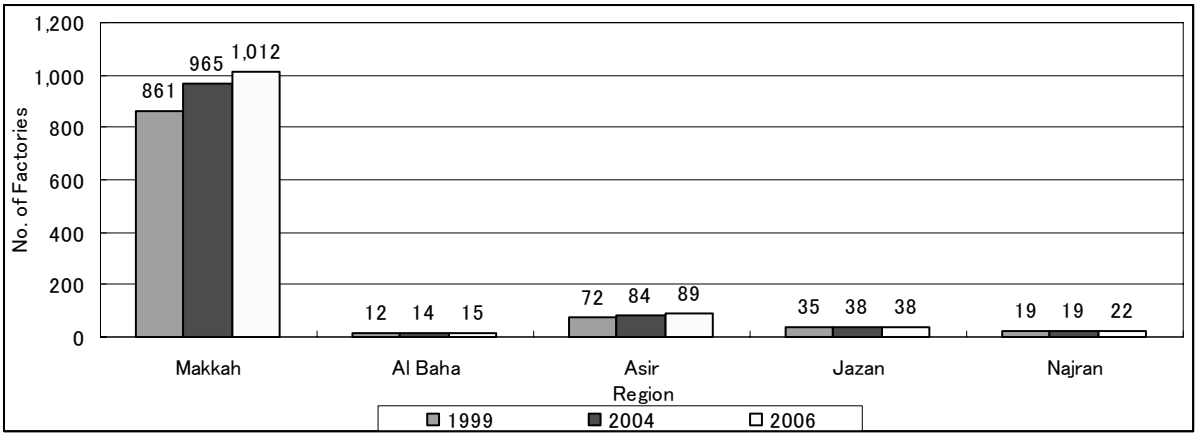
The following table shows breakdown of the number of operating factories classified by industrial sectors in all 13 regions of the country in 2006.

Table 2-7 Breakdown of the Number of Operating Factories in All 13 Regions of the KSA in 2006

Sector	Al- Baha	Al-Jouf	Al-Madina Al-Munaww ara	Al-Qassim	Asir	Eastern Province	Hail	Jazan	Makkah Al-Mukarrama	Najran	Northen Frontiers	Riyadh	Tabuk	Total
Food and Beverages	4	14	39	41	12	106	8	9	172	4	2	182	10	**603**
Textiles, readymade clothes and leather	1	0	8	3	1	29	0	1	62	0	0	86	0	**191**
Wood, wooden products and furniture	0	0	7	5	1	47	2	0	44	0	0	83	0	**189**
Paper, printing and publication	3	0	1	6	2	51	3	1	69	0	0	91	0	**227**
Chemical industries and plastic products	3	4	34	32	15	224	5	2	240	5	1	293	11	**869**
building materials glass, ceramic and metal basic industries	4	5	32	22	41	133	6	22	121	10	5	202	8	**611**
Basic Metallic	0	0	14	20	14	150	6	2	156	3	0	243	2	**610**
Manufactured metals, machines and equipment	0	0	8	15	2	108	0	0	118	0	1	201	0	**453**
Transportation and warehouse	0	0	2	0	0	5	0	1	5	0	0	2	1	**16**
Other industries	0	0	3	1	1	18	0	0	25	0	0	31	0	**79**
Total	**15**	**23**	**148**	**145**	**89**	**871**	**30**	**38**	**1,012**	**22**	**9**	**1,414**	**32**	**3,848**

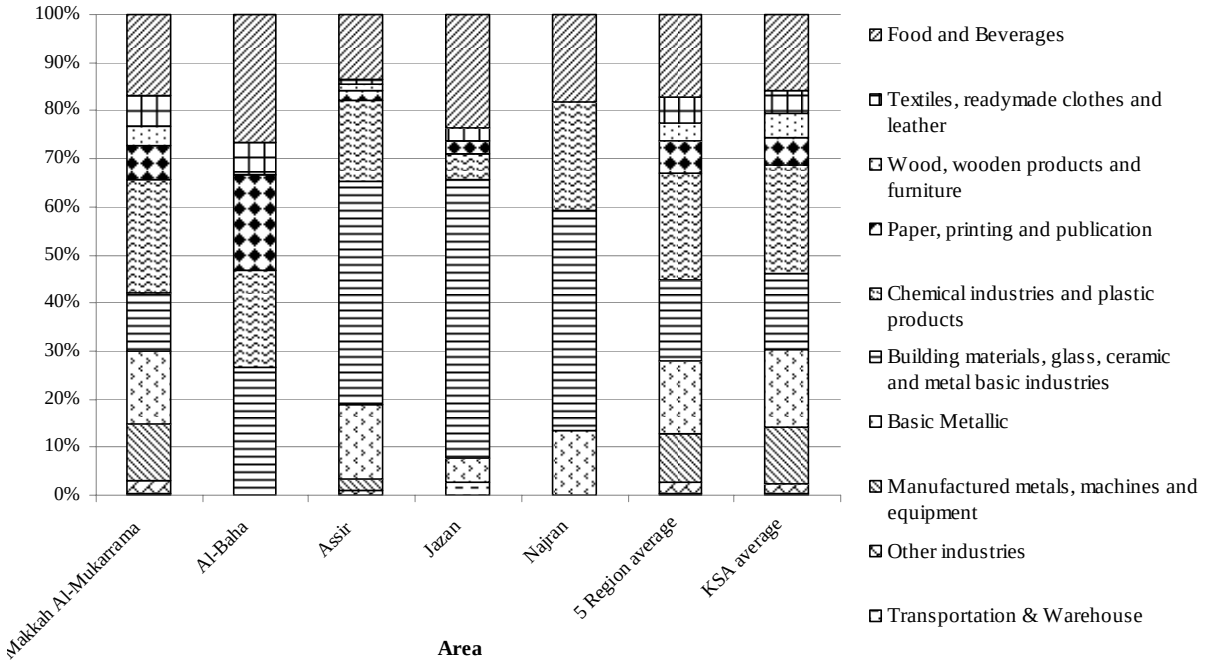
Sources: Saudi Organization for Industrial States & Technology Zone, and the Eighth Development Plan

As of 2006, the majorities of factories (86%) in the five regions were located in Makkah region, as shown in Figure 2-3. Food and beverage processing, chemical products, and wooden material processing are the major industrial activities. The distribution of factories by sector in the five regions is almost equal to the national distribution, as shown in Figure 2-4.



Sources: Saudi Organization for Industrial States & Technology Zone, and the Eighth Development Plan

Figure 2-3 The Number of Operating Factories in Five Regions



Source: Saudi Organization for Industrial States & Technology Zone

Figure 2-4 The Sector Share Rate of Factories by Regions

2.5 Infrastructure

(1) Roads

Table 2-8 shows length of roads by region in 2003. The road length of the targeted five regions make up about 38% of the KSA's road network, and 80% are unpaved and 20% are paved while 73% are unpaved and 27% are paved in the KSA national average. Asir, Riyadh, and Makkah have high proportion of the road network, and the proportion of road network in Northern borders, Najran, and Jazan is low.

Table 2-8 Road Network by Region in 2003

Region	Type of Paved Roads								Unpaved Roads		Total	
	Total		Main		Secondary		Feeder					
	d=a+b+c (km)	d/f (%)	a (km)	a/d (%)	b (km)	b/d (%)	c (km)	c/d (%)	e (km)	e/f (%)	f=d+e (km)	f/∑f (%)
Riyadh	11,040	52	2,247	20	2,113	19	6,680	61	10,214	48	21,254	13.3
Medina	3,250	17	1,032	32	810	25	1,408	43	15,681	83	18,931	11.8
Qassi,	4,276	23	450	11	873	20	2,953	69	14,692	77	18,968	11.8
Eastern	5,081	61	2,218	44	1,133	22	1,730	34	3,210	39	8,291	5.2
Tabuk	2,062	19	1,405	68	156	8	501	24	8,525	81	10,587	6.6
Hail	2,631	20	410	16	372	14	1,849	70	10,710	80	13,341	8.3
Northern	1,326	59	896	68	-	-	430	32	903	41	2,229	1.4
Jawf	1,175	21	713	61	-	-	462	39	4,353	79	5,528	3.5
Makkah	4,740	23	1,635	34	990	21	2,115	45	15,969	77	20,709	12.9
Al Baha	1,162	17	119	10	280	24	763	66	5,772	83	6,934	4.3
Asir	3,770	16	905	24	880	23	1,985	53	20,133	84	23,903	14.9
Jazan	949	18	205	22	130	14	614	65	4,207	82	5,156	3.2
Najran	1,478	34	455	31	525	36	498	34	2,868	66	4,346	2.7
5 Regions Total	12,099	20	3,319	27	2,805	23	5,975	49	48,949	80	61,048	38.1
Total	42,940	27	12,690	30	8,262	19	21,988	51	117,237	73	160,177	100.0

Source: The Eighth Development Plan

Source: www.worldmapfinder.com

Figure 2-5 Main Road of KSA

Eastern Region, Northern Borders, and Riyadh have high ratio of paved roads and Asir, Al Baha, and Medinah have high ratio of unpaved roads. In paved roads, Makkah has high ratio of main road, and Al Baha and Jazan have high ratio of feeder road in the targeted five regions. Figure 2-5 shows region boundaries and main roads of KSA.

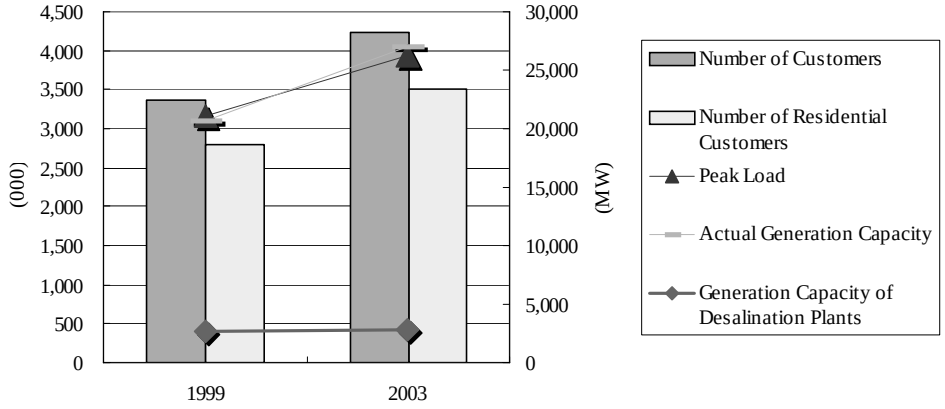
(2) Electricity

The rate of electrical service coverage in 2003 was 90%, the annual growth rate of the service coverage from 1999 to 2003 was 3.3%, and the annual growth rate of per capita consumption of electricity was 1.7%, which indicates the electricity sector is growing constantly. (See Table 2-9) About 83% of customers of the electrical service were residents, and the number of the entire customers annually increased by 5.8%. According to The Eighth Development Plan, the estimation of electricity service coverage in 2004 is 92% and it plans to achieve 100% in 2009.

Table 2-9 Electricity Sector Indicators

Items	Unit	1999	2003	Average Annual Growth Rate(%)
Per Capita Consumption	KWH	5,444	5,833	1.7
Number of Customers	000	3,372	4,232	5.8
Number of Residential Customers	000	2,792	3,497	5.8
Service Converges	%	79.1	90	3.3
Electricity Consumption	Blillion KWH	106	142	7.6
Peak Load	MW	21,101	26,272	5.6
Actual Generation Capacity	MW	20,647	27,018	7.0
Generation Capacity of Desalination Plants	MW	2,675	2,866	1.7
Total Number of Employees	Person	28,785	29,189	0.3
Share of Saudis	%	69.1	79.4	3.5
Average Number of Customers per Employees	Customer	117	145	5.5
Average Sold Electricity per Employee	MWH	3,669	4,48	7.2

Source: The Eighth Development Plan



Source: The Eighth Development Plan

Figure 2-6 Number of Customers and Generation Capacity in the Electrical Sector

The electricity consumption made up annually 7.6% and the peak load became 1.2 fold in the four years from 1999 to 2003. The actual generation capacity became 1.3-fold increase during the period to cover the peak load. Meanwhile, the proportion of generation capacity in desalination plants to the total generation capacity was about 11% in 2003. In addition, the number of the customers per employee in this sector and sold electricity per the employee were largely increased in the four years because the number of employees in the sector grew only 0.3% annually though the number of customers and the electricity consumption grew largely.

2.6 Employment

About 33% of the total labor in the private sector was Saudi and 67% was foreigner in 2003. The proportion of the number of the productive sectors was 52% of the entire labor in the private sector and the ratio of the services sectors was 46%, which is shown in Table 2-10. The Saudi labor in the services sectors was more than the Saudi labor in the productive sectors while the non-Saudi labor in the productive sectors was more than the non-Saudi labor in the services sectors.

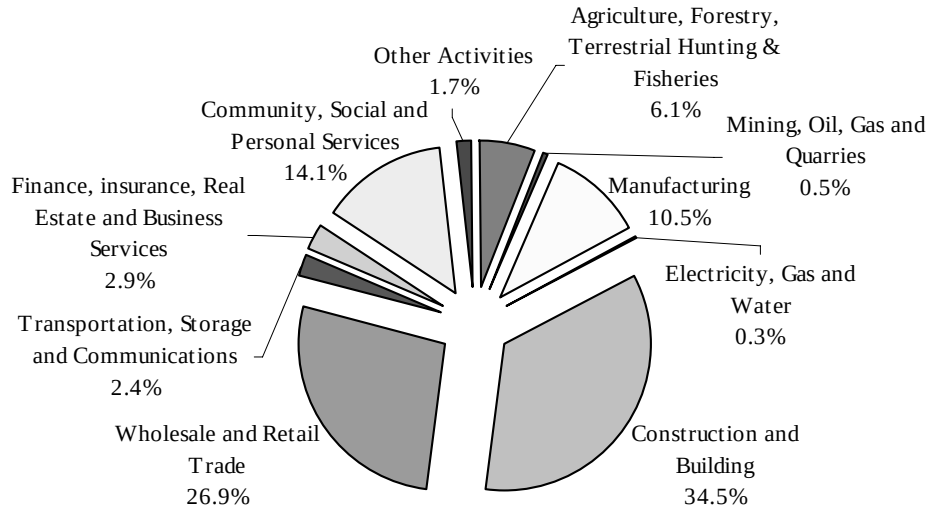
In the private productive sectors, the sub-sectors that occupied more than five percent to the general total were construction and building (35%), manufacturing (11%), and agriculture, forestry, terrestrial hunting & fisheries (6%). In these three sub-sectors, the ratio of non-Saudi labor was higher than the ratio of Saudi labor; especially non-Saudi labor in agriculture, forestry, terrestrial hunting & fisheries was nine-times as many as Saudi labor in the sector.

In the services sectors, the sub-sectors that occupied more than five percent to the general total were wholesale and retail trade (27%) and community, social and personal services (14%). In these two sectors, the ratio of non-Saudi labor was higher than the ratio of Saudi labor but the ratios of non-Saudi labor were not so high in comparison with the productive sectors.

Table 2-10 Distribution of Labor in the Private Sector by Economic Activity and Nationality, 2003

Economic Activity	Saudi		Non-Saudi		Total	
	000	%	000	%	000	%
Agriculture Forestry, Terrestrial Hunting & Fisheries	46	10	393	90	438	6.1
Mining, Oil, Gas and Qusrries	21	54	18	46	39	0.5
Manufacturing	256	34	500	66	756	10.5
Electricity, Gas and Water	13	51	12	49	25	0.3
Construction and Building	686	28	1,800	72	2,487	34.5
Total Productive Sectors	1,022	27	2,723	73	3,744	52.0
Wholesale and Retail Trade	676	35	1,264	65	1,939	26.9
Transportation, Storage and Communications	71	41	100	59	171	2.4
Finance, Insurance, Real Estate and Business Services	140	68	66	32	206	2.9
Community, Social and Personal Services	436	43	583	57	1,019	14.1
Total Services Sectors	1,322	40	2,013	60	3,335	46.3
Other Activities	45	36	81	64	126	1.7
Total	2,389	33	4,817	67	7,205	100.0

Source: The Eighth Development Plan



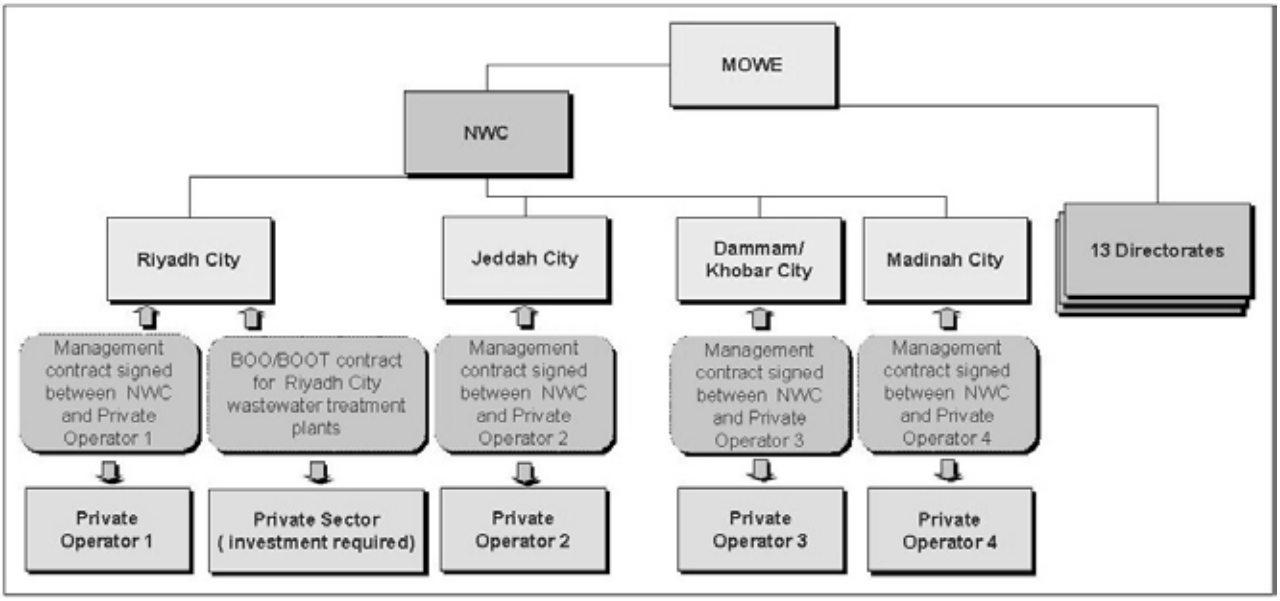
Source: The Eighth Development Plan

Figure 2-7 Proportion of Labor in the Private Sector by Economic Activity, 2003

2.7 Privatization on Water Sector

(1) National Water Company (NWC)

According to the Management Contract for Riyadh City[1], MOWE is establishing NWC to improve the overall performance of water sector. NWC will change itself to become a holding company eventually without any further operating functions. The short-term structure of the NWC is shown in Figure 2-8.



Source: Management Contract for Riyadh City

Figure 2-8 Short-term Structure of NWC

(2) Public Private Partnership (PPP)

Management Contract for Riyadh City says that the Supreme Economic Council[2] has earmarked 20 sectors for privatization, of which the major ones are power, desalination, water and sewage, telecommunications, railways, and the national airline. The privatization strategy of MOWE approved by the Council includes management, leasing, financing, and sale contracts in privatization.

[1] Summary Project Information Document, Management Contract for Riyadh City, MOWE, November 2006
[2] It is established in 1999, aimed at increasing investment and promoting privatization.

2.8 Economic Value of Water

(1) Water Tariff

The eighth development plan mentions that average water consumption for a family of six is estimated to be around 41 m^3/month. Such consumption falls under the first segment. (See Table 2-11) Consequently the actual price paid by most consumers is SR 0.10 per cubic meter.[3]

Table 2-11 Structure of Water Tariff for Municipal Purposes

Segment	Volume (m^3)	Tariff (SR/m^3)
First	0-50	0.10
Second	51-100	0.15
Third	102-200	2.00
Fourth	201-300	4.00
Fifth	301 and Over	6.00

Source: The Eighth Development Plan

(2) Water Cost

Household water and sanitation services in Saudi Arabia: an analysis of economic, political and ecological issues[4] made a trial calculation of cost comparison between desalinated water and groundwater. It said that the accounting cost of one cubic meter of domestic water from the New Riyadh Wells Project might be estimated at some US$ 0.36. And the cost became US$ 0.54 per cubic meter, added the opportunity cost of capital or US$ 0.18 per cubic meter.

The production cost of desalinated water produced in recently built desalination plants in Sharjah could be estimated at about US$ 1.84 per cubic meter, which consisted of the cost of desalinated water (US$ 0.52/m^3) and the pipeline transmission cost of the desalinated water from the Gulf Coast to Riyadh (US$ 1.32/m^3). While, the weighted average accounting cost of the 30 existing Saudi plants could be calculated at US$ 0.67 per cubic meter. When added the opportunity cost of capital and the pipeline transmission cost to the accounting cost, the grand total became US$ 2.37 per cubic meter though the calculated cost included the cost of the electricity that was produced in those plants.

Table 2-12 Costs Comparison among Three Water Alternative Sources

Water Sources	Accounting Cost a	Opportunity Cost of Capital b	Economic Cost c=a+d	Pipeline Transmission d	Grand Total C+d
Riyadh's New Wells Project	0.36	0.18	0.54	*-	0.54
Sharjah's New Desalination Plan	0.35	0.17	0.52	1.32	1.84
Average 30 desalination Plants (1998)	0.67	0.38	1.05	1.32	**2.37

* Included in accounting cost

** Including the value of electricity generated

Source: Household water and sanitation services in Saudi Arabia: an analysis of economic, political and ecological issues

3. Institutions and Organization on Water Resources Development and Management

3.1 Five-Year National Development Plans

(1) Outline

As described in the Plan of Operation for the JICA Study that was submitted in August 2007, the Study Team gathered the previous and present 5-Year National Development Plans in KSA obtained from the Ministry of Economy and Planning (MOEP).

First 5-Year National Development Plan (1970/71 – 1974/75) was formulated in 1970 and eighth 5-Year National Development Plans had been issued in 2006. The latest 5-Year National Development Plan was formulated in 2005 that will be effective up to 2009.

The Study Team reviewed those 5-Year National Development Plans to examine a historical change of

[3] 23.2.7 Water Cost (p. 476), The Eighth Development Plan

[4] Elie Elhadj, SOAS Water Research Group, Occasional Paper 56, SOAS/KCL Water Research Group, School of Oriental & African Studies and King's College London, University of London, May 2004

water vision, policies, strategies and action plans and to evaluate the achievements of those strategies and plans in the past.

(2) Review Results of Water Related Portions in the 5-Year National Development Plans

The Study Team organized information on the water related portions under the following categories:

- Present conditions
- Main issues
- Saudiization
- Economic efficiency
- Role of private sector
- Water demand forecast
- Future water vision
- Development strategy
- Establishment of Ministry of Water and then consolidation of water and electricity, etc.

(a) Present Conditions

The basic information on available water resources such as conventional and non-conventional sources, water consumption and water supply & demand balance had fully been reported since the Third 5-Year National Development Plans (1980/81 – 1984/85). Water cost and budgetary allocation were reported in detail in the latest Eighth Five-Year National Development Plan (2005/06 – 2009/10).

(b) Main Issues

A wide variety of main issues has been reported in each development plan. In Second and Third development plans, wasteful practices of irrigation and severe water shortage by over-pumping were recognized as a main issue.

Up to the 1990s, increase of water consumption of non-renewable groundwater and agricultural consumption of water had become an issue. The formulation of National Water Plan had been necessitated in almost all development plans.

After the1990s, water pricing, reclaimed water, water conservation and water & waste water services have become a main issue. In the latest development plan, monitoring, follow-up and enforcement of regulation, strengthening of water legislation and administrative centralization became a main issue.

(c) Saudiization

The Saudiization was promoted in the Fifth and Sixth development plans. By those plans, the Saudiization in water sector was considered to be achieved.

(d) Economic Efficiency

The economic efficiency was firstly highlighted in the Sixth development plan (1995/96 – 1999/2000).

(e) Role of Private Sector

Since the Third development plan, a role private sector has been emphasized.

MOWE is in process of reforming the water sector in KSA. The basic idea of this reform process is to improve the overall performance of the sector in various regards of through the transfer of services to a business minded environment and the involvement of the private sector. The water sector reform program basically aims at the following objectives:

- Provide access to clean and good quality potable water for all residents
- Provide sanitation connections to all households and safe disposal of waste water
- Improve organization performance and customer service, with a view to gradually becoming a commercially oriented organization
- Provide reasonably priced water and sanitation services with a view to cost recovery
- Progress towards privatization to facilitate the enhanced performance of the sector
- Protect the natural environment and conserve natural resources in KSA.

MOWE has completed a Strategic Transformation Plan (STP) over the past tow years that provides a framework of and guidance for the further reform and privatization path. In addition, MOWE has carried out a number of groundwork studies and audits on the technical status of the water supply and waste water collection system that result in concrete recommendations for the improvement of the physical infrastructure.

The STP main results can be summarized as:

- Initiation of PPP projects (Management/O&M Contract and BOO) for the water and waste water operations of the four main cities of Saudi Arabia: Riyadh, Jeddah, Medinah and Damman/Khobar. In the long term, MOWE has plans to move to more complex contracts like Concession and/or total privatization, etc.
- Formation of NWC that will in the short term facilitate privatization process and oversee the regional operations under the PPP contracts. In the long term, NWC will oversee most water and waste water operations of KSA. NWC will include regional business units (RBUs) and a core to manage and provide strategic guidance to RBUs.
- Gradual transfer of manpower and assets from the existing entity to NWC.
- Review the proposed institutional setting and recommend methodology to regulate the Jeddah City Management/O&M contract in the short term through contractual clauses and study the need for independent regulator to oversee the BOO and concession contracts in the long run. Presently it is the MOWE intention to regulate the Management contract through clauses built with in the contract.

In addition to the above information regarding NWC, the following article was obtained from MENAFN – Oxford Business Group on 10 February 2008:

In a bid to manage the privatization of water services and save diminishing water resources, Saudi Arabia's Supreme Economic Council (SEC) has recently licensed NWC. The creation of the company is another step in the government's plan to restructure the country's ground and sewage water sector.

Earmarked in 2002 by the SEC for privatization, it was decided in September 2006 that a complete overhaul of the water sector, via the creation of a national company, would best serve the Gulf state. The new company is expected to significantly improve the sector's performance, especially in the area of water conservation. Some 20% of water leaks out of desalination plants.

The NWC, reported to have a capitalization of $5.9bn, will have 2.2bn shares, each with a nominal value of $2.68, and a paid-up capital of $1.83bn with 684.88m shares, according to Minister of Water and Electricity Abdullah bin Abdul-Rahman Al Hussayen. He said the company would be wholly owned by the Public Investment Fund, which is overseen by the ministry of finance.

The new company is to be 100% government owned via the Public Investment Fund, which, according to its website, provides loans to ventures that will develop the Saudi economy. However, the minister did give an indication the NWC could be sold to the public in the future. Al Hussayen said, "The Council of Ministers will look into the possibility of selling the company's shares in an IPO [initial public offering] in light of proposals to be made by the ministry of water and electricity in coordination with the finance ministry and other authorities."

The NWC will operate in all areas pertaining to underground water, drinking water distribution and collection and treatment of sewage. It will take control, in phases, of all the kingdom's groundwater wells and sewage and desalination plants from various different government bodies to simplify the process of water management, which over the years has involved a myriad of entities. Some of these agencies included the ministries of agriculture and water and of municipal and rural affairs as well as the government-owned Saline Water Conversion Corporation. An international firm, to be selected by the NWC's board of directors, will be appointed for five years to manage the company.

Given the size of the country, the reform aims to separate water and waste water operations on a city-by-city basis. Taking over operations first in Riyadh, the largest consumer of water in the kingdom, the NWC is expected to then move to Jeddah, followed by Medina, Dammam and Mecca in three months. The company is expected to provide services to the entire nation in three years

Demand for water in Saudi Arabia, which desalinates more water than any other country, is increasing rapidly due to the kingdom's growing population. The birth rate, which is 46% higher than the world average, is an important factor in the government's need to improve supply for the future.

According to ministry of municipality and rural affairs, Saudi Arabia has limited water resources and it is the largest country in the world without running surface water. It is believed that the country's underground water reserves are finite particularly due to heavy use.

Currently, consumption is estimated at 240 liters per person day, according to local media reports. Waste is excessively high and the government is keen to utilize private investment in a bid to minimize water cuts and meet demand. Overall demand has increased five-fold in the past five years and is expected to increase to 12m cubic meters by 2030.

PPPs have been identified by the ministry for water and electricity as the best means to produce and distribute water throughout the nation. Since the decision for reform in the water sector took place the ministry carried out an in-depth study of international PPP models. Looking at the experiences other countries had, the ministry chose the one they felt best suited the requirements of the country, while keeping in mind what elements would be good for attracting partners.

In the past, Al Hussayen has outlined the government's commitment to the reform process and the attractive macroeconomic conditions the kingdom could offer to the private sector. Many industry analysts acknowledge that investment in the water sector is an attractive possibility for potential partners.

The government, in their efforts to attract private companies, has reduced the income tax rate for foreign firms from 45% to 20%, and standardized the bidding processes to increase transparency.

(f) Water Demand Forecasts

The water demand forecasts, including the assumption for reclaimed waste water, water desalination capacity, total water demand and demand for water & waste water services were firstly prepared in the Fifth development plan (1990/91 – 1994/95).

(g) Future Water Vision

Water vision in the future was firstly manifested in the latest Eighth development plan below:

- Satisfying the growing demand for water for residential and industrial purposes
- Gradually decreasing the demand for water for agricultural purposes

This water vision manifested is expected to be realized through the following measures:

- Development of non-conventional and renewable water resources
- Enhancing water conservation and protection of water resources
- Applying the economic value of water
- Administrative development

The national vision for water sector is to be prepared every five years by the MOEP, and instituted by Royal Decree (currently in the Eighth Development Plan).

(h) Development Strategy

The development strategy including objectives and policies has clearly been indicated since the First development plan up to the latest Eighth development plan.

The development strategy in each development plan is summarized below:

Table 3-1 Development Strategy in Each 5-Year National Development Plan

Development Plan	Main Development Strategy
First (1970/71 – 74/75)	**Objectives** 1. Determine potential water resources and develop them as required 2. Deliver water from source to consumers 3. Establish the necessary administrative framework 4. Provide for the efficient use of water
Second (1975/76 – 1979/80)	**Objectives** 1. Meet the KSA's social and economic demands for an adequate and safe supply of water **Policies** 1. Continue to develop groundwater to meet immediate water demands 2. Accelerate development of the supply of desalinated seawater 3. Improve water quality 4. Provide water to new industries 5. Permit increased use of water for agricultural purposes 6. Provide water for mining operations 7. Plan the development of the desalination system 8. Establish and maintain a comprehensive information system for water supply 9. Conduct special studies on surface, groundwater and desalination 10. Improve the conservation and management of water resources 11. Increase the capabilities of the agencies concerning with water resources
Third (1980/81 – 1984/85)	**Objectives** 1. Provide sufficient quantities of good quality water 2. Secure water supplies 3. Conserve and develop the present known water resources efficiently 4. Seek new water resources **Strategy** 1. Maximize the use of available water supply at the least cost without unnecessary rates of decrement of non-renewable, fresh water resources **Policies** 1. Conclude as soon as possible the preparation of the National Water Plan 2. Continue to implement projects 3. Improve knowledge of the water resource base and make detailed hydrological studies 4. Implement water conservation techniques 5. Continue to introduce modern labor and water saving irrigation techniques 6. Convert to modern and water saving techniques 7. Prepare the way for enforcement of the National Water Plan
Fourth (1985/86 – 1989/90)	**Objectives** 1. Meet the present and future water needs of society 2. Limit the development of all water resources to prudent levels and to effect their conservation 3. Enhance the utilization of existing water resources through the construction of dams for recharging aquifers, and through improved methods of collection, treatment and utilization of sewage water **Policies** 1. Coordinate the development and utilization of all water resources under the guidance of the National Water Plan 2. Maintain a reliable data base on water resources and demand 3. Implement water supply projects continuously 4. Establish administrative units for the enforcement of laws, by-laws, regulations and water rights 5. Monitor the consumption of all water users and the quality of water used 6. Restrict pumping rates 7. Introduce water-saving techniques
Fifth (1990/91 – 1994/95)	**Objectives** 1. Reduce the rate of water consumption **Policies** 1. Establish a phased conservation program through the implementation of a water fee structure and revenue collection system. 2. Fully enforce regulations concerning the conservation of water, and water consumption for agricultural purposed regularly monitored. 3. Reevaluate subsidies towards the cost of well drilling and pump purchased. 4. Resume hydrologic studies of principal and secondary deep aquifers. 5. Complete the National Water Plan, along with the National Water Code and related legal documents for enforcement.
Sixth (1995/96 – 1999/00)	**Objectives** 1. Provide sufficient quantities of good quality water to meet the needs of population, the

Development Plan	Main Development Strategy
	producing sectors and other public services in a more efficient manner 2. Conserve water resources-particularly non-renewable groundwater-and develop there resources to meet current and future demand 3. Improve the management, operation and maintenance of operation water facilities, such as desalination plants, and reduce their costs as much as possible 4. Increase the efficiency and utilization of non-conventional water resources, such as desalinated water, reclaimed waste water and agricultural drainage water, so as to maintain the natural water resources in the Kingdom 5. Raise labor productivity in the water sector and train Saudi manpower to adapt to the continuous development in water technologies **Policies** 1. Consider water as the most basic and valuable resource, and as an important factor in measuring the economic efficiency of public and private sector projects 2. Resume the water studies program to update the hydrological information on water aquifers, and the water potential studies fro some areas 3. Issue the National Water Plan as soon as possible 4. Establish rules for the operation and maintenance of existing water resources in order to preserve their productive efficiency 5. Continue the implementation of water supply projects 6. Make expanded use of reclaimed waste water for agricultural and recreational purposes 7. Prepare suitable training programs fro the manpower working in the sector 8. Continue to be issued regulations and legislation with respect to the organization of water consumption for all purposes and on an economic basis 9. Develop a revenue collection program
Seventh (2000/01 – 2004/05)	**Objectives** 1. Continue with the supply of potable water in sufficient quantities and good quality 2. Consider water as basic factor and an important determination in assessing the economic viability of public and private projects 3. Conserve water resources and rationalize water consumption 4. Increase the role of the private sector in management, operation and maintenance of water facilities **Policies** 1. Review the existing policies of the agriculture and water sectors and regulate water consumption priorities 2. Reconsider the administrative organization of the water sector 3. Support a computerized central database 4. Expand and upgrade the hydrological and hydrogeological monitoring network 5. Develop and support renewable surface and ground water resources 6. Upgrade the detailed hydrogeological studies and issue the national water plan 7. Improve the system of collecting water fees 8. Enhance the role of the private sector in the field of water services 9. Develop non-conventional water resources 10. Develop Saudi manpower in the water sector
Eighth (2005/06 – 2009/10)	**Objectives** 1. Conserve and develop water resources, along with ensuring rationalized use of these resources 2. Provide water and waste water services for all segments of the population of the Kingdom at a high level of quality and reliability and at the lowest possible cost while taking into consideration the purchasing power of low income citizens 3. Provide water for industrial and agricultural purposes within the limit of what is dictated by sustainability of water resources and socio-economic effectiveness 4. Realize the integrated management of the Kingdom's water resources **Policies** 1. Intensify water rationalization and conservation techniques 2. Develop desalination and reclaimed waste water as additional non-conventional water resources 3. Apply the economic value of water approach in all uses and realize sustainable balance between water prices and the cost of production 4. Increase the efficient utilization of renewable water, and endeavor to develop such water 5. Protecting natural water resources against pollution 6. Give priority to meeting the demand for water used for drinking and municipal purposes while encourage the utilization of reclaimed waste water for agricultural , industrial and other purposes 7. Improve the standard of water sector's management 8. Encourage the private sector to invest in waste water collection and treatment facilities 9. Increase the actual capacity of water desalination and encourage private investment in the desalination sector 10. Enhance the contribution of national manpower in the water sector 11. Finalize the studies and research pertaining to the preparation of the National Water Plan

Development Plan	Main Development Strategy
	12. Review the legislation that regulates water uses 13. Establish comprehensive databases of the water sector

(i) Establishment of Ministry of Water and then Consolidation of Water and Electricity

To secure more effective water resources management and national leveled water planning and a higher level of sustainability and continuity of water development and progress of KSA, in 2002 all water agencies and authorities were merged under the Ministry of Water. The specific objectives of the new Ministry as stated in the Royal Decree No. 125 on 16 July 2001 are to:

- Supervise the management, monitoring and organization of the water sector and its facilities
- Carry out all related studies needed to assess the country's water supplies and storage volumes
- Prepare a comprehensive water plan defining policies for water resources development, protection and conservation
- Prepare a national program to expand the drinking water and waste water networks in all urban areas of KSA
- Suggest the required organizations needed for water resources protection
- Study and propose new water tariffs for all users of water
- Determine how to improve the performance of waste water collection systems
- Develop mechanisms, frameworks and implementation strategies for private sector involvements, operation and maintenance

In addition to those responsibilities of the Ministry of Water (MOW) listed above, measures are also needed to:

- Reduce the irrigation water consumption to increase the long-term productivity and quality of the aquifers
- Control leakage and minimize water losses from water supply networks
- Augment groundwater resources from non-conventional resources such as desalination, waste water reuse
- Implement artificial aquifer recharge

In September 2003, responsibilities for the electricity sector were added to the mission of MOW and its name was changed to the MOWE. This decision was made to achieve better coordination between the water and power sectors as most of seawater desalination plants produce both water and electricity. The Ministry has adopted an Integrated Water Resources Management (IWRM) tools to implement its short-term and long-term water strategies, which are presently under development. This approach is aimed at achieving the coordinated development and management of water, land and related resources in ways that will maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of valuable groundwater resources and vital ecosystems.

(j) Characteristics of the Eighth 5-Year National Development Plan

The Eighth development plan marked a new phase in the development process that has spanned over three decades, and also represented the first landmark in a strategic approach for the national economy, which extends over the next twenty years and encompasses four consecutive five-year plans. As such, this approach reflected a new turn in the methodology adopted for strategic planning in KSA. In previous plans, the long-term general objectives that defined the government's strategic development directions served as the point of departure for setting priorities and the areas of focus of each plan.

The Eighth Development Plan defined more precise targets and translated them into quantitative terms (whenever possible) and clearly spelled out implementation schedules and the responsibilities of the implementation agencies, as well as the issues they would address.

(k) Water Demand and Supply Balance in 5-Year National Development Plans

Since the Second 5-Year National Development Plan (1975 – 80), the present and future water demand and supply balance was estimated as shown in Table 3-2.

The latest Eighth 5-Year Development Plan expected the low growth rate of water supply by renewable surface and groundwater and the sharp reduction of water supply by non-renewable groundwater and the high growth rate of non-conventional water as summarized below.

Table 3-2 Expected Water Demand and Annual Growth Rate in latest Development Plan

Water Resources	Water Consumption in 2004 (MCM/year)	Expected Water Demand In 2009 (MCM/year)	Annual Growth Rate (%)
Renewable Surface and Groundwater (Arabian Shield & Continental Shelf)	6,500	6,900	1.0
Non-Renewable Groundwater	12,400	9,270	-5.0
Non-conventional water (Desalinated Water and Reclaimed Waste Water)	1,370	2,090	8.0
Total	20,270	18,260	-2.0

3.2 Long-Term Strategy 2025

(1) Overview

The Long-Term Strategy 2025 (LTS 2025) marks the culmination of an extensive process of consultation, analysis and thinking. The work on this strategy began with the Royal Consent on July 2, 1998 giving the responsibility to the Ministry of Economy and Planning to organize a National Symposium on the "Future Vision for the Saudi Economy" held on October, 2002.

The Symposium reviewed the past performance of the Saudi economy and development strategic options for dealing with current and future challenges facing the Saudi economy. The symposium provided the foundation for designing a long-term strategy to achieve the future vision for the Saudi economy.

The proposed long-term strategy is supported by three pillars.

- The first pillar of this long-term strategy involves clear articulation of Vision 2025. It defines the direction and destination for the Saudi economy for the next twenty years.
- The policies required to achieve Vision 2025 constitute the second pillar of the strategy. These policies provide the "means" for achieving the "ends" enunciated in KSA Vision 2025.
- The first pillar specifies what the society wants to achieve and the second pillar outlines "how" the society can achieve it.
- The third pillar consists of follow-up and implementation mechanisms to ensure that aspirations articulated in Vision 2025 are converted into reality on the ground. This pillar operationalizes the old adage: "what gets measured gets done."
- These three pillars are like the individual legs of a three-legged stool. Each leg is indispensable and equally important to achieve the objectives of the long-term strategy.

(2) Long-Term Strategy for Water Sector

Vision 2025 listed the following challenges that are facing the Saudi economy:

- Employment generation
- Poverty reduction
- Improvement in Quality of Life
- Achievement of sustainable development by:
    a) Diversification of the economy
    b) Rationalization of water usage
    c) Promotion of balanced regional development
    d) Improving management of public finances
- Improvement in implementation and execution of public policies

To promote a prudent water management to rationalize water usage, Vision 2025 listed the following core set of strategic policies in water sector:

- Issue a clear statement of water policy
- Revive benchmarking of water utilities
- Implement Result-oriented conservation drive
- Increase PSP (Private Sector Participation) in water and waste water sector (including dams)
- Tariff reform
- Update estimates of total water resources

3.3 National Water Strategy (NWS)

(1) Background and Present Status

(a) Background

In 2003, the MOWE requested World Bank (WB) to support for the development of an Integrated Water Resources Management Strategy and Short/Long Term Action Plans for KSA. A scope of work, based on a comprehensive assessment of the water resources, focuses on the following:

- Broad-based water demand management rather than supply management policy
- A cross-sectoral program for reducing non-renewable groundwater withdrawal and more sustainable aquifer management
- A comprehensive program for reclaimed waste water reuse in agriculture irrigation
- Reorganization of the legal and institutional framework

The overall scope of the MOWE-WB Cooperation Program was agreed upon to include the following three phases:

- Phase I: Assessment of the current water resources management situation
- Phase II: Development of strategic water sector management policies through extensive in-country consultations
- Phase III: Development of an action plan for implementation of the strategy

According to MOWE, Phases I and II were completed and WB was requested to revise the general objectives of Phase II. MOWE assumed in August 2007 that within two months, final comments of MOWE would be informed WB. Phase III is scheduled to commence after the final approval of MOWE is given to the Phase II.

The JICA Study Team obtained the following WB reports during the first site survey from July to August 2007:

- Assessment of the Current Water Resources Management Situation, Phase I – Volume 1: Main Report, December 18, 2003, Draft for Workshop Discussions.
- Assessment of the Current Water Resources Management Situation, Phase I – Volume 2: Stocktaking Thematic Annexes, December 18, 2003, Draft for Workshop Discussions.
- National Water Strategy, the Water Sector of the Kingdom of Saudi Arabia, Riyadh, March 2007, Draft last modified on March 23, 2007.

According to MOWE, the Action Plan which will be executed after the completion of Phases I and II, including the following plans:

- Updating of groundwater mathematical models of major aquifers
- Detailed water resources studies of non-sedimentary rock which is known as Arabian Shield and to depend on renewable water resources
- Study of water potentials in basaltic and sub-basaltic aquifers
- Preparation of comprehensive water system and development of needed regulation for its execution
- Preparation of studies and designs for reclaimed waste water reuse in different purposes, excluding domestic use
- Updating and development of hydrological and observation well network

(b) Present Status

Six months after the Plan of Operation for the Study submitted in August 2007, the Study Team has obtained no latest information on:

- Final approval of MOWE on the National Water Strategy proposed by WB
- Final version of National Water Strategy Report revised reflecting the comments of MOWE
- Schedule on the commencement of Phase III and its general outline

Therefore, the Study Team should assure the above matters through discussions with MOWE when the Draft Progress Report (1) is to be submitted to MOWE.

(2) Identification of Current Situation and Issues

The WB Study Team identified the most pressing issues that the water sector in KSA is facing, and grouped those issues under the definition of five policy gaps as summarized below:

(a) Water Scarcity Gap

- The current levels of groundwater withdrawals, mostly water for irrigation, far exceed the level of natural recharge of the aquifers. This implies exploitation of the groundwater well beyond its sustainable yield.
- A fundamental reason for the over-draft of the aquifers is the economic signals which farmers have been receiving for the 25 years, characterized by two mutually reinforcing forces, both leading to the unsustainable use of groundwater. One is the high level of agricultural support (energy subsidies, price support and highly subsidized loans) which induced a precipitous increase in the cultivated area and discourages water savings. The second one is the negative externality that emerges due to the unrestricted access to groundwater.
- The problem is exacerbated by two additional factors. On one hand farmers are treating groundwater as a free good, assuming that it is their right to take (and to waste) as much water as they want. On the other hand there is the lack of government control and regulation of the irrigation activity.

(b) Water Conservation Gap

- The current tariff for urban water supply (levels and structure) provides no incentive to conserve water, yielding per capita consumption levels that are inconsistent with the water scarcity condition in the Kingdom. The low pricing of water is also a disincentive for reducing the excessive water losses occurring along the distribution networks.
- Another aspect revealing a lack of conservation is the imbalance between reclaimed waste water supply and its reuse. This is attributed to the lack of a central policy and long-term plan considering reclaimed waste water as an additional source with economic value. The benefit of such a policy is two-fold: as a safeguard against pollution and environmental degradation; as a way of securing additional water supplies for a variety of uses (the second least expensive water to reclaim).
- Irrigation is the area with the worst water conservation results. The 45% irrigation efficiency mentioned earlier occurs despite the large investments made in the modernization of the irrigation infrastructure (financed by large government subsidies). This is attributed in part to the lack of government control, giving farmers unrestricted and free access to the resource.

(c) Water Service Gap

- Water supply and sanitation (WSS) services present a mixed record. Aside from just a few exceptional cities with good service, the quality of service remains noticeably below internationally acceptable standards. An important portion of the population remains dependent on supply through water tankers, and waste water collection and treatment are the areas requiring the most improvement.
- Although Saline Water Conversion Corporation (SWCC) provides bulk desalinated water to the regional directorates free of charge, utilities recover on average less than 5 per cent of their O&M cost (water tariffs are among the lowest in the world). Such a low level of cost recovery

has prevented the investments necessary to keep up with the networks expansion and service improvements. Furthermore, the lack of cost recovery from users discourages the private sector from getting involved in the financing of the sector.

(d) Water Governance Gap

- Past water administrators have dedicated their best efforts to building the major water infrastructure and providing water services, with little attention to base resource management (functions involving resource assessment, monitoring, planning, allocation, protection and control). This is a serious overlook responsible for many of the problems the water sector is facing today, even threatening the very existence of the resource.
- The MOWE should institute radical management changes by adding new functions to its day-to-day water administration, enhance coordination with all water actors as well as provide the means and technical instruments for successful management. At that stage political support will be needed to establish the new organizations, build capacity and improve upon current recruitment policies.

(e) Financial Gap

- Water related activities impose a heavy burden on the government budget. The cost derives mainly from two fronts: the high level of farm subsidies supporting commercial irrigation activities and the lack of cost recovery in water provision services (urban areas). Agriculture and macroeconomic policies have aggravated the situation by encouraging farmers to select low-valued crops rather than higher valued, tradable crops. Under the current situation one should expect a substantial gap between the productions cost to farmers and the true cost of agriculture to the Saudi economy as a whole.
- Outside the agriculture sector the negative financial impact is equally severe. Irrigation competes with urban areas for water supply making household use even more dependant on desalinated seawater, a more expensive proposition considering the high production and conveyance costs of desalinated water. This occurs despite the fact that most urban areas are close to or lay directly above sufficient groundwater reserves to meet their domestic needs at a much lower cost.
- On the other hand, the lack of cost recovery hinders the WSS sector capacity to extend sewerage services to more areas and build new treatment facilities. Given the high cost of infrastructure and the many projects competing for government funds, it is doubtful that the government alone can meet the goal of increasing sewerage coverage up to 94% in 25 years and simultaneously increase the capacity for waste water reuse.

(3) Recognized Policy Framework for National Water Strategy

Three premises such as Sustainability, Efficiency and Equity embody the essence of the KSA water strategy. These premises are recognized in two master documents of the KSA: the Vision 2025 and the Eighth National Development Plan by MOEP, 2006. In turn, the three premises were translated into a series of clear mandates that guided the preparation of the water strategy as listed below:

- Declare water a national good for public use, subject to government regulation
- Stop the devastation of the base resource and reverse the course of action
- Shift in paradigm: from water supply management to water demand management
- Find a balance between water development and resource protection
- Adopt a virtual water strategy to relieve the pressure on the water resources
- Promote high value of water so as to increase water productivity
- Reach universal coverage of water supply and sanitation services
- Attain cost recovery for water services
- Provide legal protection to water users
- Adopt integrated planning as the rationale for water allocation
- Exercise water management at the lowest appropriate level
- Improve public awareness and encourage water conservation

(4) Proposed Strategic Choices (Summary)

The NWS proposed a list of strategic choices and associated measures and actions that, if undertaken as prescribed, will secure the base resource and substantially improve water resources management. Measures and actions of the NWS are tailored to close the policy gaps cited in 3.3.2.

(5) Recommended Policies Coordination

- Several of the issues and policy gaps cited earlier are a demonstration of the disparity between water needs and water availability embedded in the sectoral strategies. The conflict should not come as a surprise since by its own nature water allocation is characterized by competing and at times mutually exclusive demands. It is this particular condition that makes imperative the harmonization of the sectoral strategies and action plans that directly or indirectly impact the Kingdom's water resources.
- The process starts by creating horizontal linkages across all water users to find the best possible solution to the water allocation problem. Conflicting interests can be reconciled by establishing technical and political coordination so that a coordinated approach to development can be implemented. Technical coordination can be achieved by setting up an integrated water resources planning (IWRP) process. This is the instance when all water related agencies gather (at the technical level) to harmonize water demands with water availability, yielding as output unambiguous instructions for bulk water allocation.
- But establishing effective coordination is more a political challenge than a technical one. For that reason the KSA should create an executive body to overcome sectoral interests and set the government in motion to ensure the coordination of sectoral policies affecting the Kingdom's water resources and to arbitrate in possible conflicts if necessary. The NWS recommends the formalization of an intra-governmental and interagency coordination body to be named the Kingdom's Water Council (KWC), to focus coordination and integrated planning in the water sector and enforce collaborative decision making.

(6) Indicated Enabling Environment

- The NWS offers prospects for greater water use efficiencies; water conservation; equitable and efficient water allocation; monitoring and protection of the sources; increasing the reuse of water; enhancing water productivity and expansion in the population served. But bringing all these expectations to realization entails a number of reforms to the water institutional structure that include: new enabling legislation, new organization, new management instruments, mechanisms for policy coordination, building and recruiting new capacities, reformulation of staff retribution regimes; and foremost, strong ownership of the new policy environment.
- The new institutional structure will be founded in a modern legal and regulatory framework, supported by proper instruments, to give the MOWE the power to exercise specific water management functions. The various laws in place within the Kingdom will be revised to assure compatibility with MOWE's new mandate in order to conform to a new National Water Law (NWL) –a law of principles– spelling out the water policies of the Kingdom and setting the framework for more detailed by laws and regulations within each separate area of responsibility and water using sectors.
- The issues exposed earlier revealed the inherent limitation of the present institutional arrangements of the MOWE to deal effectively with the current water problems. While the "public good" character of the water is undisputed in the Kingdom, government had been absent from the basic functions of resource management. Hence a new organizational structure is in order, aimed at promoting integrated water resources management functions in the Kingdom.

3.4 Institutional, Organizational and Budgetary Aspect

(1) Current State on Institutional and Organization Framework

The current state on institutional and organizational framework relating to water resources development and management in KSA is shown in Figure 3-1.

- MOWE is currently a core body for water resources development and management in KSA, which has the mandate to formulate a basic policy on water sector, permit well digging for well digging contractors, inspection the facilities and actual implementation on water and sewerage sector. MOWE also receives desalinated water from SWCC and distribute it to customers.
- Ministry of Agriculture (MOA) formulates an agricultural policy in the agriculture sector which currently consumes over 85 % of water resources in KSA, and MOA also authorizes permits / license for reuse of reclaimed waste water.
- SWCC, an inter-agency of MOWE, operates saline water conversion plants nationwide KSA and supply its bulk desalinated water to MOWE and municipalities for their water distribution to customers.
- Saudi Geological Survey (SGS) has a mandate to carry out survey works to identify water resources and water storage, determine the qualities and quantities of surface and groundwater, and determine water suitability in consultation with MOWE.
- MOEP formulates a national development plan including water and agricultural sectors based on the data / information supplied by MOWE and MOA.

The demarcation of major agencies relating to water sector is shown in Table 3-3.

Table 3-3 Demarcation of Major Agencies relating to Water Sector

Agencies	Water Resources Development & Management					Water Users		
	Infrastructure	Policy / Legislation	Management	Political / Economy	Tariff Collection	Irrigation	Sanitation (Waste Water)	Others (e.g. Industries)
MOWE	O	O	O	O			O	
MOA						O	O	
MOMRA	O		O				O	
MOEP		O		O				O
MOF				O	O			
SWCC	O							O

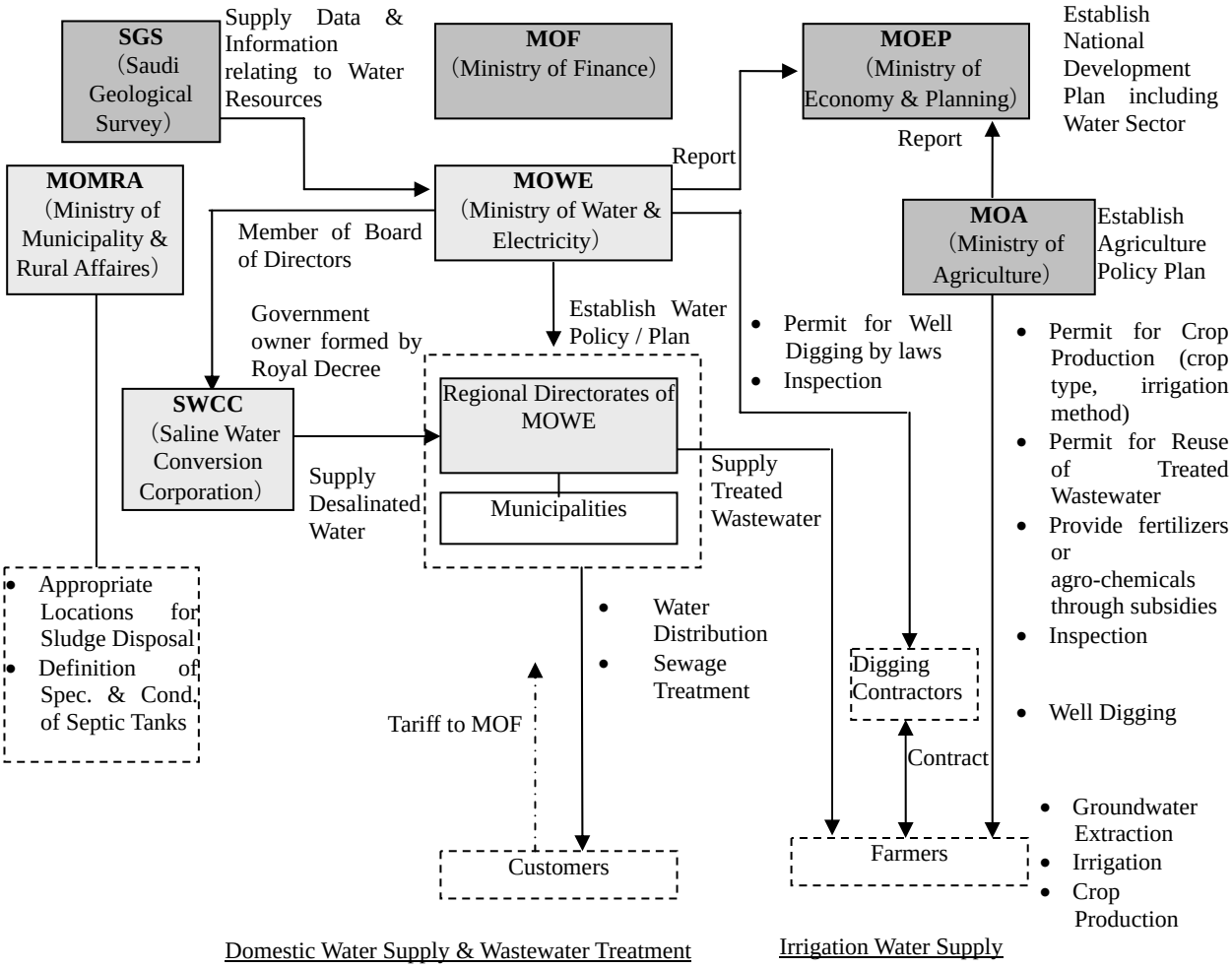


Figure3-1 Current State on Institutional and Organizational Structures Relating to Water Resources Development and Management

(2) Institutional and Organizational Reform Process in Water Sector

The water and waste water sector in KSA is facing drastic challenges from the following backgrounds:

KSA is a large country covering an area of approximately 2.24 Million km^2 with a population of about 24 million.

Water is scarce and a precious resource due to its limited resources (average rainfall is 70 mm/year) in KSA.

Due to growing population increase (3% annual growth) and rapid economic growth, water demand in KSA is increasing rapidly.

Present water tariff in KSA is in lowest level in the world, while water production and its distribution costs are in highest level.

The estimated UFW (Unaccounted for Water) percentage for the country is about 35 %

In order to deal with the challenges the Government of KSA has launched a reform process in water sector.

The government's overall key objectives for the reform are:

- Providing access to clean and good quality potable water for all residents
- Providing sanitation access to all households and safe disposal of waste water
- Providing reasonably priced water and sanitation services, which can contribute cost recovery and

improved services
- Radically streamline, and improve the water sector performance, operational efficiency, and be in line with international best practices
- Improve customer services
- Protecting the environment and encouraging the conservation of natural water resources.

Reform 1: Centralization in Water & Sewerage Sector, Establishment of MOWE

Before 2001, the jurisdiction for the provision of water and sewerage services in KSA was divided into a number of ministries and subordinate agencies. The Ministry of Agriculture and Water (MOAW) was responsible for the development of natural water resources. The SWCC which was established in 1974 has supplied desalinated water for municipal use. The Ministry of Municipalities and Rural Affairs (MOMRA) was responsible for the provision of both water and waste water services to domestic customers.

In order to centralize and streamline roles and responsibilities within the water sector, the creation of a MOW was authorized by the Government in July 2001. This Ministry was expected to oversee the country's water sector, and has taken over the water-related roles from the MOAW, and MOMRA. In 2003, the Ministry was expanded to incorporate the electricity sector and established as the MOWE.

Reform 2: Introduction of PPP

In 1999, the Supreme Economic Council was established, aimed at increasing investment and promoting privatization. Several new investment regulations have been introduced, opening up most sectors to foreign investment and reducing taxes on such investment in most sectors to 20%, and to 30% in the natural gas sector.

PPP was expected to deliver on the promise of improved water quality and customer service and visible increases in capital investment and the replacement of aging facilities, taking into account best practices, successful business models and adherence to international efficiency standards and given the projected increases in water demand in KSA. The Kingdom's Supreme Economic Council passed a Resolution (5/23), in June 2002, which established a framework for the involvement of the private sector in investing in water infrastructure.

Furthermore, the incorporation document (No. 27472 dated 9/7/1423H) for the creation of MOWE also specifies MOWE shall have responsibilities directly related to PPP:

Setting the suitable mechanisms, frameworks and arrangements for the private sector investment in water sector

Water Sector is among the 20 different sectors approved for privatization pursuant to Council of Ministers' Resolution No. 219 (6/9/1423H)

The privatization strategy approved by the Supreme Economic Council including all possible contracts in privatization such as management, leasing, financing and financing (e.g. BOT and Concession) contracts

Reform 3 (Under Process): Establishment of NWC

The Government intends to reform the sector further and introduce a new institutional and regulatory framework and revised tariff structure. A restructuring of the sector is also expected to include water demand management initiatives, including a reduction in non-revenue water, and the introduction of metering system nationwide KSA. The reforms will also include serious attempts to attract significant private capital for investments capacity extensions, and other infrastructure improvements, in order to alleviate the burden on the national budget.

A major result of this reform process will be the establishment of the NWC to improve the overall performance of the sector in various aspects through the transformation of the service providers to commercially oriented organizations and the involvement of the private sector. NWC is expected to start as government-owned statutory company formed by Royal Decree and registered as joint-stock-company. As the privatization process evolves the role of the NWC will change to

accommodate the requirements of the sector. It will gradually integrate the operations of the other major cities. The short-term institutional structure in water sector is shown in Figure 3-2.

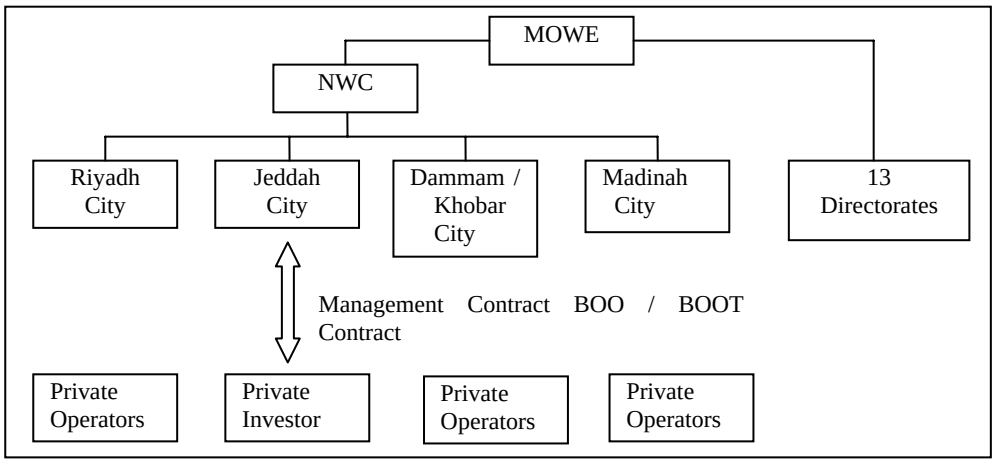


Figure 3-2 Short-term Institutional Structure in Water Sector (Under Process)

(3) Current State on Organizational Demarcations / Mandates of Relevant Authorities

(a) Ministry of Water and Electricity

1) Head Quarter

In accordance with Resolution No.125, the water directorates and departments of the MOAW directorates and departments of the 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

MOWE headquarter currently has the departments as shown in Figure 3-3. Each department has 20 to 40 staffs.

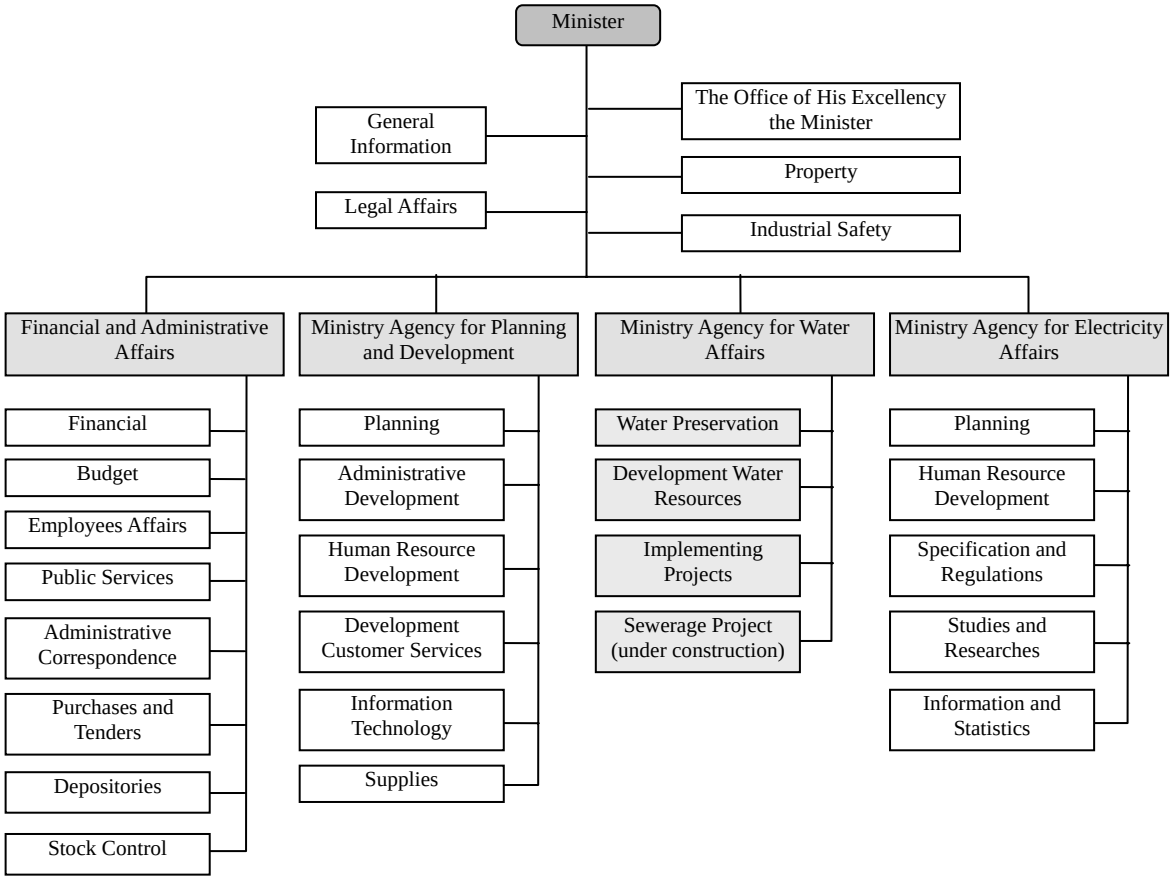


Figure 3-3 Organization Chart of MOWE

2) Regional Office of MOWE

MOWE has its regional offices in 13 regions. The functional outline of each department of the 5 regions in the study area is shown in Table 3-8. The organization chart of Al Baha regional office is illustrated in Figure 3-4.

Table 3-4 Outline of Each Department of Regional Offices of 5 Regions in Study Areas

Region	Department	Others
Abha	• O & M Department - Wells & Dams - Pipeline Networking - Emergency & Water Conservation • Project Department • Finance & Administration Department	
Najran	• Technical Department - Study / Project Section - Maintenance Section - Sewage System Section • Water Services Department - Geology Section - Hydrology Section - Dam Section - Rural Water Related Section - Water Truck Section • Finance & Administration Department • 2 Branch Offices	
Jazan	• Project Department - Dam Section - Water Supply Section - Sewage System Section • Finance & Administration Department	Number of Technical Staffs Civil Engineer: 4 Mechanical Engineer: 5 Chemical Engineer: 2 Geologist: 2

Region	Department	Others
	• Water Conservation Department • Public Relations Department • Tank Truck Department • Study Department • Maintenance Department • Training Department	Hydrologist: 1
Makkah	• Technical Department - Study Section - Contract Section - Water Section - Architecture Section - Others • Maintenance Department • Office Management / Planning Department	Total Staffs: 200
Al Baha	• Rationalization Department • Study for Water • Operation & Maintenance Department • Technical Affairs Department • Data Technology Department • Properties Department • Industrial Security Department • Administrative Affairs Department • Public Relations Department • 5 Branch offices	Total Staffs: 200

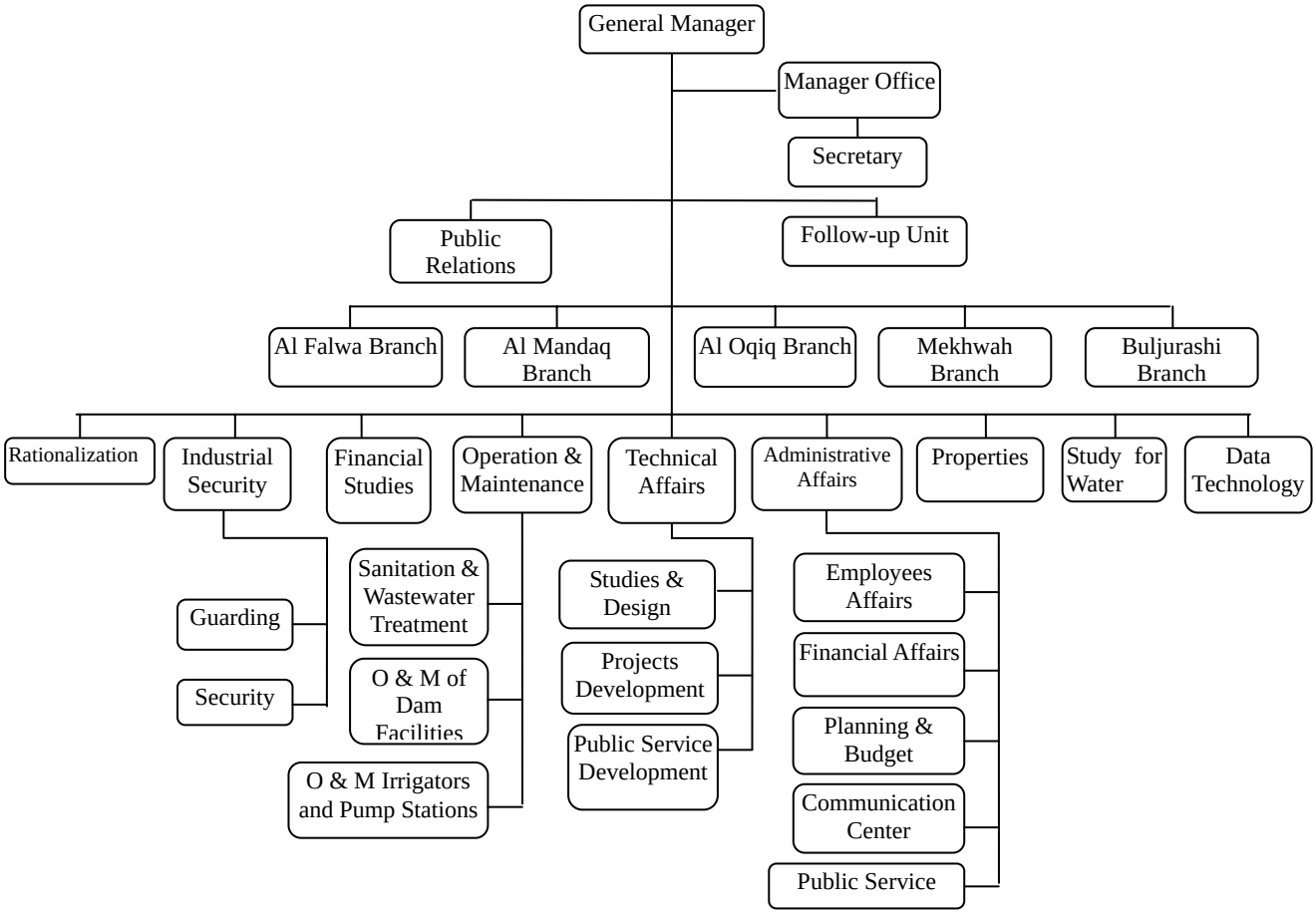


Figure 3-4 Organization Chart of Al Baha Regional Office

(b) Ministry of Agriculture

MOA is the former organization body which had the mandate for water resources development and management before it came under the jurisdiction of MOWE.

The organization chart of MOA is shown in Figure 3-5. The departments relating to reuse of reclaimed waste water and irrigation water which is consuming 85% of the total water consumption in KSA is independent from the following major departments.

- General Authority for Administrative and Financial Affairs
- Under Secretary Assistant for Lands Affairs
- Under Secretary Assistant for Live Stock
- Under Secretary for Fish Resources
- Under Secretary for Agriculture Research and Development
- Under Secretary for the Agriculture Affairs

The regional offices of MOA in 13 regions are under the direct jurisdiction of the minister.

(c) Saline Water Conversion Corporation

SWCC is the authority that supplies water in KSA. SWCC is administratively related to MOWE whose minister is currently a chairman of the board of directors of SWCC. The organization chart of SWCC is shown in Figure 3-6. SWCC has all necessary powers to achieve its main objective, which is to support natural water resources through providing desalination in 13 regions and cities in which water sources are insufficient.

Pursuant to Council of Ministers' Resolution No. 219 (6/9/1423H), the privatization of desalination has been given a top priority among various utilities.

(d) Saudi Geological Survey

SGS was established as an independent entity attached to the Ministry of Petroleum and Mineral Resources following a Council of Ministers Decision in 1999.The tasks and duties of the SGS are similar to those of most geological surveys worldwide, and include mapping, grass-roots mineral exploration, geo-hazard and geo-environmental studies, hydro-geological studies and services to the community. Its organization chart is shown in Figure 3-7. SGS has about 800 staffs and the head office in Jeddah with the staff number of about 650.

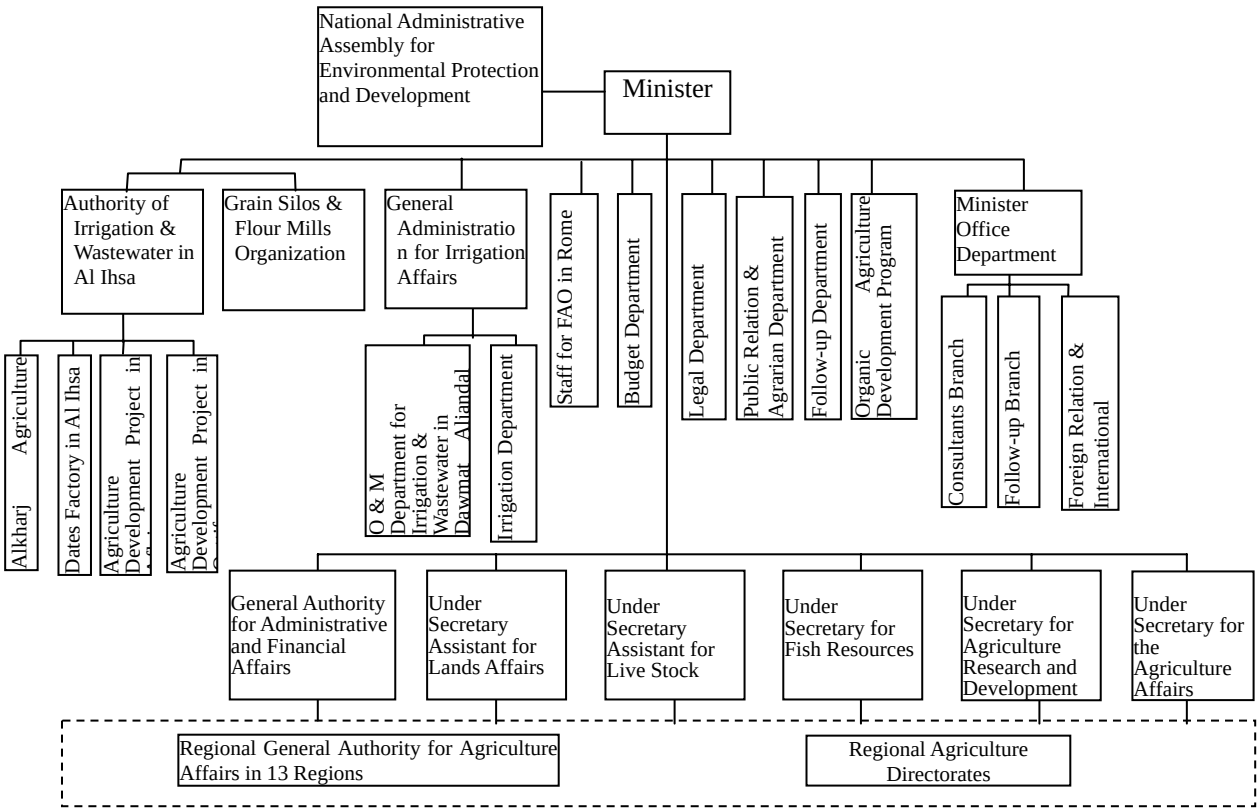


Figure 3-5 Organization Chart of MOA

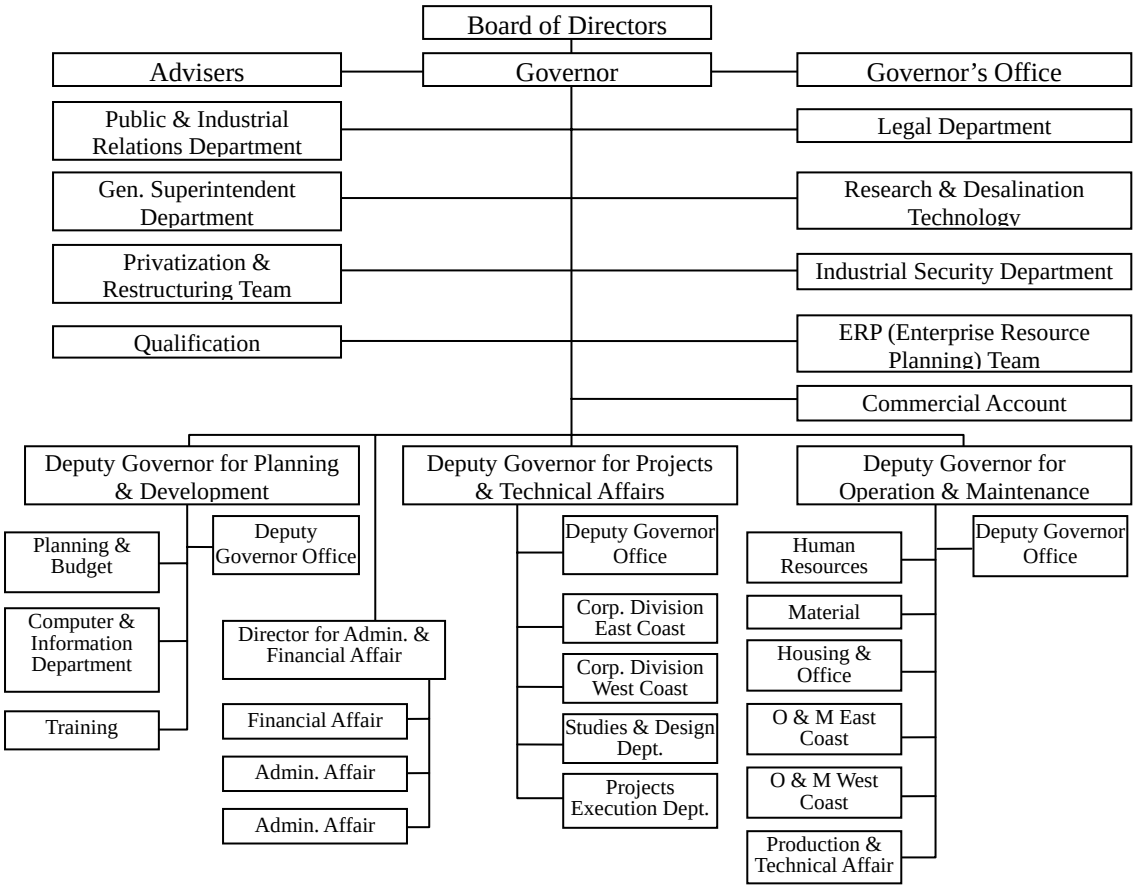


Figure 3-6 Organization Chart of SWCC

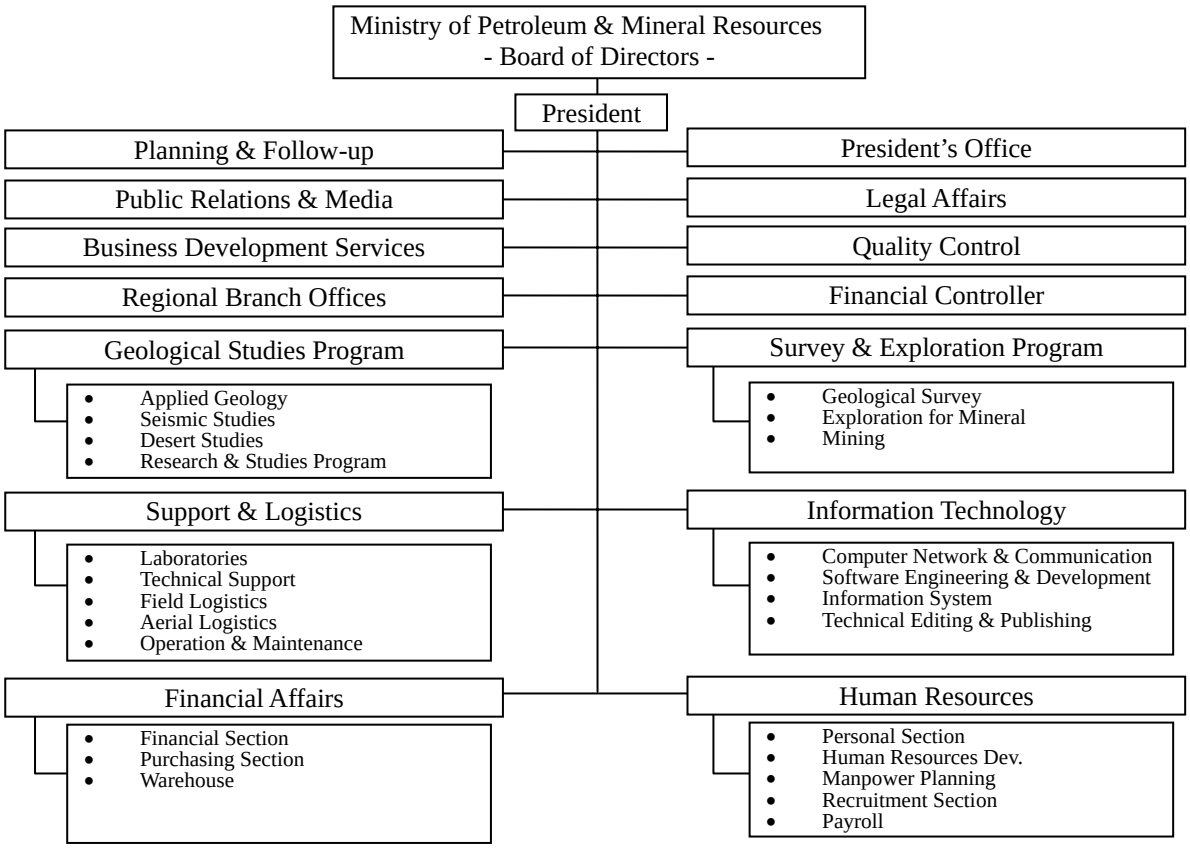


Figure 3-7 Organization Chart of SGS

(4) Problems Surrounding Institutional / Organizational Issues

The water resources development and management in KSA has been consolidated to MOWE since 2003 institutionally and is still in reform process at the present.

The institutional / organizational problems surrounding in water sector are shown as follows;

Organizational and jurisdictional problems surrounding irrigation water:

The jurisdiction on irrigation water which is exceeding 85%of total water consumption is not clear between MOWE and MOA. MOA has the irrigation department, while the jurisdiction of water resources including groundwater legally belongs to MOWE. There is no cross-sectional organization body or coordination institution of two ministries for above jurisdictional problems.

Law enforcement and MOWE's human resource capability:

In the sight of laws and regulations on water resources management (Royal Decree No M/34 or Council of Ministers' Resolution No. 62044), MOWE shall grant the license for digging wells, inspect the sight and carry out the management in water resources management. However, it is uncertain that MOWE has an enough capacity of human resources to enforce above legal provisions.

Role, demarcation and mandates among the headquarter and regional offices of MOWE:

The role, demarcation and mandates among the headquarter and regional offices of MOWE are not clear. In some examples, the regional offices have more data / information on water resources management to be necessary for formulating mid-term or long-term plan, while the headquarter has the mandates for preparing such plans.

Private extraction of groundwater and the limits of government's involvement:

The land owner extracts groundwater privately within his land in Middle-East Countries, in which there is a limit for government organs to manage the groundwater compared to surface water.

Uncertain organ or no organ for water allocation and data gathering:

It is uncertain whether there is an organ which control / manage the data for water allocation and water use amount, or not. Therefore, it will be hard for the government to conduct the planned water management based on scientific data. The provision on water right is not clear.

Free of charge for irrigation water: No tariff is charged for irrigation water at present, which is estimated to cause the farmers to extract the groundwater unlimitedly.

Educational campaign for water saving:

Water saving is currently carried out for municipal water. However, for irrigation water, it is not doubtful that such education including technical knowledge on irrigation methods for saving water is implemented for farmers.

Tariff issues:

There is no water charge on irrigation water. Even in municipal water, its water tariff is extremely lower compared to its international level or its water cost (e.g. water tariff to per capita GDP: 0.14 % in KSA in 1999 compared to that of over 0.75% in the world, and tariff to water cost: the average tariff for a family of 6 is 0.1 SR/m^3 because of its consumption of around 41 m^3/month is higher the water cost 4.0 SR/m^3 consisting of production cost 1.5 SR/m^3 plus distribution cost 2.5 SR/m^3). Furthermore, tariff structure is same for all customers: household, commercial or industrial use.

(5) Budgetary Aspect relating to Water Resources Development and Management

Pursuant to Royal Decree No.381, the Ministry of Finance (MOF) was established. MOF has had the mandates for the organization, maintenance and collection of the government's finances, as well as for initiating budgeting methods.

(a) National Budget in Last 3 Years and Public Investment to Water Sector

The national budget consisting of revenues and expenditures for the last 3 fiscal years of 2005, 2006

and 2007 is shown in Table 3-5. The budget allocation from its expenditure to each sector is shown in Table3-10. The budget for water, agriculture and infrastructure sector is allocated annually by 6.5 to 7.0 % (accounting for 22.5-28.5 Billion SR) for total expenditure of the government budget expenditure.

Table 3-5 National Budget in 2005, 2006 and 2007 (Performance)

Unit in Billion Saudi Riyals

Year	Revenue	Expenditure	Surplus / Deficit	
2005	555	341		214
2006	655	390		265
			Breakdown;	
			Additional Development Projects:	40
			Public Investment Fund:	20
			Government's Reserves Account:	100
			Others (incl. public debt):	105
2007	621.5	443		178.5
			Breakdown;	
			Real Estate Development Bank:	25
			Government's Reserves Account:	100
			Others (incl. public debt):	53.5

Source:
1) Ministry of Finance
2) http://www.saudiembassy.net/2006News/Statements

Table 3-6 Budget Allocation to Each Sector (Projection)

Unit in Billion Saudi Riyals (Percentage)

No.	Sector	Year		
		2006	2007	2008
1	Education & Human Resource Development	87.3 (26.1)	96.7 (25.4)	105.0 (25.6)
2	Health & Social Affairs	31.0 (9.3)	39.5 (10.4)	44.4 (10.8)
3	Water, Agriculture & Infrastructure	22.5 (6.7)	24.8 (6.5)	28.5 (7.0)
4	Municipal Services	12.4 (3.7)	15.5 (4.1)	17.0 (4.1)
5	Transportation & Telecommunications	11.5 (3.4)	13.6 (3.6)	16.4 (4.0)
6	Others	170.3 (50.8)	189.9 (50.0)	198.7 (48.5)
Total Expenditure		335.0	380.0	410.0

Source:
1) Ministry of Finance
2) http://www.saudiembassy.net/2006News/Statements
3) http://www.soietz.gov.sa/

(b) Annual Budget of MOWE

The annual budget in the past 4 years of 2004 to 2007 is shown in Table 3-7. The annual increase rate of investment for new projects is 20 % to 50% for the previous year.

Table 3-7 Annual Budget of MOWE

Unit in 1,000 Saudi Riyals

Category	Regions	2004	2005	2006	2007
Third (Operation & Maintenance)	The Public Office	2,146	2,297	1,702	328
	Riyadh	1,063	1	2,393	3,298
	Makkah	**1,325**	**1,480**	**1,582**	**1,748**
	Ash Sharqiyah	1,325	856	1,191	1,085
	Al-Madinah	574	551	741	682
	Ha'il	0	0	0	296
	Al-Qasim	603	697	1,084	843
	Al-Hudud Ash Shamaliyah	0	0	0	290
	Asir	**199**	**209**	**510**	**599**
	Tabuk	63	82	199	197
	Al-Jawf	0	0	0	180
	Al Baha	**0**	**0**	**0**	**191**
	Jazan	**0**	**0**	**0**	**266**
	Najran	**0**	**0**	**0**	**102**
	Others	0	181	0	0
	Total	7,298	6,353	9,402	10,105
Fourth (New Project)	The Public Office	10,563	11,121	10,362	9,129
	Riyadh	3,683	4,482	9,782	10,319
	Makkah	**3,914**	**4,820**	**8,947**	**13,351**
	Ash Sharqiyah	2,013	2,106	3,263	3,738
	Al-Madinah	1,000	0	1,926	2,275
	Ha'il	0	1,312	0	1,320
	Al-Qasim	1,201	0	2,522	3,266
	Al-Hudud Ash Shamaliyah	0	1,207	0	1,166
	Asir	**902**	**436**	**2,104**	**2,871**
	Tabuk	349	0	1,181	1,627
	Al-Jawf	0	0	0	836
	Al Baha	**0**	**0**	**0**	**979**
	Jazan	**0**	**0**	**0**	**1,507**
	Najran	**0**	**0**	**0**	**965**
	Others	2,955	5,441	8,765	8,086
	Total	26,579	30,927	48,852	61,437

Source: Ministry of Water & Electricity

Notes: The figures of First (Salary) and Second (Bonus) categories were not available.

4. Recommendation for Improvement of Institutions and Organizations

4.1 Personnel Training and Capacity Building

In the engineering management of MOWE head office and general directorates of water in region, the state of extensive or entire dependence on some consultant companies or contractors can be seen partly. In order to demonstrate an initiative as the management and regulatory organization of water, and to attain improvement and strengthening of the personnel's temperament, it is necessary to master external organizations such as consultants and contractors as hand and foot, and to raise engineers and administrators who can do supervision and instruction of subsidiary organizations.

The work field and class classification of engineer and administrator are shown in Figure 4-1.

In order to not only i) make bottom-up of skill of skilled workers concerning terminal equipment and ii) make bottom-up of technical level of site managers regarding control of independent facility, but also iii) raise managers or engineers who can control combined several facilities, iv) raise director who can manage each division of higher rank, and furthermore v) raise general director who can manage synthetically the whole of the organization, the improvement of the following organizations and systems are proposed.

(1) Establishment of a Training Center

In order to raise the skill and the technical level of the skilled workers concerning terminal equipment and the site engineers relating each facility, the following training and technical education are carried

out. For this reason, the foundation of a training center and instructors stationed in are required.

- Skill-up training for control and maintenance of each terminal equipment
- Technical education for control, maintenance and management of each facility
- Technical education for planning, investigation, design and construction management of each project

(2) Strengthening of on the Job Training at Work Site

In order to apply and reflect the results of education received in the training center to each worksite, and fix it as an absolute technique, repeating site work education (on the job training) and training center education are carried out. For this reason, at each work site the system that a higher rank leader guides group constituents by making-up team organization is proposed.

(3) University and Research Institution Training

The training for middle-level manager and engineer is carried out according to utilization of the university and the research institution, and more advanced management ability and technical capabilities are mastered.

The creation of training program and teaching materials are requested to a university and a research institution.

(4) Other External Training

In order that upper position manager and engineer master a broad view and make it reflected in the management work, overseas trainings and temporary transfers to external organization (for example, temporary transfer to a consultant with technical high-level capabilities, etc.) are carried out.

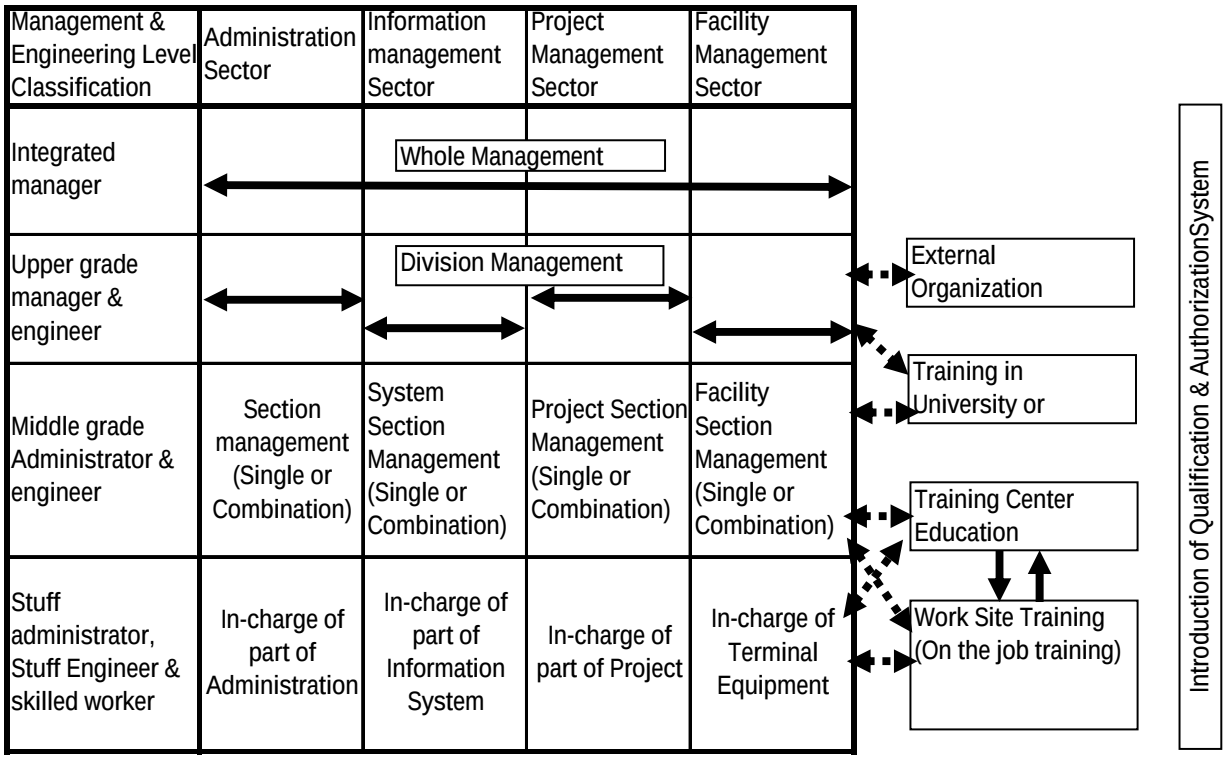


Figure 4-1 Diagram of Education System by Sector and Work Level Classification

(5) Introduction of Qualification and Authorization System

In order to encourage the personnel's spontaneous capacity building, the qualification system for every member is introduced. Moreover, an acquisition of qualification or authorization of an external authority is also encouraged.

The system that the acquisition of qualification contributes to the status promotion is required.

4.2 Promotion of Educational Campaign for Water Supplies

About the educational campaign for water supplies, the sections in charge of MOWE head office and each general directorates of water in region in its duty take out a booth in each office, and is developing water-saving campaign activity. Moreover, a water-saving campaign week (1 time and about one week per year) is set up, and televising of the TV commercial for water-saving encouragement and printing of the newspaper advertisement are performed.

Moreover, in the office of general directorate of water in Abha, the water-saving campaign room for woman is prepared with the different entrance against usual entrance.

However, the present campaign has performed only about the dissemination of water saving (the promotion of use of the water-saving instruments attached to a water facet or a toilet tank), and the object has mainly performed only for visitor of MOWE head office and general directorate offices in region except the water-saving campaign week.

In order to expand and promote the educational campaign which improves and raises the resident consciousness, performance of following activities is proposed.

The diagram of the educational campaign for water supplies is shown in Figure 4-2.

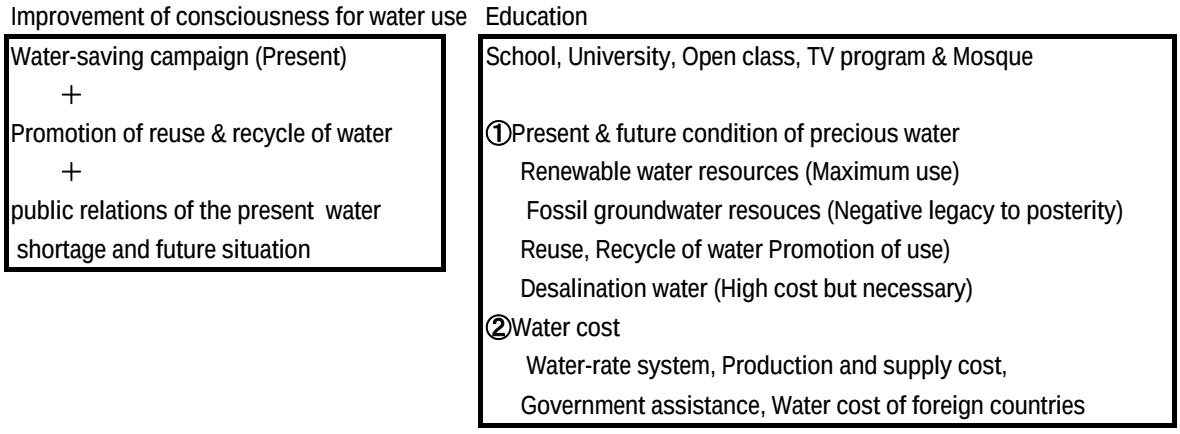


Figure 4-2 Diagram of Campaign Activity of Water Use

(1) Expansion of an Improvement and Educational Campaign of Precious Water Use

In addition to the water-saving campaign under present execution, the following activities are developed.

- Performance of public relations of the present condition of water shortage and future situation is added as an activity which makes the object persons recognize strongly the necessity of water saving.
- The promotion campaign for reuse of domestic water and use of recycling water are added, and the activity to dissemination of 3R (Reduce, Reuse, Recycle) of water use is developed.
- Performance of campaign activity which promotes rain water storage (water harvesting) and use the water at each home and gardening site.

(2) Performance of the Education for Understanding the Present Condition of Water Shortage and Problem Water Service Enterprise Encountered, and Fixing the Action Pattern for Saving Water Use

In order to make the whole resident recognize the present condition of water shortage and prediction of future situation, and to fix the action pattern for water use, the teaching materials "Present condition of water and right water use" which set by the school education curriculum in elementary school, junior high school, high school, and university, and set by each level at the general open class are

prepared and taken in.

Moreover, a TV program is manufactured and broadcast. Furthermore, the publicity work in a mosque is developed.

The contents are carried out as follows.

(a) The Present Condition and the Prediction of Future of Water Resources

Renewable water resources

The present condition of surface water (dam reservoir intake, flood control by dam) and the present condition of groundwater resources (use for the amount of recharge) and the predicted future situation, and the necessity for the maximum effective use of renewable water are explained.

Fossil groundwater

The present situation of fossil groundwater use and the predicted future situation of fossil groundwater use, control of fossil groundwater use under predicting future situation, and exceeding use of fossil groundwater becoming a negative legacy to posterity are explained.

Salt water conversion

Although desalination water is high cost, the necessity for effective use of desalination water as a water resources for covering shortage natural water is explained

Reuse and recycle of water

The necessity of effective use of reuse and recycle water because of setting off present water shortage condition is explained.

(b) Water Cost

The present water-rate system, actual water production and supply cost, and government assistance situation are made to know, and the necessity for the payment of water rates is explained from comparison with the water cost of foreign countries.

4.3 Organization Structure and Management System

(1) The Problem of the Present Organization

The present water administrative organization of Saudi Arabia shows in Figure 4-3, and there are the following weak points.

- Though the cooperation and regulating function between MOWE which manages and supplies a drinking and domestic water, and MOA which manages water for agricultural use are scarce and recognizes water shortage mutually, intake or withdrawal are performed uniquely in each organization without restrictions and connection.
- Since intake or withdrawal and water supply of natural water are individually carried out at every region and each facility and synthetic water supply management and maintenance are not performed, synthetic water supply and water allocation management over between each province and the integrative management and effective use of surface water and groundwater based on the IWRM are difficult.

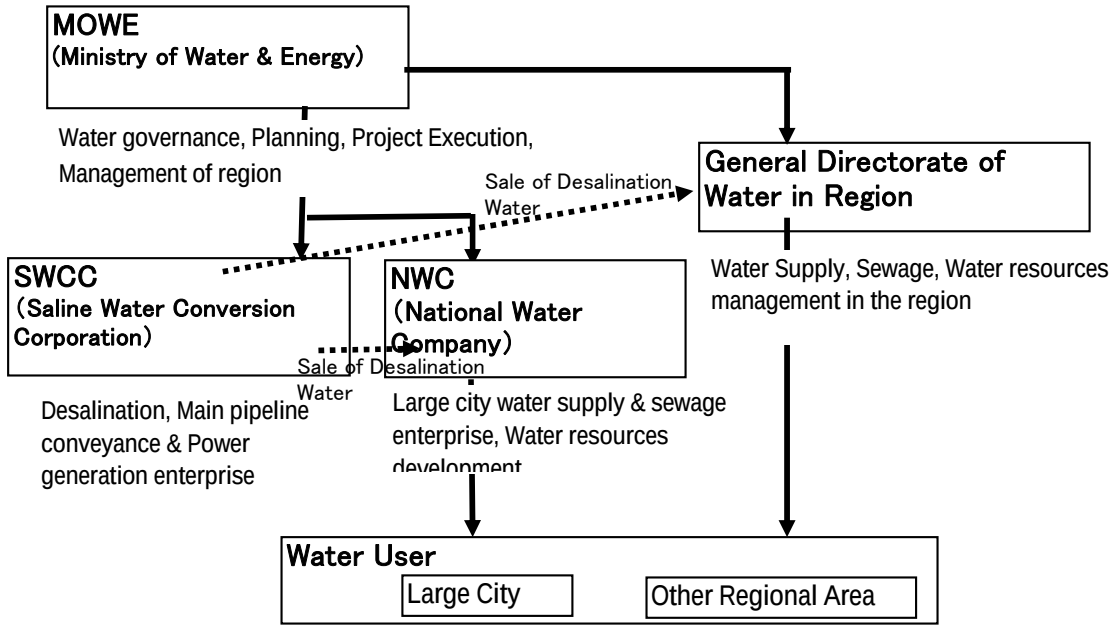


Figure 4-3 Water Organization (Present)

(2) The Proposal of New Organization Foundation

In order to solve the problem of the present organization and to perform integrated management of water, the system for organizations shown in Figure 4-4 is proposed.

The role of the present organization is arranged and the following new organizations are added.

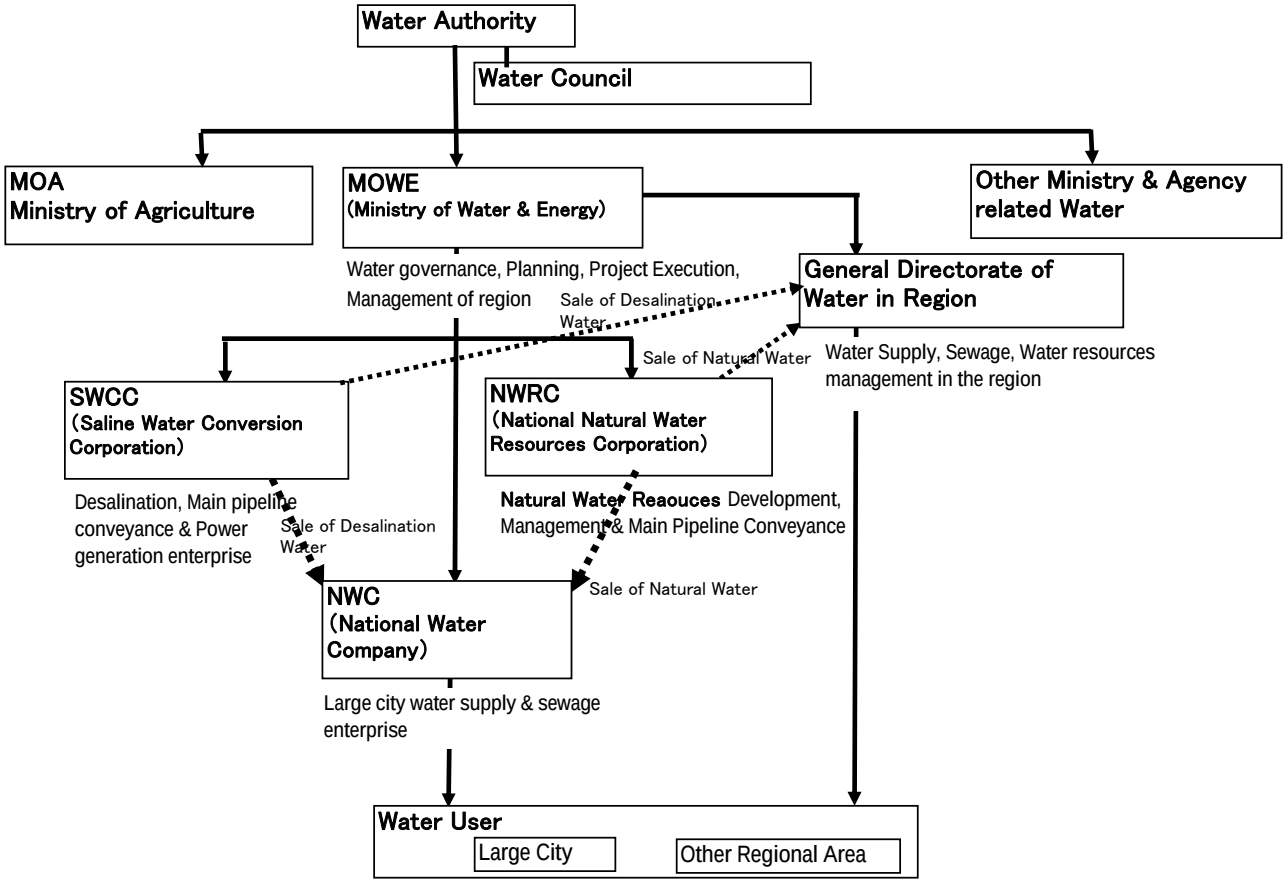


Figure 4-4 Improved Water Organization (Propose)

(a) Water Authority and Water Council

Water authority is constituted by the minister and secretary of each ministry and agency related to water, and the director general, and perform determination of national water policy and basic strategy of water, and adjustment between relevant ministries and agencies.

Water council is constituted by the deputy minister, vice-president official, and academic expert of relevant ministries and agencies as a consultative body of water policy, is deliberated to consultation of water authority, and proposes a draft doctrine etc.

(b) Renewable Water Production Corporation (RWPC)

It includes in a Renewable Water Production Corporation (RWPC, Renewable Water Production Corporation) water supply-and-demand water supply network.

The management and maintenance of dams for integrated control and other large-scale important dams, the management and maintenance of main groundwater basins which perform joint operations, the control of intake or withdrawal of main natural water, water supply networks are managed specially, and the public company which supplies natural water is founded.

This public corporation achieves the following roles and a function.

- Control and maintenance of large-scale dams and middle-scale dams (flood control, intake control, control and maintenance of facilities)
- Control and maintenance of main groundwater basins (aquifer management, withdrawal management, water quality monitoring and supervision, control and maintenance of facilities)
- Main pipeline transportation (transportation control, control and maintenance of facilities) and sale of the taken natural water
- The planning, investigation, design, and construction management of large-scale dams and middle-scale dams, and groundwater withdrawal facilities by commission from MOWE
- Promotion of dissemination of rain water harvesting facilities

(3) The Proposal for the System Improvement of Existing Organizations

The establishment of new organization is proposed by reorganizing the role and function of the existing organizations as shown below.

(a) MOWE Head Office

MOWE head office carries out planning of water management based on water policy, management of subordinate organizations, instruction of waterworks and sewage enterprises enforcement, and planning to construction management of large-scale facilities.

The following roles are performed.

- Setup and management of planning of the overall plan of the water administration organizations based on the water policy and strategy and activity target of subordinate organizations.
- Planning, investigation, design and construction management of large-scale facility construction enterprise
- Control of the network for collection of basic data, and management of central database such as rainfall, river discharge, water level of dam reservoir, storage volume, intake volume, water quality of surface water resources, groundwater level of main aquifer and groundwater basin, groundwater storage volume, withdrawal volume, water quality of groundwater, etc.
- Control of intake and withdrawal restriction and control of instruction
- Instruction of watershed conservation and management
- Instruction of public relations and dissemination for water policy, water management plan, present condition of water supply and predicting future situation, and enforcement management
- Introduction and management of personnel training and capacity building
- Management of research and technical knowledge

(b) General Directorate of Water in Region

Each general directorate of water in region carries out operation and maintenance of intake facilities, water transfer and water supply network in jurisdiction territory except the big cities managed by RWPC and facilities controlled by NWC, execution of water supply and sewage enterprise of province except big cities, planning /investigation /design and construction management of middle-scale and small- scale facilities. The following roles are completed.

- Decision of the enterprise execution plan under instruction of MOWE
- Control of maintenance of facilities of the jurisdiction area,
- Plan, investigation, design and construction management of small-scale facilities
- Collection of the basic data of jurisdiction area, and information data input to network
- Execution of water withdrawal restriction and actual crackdown in jurisdiction area
- Implementation of the educational campaign for water supply (public relations, dissemination and education)

(c) Saline Water Conversion Corporation (SWCC)

SWCC has already undertaken the desalination enterprise and the power generation enterprise. SWCC continues succeedingly these enterprises and makes them develop.

The main roles of the organization are as follows.

- Execution of desalination enterprise
- Execution of main pipeline transportation enterprise of the desalination water containing intake water from related dam group
- Execution of control and maintenance of possession facilities and plan, investigation, design and construction management of new facilities

(d) National Water Company (NWC)

NWC is execution organization of the water supply enterprise and sewer enterprise of the waterworks of the big city which operated since 2008.

Although the water resources development enterprise mainly concerned with groundwater is also included, the part of management of water resources development enterprise is transferred to RWPC, and it is proposed that NWC is conducted as a specialty company of water supply enterprise and sewage enterprise in large cities.

The main roles are as follows.

- Execution of water supply enterprise and sale of drinking and domestic water by purchase desalination water from SWCC and natural water from RWPC
- Control and maintenance of water purification facilities, water supply facilities, and water supply network, and design to construction management of new facilities
- Execution of a sewage enterprise, control and maintenance of sewage facilities, and design to construction management of new facilities
- Supply and sale of recycle water
- Promotion of reuse of water and recycle use of sewage

(4) Foundation of Agricultural Water Management Division and Agricultural Cooperative Association

In 3 regions which are target areas of the proposed M/P, owing to surplus withdrawal of agricultural water, there is much information that withdrawal of drinking and domestic water is suppressed. Due to no performance for effective restriction, withdrawal of drinking and domestic water not only becomes difficult, but also agricultural farms come under influence of exceed withdrawal and become severe to take agricultural water mutually. That kind of water shotage situation goes from bad to worse gradually and rapidly at part like Jazan region.

In order to use sustainable agricultural water and develop continuous farming, the foundation of the

following organizations is proposed. The improvement diagram of an agricultural organization is shown in Figure 4-5.

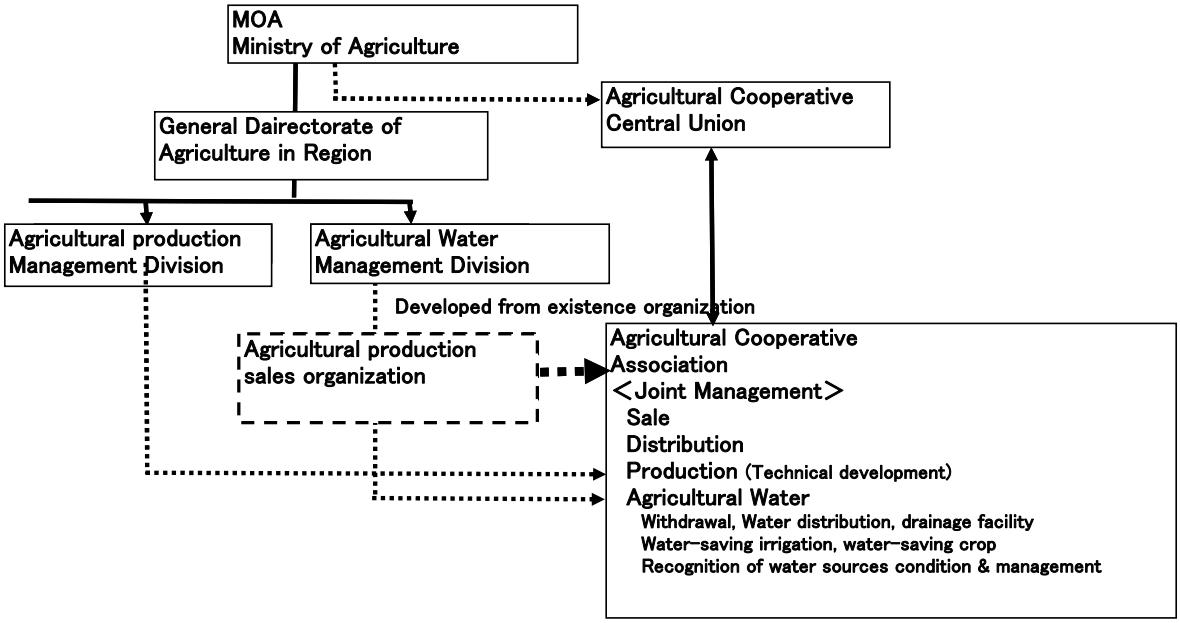


Figure 4-5 Improved Agricultural Organization (Propose)

(a) Agricultural Water Management Division (Inner Organization in General Directorate of Agriculture in Region)

The establishment of the organization which has the functions of execution of agricultural water use management and adjustment between the farmers and other water basin users is proposed.

- Evaluation of the capability of the environment, the aquifer, the reservoir and withdrawal facilities in the place of agricultural water use
- Grasp of the actual use condition and the problem
- Management for agricultural water supplies, and instruction
- Water-saving technology, the reuse technology of irrigation water, instruction of recycle water use and dissemination

(b) Agricultural Cooperative Association

The foundation of the organization and system which expands from the present organization of agricultural-products sales at market such as morning fair at rural areas in part, and develops to the cooperative organization which has the following functions, and propels independently joint use and joint control of water resources, water-saving agricultural technique, etc. is proposed.

- Execution of joint management of production of agricultural products, sale, and distribution.
- Execution of joint control of withdrawal and water supply /drainage facilities maintenance, and voluntary management for agricultural water use.
- Performance of joint development of agricultural technology, and joint introduction of technological know-how.
- Performance of joint practical study, dissemination, and educational activity for performing continuous agricultural activity together.

(Grasp of water-resources present condition, head management, water-saving irrigation, water-saving crop cultivation, rain water harvesting technology, etc.)

(c) Government Support System

Establishment of the system by government organization, which carries out the priority grant of

support and the government subsidy preferentially to the joint enterprise and the joint activity by farmers, is required in order to strengthen sustainable agricultural activity.

- The joint enterprise for promoting agricultural activity activation (Establishment of the Agricultural Cooperative Association is included)
- The enterprise of decrease water use (the conversion enterprise to water-saving crops, the water-saving facilities construction enterprise, etc.)
- The enterprise for shift to joint agricultural water management

5. Stakeholder Meeting and Work Shop

5.1 Stakeholder Meeting

The stakeholder meetings were held sixth during in 17th February 2008 and in 18th May 2010. The outline of the stakeholder meetings is shown in Table 5-1.

Table 5-1 Stakeholder Meetings

Meeting	Venue	Date	Participants	Outline of contents
1st Stakeholder Meeting	Abha	February 17, 2008	51 persons	Part 1; Presentation of outline, progress and future schedule of JICA study Part 2; Group discussion of water issue
2nd Stakeholder Meeting	Al Baha	November 10, 2008	80 persons	Part 1; Presentation of current JICA study, basic policy/strategy and criteria for M/P Part 2; Group discussion of water issue
3rd Stakeholder Meeting	Jazan	March 10, 2009	60 persons	Part 1; Presentation of water balance and formulation of basic policy/strategy Part 2; Group discussion of water issue
4th Stakeholder Meeting	Abha	January 19, 2010	38 persons	Presentation of policy/strategy/action plan for 5 regions & water supply M/P for 3 regions, and question & answer
5th Stakeholder Meeting	Jazan	May 18, 2010	45 persons	Presentation of water M/P of JICA study, and question & answer

(1) 1st Stakeholder Meeting

(a) Agenda

The 1st Stakeholder Meeting was held in Abha on 17th February 2008 as a first full meeting in order to share the fact findings of the current progress of the JICA Study and identify the water-related issues through participatory approach. Table 5-2 shows the agenda of the meeting and outline of the contents. The meeting was composed of two parts, part 1 for presentation by the counter part (MOWE), JICA office and the Study Team and part 2 for group meeting of needs assessment and PCM workshop (problem analysis).

Table 5-2 Agenda of 1st Stakeholder Meeting

Program	Agenda	Contents
Part I		
1. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 1st Stakeholder Meeting
2. Opening Speech (2)	Opening speech by JICA Riyadh Office	The briefing on JICA, activity of JICA Riyadh office and background of the Study.
3. Presentation of the JICA Study	Presentation of the current progress of the Study by JICA Study Team	Purpose, outline, schedule, actual progress of JICA Study and problems surrounding of the Study (to be presented by slides / MS Power Points)
4. Q & A	Q & A for 4. Presentation of the JICA Study	Questions and answers for the presentation of the JICA Study
	Q & A	Q & A for the JICA Study
Part II		
PCM Workshop		
5. Explanation on Group Meeting	Explanation on Group Meeting	The JICA Study Team makes an explanation on the outline of the group meeting. After the explanation, a grouping will be carried out.
6. Needs Assessment	Needs assessment	The participants identify the current water issues in the study area through brain-storming.

Program	Agenda	Contents
7. Ranking	Ranking	The participants prioritize above water issues for selecting core problem to be used for Cause – Effect Analysis.
8. Cause – Effect Analysis	Cause-Effect Analysis	The participants conduct cause-effect analysis and prepare the problem-trees diagram for above prioritized core problems.
9. Presentation by Participants	Presentation by each groups	Each group makes presentation for the results of the group meetings.
10. Closing Address	Closing by Central Government Officers	Closing by Central Government Officer for the meeting's results and outcome.

(b) Participant

The selection of the target stakeholders was carried out in consideration of each role in various aspects of water resources management, namely, regulators, water users and water providers, etc. All stakeholders of the surrounding regions such as Makkah, Al Baha, Jazan and Najran were invited in addition to Asir Region whose capital is Abha.

The number of participants of the stakeholder meeting is shown in Table 5-3 Total participants were 51 persons including JICA Saudi Arabia office and the study team.

Table 5-3 Numbers of Participants for Each Organization

Classification of Organization	Number of Attendants
SWCC	2
Al Baha Region	3
Asir Region	6
MOEP	1
MOA	6
MOWE, headquarters	6
MOWE, Jazan	2
MOWE, Asir	9
MOWE, Najran	1
Islamic Affair	1
Arabic Consulting Office	1
School Director	1
Farmers	5
Chamber of Commerce	1
Business man	1
JICA Representative, Riyadh	1
JICA Study Team	4
Total	51

Data) Attendant List

(c) Group Meeting

The group meeting was held in part 2 for identifying the water related issues and their need assessment etc. through participatory approach consisting of brain storming and PCM (Project Cycle Management) method.

Participants were divided into 4 groups consisting of approximately 10 persons in order to draw their opinions, identify and shear the water issues efficiently. Moderators were allocated to each group for the smooth proceeding of the workshop.

(4) Water Issues Discussed in the Group Meeting

The water issues with ranking discussed by participants in the group meeting are shown in Table 5-4. The issues identified by participants are categorized as shown in Table 5-5.

Important issues extracted as rank 1 and rank 2 in each group meeting are as follows;

1) Issue selected as Rank 1

a) Depletion of wells for irrigation
b) Doubt for possibility of reuse of waste water

c) Insufficiency of water distribution network, and a large amount of leakage
d) Insufficiency of information system on monitoring, analysis and public relation for water resources management

2) Issue selected as Rank 2

a) Shortage of drinking water
b) Overuse of some kind of domestic water such as swimming pool etc.
c) Unavailability of desalination in some areas
d) Lack of integrated water resources management (IWRM)

As the most important water issue, each group identified respectively drying up of wells for irrigation, doubt for reliability of reuse of waste water, shortage of expansion and maintenance of water distribution network including leakage protection, and insufficiency of information system on monitoring, analysis and public relation system for water resources management.

As second important water issue, shortage of drinking water in some area, unsuitable water use for water supplies, insufficient correspondence for unavailable areas of desalinated water, and lack of an integrated water resources management are identified.

The items brought up by several group are as follows;

1) Items brought up by 3 groups

a) Doubt for possibility of reuse of waste water
b) Proceeding of groundwater pollution

2) Items brought up by 2 groups

a) Shortage of dissemination for proper irrigation method including farming method by water saving irrigation
b) Shortage of operation and maintenance of some dams
c) Insufficient of water distribution network and great volume of leakage
d) Lack of IWRM
e) Insufficient of information system on monitoring, analysis and public relation for water resource management

1) a) are considered to indicate distrust and dissatisfaction in feasibility and safety about reuse of waste water. 2) b) are considered that participants believe firmly the operation and maintenance of dams is necessary to achieve the purpose of water reservation or recharge. For these items, the related organization shall perform accountability.

Table5-4 Water Issues Prioritized in the Group Discussion

Group No.	Rank	Water Issues
1	1	Lack of careful information for groundwater reserve in each area
	2	Insufficient dissemination of alternative sources to water desalination
	3	Farming crops using water saving irrigation
	4	Ground water pollution
	5	Possibility of using waste water for industries cities
	6	Lack of dam operation and maintenance in some area
2	1	Utilizing the waste water
	2	Too much building of swimming pools in the area
	3	Too mach leakage from the water network
	4	Unavailability of dam management
	5	Random well digging in the area
	6	Unrecognizing public(citizens and foreigners) of awariness of water shortage
3	1	Unavailability of water distribution network in Asir
	2	Unavailability of Integrated water management in the area
	3	Ground water is polluted (wells)
	4	Lacked of trust the reclaimed waste water
4	1	Depletion of irrigation water in wells
	2	Lack of sufficient drinking water for the region

Group No.	Rank	Water Issues
	3	Lack of ability in terminals for perfect treated water in the area
	4	Lack of utilization of irrigation methods
	5	Water costs analysis
	6	Brackish irrigation water
	7	Preparation and Training worker how to collect water information and analysis, Then make Perfect Data Basis
	8	Unavailability of drainage network to cover some area – cities – village and benefit from waste water

Table 5-5 Grouping of Issues in the 1st Stakeholder Meeting (1/2)

Group No.	Rank	Problems or Issues	Drinking W.	Domestic W.	Agriculture W.			Waste Water			W. Pollution
			Shortage	Water use & restriction	Technique for irrigation	Depletion of wells	Deteriora-tion of water quality	Possibility of Utilization	Benefit of utilization	Infrastruc-ture of drainage network	Ground water pollution
1	1	Unavailability of ground water careful information for each area and reserve									
	2	Unavailability of alternatives to water desalination									
	3	Farming crops using little water			○						
	4	Ground water pollution									○
	5	Possibility of using waste water for industry area or cities						○			
	6	Lack of dam operation and maintenance in some area									
2	1	Utilizing the waste water						○			
	2	Too much building swimming pools in the area		○							
	3	Too mach leakage from the water network									
	4	Unavailability of dam management									
	5	Random well digging in the area									
	6	Unrecognizing public(Citizens and Foreigners) of awareness of water shortage									
3	1	Unavailability of water distribution network in Asir									
	2	Unavailability of Integrated water management in the area									
	3	Ground water is polluted (wells)									○
	4	Lack of trust the treated waste water						○			
4	1	Depletion of irrigation water in wells				○					
	2	Lack of sufficient drinking water for the region	○								
	3	Lack of ability of terminals for perfect water treatment in the area									
	4	Lack of utilization of irrigation methods			○						
	5	Analysis of water cost									
	6	Brackish irrigation water			△		○				○
	7	Training for workers how to collecting water information and analysis, and installation of perfect data basis									
	8	Unavailability of drainage network to cover some area -villages-cities and Benefit from waste water							○	○	
Number of related subject			1	1	2	1	1	3	1	1	3

Remarks; Abbreviation; W.; water, O&M; operation and maintenance, IWRM; integrated water resources management

Table 5-5 Grouping of Issues in the 1st Stakeholder Meeting (2/2)

Group No.	Rank	Problems or Issues	W. Facility				Water Resources Management					
			O & M (Dam)	W. network & seepage	Unavail-ability of de-sarination	W. treatment of terminal	IWRM	Control of well con-struction	Information & publicity	Data base	Training	Awareness
1	1	Unavailability of ground water careful information for each area and reserve							○			
	2	Unavailability of alternatives to water desalination			○							
	3	Farming crops using little water										
	4	Ground water pollution										
	5	Possibility of using waste water for industry area or cities										
	6	Lack of dam operation and maintenance in some area	○									
2	1	Utilizing the waste water										
	2	Too much building swimming pools in the area										
	3	Too mach leakage from the water network		○								
	4	Unavailability of dam management	○									
	5	Random well digging in the area						○				
	6	Unrecognizing public(Citizens and Foreigners) of awareness of water shortage										○
3	1	Unavailability of water distribution network in Asir		○								
	2	Unavailability of Integrated water management in the area					○					
	3	Ground water is polluted (wells)										
	4	Lack of trust the treated waste water										
4	1	Depletion of irrigation water in wells										
	2	Lack of sufficient drinking water for the region										
	3	Lack of ability of terminals for perfect water treatment in the area				○					△	
	4	Lack of utilization of irrigation methods										
	5	Analysis of water cost					○		△			
	6	Brackish irrigation water										
	7	Training for workers how to collecting water information and analysis, and installation of perfect data basis							○	○	○	
	8	Unavailability of drainage network to cover some area -villages-cities and Benefit from waste water										
Number of related subject			2	2	1	1	2	1	2	1	1	1

Remarks; Abbreviation; W.; water, O&M; operation and maintenance, IWRM; integrated water resources management

(2) 2nd Stakeholder Meeting

(a) Agenda

The 2nd Stakeholder Meeting was held in Al Baha on 10th November 2008 in order to share the fact findings of the current progress of the JICA Study and identify the water-related issues through participatory approach. Table5-6 shows the agenda of the meeting and outline of the contents. The meeting was composed of two parts, part 1 for presentation of the JICA Study by the counter part (MOWE) and part 2 for group meeting by PCM method.

Table 5-6 Agenda of 2nd Stakeholder Meeting

Program	Agenda	Contents
1. Reception		Reception and Registration
Part 1		
2. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 2nd Stakeholder Meeting
3. Opening Speech (2)	Opening speech by JICA Riyadh Office	The briefing on JICA, activity of JICA Riyadh office and background/ progress of the Study.
4. Presentation of the JICA Study	Presentation of the current progress of the Study by MOWE counterpart	The current JICA Study including water demand, water balance/ water resources potential, and basic policy/ strategy for formulation of M/P
5. Q & A	Q & A for Presentation of the	Questions and answers for the present water issues and

Program	Agenda	Contents
	JICA Study	correspondence of government organizations
Part 2		
PCM Workshop		
6. Water issues in the area	Group discussion for water issues in the area	The participants discuss about water issues in the area using PCM procedure under MOWE's moderators in separated 5 groups.
7. Grouping and Ranking	Grouping and ranking	The participants prioritize above water issues for selecting core problem to be used for Cause – Effect Analysis in each group.
8. Presentation by Participants	Presentation by 5 groups	5 groups make presentation for the results of the group meetings.
9. Closing Address	Closing by General Directorate of Water, Al Baha	Closing by General Directorate of water for the meeting's results and outcome.

(b) Participants

The selection of the participants was carried out in consideration of each role in various aspects of water resources management, namely, regulators, water users and water providers, etc. All stakeholders of the surrounding regions such as Makkah, Al Baha, Jazan and Najran were invited in addition to Al Baha Region whose capital is Al Baha.

The number of participants of the stakeholder meeting is shown in Table 5-7. The total participants were 80 persons including JICA Saudi Arabia office and the study team.

Table 5-7 Numbers of Participants for Each Organization

Classification of Organization	Number of Participants
Al Baha Region	1
MOA Al Baha	2
Ministry of Education (MOE) Al Baha	3
MOWE, headquarters	10
MOWE, Al Baha	17
MOWE, Jazan	2
MOWE, Asir	1
MOWE, Makkah	1
Water Blanch, Al Mandaq, Al Aqiq, Baljurashi	5
Public Court Al Baha (Legal researcher)	1
Al Baha Region Council (Qulwa Province)	1
Sheikh of tribe	1
Al Mikhwa Town	1
Promotion of Virtue & Prevention of Vice Organization	2
Islamic Affairs, Imam and Mosque Teacher	6
Al Baha Scientific Institute	1
Al Baha Observation House	1
University (Assistant professor, Lecturer)	2
School Headmaster and Teachers	2
Farmer	4
Businessman	1
Companies (SABC, Grulf, HGRD, Orysa Establishment)	5
Journalist (Al Watan, Al Medeina)	2
Al Baha TV	2
JICA Representative, Riyadh	1
JICA Study Teamh	5
Total	80

Data) Attendant List and Questionnaire

(c) Question and Answer for the Presentation

The questions or comments from participants after the presentation and answer to them are arranged as follows. In addition, the questions and comments can be interpreted to be not against the presentation but to be things to the plans and implementations of MOWE.

1) Priority of Groundwater Use

Domestic water must be prioritized than other use purposes. Groundwater should be used for domestic

purpose preferentially, and industrial purpose shall be used as a second priority. Thus, the legislation for water resource management should be established as soon as possible.

In order to preserve potable water, KSA government is going to plan to cut down agricultural water demand due to control of the agricultural area.

2) Correspondence to Water Scarcity in Al Baha

Construction of water supply network is on-going and 15 dams have been developing by MOWE. In order to solve water scarcity for the future, the investigation* of aquifer within KSA has been carried out to clarify groundwater potential based on National Water Strategy.

- Detailed Hydro-geological Investigation for Groundwater Resource Evaluation

3) Measures of Groundwater Contamination

In Al Baha, 25 sewerage treatment plants would have been planned for the future. However, not only such sewerage development but also an improvement of public awareness on sanitation is important.

Sewerage system and sanitation facilities are required for preserving public water body. In order to clarify contaminated area, investigation on current status of water quality has been conducted by private sectors under management of MOWE.

4) Development of Underground Dam

This is a matter of central MOWE. The MOWE has been planning and designing at all times.

5) Improvement of Current Law and Regulations

In order to preserve water source and rationalize water resource management, MOWE has been preparing the National Water Strategy*.

6) Illegal Drilling of Wells

Against problem that 4,000 – 5,000 wells have been drilled without any licenses in Al Baha, MOWE replay as follows. A penalty will be imposed upon the drilling companies and the owners of wells. The amount of penalty is of SR.15, 000 against both parties. In addition, the wells that were not approved by the relevant bureaus must be back-filled by the owners with their own expenses.

7) Correspondence to Delivery of Contaminated Water by Private Water Tanker

Water carried by water trucks is categorized into two. One is taken from water supply network which is managed by MOWE, and other water is taken from other water sources such as dug, shallow wells. Water of water supply system is definitely good quality but the water of dug wells is most probably contaminated. Therefore, companies of all the water trucks should be controlled by MOWE appropriately. If the contaminated water is sold to people, some penalties must be imposed to the companies of water trucks by MOWE.

(d) Group Meeting

The group meeting was held in part 2 for identifying the water related issues in the area using PCM method. The participants were divided into 5 groups consisting of approximately 10 persons in order to draw their opinions, identify and shear the water issues efficiently. Moderators were allocated to each group for the smooth proceeding of the group discussion. The moderator of group meeting and number of participants is shown in Table 5-8.

Table 5-8 Moderator of Group Mmeeting and Number of Participants

Group No.	Moderator	Moderator's Organization	Number of Participants
1	Mr. Fahad Ahmed Al-Beajan	MOWE	9
2	Mr. Mohamed Ali Al Aidarous	MOWE	9
3	Mr. Hassan Moustafa Al-Shrime Mr. Fahad Miftah Al-Zahrani	MOWE	9
4	Mr. Idres Omar Balkhar	MOWE	11
5	Mr, Saud Saad Al-Zahrani Mr. Abdulah Al-Zahrani	MOWE, Al Baha	7

(e) Water Issues Discussed in the Group Meeting

The important water issues selected in the group meeting is shown in Table 5-9. “Shortage of drinking and domestic water” and “Contamination of groundwater” are considered to be common water issues through each group. As causes for these water issues, “Lack of desalination network”, “Lack of reuse of waste water”, “Overuse of agricultural water”, “Lack of allocation of water use”, “Insufficiency of awareness of water shortage” and “Defect of sewage disposal” are suggested in the table. When these causes can be solved, most of issues shall be dissolved.

Table 5-9 Higher Rank 3 of Important Water Issues Selected in Each Group Discussion

Group	Rank	Description	Remarks
1	1	Scarcity of drinking and domestic water	Al Baha Region
	2	Lack of allocation of water use	
	3	Contamination of groundwater	
2	1	Lack of desalination network	Including specified area such as Kulwa, Doferu and Aqiq
	2	Insufficiency of awareness of water shortage	
	3	Contamination of groundwater for drinking water	
3	1	Shortage of drinking water	Al Baha Region
	2	Shortage of agricultural water	
	3	Sewage disposal into valley	
4	1	Scarcity of water sources	Al Baha Region
	2	Contamination of well water	
	3	Lack of reuse of waste water	
5	1	Shortage of drinking water	Al Baha Region
	2	Overuse of agricultural water	
	3	Lack of reuse of waste water	

Detailed contents of each group discussion are arranged as follows. Group discussion proceeded in order of 1) Writing water issue on card, 2) grouping and 3) Ranking to select important issues in each group. Some groups proceed to discuss idea of solution.

Group 1
(a) Water issues and Grouping
1) Domestic water
a) Drinking water and house use water is not sufficient in the area. b) Pollution of water in wadies is arisen because of garbage disposal of the city c) Water from desalination plant has not distributed yet.
2) Water resources management
a) Water allocation between drinking water and irrigation water is not carried out. b) Persons for water sources control is shortage. c) Water from production wells is shortage.
3) Waste water treatment
a) Drinking water and agriculture water sources are contaminated by waste waters. b) Treatment of waste water is not carried out enough.
4) Agriculture water
a) Priority for drinking water is not confirmed against agriculture water.
(b) Ranking
1) Shortage of drinking water and house use water in the area occur.
2) Water allocation between drinking water and irrigation water is not carried out.
3) Drinking water and agriculture water sources are contaminated by waste water.
Group 2
(a) Water issues and Grouping
1) Water facility (Intake, Dam, Well, Water treatment facility etc.)
a) Desalination network has not constructed in the area. (Qelwah area in Al Baha Region) b) Facility for use of renewable water sources is not developed. (Al Baha Region) c) Water intake facilities including dams and wells is shortage. (Qelwah area in Al Baha Region) d) Construction of dams is not carried out enough. (Al Baha Region)
2) Water resources management
a) Awareness of water shortage is insufficient.

b) Many of wells are drying up. (Doferu village in Al Baha Region)
3) Drinking water
a) Contamination of groundwater is serious. (Qelwah area in Al Baha Region) b) Change to salt water of some wells is increasing. (Doferu village in Al Baha Region)
4) Agriculture water
a) Shortage of Agriculture water occurs. (Aqiq area in Al Baha Region) b) Withdrawal of agriculture water becomes difficult due to increase of well for other purposes. (Bera valley) c) Dissemination of irrigation technique is not enough. (Qelwah area in Al Baha Region)
(b) Ranking
1) Desalination network has not constructed to the area. (Qelwah area in Al Baha Region)
2) Awareness of water shortage is insufficient.
3) Contamination of groundwater is serious. (Qelwah area in Al Baha Region)
Group 3
(a) Water issues and Grouping
1) Drinking and Domestic water
a) Drinking water in wells decreases. b) Drinking water sources are not secured. c) Pollution of water increases by waste water in valleys and dams. d) Drinking water from dams is not sufficient. e) Specialized technicians for control of water supply are not sufficient. f) Control for distribution of water supply is not sufficient. g) Rainfall water use is not advantaged enough. h) Transportation of water tanker to houses is not sufficient.
2) Agricultural water
a) Agricultural water in wells becomes short. b) Drilling of wells is not organized well. c) Allocation of agricultural water and drinking water is difficult. d) Development of small dams and big dams is not sufficient. e) Degraded wells increase. f) Desertification proceeds.
3) Waste water treatment
a) Waste water disposals into valleys are carried out. b) Waste treatment water is not used for agriculture. c) Waste water treatment facilities are not developed enough. d) Persons for control of waste water treatment in government organization are not sufficient.
4) Water facility
a) Protection procedure of dam reservoir water quality is not carried out. b) Recharge wells near dams are not constructed.
5) Water resources management
a) Water to be used is not enough.
(b) Ranking
1) Drinking water in wells decreases.
2) Agricultural water in wells becomes short.
3) Waste water disposals into valleys are carried out.
(c) Idea of solution;
1) Drinking water
a) Selection of well fields is carried out for drinking water. b) Tankers for water supply are prepared. c) Suitable water use in each season is carried out. d) Construction of dams is performed. e) Conservation of watershed of water sources to prevent of contamination is performed. f) Waste water disposal in wadi is restricted. g) Network for water supply by pipelines are enlarged and maintained. h) Continuous water quality analysis for control of water supply is carried out.
2) Agriculture water
a) Control of withdrawal of wells with allocation of agriculture use and water supply use is performed. b) Irrigation with water saving method is carried out. c) Suitable plants for water saving is selected by farmers and firms. d) Control of well construction is performed.

3) Waste water treatment
a) Waste water treatment facilities are constructed. b) Reuse of waste water is performed. c) System of reuse of waste water is functioned by government organization.
Group 4
(a) Water issues and Grouping
1) Drinking water
a) Scarcity of water sources is serious. b) Contamination of portable water occurs c) There is no public network for drinking water
2) Water facility
a) Contamination of well water occurs. b) Maintenance of dam is insufficient. c) Compliance for well drilling is not carried out. d) Citizen awareness on overuse of water lacks.
3) Agricultural water
a) Reuse of waste water as agricultural water is not carried out. b) Drip irrigation system lacks.
4) Domestic water
a) No treated water is used. b) Water supply networks are not furnished. c) Sufficient awareness of the citizens and expatriates on importance of rationalization of water use lacks.
5) Industrial water
a) Allocation of special resources for industrial water demand fails.
6) Waste water treatments
a) Construction of facilities is not accepted by some residents
7) Reuse of waste water
a) The use of treated water is not accepted socially and psychologically. b) Awareness of usage of waste water lacks.
8) Water resources management
a) Observation of wells and dams in order to control their water lacks.
(b) Ranking
1) Scarcity of water sources is serious.
2) Contamination of well water occurs.
3) Reuse of waste water as agricultural water is not carried out.
Group 5
(a) Water issues and Grouping
1) Drinking water
a) Shortage of water is severe. b) Water quality and stability for water use are insufficient. c) Strategic reservoir for emergency water use is not prepared.
2) Agriculture water
a) Overuse of water in agricultural purposes is carried out. b) Dams for agricultural purposes are not adequate.
3) Domestic water use
a) Reallocation of treated waste water is not considered. b) Water leakage within houses occurs. c) Reuse of domestic water for car washing and courtyards is not considered.
4) Industrial water
a) Reuse of treated waste water for factories is not carried out.
5) Waste water treatment
a) Tertiary treatment is required to utilize waste water.
6) Reuse of reclaimed waste water
a) Reclaimed waste water has not used for trees, gardens and landscape irrigation
7) Water facilities
a) Dams and wells for potable water are little. b) Quantity of treated water is few.
8) Water resources management

a) Capacity building and supervision of human resources is not sufficient.
(b) Ranking
1) Shortage of water is severe.
2) Overuse of water in agricultural purposes is carried out.
3) Reallocation of reclaimed waste water is not considered.
(c) Causes and Idea of solution
1) Causes of “shortage of drinking water”
a) Lack of future developing plans compatible with increasing number of population b) Lack of participation c) Lack of sources “Dams and Wells” d) Decline of groundwater level e) The absence of desalination plants serving the region f) Increasing population growth
2) Idea of solution for “Lack of developing plans compatible with increasing numbers of population”
To solve such problem, specialized consultant offices and expert organization shall be designated to investigate water problems in the region.

(f) Questionnaire Survey

During the stakeholder meeting, the questionnaire survey is carried out for confirmation of following items;

1) Comments for the presentation of the current JICA study,
2) Comments for the most important water related issues for each participant, and
3) Comments for water tariff system and agricultural water use.

The questionnaire is attached in Reference 1 of the end of the chapter. 43 answers against 78 participants (ratio of respondents; 55.1%) were obtained.

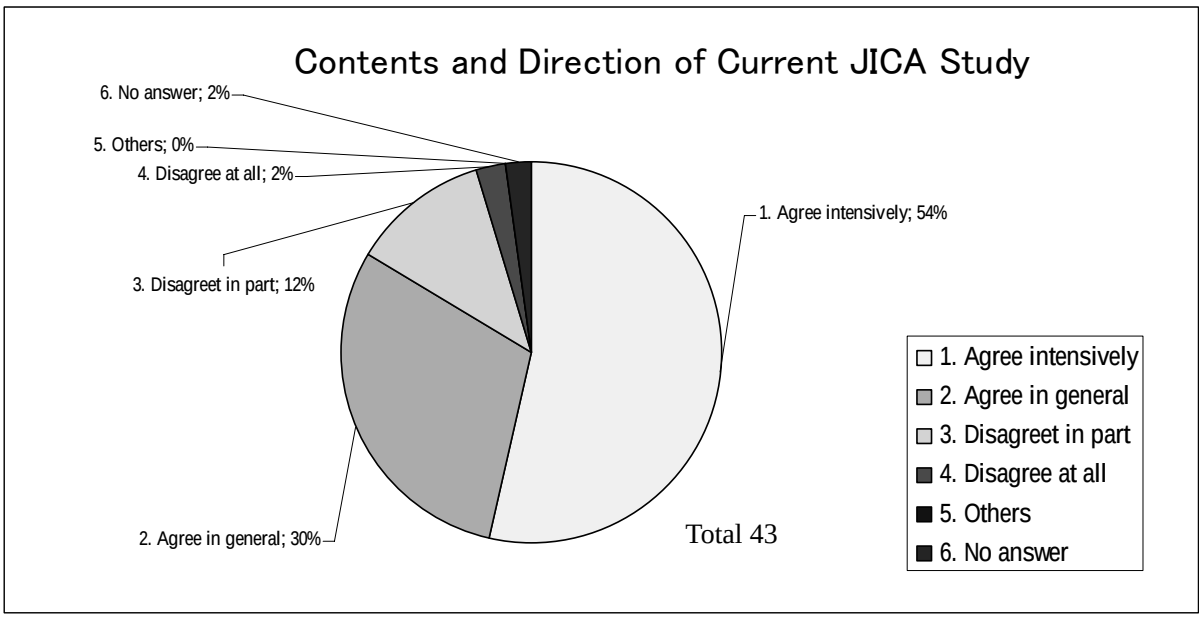
1) The Current JICA Study

According to counting of respond, extensive and in-general consents hold 81 %. Respondents can be interpreted to agree basically with the content and direction of the JICA study. As comments, following items are described.

i) Approval for the Study or same kind of projects (below mentioned a)-d));	4 comments
ii) Suggestion for approach of the Study (below mentioned e)-h));	4 comments
iii) Scarcity of water in Al Baha or a specified region (below mentioned i)-j));	3 comments
iv) Importance of actualization of the project (below mentioned l)-m));	2 comments

The answer of participants about the question “What do you think about contents and direction of the current JICA Study?” is as follows;

1) I agree extensively;	23 (53.5%)
2) I agree in general	13 (30.2%)
3) I cannot agree a part	5 (11.6%)
4) I cannot agree at all	1 (2.3%)
5) Others	0 (0.0%)
6) No answer	1 (2.3%)



Furthermore, following comments from 13 participants were obtained.

a) I agree with the Study because it responds to the interests of this region. (Engineer)
b) I agree because this subject is important. (Imam)
c) This study is one of the most important studies worldwide. (Teacher)
d) I recommend these studies in this region to increase. (Engineer)
e) The issue of water resources management should be focused on. (Anonymity)
f) This topic can benefit common people through intensive education. (Teacher)
g) Take into consideration that the Study is performed according to the criteria of the Statistic Authority. (Engineer)
h) Diversifying sources of water extraction leads developing the region. (Anonymity)
i) An urgent countermeasure for scarcity of water is required in Al Baha Region. (Farmer)
j) The Study is required, but it is late because people in Al Baha are suffering water scarcity. (Anonymity)
k) Exploratory wells for contamination of groundwater should be installed in Al-Ahsabah Town. (Farmer)
l) The recommendations and suggestions of the Study should be implemented and realized. (Professor)
m) If the meeting makes recommendations and the attendants notify and effectuate them, we can serve commonweal. (Administrator)

2) Water Related Issues

Responses of water related issue surrounding a respond, causes of the issue and idea for solution of the issue are obtained.

Ranking of water issues according to responds of questionnaires is 1) Scarcity of water in Al Baha (49% including specified area), 2) Contamination or saline contamination of groundwater (9%), and 3) Shortage of agricultural water (5%).

Ranking of cause of water issues is 1) Scarcity of water sources (24%), 2) Decrease of rainfall (24%), 3) Not construction of desalination network (10%), and 4) Overuse of water (10%).

Ranking of idea for solution is 1) Construction of desalination network, 2) Construction of dam (19 %)

3) Development of water sources (7 %), 4) Rationalization of water use (7 %), and 5) Awareness of water shortage (7 %).

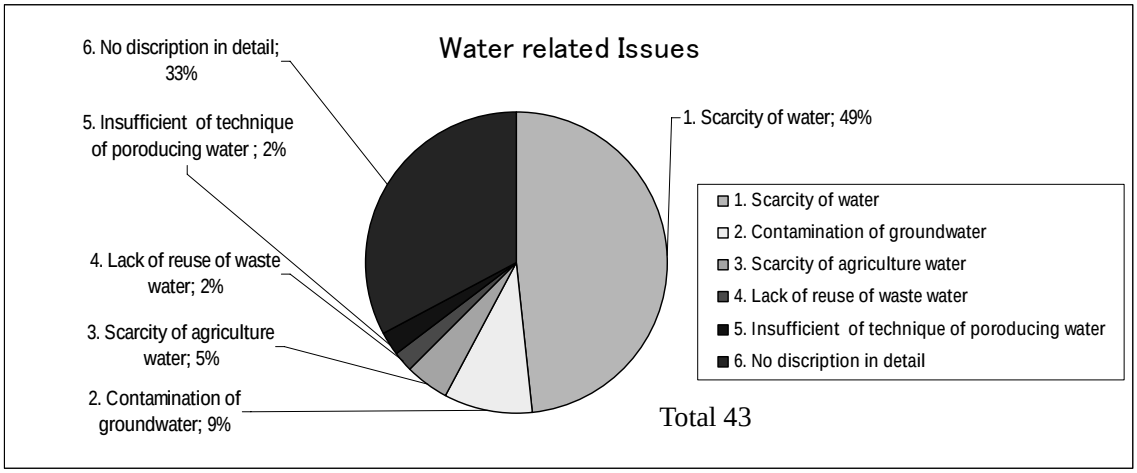
The respondents are considered to have caught the water shortage as the very serious problem due to scarcity of water sources and rainfall decrease, and to be waiting eagerly for early realization of

construction of a desalination plant, and construction of a dam as the solution. Moreover, groundwater contamination is serious by the sewage disposal to the wadies.

The answer of participants about the question "What is the most important water issue related to renewable water resources at your place of residence or in your Governorate or in your Region?" is arranged as shown follows.

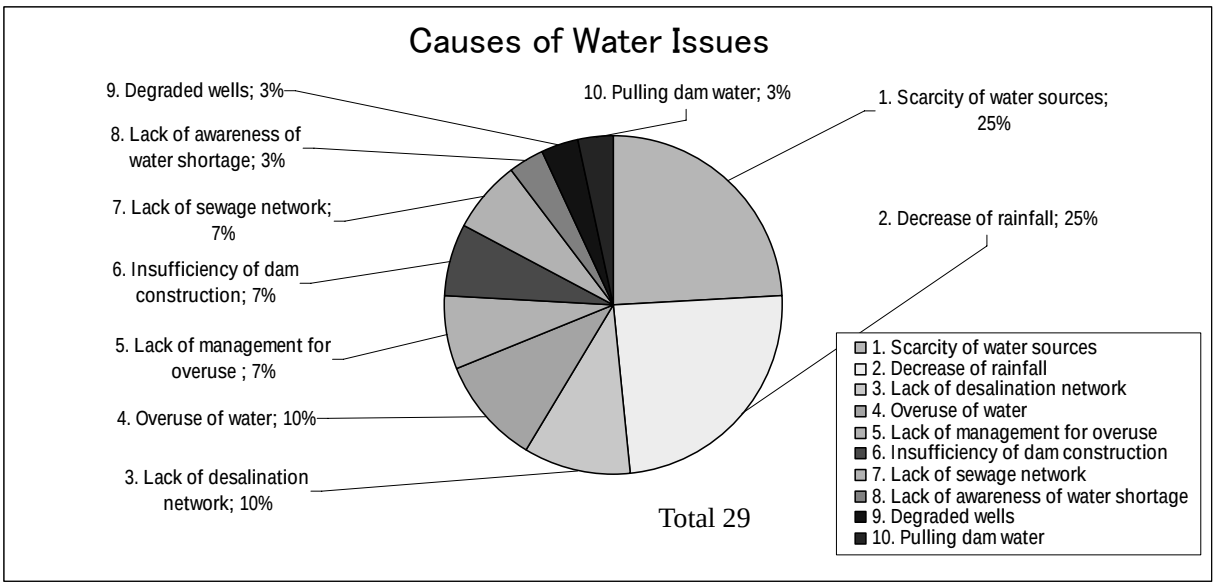
1) Water issue

a) Water shortage in Al Baha is serious.	19 (44.2 %)
b) Water shortage in specified area such as Al Ahsabah and Kulwah	2 (4.7 %)
c) Contamination or salination of groundwater has occurred.	4 (9.1 %)
d) Shortage of agricultural water is severe.	2 (4.7 %)
e) Technique for processing water is insufficient.	1 (2.3 %)
f) Others (Contents are not clear in order to select only grouping items.)	14 (32.6 %)



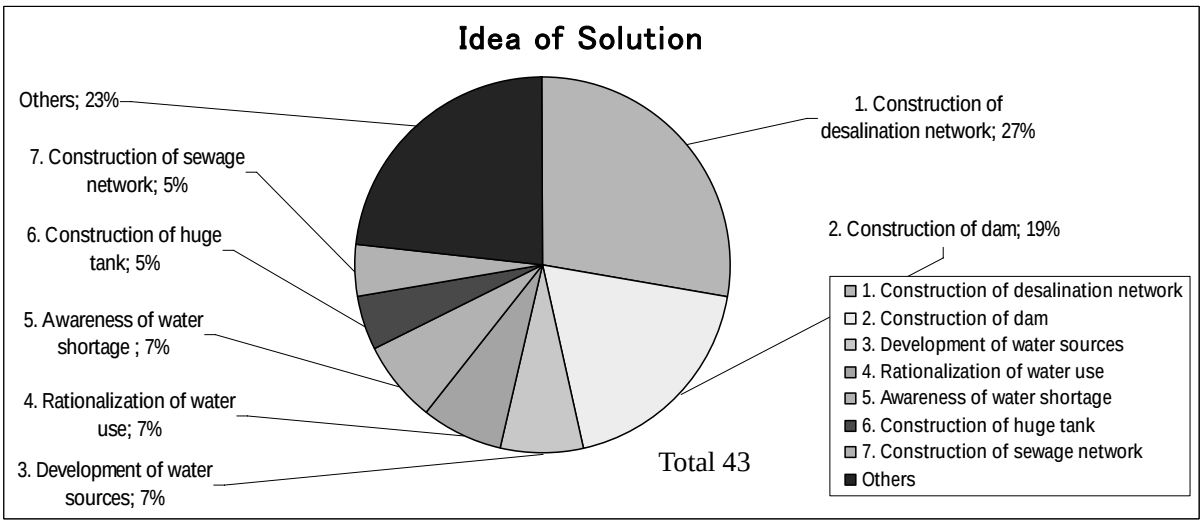
2) Cause of the water issue

a) Scarcity of water sources is serious.	7 (24.1 %)
b) Rainfall is descending.	7 (24.1 %)
c) Desalination network is not constructed.	3 (10.3 %)
e) Overuse of water is continuous.	3 (10.3 %)
f) Management for overuse of water is lacking.	2 (6.9 %)
g) Construction of dams is not sufficient.	2 (6.9 %)
h) Sewage network is not furnished.	2 (6.9 %)
i) Awareness of water shortage is lacking.	1(3.4%)
j) Degraded wells increase.	1(3.4%)
k) Pulling dam water is carried out.	1(3.4%)



3) Idea of solution

a) Construction of desalination network	12 (27.9 %)
b) Construction of dam	8 (18.6 %)
c) Development of water sources	3 (7.0 %)
d) Rationalization of water use	3 (7.0 %)
e) Awareness of water shortage	3 (7.0 %)
f) Construction of huge tank for water storage	2 (4.7 %)
g) Construction of sewage network	2 (4.7 %)
h) Regulation of water use	1 (2.3 %)
i) Continuous investigation and study	1 (2.3 %)
j) Use of drainage water	1 (2.3 %)
k) Dissemination of water saving irrigation method	1 (2.3 %)
l) Control of agricultural water use	1 (2.3 %)
m) Raising water tariff to reduce overuse	1 (2.3 %)
n) Preserving water sources for emergency condition	1 (2.3 %)
o) Maintenance of degraded wells	1 (2.3 %)
p) Creation of strong organization or companies for water resources management	1 (2.3 %)
q) Separation of sewage disposal place and well field	1 (2.3 %)



3) Water Tariff System and Agricultural Water Use

1) Water tariff system for saving water use and expansion of water supply facilities

The consent of payment of a water tariff equivalent to operation and maintenance cost of water supply holds 86 % (below mentioned a)+b)+c)) according to counting of responds.

Most of responders basically agree with the recommendation that water user shall pay a reasonable water tariff equivalent to operation and maintenance cost of water supply in order to save water use and expand water supply facilities by the paid water charge.

The explanation of the situation and the question is as below;

JICA study team recognized that finds your country's water tariff is very low (0.1 SR/m^3 at 50 m^3 or less, and 0.15 SR/m^3 at 100m^3 or less), and the amount of the water use is not measured as for many. If water users pay a reasonable water tariff equivalent to operation and maintenance cost of water supply (about 5 to 6 SR/m^3, this number is under investigation), then an excessive use of water supply can be decreased. Moreover, expansion and improvement of water supply facilities can be performed more than former situation by the paid water charge.

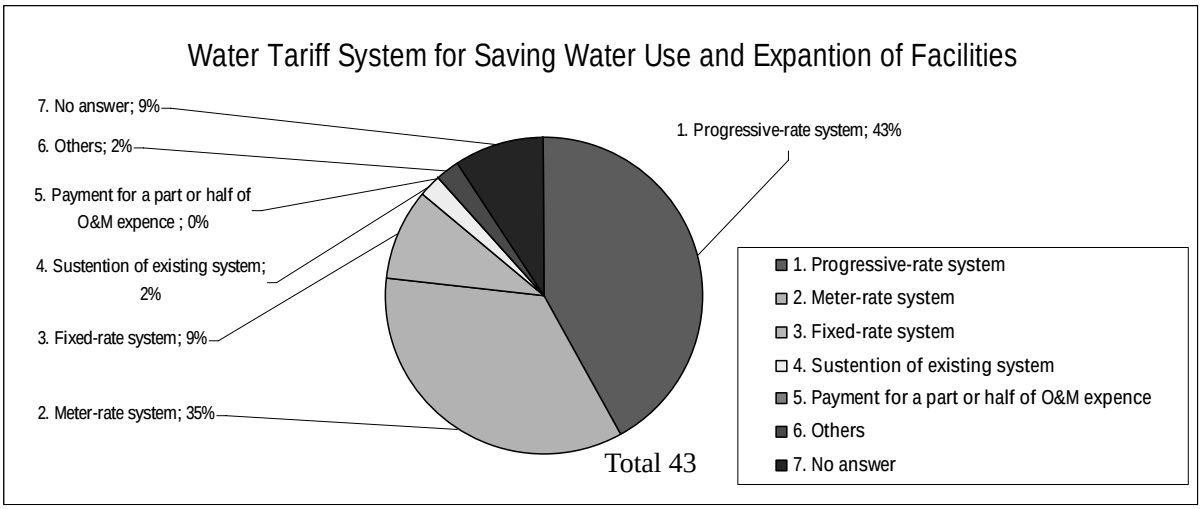
What do you think when JICA study team recommends a new water tariff system that water user shall pay necessary operation and maintenance cost for water supply?

The answer of participants about the question is as follows (including multiple answers);

a) Water user should pay the water tariff with a fixed rate system	4 (9.3 %)
b) Water user should pay the water tariff with a meter-rate system	15 (34.9 %)
c) Water user should pay the water tariff with a progressive-rate system. (Small tariff for small consumer and a progressive tariff for a large consumer)	18 (41.9 %)
d) Water user should pay a half or a part of necessary expense.	0 (0.0 %)
e) Water tariff should sustain at present condition.	1 (2.3 %)
f) Others (Water user should not pay any money for drinking water. It is the simplest right.)	1 (2.3 %)
g) No answer	4 (9.3 %)

Otherwise, 2 comments are obtained as follows.

i) The water tariff should be applied by mater-rate in only water supply network.
ii) Water tariffs classified by purpose of consumption should be applied.



2) Agriculture water use

Concerning measures of agricultural water use, responds select "Dissemination of irrigation method and crop cultivation for saving water" as first priority (35%), "Withdrawal control of wells by flow

meter installation" as second priority (16%) and "Management of water resources in each watershed" as third priority (11%). "Water tariff system for groundwater use" for saving groundwater excessive use holds 0%. It seems that responds have resistance in introduction of the tariff system to groundwater use.

The explanation of the situation and the question is as below;

Agricultural water accounts for 85% of water use of surface water and ground water. In some agricultural areas, water issues (such as decline of ground water level, deterioration of water quality, drying up of wells and so on) seems to be aggravated by over-withdrawal.

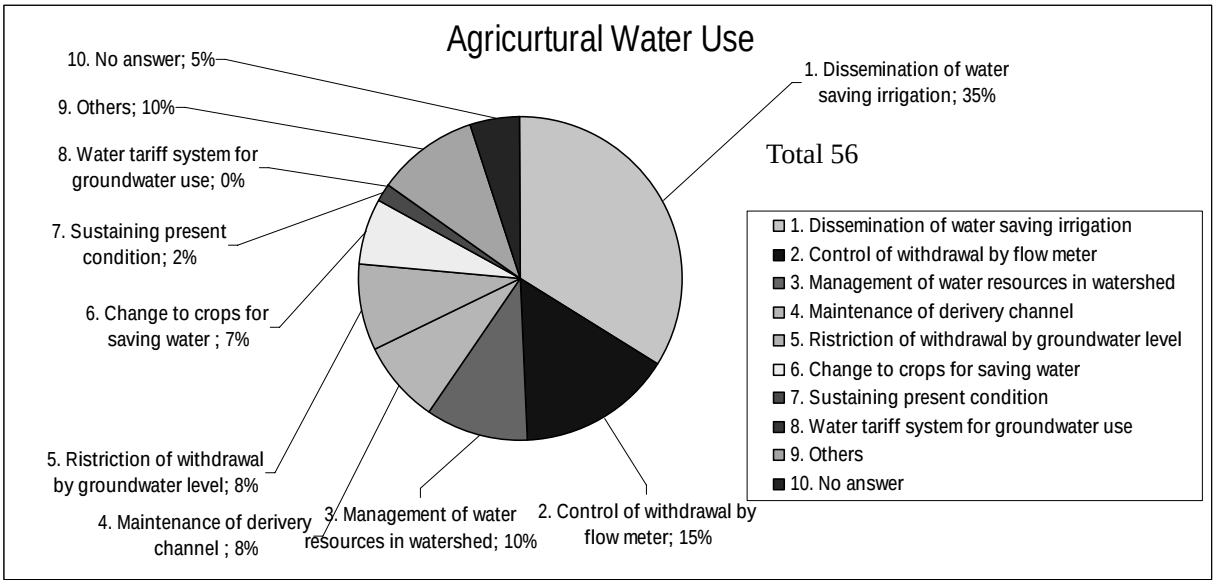
What do you think about effective solution for sustainable agricultural water use?

The answer of participants about the question is as follows (including multiple answers);

a) Withdrawal control of wells by flow meter installation	9 (15.3 %)
b) Restriction of withdrawal of wells by monitoring of groundwater level	5 (8.5 %)
c) Water tariff system for groundwater use	0 (0.0 %)
e) Management of water resources in each watershed	6 (10.2 %)
f) Dissemination of irrigation method and crop cultivation for saving water	20 (33.9 %)
g) Switching to crop cultivation for saving water	4 (6.8 %)
h) Maintenance of delivery channel or pipe lines and countermeasure against leakage	5 (8.5 %)
i) Keeping at the present condition.	1 (1.7 %)
j) Others (mentioned bellow)	6 (10.2 %)
k) No answer	3 (5.3 %)

Others consist of following descriptions.

i) Prevention of unnatural enlargement of farmland
ii) Reuse of waste water for agriculture
iii) Protection of water sources is important. Food can be imported.
iv) Construction of dams for agriculture water
v) Imposing water saving irrigation system
vi) Tools for water rationalization shall be prepared, and guidance for people is necessary.



Reference1 Questionnaire

The 2nd Stakeholder Meeting in Al Bahah

QUESTIONNAIRE

Please circle the number beside the phrase that describes your answer. When there is no appropriate item, please put your comments in the bracket. Moreover, if you have questions and/or comments in the Study, please describe briefly in an appropriate column. You can use a back side of this sheet, or please send your comments to MOWE or JICA Study Team later, if the comments become long.

< Respondent >

You can use anonymity if necessary, please fill in the bracket. The following information will be used for our analysis of the questionnaire only.

Name;(_____ **)**
Address; (City/town/village;_____ **Governorate;**_____ **Region;**_____ **)**
Occupation; (_____ **) Organization;(** _____ **)**
Contact; (If possible,) Phone No.; (_____ **) E-mail; (** _____ **)**

Part 1 Current JICA Study

What do you think about contents and direction of the current JICA study?

1) I agree extensively. 2) I agree in general. 3) I cannot agree a part. 4) I cannot agree at all.

5) Others (_____)

Comments; _____

Part 2 Water related issues

What is the most important water issue related to renewable water resources at your place of residence or in your Governorate or in your Region?

2-1 The most important water issue for you; _____

2-2 Kind of water issue (Group classification)

1) Drinking water, 2) Domestic water (excluding drinking water), 3) Agricultural water, 4) Industrial water, 5) Waste water treatment, 6) Reuse of waste water, 7) Water pollution, 8) Water facility (Intake, Dam, Well, Water treatment facility etc.), 9) Water resources management,

10) Others (_____)

2-3 Description of the water issue mentioned above.

1) Current situation of the water issue; _____

2) Area of the water issue; _____

3) The year in which the water issue was observed; _____

2-4 Major causes of the issue

_____

2-5 Effective solution (Your opinion)

_____

Part 3 Others

Please circle the number beside the phrase that describes your answer.

3-1 Saving Water Use and Water Tariff

JICA study team recognized that finds your country's water tariff is very low (0.1 SR/m^3 at 50 m^3 or less, and 0.15 SR/m^3 at 100m3 or less), and the amount of the water use is not measured as for many. If water users pay a reasonable water tariff equivalent to operation and maintenance cost of water supply (about 5 to 6 SR/m^3, this number is under investigation), then an excessive use of water supply can be decreased. Moreover, expansion and improvement of water supply facilities can be performed more thanformer situation by the paid water charge.
What do you think when JICA study team recommends a new water tariff system that water user shall pay necessary operation and maintenance cost for water supply?

1) Water user should pay the water tariff with a fixed rate system

2) Water user should pay the water tariff with a meter-rate system

3) Water user should pay the water tariff with a progressive-rate system.
(Small tariff for small consumer and a progressive tariff for a large consumer)

4) Water user should pay a half or a part of necessary expense.

5) Water tariff should sustain at present condition.

6) Others; (_____)

3-2 Agricultural Water Use

Agricultural water accounts for 85% of water use of surface water and ground water. In some agricultural areas, water issues (such as decline of ground water level, deterioration of water quality, drying up of wells and so on) seems to be aggravated by over-withdrawal.
What do you think about effective solution for sustainable agricultural water use?

1) Withdrawal control of wells by flow meter installation

2) Restriction of withdrawal of wells by monitoring of groundwater level

3) Water tariff system for groundwater use

4) Management of water resources in each watershed

5) Dissemination of irrigation method and crop cultivation for saving water

6) Switching to crop cultivation for saving water

7) Maintenance of delivery channel or pipe lines and countermeasure against leakage

8) Keeping at the present condition.

9) Others; (_____)

(3) 3rd Stakeholder Meeting

(a) Agenda

The 3rd Stakeholder Meeting was held in Jazan on 10th March 2009 in order to share the study findings concerning the procedure/ result of water balance analysis and the formulation of basic policy/ strategy on water resources development/ management, and identify the water-related issues through participatory approach. Table 5-10 shows the agenda of the meeting and outline of the contents. The meeting was composed of two parts, part 1 for presentation of the JICA Study and part 2 for group discussion by PCM method.

Table 5-10 Agenda of 2nd Stakeholder Meeting

Program	Agenda	Contents
1. Reception		Reception and Registration
Part 1		
2. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 3rd Stakeholder Meeting
3. Opening Speech (2)	Opening speech by JICA Saudi Arabia Office	The briefing on JICA, activity of JICA Saudi Arabia office and background/ progress of the Study.
4. Presentation of the JICA Study	Presentation of the current progress of the Study by MOWE counterpart	The current JICA Study including the water balance analysis and the formulation of basic policy/ strategy on water resources development/ management
5. Q & A	Q & A for Presentation of the JICA Study	Questions and answers for the presentation, present water issues and correspondence of government organizations
Part 2		
PCM Workshop		
6. Water issues in the area	Group discussion for water issues in the area	The participants discuss about water issues in the area using PCM procedure under MOWE's moderators in separated 4 groups.
7. Grouping and Ranking	Grouping and ranking	The participants prioritize above water issues for selecting core problem to be used for Cause – Effect Analysis in each group.
8. Presentation by Participants	Presentation by 5 groups	4 groups make presentation for the results of the group discussion.
9. Closing Speech	Closing by General Directorate of Water, Jazan	Closing by General Directorate of water for the meeting's results and outcome.

(b) Participants

Total participants were 60 persons including JICA Saudi Arabia office and the study team.

(c) Question and Answer for the Presentation

The questions or comments from participants after the presentation and answer to them are arranged as follows.

1) Damage of Water Supply in Wadis and Water Supply from Jizan Dam

The first speaker, who was a farmer; talked about wadi problems as follows.

i) There is a vast agricultural land located at wadis, which demand water to meet agricultural purpose (irrigation).
ii) Jizan Dam is closed an operation and became no longer provide water for our agricultural purposes.
iii) It is said that the water of Jizan Dam would be used for providing potable water.

Mr. Ahmad Najmi, Vice General Director of General Directorate of Water for Jazan Region, explained that the findings of ongoing investigation of JICA would provide for us a useful recommendation and a better solution to overcome such problems.

Dr. Saud commented on this topic, that the study has been concentrating on water uses for different purposes and excellent aspect, on the other hand, Allah gives us enough volume of water for drinking and agricultural purposes.

Dr. Saud argued that all figures were very optimistic, and 30% of the available water could be exploited."

2) Water Shortage and Health Hazard of Wells in Damak

A citizen from Damak Province complained the shortage of water supply network in some Damak's villages and he asked a question that the use of artesian well waters would have health hazards on to people.

Mr. Ahmad Najmi replied confirmed that a water supply network would cover all village and suburb of Damak soon.

3) No Licenses for Drilling of Wells

A Farmer complained that there were many farmers who had drilled wells without licenses which affected directly the drawing of licensed one.
Mr. Said Al-Doeir, Director General of Water Resources Development replied that Jazan was a limited area and heavy mining of water would lead to a disaster. Mr. Said added that such problem should be solved by the owner and well drilling without licenses is absolutely prohibited.
The citizen must inform the responsible authority about such wrong behavior.

4) Water Supply Network Coverage

Another citizen complained that the water supply network had not reached his village.

Mr. Najmi answered that the water supply network construction project has been awarded to a contractor. He added that such project would supply desalinated water to all provinces and villages of the region within one or two years.

5) Water Supply Network Coverage for Villages

A participant from Al-Doeir province informed that runoff induce the destruction of water supply network which caused discontinuity of water supply for villages, he requested for dam construction for the benefit of both farmers and investors.

Dr. Saud referred to ongoing investigations which would include a feasibility study of constructing dams and constructing water supply network in order to provide water for villages located at Jazan Region. He also confirmed that the Ministry of Water and Electricity would endeavor to provide water and sanitation for all regions in need of such services.

6) Detail Study Relationship between Salty Ground water and Dam Construction

A participant from Jazan region pretended that dams had negative affects. He added that in the past they extracted water from 15 meters deep while currently they extracted from 60 meters deep. He asked that there would be still groundwater. Also he said that dams had been the main cause of damage by salt. He claimed that a detailed study should be carried out on such two issues

(d) Water Issues Discussed in the Group Meeting

The Participants of the meeting grouped into four groups for further discussion on water issues. The four groups discussed and arranged about water issues in the Region shown in Table 5-11.

Table 5-11 Water Issues Arranged in the Group Discussion

Categories	Group 1	Group 2	Group 3	Group 4
Drinking Water	Scarcity of water	Not availability of drinking water	Decreasing of rainfall and effect of evaporation	Secure of water
Water Quality	Pollution & saltiness			Saltiness & pollution of water
Water resources and facilities	Low number of water governor branches	Not availability of water network	Not availability of underground dams	Not availability of water networks
Management	Weak public awareness of water	Weal public awareness of water	Poor awareness and random well drilling	
Agricultural water	Maintenance of irrigation water for Jizan Dam	Irrigation channel not included for irrigated area	wrong irrigation method	
Sewage water	Establishing sewage network & treatment system			

(e) Actual Water Consumption Rate by Region Based on Questionnaire

Based on the answer of the questionnaire by 28 respondents in total, the water consumption rate per capita by every region was arranged shown in Table 5-12.

Table 5-12 Water Consumption Rate per Capita by Region

Name of Region	Number of respondents	Range of consumption rate (l/capita/day)	Average consumption rate (l/capita/day)	Remarks (governorate)
Makkah Region	2	146-167	156	Jeddah
Al Baha Region	7	76- 167	120	Baha, Mandaq, Alatwlah
Jazan Region	19	36 -556	174	Bany malek, Baysh, Damad, Jizan, Samta, Ab Areesh, Sabya
Total	28	36 -556	160	3 Regions

(4) 4th Stakeholder Meeting

(a) Agenda

The 4th Stakeholder Meeting was held in Abha on 19th January 2010 in order to share the study findings concerning the policy/ strategy/ action plan and water supply facility plan on water resources development/ management. Table 5-13 shows the agenda of the meeting and outline of the contents.

Table 5-13 Agenda of 4th Stakeholder Meeting

Program	Agenda	Contents
1. Reception		Reception and Registration
2. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 4th Stakeholder Meeting
3. Opening Speech (2)	Opening speech by Asir Region Government's Office	Opening ceremony for 4th Stakeholder Meeting by General Manager of water division
4. Opening Speech (3)	Opening speech by JICA Saudi Arabia Office	The briefing on JICA, activity of JICA Saudi Arabia office and background/ progress of the Study.
5. Presentation of the JICA Study	Presentation of the current result of JICA Study	The water policy/ strategy/ action plan and the water supply facility plan
6. Q & A	Q & A for Presentation of the JICA Study	Questions and answers for the presentation
7. Closing Speech	Closing Speech by General Directorate of Water in Asir	Closing Speech by General Directorate of water in Asir for the meeting's results and outcome.

(b) Participants

Total participants were 38 persons including JICA Saudi Arabia office and the study team.

Table 5-14 Numbers of Participants for Each Organization

Classification of Organization	Number of Participants
Al Baha Region	1
MOWE, headquarters	10
MOWE, Al Baha	4
MOWE, Jazan	3
MOWE, Asir	7
MOWE, Makkah	2
MOWE, Najran	2
JICA Saudi Arabia Office Representative	1
JICA Study Team	8
Total	38

Data) Attendant List and Questionnaire

(c) Question and Answer for the Presentation

The questions or comments from participants after the presentation and answer to them are arranged as follows.

1) Consideration and treatment of empty dam during last several years

- Although those dams might be empty during last several years, they can reserve some quantity of

water when rain falls. The reservoir water should be used effectively. The renewable groundwater and fossil water with potentials, which the JICA study team explained previously, shall also be utilized effectually.

- The study on renewable water resources including dam reservoir water has been carried out by JICA study team. The precipitation fluctuation in KSA is tough now, but it could improve in the future.
- This sever environmental condition in KSA is not going to last forever. Rain will fall some day and when it does we must be well prepared. We envisions the water as a gift from heaven that people must value its utilization and therefore we are suggesting the reuse of treated sewage water for agriculture and industry due to its stability and reasonable cost.

2) Dissemination of application of sewage recycle water for agricultural water

< My farm has been lacking water and I have not known what to do since long time until the JICA Study Team kindly visited my farm 2 weeks ago and suggested using treated sewage water origination, assuring that it does not harm our environment at all. The majority of farmers is against treated sewage water use because they believe it harms their agricultural productions which I believe it is wrong and need to be corrected. How can we educate our people? >

- In Riyadh city, public awareness of treated sewage water usage has been improved successfully to the level that Riyadh industry and agriculture sectors count on it greatly because it possesses sustainability and less production cost than desalinated water. It is very important to conduct extensive public campaign throughout the kingdom as we did in Riyadh.
- 3 R campaign (Reduce, Reuse, and Recycle) that has been found, implemented and resulted positively throughout Japan, therefore, spreading awareness of treated sewage water usage should be implement it throughout the Kingdom of Saudi Arabia.

3) Effective Use of water flowing into the Red Sea

- A study on farming the desert by irrigation of sewage water treated biologically not chemically was firstly conducted in Egypt and has been also carried out successfully in Saudi Arabia recently.
- The prince of Asir has declared that sewage water treated by Asir treatment plant is safe to use for irrigating in our farms. Unfortunately, it was not because some our productions were contaminated.
- The treated sewage water can be used to irrigate some of farming productions but not all.
- When sewage is treated probably it enriches farming soil by its vital substances.

4) Solution of dumping sewage into valleys without treatment in Asir

- We are constructing new sewage pipe line that will be complete within a year from now. Recently we are working so hard on this project but we need more time to finish it so I would like from all the farmers to have some patience until it is done.

(5) 5th Stakeholder Meeting

(a) Agenda

The 5th Stakeholder Meeting was held in Jazan on 18th May 2010 in order to share the study findings concerning the water M/P. Table 5-15 shows the agenda of the meeting and outline of the contents.

Table 5-15 Agenda of 5th Stakeholder Meeting

Program	Agenda	Contents
1. Reception		Reception and Registration
2. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 5th Stakeholder Meeting
3. Opening Speech (2)	Opening speech by JICA Saudi Arabia Office	The briefing on JICA, activity of JICA Saudi Arabia office and background/ progress of the Study.
4. Presentation of the JICA Study	Presentation of the result of JICA Study	The water M/P (Outline of the water M/P, Read sea lifeline project, Water resources development/ water supply plan, Water demand management, O&M plan, Improvement plan of organization, Recommendation)
5. Q & A	Q & A for Presentation of the JICA Study	Questions and answers for the presentation
6. Closing Speech	Closing Speech by General Directorate of Water in Jazan	Closing Speech by General Directorate of water in Jazan for the meeting's results and outcome.

(b) Participants

Total participants were 45 persons including JICA Saudi Arabia office and the study team.

Table 5-16 Numbers of Participants for Each Organization

Classification of Organization	Number of Participants
Jazan Region Office	3
MOWE, headquarters	7
MOWE, Al Baha	3
MOWE, Jazan	10
MOWE, Jazan, Blanch office (Al Bidani, Sabia/Baysh)	2
MOWE, Jazan, Jizan dam office	1
MOWE, Asir	3
MOWE, Makkah	3
MOWE, Najran	1
Islamic Affairs, Imam and Mosque Teacher	1
Ministry of Agriculture Jazan	3
Farmer	1
Journalist	2
JICA Saudi Arabia Office Representative	1
JICA Study Team	4
Total	45

Data) Attendant List and Questionnaire

(c) Question and Answer for the Presentation

The questions or comments from participants after the presentation and answer to them are arranged as follows.

1) Bases such as quantity applied by investigation, Solutions to the consideration to the various water demand, and Solution of the shortage of the water supply of Jazan region

- The JICA Study Team bases on the observation record of MOWE headquarter, General Directorate of water in Al Baha, Asir and Jazan, or related other organizations, and investigation results by own JICA Study Team.

About prediction of water demand, it predicts using basal conditions such as each region population and water supply standard physical unit.

In development of renewable water resources, although there is change of dam storage water volume etc., it is a plan to give priority to use renewable water resources firstly and use desalinization water for compensation of insufficiency.

(Explanation supplement of MOWE) Although the JICA Study Team has been carrying out hard work not only at office but at site during the consultation period of three years, it is working for the fund of the Japanese government and MOWE has not paid the study cost.

2) Is the mountain area contained in the investigation? Is the water demand of livestock (pasturage, animal husbandry) also included?

- Investigation covers the Jazan whole region. The water needed upstream area can be given priority to use by water producing area, it has become a plan to distribute downstream the water which carries out invalid discharge, and reservation of the water in mountain area is possible.

3) Can't the seawater intrusion by recharge wells be prevented using the existing well? In addition, there is a new pipeline construction plan which connects the Hali dam and Jeddah through Shuaiba.

- Pouring by new recharge well is required. About a new pipeline construction plan, since the detailed plan is not made, it has not received, but after taking them into consideration, the JICA Study Team's plan is proposed.

4) Jazan Region Office progresses agricultural projects and would like to combine investigation results of JICA Study Team and our investigation results. We would like to participate in the workshop held from now on.

- It will participate, if there is an opportunity. The development of groundwater is severe in the region, and the groundwater situation of the Jazan region needs to change agriculture into crops with few water amounts of consumption, in order to maintain reservation of water and life of next-generation.

5) Other comments

- Eight proposals are effective and tell them to the farmer of Jazan.
- The proposal which recharge sewage treated water in order to reduce seawater intrusion is a good idea, and should be applied by Jazan region.

5.2 Work Shop

The work shops were held sixth during in 28th March 2009 and in 26th May 2010. The outline of the work shops is shown in Table 5-17.

Table 5-17 Outline of Workshop

Time	Date	Venue, Region	Main Agenda
1st	Mar.28,2009	Wadi Hirjab, Bisha, Asir Region	Monitoring on surface runoff and sub-surface water in Wadis and arrangement of monitoring data
2nd	Jun 8, 2009	Abha, Asir Region	Water resources potential, Demand projection, Selection of Regions for the M/P study
3rd	Jun13,2009	Al Baha, Al Baha Region	Current water supply, Water resources development by dam construction, Water supply by desalination seawater
4th	Jun13, 2009	Jizan, Jazan Region	Hydrological water balance, SWAT model, Agricultural demand in the Region
5th	Jan. 12 2010	Abha, Asir Region	Basic policy, strategy and action plan for water resources development, Water M/P
6th	May 26 2010	Riyadh, Riyadh Region	Outline and important points of the M/P, Japanese Technology related renewable water resources development and management

(1) 5th Work Shop

(a) Agenda

The 5th Work Shop was held in Abha on 12th January 2010 in order to share the study findings the basic policy, strategy and action plan for water resources development, and water M/P outline. Table 5-18 shows the agenda of the work shop and outline of the contents.

Table 5-18 Agenda of 5th Work Shop

Program	Agenda	Contents
1. Reception		Reception and Registration
2. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 6th Work Shop
3. Opening Speech (2)	Opening speech by JICA Saudi Arabia Office	The briefing on JICA, activity of JICA Saudi Arabia office and background/ results of the Study.
4. Presentation (1)	Presentation of the JICA Study (1)	The water Policy/ strategy/ action plan of 5 Regions
5. Q & A	Q & A for Presentation of the JICA Study (1)	
6. Presentation (2)	Presentation of the JICA Study (2)	The water M/P of selected 3 Regions
6. Q & A	Q & A for Presentation of the JICA Study (2)	
7. Closing Speech	Closing Speech by General Directorate of Water in Asir	Closing Speech by General Directorate of water in Asir for the meeting's results and outcome.

(b) Participants

Total participants were 31 persons including JICA Saudi Arabia office and the study team.

Table 5-19 Numbers of Participants for Each Organization

Classification of Organization	Number of Participants
MOWE, headquarters	4
MOWE, Al Baha	4
MOWE, Jazan	2
MOWE, Asir	6
MOWE, Makkah	3
MOWE, Najran	1
Consultant	1
JICA Saudi Arabia Office Representative	1
JICA Study Team	8
Total	31

Data) Attendant List and Questionnaire

(c) Question and Answer for the Presentation

The questions or comments from participants after the presentation and answer to them are arranged as follows.

1) MOWE (Makkah)

Mr. Habib Mohammed Khayat (Senior Geologist)

C1. Some of our pipe line projects were actually canceled due to public appeal where concerned properties' owners refused to release their landscapes to the government.

(Mr. Watanabe's Explanation)

I do not think that we are going to have such problems because our suggested Life pipe line is going to be laid down parallel to the already excited costal road along the Red Sea which will facilitate its implementation and minimize its construction cost.

C2. Some of the On-going dams' projects you mentioned are not known for us. Perhaps such dams are excited but under different names so we suggest that you check your information.

(Mr. Shingu's Explanation)

We got our information from projects Design & Implementation Department in MOWE (Riyadh). However if you think it must be checked we would like you to verify whether it is correct or not and then give us your feedback on it ASAP.

Q1. Does the proposed Red See Water Life Line project guarantee total water supply that can cover the all area?

(Mr. Watanabe's Explanation)

Yes, it will when it is managed by the proposed RWPC

2) MOWE (Al Baha)

Mr. Jabr Al-Fifi (Senior Geologist)

C1. We are extremely pleased to hear your proposal of constructing a new desalination plant and totally agree that it is important to be built in near future but we want it to be in our region (Al Baha) so we can be in control of supplying our region efficiently and end being controlled by Makkah Water Directorate. We will send you where exactly we want you to construct it ASAP.

(Mr. Shingu's comment)

Ok, we will be waiting for you.

C2. It is important to conduct a financial study for determining whether or not the cost of implementing the Red See Water Life Line project is less or equal to the cost of expanding Al Shoaibah & Al Soqaiq desalination plants.

(Mr. Watanabe's Explanation)

Surely, it is important. That is what Mr. Natsuda is working on now. Additional details shall be provided in near future.

C3. Water transmission volume from Taif to Al Baha will be 70,000m^3/day by 2020.

C4. New Desalination plant is planned by JICA on Dawqah and transmission pipeline is planned from Dawqah to Al Baha. Engineer of Al Baha suggested that more suitable place of

Desalination plant will be investigated by them.

3) MOWE (Asir)

Mr. Yahia Motawa (Geologist)

C1. We believe that establishing the proposed company (RWPC) is a great solution that can guarantee sustainable water supply for our region but we want it to be managed by firstly Japanese experts and secondly provide some role to Asir water directorate.

Mr. Yasser Al-Asmaree (Geologist)

C3. I'd like to remind the JICA Study Team that we cannot count on dams located in Air region because their reservoirs are recently empty. For instance, the biggest dam King Fahd is also empty recently.

(Mr. Watanabe's Explanation)

We cannot count on dams entirely but we must use their reservoirs when full of water. On one hand we know that the precipitation fluctuation is tough, but on the hand we also believe that it is essential to benefit from these dams efficiently.

4) MOWE (Jazan)

No question & comment

5) MOWE (Najran)

No question & comment

(2) 6th Work Shop

(a) Agenda

The 6th Work Shop was held in Riyadh on 26th May 2010 in order to disseminate the outline and important points of the M/P, and the Japanese technology related renewable water resources development and management. Table 5-20 shows the agenda of the work shop and outline of the contents.

Table 5-20 Agenda of 6th Stakeholder Meeting

Program	Agenda	Contents
1. Reception		Reception and Registration
2. Opening Speech (1)	Opening speech by MOWE	Opening ceremony for 5th Work Shop
3. Opening Speech (2)	Opening speech by JICA Saudi Arabia Office	The briefing on JICA, activity of JICA Saudi Arabia office and background/ progress of the Study.
4. Presentation (1)	Presentation of the JICA Study Team	Master Plan Study on Renewable Water Resources Development in Southwest Region, KSA
5. Presentation (2)	Presentation of the Japan Water Agency	Institutions for Integrated Water Resources Development
6. Q & A	Q & A for Presentation of (1) and (2)	
7. Presentation (3)	Presentation of the Global Water Resources and Reuse System Association, Japan	Compact MBR STP to Cope with Infrastructure Demand of Community Development and Decentralization of STP
8. Presentation (4)	Presentation of The University of Tokyo, Japan	An Introduction of Numerical Simulation Technology for Water Resources Development and Management by Combination with Dams and Aquifers
9. Q & A	Q & A for Presentation of (3) and (4)	
10. Closing Speech	Closing Speech by MOWE	Closing Speech by MOWE

(b) Participants

Total participants were 64 persons including JICA Saudi Arabia office and the study team.

Table 5-21 Numbers of Participants for Each Organization

Classification of Organization	Number of Participants
MOWE, Headquarters	17
MOE, headquarters	3
MOA, headquarters	3
PNE	3
MOWE, Al Baha	2
MOWE, Jazan	1
MOWE, Asir	3
MOWE, Makkah	2
Donor organization (GTZ)	1
Company (Saudi Arabian)	5
University	2
Public organization and Company (Japanese)	12
Journalist	2
Japan Embassy	1
JICA Head Office	2
JICA Saudi Arabia Office	3
JICA Study Team	4
Total	64

Data) Attendant List and Questionnaire

(c) Question and Answer for the Presentation

The questions or comments from participants after the presentation and answer to them are arranged as follows.

(Eng. Ahmad Ali Al-Yousif, Studies and Design/Project "MOWE")

C1: I think that your study is effective. But I also think that there some figures that incorrect. In order to structure your strategy you need to verify those figures.

Q1: How did you get these figures?

(Mr. Watanabe, JICA Team leader)

A1: there are some under construction and future projects that we need to consider in our study so those figures actually represent those amounts of water can be obtained in the future. For instance, we propose that Hali dam shall be used in supplying Al Baha in the future.

(Ahmad Ali Al-Yousif)

C2: You cannot use Hali dam for supplying water to Al Baha because it belongs to Asir region.

(Dr. A. Mohammed I Al Saud, Deputy Minister of Water Affairs "MOWE")

C3: You should understand that in such studies figures will be defined based on certain Desalinization method. Anyways, I'd like you to give chance to other participant to share discussion.

(Abdulakareem Alghamdi, Irrigation General Manager "MOA")

C4: I'm happy to participate in today's workshop and think that the 2 presentation were great. Also, I'd like to mention to everyone that even though there is geographical difference between our country and Japan, we should understand that we can benefit from the Japanese experience in O&M (operation & maintenance) which we lack in KSA unfortunately.

(Ahmad Ali Al-Yousif)

Q5: Is the quality of treated water good enough for irrigation?

(Dr. Bassem Osman, Hitachi)

A5: The quality of the sewage that is treated by the (MBR) facility is good for some kind of irrigations, but it is treated again by the (RO) facility it can be used for all kind of irrigations.

Mr. Habib Mohammed Khayat, Senior Geologist "Makkah Water Division)

Q6: Did you consider the depth of the geological layers in your model?

(Prof. Tosaka Hiroyuki, The university of Tokyo)

A6: Yes, I did. Basically, we consider more than 10 geological layers in each study. But in this model, I considered few layers only.

(Ahmad Ali Al-Yousif)

Q7: Where can (MBR) facilities be used?

A7: This technology of the (MBR) facilities can be implemented on large scales such as factories

and small scales such as houses.

(Mr. Nagata Kenji, JICA Monitoring Mission)

Q8: How much does the sewage treatment cost by the (MBR) system that you introduced?

(Bassem Osman)

A8: The initial treatment cost is different. As the capacity of the (MBR) facility increases the total cost decreases. For instance, the cost of treating 1 cubic meter of sewage is less than 1 USD (1Derham "UAE currency") which is less than half of the cost of desalinating 1 cubic meter water. However, we recommend that the capacity of (MBR) facility should be more than 250 cubic meter for reasonable treatment cost.

(Mr. Said Ali al Duair, Director General for Water Resources Development "MOWE")

Q9: does the treatment of the (MBR) facility Tertiary?

(Bassem Osman)

A9: Yes, it is.

(Ahmad Ali Al-Yousif)

Q10: Does it need maintenance?

(Bassem Osman)

A10: Yes, it needs maintenance every 5years. The merit of using the (MBR) facility is being easy to be transferred in short time quickly.

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)

I. ECONOMIC AND FINANCIAL ANALYSIS

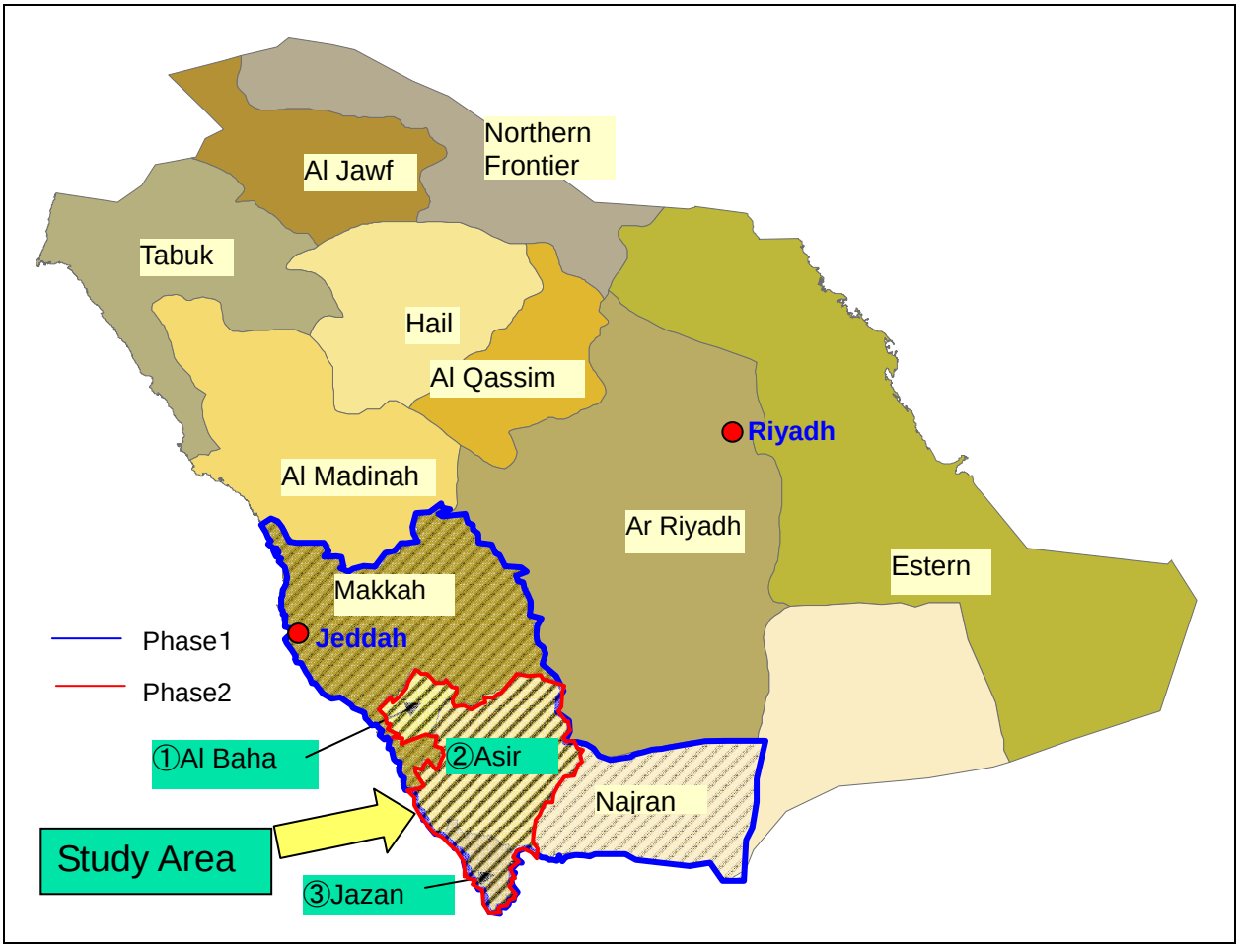
OCTOBER 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

SANYU CONSULTANTS INC.

The Kingdom of Saudi Arabia Location of Map



Final Report
Supporting Report (I)

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List of Tables and Figures

List of Abbreviations

Abbreviation and Acronym	English	Arabic (عربي)	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 الأثر البيئي	環境アセスメント
ER	Effective Rainfall	الأمطار الفعالة	有効雨量
ET	Evapotranspiration	البخرنتح	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 Conversion 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	ادارةالأرصاد 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 ميغاوات	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 (عربي)	Japanese (日本語)
NCWCD	National Commission for Wildlife Conservation and Development	اللجنة الوطنية لحماية و تطويرالحياة 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庁
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	العملنطاق	業務範囲
SWAT	Soil and Water Assessment Tool	أداة تقييم التربة والمياه	土壌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

I. ECONOMIC AND FINANCIAL ANALYSIS

1. Economic and Financial Evaluation

Economic and financial analyses were carried out to the overall water supply plan in housing and industry in the Water Master Plan (M/P), which utilizes desalination plants, wells and dams. These analyses include new, planed and constructing facilities, which are necessary for the procurement of the planned water quantity. The economic/financial feasibility of the water supply plan was considered through the comparison of the total benefit and the total cost. Net Present Values (NPV) of the benefit and the cost were calculated by discount rates for the check of the ratio of B/C.

1.1 Basic Conditions of the Analyses

Basic conditions of the economic and financial analyses are shown in the next table.

Table 1-1 Basic Conditions of the Economic and Financial Analyses

Items	Conditions
1. Prices	The prices as of January 2010
2. Exchange rate	SAR 1 = USD 0.2673
3. Standard conversion factor	120 %
4. Opportunity cost of capital	6.5 %
5. Evaluation period	30 years
6. Period of durability	
1) Desalination plant	25 years
2) Water transmission facility	25 years
3) Deep well	25 years
4) Dam	80 years

(1) Adjustment of the Inflation

The increase of the inflation rate during the last decade is about 21%. The cost of living declined up to 2001 and after that it rose up. The standard year of the economic / financial analysis was set in 2009 (= project year 0). The desalination costs in the past were to be converted into the current prices in 2009 by the conversion coefficient of each year.

(2) Standard Conversion Factor

International price of fuel was considered in the conversion from the financial cost of the project to the economic cost because a lot of subsidy was introduced for the restraint of oil price in the Kingdom of Saudi Arabia (KSA). It was estimated that the fuel cost was restrained one third of the international price by the subsidy, considering the retail price of gasoline as the index of the fuel cost. The proportion of the fuel cost to the construction cost, which occupies the greater part of the project cost, was not clarified, but it is considered to be less than the proportion of the fuel cost to the desalination cost.

According to the annual report of the Saline Water Conversion Corporation (SWCC), the cost ratio of the fuel to the desalinated water is about 12%[1]. Then, 10% was applied to the examination of the conversion factor, and other ratios were considered in the following sensitivity analysis. Therefore, the standard conversion factor from the market price to the economic price was set at 120% since the 10% of the project cost was tripled. (10% x 3 + 90%)

As for the proportion of the subsidy in gasoline price, it was estimated double of the market price. The international price was set at 0.37$/lit, deducting the tax of 29%[2] from 0.52$/lit[3], the prince in the second quarter of 2009 in USA, which was utilized as the world index of gasoline price. The retail

[1] The cost proportion of the fuel to the desalination including the transmission in west coast plants in 2008 was 12.2%.

[2] 23.2% (individual indirect tax) + 5.7% (retail sales tax) ≒ 29% The retail sales tax is determined in each state. 5.7% is the mean value between the maximum value of 8.5% and the minimum value of 2.9%.

[3] Source: *Energy Prices and Tax*, IEA

price at the same time in Riyadh, 0.12$/lit was applied to the market price in KSA. Therefore, it was estimated that the fuel cost in KSA was restrained one third by the subsidy of two thirds of the international price.

(3) Opportunity Cost of Capital

The opportunity cost of capital was set at 6.5%, which was the intermediate value between 5% and 8%, because the reference standard of SWCC was 5 - 7% and NWC was 6 - 8%. The setting between 6% and 7% is considered to be appropriate since the average interest rate of the central bank in 2004 - 2008 is 4.0%, and the maximum is 5.3% in 2006.

(4) Periods of Durability of the Planned Facilities

The planned facilities in the target three districts are categorized into four types; desalination plants, water transmission facilities, deep wells for fossil water, and dams. The water volume in the future is assumed to be kept getting the planned volume up to the end of the service lives of each facility, which were shown in the above table. The service life of the desalination plants (25 years) is shown in *2008 Annual Report for Operation & Maintenance*[4] of SWCC. And the same period was applied to the service lives of the water transmission facilities and the deep wells. Regarding the service life of dams, the standard periods of 50 years for fill dams and 80 years for concrete dams are decided in Japan. And 80 years was applied to the life of all proposed dams since almost all the dams were considered to be constructed by concrete.

1.2 Water Value of the Water Supply Plan

(1) The Financial Value of Water

The financial value of water in housing and industry is the tariff of water, which is decided in the National Water Strategy and confirmed through the National Water Company (NWC) in January 2010. It is recognized that actual tariff is about 0.10 - 0.15 SR/m^3 since the volume of most water users are less than 100 m^3/month. However, the weighted mean of water tariff was applied in the analysis as we could grasp the proportion of the water consumption amount in each band of the water tariff structure from the report of the World of Bank (WB). The next table shows the weighted mean of water tariff is 0.40 SR/m^3, using the proportion of each tariff band. This water price was applied to the financial water value, which could be obtained through the implementation of the water supply plan.

Table 1-2 Estimation of Weighted Mean of Water Tariff

m^3/month	Band	Price 1) (SR/m^3)	Proportion 2) (%)	Partial price (SR/m^3)
		A	B	a*b
< 50	A	0.10	60	0.06
50 – 100	B	0.15	25	0.04
100 – 200	C	2.00	15	0.30
200 – 300	D	4.00	-	-
> 300	E	6.00	-	-
Weighted mean of water tariff (Financial water price)				0.40

1) NWC, 2010

2) Estimation from Fig. Riyadh Residential Water Consumption and Tariff, *Proposal for a National Water Strategy*, June 2009, WB

(2) The Economic Value of Water

On the other hand, if the water development plan is not implemented, the most economical and realistic alternative way of developing water is the usage of desalination plants. The cost of desalinated water was estimated, using the practical data of SWCC and the conversion coefficient of inflation. The water production costs in the next table are the averages of all plants of SWCC in each year. In the annual report of SWCC, water transmission costs are indicated by the plants in the east

[4] Table of Remaining Life Time for SWCC Plants

coast, the plants in the west coast and the whole plants, hence the data of the west coast were applied to the estimation of the cost of desalinated water.

The total cost of the desalinated water is considered the social cost of water because desalination is the most economical way to develop water in the target regions, where the usage of ground water should be limited basically though the cost of usage of wells is lower than that of desalination. Therefore, 4.16 SR/m3 of the water price was multiplied by 120% of the conversion factor to the economic price and applied to the economic value of water in the economic analysis.

Table 1-3 Cost Estimation of Desalinated Water

Year	Conversion coefficient	Water production cost - SWCC plants (SR/CM)		Water transmission cost - West coast (SR/CM)		Total (SR/CM)
	A	B	c=a*b	D	e=a*d	f=c+e
2004	1.220	2.25	2.75	1.20	1.46	4.21
2005	1.212	2.35	2.85	1.19	1.44	4.29
2006	1.186	2.23	2.64	1.18	1.40	4.04
2007	1.139	2.27	2.58	1.33	1.51	4.10
2008	1.036	2.38	2.47	1.61	1.67	4.13
Average		2.30	2.66	1.30	1.50	4.16

Source: *2008 Annual Report for Operation & Maintenance*, SWCC

The grounds for the calculation of the project benefit are summarized in the next table.

Table 1-4 Grounds for the Calculation of the Project Benefit

Project Benefit	Unit Benefit	Remark	Source
Municipal water	0.40 SR/m^3	Financial value of water, weighted mean of water tariff	Proposal for a National Water Strategy by WB
Municipal water	4.99 SR/m^3	Economic value of water, estimated by the cost of desalination	Operation and maintenance report of SWCC

1.3 Cost of the Water Supply Plan

(1) Summary of the Project Cost

Necessary facility plan for the water supply was formulated, which were shown in the Table 1-1 and 1-2, and the project cost including the disbursement plan was proposed. The construction costs and the annual operation and maintenance costs of each facility are summarized in the next table. More than 60% of the construction cost is occupied by the water transmission facility. Adding the construction cost of the desalination plants to the cost of the transmission facilities, the proportion exceeds 75%. As for the operation and maintenance (O&M) cost, the desalination plant occupies more than 60% of the total cost. Adding the cost of the transmission facilities to the cost of the desalination plants, it exceeds 92% of the total annual cost.

Table 1-5 Summary of the Project Cost

Proposed Facilities	Al Baha (MSR)	Asir (MSR)	Jazan (MSR)	Three regions (MSR)	Proportion (%)
Construction Cost					
Desalination plant	134.4	322.0	337.4	793.8	12.0
Transmission facility	1,247.3	2,228.6	709.7	4,185.6	63.2
Deep well	-	647.9	-	647.9	9.8
Dam	456	151.9	381.9	989.9	15.0
Total	1,837.8	3,350.4	1,429.0	6,617.1	100.0
Annual O&M Cost					
Desalination plant	33.6	80.5	84.4	198.5	66.4
Transmission facility	17.0	49.5	10.6	77.2	25.8
Deep well	-	18.5	-	18.5	6.2
Dam	2.3	0.8	1.9	4.9	1.6
Total	52.9	149.2	96.9	299.0	100.0

The financial and economic costs are summarized in the next table.

Table 1-6 Financial and Economic Project Cost (MSR)

Project Cost	Construction Cost				Annual O&M Cost			
	Al Baha	Asir	Jazan	Total	Al Baha	Asir	Jazan	Total
Financial Cost	1,838	3,350	1,429	6,617	52.9	149.2	96.9	299.0
Economic Cost	2,205	4,020	1,715	7,941	63.5	179.0	116.3	358.8

(2) Disbursement Plan of the Project Cost

The construction period of proposed facilities was uniformly assumed to be five years before the commencement of the use of the facilities because most existing facilities in the water development field were constructed about five years. Then one fifth of the construction cost was appropriated equally for each year of the construction period. Annual O&M costs were estimated by the types of facilities, using the experimental ratio of O&M cost to the construction cost, and appropriated equally for each year during the periods of the service lives of the each facility.

1.4 Results of the Financial and Economic Analysis

(1) Result of the Financial Analysis

The financial analysis was carried out, applying the financial value of water to the benefit of the water supply plan. The B/C ratio discounted by 6.5% is 0.10. This result is caused by the low establishment of the water tariff as a matter of course. The water tariff should be raised about ten times of the current water price level if it covers the whole cost in the current tariff structure.

(2) Result of the Economic Analysis

Table 1-7 Result of the Economic Analysis

Indicators	Values
EIRR	6.8 %
B/C	1.02
Net Present Value	158 MSR

The Economic Internal Rate of Return (EIRR) was calculated at 6.8%. The standard of the discount rate in the water development sector is considered between 6 and 7%, approximately. Hence the proposed water supply plan could be evaluated feasible from the national economic aspect. This result means that the proposed water supply plan is one of the mixed models of desalinated, surface and ground water, which can be feasible even if the standard discount ratio is applied to them.

(3) Sensitivity Analysis

Sensitivity Analysis was carried out in two points of view; 1) Rising of the project cost (+10% and 20%), and 2) Changing of the conversion factors for the project benefit and cost. In the estimation of the project benefit, assuming that the cost proportion of the fuel to the desalination was increased to 15%, the conversion factor was set at 130% since the 15% of the desalinated water cost was tripled. (15% x 3 + 85%) Also, in the calculation of the project cost, assuming that the proportion of the fuel cost to the project cost was decreased to 5%, the conversion factor was set at 110%. (5% x 3 + 95%) The calculation results of the combination with these conditions are indicated in the next table.

Table 1-8 EIRR in Each Case (%)

Case	Conversion Factor		Project Cost		
	Cost	Benefit	+ 0 %	+ 10 %	+ 20 %
A	120	120	6.8	5.6	4.6
B	120	130	7.7	6.6	5.5
C	110	120	7.8	6.7	5.6
D	110	130	8.8	7.6	6.6

Case-A is the standard case, which shows that if the project cost raises by 10%, the EIRR becomes less

than 6%. Case-B is assumed that the cost proportion of the fuel to the desalination increases to 15% and the value of the developed water is multiplied by 130% (15% x 3 + 85%), which shows that even if the project cost raises by 10%, the EIRR is still more than 6% but if the project cost raises by 20%, the EIRR becomes less than 6%.

Case-C is assumed that the cost proportion of the fuel to the project cost decreases to 5% and the whole cost is multiplied by 110% (5% x 3 + 95%), which shows that even if the project cost raises by 10%, the EIRR is still more than 6% but if the project cost raises by 20%, the EIRR becomes less than 6% as well as the Case-B. Case-D is assumed that the cost proportion of the fuel to the desalination increases to 15% and the cost proportion of the fuel to the project cost decreases to 5%, which shows that even if the project cost raises by 20%, the EIRR is still more than 6%.

If the standard conversion factor of 120% (Case-A) conforms to the actual situation, it can be considered that the increase of the fuel cost in the desalination (Case-B and Case-D) is the case of the oil price rising, and the decrease of the fuel cost in the project cost (Case-C and Case-D) is the case of the reduction of oil use in the construction because of technical innovation for example.

(4) Water Value in Agriculture

The benefit in agriculture was not considered in the economic analysis since the necessity of the conversion of water sources from the groundwater to the surface water did not become clear in the proposed plan. If the necessity of the conversion of water sources becomes clear, the economic benefit can be estimated. The estimated value by each crop, which is indicated in the next table, will be applied to the evaluation of the irrigation projects. The financial benefits are the estimates of net annual farm income at market prices, and the economic benefits (water productivity) are the estimates of economic returns of water, which stems from the agricultural activities.

Table 1-9 Estimates of Net Annual Farm Income and Water Productivity

(SR/TCM)	Wheat	Alfalfa	Dates	Other fruits	Veget.	Milk	Other livestock	Total
Net income (Financial benefit)	107	60	1,695	388	217	449	9,835	611
Water productivity (Economic benefit)	-222	-116	1,443	266	87	-249	982	221

Source: *Economic Analysis of Irrigated Agriculture: The Water Perspective* , July 2006, WB