Appendices

Appendix-1
GIS Database Definition

CHAPTER 1 MAPINFO DATA

The GIS database had prepared by the JICA Study Team. GIS layers had developed in MapInfo format had 52 layers. Those layers were consisted as listed below:

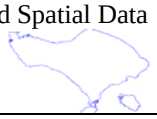
MapInfo Data

No.	Layer Name	Data Type	Number	Data Source	Notes
Public Administration					
1	Bali	polygon	1	MAP	boundary of Bali Province
2	Regency	polygon	10	MAP	boundary of regency (Penida islands are to be independent)
3	District	polygon	55	MAP	boundary of district
4	Village	polygon	687	MAP	boundary of village
5	Capital of Regency	point	9	MAP	location of capital of regency
6	Capital of District	point	55	MAP	location of capital of district
Topographical and Natural Condition					
7	Sub Basin	polygon	20	Study Team	boundary of sub-basin area (newly proposed)
8	Old Sub Basin	polygon	20	PU	boundary of old sub-basin area
9	River Basin	polygon	550	MAP	boundary of river basin area
10	Lakes	polygon	4	MAP	boundary of lakes
11	Springs	point	744	PU & Study Team	location of springs
12	Rivers	polyline	-	Landsat & MAP	centerline of rivers
13	Contours	polyline	-	MAP	over 200m: interval 12.5m under 200m: interval or 6.5m
14	Index Contour	polyline	-	MAP	main contour; interval 50m
15	Land use	polygon	-	Landsat	boundary of land use (17 categories)
16	Irrigation Area	polygon	-	Landsat	boundary of irrigation area abstracted from land use
17	Geology	polygon	-	GEO	boundary of geology (17 categories)
18	Hydrogeology	polygon	-	GEO	boundary of hydrogeology (7 categories)
19	Soil	polygon	-	AGR	boundary of soil (15 categories)
20	Isohyet	polyline	-	Study Team	isohyetal map (annual rainfall)
21	Natural Protect Area	polygon	-	HUT	boundary of natural protect area (4 categories)
Institutional Condition					
22	Existing Dams	polygon	4	PU	boundary of dam reservoir
23	Existing Dams Catchment Area	polygon	4	PU	boundary of dam catchment area
24	Wells	point	321	PU & Study Team	location of wells
25	Weirs	point	443	PU & Study Team	location of weirs
26	Hydrological station	point	42 (49)	PU	location of water level and discharge station(include 7 old stations)
27	Hydrological Catchment	polygon	44	Study Team	boundary of station's catchment area
28	Rainfall Station(PU)	point	32	PU	location of rainfall stations managed by PU
29	Rainfall Station(BMG)	point	104	BMG	location of rainfall stations managed by BMG
30	Meteorological Station(PU)	point	9	PU	location of meteorological stations managed by PU
31	Meteorological Station(BMG)	point	4	BMG	location of meteorological stations managed by BMG
32	Water Quality	point	81	PU & Study Team	location of water quality sampling point

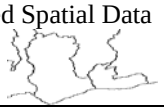
No.	Layer Name	Data Type	Number	Data Source	Notes
Transportation					
33	Roads	polyline	-	MAP	centerline of roads
34	Port	point	16	MAP	location of ports
35	Airport	point	1	MAP	location of airport
36	Bus terminal	point	6	MAP	location of bus terminals
History and Culture					
37	Historical place	point	9	MAP	location of historical place
38	Cultural facility	point	24	MAP	location of cultural facility
Disaster History					
39	Flood area	point	121	Study Team	location of flood area
40	Debris flow area	point	10	Study Team	location of debris flow area
41	Slope failure	point	6	Study Team	location of slope failure
42	Landslides	point	73	Study Team	location of landslides
Plan					
43	Proposed Dam	point	29	PU	location of proposed dam by PU
44	DamSite	point	2	Study Team	location of proposed dam by JICA Study Team
45	Reservoir Area	polygon	1	Study Team	boundary of Ayung dam reservoir area
46	AyungDamCacthmentArea	polygon	1	Study Team	boundary of Ayung dam catchment area
47	TerminalPoint	point	2	Study Team	location of water terminal point
48	Pipeline	polyline	2	Study Team	centerline of pipeline
49	Water Treatment Plant	point	3	Study Team	location of water treatment plant
50	River Improvement	polyline	10	Study Team	river improvement zone
Flood Simulation Model					
51	tArea	polygon	1	Study Team	flood simulation area for Badung, Mati river
52	Flood_Elv	point	1343	Study Team	elevation data for flood simulation model
Others					
53	Topographical map	raster	51	MAP & Study Team	scanned files (jpeg)
54	Grids	polygon	51	MAP	boundary of grids of topographical map

PU : Data provided by Public Works Service of Bali Province
HUT : Data provided by Forestry Service of Bali Province
BMG : Data provided by Meteorological and Geophysical Agency
MAP : Topographic map (scale 1:25,000) prepared by Survey Coordination and National Mapping Board
GEO : Reconnaissance hydrogeological map prepared by the Geological of Indonesia (scale 1:250,000 on 1972)
AGR : Soil map prepared by Ministry of Agriculture (scale 1:250,000 on 1970)
Study Team: Inventory survey or created by JICA Study Team
Landsat: Landsat7 on 2003

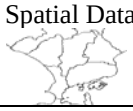
(1) Bali

Data Type	Boundary of Bali province		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	The object was presented as a region or polygon. Base color of boundary line was blue and there was no hatch pattern for the region.		
Table Name	Bali.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential no.
Code	Integer	15	No. Of Code = 51
Name	Character	30	Name of Province
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

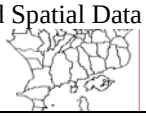
(2) Regency

Data Type	Boundary of regency		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	The objects were presented in region shape or polygon Base color of boundary line was black and no hatch pattern for the region.		
Table Name	Regency.tab		
Detailed info related to object			
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential no.
Code	Integer	15	Code No. Of Regency Code No. of province + Code No. of Regency
Name	Character	35	Regency name
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

(3) District

Data Type	Districts boundaries of Province of Bali		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	District data published by BPS		
Presented Spatial Data 	The objects were presented in region shape or polygon Base color of boundary line was black and no hatch pattern for the region		
Table Name	District.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential no.
Code	Integer	15	Code No. of district Code No. of province + Code No. of Regency + Code No. of district
Name	Character	35	District name
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

(4) Village

Data Type	Districts boundaries of Province of Bali		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	District data published by BPS		
Presented Spatial Data 	The objects were presented in region shape or polygon Base color of boundary line was black and no hatch pattern for the region		
Table Name	Village.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential no.
Code	Float	-	Code No. of village Code No. of province + Code No. of Regency + Code No. of district + Code No. of village
Name	Character	30	Village name
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

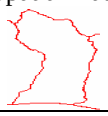
(5) Capital of Regency

Data Type	Object which shown as Regency major (capital city)		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	The objects were presented as a symbol and shown as a red circle with a star inside.		
Table Name	Capital of regency.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Integer	-	Code No. Of Regency Code No. of province + Code No. of Regency
Name	Character	30	Name of the city

(6) Capital of District

Data Type	Object which shown as district major (capital city)		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	-		
Table Name	Capital of District.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Integer	-	Code No. of district Code No. of province + Code No. of Regency + Code No. of district
Name	Character	30	District name

(7) Sub Basin

Data Type	Boundary of Basin unit division of Bali to be 20 sub basin		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Sub basin division analysis result of the JICA Study Team		
Presented Spatial Data 	The object was presented as a region or polygon with red boundary line and no hatch pattern for the region.		
Table Name	Sub basin.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	No. of Sub Basin Code
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit
RunoffDepth	Float	-	Average annual run off in mm unit
AnnualRainfall	Float	-	Average annual rainfall in mm unit

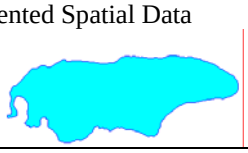
(8) Old Sub Basin

Data Type	Boundary of Basin unit division of Bali to be 20 sub basin		
Primary Data Source	provided by Public Works Service of Bali Province		
Supporting Data Sources	-		
Presented Spatial Data 	The object was presented as a region or polygon with red boundary line and no hatch pattern for the region.		
Table Name	Old Sub basin.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	No. of Sub Basin Code
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

(9) River Basin

Data Type	Catchment area of first order river		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	The catchment area of the first order river was done by the JICA Study Team		
Presented Spatial Data 	The object was presented as a region or polygon with black boundary line and no hatch pattern for the region.		
Table Name	River basin.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
River code	Decimal	11	No. of River basin code
Name	Character	40	Name of the river basin (follow the name of the first order river)
Area	Float	-	Area of the region in m2 unit

(10) Lakes

Data Type	Objects shown as lakes or reservoirs		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Reservoir data provided from sub Dinas Pengairan Dinas PU Bali		
Presented Spatial Data 	The object was presented as a region or polygon with blue boundary line and cyan solid color pattern for the region.		
Table Name	Lakes.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	20	The river basin name of the lakes or reservoirs
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

(11) Springs

Data Type	All objects shown as springs		
Primary Data Source	Springs data provided from Public Works Service of Bali Province		
Supporting Data Sources	Field visit and investigation using GPS by the JICA Study Team		
Presented Spatial Data 	The object was presented as a symbol using font of MapInfo Oil and Gas and the symbol was colored blue		
Table Name	Springs.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	10	-
Name	Character	31	Name of spring
Lat	Float	-	Latitude in degree unit
Long	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50) in m unit
Y	Float	-	Y Coordinate (UTM Zone 50) in m unit
Z	Float	-	Elevation from mean sea level-rata
SWS_Code	Character	10	Sub Basin Code No.
Desa_Code	Float	-	Village Code No.
Quantity	Float	-	Discharge in m3/sec unit
Quantity for Irrigation	Float	-	Amount of irrigation water demand in m3/sec unit
Quantity for PDAM	Float	-	Amount of drinking water by PDAM in m3/sec
Quantity for Other	Float	-	Amount of water demand for others needs in m3/sec unit
Village	Character	25	Name of village
District	Character	14	Name of district
Regency	Character	10	Name of Regency
O_M	Character	35	Operation and management responsibility
Present condition	Character	41	Current condition of spring
Notes	Character	91	Other notes about the spring
Data sources	Character	20	Data source used
Photograph	Character	21	Image (photo) file name

(12) Rivers

Data Type	All objects presented as river both continue or intermittence rivers		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	The river was presented in polyline. The continue river was presented as blue continues line. The intermittence river was presented as blue dashed line.		
Table Name	Rivers.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
Name	Character	100	River Name
Length_m	Float	-	River length in km unit
Sub basin	Character	20	Sub Basin Code No.
Main	Decimal	4	River flag (1: main river, 0: non main rever)
River_Code	Decimal	4	River Code No.

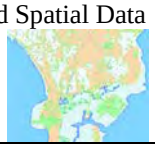
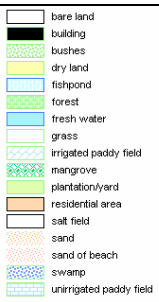
(13) Contours

Data Type	Contour line in 12.5 meter interval		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Update by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	contour.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Elevation	Float	-	Elevation from mean sea level in meter unit

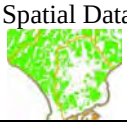
(14) Index Contours

Data Type	Contour line in 50 meter interval		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	-		
Table Name	Indx_contour.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Elevation	Float	-	Elevation from mean sea level in meter

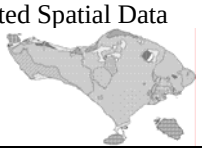
(15) Land Use

Data Type	Land use covered Bali island		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Landsat imagery ETM+7 2003 to revised land system		
Presented Spatial Data 	The object was presented as a polygon with hatch pattern follow the category name		
Table Name	Landuse.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit
Category	Character	35	

(16) Irrigation Area

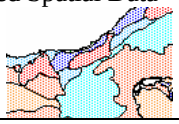
Data Type	Existing irrigation area covered Bali island		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Landsat imagery ETM+7 2003 to revised land system		
Presented Spatial Data 	The object was presented as a polygon with hatch pattern follow the category name		
Table Name	Irrigation area.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit
Category	Character	35	-

(17) Geology

Data Type	Geology pattern in Bali island		
Primary Data Source	Hydrogeology map 1972 published by the Geological of Indonesia		
Supporting Data Sources	-		
Presented Spatial Data 	The object was presented as a polygon with hatch pattern follow the category name		
Table Name	Geology.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit
Category	Character	160	-

Volcanics of old Buyan-Beratan volcano and old Batur volcano
Asah Formation : lavas, breccias, pumiceous tuffs with calcareous crack fillings
Seraya volcanics
Volcanics of present Mt. Batur
Alluvial Deposit
Selatan Formation : predominantly limestone
Ulakan Formation : volcanic breccias, lavas, tuffs with intercalations of calcareous material
Volcanic products of subrecent : Mt. Pohen, Mt. Sengayang, Mt. Lesung
Lavas of Pawon Parasitic cone
Volcanics products of Mt. Batukau
Volcanics products of Mt. Agung
Buyan-Beratan and Batur tuffs and lahar deposits
Palasari Formation : conglomerates, sandstones, reef limestones
Prapatagung Formation : limestones, calcareous sandstones, marls
Pulaki volcanics : lavas and breccias
Jembrana volcanics : lavas, breccias, tuffs of the volcanoes Kelatakan, Merbuk, Patas and associated rocks
Sorga Formation : tuffs, marls, sandstone

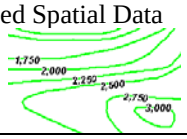
(18) Hydrogeology

Data Type	hydrogeology pattern boundary		
Primary Data Source	Hydrogeology map 1972 published by the Geological of Indonesia		
Supporting Data Sources	-		
Presented Spatial Data 	The object was presented as a polygon with hatch pattern follow the category name		
Table Name	Hidrogeology.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit
Category	Character	100	Locally large potential 10 l/sec Locally intermediate potential 5 l/sec Affected by seawater (salty) Locally very small potential 0.1 l/sec Locally small potential 0.5 l/sec Locally extremely small potential 0.1 l/sec„ karstic area or lava Locally rather small potential 1 l/sec

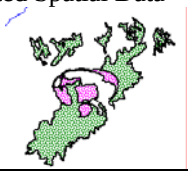
(19) Soil

Data Type	Soil categories in Bali Island		
Primary Data Source	Soil Map 1970 published by Ministry of Agriculture		
Supporting Data Sources	-		
Presented Spatial Data 	The object was presented as a polygon with hatch pattern follow the category name		
Table Name	Soil.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit
Category	Character	100	Yellowish Brown Regosol Grey Brown Regosol Hidromorf Aluvial Red Brown Mediteran Yellowish Brown Latosol Brown Regosol Humus Regosol Grey Regosol Grey Brown Aluvial Brown Latasol and Litosol Red Brown Latosol and Litosol Grey Brown Andosol Brown mediteran

(20) Isohyet

Data Type	Isohyetal contour line using yearly average rainfall		
Primary Data Source	Meteorological and Geophysical Agency		
Supporting Data Sources	Analysis by the JICA Study Team		
Presented Spatial Data 	Isohyetal line was presented as polyline colored in green line		
Table Name	Isohyet.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Prec	Integer	-	Yearly average rainfall in mm unit

(21) Nature Protect Area

Data Type	Boundary of natural protect area		
Primary Data Source	Forestry Service of Bali Province		
Supporting Data Sources	-		
Presented Spatial Data 	Object was presented as polygon and the hatch pattern will follow the category name Protected Forest Limited Production Forest Nature Reserve Fixed Production Forest		
Table Name	Nature protect area.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	Name of forest classification
Area	Decimal	20.2	Area of the region in km2 unit
Perimeter	Decimal	20.2	Perimeter of the region in km unit

(22) Existing Dams

Data Type	All reservoirs or dams which already constructed in Bali Province		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	-		
Table Name	Existing dams.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	30	Name of reservoir or dam
SWS code	Character	10	Sub basin code No of dam location
Desa code	Character	30	Village code No of dam location
Date	Character	4	Construction date
Type	Character	50	Type of reservoir or dam
Capacity	Float	-	Capacity of reservoir or dam
Purpose	Character	100	Purpose of reservoir or dam
Height	Float	-	Reservoir or dam height in meter unit
Crest length	Float	-	Crest length in meter unit
Crest elevation	Float	-	Crest height in meter unit
HWL	Float	-	High water level in meter unit
Catchment area	float	-	Catchment area of reservoir or dam in km2 unit

(23) Existing Dams Catchment Area

Data Type	Catchment area of the existing reservoirs or dams		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Contour layer with 12.5 meter interval		
Presented Spatial Data 	-		
Table Name	Catchment of Existing Dams.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	Name of reservoir or dam
Area	Float	-	Area of the region in km2 unit
Perimeter	Float	-	Perimeter of the region in km unit

(24) Wells

Data Type	Drilled wells constructed		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	Field survey by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Wells.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
No	Float	-	Sequential No.
Code	Character	8	Code No.
Name	Character	25	Name of well
Latitude	Float	-	Latitude in degree unit
Longitude	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Elevation from mean sea level in meter unit
SWS_Code	Character	10	Sub basin code No.
Desa_Code	Float	-	Village code No.
Type	Character	7	Type of well
Depth	Character	10	Depth of well in meter unit
Discharge	Character	6	Discharge of well in m3/sec unit
Power	Character	10	Energy source to operate
Year of constructed	Character	10	Construction year
Pump capacity	Character	10	Pump capacity in liter/sec unit
Pump Diameter	Character	10	Pump diameter in inch unit
Screen	Character	11	screen
Dia	Character	10	Screen diameter in meter unit
SWL	Character	11	Static water level in meter unit
Draw down	Character	10	Drown down in meter unit
PWL	Character	10	Pumping water level in meter unit
Sc L	Character	10	Specific Ssorage
T M2 day	Character	10	Transmissibility in m2/day unit
K m day	Character	10	Conductivity in m/day unit
EC ms	Character	10	Electric conductivity in ms unit
Village	Character	20	Name of village
District	Character	20	Name of district
Regency city	Character	10	Name of regency
O M	Character	15	Operation and management responsibility
Data sources	Character	21	Data sources

(25) Weirs

Data Type	All weirs had been constructed and build in Province of Bali		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	Field survey by the JICA Study Team		
Presented Spatial Data	-		
Table Name	Weirs.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
No	Float	-	Sequential No.
Code	Character	12	Code No.
Name	Character	28	Name of weir
Latitude	Float	-	Latitude in degree unit
Longitude	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Weir elevation from mean sea level in meter unit
SWS_Code	Character	10	Sub basin code No.
Desa_Code	Float	-	Village code No.
Type	Character	11	Type of weir
Irrigation System	Character	28	Irrigation system
Irrigated Area_Ha	Character	10	Irrigated area in hectare unit
Discharge m3/sec	Character	10	Discharge intake in m3/sec unit
Year_of_Constructed	Character	10	Construction year
River	Character	27	River name
Village	Character	20	Name of village
District	Character	12	Name of district
Weir Width	Character	10	Width of weir
Weir Height	Character	10	Height of weir
Weir Condition	Character	9	Current weir condition
Pier Width	Character	10	Width of pier
Pier Height	Character	10	Height of Pier
Qty	Character	7	Number of piers
Pier Condition	Character	7	Current condition of pier
Intake Width	Character	10	Width of intake
Intake Height	Character	10	Height of intake
Qty 2	Character	10	Number of intake
Intake Condition	Character	20	Current condition of intake
Flushing Width	Character	10	Width of flushing gate
Flushing Height	Character	10	Height of flushing gate
Qty 3	Character	10	Number of flushing gate
Flushing Condition	Character	17	Current condition of flushing gate
Stilling Basin	Character	17	Current condition of stilling basin
Notes	Character	62	Other important notes about weir
O & M	Character	6	Operation and management responsibility
Data Sources	Character	20	Data sources
Photograph	Character	26	Image (photo) file name

(26) Hydrological Station

Data Type	Hydrological monitoring station in Province of Bali		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	-		
Presented Spatial Data 	-		
Table Name	Hydrological station.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	25	Station code
Name	Character	50	Name of station
Latitude	Decimal	12.6	Latitude in degree unit
Longitude	Decimal	12.6	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Elevation of station in m unit
SWS code	Character	15	Sub basin code No.
Desa code	Character	15	Village code No.
Year	Character	10	Completion construction date
Catchment area	Decimal	12.6	Catchment area of station

(27) Hydrological Catchment

Data Type	Catchment area of hydrological monitoring station		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	Revised by the JICA Study Team		
Presented Spatial Data 	Object was presented as a region (polygon) with red colored boundary line with no pattern within		
Table Name	Hydrological catchment.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	20	Code number of station
Name	Character	50	Name of hydrological station
Area	Decimal	12.3	Area of the region in km2 unit
Perimeter	Decimal	12.3	Perimeter of the region in km unit

(28) Rainfall station (PU)

Data Type	Rainfall monitoring station operated by PU		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	Revised by the JICA Study Team		
Presented Spatial Data 	Object was presented as symbol and shown as a black circle with red diamond inside		
Table Name	Rainfall station (PU).tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	20	Code number of station
Name	Character	50	Name of rainfall monitoring station
Latitude	Float	-	Latitude in degree unit
Longitude	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Elevation in meter uint
SWS code	Character	10	Sub basin code No.
Desa code	Float	-	Village code No.
Year	Integer	-	Completed construction date

(29) Rainfall station (BMG)

Data Type	Rainfall monitoring station operated by BMG		
Primary Data Source	Meteorological and Geophysical Agency		
Supporting Data Sources	Revised by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Rainfall station (BMG).tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	20	Code No. of station
Name	Character	50	Name of rainfall monitoring station
Latitude	Float	-	Latitude in degree unit
Longitude	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Elevation in meter unit
SWS code	Character	10	Sub basin code No.
Desa Code	Float	-	Village code No.
Year	Character	4	Completed construction date

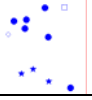
(30) Meteorological Station (PU)

Data Type	Meteorological monitoring station operated by PU		
Primary Data Source	Public Works Service of Bali Province i		
Supporting Data Sources	Revised by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Meteorological station (PU).tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	10	Code No. of station
Name	Character	25	Name of station
Latitude	Float	-	Latitude in degree unit
Longitude	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Elevation in meter unit
SWS code	Character	10	Sub basin code No.
Desa code	Character	15	Village code No.
Year	Integer	-	Completed construction date

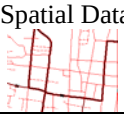
(31) Meteorological Station (BMG)

Data Type	Meteorological monitoring station operated by Meteorological and Geophysical Agency		
Primary Data Source	Meteorological and Geophysical Agency		
Supporting Data Sources	Revised by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Meteorological station (BMG). Tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	10	Code No. of station
Name	Character	25	Name of station
Latitude	Float	-	Latitude in degree unit
Longitude	Float	-	Longitude in degree unit
X	Float	-	X Coordinate (UTM Zone 50)
Y	Float	-	Y Coordinate (UTM Zone 50)
Z	Float	-	Elevation in meter unit
SWS code	Character	10	Sub basin code No.
Desa code	Character	15	Village code No.
Year	Integer	-	Completed construction date

(32) Water Quality

Data Type	Water quality monitoring station in Bali Island		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	Update by the JICA Study Team		
Presented Spatial Data 			
Table Name	Water quality.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	Name of monitoring station
Type	Character	20	Type of station (river, lake, well, and spring)
Latitude	Decimal	20.2	Latitude in degree unit
Longitude	Decimal	20.2	Longitude in degree unit
X	Decimal	20.2	X Coordinate (UTM Zone 50)
Y	Decimal	20.2	Y Coordinate (UTM Zone 50)
Z	Decimal	20.2	Elevation in meter unit
SWS code	Integer	-	Sub basin code No.
Desa code	Integer	-	Village code No.

(33) Roads

Data Type	Road and street network in Province of Bali		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	Landsat ETM+7 imagery year 2003		
Presented Spatial Data 	Airport road, province road, regency road, village road, ring road, tunnel, other road, foot steps		
Table Name	Road.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Category	Character	50	Road category name
Name	Character	100	Name of street
Length	Decimal	20.2	Road length in meter unit

(34) Port

Data Type	Port in Bali		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	Object was presented as symbol in red color		
Table Name	Port.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	Name of port

(35) Airport

Data Type	Airport in Bali		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	Object was presented as symbol in red colored		
Table Name	Airport.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	Name of airport

(36) Bus terminal

Data Type	Bus terminal in Bali		
Primary Data Source	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Supporting Data Sources	-		
Presented Spatial Data 	Object was presented as symbol in red colored		
Table Name	Bus terminal.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	40	Name of Bus Terminal

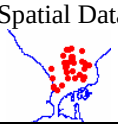
(37) Historical Place

Data Type	Historical place in Bali		
Primary Data Source	Bali Map, CV. Indo Prima Sarana		
Supporting Data Sources	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Presented Spatial Data 	-		
Table Name	Historical place.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	100	Name of historical place

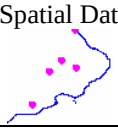
(38) Cultural Facility

Data Type	Cultural facility in Bali		
Primary Data Source	Bali Map, CV. Indo Prima Sarana		
Supporting Data Sources	Topographic Map 1:25.000 1999 – 2003 published by Survey Coordination and National Mapping Board		
Presented Spatial Data 	-		
Table Name	Cultural facility.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	100	Name of cultural facility

(39) Flood area

Data Type	Flood in Bali over the last twenty years		
Primary Data Source	Bali Water Resources Development and Management Project, Newspaper Bali Post 1980 - 2004		
Supporting Data Sources	Field visit and site inspection by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Flood area.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Date	Date	50	Flood date
Flood area	Character	254	Name of flood village

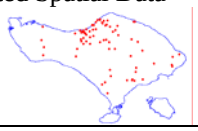
(40) Debris flow area

Data Type	Debris flow in Bali over the last twenty years		
Primary Data Source	Bali Water Resources Development and Management Project, Newspaper Bali Post 1980 - 2004		
Supporting Data Sources	Field visit and site inspection by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Debris flow area.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Date	Date	50	Debris flow date
Debris flow area	Character	254	Name of debris flow village

(41) Slope failure

Data Type	Slope failure in Bali over the last twenty years		
Primary Data Source	Bali Water Resources Development and Management Project, Newspaper Bali Post 1980 - 2004		
Supporting Data Sources	Field visit and site inspection by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Slope failure.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Date	Date	50	Slope failure event date
Slope failure	Character	254	Name village with slope failure

(42) Landslides

Data Type	Slope failure events in Bali over the last twenty years		
Primary Data Source	Bali Water Resources Development and Management Project, Newspaper Bali Post 1980 - 2004		
Supporting Data Sources	Field visit and site inspection by the JICA Study Team		
Presented Spatial Data 	-		
Table Name	Landslide.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Date	Date	50	landslide event date
Landslide	Character	254	Name of landslided Village

(43) Proposed Dam

Data Type	Reservoirs or dams that were proposed to be constructed		
Primary Data Source	Public Works Service of Bali Province		
Supporting Data Sources	Field inspection by GPS		
Presented Spatial Data ●	Object was presented as a symbol using font of MapInfo Symbol colored in red		
Table Name	Proposed dam.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	50	Name of proposed reservoirs or dams
Village	Character	50	Name of village
District	Character	50	Name of district
Regency	Character	50	Name of regency
River	Character	60	River name
Catchment area	Decimal	20.2	Catchment area of proposed dam in km2 unit
Rainfall station	Character	100	Name of rainfall station within
Average rainfall	Decimal	20.2	Mean rainfall in mm unit
Q average year	Decimal	20.2	Mean discharge in m3/sec unit
Height	Decimal	10.2	Proposed height of reservoirs or dams in m unit
Capacity	Decimal	20.2	Proposed capacity in m3/sec unit
Purpose	Character	70	Purpose
Topograpich elev max	Decimal	20.2	Maximum elevation in m unit
River bad elevation	Decimal	20.2	River bed elevation in m unit
I average	Decimal	20.3	Mean river slope

(44) DamSite

Data Type	Dam site proposed by the JICA Study Team		
Primary Data Source	The JICA Study Team		
Supporting Data Sources	-		
Presented Spatial Data ★	-		
Table Name	DamSite.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Name	Character	254	Dam name

(45) Reservoir Area

Data Type	Ayung dam reservoir area		
Primary Data Source	The JICA Study Team		
Supporting Data Sources	-		
Presented Spatial Data 	-		
Table Name	ReservoirArea.TAB		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Elevation	Float	-	Elevation in m unit

(46) Ayung Dam Catchment Area

Data Type	Ayung dam catchment area
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data	-
Table Name	AyungDamCacthmentArea.TAB
Detailed info related to object	-

(47) Terminal Point

Data Type	Terminal point of water supply pipeline
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data ★	-
Table Name	TerminalPoint.TAB
Detailed info related to object	-

(48) Pipeline

Data Type	Water supply pipeline
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data	-
Table Name	Pileline.TAB
Detailed info related to object	-

(49) Water Treatment Plant

Data Type	Water treatment plant
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data ★	-
Table Name	WaterTreatmentPlant.TAB
Detailed info related to object	-

(50) River Improvement

Data Type	River improvement section
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data	-
Table Name	RiverImprovement.TAB
Detailed info related to object	-

(51) tArea

Data Type	Flood simulation area for Badung and Mati river
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data	-
Table Name	tArea.TAB
Detailed info related to object	-

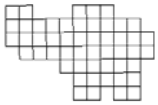
(52) Flood_Elv

Data Type	Elevation model of flood simulation for Badung and Mati river
Primary Data Source	The JICA Study Team
Supporting Data Sources	-
Presented Spatial Data	-
Table Name	Flood_Elv.TAB
Detailed info related to object	-

(53) Topographical map

Data Type	Raster map by scanned and geo-referenced to the UTM projection
Primary Data Source	Raster map from Topographic map 1:25.000 scale edition 1999 - 2003
Supporting Data Sources	-
Presented Spatial Data	
Table Name	Topographical map.tab
Detailed info related to object	-

(54) Grids

Data Type	Grid of coordinate system		
Primary Data Source	Prepared by the JICA Study Team		
Supporting Data Sources	-		
Presented Spatial Data 	-		
Table Name	Grid.tab		
Detailed info related to object	-		
Data Attribute Name	Field Type	Width	Notes
ID	Integer	-	Sequential No.
Code	Character	10	Grid Code No.
Name	Character	15	Grid name
X1	Float	-	Lower left corner X Coordinate (UTM Zone 50)
Y1	Float	-	Lower left corner Y Coordinate (UTM Zone 50)
X 2	Float	-	Upper right corner X Coordinate (UTM Zone 50)
Y 2	Float	-	Upper right corner Y Coordinate (UTM Zone 50)

CHAPTER 2 MS-ACCESS DATA

The database of Microsoft Access file format is 2 files, observational data and water balance parameter data (socio-economic data, irrigation data and water balance system data).

Ms-Access Data

No.	Table Name	Data Source	Notes
Observational data			
1	Hydrological Data	PU	daily discharge and water level from 1968 to 2003
2	Meteorological Data (BMG)	BMG	daily rainfall, temperature, evapotranspiration, wind from 1961 to 2003
3	Meteorological Data (PU)	PU	daily temperature, evapotranspiration, wind from 1993 to 2003
4	Water Quality	PU & Study Team	BOD, COD, Ph, temperature and so on
5	Subak	PU & Study Team	Subak list
Socio-economic data			
6	Population	Study Team	population by regencies and Nusa Penida
7	Domestic Unit Consumption	Study Team	domestic water unit consumption by regencies and Nusa Penida
8	CMRatio	Study Team	ratio to domestic water demand
9	Industrial Output	Study Team	industrial output by regencies and Nusa Penida
10	Industry Unit Consumption	Study Team	industry water unit consumption by regencies and Nusa Penida
11	Hotel Room	Study Team	hotel rooms by regencies and Nusa Penida
12	Hotel Unit Consumption	Study Team	hotel water unit consumption by regencies and Nusa Penida
13	Served Ratio	Study Team	public water served ratio by regencies and Nusa Penida
14	Leakage Ratio	Study Team	leakage ratio by regencies and Nusa Penida
Irrigation data			
15	Irrigation Area	Study Team	irrigation area by regencies
16	Crop Pattern	Study Team	crop Pattern by regencies
17	Crop coefficient	Study Team	crop Pattern by regencies and crops
18	Effective Rainfall	Study Team	effective Rainfall by regencies
19	Evapotranspiration	Study Team	crop evapotranspiration by regencies
20	Irrigation others	Study Team	other data for irrigation water demand parameter
Water Balance System			
21	C_DemandArea	Study Team	code number of regencies and Nusa Penida
22	C_PlanDemandArea	Study Team	code number of public water service area
23	C_Regency	Study Team	code number of regencies
24	Water Potential	Study Team	water potential by sub-basins
25	Supply Plan	Study Team	public water supply planning data by public water service area
26	Irrigation Area Ratio	Study Team	irrigation area ratio by regencies and sub-basins

PU : Data provided by Public Works Service of Bali Province
BMG : Data provided by Meteorological and Geophysical Agency
Study Team: Inventory survey or created by the JICA Study Team

(1) Hydrological data

Field Nama	Field Type	Unit	Notes
SerNo	Long	-	Sequential No.
Code	Text	-	Hydrological station code no.
ObsDate	Date	-	Data of observation
Discharge	Float	m3/sec	Daily Mean river discharge
WL	Float	m	Daily mean river water level

(2) Meteorological data (BMG)

Field Nama	Field Type	Unit	Notes
SerNo	Long	-	Sequential No.
Code	Text	-	Meteorological station code no.
ObsDate	Date	-	Data of observation
Rain	Float	mm	Daily rainfall (mm)
Temp 07	Float	° C	Temperature at 07.00
Temp 13	Float	° C	Temperature at 13.00
Temp 18	Float	° C	Temperature at 18.00
Temp AV	Float	° C	Mean daily temperature
Temp Max	Float	° C	Maximum daily temperature
Temp Min	Float	° C	Minimum daily temperature
SS	Float	%	Percentage of solar radiation
Ev	Float	mm	Mean daily evaporation
PP	Float	mmHg	Mean daily pressure
RH 07	Float	mmHg	Humidity pressure at 07.00
RH 13	Float	mmHg	Humidity pressure at 13.00
RH 18	Float	mmHg	Humidity pressure at 18.00
RH AV	Float	mmHg	Mean humidity per hour
Wind AV	Float	km/hour	Mean wind velocity
		-	Mean wind direction
Wind Max	Float	km/hour	Maximum wind velocity
		-	Direction of maximum wind velocity

(3) Meteorological data (PU)

Field Nama	Field Type	Unit	Notes
SerNo	Long	-	Sequential No.
Code	Text	-	Meteorological station code no.
ObsDate	Date	-	Data of observation
Temp 07	Float	° C	Temperature at 07.00
Temp 13	Float	° C	Temperature at 13.00
Temp 18	Float	° C	Temperature at 18.00
Temp AV	Float	° C	Mean daily temperature
Temp Max	Float	° C	Maximum daily temperature
Temp Min	Float	° C	Minimum daily temperature
SS	Float	%	Percentage of solar radiation
Ev	Float	mm	Mean daily evaporation
PP	Float	mmHg	Mean daily pressure
RH 07	Float	mmHg	Humidity pressure at 07.00
RH 13	Float	mmHg	Humidity pressure at 13.00
RH 18	Float	mmHg	Humidity pressure at 18.00
RH AV	Float	mmHg	Mean humidity per hour
Wind AV	Float	km/hour	Mean wind velocity
		-	Mean wind direction
Wind Max	Float	km/hour	Maximum wind velocity
		-	Direction of maximum wind velocity

(4) Water quality

Field Name	Field Type	Unit	Note
SerNo	Long	-	Sequential No.
Code	Text	-	Water quality monitoring station code no.
ObsDate	Date	-	Data of observation
Temperature	Float	° C	-
Ph	Float	-	-
Ph class	Text	-	Estimation*
Electric Conductivity	Float	-	-
Electric Conductivity class	Text	-	Estimation*
DO	Float	Mg/L	-
DO class	Text	-	Estimation*
KMnO4	Float	Mg/L	-
KMnO4 class	Text	-	Estimation*
Turbidity	Float	Mg/L	-
Turbidity class	Text	-	Estimation*
COD	Float	Mg/L	-
COD class	Text	-	Estimation*
BOD	Float	Mg/L	-
BOD class	Text	-	Estimation*
NO3	Float	Mg/L	-
NO3 class	Text	-	Estimation*
NO2	Float	Mg/L	-
NO2 class	Text	-	Estimation*
SS	Float	Mg/L	-
SS class	Text	-	Estimation*
TDS	Float	Mg/L	-
TDS class	Text	-	Estimation*
CN	Float	Mg/L	-
CN class	Text	-	Estimation*
T-N	Float	Mg/L	-
T-N class	Text	-	Estimation*
T-P	Float	Mg/L	-
T-P class	Text	-	Estimation*
CL	Float	Mg/L	-
CL class	Text	-	Estimation*
NH3	Float	Mg/L	-
NH3 class	Text	-	Estimation*
TSS	Float	-	-
TSS class	Text	-	Estimation*
Phosphate	Float	-	-
Phosphate class	Text	-	Estimation*
Bactery E Coli	Float	-	-
Bactery E Coli class	Text	-	Estimation*
Coliform	Float	MPN	-
Coliform class	Text	-	Estimation*
Cd	Float	Mg/L	-
Cd class	Text	-	Estimation*
Cr	Float	Mg/L	-
Cr class	Text	-	Estimation*
Hg	Float	Mg/L	-
Hg class	Text	-	Estimation*
Cu	Float	Mg/L	-
Cu class	Text	-	Estimation*
NI	Float	-	-
NI class	Text	-	Estimation*
Zn	Float	Mg/L	-
Zn class	Text	-	Estimation*
Mn	Float	Mg/L	-

Field Name	Field Type	Unit	Note
Mn class	Text	-	Estimation*
Pb	Float	Mg/L	-
Pb class	Text	-	Estimation*
Fe Total	Float	Mg/L	-
Fe Total class	Text	-	Estimation*
AS	Float	Mg/L	-
AS class	Text	-	Estimation*
Drop Fe	Float	-	-
Drop Fe class	Text	-	Estimation*
Number of Parameter	Float	-	-
Class A	Text	-	-
Frequency	Float	-	-
Class B	Text	-	-
Frequency	Float	-	-
Class C	Text	-	-
Frequency	Float	-	-
Class D	Text	-	-
Frequency	Float	-	-

Estimation*) A: water that can be used for drinking directly without treatment, B: water that can be used for drinking with treatment, C: water that can be used only for fishery, livestock and irrigation, D: water that can be used for irrigation

(5) Subak

Field Name	Field Type	Unit	Note
SerNo	Long	-	Sequential No.
Subak Name	Text	-	Name of Subak
Irrigation Area	Float	ha	Irrigated Area
Pesedahan	Text	-	Traditional administration system on water use within certain area of river or Regency
District Name	Text	-	Name of District
District Code	Long	-	District Code No.

(6) Population

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Year	Integer	-	Year
Jembrana	Long	person	Population in Jembrana
Tabanan	Long	person	Population in Tabanan
Badung(PDAM)	Long	person	Population in Badung(PDAM)
Badung(PTTB)	Long	person	Population in Badung(PTTB)
Gianyar	Long	person	Population in Gianyar
Klungkung	Long	person	Population in Klungkung excluded Nusa Penida
Nusa Penida	Long	person	Population in Nusa Penida
Bangli	Long	person	Population in Bangli
Karangasem	Long	person	Population in Karangasem
Buleleng	Long	person	Population in Buleleng
Denpasar	Long	person	Population in Denpasar

(7) Domestic Unit Consumption

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Category	Text	-	P: public water supply user N: non-public water supply user
Year	Integer	-	Year
Jembrana	Integer	liter/capita/day	Domestic water unit consumption in Jembrana
Tabanan	Integer	liter/capita/day	Domestic water unit consumption in Tabanan
Badung(PDAM)	Integer	liter/capita/day	Domestic water unit consumption in Badung(PDAM)
Badung(PTTB)	Integer	liter/capita/day	Domestic water unit consumption in Badung(PTTB)
Gianyar	Integer	liter/capita/day	Domestic water unit consumption in Gianyar
Klungkung	Integer	liter/capita/day	Domestic water unit consumption in Klungkung excluded Nusa Penida
Nusa Penida	Integer	liter/capita/day	Domestic water unit consumption in Nusa Penida
Bangli	Integer	liter/capita/day	Domestic water unit consumption in Bangli
Karangasem	Integer	liter/capita/day	Domestic water unit consumption in Karangasem
Buleleng	Integer	liter/capita/day	Domestic water unit consumption in Buleleng
Denpasar	Integer	liter/capita/day	Domestic water unit consumption in Denpasar

(8) CMRatio

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Year	Integer	-	Year
Jembrana	Single	-	Ratio to domestic water demand in Jembrana
Tabanan	Single	-	Ratio to domestic water demand in Tabanan
Badung(PDAM)	Single	-	Ratio to domestic water demand in Badung(PDAM)
Badung(PTTB)	Single	-	Ratio to domestic water demand in Badung(PTTB)
Gianyar	Single	-	Ratio to domestic water demand in Gianyar
Klungkung	Single	-	Ratio to domestic water demand in Klungkung excluded Nusa Penida
Nusa Penida	Single	-	Ratio to domestic water demand in Nusa Penida
Bangli	Single	-	Ratio to domestic water demand in Bangli
Karangasem	Single	-	Ratio to domestic water demand in Karangasem
Buleleng	Single	-	Ratio to domestic water demand in Buleleng
Denpasar	Single	-	Ratio to domestic water demand in Denpasar

(9) Industry Output

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Year	Integer	-	Year
Jembrana	Long	rupiah	Industry output in Jembrana
Tabanan	Long	rupiah	Industry output in Tabanan
Badung(PDAM)	Long	rupiah	Industry output in Badung(PDAM)
Badung(PTTB)	Long	rupiah	Industry output in Badung(PTTB)
Gianyar	Long	rupiah	Industry output in Gianyar
Klungkung	Long	rupiah	Industry output in Klungkung excluded Nusa Penida
Nusa Penida	Long	rupiah	Industry output in Nusa Penida
Bangli	Long	rupiah	Industry output in Bangli
Karangasem	Long	rupiah	Industry output in Karangasem
Buleleng	Long	rupiah	Industry output in Buleleng
Denpasar	Long	rupiah	Industry output in Denpasar

(10) Industry Unit Consumption

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Year	Integer	-	Year
Jembrana	Single	m^3 /million rupiah/day	Industry water unit consumption in Jembrana
Tabanan	Long	m^3 /million rupiah/day	Industry water unit consumption in Tabanan
Badung(PDAM)	Long	m^3 /million rupiah/day	Industry water unit consumption in Badung(PDAM)
Badung(PTTB)	Long	m^3 /million rupiah/day	Industry water unit consumption in Badung(PTTB)
Gianyar	Long	m^3 /million rupiah/day	Industry water unit consumption in Gianyar
Klungkung	Long	m^3 /million rupiah/day	Industry water unit consumption in Klungkung excluded Nusa Penida
Nusa Penida	Long	m^3 /million rupiah/day	Industry water unit consumption in Nusa Penida
Bangli	Long	m^3 /million rupiah/day	Industry water unit consumption in Bangli
Karangasem	Long	m^3 /million rupiah/day	Industry water unit consumption in Karangasem
Buleleng	Long	m^3 /million rupiah/day	Industry water unit consumption in Buleleng
Denpasar	Long	m^3 /million rupiah/day	Industry water unit consumption in Denpasar

(11) Hotel Room

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Category	Text	-	S: star hotel N: non-star hotel
Year	Integer	-	Year
Jembrana	Long	room	Hotel room number in Jembrana
Tabanan	Long	room	Hotel room number in Tabanan
Badung(PDAM)	Long	room	Hotel room number in Badung(PDAM)
Badung(PTTB)	Long	room	Hotel room number in Badung(PTTB)
Gianyar	Long	room	Hotel room number in Gianyar
Klungkung	Long	room	Hotel room number in Klungkung excluded Nusa Penida
Nusa Penida	Long	room	Hotel room number in Nusa Penida
Bangli	Long	room	Hotel room number in Bangli
Karangasem	Long	room	Hotel room number in Karangasem
Buleleng	Long	room	Hotel room number in Buleleng
Denpasar	Long	room	Hotel room number in Denpasar

(12) Hotel Unit Consumption

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Category	Text	-	S: star hotel N: non-star hotel
Year	Integer	-	Year
Jembrana	Single	m^3 /room/day	Hotel water unit consumption in Jembrana
Tabanan	Single	m^3 /room/day	Hotel water unit consumption in Tabanan
Badung(PDAM)	Single	m^3 /room/day	Hotel water unit consumption in Badung(PDAM)
Badung(PTTB)	Single	m^3 /room/day	Hotel water unit consumption in Badung(PTTB)
Gianyar	Single	m^3 /room/day	Hotel water unit consumption in Gianyar
Klungkung	Single	m^3 /room/day	Hotel water unit consumption in Klungkung excluded Nusa Penida
Nusa Penida	Single	m^3 /room/day	Hotel water unit consumption in Nusa Penida
Bangli	Single	m^3 /room/day	Hotel water unit consumption in Bangli
Karangasem	Single	m^3 /room/day	Hotel water unit consumption in Karangasem
Buleleng	Single	m^3 /room/day	Hotel water unit consumption in Buleleng
Denpasar	Single	m^3 /room/day	Hotel water unit consumption in Denpasar

(13) Served Ratio

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Category	Text	-	D: domestic water demand C: commercial and other water demand I: industry water demand H: star hotel water demand N: non-star hotel water demand
Year	Integer	-	Year
Jembrana	Single	-	Public water coverage ratio in Jembrana
Tabanan	Single	-	Public water coverage ratio in Tabanan
Badung(PDAM)	Single	-	Public water coverage ratio in Badung(PDAM)
Badung(PTTB)	Single	-	Public water coverage ratio in Badung(PTTB)
Gianyar	Single	-	Public water coverage ratio in Gianyar
Klungkung	Single	-	Public water coverage ratio in Klungkung excluded Nusa Penida
Nusa Penida	Single	-	Public water coverage ratio in Nusa Penida
Bangli	Single	-	Public water coverage ratio in Bangli
Karangasem	Single	-	Public water coverage ratio in Karangasem
Buleleng	Single	-	Public water coverage ratio in Buleleng
Denpasar	Single	-	Public water coverage ratio in Denpasar

(14) Leakage Ratio

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Year	Integer	-	Year
Jembrana	Single	-	Leakage ratio in Jembrana
Tabanan	Single	-	Leakage ratio in Tabanan
Badung(PDAM)	Single	-	Leakage ratio in Badung(PDAM)
Badung(PTTB)	Single	-	Leakage ratio in Badung(PTTB)
Gianyar	Single	-	Leakage ratio in Gianyar
Klungkung	Single	-	Leakage ratio in Klungkung excluded Nusa Penida
Nusa Penida	Single	-	Leakage ratio in Nusa Penida
Bangli	Single	-	Leakage ratio in Bangli
Karangasem	Single	-	Leakage ratio in Karangasem
Buleleng	Single	-	Leakage ratio in Buleleng
Denpasar	Single	-	Leakage ratio in Denpasar

(15) Irrigation Area

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Year	Integer	-	Year
Jembrana	Long	ha	Irrigation area in Jembrana
Tabanan	Long	ha	Irrigation area in Tabanan
Badung	Long	ha	Irrigation area in Badung
Gianyar	Long	ha	Irrigation area in Gianyar
Klungkung	Long	ha	Irrigation area in Klungkung
Bangli	Long	ha	Irrigation area in Bangli
Karangasem	Long	ha	Irrigation area in Karangasem
Buleleng	Long	ha	Irrigation area in Buleleng
Denpasar	Long	ha	Irrigation area in Denpasar

(16) Crop Pattern

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
RegCode	Integer	-	Regency code number
CropNo	Integer	-	Serial number for crop pattern by regency
Pattern	Text	-	Crop pattern name
AR2005	Single	-	crop area ratio to total irrigation area in 2005
AR2010	Single	-	crop area ratio to total irrigation area in 2010
AR2015	Single	-	crop area ratio to total irrigation area in 2015
AR2020	Single	-	crop area ratio to total irrigation area in 2020
AR2025	Single	-	crop area ratio to total irrigation area in 2025

(17) Crop coefficient

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
RegCode	Integer	-	Regency code number
CropCode	Integer	-	Serial number for crop pattern by regency
PtnCode	Integer	-	Serial number
Jan1	Single	-	Crop coefficient in first half of January
Jan2	Single	-	Crop coefficient in latter half of January
Feb1	Single	-	Crop coefficient in first half of February
Feb2	Single	-	Crop coefficient in latter half of February
Mar1	Single	-	Crop coefficient in first half of March
Mar2	Single	-	Crop coefficient in latter half of March
Apr1	Single	-	Crop coefficient in first half of April
Apr2	Single	-	Crop coefficient in latter half of April
May1	Single	-	Crop coefficient in first half of May
May2	Single	-	Crop coefficient in latter half of May
Jun1	Single	-	Crop coefficient in first half of June
Jun2	Single	-	Crop coefficient in latter half of June
Jul1	Single	-	Crop coefficient in first half of July
Jul2	Single	-	Crop coefficient in latter half of July
Aug1	Single	-	Crop coefficient in first half of August
Aug2	Single	-	Crop coefficient in latter half of August
Sep1	Single	-	Crop coefficient in first half of September
Sep2	Single	-	Crop coefficient in latter half of September
Oct1	Single	-	Crop coefficient in first half of October
Oct2	Single	-	Crop coefficient in latter half of October
Nov1	Single	-	Crop coefficient in first half of November
Nov2	Single	-	Crop coefficient in latter half of November
Dec1	Single	-	Crop coefficient in first half of December
Dec2	Single	-	Crop coefficient in first half of December

*) in case that crop coefficient value is -9, the term is land preparation for paddy field.

(18) Effective Rainfall

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
RegCode	Integer	-	Regency code number
Jan	Single	mm/day	Effective rainfall in January
Feb	Single	mm/day	Effective rainfall in February
Mar	Single	mm/day	Effective rainfall in March
Apr	Single	mm/day	Effective rainfall in April
May	Single	mm/day	Effective rainfall in May
Jun	Single	mm/day	Effective rainfall in June
Jul	Single	mm/day	Effective rainfall in July
Aug	Single	mm/day	Effective rainfall in August
Sep	Single	mm/day	Effective rainfall in September
Oct	Single	mm/day	Effective rainfall in October
Nov	Single	mm/day	Effective rainfall in November
Dec	Single	mm/day	Effective rainfall in December

(19) Evapotranspiration

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
RegCode	Integer	-	Regency code number
Jan	Single	mm/day	Evapotranspiration in January
Feb	Single	mm/day	Evapotranspiration in February
Mar	Single	mm/day	Evapotranspiration in March
Apr	Single	mm/day	Evapotranspiration in April
May	Single	mm/day	Evapotranspiration in May
Jun	Single	mm/day	Evapotranspiration in June
Jul	Single	mm/day	Evapotranspiration in July
Aug	Single	mm/day	Evapotranspiration in August
Sep	Single	mm/day	Evapotranspiration in September
Oct	Single	mm/day	Evapotranspiration in October
Nov	Single	mm/day	Evapotranspiration in November
Dec	Single	mm/day	Evapotranspiration in December

(20) Irrigation Others

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
LandPrp	Single	mm/day	Land preparation water for paddy field
Sploss	Single	mm/day	Seepage loss
Efficiency	Single	-	Irrigation efficiency
Replacement	Single	mm/day	Water layer replacement

(21) C_DemandArea

Field Name	Field Type	Unit	Note
RegCode	Long	-	Demand area code number
Regency	Text	-	Demand area name

(22) C_PlanDemandArea

Field Name	Field Type	Unit	Note
RegCode	Long	-	Public water service area code number
Regency	Text	-	Public water service area name

(23) C_Regency

Field Name	Field Type	Unit	Note
RegCode	Long	-	Regency code number
Regency	Text	-	Regency name

(24) WaterPotential

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
Code	Long	-	Sub-basin code number
SWN	Double	million m^3 /year	Surface water potential in normal year by sub-basin
SWD	Double	million m^3 /year	Surface water potential in drought year by sub-basin
GW	Double	million m^3 /year	Groundwater potential by sub-basin

(25) Supply Plan

Field Name	Field Type	Unit	Note
PrjNo	Long	-	Project number for Water Balance System
SNO	Long		Serial number
AreaCode	Integer		Public water supply service area code
Item	Text		Public water supply system name
2005	Integer	liter/sec	Public water supply volume in 2005
2006	Integer	liter/sec	Public water supply volume in 2006
2007	Integer	liter/sec	Public water supply volume in 2007
2008	Integer	liter/sec	Public water supply volume in 2008
2009	Integer	liter/sec	Public water supply volume in 2009
2010	Integer	liter/sec	Public water supply volume in 2010
2011	Integer	liter/sec	Public water supply volume in 2011
2012	Integer	liter/sec	Public water supply volume in 2012
2013	Integer	liter/sec	Public water supply volume in 2013
2014	Integer	liter/sec	Public water supply volume in 2014
2015	Integer	liter/sec	Public water supply volume in 2015
2016	Integer	liter/sec	Public water supply volume in 2016
2017	Integer	liter/sec	Public water supply volume in 2017
2018	Integer	liter/sec	Public water supply volume in 2018
2019	Integer	liter/sec	Public water supply volume in 2019
2020	Integer	liter/sec	Public water supply volume in 2020
2021	Integer	liter/sec	Public water supply volume in 2021
2022	Integer	liter/sec	Public water supply volume in 2022
2023	Integer	liter/sec	Public water supply volume in 2023
2024	Integer	liter/sec	Public water supply volume in 2024
2025	Integer	liter/sec	Public water supply volume in 2025

(26) Irrigation Area Ratio

Field Name	Field Type	Unit	Note
Subbasin	Text	-	Sub-basin name
RegCode	Long	-	Regency code number
RegName	Text	-	Regency name
Ratio	Single	-	Sub-basin area ratio to regency

Appendix-2
Water Balance
System User Guide

THE COMPREHENSIVE STUDY
ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT
IN BALI PROVINCE IN THE REPUBLIC OF INDONESIA

SUPPORTING REPORT (M)
GIS DATABASE

WATER BALANCE SYSTEM USER GUIDE

Table of Contents

CHAPTER 1 OUTLINE OF WATER BALANCE SYSTEM

The JICA Study Team had developed the programs as a supporting tool called "Water Balance System" for water resources management. Using this system, you can simulate about water balance "Water potential and water demand in future" and "Public water supply and public water demand in future". Refer to Table-1.1 for outline of Water Balance System.

Table- 1.1 Outline of Water Balance System

Simulation Item	Contents	Output
Water potential and water demand in future	Compare water potential and water demand in future in whole Bali, regencies and sub-basins. Water potential ● surface water included spring water ● ground water Water demand in 2005, 2010, 2015, 2020 and 2025 ● domestic water ● commercial/institutional water ● industry water ● hotel water ● irrigation water	Tables and Graphs as an excel file. ● Whole Bali (1 sheet) ● Regency and Nusa Penida (10 sheets) ● Sub basin (20 sheets)
Public water supply and public water demand in future	Compare public water supply in future and public water demand in future in public water service areas. Public water supply in 2005 to 2025 ● existing ● planning Public water demand in 2005 to 2025 ● domestic water ● commercial/institutional water ● industry water ● hotel water	Tables and Graphs as an excel file. ● Public water service area (11 sheets)

Note: refer to Table-1.2 for regency and Nusa Penida, sub-basin and public water service area.
refer to Table-1.3 for example output.

The system has 3 main functions, i.e. setting parameter data, calculating water demand in future and output results of calculation. The system has the default parameters estimated by the JICA Study Team. If you will simulate a new case, you can read the default values without inputting all parameters. If you want to revise the default parameters, you can revise the parameter data you want to revise. Then you can execute the water balance and export to an excel file. The setting parameters data and results data are saved to the database as a project data, and you can read these data according to need (refer to Figure-1.1). For further simulation, you can use both the default parameters and the previously entered data read from the database.

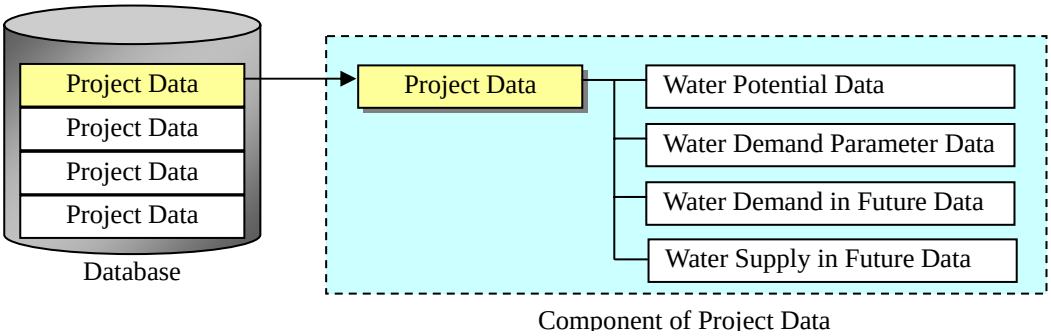
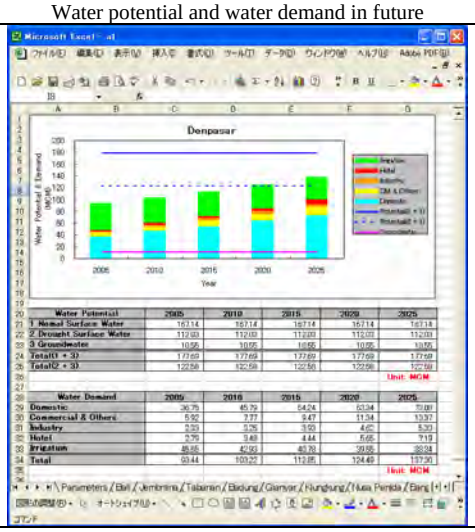
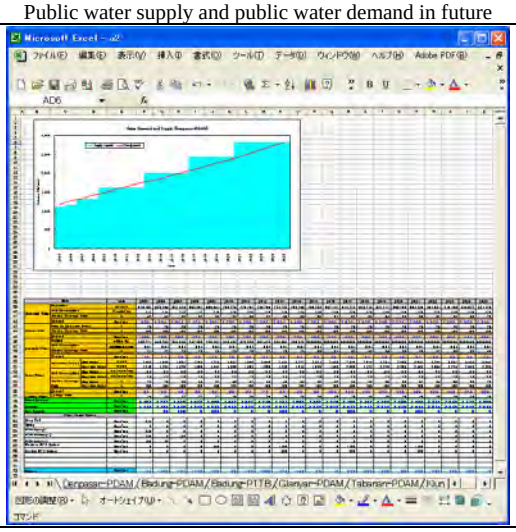


Figure-1.1 Structure of Project Data

Table- 1.2 Target Area

Simulation Item	Target Area
Water potential and water demand in future	Regency and Nusa Penida 
	Sub basin 
Public water supply and public water demand in future	Public water service area 

Table- 1.3 Example Output

Water potential and water demand in future	Public water supply and public water demand in future
	

Refer to Figure- 1.2 for the system flow diagram.

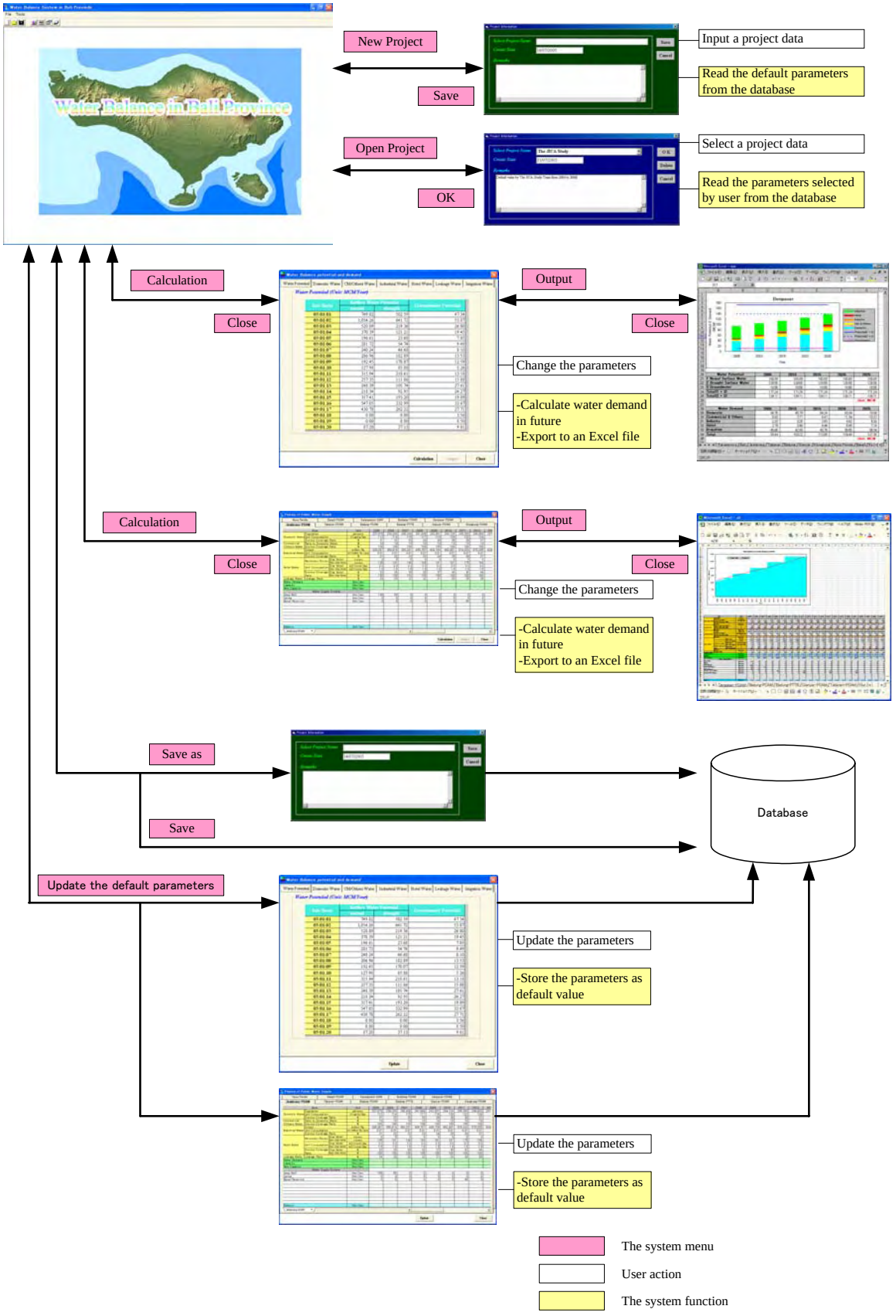


Figure-1.2 Water Balance System Flow Diagram

CHAPTER 2 INSTALLING

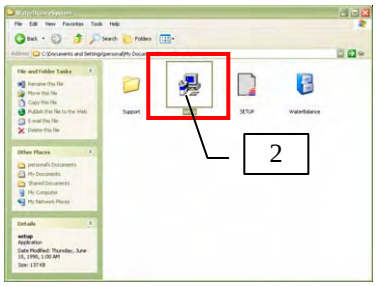
Since the system is built by “Microsoft Visual Basic”, user has to install the application for using the system. These are the system requirements for Water Balance System:

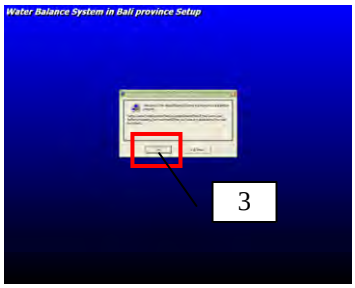
Table-2.1 The System Requirements

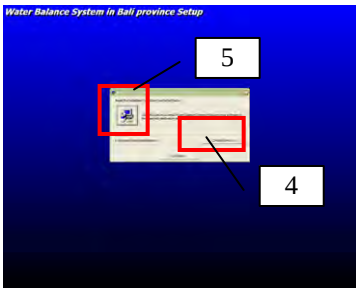
Operating Systems	Memory	Dusk Space	Application
Windows 2000 Windows XP	32 MB of RAM with a minimum of a Pentium PC	10 MB	Microsoft Excel2000/ XP

To install Water Balance System:

1. Insert install CD to CD drive.
2. Double click “WaterBlanceSystem/setup.exe”.
3. Click **OK** button.
4. If you want to change the default installing directory, click Change Directory button.
5. Click icon.





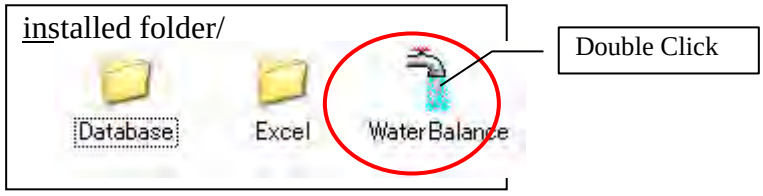


CHAPTER 3 STARTING AND EXITING

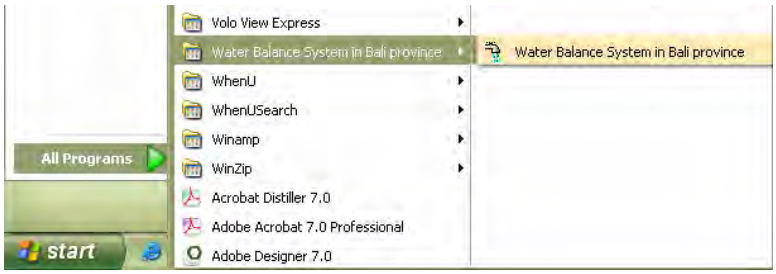
3.1 Starting

To start Water Balance System:

- Double click “installed folder/waterbalance.exe”.



- Or on the **Start** menu, point to **Program** and click **Water Balance System in Bali Province**.



3.2 Exiting

To exit Water Balance System:

- On the **File** menu, click **Exit**.

CHAPTER 4 SIMULATING WATER BALANCE

4.1 Registering New Project

You can simulate a new case of water balance. At the beginning, you have to register project information such as Name, Date and Remarks. After saving the project information, the system will read the default parameters. And then you can start a new simulation.

To register a new project:

1. On the **File** menu, click **New Project**. The **Project Information** dialog box displays.
2. Input by keyboard **Name**, **Date**, **Remarks**.
3. Click the **OK** button to read the default parameters and close the dialog box.

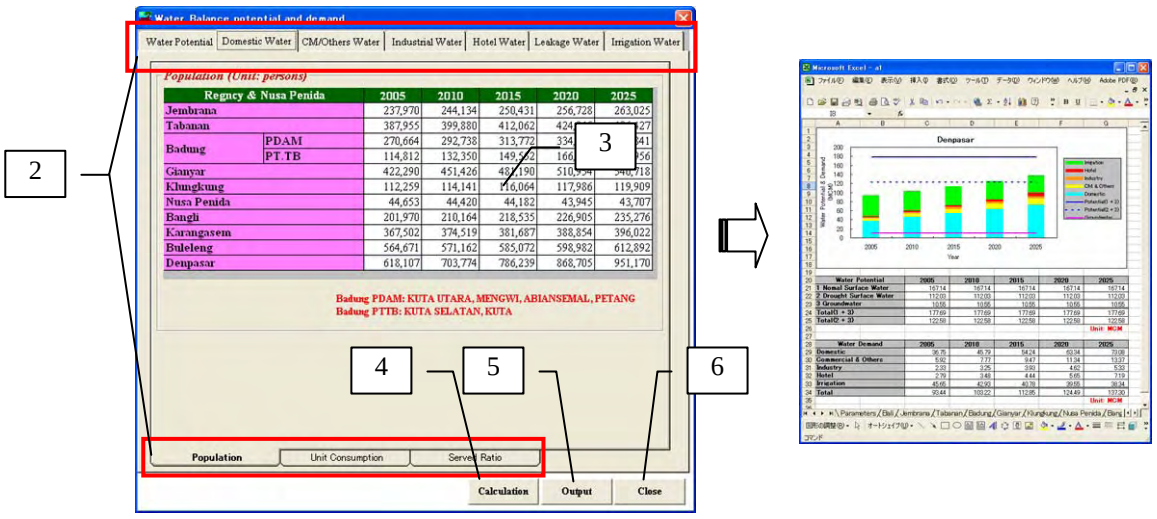
Name: project name within 100 characters
Date: creation date; the default is the PC current time
Remarks: remarks for simulation case

4.2 Simulating Potential and Demand

You can simulate water balance to compare water potential and water demand in future. Also you can export the results to an Excel file.

To simulate potential and demand:

1. On the **Tools** menu, point to the **Calculation of Water Balance** and click **Potential and Demand** to display the **Water Balance potential and demand** dialog box.
2. If you want to display the other parameter data, click a tab you want.
3. If you want to revise the parameter data, input by keyboard (refer to "4.4 Revising the Parameters" in details).
4. Click the **Calculation** button to calculate water demand in future.
5. Click the **Output** button to export the results to an Excel file and open the Excel. If you don't complete the calculation, you can't use the output function.
6. Click the **Close** button to close the dialog box.



(a) Domestic Water Demand

Domestic water demand is estimated by multiplying population by unit water consumption. Water consumer is divided into PDAM user and non-PDAM user, unit water consumption for each user is different.

DWD (20XX) = POP (20XX) x SR (20XX) x UC1 (20XX) / (1-LKG (20XX))
+ POP (20XX) x (1-SR (20XX)) x UC2 (20XX)

Where,
DWD: domestic water demand (l/day)
POP: population
SR: service ratio of PDAM (%)
UC1: unit water consumption by PDAM user (l/capita/day)
UC2: unit water consumption by non-PDAM user (l/capita/day)
LKG: leakage ratio (%)
20XX: 2005, 2010, 2015, 2020 or 2025

(b) Commercial/Institutional Water Demand

Commercial/institutional water demand is estimated by multiplying domestic water demand by a certain ratio.

CWD (20XX) = DWD (20XX) x R (20XX) x SR (20XX) / (1-LKG (20XX))
+ DWD (20XX) x R (20XX) x (1 - SR (20XX))

Where,
CWD: commercial/institutional water demand (l/day)
DWD: domestic water demand (l/day)
R: ratio of commercial/institutional water demand against domestic water demand (%)
SR: service ratio of PDAM (%)
LKG: leakage ratio (%)
20XX: 2005, 2010, 2015, 2020 or 2025

(c) Industrial Water Demand

Industrial water demand is estimated by multiplying industrial output by unit water consumption.

IWD (20XX) = IO (20XX) x UC (20XX) x SR (20XX) / (1 – LKG (20XX))
+ IO (20XX) x UC (20XX) x (1 - SR (20XX))

Where,
IWD: industrial water demand (m^3 /day)
IO: industrial output (million rupiah)
UC: unit water consumption by PDAM user (m^3 /million rupiah/day))
SR: service ratio of PDAM (%)
LKG: leakage ratio (%)
20XX: 2005, 2010, 2015, 2020 or 2025

(d) Hotel Water Demand

Hotel water demand is estimated by multiplying number of necessary hotel rooms by unit water consumption.

HWD (20XX) = HR1 (20XX) x UC1 (20XX) x SR1 (20XX) / (1 – LKG (20XX))
+ HR1 (20XX) x UC1 (20XX) x (1 - SR1 (20XX))
+ HR2 (20XX) x UC2 (20XX) x SR2 (20XX) / (1 – LKG (20XX))
+ HR2 (20XX) x UC2 (20XX) x (1 – SR2 (20XX))

Where,
HWD: hotel water demand (m^3 /day)
HR1: number of necessary star hotel rooms

HR2: number of necessary low class hotel rooms

UC1: unit water consumption by star hotel (m^3 /room/day)

UC2: unit water consumption by low class hotel (m^3 /room/day)

SR1: service ratio of PDAM (%)
SR2: service ratio of PDAM (%)
LKG: leakage ratio (%)
20XX: 2005, 2010, 2015, 2020 or 2025

(e) Irrigation Water Demand

Irrigation water demand is estimated by multiplying irrigation area by requirement water, and dividing by irrigation efficiency.

IWD (20XX) = IA (20XX) x RW / E
Where,

IWD: irrigation water demand (m^3 /day)

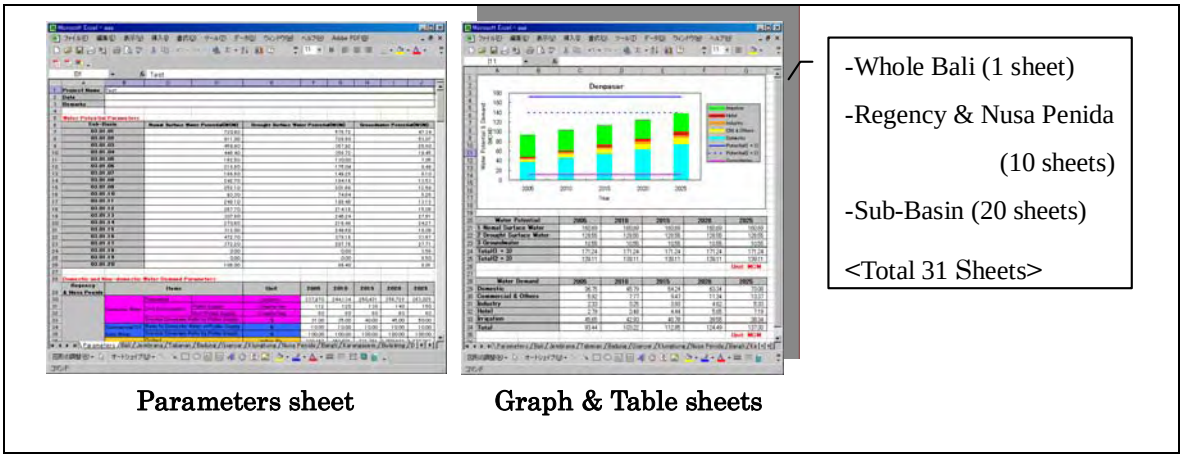
IA: irrigation area (ha)

RW: requirement water (m^3 /day/ha))

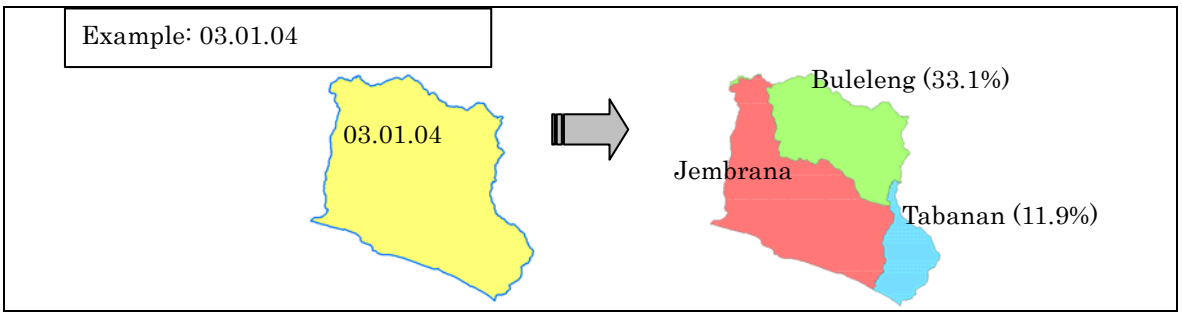
E: irrigation efficiency (%)
20XX: 2005, 2010, 2015, 2020 or 2025

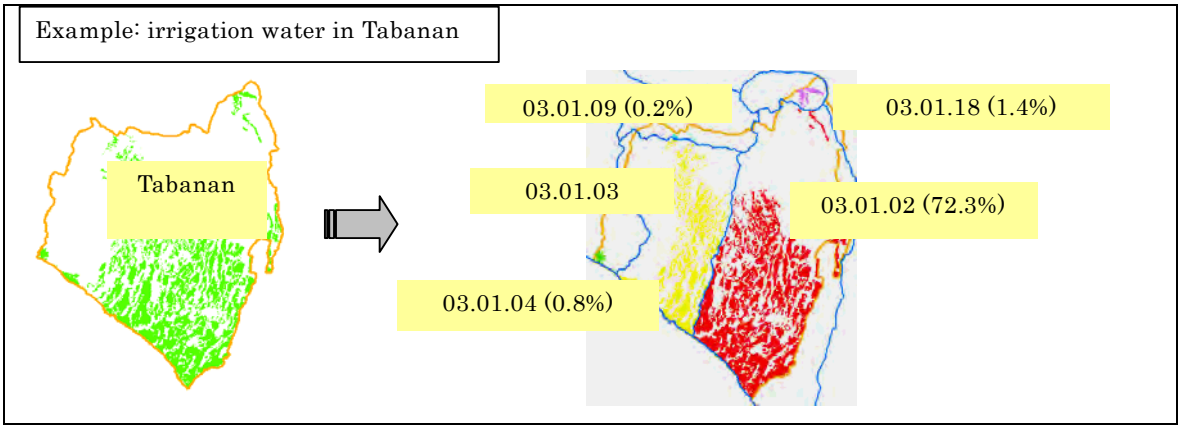
(f) Water Balance

The system can output results of water balance in whole Bali, in each regency and Nusa Penida and in each sub-basin. Parameters for calculation are also shown as output. Each result data are divided by sheets, are indicated by graph and table.



Since water potential is set by sub-basin and water demand is estimated by regency and Nusa Penida, conversion to each other is necessary for calculation of water balance. Water potential in a sub-basin is simply allocated by ratio of overlapping sub-basin and each regency. However, land use pattern is considered for estimating water demand by sub-basin. Domestic, commercial, industrial, hotel water demand are allocated by ratio of overlapping sub-basin and residential area of each regency and irrigation water demand is allocated by ratio of overlapping sub-basin and irrigated paddy field of each regency.



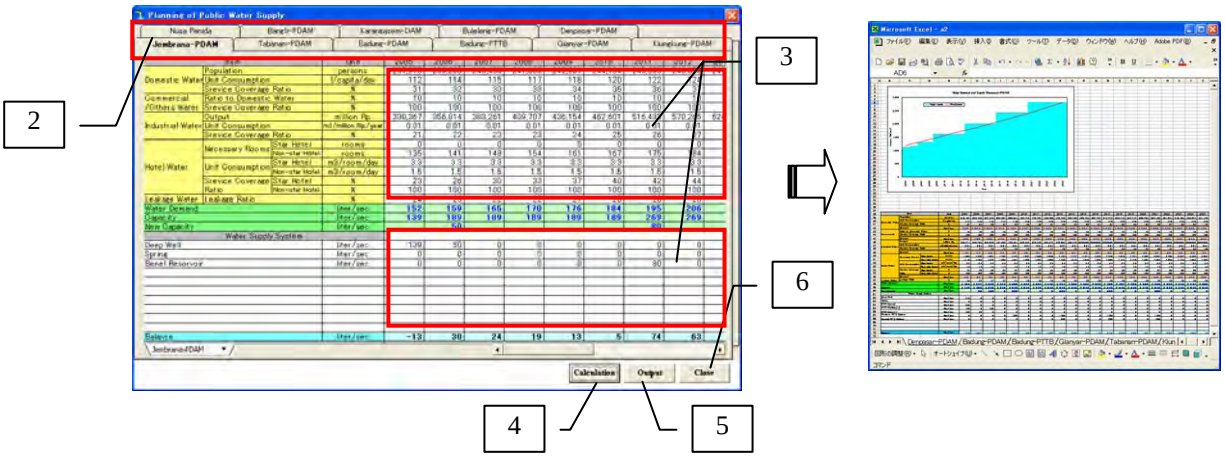


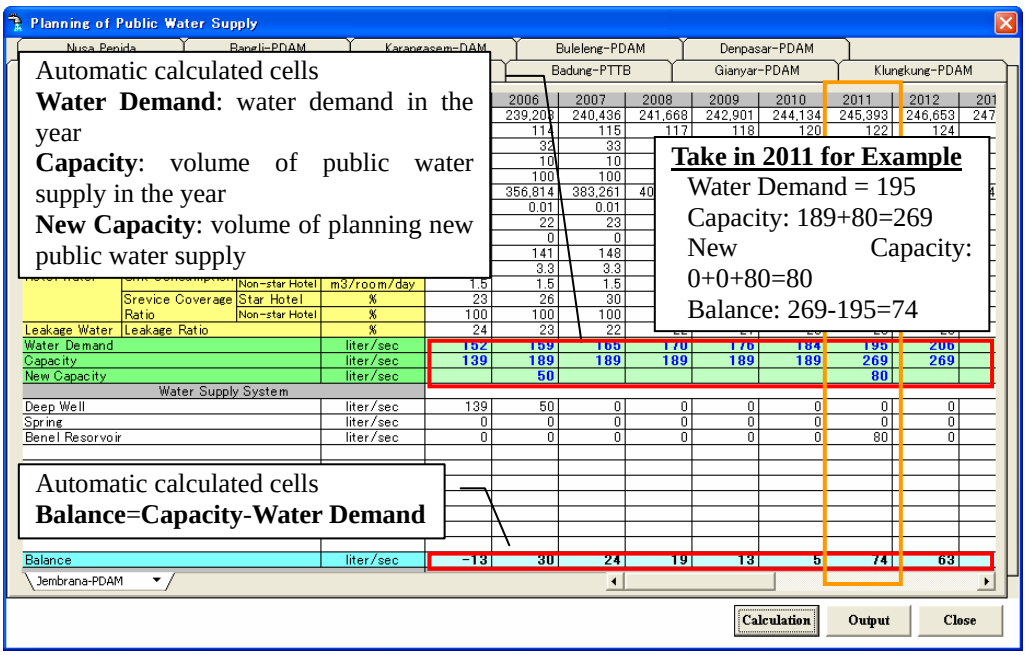
4.3 Simulating Public Water Supply and Demand

You can simulate water balance to compare public water supply and water demand in future. Also you can export the results to an Excel file.

To simulate public water supply and demand:

1. On the **Tools** menu, point to the **Calculation of Water Balance** and click **Public Water Supply and Demand** to display the **Planning of Public Water Supply** dialog box.
2. If you want to display the other parameter data, click a tab you want.
3. If you want to revise the parameters data, input by keyboard (refer to "4.4 Revising the Parameters" in details).
4. Click the **Calculation** button to calculate public water supply and water demand in future.
5. Click the **Output** button to export the results to an Excel file and open the Excel. If you don't complete the calculation, you can't use the output function.
6. Click the **Close** button to close the dialog box.





(a) Domestic Water Demand

Domestic water demand is estimated by multiplying population by unit water consumption. Water consumer is divided into PDAM or PTTB user.

DWD (20XX) = POP (20XX) x SR (20XX) x UC (20XX) / (1-LKG (20XX))

Where,

DWD: domestic water demand (l/day)
POP: population
SR: service ratio of PDAM or PTTB (%)
UC: unit water consumption by PDAM or PTTB user (l/capita/day)
LKG: leakage ratio (%)
20XX: 2005 to 2025

(b) Commercial/Institutional Water Demand

Commercial/institutional water demand is estimated by multiplying domestic water demand by a certain ratio.

CWD (20XX) = DWD (20XX) x R (20XX) x SR (20XX) / (1-LKG (20XX))

Where,

CWD: commercial/institutional water demand (l/day)
DWD: domestic water demand (l/day)
R: ratio of commercial/institutional water demand against domestic water demand (%)
SR: service ratio of PDAM or PTTB (%)
LKG: leakage ratio (%)
20XX: 2005 to 2025

(c) Industrial Water Demand

Industrial water demand is estimated by multiplying industrial output by unit water consumption.

IWD (20XX) = IO (20XX) x UC (20XX) x SR (20XX) / (1 – LKG (20XX))

Where,

IWD: industrial water demand (m^3 /day)
IO: industrial output (million rupiah)
UC: unit water consumption by PDAM user (m^3 /million rupiah/day))

SR: service ratio of PDAM or PTTB (%)
LKG: leakage ratio (%)
20XX: 2005 to 2025

(d) Hotel Water Demand

Hotel water demand is estimated by multiplying number of necessary hotel rooms by unit water consumption.

$$HWD(20XX) = HR1(20XX) \times UC1(20XX) \times SR1(20XX) / (1 - LKG(20XX)) + HR2(20XX) \times UC2(20XX) \times SR2(20XX) / (1 - LKG(20XX))$$

Where,

HWD: hotel water demand (m^3 /day)
HR1: number of necessary star hotel rooms
HR2: number of necessary low class hotel rooms
UC1: unit water consumption by star hotel (m^3 /room/day)
UC2: unit water consumption by low class hotel (m^3 /room/day)
SR1: service ratio of PDAM or PTTB (%)
SR2: service ratio of PDAM or PTTB (%)
LKG: leakage ratio (%)
20XX: 2005 to 2025

4.4 Revising the Parameters

If you want to revise the parameters for water balance, you can revise.

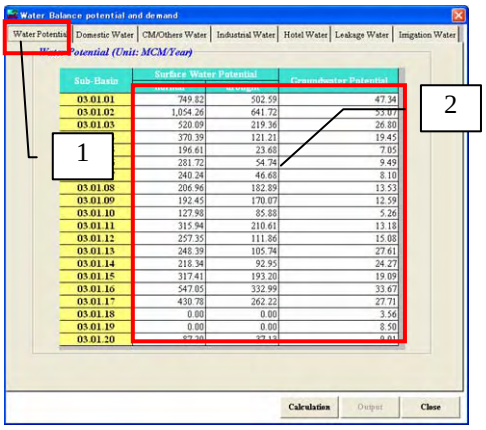
4.4.1 Potential and Demand

(1) Water Potential

You can revise the water potential data such as surface water (normal level and drought level) and groundwater by sub-basin. Spring water is included in surface water.

To revise the water potential data:

1. Click the **Water Potential** tab to display the potential data.
2. Input the data you wan to revise by keyboard.



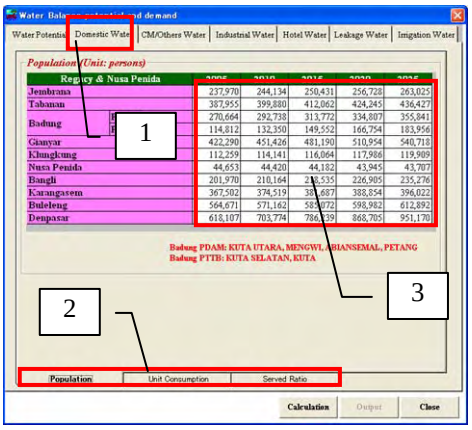
Data Item		Unit	Notes
Surface water potential	Normal	MCM/year	normal level of surface water potential
	Drought	MCM/year	drought level of surface water potential
Groundwater Potential		MCM/year	groundwater potential

(2) Domestic Water Demand

You can revise the domestic water demand parameters such as population, unit consumption served public water, unit consumption no served public water, served ratio of public water supply by regency and Nusa Penida.

To revise the domestic water demand parameters:

1. Click the **Domestic Water** tab to display the domestic water demand parameters.
2. Click a tab to display the other parameters.
3. Input the data you wan to revise by keyboard.



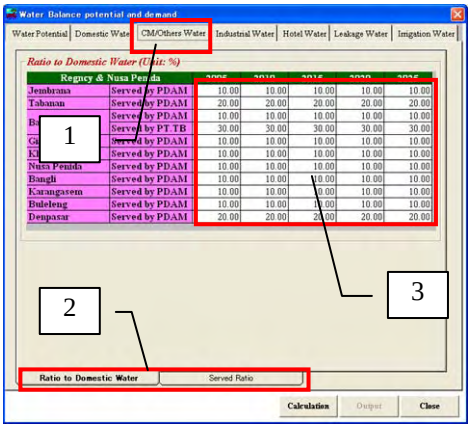
Data Item		Unit	Notes
Population		persons	population
Unit consumption	Served by PDAM or PTTB	liter/capita/day	unit water consumption of public water supply
Unit consumption	No served	liter/capita/day	unit water consumption of non-public water supply
Served ratio		%	service coverage ratio of public water supply

(3) Commercial/Institutional Water Demand

You can revise the commercial/institutional water demand parameters such as ratio of domestic water demand and served ratio of public water supply by regency and Nusa Penida.

To revise the commercial/institutional water demand parameters:

1. Click the **CM/Other Water** tab to display the commercial/institutional water demand parameters.
2. Click a tab to display the other parameters.
3. Input the data you wan to revise by keyboard.



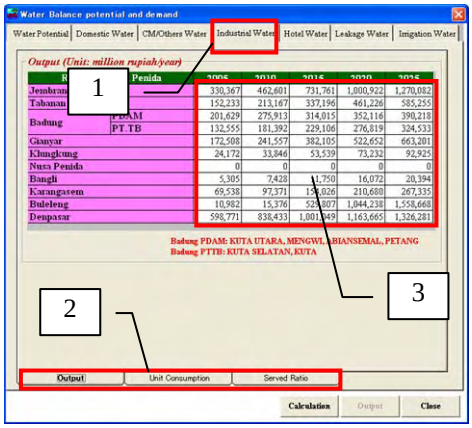
Data Item	Unit	Notes
Ratio to Domestic Water	%	ratio to domestic water demand
Served ratio	%	service coverage ratio of public water supply

(4) Industry Water Demand

You can revise the industry water demand parameters such as output, unit consumption and served ratio of public water supply by regency and Nusa Penida.

To revise the industry water demand parameters:

1. Click the **Industrial Water** tab to display the industry water demand parameters.
2. Click a tab to display the other parameters.
3. Input the data you wan to revise by keyboard.



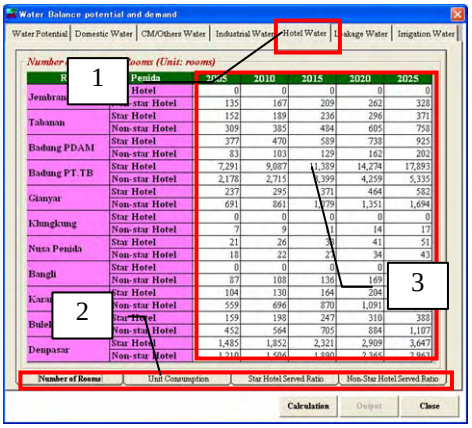
Data Item	Unit	Notes
Output	million Rp./year	manufacturing industry output
Unit consumption	m3/ million Rp./day	unit water consumption of manufacturing industry
Served ratio	%	service coverage ratio of public water supply

(5) Hotel Water Demand

You can revise the hotel water demand parameters such as number of room, unit consumption and served ratio of public water supply by regency and Nusa Penida.

To revise the hotel water demand parameters:

1. Click the **Hotel Water** tab to display the hotel water demand parameters.
2. Click a tab to display the other parameters.
3. Input the data you wan to revise by keyboard.



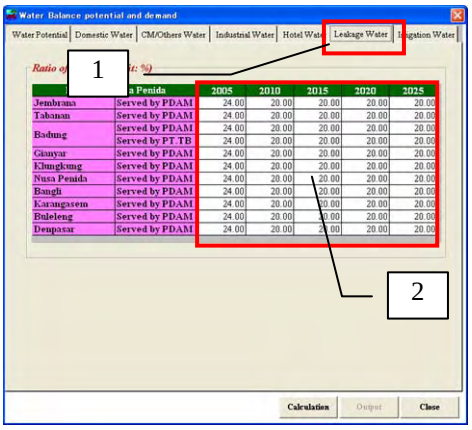
Data Item		Unit	Notes
Number of rooms	Star hotel	Rooms	the number of star hotel or non-star hotel room
	Non-star hotel		
Unit consumption	Star hotel	m3/ room/day	unit water consumption of star hotel or non-star hotel
	Non-star hotel		
Served ratio	Star hotel	%	service coverage ratio of public water supply
	Non-star hotel		

(6) Leakage Water

You can revise the leakage ratio by regency and Nusa Penida.

To revise the leakage water demand parameters:

1. Click the **Leakage Water** tab to display the leakage water parameters.
2. Input the data you wan to revise by keyboard.



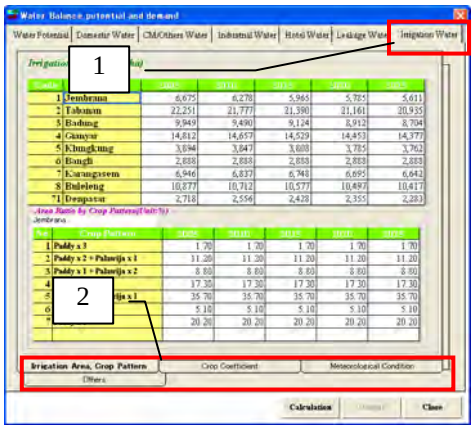
Data Item	Unit	Notes
Leakage ratio	%	leakage ratio

(7) Irrigation Water Demand

You can revise the irrigation water demand parameters such as irrigation area, crop pattern, crop coefficient, effective rainfall, evapotranspiration and so on.

To revise the irrigation water demand parameters:

1. Click the **Irrigation Water** tab to display the irrigation water demand parameters.
2. Click a tab to display the other parameters.



Data Item	Unit	Notes
Irrigation area	ha	irrigation area
Area ratio by crop pattern	%	ratio of crop pattern included in irrigation area
Crop coefficient	%	monthly Crop coefficient
Effective rainfall	mm/day	monthly effective rainfall
evapotranspiration	mm/day	monthly evapotranspiration
Land preparation	mm/day	land preparation for paddy
Seepage loss	mm/day	Percolation losses into soil profiles
Irrigation efficiency	%	to take account for losses of water during conveyance, distribution of field canal and field application
Water layer replacement	mm/day	water layer replacement

To revise the irrigation area and area ratio by crop pattern:

3. Click the **Irrigation Area, Crop Pattern** tab.
4. The irrigation area data by regency is shown in the upper table. The area ratio by crop pattern in Jembrana is shown in the lower table.
5. Input the data you wan to revise by keyboard.
6. If you want to revise the area ratio by crop patter in the other regency, double click the area name in the upper table to change the area ratio by crop patter in the other regency.

To revise the crop coefficient:

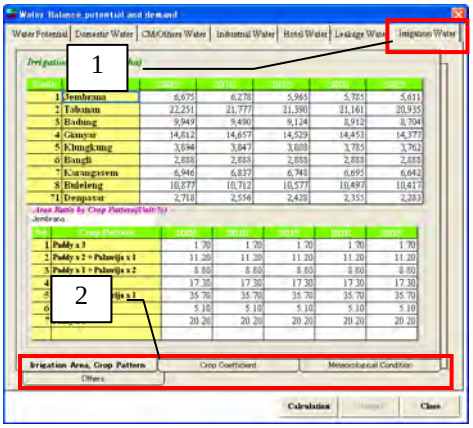
7. Click the **Crop Coefficient** tab.
8. The crop coefficient data in Jembrana is shown in the table.
9. Input the data you wan to revise by keyboard.
10. If you want to revise the crop coefficient in the other regency, click area name and fill in one area name to change the crop coefficient data in the other regency.

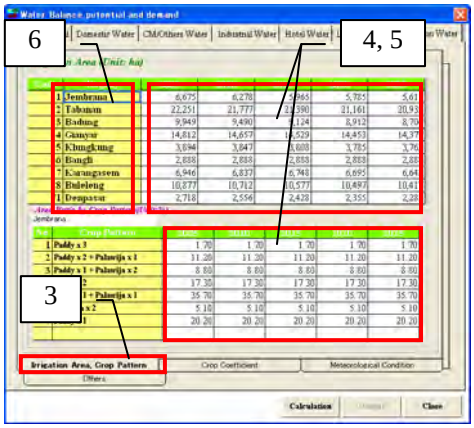
To revise the effective rainfall and evapotranspiration:

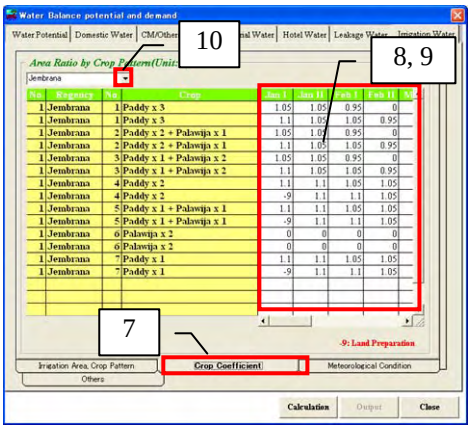
11. Click the **Meteorological Condition** tab.
12. Input the data you wan to revise by keyboard.

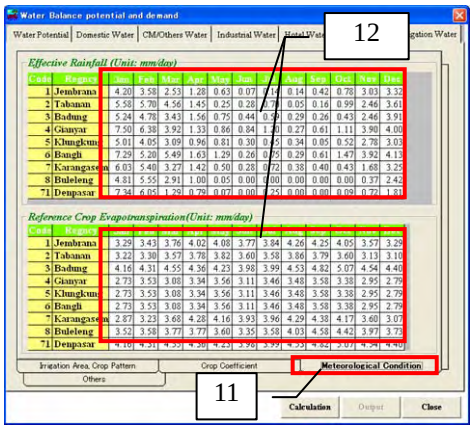
To revise the other parameters:

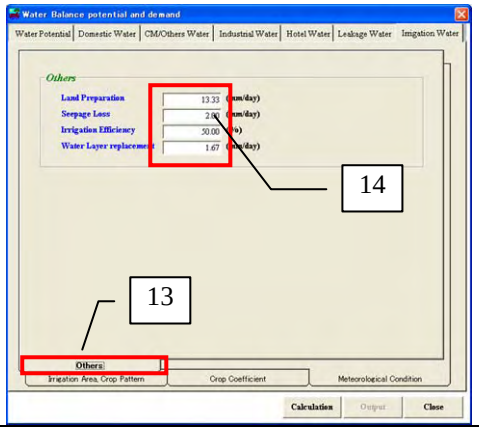
13. Click the **Others** tab.
14. Input the data you wan to revise by keyboard.









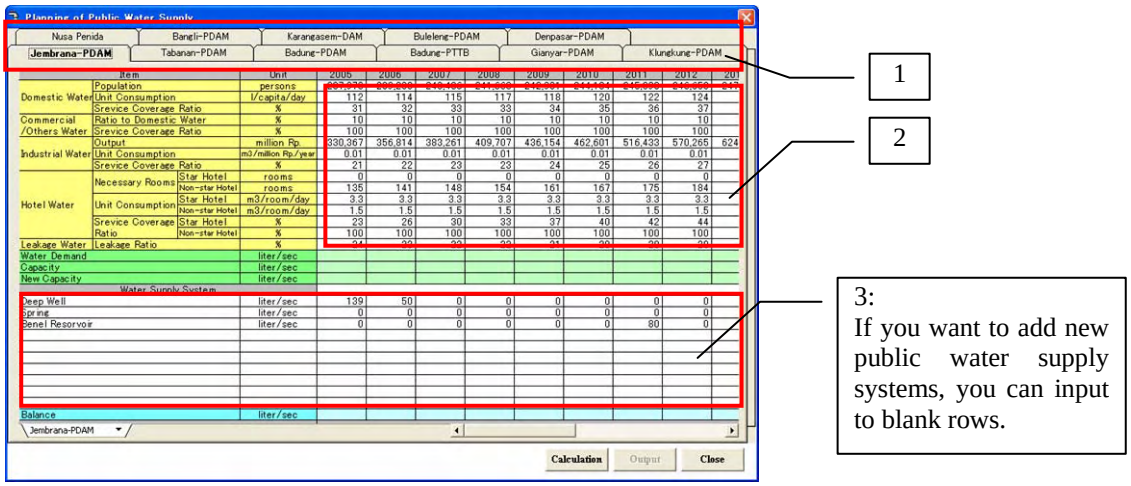


4.4.2 Public Water Supply and Demand

You can revise the public water supply and water demand.

To revise the water potential data:

1. Click a tab you want to revise in the public water supply area to display the parameters in the area you select.
2. Input the data you wan to revise the water demand parameters by keyboard.
3. Input the data you wan to revise the public water supply parameters by keyboard.



Data Item			Unit	Notes
Domestic Water	Population		persons	population
	Unit consumption		liter/capita/day	unit water consumption of public water supply
	Service coverage ratio		%	service coverage ratio of public water supply
Commercial/ institutional water	Ratio to Domestic Water		%	ratio to domestic water demand
Industrial water	Output		million Rp./year	service coverage ratio of public water supply
	Unit Consumption		m3/million Rp./year	unit water consumption
	Srevice Coverage Ratio		%	service coverage ratio of public water supply
Hotel water	Necessary Rooms	Star Hotel	rooms	the number of star hotel or non-star hotel room
		Non-star Hotel		
	Unit Consumption	Star Hotel	m3/room/day	unit water consumption of star hotel or non-star hotel
		Non-star Hotel		
	Srevice Coverage Ratio	Star Hotel	%	service coverage ratio of public water supply
		Non-star Hotel		
Leakage water	Leakage Ratio		%	leakage Ratio
Water supply system			liter/sec	volume of public water supply

4.5 Saving Project Data

To save the project data (all parameters you input):

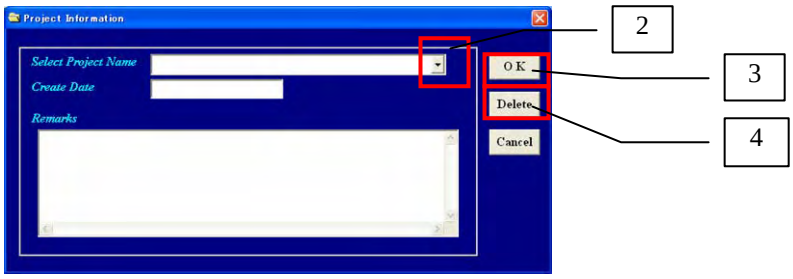
- On the **File** menu, click **save** or **save as** to save the project data.

4.6 Reading Existing Project Data

You can read the previous project data.

To read previous project data:

1. On the **File** menu, click **Open Project** to display the **Project Information** dialog box.
2. Select a project name you wan to read.
3. Click OK button to read the parameters of the project you selected.
4. If you want to delete a project data, click **Delete** button to delete a project data from the database.



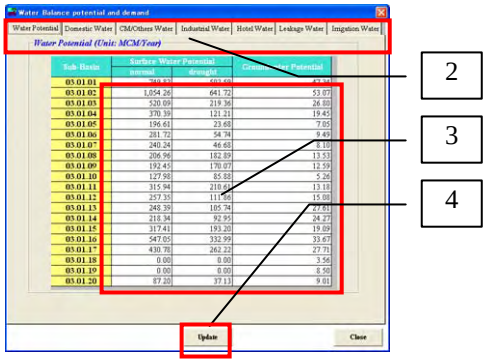
CHAPTER 5 UPDATING THE DEFAULT VALUE

You can update the default value.

5.1 Potential and Demand

To update the default value:

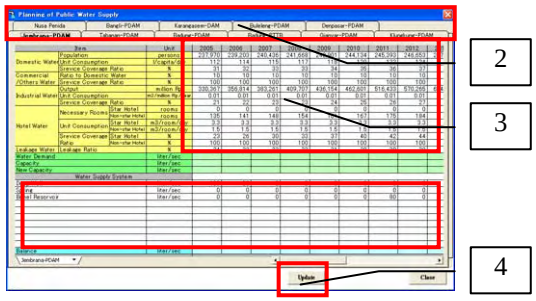
1. On the **Tools** menu, point to the **Update Default Value** and click **Potential and Demand** to display the **Water Balance potential and demand** dialog box.
2. If you want to display the other parameter data, click a tab you want.
3. Input the data you wan to revise by keyboard (refer to “4.4 Revising the Parameters” for how to revise).
4. Click **Update** button.



5.2 Public Water Supply and Demand

To update the default value:

1. On the **Tools** menu, point to the **Update Default Value** and click **Public Water Supply and Demand** to display the **Planning of Public Water Supply** dialog box.
2. If you want to display the other parameter data, click a tab you want.
3. Input the data you wan to revise by keyboard (refer to “4.4 Revising the Parameters” for how to revise).
4. Click **Update** button.



DIRECTORATE GENERAL OF WATER RESOURCES,
MINISTRY OF PUBLIC WORKS
PUBLIC WORKS SERVICE, BALI PROVINCE

THE COMPREHENSIVE STUDY
ON
WATER RESOURCES DEVELOPMENT
AND MANAGEMENT IN BALI PROVINCE
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT
SUPPORTING REPORT

[K] COST ESTIMATE

AUGUST 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.
NIPPON KOEI CO., LTD.

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SUPPORTING REPORT (K)
COST ESTIMATE

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K-1 INTRODUCTION

Cost estimation of projects examines in Master Plan and Feasibility Study. Unit prices used for cost estimation of projects are determined based on the "Degree of Governor of Bali No.17 year 2004 for Goods and Service Prices Standard for Government Needs of Bali Province" and "Journal for Construction Material and Interior Edition XXII of the examined year."

Unit prices not covered by the above information are obtained by quotations from manufactures, suppliers or distributors of products required for projects or estimation from the prices of the similar projects in the past in Indonesia.

Distributions of project cost are as mentioned in the Table-K.1, and operation maintenance cost (O&M) is examined on the condition shown in the Table-K.2.

Table-K.1 Conditions of Cost Estimates for Project Cost

Distribution	Conditions of Cost Estimates
(1) Direct Cost	Labor Cost, Materials Cost and Equipment Cost for Construction etc.
(2) Land acquisition (2-3%)	Reservoir Project: 3% of Construction Cost Other Project: 2% of Construction Cost
(3) Administration (5%)	5% of Construction Cost
(4) Engineering Fee (10%)	10% of Construction Cost
(5)Contingency (10%)	10% of (1)～(4) Item
(6) Tax etc	Because the government projects become a tax exemption, it isn't summed up

Table-K.2 Operation and Maintenance Cost of Project

Items	Multi-purpose Ayung Dam	Water Supply System for Southern Bali Area			Flood Control Plan
		Western	Eastern	Central	River Improvement of Badung and Mati River
General O&M for Dam	0.2% of construction cost	-	-	-	0.5% of construction cost
Operation cost for Intake/Treatment	-	30kWh/(lit/sec)/day		20kWh/(lit/sec)/day	
Electricity Price	-	750 Rp/kWh			
Chemical cost for Water Treatment	-	176 Rp/m^3: average cost between upstream river and downstream river (respectively 88 Rp/m^3, 264 Rp/m^3)			
Repair/Maintenance	-	3% of Electric Equipment/Machinery Cost			

The Examination Project Cost with Master Plan and Feasibility Study is as mentioned in Table-K.3, Table-K.4.

Table-K.3 Project Cost of Master Plan

(Unit: Rp. million)

Projects	Construction Cost	Land Acquisition and Compensation	Government Administration Expense	Engineering Services	Sub-Total	Contingency	Project Cost
■ Integrated Project							955,078
1.Ayung Reservoir (1) Dam & Reservoir (2) Power Facilities	692,648 553,748 138,900	13,853	34,632	69,265	810,398	81,040	891,438
2.Benel Reservoir	49,448	989	2,472	4,945	57,854	5,785	63,640
■ Water Supply Project							828,337
3.Western Water Supply System (W1)	51,329	1,027	2,566	5,133	60,055	6,005	66,060
4.Central Water Supply System (C1)	222,666	4,453	11,133	22,267	260,519	26,052	286,571
5.Eastern Water Supply System (E5)	248,668	4,973	12,433	24,867	290,942	29,094	320,036
6.Water Treatment for Denpasar	17,235	345	862	1,724	20,165	2,016	22,181
7.Water Treatment for Jemnrana (Benel)	8,044	161	402	804	9,411	941	10,353
8.Water Supply – Well: Related regencies	62,997	1,260	3,150	6,300	73,706	7,371	81,077
9.Water Supply – Spring: Related regencies	32,680	654	1,634	3,268	38,236	3,824	42,059
■ Flood/Sediment Control Project							1,267,234
10 Badung & Mati Rivers Flood Control	91,135	1,823	4,557	9,114	106,628	10,663	117,291
11. Singaraja Area Flood Control	18,074	361	904	1,807	21,147	2,115	23,261
12. Flood/Sediment Control: Related regencies	478,632	9,573	23,932	47,863	560,000	56,000	616,000
13. Coastal Protection: Related regencies	396,800	7,936	19,840	39,680	464,256	46,426	510,682
■ Irrigation Project							748,514
14. Irrigation Improvement (from Ayung)	71,250	1,425	3,563	7,125	83,363	8,336	91,699
15. Irrigation Improvement (from Benel)	7,500	150	375	750	8,775	878	9,653
16. Irrigation Improvement: Related regencies	502,845	10,057	25,142	50,285	588,329	58,833	647,162
■ Total							3,799,163

Table-K.4 Priority Project Cost of Feasibility Study

(Unit: Rp. million)

Project	Direct Cost	Land Acquisition	Administration	Engineering Fee	Sub Total	Contingency	Project Cost
◆Ayung Dam	837,127	25,114	41,856	83,713	987,810	98,781	1,086,591
◆Water Supply Project	370,854	12,384	18,543	37,085	438,866	43,887	482,753
-West Water Supply System	87,957	1,759	4,398	8,796	102,910	10,291	113,201
-Central Water Supply System	136,996	7,707	6,850	13,700	165,252	16,525	181,778
-East Water Supply System	145,901	2,918	7,295	14,590	170,704	17,070	187,775
◆River Improvement Project	110,024	2,200	5,501	11,002	128,727	12,873	141,600
Badung River	56,274	1,125	2,814	5,627	65,840	6,584	72,424
Mati River	53,750	1,075	2,687	5,375	62,887	6,289	69,176
Grand Project Cost	1,318,005	39,698	65,900	131,800	1,555,403	155,541	1,710,944

Note) Central Water Supply System is based on the Water Supply plan 600lit/s.

K-2 COST ESTIMATES OF MASTER PLAN STUDY

K-2.1 Conditions of Cost Estimates

(1) Basic Factors in Analysis of Unit Cost

Cost estimation for the Study is based on the costs and prices in Indonesian Rupiah (Rp.) at the time of June 2005, which exchange rate of 1 US$ = 9,260 Rp. = 106.97 yen is applied for conversion of currencies.

Unit prices used for cost estimation of projects in Master Plan Study are determined based on the "Degree of Governor of Bali No.17 year 2004 for Goods and Service Prices Standard for Government Needs of Bali Province" and "Journal for Construction Material and Interior Edition XXII July 2004".

Unit prices not covered by the above information are obtained by quotations from manufactures, suppliers or distributors of products required for projects or estimation from the prices of the similar projects in the past in Indonesia.

(2) Composition of Project Cost

The Project cost is composed of the following cost items:

- Construction cost
- Land acquisition and compensation
- Government administration expense
- Engineering services
- Contingency

<Construction Cost>

The cost required for the construction of facilities and other related works including the preparatory works. The cost covers labor, material and equipment costs for construction including installation and erection of equipment, etc.

< Land Acquisition and Compensation >

This cost covers the cost associated with the acquisition of land for construction facilities and their influenced area, and the compensation for properties such as resettlement of residents, permanent and temporary use of land, etc.

Cost for land acquisition and compensation is assumed at three (3) percent of construction cost for reservoir project and two (2) percent of construction cost for other projects. These assumptions are verified with some of land acquisition and compensation cost using average unit rate for land.

< Government Administration Expense >

The administration expense incurred by the Government for the execution of the Works is estimated in local currency portion to be five (5) percent of the construction cost.

<Engineering Services>

The cost of engineering services is composed of consulting service costs for design, supervision and management for the implementation of the project and is taken as ten (10) percent of the construction cost.

<Contingency>

Since it is impracticable during design stage of the project to foresee every consequence of executing works or to envisage all the details of construction, contingency is usual provided to cope with unforeseen physical conditions and price escalation due to inflation. The rate of the physical and

price contingencies are estimated as ten (10) percent of construction cost, land acquisition and compensation, administration expense and engineering services.

<Government Tax>

The government tax in Indonesia is the Value Added Tax (10%) which is not included for project cost estimation.

K-2.2 Project Cost

(1) Methods of Estimation for Project Cost

The cost estimation for the construction works was made based on the quantities of labor, materials, equipment and other related items calculated form design drawings for structures and facilities.

(2) Unit Price Employed for Project Cost

Typical unit prices employed for project cost estimate are summarized in Table-K.5. For reservoir construction in (1), unit price per dam embankment volume in m^3 includes all dam embankment works, related civil structure works, coffer dam and other related miscellaneous works. This unit price refers to the similar past projects in Indonesia, such as Wonorejo Dam, Batutugi Dam, SSIMP, etc.

For water supply project, unit prices for transmission pipes and steel pipe bridges per meter include fabrication, transportation and installation of steel pipes, related civil works, mechanical works and other miscellaneous works.

The unit price for water treatment plant construction is calculated by daily water production volume in m3/day, which includes water treatment plant, related civil and building works, related electrical and mechanical works and other miscellaneous works.

The unit price for pumping station is calculated by necessary pump capacity in m3/Head/kW, which includes pump, related civil and building works, related electrical and mechanical works and other miscellaneous works.

For groundwater project, unit price for one deep well is calculated based on the conditions with 100 m depth, 8 inch diameter and 10 liter/sec capacity, which includes boring and other related works, submerged pump and its installation and pump house and other miscellaneous works.

For river improvement project, the unit price per meter is calculated based on actual project cost in annual budget for river improvement cost in Bali and includes channel normalization, bank protection, embankment improvement and other facilities for disaster protection.

The unit price for river improvement works for Badung and Mati rivers per meter includes riverbed excavation with 10 m width and 2 m depth, its disposal, groundsill in every 500 m, gabion mattress and sodding works in riverbed sides, wet masonry protection, bridge works in every 1 km and other miscellaneous works. Demolition of existing weir and construction of new gate structures are separately estimated. The gate structure in Badung river is calculated based on 5 m water depth and 20 m length. The structure in Mati river is calculated based on 3 m water depth and 20 m length.

For irrigation project, the unit price per ha of irrigated area is calculated based on actual project cost in annual budget for rehabilitation cost for irrigation facilities in Bali.

For coastal conservation project, the unit price per m of beach is calculated based on actual project cost in annual budget for conservation cost for beach in Bali.

Table-K.5(1/2) Unit Price for Cost Estimate

Work Item	Unit	Unit Price		
		(J Yen)	(US$)	(Rp.)
Reservoir Project				
(1) Dam for Ayung River	m^3		220	
Water Supply Project				
(2) Transmission Pipe Φ400	m	13,300		
(3) Transmission Pipe Φ500	m	16,600		

Table-K.5(2/2) Unit Price for Cost Estimate

Work Item	Unit	Unit Price		
		(J Yen)	(US$)	(Rp.)
(4) Transmission Pipe Φ600	m	20,500		
(5) Transmission Pipe Φ700	m	24,500		
(6) Transmission Pipe Φ800	m	32,200		
(7) Transmission Pipe Φ900	m	41,100		
(8) Transmission Pipe Φ1000	m	50,200		
(9) Transmission Pipe Φ1100	m	59,400		
(10)Steel Pipe Bridge Φ500	m	123,000		
(11)Steel Pipe Bridge Φ700	m	2,400,000		
(12)Steel Pipe Bridge Φ800	m	351,000		
(13)Steel Pipe Bridge Φ900	m	463,000		
(14)Steel Pipe Bridge Φ1000	m	554,000		
(15)Water Treatment Plant (Q ＜ 100 liter/sec)	m^3/day	16,000		
(16)Water Treatment Plant (Q＞100 liter/sec)		13,000		
(17)Pumping Station	m^3/Head/kW	2,200		
(18)Deep Well Construction (10 liter/sec)	well			760,000,000
(19)Spring Water Facilities (10 liter/sec)	place			250,000,000
River Improvement Project				
(20)River Improvement for Others	m			1,500,000
(21)River Improvement for Badung/Mati	m			4,000,000
(22)Gate Structures in Badung	Ls			35,000,000,000
(23)Gate Structures in Mati	Ls			11,500,000,000
Irrigation Project				
(24)Rehabilitation of Irrigation facilities	ha			7,500,000
Coastal Conservation Project				
(25)Coastal Protection	m			6,000,000

(3) Construction Cost Estimate

The Bill of Quantities for major items for construction cost estimate is shown in Table-K.6.

Table-K.6 Quantities for Water Resources Development Project

Work Item	Specification	Unit	Quantity
1. Ayung Reservoir Project			
1.1 Gravity Dam	Concrete	m^3	299,000
2. Water Supply Project (W1)			
2.1 Weir and Intake Structure	20 m height, 50 m length	Ls	1
2.2 Raw Water Transmission Pipe	Φ500	m	10,900
2.3 Water Treatment Plant	Q=300 liter/sec	m^3/day	26,000
3. Water Supply Project (C1)			
3.1 Weir and Intake Structure	20 m height, 50 m length	Ls	1
3.2 Raw Water Transmission Pipe	Φ1,100	m	8,000
3.3 Water Treatment Plant	Q=1,800 liter/sec	m^3/day	155,500
4. Water Supply Project (E5)			
4.1 Weir and Intake Structure	20 m height, 50 m length	Ls	1
4.2 Raw Water Transmission Pipe	Φ500	m	32,800
4.3 Raw Water Transmission Pipe	Φ900	m	18,800
4.4 Raw Water Transmission Pipe	Φ1000	m	5,000
4.5 Pipe Bridge	Φ500	m	560
4.6 Pipe Bridge	Φ900	m	280
4.7 Water Treatment Plant	Q=800 liter/sec	m^3/day	69,000
4.8 Pumping Station	6.0 m^3/min x 33m x 55kW x 4P	Ls	1
5. Badung River Flood Control Project			
5.1 River Improvement Works	as described in 6.2.2	m	4,500
5.2 Gate Structure	5 m height, 20 m length	Ls	1
6. Mati River Flood Control Project			
6.1 River Improvement Works	as described in 6.2.2	m	6,500
6.2 Gate Structure	3 m height, 20 m length	Ls	1

Each construction cost is estimated based on the above conditions.

Table-K.7 shows construction cost estimation for water resources development projects in Bali in Master Plan Study.

Table-K.7(1/2) Construction Cost Estimate for Water Resources Development Project

(US$1= Rp.9,260)

Projects	Foreign Currency (USD thousand)	Local Currency (Rp. million)	Total Equivalent (Rp. million)
Integrated Project			
1. Ayung Reservoir	**43,390**	**290,857**	**692,648**
(1) Reservoir	32,890	249,187	553,748
(2) Power Facilities	10,500	41,670	138,900
2. Benel Reservoir	-	49,448	49,448
(1) Reservoir	-	32,308	32,308
(2) Intake Works	-	14,835	14,835
(3) Mechanical/electrical works	-	1,409	1,409
(4) Others	-	896	896
Water Supply Project			
3. Western Water Supply system (W1)	**3,860**	**15,590**	**51,329**
(1) Civil Works	386	2,922	6,493
(2) Transmission Pipes	1,269	3,916	15,663
(3) Water Treatment Plant	2,205	8,752	29,173
(4) Pumping Station	-	-	-
4. Central Water Supply System (C1)	**16,949**	**65,717**	**222,666**
(1) Civil Works	386	2,922	6,493
(2) Transmission Pipes	3,332	10,284	41,136
(3) Water Treatment Plant	13,232	52,511	175,037
(4) Pumping Station	-		-
5. Eastern Water Supply System (E5)	**19,580**	**67,357**	**248,668**
(1) Civil Works	386	2,922	6,493
(2) Transmission Pipes	12,386	38,231	152,924
(3) Water Treatment Plant	5,883	23,347	77,823
(4) Pumping Station	925	2,857	11,427
Water Supply Project			
6. Water Treatment for Denpasar (Waribang-2)	-	**17,135**	17,135
7. Water Treatment for Jemnrana (Benel)	-	**8,044**	8,044
8. Water Supply – Well: Related Regencies	-	62,997	62,997
(1) Badung	-	11,385	11,385
(2) Gianyar	-	11,385	11,385
(3) Jembrana	-	14,421	14,421
(4) Bangli	-	75,590	75,590
(5) Karangasem	-	5,313	5,313
(6) Buleleng	-	11,385	11,385
(7) Kulungkung	-	1,518	1,518
9. Water Supply – Spring: Related Regencies	-	**32,680**	**32,680**
(1) Badung	-	2,600	2,600
(2) Gianyar	-	7,590	7,590
(3) Tabanan	-	5,460	5,460
(4) Bangli	-	4,420	4,420
(5) Karangasem	-	6,500	6,500
(6) Buleleng	-	3,900	3,900
(7) Kulungkung	-	2,210	2,210
Flood/Sediment Control Project			
10. Badung & Mati Rivers Flood Control		**91,135**	**91,135**
(1) Badung	-	51,772	51,772
(2) Mati	-	39,363	39,363
11.Singaraja Area Flood Control	-	**18,074**	**18,074**
(1) Buleleng	-	8,294	8,294
(2) Banyumala	-	9,780	9,780
12. Flood/Sediment Control: Related Regencies	-	**478,631**	**478,631**
(1) Badung/Denpasar	-	38,765	38,765
(2) Gianyar	-	30,688	30,688
(3) Tabanan	-	59,195	59,195
(4) Klungkung	-	16,765	16,765
(5) Bangli	-	35,550	35,550
(6) Karangasem	-	98,037	98,037
(7) Jembrana	-	100,374	100,374
(8) Buleleng	-	99,257	99,257
13. Coastal Protection: Related Area	-	**396,800**	**396,800**

Table-K.7 (2/2) Construction Cost Estimate for Water Resources Development Project

(US$1= Rp.9,260)

Projects	Foreign Currency (USD thousand)	Local Currency (Rp. million)	Total Equivalent (Rp. million)
Irrigation Project			
14. Irrigation Improvement (from Ayung Reservoir)	-	**71,250**	**71,250**
15. Irrigation Improvement (from Benel Reservoir)	-	**7,500**	**7,500**
16. Irrigation Improvement: Related Regencies	-	**502,845**	**502,845**
(1) Badung	-	45,350	45,350
(2) Gianyar	-	44,000	44,000
(3) Tabanan	-	77,450	77,450
(4) Kulungkung	-	32,100	32,100
(5) Bangli	-	49,750	49,750
(6) Karangasem	-	74,650	74,650
(7) Jembrana	-	73,545	73,545
(8) Buleleng	-	106,000	106,000

Estimated Project Cost

Each project cost is estimated based on the conditions described in Table-K.8 shows project cost estimation for water resources development projects in Master Plan Study.

Table-K.8 Cost Estimate for Water Resources Development Project

(Unit: Rp. Million)

Projects	Const-ruction Cost	Land Acquisition and Compensation	Government Administration Expense	Engineering Services	Sub-Total	Contingency	Project Cost
■ Integrated Project							955,078
1.Ayung Reservoir (1) Dam & Reservoir (2) Power Facilities	692,648 553,748 138,900	13,853	34,632	69,265	810,398	81,040	891,438
2.Benel Reservoir	49,448	989	2,472	4,945	57,854	5,785	63,640
■ Water Supply Project							828,337
3.Western Water Supply System (W1)	51,329	1,027	2,566	5,133	60,055	6,005	66,060
4.Central Water Supply System (C1)	222,666	4,453	11,133	22,267	260,519	26,052	286,571
5.Eastern Water Supply System (E5)	248,668	4,973	12,433	24,867	290,942	29,094	320,036
6.Water Treatment for Denpasar	17,235	345	862	1,724	20,165	2,016	22,181
7.Water Treatment for Jemnrana (Benel)	8,044	161	402	804	9,411	941	10,353
8.Water Supply – Well: Related regencies	62,997	1,260	3,150	6,300	73,706	7,371	81,077
9.Water Supply – Spring: Related regencies	32,680	654	1,634	3,268	38,236	3,824	42,059
■ Flood/Sediment Control Project							1,267,234
10 Badung &Mati Rivers Flood Control	91,135	1,823	4,557	9,114	106,628	10,663	117,291
11. Singaraja Area Flood Control	18,074	361	904	1,807	21,147	2,115	23,261
12. Flood/Sediment Control: Related regencies	478,632	9,573	23,932	47,863	560,000	56,000	616,000
13. Coastal Protection: Related regencies	396,800	7,936	19,840	39,680	464,256	46,426	510,682
■ Irrigation Project							748,514
14. Irrigation Improvement (from Ayung)	71,250	1,425	3,563	7,125	83,363	8,336	91,699
15. Irrigation Improvement (from Benel)	7,500	150	375	750	8,775	878	9,653
16. Irrigation Improvement: Related regencies	502,845	10,057	25,142	50,285	588,329	58,833	647,162
■ Total							3,799,163

The project costs for each phase is also estimated and summarized in Table-K.9 below:

Table-K.9 Summary of Project Cost by Phase

(Unit: Rp. Million)

Projects	Phase				Total
	2006-2010	2011-2015	2016-2020	2021-2025	
■ Integrated Project	**249,753**	**644,041**	**61,284**	**0**	**955,078**
1. Ayung Reservoir	249,753	612,221	29,464	-	891,438
2. Benel Reservoir	-	31,820	31,820	-	63,640
■ Water Supply Project	**41,604**	**386,230**	**253,132**	**147,371**	**828,337**
3. Western Water Supply System (W1)	-	43,532	11,264	11,264	66,060
4. Central Water Supply System (C1)	-	151,408	67,581	67,582	286,571
5. Eastern Water Supply System (E5)	-	155,293	134,693	30,050	320,036
6. Water Treatment for Denpasar	22,181	-	-	-	22,181
7.Water Treatment for Jemnrana (Benel)	-	-	10,353	-	10,353
8. Water Supply – Well: Related regencies	17,583	24,420	19,537	19,537	81,077
9. Water Supply – Spring: Related regencies	1,840	11,577	9,704	18,938	42,059
■ Flood/Sediment Control Project	**337,892**	**366,002**	**281,670**	**281,670**	**1,267,234**
10. Badung & Mati Rivers Flood Control	46,917	70,374	-	-	117,291
11. Singaraja Area Flood Control	9,304	13,957	-	-	23,261
12. Flood/Sediment Control: Related regencies	154,000	154,000	154,000	154,000	616,000
13. Coastal Protection: Related Area	127,671	127,671	127,670	127,670	510,682
■ Irrigation Project	**161,791**	**207,641**	**212,466**	**166,616**	**748,514**
14. Irrigation Improvement (from Ayung)	-	45,850	45,849	-	91,699
15. Irrigation Improvemet (from Benel)	-	-	4,827	4,826	9,653
16. Irrigation Improvement: Related regencies	161,791	161,791	161,790	161,790	647,162
■ Total	**791,040**	**1,603,914**	**808,552**	**595,657**	**3,799,163**

K-2.3 Operation and Maintenance (O&M) Cost

(1) Methods of Estimation for O&M Cost

Operation and maintenance (O&M) cost includes expenses of O&M staff, material and labor costs for operation, repair and maintenance of project facilities and running cost of the project.

(2) Unit Cost Employed for O&M Cost

The annual O&M cost for the projects is estimated based on the conditions and components of each project as follows:

- Reservoir: 0.2 % of direct construction cost
- Water treatment plant: 3.0 % of direct construction cost
- Pumping stations: 5.0 % of electrical/mechanical works cost
- Operation cost for plant/pump 8.5 yen/kwh

(3) Estimated O&M Cost

The annual O&M costs for water supply projects are estimated as shown in Table-K.10.

Table-K.10 Annual O&M Costs for Water Supply Project

(Unit: Rp. million)

Component	Western Water Supply System	Central Water Supply System	Eastern Water Supply System
1. Reservoir		560	
2. Water treatment Plant	875	5,250	2,319
3. Pumping Station			860
4. Operation Cost	3,222	9,666	7.348

K-3 COST ESTIMATES OF FEASIBILITY STUDY

The priority projects selected with Master Plan Study were 3 projects next to show, and grand total project cost becomes about 1.7 trillion Rp (155 billion yen) to show in the Table-K.11.

- Multi-purpose Ayung Dam Project
- Water Supply System Project for Southern Bali Area
- Flood Control Project for Badung and Mati River

As for the distributions, cost of Ayung dam is Rp.1.1 trillion (JPY 99 billion), project cost of water supply system for Southern Bali Area is Rp.0.48 trillion (JPY 44 billion) and cost of Flood Control Project for Badung and Mati River is Rp.0.14 trillion (JPY 13 billion).

Table-K.11 Priorities Project Cost

(Unit: Rp. million)

Project	Direct Cost	Land Acquisition	Administration	Engineering Fee	Sub Total	Contingency	Project Cost
◆Ayung Dam	837,127	25,114	41,856	83,713	987,810	98,781	1,086,591
◆Water Supply Project	370,854	12,384	18,543	37,085	438,866	43,887	482,753
-West Water Supply System	87,957	1,759	4,398	8,796	102,910	10,291	113,201
-Central Water Supply System	136,996	7,707	6,850	13,700	165,252	16,525	181,778
-East Water Supply System	145,901	2,918	7,295	14,590	170,704	17,070	187,775
◆River Improvement Project	110,024	2,200	5,501	11,002	128,727	12,873	141,600
Badung River	56,274	1,125	2,814	5,627	65,840	6,584	72,424
Mati River	53,750	1,075	2,687	5,375	62,887	6,289	69,176
Grand Project Cost	1,318,005	39,698	65,900	131,800	1,555,403	155,541	1,710,944

K-3.1 Conditions of Cost Estimates

(1) Basic Factors in Analysis of Unit Cost

Cost estimation for the Study is based on the costs and prices in Indonesian (Rp.) at the mean of one year in 2005, which exchange rate of 1 US$ = 9,750 ,Rp. = 110.74 yen is applied for conversion of currencies. Estimated conditions are shown in the Table-K.12.

Table-K.12(1/2) Conditions of Cost Estimation for Project Cost

Distribution	Conditions of Cost Estimates
(1) Direct Cost	The cost covers labor, material and equipment costs for construction including installation and erection of equipment, etc.
(2) Land Aquistion	Reservoir project: oward the construction fee, 3%, Other project: Toward the construction fee, 2%,
(3) Administration	Toward the construction fee, 5%
(4) Enginering Fee	Toward the construction fee, 10%

Table-K.12(2/2) Conditions of Cost Estimation for Project Cost

Distribution	Conditions of Cost Estimates
(5) Contingency	Toward the (1) - (4), 10%
(6) Tax, etc.	It isn't summed up.

(2) Unit Price used for Project Cost

Unit prices used for cost estimation of each projects are determined based on the "Degree of Governor of Bali No.17 year 2004 for Goods and Service Prices Standard for Government Needs of Bali Province" and "Journal for Construction Material and Interior Edition XXII of the examined year."

Unit prices not covered by the above information are obtained by quotations from manufactures, suppliers or distributors of products required for projects or estimation from the prices of the similar projects in the past in Indonesia.

(3) Methods of Estimation for Project Cost

Each project costs were calculated in the method shown in the following.

1) Project cost for multi-purpose Ayung dam
   - Unit prices were done referring to the value of the dam cost of Indonesia which it is ordered from in August, 2005. Others construction quantity was calculated from the drawing or the same seed construction.

2) Water supply project cost for Southern Bali Area
   - Cost of the water supply project was done referring to the result of the details design examined by a local Indonesian consultant in September 2004 .
     Materials of cost estimation for West Water Treatment System are shown in Appendix-1. (Refer to the following report.)

     Reference: LAPORAN AKHIR PEKERJAAN: PENYUSUNAN PERENCANAAN DETAIL INSTALASI PENGOLAHAN AIR(IPA)PENET SEP 2004
   - The details design which a local consultant examined is done by September2004. Therefore, as for the cost in 2005, 15% of the price increases were anticipated.

3) Flood Control Project of Badung and Mati River
   - A calculated cost and an estimate cost from the local construction execution dealer were used.

K-3.2 Multi-purpose Ayung Dam Project Cost

Dam site for Ayung multipurpose dam with catchments area of 218km^2, reservoir volume of 1,000 thousand m^3 and dam height of 66m is located at the downstream of meeting points of Ayung River and Siap River, belong to Buangga village Petang District in Badung Regency in right side and Payangan village Payangan District Gianyar Regency in the left bank.

The complete expectation figure of Ayung Dam is shown in Figure-K.1.

Figure-K.1 A complete expectation figure of Ayung Dam Plan (A view from Downstream)

(1) Methods of Estimation for Project Cost

- Unit prices were done referring to the value of the dam cost of Indonesia which it is ordered from in August, 2005.
- Others construction quantity was calculated from the drawing or the same seed construction.
- The cost estimation for the construction works was made based on the quantities of labor, materials, equipment and other related items calculated form design drawings for structures and facilities.
- An import machine purchase price, a round-trip fare, an establishment removal cost and the fare of the local supply machine are summed up for " Mobilization and De Mobilization ". (A repayment fee is 70%.)

(2) Unit Price Used for Project Cost

Typical unit prices used for project cost estimate are summarized in Table-K.13. And, a unit cost was converted into the m^3 cost and the m^2 cost and used, because there were many construction items of dam work.

Table-K.13(1/2) Unit Price of Cost Estimate

Unit Price of Construction Materials			Unit Price of Construction Labors			Remarks
Item	Unit	Unit Rate (Rp.)	Item	Unit Price (Rp./day.)	Overtime (Rp./hr)	
Gasoline	L	6,600	Foreman	75,000	18,750	
Diesel	L	6,100	Skilled Labor	50,000	12,500	
Labricant	L	15,500	Common Labor	41,000	10,250	
Grease	kg	20,000	Heavy Equipment Operator	75,000	18,750	
Cement	kg	725	Assistant Operator	60,000	15,000	
Additives: Concrete	kg	9,250	Driver	60,000	15,000	
Additives: Shotcrete	kg	20,000	Mechanic	75,000	18,750	
Additives: Grouting	kg	30,000	Electrician	75,000	18,750	
Sand for Concrete	m^3	140,000	Chief Mason	50,000	12,500	
Sand for Others	m^3	120,000	Mason	41,000	10,250	
Gravel for Concrete: 20mm/under	m^3	175,000	Surveyor	75,000	18,750	
Gravel for Concrete: 20mm/over	m^3	175,000	Assistant Surveyor	50,000	12,500	
Gravel for Backfill	m^3	100,000	Chief Carpenter	75,000	18,750	