FIGURES

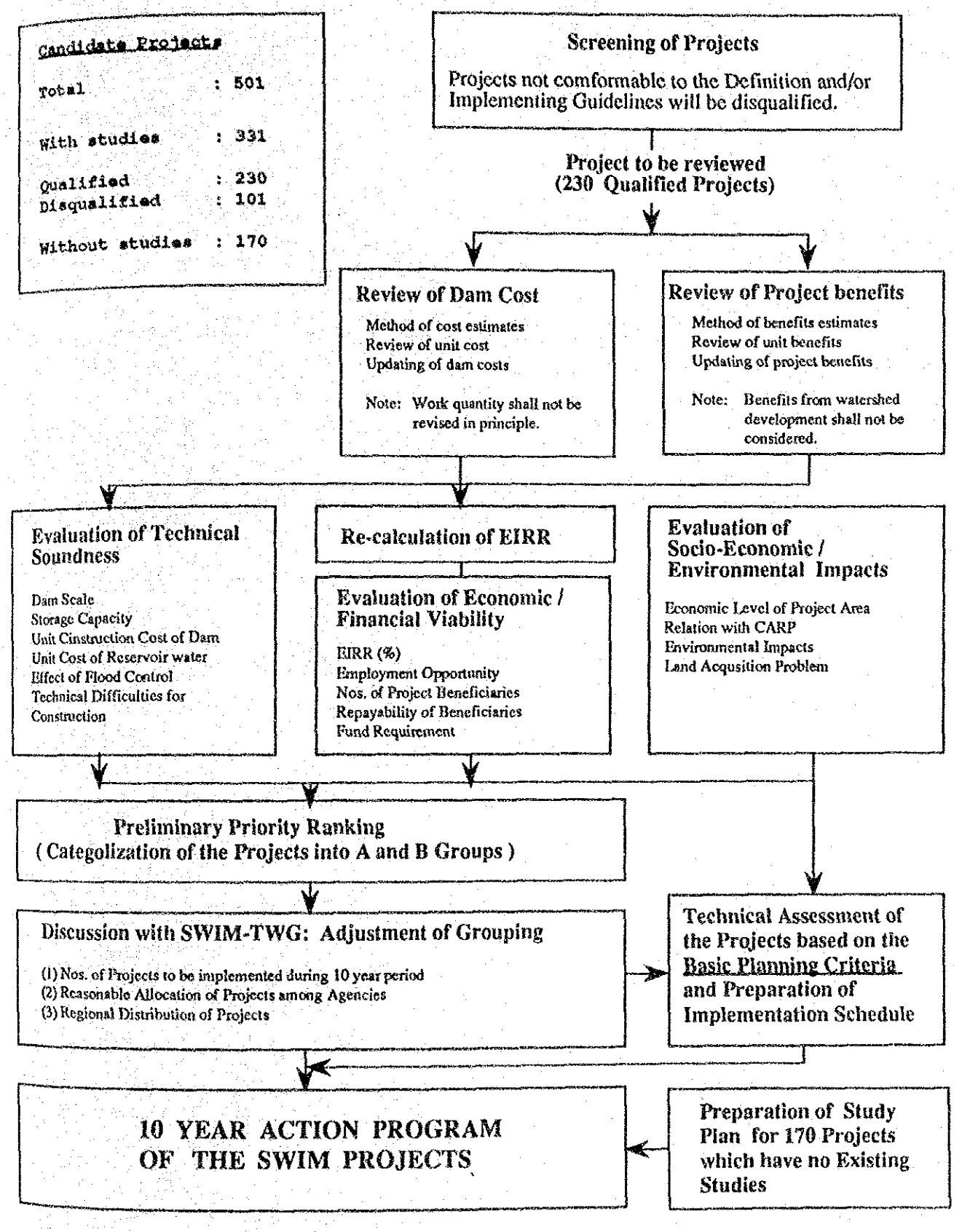

Fig.D.1.1 WORK FLOW OF PRIORITY RANKING

ANNEX E

BASIC PLANNING CRITERIA FOR SWIM PROJECTS

ANNEX E BASIC PLANNING CRITERIA FOR SWIM PROJECTS

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ANNEX E BASIC PLANNING CRITERIA FOR SWIM PROJECTS

SUMMARY

The "Basic Planning Criteria" consists of the following five guidelines:

I. General Guideline

II. Guideline for Survey and Investigation

III. Guideline for Project Planning

IV. Guideline for Design of Major Structures (dam and its appurtenant structures)

V. Guideline for Operation and Maintenance (O&M) of Major Structures (dam and its appurtenant structures)

I. General Guideline

The guideline includes the definition of the SWIM Projects, guideline for screening or qualification of the projects, and application of the Criteria.

II. Guideline for Survey and Investigation

The guideline shows basic data to be collected, and survey and investigation methods to be applied for feasibility study of the SWIM project on the following sectors:

(a) Dam
(b) Agriculture and irrigation
(c) Mini-hydropower
(d) Water supply
(e) Inland fishery
(f) Flood control
(f) Environmental conservation
(g) Watershed management

III. Guideline for Project Planning

The guideline shows basic methods and procedures for project planning on feasibility level on the following fields:

(a) Dam
(b) Agriculture and irrigation
(c) Mini-hydropower
(d) Water supply
(e) Inland fishery
(f) Flood control
(g) Environmental conservation
(h) Watershed management
(i) Construction plan and implementation schedule
(j) Project cost estimate
(k) Project evaluation

IV. Guideline for Design of Major Structures (dam and its appurtenant structures)

The guideline presents basic design concepts to be applied for preliminary design of the fill type dam and its appurtenant structures such as diversion works, outlet works and spillway at feasibility study stage.

V. Guideline for Operation and Maintenance (O&M) of Major Structures (dam and its appurtenant structures)

The guideline indicates basic concepts for O&M of the fill type dam and its appurtenant structures, which will be applied to study O&M of dam in the feasibility study stage and be used as a basic guideline for preparation of O&M manual for individual projects.

1 GENERAL GUIDELINE

1.1 Salient Feature of the SWIM Projects

1.1.1 Definition of the SWIM Projects

The SWIM Projects are conceived as a first line of defense against floods and at the same time, act as multi-purpose mini-reservoirs involving irrigation, soil erosion control, mini-hydropower, water supply and fish culture.
The definition of the SWIM Projects is;
"those small scale water impounding dams with a structural height of not more than 30 m and/or volume of storage not exceeding 50 MCM".

Explanation:

In addition to the definition of the SWIM Projects, the following implementing guideline is set forth for qualifying the proposed projects:

(1) The project shall preferably be a multi-purpose water resources development on a small scale and at the same time, provide a first line of defense against floods.

(2) The project shall include a small scale water-impounding dam which has structural height of not more than 30 m and/or a volume of storage not exceeding 50 MCM.

(3) The project shall include both engineering and vegetative protection works in the watershed area of the prospective dam and reservoir.

(4) The watershed area to be protected shall not be more than 100 km^2.

(5) The irrigation development area shall not be more than 500 ha.

(6) The installed capacity of hydropower generation shall not be more than 5,000 kW.

(7) The construction cost of dam and its appurtenant structures shall not exceed 50 million pesos (at 1989 constant price).

Note : In case of multi-purpose projects, the principal feature of the project should be properly identified in order to establish the priority of water utilization.

1.1.2 General Guideline for Screening or Qualification

The projects identified by each agency shall be screened or qualified through the "General Guideline for Screening or Qualification" as presented below.

Explanation:

The "General Guideline for Screening or Qualification" for the SWIM projects is as follows:

(1) The proposed project must be conformable to the definitions, purposes and objectives of the SWIM Projects.

(2) The proposed project must be conformable to the provisions of the "Philippines Water Code" regarding appropriation and utilization of water.

(3) The proposed project should be supported by in depth technical studies which cover necessary information to verify that it is technically sound for implementation.

(4) The proposed project must show higher economic viability than the minimum acceptable in terms of EIRR, B/C and NPV.

(5) An environmental impact study must be carried out before project implementation, and an environmental compliance certificate from the environmental management bureau be obtained if the project falls within the category of environmentally critical project, or within an environmentally critical area.

(6) The proposed project must be acceptable to the people of the areas to be influenced. In particular, the project should not have land acquisition problem.

(7) The proposed project must be financially viable and affordable for the project beneficiaries to pay the annual charges for operation and maintenance of the project.

(8) Any other projects considered necessary under special administrative requirement.

1.2 Purpose and Application of the Criteria

The "Basic Planning Criteria" (the Criteria) is primarily used for technical evaluation of the listed projects for the JICA SWIM Master Plan Study and secondarily used as a basic guideline for feasibility study of the SWIM project.

Explanation:

The Criteria is prepared primarily for technical evaluation of the listed projects for the JICA SWIM Master Plan Study (the Study). The Criteria therefore deals with only basic technical items to be evaluated in the Study and is not intended to provide comprehensive criteria covering all items to be studied in the feasibility study stage. It is however expected that the Criteria will be used as a basic guideline for feasibility study of the SWIM project and further be developed in near future for general use for planning of the SWIM project.

The Criteria is prepared based on the following premises:

(1) The procedures, methods and parameters adopted in this Criteria basically follow the existing studies of the SWIM projects which were reviewed in Phase-I of the Study.

(2) In case that the existing procedures, methods, etc. are different by each agency, they are reconciled as much as possible in order to equalize study level.

(3) The existing procedures, methods, etc. reviewed in Phase-I are attached as "Existing Studies" to each study item for reference.

(4) In general, there are many types of dam for the purpose of water impounding. However, since all impounding dams of the projects listed in the Study are of fill type, the Criteria deals with the SWIM projects formulated with the fill type dam.

(5) The guideline relating to dam is described into two separate dam height ranges; dam height, $H < 15$ m, and dam height, $H \geq 15$ m, if required.

2 GUIDELINE FOR SURVEY AND INVESTIGATION

2.1 Dam

2.1.1 Meteorological and Hydrological Investigation

Meteorological and hydrological investigations shall be made in order to study meteo-hydrological characteristics of the project area.

Explanation:

The following meteorological and hydrological data shall be collected through the necessary investigations. The objective period of data collection is recommended to be more than recent 10 years.

(1) Meteorological data:

(a) Monthly and daily rainfall and storm intensities
(b) Monthly temperature, maximum, minimum and mean temperatures
(c) Evaporation rates
(d) Relative humidities
(e) Wind directions and velocities
(f) Number of typhoons

(2) Hydrological data:

(a) Daily, monthly and annual maximum streamflow records at the proposed damsite or in nearby watersheds of similar run-off characteristics
(b) Flood hydrograph records and flood marks at the proposed damsite or in drainage basin of similar characteristics, for at least 3 (three) different storms
(c) Sediment sampling and its analysis, etc.
(d) Water sampling for water quality and analysis, etc.

Existing Studies:

Items	DPWH	NIA	BSWM
Meteorology			
- Rainfall	-Using data of adjacent station	-Using data of adjacent station	-Using data of adjacent station
- Evaporation	-Using data of adjacent station	-Using data of adjacent station	-Using data of adjacent station

Hydrology - Run-off	-Using data of adjacent similar river	-Using data of adjacent similar river	-Using data of adjacent river in the same water resources region
- Flood	-Using data of adjacent similar river	-Using data of adjacent similar river	-Not use
- Sediment	-Based on the existing data	-Based on the existing data	-Using relationship between sediment volume and catchment area

2.1.2 Investigation on River Conditions

River conditions shall be investigated through data collection and field survey.

Explanation:

Data obtained through the investigations on the river conditions are used in dam design for sedimentation analysis, changes of water quality and temperature and environmental assessment. The investigation items are as follows:

(1) Sediment yield and configuration of sedimentation (sediment yield and river bed condition)

(2) Influence of back water by reservoir to the upstream reach of the river (condition of the upstream reach)

(3) Maintenance flow (average daily/monthly river discharge during dry season, water right)

(4) River channel behavior and characteristics and flooding conditions

Existing Studies:

-Unknown

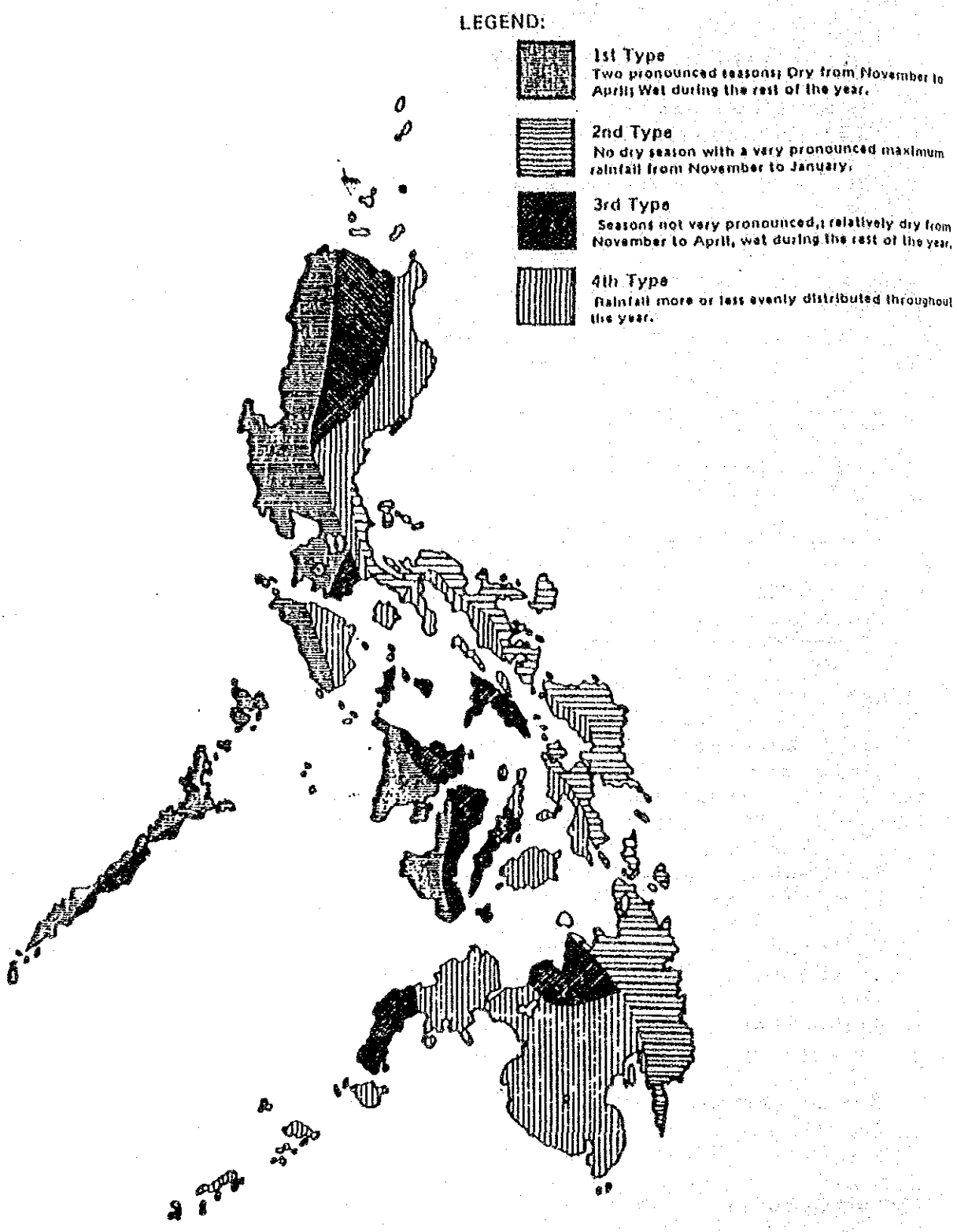


Fig.E.2.1 Climatological Map of the Philippines

2.1.3 Investigation on Water Rights

Existing water rights along the river where there is a proposed SWIM project shall be investigated through data collection.

Explanation:

Data on existing water users/water permit grantees shall be checked from the records compiled by the National Water Resources Board (NWRB). Grantees shall be identified with the corresponding amount of water withdrawn or diverted. Non-grantees shall be identified through field investigation and the amount of diversion determined. Data obtained from these investigations will be used in the dam planning for analysis of available river discharge.

Except when priority in time has been established, the order of preference in the use of water shall be as follows:

(1) domestic and municipal use
(2) irrigation
(3) power generation
(4) fisheries
(5) livestock raising
(6) industrial use
(7) recreational use
(8) other uses

Reference: The Philippine Water Code of 1976 (PD 1067).

Existing Studies:

Study Items	DPWH	NIA	NEA	BSWM
Field Investigation	made.	made.	not made.	not made.
Records of NWRB	made.	made.	not made.	not made.

2.1.4 Topographic Survey

Topography of the river basin, reservoir and its surrounding area and proposed dam site shall be clarified through data collection and topographic surveys.

Explanation:

(1) River basin

A map of the river basin, a river system map and a lineament

map shall be prepared using the available topographic maps in a scale of 1/50,000 to 1/25,000.

(2) Reservoir and surrounding area

Topographic map covering the reservoir and its surrounding area shall be prepared in a scale of 1/1,000 to 1/2,000 with contour interval of 1 m.

(3) Dam site and surrounding area

(a) Topographic map for dam site shall be prepared in a scale of 1/200 to 1/500 with contour interval of 1 m. Mapping area shall be determined as; length: about 4 times of the proposed dam height in the upstream and downstream directions from the dam center, and width: about 3 times of the proposed crest length or twice of the proposed dam height.

(b) Longitudinal leveling along dam axis shall be made in a scale of 1/200 to 1/500, covering the proposed location of spillway and other structures, if their locations unknown, covering up to at least the same length as the dam height outside from both ends of the dam crest.

Existing Studies:

Items	DPWH	NIA	BSWM
Dam site	-Preparing map in a scale of 1/500 to 1/4,000, mostly 1/500 to 1/1,000 with 1 m contour.	-Preparing map in a scale of 1/500 to 1/4,000, with 1 m contour.	-Preparing map in a scale of 1/500 with 1 m contour.
Reservoir	-Preparing map in a scale of 1/400 to 1/4,000, mostly 1/500 to 1/2,000 with 1 m contour.	-Preparing map in a scale of 1/2,000 to 1/4,000, with 1 m contour.	-Preparing map in a scale of 1/1,000 with 1 m contour.

2.1.5 Geological Investigations

Geological conditions of the proposed reservoir and surrounding area including the proposed dam site and borrow areas shall be clarified through data collection, field survey and necessary laboratory tests.

Explanation:

(1) General geological map

Outline of geological structure of the project area including the proposed dam site shall be studied from the 1/1,000,000 and/or 1/50,000 scale geological maps available in the Philippines (The Geology of the Philippines, Vol. 1., published by the Bureau of Mines and Geo-Sciences).

(2) Surface-geological survey and preparation of map

The surface-geological survey shall be conducted and the following maps shall be prepared:

(a) Geological map for reservoir area and its surrounding area including borrow area in a scale of 1/1,000 to 1/2,000
(b) Geological map for dam site area in a scale of 1/200 to 1/500

(3) Sub-surface geological survey

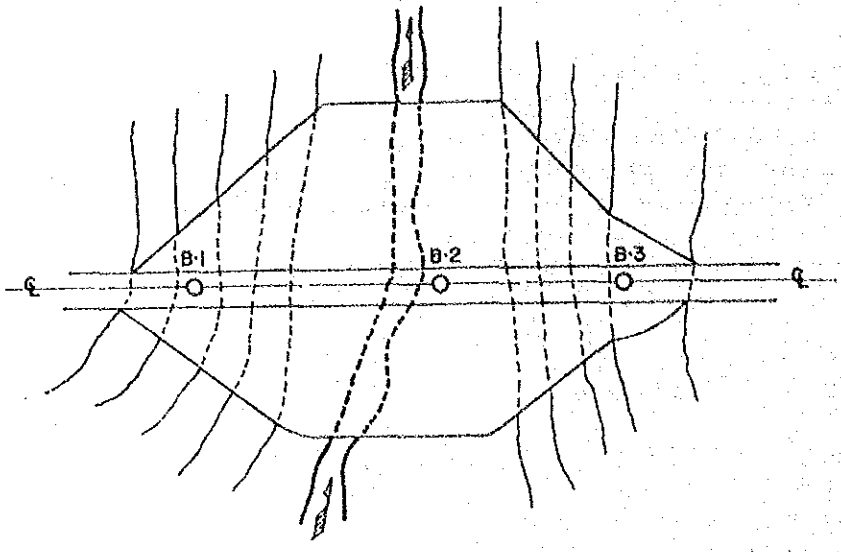
(a) Drilling (refer to Fig.E.2.2)

- In case of dam height of not less than 15 m ($H \geq 15$ m);

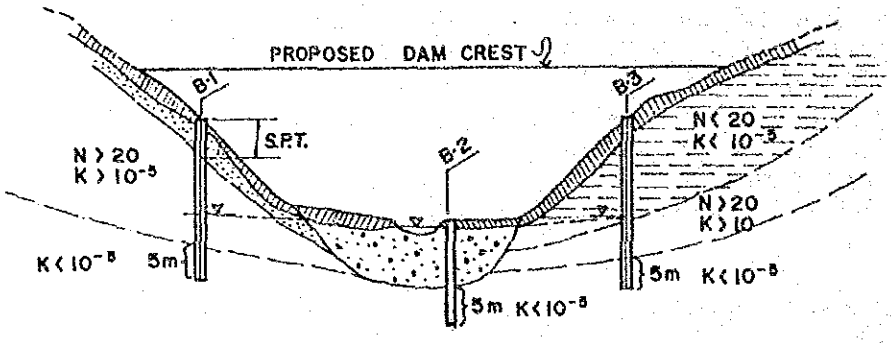
  In this stage of investigation, at least three drillings along the dam axis; at both sides of the river and river bed, shall be required. Permeability test and standard penetration test utilizing boreholes shall be required. Standard drilling depth at the dam site should be not less than 2/3 of the dam height and drilling shall be conducted up to a depth where ground water level is confirmed. Drilling depth of bed rock (Bed rock is considered to be N-value > 20 on 3 consecutive readings and K-value < 10^{-5} cm^2/sec) shall be in principle at least 5 m for confirmation.

- In case of dam height of less than 15 m ($H < 15$ m);

  At least three auger drillings and cone penetrometer tests along the dam axis; at both sides of the river and river bed, shall be required. Permeability test utilizing the boreholes shall also be required every 5 meters. Standard depth of auger boring is 5 m each.

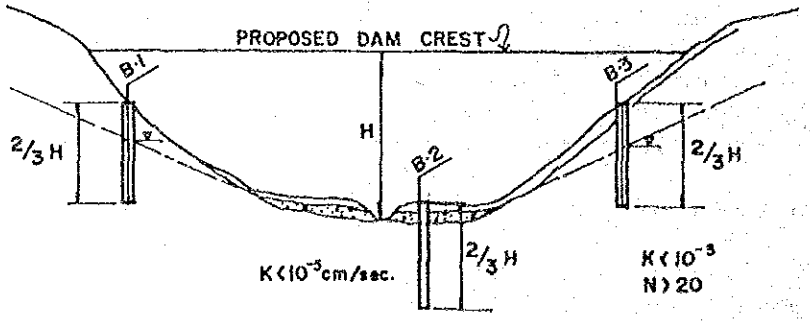


DRILLING LOCATION PLAN



NOTE: PERMEAVILITY TEST EVERY 5m.
STANDARD PENETRATION TEST ; EVERY METER

CASE I : SOFT FOUNDATION



CASE II : HARD ROCK FOUNDATION

Fig.E.2.2 GUIDE FOR DRILLING

(b) Test pits

Test pits shall be adopted for the investigation of river bed deposit, and soft foundation. For river bed deposits of soft foundation, to determine the depth and the grain size distribution of the materials, cone penetrometer tests shall be done in the test pits, and disturbed and undisturbed samples for shearing test in the laboratory shall be collected.

If auger drilling cannot penetrate the hard rock foundation, test pit is recommended. Depth of the pit shall be up to the top of the foundation.

(4) Geological profile for dam site.

(a) The profile shall be a section along the dam axis as viewed from the upstream side.

(b) Scale shall be 1/200 to 1/500, and vertical and horizontal scales be same.

(c) Based on the results of drillings, rocks and their permeability shall be classified and indicated on the maps, and the ground water table be shown as well.

Existing Studies:

Items	DPWH	NIA	BSWM
Reconnaissance	-Ground surface geology	-Ground surface geology	-Ground surface geology
Investigation average number: boring depth:	-Boring 3 3-30 meters	-Boring 5 3-30 meters	-Auger boring 3 0.5-3 meters

2.1.6 Investigation on Construction Material

Location, quantity of deposits and other necessary data concerning required materials for dam construction shall be grasped through investigation, testing, etc.

Explanation:

(1) Items for investigation of construction material

(a) Deposit condition and available volume, engineering classification, and physical and mechanical properties

of materials in the reservoir and at dam site, particularly excavated materials from spillway site

(b) Selection of borrow area of core material

(c) Selection of borrow area of contact clay material

(d) Selection of borrow area of filters, concrete aggregates and riprap materials

The location and quantity of deposits for construction materials in each site shall be presented in the report.

(2) Test items on construction materials of dam including test of soft foundation

Dam Height	Material	Test Item
H < 15 M	Contact clay	Gs, Wf, LL, PL, SP
	Core	Gs, Wf, LL, PL, SP, rd, K, ϕ and C, Cd
	Random	Gs, Wf, LL, PL, SP
	Filter	Gs, SP, WG, K
	Concrete Aggregate	Gg, SP, WG, LA, Sb, LW
	Riprap	Gg, WG, Sb
	Soft foundation of dam	Undisturbed sample Gs, Wf, LL, PL, SP, ϕ and C, Cd
H $\geq$ 15 M	Contact clay	Gs, Wf, LL, PL, SP
	Core	Gs, Wf, LL, PL, SP, rd, K, ϕ and C, Cd
	Random	Gs, Wf, LL, PL, SP, rd, K, ϕ and C, Cd
	Filter	Gs, SP, WG, K
	Concrete Aggregate	Gg, SP, WG, LA, Sb, LW
	Riprap	Gg, WG, Sb
	Soft foundation	Undisturbed sample Gs, Wf, LL, PL, SP, ϕ and C, Cd

Legend:

Symbol	Test Item	Symbol	Test Item
Gs	Specific gravity of soil	Wf	Field water content
LL	Liquid limit	PL	Plastic limit
SP	Grain size analysis	Gg	Specific gravity of gravel

WG	Moisture absorption ratio	LA	Los Angeles rattler
Sb	Stability	LW	Loss by washing
rd	Compaction	K	Permeability
ϕ & C	Shearing	Cd	Consolidation

Note:(a) In case of semi-pervious to impervious material, the non-dry preparation and non-cyclic use shall be applied for compaction test, permeability test, shearing test and consolidation test.

(b) Compaction test energy is based on: Ec = 5.625 kg.cm/cm^3.

Ec = (WxHxNxL)/V (kg.cm/cm^3)

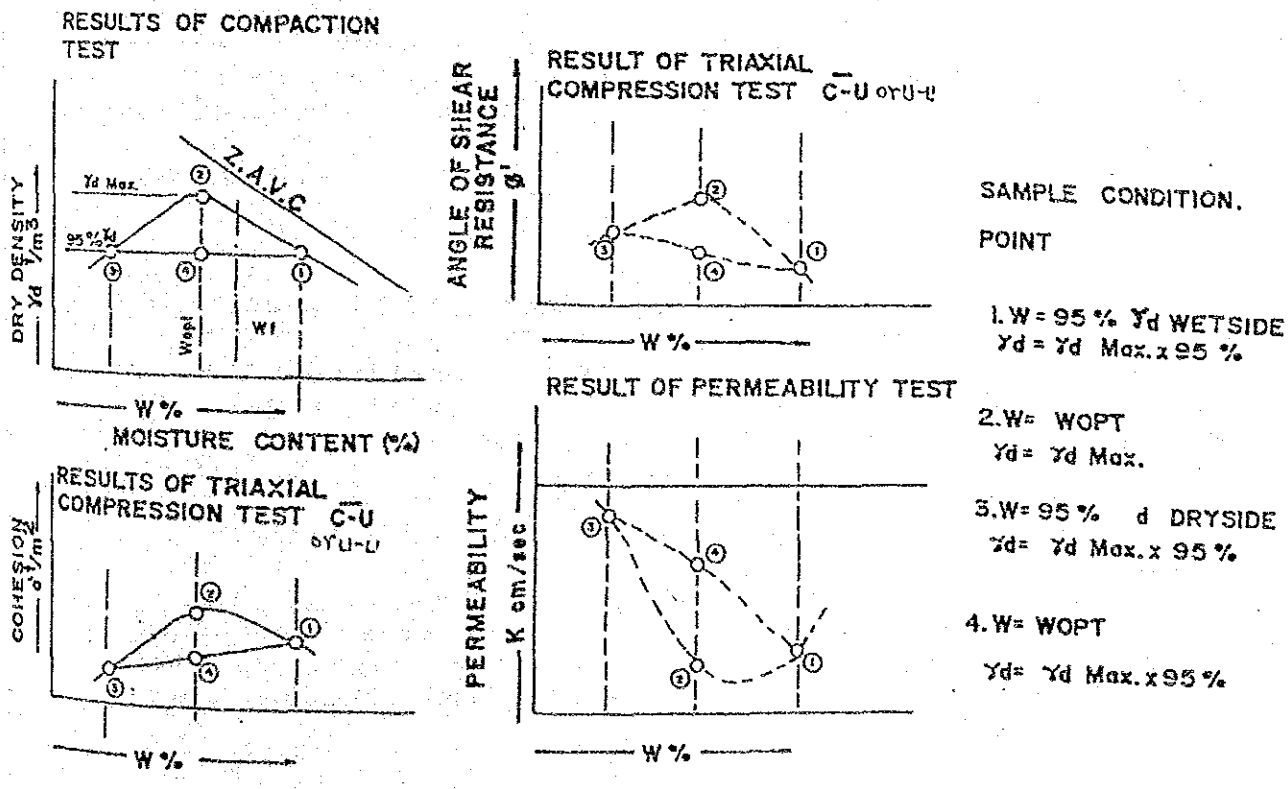
where, W : Rammer weight; 2.5 kg
H : Rammer drop height; 30 cm
N : Number of drops per layer; 30 times
L : Number of layers; 3 layers
V : Mold volume; 1,000 cm^3

(c) Shearing test

The shearing test shall be carried out by triaxial compression test, and test conditions be U-U test and C-U test.

(d) Conditions of sample

The sample conditions for permeability test and triaxial compression test are preferably as follows:



Existing Studies:

The summary of investigation and laboratory test of construction materials done by each agency are as follows:

Items	DPWH	NIA	BSWM
Objective	-fill type dam	-fill type dam	-fill type dam
Borrow area	-in reservoir and dam abutment	-in reservoir and dam abutment	-in reservoir and dam abutment
Concrete material	-sand/gravel in main river of project area	-sand/gravel in main river of project area	-sand/gravel in main river of project area
Test for impervious materials	-physical test and mechanical test*	-physical test and mechanical test*	-physical test only, mechanical test is done during construction.
Test for pervious materials	-no study	-no study	-no study

Remarks: *; Mechanical test includes compaction, permeability, triaxial compression, and consolidation tests.

Soil materials like high weathered rock are adopted to impervious zone and high permeable materials such as soft rock or gravel are adopted for pervious zone in case of zoned earthfill type dam.

2.1.7 Investigation on Land Acquisition and Compensation

Investigation on right of way, land acquisition and compensation shall be made through data collection in order to evaluate possibilities of construction of dam and to estimate these costs.

Explanation:

Investigation shall be made on the areas concerned to the proposed dam site and reservoir for right of way, land acquisition and compensation including the proposed access route to the project site.

Items to be investigated are as follows:

(1) Total areas for right of way, land acquisition and compensation related to the construction of dam

(2) Land use and land tenure conditions in the above areas

(3) Inventory of private and public properties except for land

(4) Cost data concerned to right of way, land acquisition and compensation

(5) Alternatives regarding relocation of farm lands, etc.

Existing Studies:

-Unknown

2.2 Agriculture and Irrigation

2.2.1 Investigation on Present Condition of Agriculture and Related Fields

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In order to provide necessary data for the formulation of agriculture and irrigation development plans, the present condition on following subjects shall be investigated:
(1) Natural Resources
(2) Socio-economy
(3) Agriculture

Explanation:

In order to formulate agriculture and irrigation development plans, it is necessary to know the present condition of the objective area and to grasp the problems encountered in the area. Followings shall be minimum requirement of the data for SWIM projects.

(1) Natural Resources

Items to be investigated and their study depth for SWIM projects shall be as follows:

(a) Meteorology; Following data shall be collected:

- Temperature : Monthly basis, average, at least 5 years
- Rainfall : Monthly and daily basis, at least 10 years

- Evaporation : Monthly basis

- Humidity : Monthly basis

- Solar Radiation: Monthly basis

- Wind Velocity : Monthly basis

(b) Hydrology; Run-off data shall be collected in monthly base for a period of at least 10 years. If run-off data is not available, it shall be analyzed from the run-off data of the river located adjacent to the proposed river basin or the river basin which has similar hydrological and topographical characteristics.

(c) Topography; Topographical map for the irrigation area shall be prepared in a scale of 1:4,000 with contour interval of 1 m.

(d) Soils; Soil survey shall be conducted according to the standard survey method in the Philippines only for the newly developed area. For already cultivated area, existing data on soil condition shall be collected. Also shall be checked if any physiological disease is observed in the area. Land classification map shall be prepared on a topographic map in a scale of 1:4,000.

(2) Socio-economy

Following items on socio-economy shall be investigated, especially for barangays to be included in the beneficial area:

(a) population; the number of available labor force shall be clarified.

(b) the number of farmers; the number of farmers in the study area shall be checked.

(c) farm holding size; farm holding size by family shall be examined.

(d) farmers' economy; present farmers' economy shall be investigated. Revenue (farm income, off-farm income and non-farm income) and expense (living expense by category such as food, education, farming, etc.) shall be described.

(e) land use; land use map of the study area shall be prepared. Such categories as agricultural land, pasture land, forest land, residential area, non-utilized land, etc. shall be classified.

(f) land tenure; land tenure by the scale of holding area shall be examined.

(g) water rights; the existence of water right in the objective river shall be confirmed.

(3) Agriculture

Following agricultural aspects shall be examined in the study area:

(a) cultivated crops by cropping season.

(b) cropping pattern including cropping calendar.

(c) cultivation area by cropping season and by crop

(d) farming practice including such items as the amount of seed sown, the amount of fertilizer and pesticides applied, labor input, farmers' cultivation method and technique, etc.

(e) yield and production by crop and by cropping season.

(f) unit price of farm input such as seed, fertilizer, agro-chemicals, labor wage by work item.

(g) farm budget calculated from the balance between production cost and gross benefit. Production cost and gross benefit shall be broken down into each item.

(h) agricultural supporting services including cooperatives, agricultural extension, agricultural credit, etc.

(i) considering above condition, problems encountered shall be described. Water shortage, lack of available labor force, insufficient amount of input, lack of developed land, low level of farmers' living standard, etc. may be raised as identified problems.

Existing Studies:

DPWH : Unknown.

NIA : Generally described.

BSWM : Unknown.

2.2.2 Investigation on Agricultural Infrastructures

For planning and basic design of irrigation facilities and related infrastructures, the investigation on the following items shall be carried out:
(1) Existing irrigation facilities
(2) Existing post-harvest facilities
(3) Other related infrastructures
(4) Construction materials

Explanation:

In order to get information on the present infrastructures and formulate facility plan, the inventory survey on the existing facilities relating to the irrigation development is indispensable. In most of the projects formulated by each agency, this investigation was not carried out. This investigation shall be done as follows:

(1) Existing irrigation facilities;

For the following facilities, their number, length and deteriorated condition shall be investigated:
- Intake facility
- Irrigation canal
- Drainage canal
- Related structures

(2) Existing post-harvest facilities;

For the following facilities, their number, capacity and operation condition shall be investigated:
- Rice milling facility
- Drying facility
- Storage facility

(3) Other related infrastructures;

For other related facilities, their present condition shall be investigated:
- Farm roads
- Communication
- Electricity

(4) Construction materials;

For structure plan and cost estimate, availability and price of construction materials shall be investigated.

Existing Studies:

Unknown.

2.3 Mini-hydropower

2.3.1 Power Market Survey

In order to make plan formulation of mini-hydropower for the SWIM project, the following power market survey shall be done.
(1) Present condition of power supply area
(2) Present and future power demand
(3) Power tariff

Explanation:

(1) Present condition of power supply area

In the power system of electric co-operative to which the proposed mini-hydropower station will supply the power, the existing and newly constructed power station, and transmission and distribution lines shall be investigated. Then, relation between the proposed mini-hydropower station and the existing power system, and present condition of power supply area shall be grasped exactly.

(2) Present and future power demand

In order to determine the scale of power generation, the present and future power demand in the power supply area besides the characteristics of usable water (discharge, head, etc.) is important.

Estimation of power demand shall be made by micro estimating methods for the SWIM project.

The micro estimating method employs the causal relationship between the elements forming the power demand and the causes as follows:

(a) Estimation related to private power demand; It shall be made based on population trend and per capita power consumption. In this case, it shall be noted that if the non-electrified area is electrified, people may move from adjacent districts to the electrified area, thereby creating a larger demand than predicted,

(b) Estimation related to commercial power demand; It shall be made based on commercial electric appliances diffusion ratio, and

(c) Estimation related to industrial power demand; It shall be made based on the change in power consumption rate in individual industry due to industrial structural change and technological renovation.

The survey and estimation of power demand shall be made with respect to maximum demand power and energy for every unit period such as a day, a month and a year.

(3) Power tariff

(a) For financial analysis, present and future power tariff of the electric cooperative shall be investigated.

(b) Furthermore, in case that the power system is supplied by neighboring National Power Corporation (NPC), the purchased power rate shall be investigated.

Existing Studies:

The power market survey has not been conducted. Only survey on present electrification condition has been conducted.

2.3.2 Survey on Alternative Power Plant

In order to estimate economic power benefit by development of mini-hydropower, the same scale diesel power plant as the proposed mini-hydropower plant shall be considered as an alternative power plant for the SWIM project, and fixed and variable annual costs of the diesel power plant shall be investigated.

Explanation:

(1) Fixed annual cost of the diesel power plant consists of annual equivalent cost of the construction cost, O&M cost and annual equivalent cost of replacement cost, in order to generate the same power (kW) as that of the proposed mini-hydropower plant.

(2) Variable annual cost of the diesel power plant is fuel cost for operation when the load to be generated by the proposed mini-hydropower plant is undertaken by the diesel power plant as the alternative power plant.

(3) As for estimation of economic power benefit, refer to Item 3.3.3 of this Criteria.

Existing Studies:

-Unknown

2.4 Water Supply For Domestic Use

2.4.1 Study on Water Supply Situation

In order to examine the possibility of water supply and to make a rural water supply plan, the following items shall be investigated.
(1) Water supply facilities
(2) Water quality

Explanation:

(1) Water Supply Facilities

The following items shall be investigated to know the water supply facilities of the planning area.

(a) Water Source

All possible water sources in the vicinity and their yield and quality shall be investigated. A physical inventory and survey of all existing water supply system and facilities including private wells shall be taken.

(b) Water Supply Volume

Investigation and estimation on the present water supply volume in each water source shall be made. Interview survey shall also be made if beneficiaries receive enough water for their domestic uses.

(c) Beneficiaries (service area)

The number of beneficiaries in each water source and the distance of the water source to the beneficiaries shall be determined/investigated. Communities with sources of water supply that are insufficient, that are unreliable or too far from the households will have higher priority. For the financial analysis of the project, the economic condition like annual income of the beneficiaries shall also be examined.

(d) Existing Water-born Disease

A survey shall be made to determine the prevalence of water-born diseases such as gastro enteritis, dysentery, schistosomiasis, cholera, typhoid fever, hepatitis, etc...

(2) Water Quality

Investigation on water quality includes inspection of all water supply sources to determine which of the sources are likely to be contaminated. Water samples will be collected from these sources for physico-chemical and bacteriological analysis. The Philippine Standards for Drinking Water (1978) provide the minimum standards for quality as follows:

Parameters	Maximum Permissible Level
A. Physical	
Color (units)	5 units
Odor, Threshold Odor No.(units)	Not more than 3
Solids, Total	500 mg/l
Turbidity, as SiO_2 (units)	5 units
B. Chemical	
Calcium	75 mg/l
Chloride	200 mg/l
Magnesium	50 mg/l
Nitrate as N	30 mg/l
Oil & Grease	Nil
pH	6.5 to 8.5
Phenolic Substance	0.001 mg/l
Sulfate	200 mg/l
C. Trace Elements	
Arsenic	0.05 mg/l
Barium	1.00 mg/l
Cadmium	0.01 mg/l
Chromium, Total	0.05 mg/l
Copper	1.00 mg/l
Cyanide	0.05 mg/l
Fluoride	0.06 mg/l
Iron	1.00 mg/l
Lead	0.05 mg/l
Manganese	0.50 mg/l
Mercury	0.002 mg/l
Selenium	0.01 mg/l
Zinc	5.00 mg/l
D. Radionuclide	
Alpha emitter, uuc/l	3 (gross alpha)
Beta emitter, uuc/l	30 (gross beta)
E. Pesticide	
Aldrin	0.001 mg/l
DDT	0.05 mg/l
Dieldrin	0.001 mg/l
Chlordane	0.003 mg/l
Endrin	0.0002 mg/l
Heptachlor	0.0001 mg/l
Lindane	0.004 mg/l
Toxaphene	0.005 mg/l
Methoxychlor	0.10 mg/l
PCB	Nil
2,4-D	0.10 mg/l
2,4,5-TP	0.01 mg/l
F. Bacteriological	
Coliform, MPN/100 ml	Not more than one for treated water Not more than 3 for untreated water

Source: Department of Public Works and Highways.

Existing Studies:

Study on water source:	Examined.
Study on water supply volume:	Unknown.
Study on beneficiaries:	Described, but economic study is not done.
Study on water-born diseases:	Unknown.
Study on water quality:	Examined.

2.5 Inland Fishery

2.5.1 Study on the Present Fishery Activity and Water Quality

In order to examine the possibility of future inland fishery development and to formulate a realistic development plan, the following items shall be studied.
(1) Present Fishery Activity
(2) Water Quality

Explanation:

Considering that main purpose of inland fishery is to provide protein products in a protein deficient community and that inland fishery development is a secondary purpose in the SWIM projects, objective beneficiaries shall be limited to those who live in the vicinity of a impoundment. Therefore, investigation on inland fishery shall be conducted with emphasis on such a limited area (eg. barangay level). Based on the above consideration, following items shall be investigated:

(1) Present Fishery Activity

Following items on present fishery activity shall be examined for the formulation of a plan. Not only data collection, but interview at site shall be made:

(a) Per capita fish consumption rate (demand) in the area,
(b) Present inland fishery activity,
(c) Inland fishery production (supply),
(d) Marketing system (trader, marketing place), and
(e) Fishery supporting system (cooperatives, extension services, etc.).

(2) Water Quality

Following items shall be investigated to confirm the technical soundness of development in terms of water quality:

(a) Presence of mining activity and/or human activity in the upstream of the river basin,

(b) Existing fauna and flora in the river (plankton, aquatic plant species, indigenous fish, predator, etc.), and

(c) Physico-chemical characteristics of water (temperature, transparency, color, odor, pH, dissolved oxygen, total hardness, etc.).

Existing Studies:

STUDY ITEM	DPWH	NIA	BSWM
1. Present Condition of Fish Consumption.	- a few reports mentioned based on the statistical data.	- Unknown.	- Unknown.
2. Future Demand Study	- a few reports presented on the basis of population and per capita consumption.	- Unknown.	- Unknown. - the necessity for increase of protein supply to the rural residents is considered.
3. Water Quality	- Unknown.	- Unknown.	- Unknown.

2.6 Flood Control

Flood control is regarded as incidental purpose in the SWIM Projects and its benefit is not counted in the direct benefit of the project. However, in order to discuss flood control effect of dam as a part of socio-economic impacts, necessary investigations shall be done.

Explanation:

In order to grasp the flooding condition and damageable cost in downstream area of the proposed dam site, the following items shall be investigated:

(1) some flood marks in the past and damages of crops, houses and other social infrastructures at the same time through hearing from inhabitants.

(2) extent of farmland and its cropping pattern, and number of house and social infrastructure, and their location.

2.7 Environmental Conservation

2.7.1 Investigation on Present Environmental Conditions

Present environmental conditions in the project including watershed and irrigation service area shall be investigated on the following items:
(1) Hydrology
(2) Ecology
(3) Socio-economic aspects
(4) Compensation in the inundated area

Explanation:

Investigation on the present environmental conditions aims at providing basic information on the environmental setting in the project area. This information will serve as basis for identifying the potential environmental impacts of the project. All environmental data gathered shall be appended to the report.

Investigation items shall be determined referring to the Ministry Order No.72 of DPWH, dated September 24, 1982. The minimum requirements of investigation items are listed as follows:

(1) Hydrology

(a) Surface water
- Quantity and quality
- Sedimentation/erosion

(b) Ground water
- Groundwater table

(2) Ecology

(a) Vegetation
- Forest cover, species and maturity
- Identification of rare or unique vegetation

(b) Fish and wildlife
- Distribution and relative abundance of species of animals and fish
- Identification of rare and endangered species.

(3) Socio-economic aspects

(a) Land use
- Existing land use patterns and plans
- Areas of special status, such as ecological reserves, nature reserves, military reserves, scenic spots, historic and cultural significance, etc.

(b) Public Health
- Health and living conditions

(c) Life Styles
- Existing lifestyles of the community, including cultural and spiritual community patterns.

(4) Compensation in the inundated area

- Existing housing facilities, business establishments, schools, etc. to be resettled.
- Land tenure and land use conditions to be inundated.
- Status of the families to be resettled.

Existing Studies:

-Unknown

2.8 Watershed Management

2.8.1 Investigation on Geographic Condition

Following geographic condition in the objective watershed area shall be examined:
(1) Location and accessibility
(2) Elevation
(3) Topography and geology
(4) Soils

Explanation:

It is important to know the overall condition of the watershed area. The following items shall be clarified through the examination of available data and site investigation:

(1) The location of the project area shall be described with such data as located barangays, municipalities, province and region, covering area, coordinates, etc., and also be indicated on a key map of the whole Philippines in a scale of 1:20,000,000. Accessibility shall be mentioned with the access road condition.

(2) Elevation

Through the site survey and the utilization of available topographic map, the range of elevation in the area shall roughly be examined.

(3) Topography and geology

Topographic condition shall be examined through map study using available maps in a scale of 1/10,000 to 1/50,000, supplemented by the site survey. The area shall be classified by the gradient of slope, and be shown on a

topographic map.

Geologic condition shall also be investigated based mainly on the available geological map. Geologically friable part shall especially be specified.

(4) Soils

Soil condition shall be clarified over the area through the available soil map and soil surveys. A soil capability map shall be prepared.

Existing Studies:

(1)	Location and accessibility;	Described. A location map also is prepared at a scale of 1:50,000.
(2)	Elevation;	Described.
(3)	Topography and geology;	Described. A geological map is prepared at a scale of 1:50,000.
(4)	Soils;	Described. A soil map is prepared at a scale of 1:50,000.

2.8.2 Investigation on Meteorology and Hydrology

The following items on meteorology and hydrology shall be studied:
(1) Temperature and humidity
(2) Rainfall
(3) River discharge
(4) Sediment load

Explanation:

Meteorological and hydrological data shall be collected and analyzed for the preparation of development plan including the selection of tree species to be introduced and the determination of implementation schedule.

(1) Temperature and humidity

Air temperature and relative humidity shall be collected from the meteorological station in the watershed area or the nearest area on monthly basis. Maximum, minimum and mean values shall be averaged and shown on the figure to know their seasonal fluctuation.

(2) Rainfall

Rainfall data including the amount of rainfall and the number of rainy days shall be collected on monthly basis. These data shall be presented in the same manner as the case of temperature and humidity.

(3) River discharge

Discharge record on the main river in the watershed area shall be collected on monthly basis, and presented in the same manner as the above. If run-off data is not available, shall be estimated it from rainfall data.

(4) Sediment load

Sediment load analysis shall be made through direct measurement of sediment load and the river discharge data.

Existing Studies:

(1)	Temperature and humidity;	Described in a table.
(2)	Rainfall;	Described.
(3)	River discharge;	Unknown.
(4)	Sediment load;	Unknown.

2.8.3 Investigation on Land Use and Land Tenure

Land Use and Land tenure conditions shall be examined.

Explanation:

(1) Land Use

Present land use condition shall be examined through the available map study followed by the site survey. Land use map shall be prepared with a scale of 1:50,000, classifying the watershed area into the following categories:

(a) Agricultural land (permanent and shifting),
(b) Grass land,
(c) Forest land (including plantation area),
(d) Residential/resettlement area, and
(e) Unutilized land

The area of each land use shall be presented.

(2) Land tenure

Land tenure condition in the watershed area shall be examined to know the location and area of private land. The

results shall be presented on the topographic map.

Existing Studies:

(1) Land use; Described. A land use map is prepared.
(2) Land tenure; Unknown.

2.8.4 Vegetation Condition

Vegetation condition in the watershed area shall be studied and classified into the following categories:
(1) Forest land
(2) Brush land
(3) Open land/Grass land
(4) Cultivated land

Explanation:

Vegetation condition shall be studied to have the general idea of formulating a watershed management plan. A vegetation map shall be prepared being classified into the following items:

(1) Forest land
(2) Brush land
(3) Open land/grass land
(4) Cultivated land

Existing Studies:

Unknown.

2.8.5 Investigation on Forest Condition

Present forest condition on the following items shall be examined:
(1) Forest type
(2) Main species
(3) Forest age
(4) The use of forest
(5) Forest production

Explanation:

(1) Forest type

Forest land shall further be classified into high forest

(the forest height is taller than 2 meters, maybe correspond to primary and secondary forests) and low forest (not more than 2 meters, maybe correspond to brush land).

(2) Main species

Major tree and undergrass species in the watershed area shall be examined. Five (5) to ten (10) major species shall be recorded every 200 meters of elevation.

(3) Forest age

Forest age of high forest shall be examined and classified by five years.

(4) The use of forest

The use of forest shall be studied and classified into the following uses:

(a) Production
- Timber
- Fuel wood
- Special forest products
- Others

(b) Protection
- Forest park
- Wildlife reserves
- Mossy forest
- Seed production
- Other reserves

(5) Forest production

The past record of forest production shall be examined in each forest use.

Existing Studies:

Unknown.

2.8.6 Investigation on Erosion Condition

Erosion condition in the watershed area shall be surveyed and the area be classified into the following four (4) degrees;
(1) Non to slight
(2) Slight to moderate
(3) Moderate to severe
(4) Severe to very severe

Explanation:

In order to formulate the erosion control plan, the present erosion condition of the watershed area shall be investigated and classified the area into the following four (4) degrees:

(1) Non to slight
(2) Slight to moderate
(3) Moderate to severe
(4) Severe to very severe

Existing Studies:

Unknown.

2.8.7 Investigation on Socio-economic Condition

Present socio-economic condition in the area shall be studied on the following items:
(1) Population
(2) Ethnic groups and mother tongue
(3) Industrial activities
(4) Public services
(5) Infrastructure
(6) Past flood damage

Explanation:

(1) Population

Population data in the watershed area shall be collected and shown by each village. Available labor force shall be examined through the study on age structure.

(2) Ethnic groups and mother tongue

Ethnic groups and mother tongue in the watershed shall be checked.

(3) Industrial activities

Industrial activities in the area shall be examined according to the following categories:

(a) Agriculture
(b) Industry
(c) Services

Future development plans shall also be checked if any.

(4) Public services

The presence of public services on the followings in the watershed area shall be examined:

(a) Education
(b) Health
(c) Transportation/Communication
(d) Electricity
(e) Water supply
(f) Others

(5) Infrastructure

Present condition of related facilities shall be examined:

(a) Road
(b) Electricity
(c) Others

(6) Past flood damage

Past flood records and damages shall be collected.

Existing Studies:

(1)	Population;	Described.
(2)	Ethnic groups and mother tongue;	Described.
(3)	Industrial activities;	Described.
(4)	Public services;	Described.
(5)	Infrastructure;	Unknown.
(6)	Past flood damage;	Unknown.

2.8.8 Investigation on Construction Material

The availability of construction materials shall be investigated.

Explanation:

It would be ideal from the economic viewpoint if local material could be used as construction materials. The availability of necessary materials for soil conservation and/or the construction of check dams shall be examined on the following items:

(1) Stone; to be used as the materials of check dams and hillside work.

(2) Grass and trees; to be used for hillside planting and terracing.

(3) Cement and wires; to be used for check dams, waterway, etc.

Existing Studies:

Unknown.

3 GUIDELINE FOR PROJECT PLANNING

3.1 Dam

3.1.1 Run-off Analysis

Run-off analysis shall be conducted according to the following procedures:
(1) Data collection and checking the adequacy of the data
(2) Selection of methods of run-off analysis
(3) Analysis and verification of the results

Explanation:

(1) Data collection and checking the adequacy of the data

Following points shall be considered for the data collection and checking of data:

(a) Homogeneity of the meteorological data between project site and referred station from the viewpoints of distance, topography and difference of elevation, etc.

(b) A satisfactory streamflow record in a drainage basin of similar characteristics in the vicinity of the project site, in the case of no adequate data available on the specific stream.

(c) Reasonable relationships between the streamflow data and estimated rainfall of the watershed in terms of run-off coefficients and seasonable distribution.

(d) Argumentation of the data by statistical methods, etc.

(e) Effects of water intake on streamflow data.

(f) Proper adjustments of the streamflow data by means of double mass curve method or other statistical methods, etc., as deemed appropriate.

(g) Preparation of a map of the area above the damsite showing the drainage system, contours if available, drainage boundaries, and locations of any meteorological stations and streamflow gauging stations.

(h) Available data on geological conditions, soil types, cover and land use.

(2) Selection of methods of run-off analysis.

Proper method shall be selected based on the availability of the data. The following methods are recommendable:

(a) Regression analysis
(b) Drainage area proportion
(c) Thomas and Fiering model
(d) Tank model
(e) Run-off coefficient

(3) Analysis and verification of the results

(a) Computation

The inflow to the proposed damsite as the results of the analysis shall be computed for at least 10 years on monthly or 10-day basis.

(b) Checking of the results

The results of the analysis shall be verified at least on the annual run-off depths/coefficients which should be effected by the characteristics of meteorological, hydrological and watershed conditions of the project site.

For the reference, Fig.E.3.1 is attached to indicate the average annual run-off depths in relation to the drainage areas on each water resources region. Above figures have been derived from the previous study reports of the SWIM projects.

Existing Studies:

Methods of run-off analysis conducted by each agency are as follows:

Items	DPWH	NIA	BSWM
Method of analysis	-rainfall-run-off relationship, -Thomas Fiering Method, -drainage area proportion, -run-off coefficient	-rainfall-run-off relationship -Thomas Fiering Method, -drainage area proportion, -run-off coefficient	-monthly run-off coefficient in the same region using 80% or 50% dependable rainfall

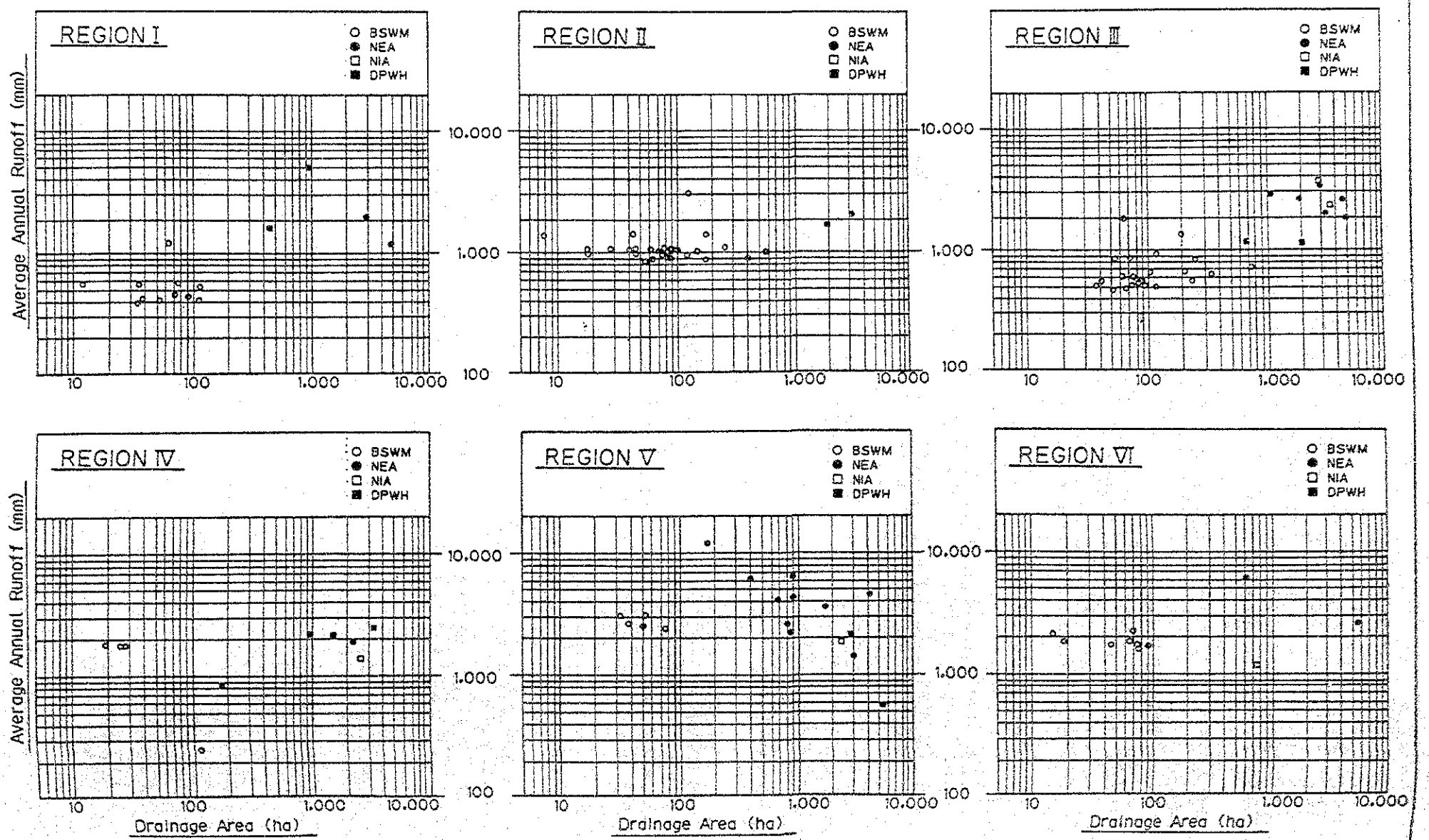


Fig.E.3.1 Relationship of Average Annual Runoff-Drainage Area (1/2)

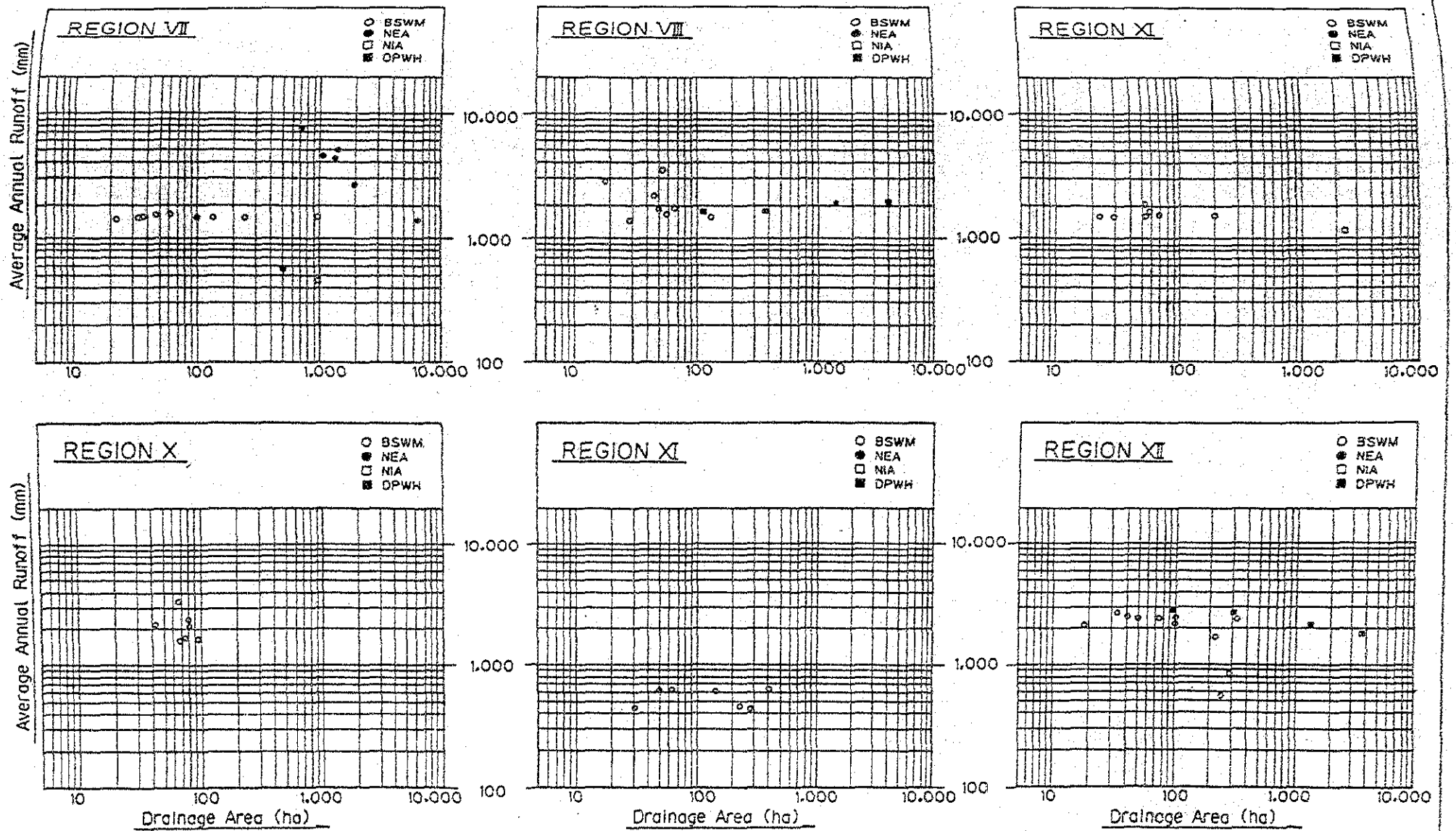


Fig.E.3.1 Relationship of Average Annual Runoff-Drainage Area (2/2)

3.1.2 Flood Analysis

Flood analysis on the inflow design flood for design of spillway shall be conducted according to the following procedures:
(1) Data collection and checking the adequacy of the data
(2) Computation of inflow design flood
(3) Magnitude criteria of flood and check of the results

Explanation:

(1) Data collection and checking the adequacy of the data.

Following points shall be considered on the data collection and check of data:

(a) Homogeneity of the storm intensities between project site and referred station from the viewpoints of distance and topography.

(b) A flood data from nearby watersheds of similar run-off characteristics, in case of no adequate data available on the specific stream.

(c) Critical rainfall pattern which tends to cause serious flood damages.

(d) Preparation of a map of the area above the damsite showing the drainage system, contours if available, drainage boundaries, and locations of any rainfall stations and streamflow gauging stations.

(e) Available data on soil types, cover, and land usage.

(2) Computation of inflow design flood

(a) Design storm

The incremental rainfall derived from the depth/intensity duration curve is rearranged to attain the most critical rainfall pattern or distribution. The initial and continuing losses are subtracted to the derivation of design storm.

(b) Unit hydrograph

- In case of the dam height of lower than about 15 m or small watershed:

Synthetic unit hydrograph shall be derived based on the SCS (SOIL CONSERVATION SERVICES OF THE U.S. DEPARTMENT OF AGRICULTURE) dimensionless unit hydrograph, and on the modified Snyder's method for the estimation of the lag time.

- In case of the dam height of higher than about 15 m:

  The unit hydrograph shall be developed from the mean dimensionless unit hydrograph derived from the referred river, and from the Snyder's method for the estimation of the lag time.

(c) Rainfall-runoff routing using the unit hydrograph

After deriving the unit hydrograph, it shall be applied to the design storm by convolution with adjustment for base flow, resulting to the inflow design flood hydrograph.

(3) Magnitude criteria of flood and checking of the results

(a) Magnitude criteria

Magnitude of inflow design flood shall be standardized based on the dam height as follows:
-In case of dam height, H<15m: at least 25-year flood
-In case of dam height, H≥15m: at least 100-year flood

(b) Checking of the results

The results of the analysis should be checked in comparison to the existing data of inflow design floods of other projects.

Fig.3.1.2 is attached to serve as the data which indicate the inflow design floods in relation to the drainage areas on each water resources region. Above data have been derived from the previous study reports of the SWIM projects.

Existing Studies:

Items	DPWH	NIA	BSWM
Analysis of design storm	-Using rainfall depth-duration-frequency curve	-Using rainfall depth-duration-frequency curve	-Using rainfall depth-duration-frequency curve
Analysis of design flood	-Using method of mean dimensionless unit hydrograph	-Using method of mean dimensionless unit hydrograph	-Using method of SCS dimensionless unit hydrograph
Return period	-1/100	-1/100	-1/25

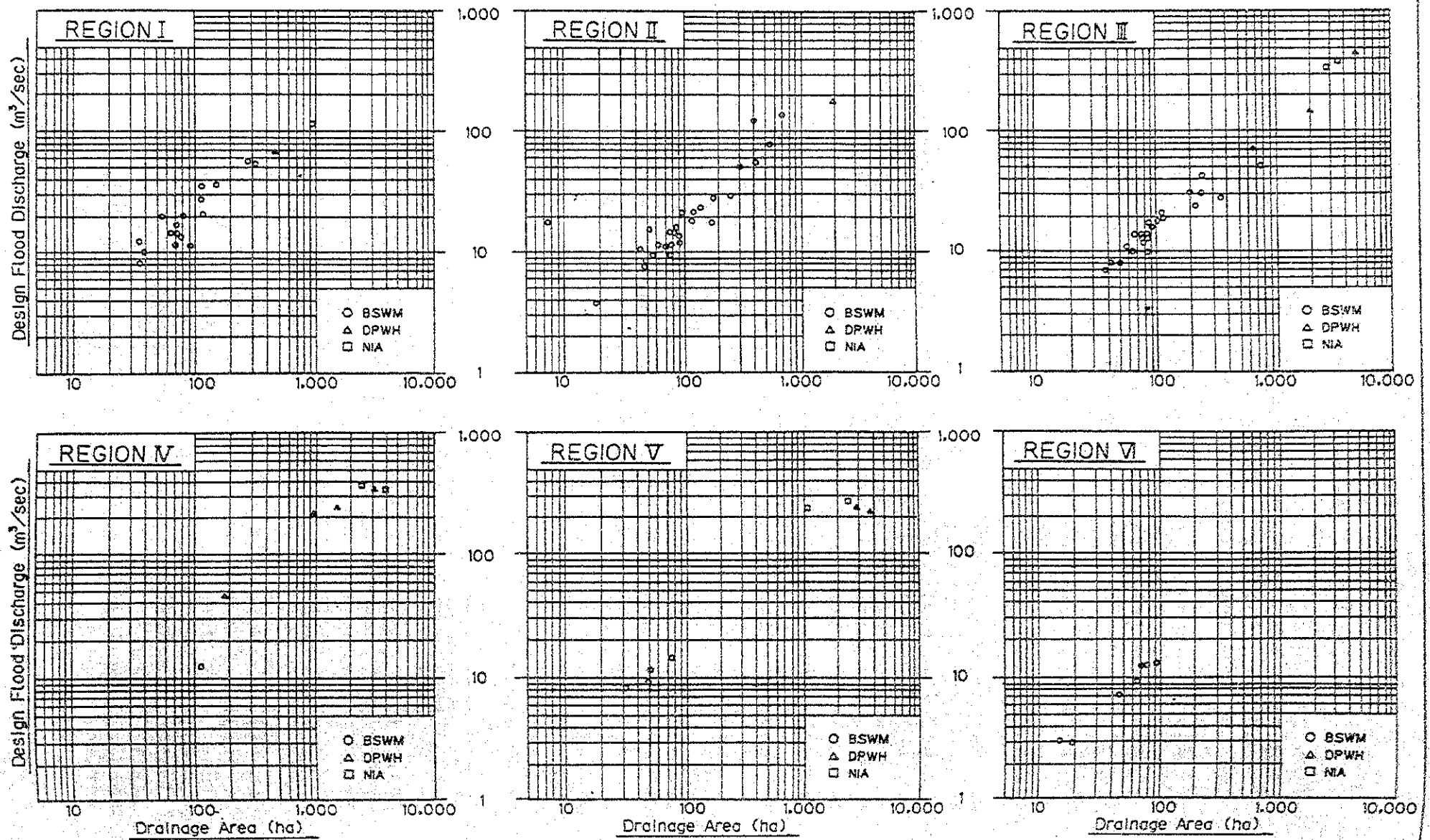


Fig.E.3.2 Relationship of Design Flood Discharge-Drainage Area (1/2)

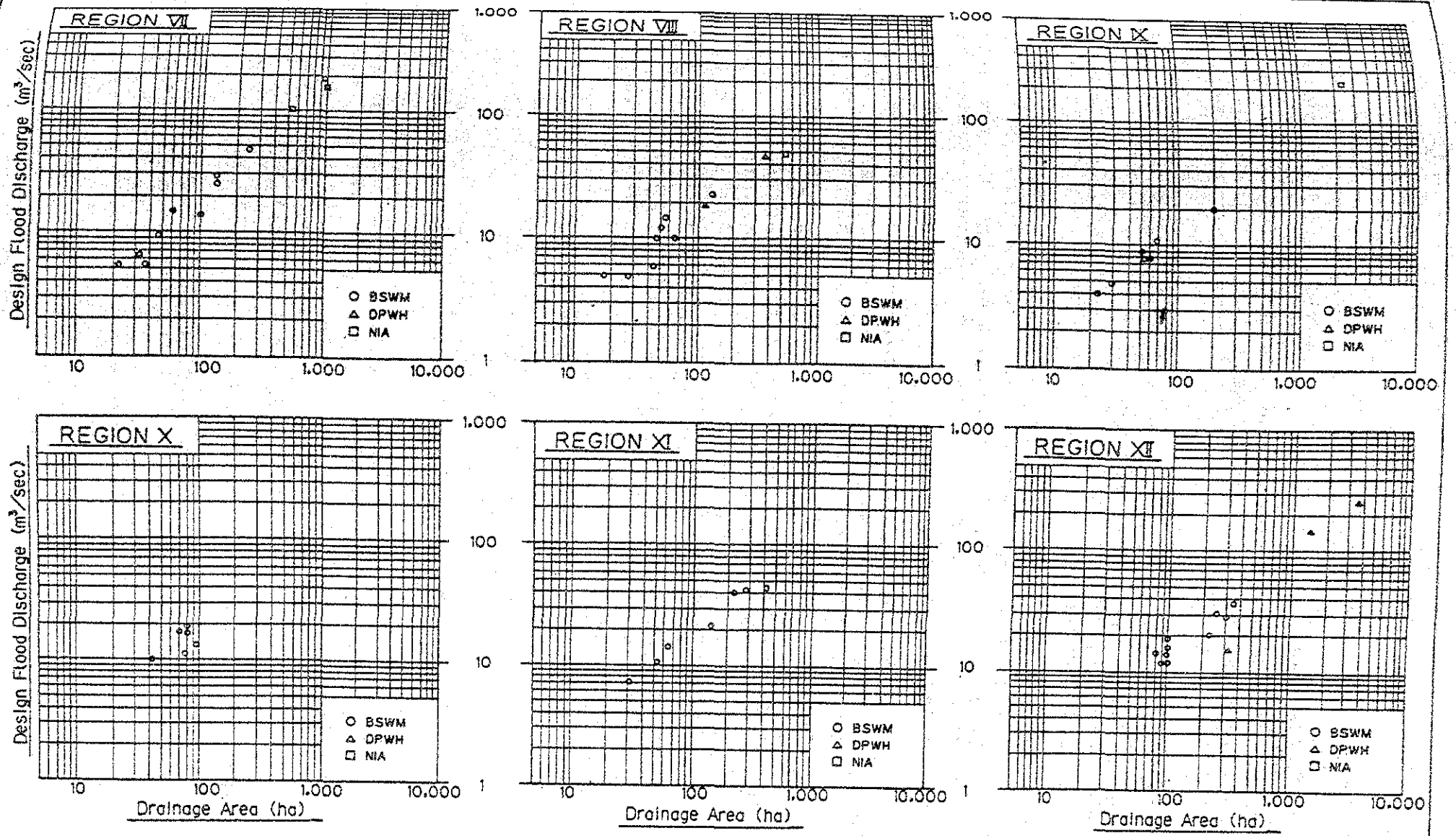


Fig.E.3.2 Relationship of Design Flood Discharge-Drainage Area (2/2)

3.1.3 Sediment Analysis

Sediment deposition in the reservoir shall be estimated based on the following procedures:
(1) Selection of method of sediment analysis
(2) Estimation of sediment volume and check of the results

Explanation:

(1) Selection of methods of sediment analysis

(a) Sediment sampling

Sampling is the surest method for accurately determining the sediment load being transported by a stream at a particular location and is the method preferable for determining the sediment inflow to a reservoir.

After the estimation of sediment inflow to a reservoir, the sediment volume can be estimated through determination of a trap efficiency and a unit weight of deposited sediment.

- For estimation of sediment inflow, using;
  - Sediment-rating curves
  - Flow-duration curves
  - Regression method, etc.

- For determination of trap efficiency, using;
  - Brune curve
  - Churchill curve, etc.

- For determination of unit weight of deposited sediment, using;
  - Lara and Pemberton method
  - Miller method, etc.

(b) Survey of existing reservoir

A survey of an existing reservoir in the same general area shall provide valuable data in determining sediment yield rates. Adjustments in the sediment yield rates shall be necessary to account for variation in drainage area characteristics of which the most important variations is the size of the drainage basin.

(c) Collection of existing data

Collection of existing sedimentation studies including sediment measurements seems to be the most practicable method for the feasibility study. Adjustments shall be necessary as mentioned above.

(2) Estimation of sediment volume and checking of the results

(a) Design sediment volume

Design sediment volume shall be estimated based on the design sedimentation rate and the design period of sediment accumulation.

The design sedimentation rates on the previous studies of SWIM projects are indicated on Fig.E.3.4.

The design sediment volume in the reservoir shall be standardized based on the dam height as follows:

- In case of dam height, H < 15m: at least 25-year accumulation
- In case of dam height, H $\geq$ 15m: at least 50-year accumulation

(b) Checking of the results

The results of the analysis shall be checked comparing with the value adopted in other projects.

Fig.E.3.3 and Fig.E.3.4 are attached to serve as the data which indicate the sediment yield/rate per year in relation to the drainage areas. Above data have been derived from the previous study reports of the SWIM projects.

Existing Studies:

DPWH and NIA study sedimentation in the reservoir referring to available existing data. BSWM estimates sediment yield on the basis of a regression equation developed by BSWM for small drainage area. Relations of sediment yield and sediment rate to drainage area in the previous studies are shown in Fig.E.3.3 for sediment yield and Fig.E.3.4 for sediment rate respectively.

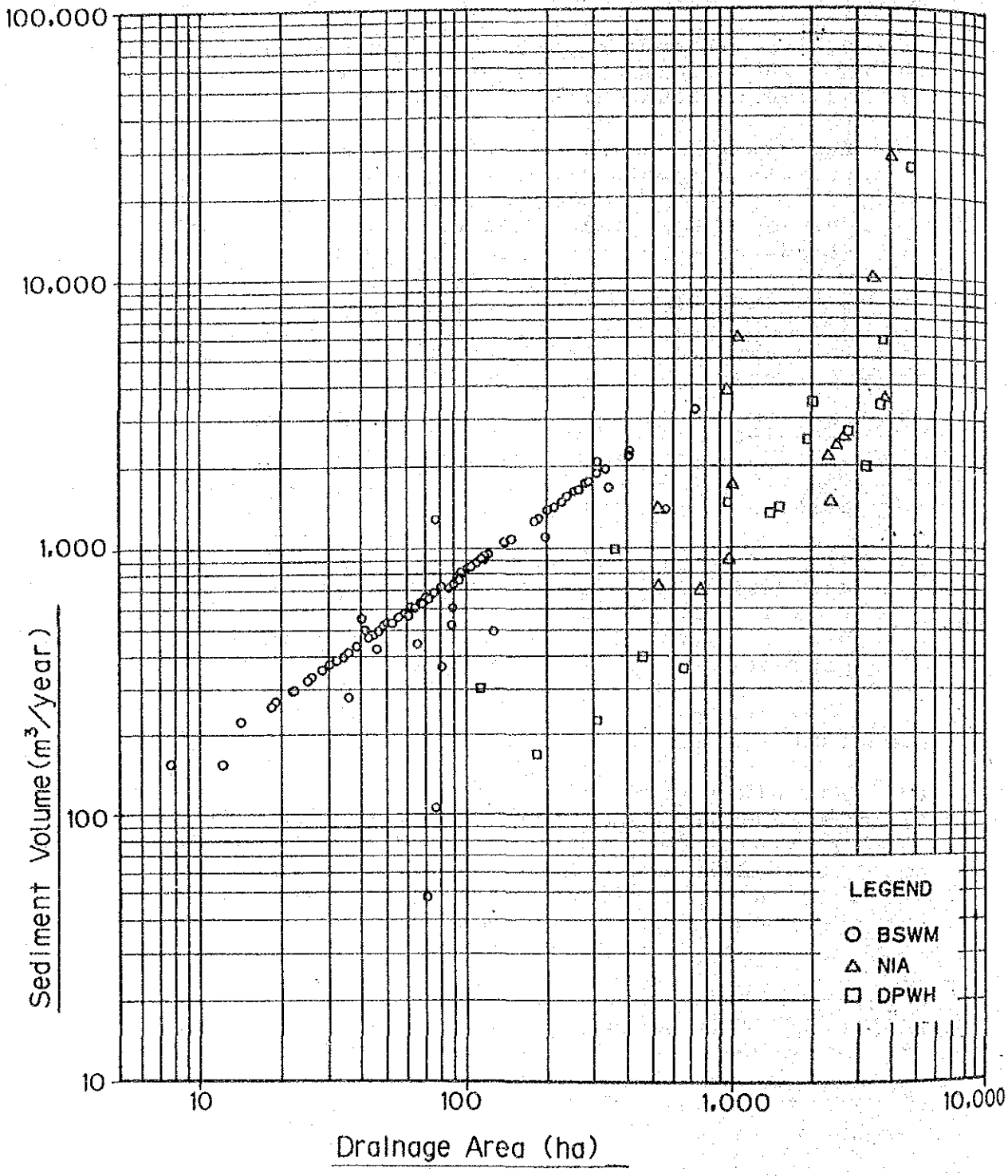


Fig.E.3.3 Relationship of Sediment Volume-Drainage Area

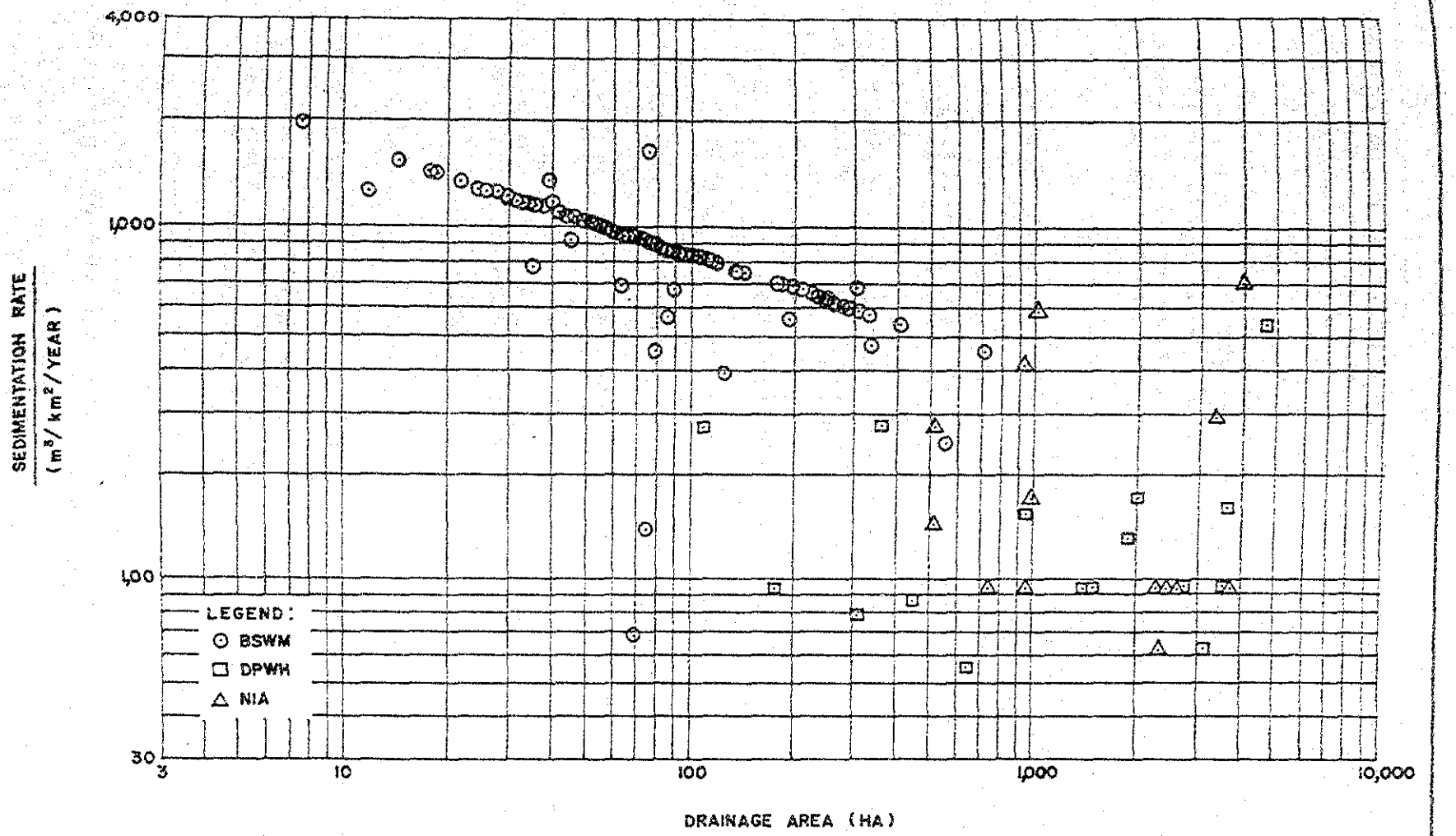


Fig.E.3.4 Relationship of Sediment Rate-Drainage Area

3.1.4 Determination of Storage Capacity

In order to determine the storage capacity of the reservoir, the water balance study shall be conducted.

Explanation:

(1) Water balance equation

The water balance study can be made by the following water balance equation:

$$I - O = S_{t+1} - S_t$$
$$S_{min} \leq S_{t+1}, S_t \leq S_{max}$$

where,

I : total inflow to the reservoir during a specific time period (MCM)

O : total outflow from the reservoir during the same specific time period (MCM), consisting of water releases for all purposes, such as irrigation, hydropower, water supply, existing water rights, if any, river maintenance flow, and evaporation losses and surplus water out of the reservoir.

S_{t+1}, S_t : storage at times (t+1) and (t) (MCM)

S_{min} : dead storage capacity (MCM)

S_{max} : maximum storage capacity subject to the topographic, geological and socio-economical conditions of the reservoir site (MCM)

(2) Input data

The data required for water balance study are as follows:

(a) Reservoir inflow

This consists of estimated run-off at the proposed damsite. Direct precipitation into the reservoir is considered to be a part of the inflow.

(b) Evaporation losses

The evaporation from the reservoir surface can be assumed to be at least 60% of the pan evaporation or calculated evaporation.

(c) Reservoir demand

This consists of irrigation, water supply and power demand.

(d) Existing water rights and river maintenance

Existing water rights and river maintenance flow should be counted in the water balance calculation with the first priority in the water demands newly developed.

(e) Storage-elevation-area relationship

Area-elevation-capacity curve should be prepared.

(f) Dead storage capacity

Dead storage capacity shall be determined in consideration of the sediment volume and inland fishery planning.

(3) Criteria to be used in the reservoir operation

In order to select the optimum reservoir capacity, several criteria have been established, which are based on experience and norms set forth for the effective utilization of the reservoir storage. In the SWIM projects, the following criteria shall be taken:

(a) Maximum shortage per year should be less than 50% of the average annual irrigation demand. If irrigation demand is computed on a 10-day basis, allowable consecutive periods of less than 50% shortage shall be two decades for rice and non for upland crops.

(b) Maximum cumulative shortage for any successive 10 years should be less than the average annual irrigation demand.

(c) No shortage of domestic water supply demand.

(d) The carryover period should be less than 12 months.

(e) The reliability of the reservoir should be above 80% to 85% for irrigation and 90% to 95% when combined with power.

(f) The average annual power plant factor should be above 40%.

(4) Reservoir operation

In case of multi-purpose projects, the water balance study shall be made after establishment of the priority of water utilization.

In case that the priority is given to irrigation compared with hydropower, the reservoir operation shall be first performed without the power component to determine the optimum irrigable area. Then reservoir operation shall be made to determine the optimum hydropower scale considering the different power alternative schemes, under the fixed reservoir scale and irrigation demand.

Existing Studies:

The dam scale is determined based on the following procedure:

- In order to meet irrigation water requirement for potential irrigation area, scale of dam reservoir is determined.

- If possible maximum dam reservoir can not cover the above irrigation requirement, scale of dam reservoir is determined at physical maximum scale, considering available water resource. Then irrigation area is reduced to meet the dam scale.

- Study on mini-hydropower development plan is made with the above fixed dam scale, considering the maximum use of river flow in the rainy season.

  During the course of water balance study, reservoir operation is made based on the following condition:

  (a) Interval, period, inflow, irrigation water requirement(IWR) are as follows:

Agency	Interval	Period	Inflow	IWR
DPWH	Monthly	10-44 years	Estimated	Monthly
NIA	Monthly	17-50 years	Estimated	Monthly
BSWM	10-day	1 year	80% dependable	10-day

  (b) Sedimentation volume in reservoir capacity is estimated based on the following term:

  DPWH: 50 years
  NIA : 50 years
  BSWM: 25 years

  (c) Evaporation rate is considered as follows:

  DPWH: 60% of pan evaporation rate
  NIA : 60% of pan evaporation rate
  BSWM: 100% of pan evaporation rate

(d) Criteria adopted for reservoir operation is as follows:

DPWH/NIA: following NIA criteria as;

- Maximum shortage per year should be less than 50% of the average annual demand.
- Maximum cumulative shortage for any successive 10 years should be less than the average annual demand.
- The carry-over period should be less than 12 months for small reservoir.

BSWM: Ensuring 100% of water demand

The relation between storage capacities and irrigation areas formulated by each agency in the existing studies are shown in Fig.E.3.5.

3.1.5 Selection of Damsite

An appropriate damsite shall be selected, fulfilling the items stipulated hereunder.

Explanation:

(1) Adaptability to development purpose

The damsite should be as near as possible to the benefit area and have a sufficient catchment area (including indirect catchment) to fulfill the development objective. In case of direct diversion of water from the dam, the location of the dam must be selected so that water can be conveyed to the benefit area by gravity flow.

(2) Adverse environmental impacts

Even if the damsite seems preferable from engineering viewpoints, the scale of land acquisition and compensation, and influence to farm land, forest, villages, road, fisheries, cultural assets, natural monuments, ecological relationship, etc. must be carefully examined.

In the preparation of the land acquisition and compensation program for the submerged area, resettlement of households and regional development around the dam site and reservoir must also be considered.

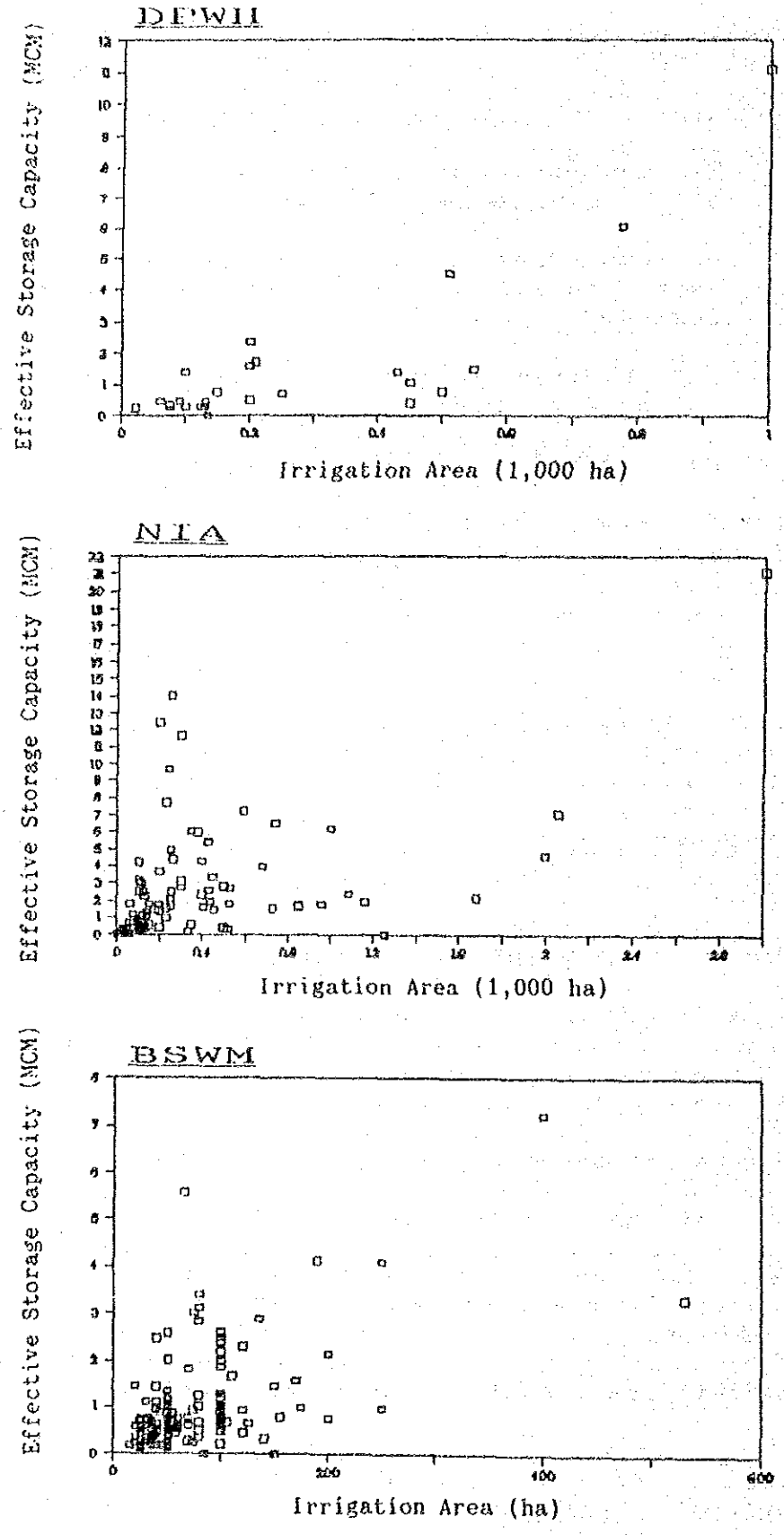


Fig.E.3.5 Relation Between Irrigation Area and Storage Capacity

(3) Relationship with other long term development plans

The proposed project must be integrated with the existing projects and future development plans. Therefore, these projects and plans must be carefully studied.

(4) Dam engineering

(a) Dam foundation and the subsurface condition of reservoir area shall possess required water tightness and strength, and be sufficiently safe against sliding failure or seepage failure.

(b) The location of the spillway, outlet works, construction of access road, temporary facilities, and embankment material must be examined carefully.

Existing Studies:

The relation between storage capacities and catchment areas at the proposed dam site in the existing studies is shown in Fig.3.1.6.

3.1.6 Selection of Dam Type

The dam type shall be selected taking into consideration the stability of embankment, easiness of construction and economic viability.

Explanation:

Dam type shall be selected through the examination on the following items:

(1) Condition of dam foundation,
(2) Quantity and quality of available embankment materials including excavated materials from spillway and other structure sites,
(3) Easiness of construction, and
(4) Dam scale.

Note: The above explanation is made only for fill type dams since all of the SWIM projects have formulated with fill type dams. However, concrete type dam may be considered upon the following conditions:

(a) Dam foundation is of rock with enough bearing capacity for concrete dam.
(b) Damsite is located at narrow riverbed with steep slope and embankment volume is considered to be very small.

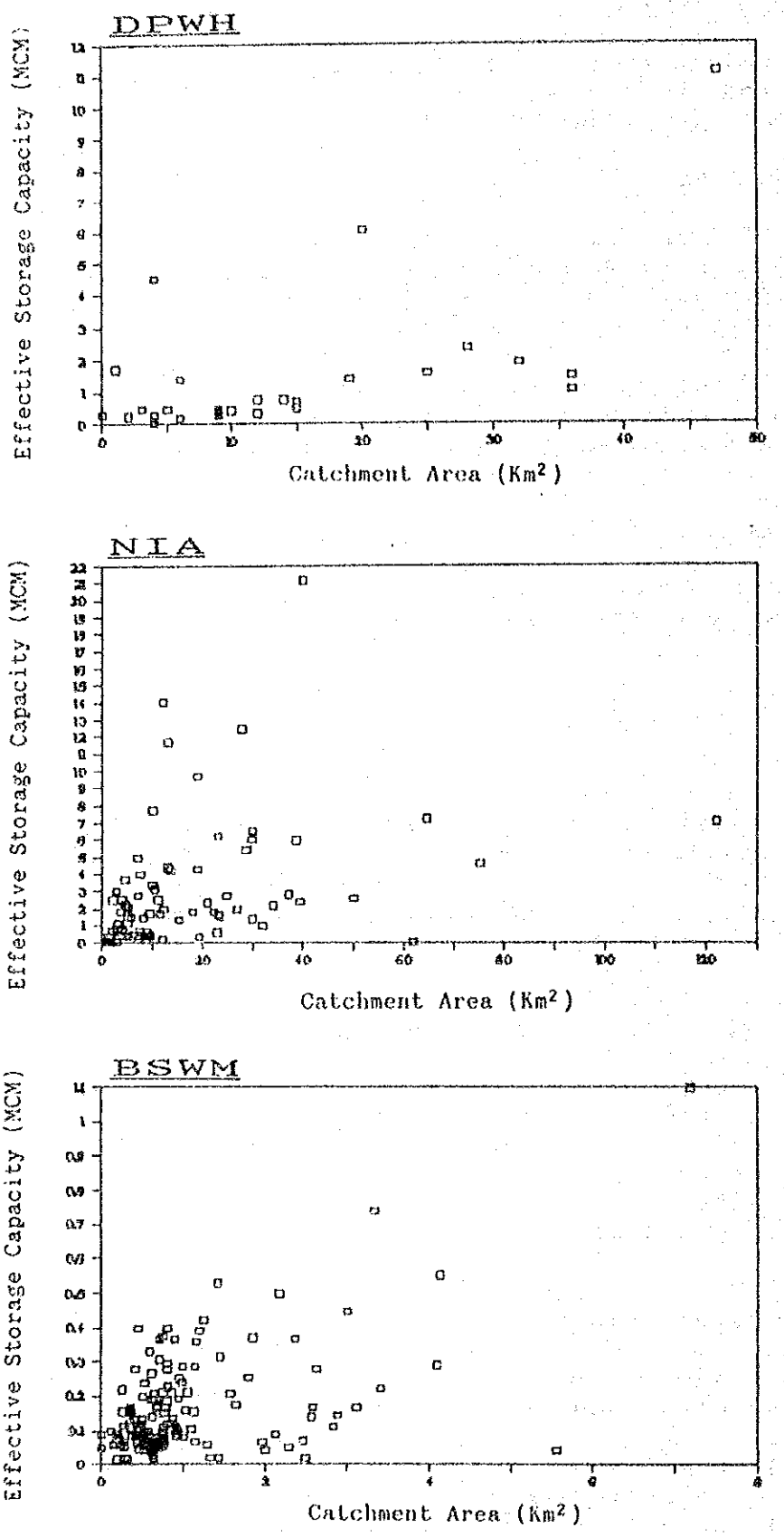


Fig.E.3.6 Relation Between Catchment Area and Storage Capacity

(c) Construction materials for concrete aggregate is available.
(d) Construction cost of spillway in fill type dam is considered expensive.

Existing Studies:

Items	DPWH	NIA	BSWM
Dam type	-zoned earthfill	-zoned earthfill	-homogeneous earthfill
Zone	-impervious -pervious -filter -toe drain	-impervious -pervious -filter -toe drain	-impervious -toe drain

3.2 Agriculture and Irrigation

3.2.1 Formulation of Agricultural Development Plan

A agricultural development plan shall be formulated through the following studies:
(1) Selection of crop
(2) Determination of cropping pattern
(3) Determination of target yield
(4) Preparation of proposed farming practice
(5) Estimation of labor requirement
(6) Estimation of production cost
(7) Study on agricultural supporting services

Explanation:

A development plan shall be formulated so as to produce maximum benefit making most of the human, water, and land resources. In order to make a practical development plan, the following items shall be studied:

(1) Selection of crop

Main crop to be introduced shall be rice. In selection of rice variety, following features shall mainly be considered:
(a) yielding ability,
(b) adaptability to the environment, especially climate,
(c) growth duration

In case of selecting upland crops as a second crop (crop diversification), following items shall be checked.
(a) adaptability to the natural condition including climate

and soil,
(b) the preference of the farmers,
(c) marketability, and
(d) profitability.

Second crops shall also be selected not to overlap their growth period with the main crop.

(2) Determination of cropping pattern

In the determination of cropping pattern, sowing time of crops shall firstly be determined. In the determination of the sowing time, as an example of rice cultivation, following shall be considered so as to assure high production:

(a) proposed sowing time shall not be much different from that in present farming system,

(b) In panicle initiation stage, low temperature shall be avoided,

(c) In maturity period, sufficient solar radiation shall be assured.

In order to make most of available land, water and human resources, the sowing period shall generally have allowance for up to one month within one area. This time lag shall be determined through the balance study of labor requirement and irrigation water requirement in the area. For example, the amount of labor requirement in the area shall be totaled on 10-day basis throughout the firstly planned standard cropping period. If the labor requirement exceed the number of available labor force in the area at any period, it is recommendable to adopt rotation work to minimize extra expenses. Water balance study between available water and irrigation water requirement shall be made in the same way.

(3) Determination of target yield

Target yield shall be determined taking the following factors into consideration:

(a) yielding ability of proposed crop/variety,
(b) climate and soil condition in the area, and
(c) farmers' skillfulness.

Target yield shall generally be 4.5 to 5.0 tons/ha in case of rice, though it depends upon the above conditions. Build-up period to attain the target yield after completion of the project shall be set to about 3 years in most crops.

(4) Preparation of proposed farming practice

Based on the proposed cropping pattern and target yield, proposed farming practice shall be prepared. For the SWIM

projects, farm mechanization shall not be considered except land preparation work, considering small scale agriculture development.
An example of proposed farming practice of rice is shown below :

Item	Description
Variety	IR series
Growth Duration	115 - 135 days
Planting	
Method	Transplanting
Nursery area	1/20 to 1/25 of planting area
Amount of seed	60 kg/ha of planting area
Nursery period	20 to 25 days
Planting density	30 cm x 15 cm, 3 seedlings per hill
Land Preparation	
Plowing: 1 time; Harrowing: 2 times; Puddling: 1 time	
Fertilizer Application	
Application rate	
N	75 kgN/ha for wet season
	80 kgN/ha for dry season
P	70 kgP_2O_5/ha for both seasons
K	50 kgK_2O/ha for both seasons
Time of application	
At nursery	5 kgN/ha
Basal application	at puddling
	20 kgN/ha, 70 kgP_2O_5/ha and 50 kgK_2O/ha
Top dressing (1)	2 weeks after transplanting: 20 kgN/ha
Top dressing (2)	2 weeks before heading: 30 - 35 kgN/ha
Weeding (manual)	4 times (3-week interval after transplanting)
Pest Control	3 liters/ha.
Harvesting	Manual harvesting

(5) Estimation of labor requirement

Based on the proposed farming practice and target yield, the required labor force shall be estimated. Labor requirement shall be classified by each work item including land preparation, sowing, transplanting, weeding, top dressing, spraying, harvesting, etc., and shall be expressed as man-days/ha.

(6) Estimation of production cost

Production cost shall be estimated by summing up the following costs:

Seed cost (₱): {Unit price of seed (₱/kg)} x {The amount of seed used (kg)}

Cost of fertilizer (₱): {Unit price of fertilizer (₱/kg)} x {The required amount of fertilizer (kg)}

Cost of Agro-chemicals (₱): {Unit price of agro-chemicals (₱/kg)} x {The necessary amount of agro-chemicals (kg)}

Labor cost (₱): {Unit wage of labor (₱/day)} x {The required number of labors (man-days)}

(7) Study on agricultural supporting services

Necessary recommendation on agricultural supporting services shall be made after examination of present condition.

Existing Studies:

DPWH :
- Rice-rice double cropping, target yield set at 4 to 5 tons/ha.
- Proposed cropping pattern is presented.
- Agricultural development plan including farming practice and labor requirement is unknown.
- Institutional plan is unknown.

NIA :
- Rice-rice double cropping, target yield 3.8 to 4.5 tons/ha depending on the cropping season.
- Proposed cropping pattern and farming practice are described.
- All the projects are related with communal irrigation under NIA.

BSWM :
- Generally rice-upland double cropping or rice-upland-upland triple cropping is planned. Target yield of rice is set at 4 to 6 tons/ha.
- Proposed cropping pattern is presented.
- Agricultural development plan such as farming practice and labor requirement is unknown.

3.2.2 Formulation of Irrigation Development Plan

The irrigation development plan shall be formulated through the following studies:
(1) Selection of irrigation area
(2) Estimation of irrigation water requirement
(3) Preliminary design of required facilities

Explanation:

In order to ensure the irrigation benefit by dam construction, the following studies on irrigation development shall be made and incorporated in the report:

(1) Selection of irrigation area

Study on selection of irrigation area shall be made using the topographic map in a scale of 1/4,000 with a contour interval of not more than 1 m, and its location be shown in the report. The following procedure shall be taken for selection of irrigation area;

(a) Determination of potential irrigation area considering topography, soils and present land use
(b) Determination of irrigable area by dam reservoir through water balance study
(c) Delineation of irrigation area

(2) Estimation of irrigation water requirement

For water balance study and facility design of irrigation canal, irrigation water requirement shall be estimated. For that purpose, irrigation water requirements shall be estimated on monthly basis and for at least 10 years. In the past SWIM reports, the various procedures for estimation of irrigation water requirement are introduced. In this Criteria, the standard calculation procedure of irrigation water requirement for rice which is mostly a main crop in SWIM, and standard value are explained as follows:

(a) Calculation formula;

$$IWR=(LP+ETp\times C+P-ER)/IE$$

where,
IWR: irrigation water requirement(mm)
LP : land preparation requirement including nursery water requirement(mm)
ETp: potential evapotranspiration(mm)
C : crop coefficient
P : percolation(mm)
ER : effective rainfall(mm)
IE : irrigation efficiency

(b) Calculation basis; monthly basis

(c) Land preparation requirement; 200 to 300mm for 30 days

(d) Potential evapotranspiration;

If evaporation data is available: equal to evaporation
If it is not available: calculated by Penman method

(e) Crop coefficient; 1.1 for all growing stages

(f) Percolation; 1 to 2 mm/day

(g) Effective rainfall; (monthly rainfall)x0.8

(h) Irrigation efficiency;

On-farm efficiency : 0.75
Conveyance efficiency: 0.8
Operation efficiency : 0.9
Overall efficiency : 0.54

(3) Preliminary design of facilities

The preliminary design of required facilities shall be made for estimation of construction cost of required facilities. The following results shall be incorporated in the report:

(a) Design Irrigation Water requirement
- 80% dependable irrigation water requirement
- Standard design irrigation water requirement; 1.2 to 1.8 l/s/ha

(b) Feature of facilities
- Type, size and total length of main and lateral irrigation canals and drains
- Feature and number of related facilities
- Feature of on-farm facilities

(c) Preliminary design drawings
- Layout map of canal (Scale:1/4,000)
- Irrigation diagram (schematic drawing of system capacity)
- Profile of main irrigation canal (Scale; Horizontal: 1/4,000, Vertical: 1/100)
- Typical drawings of canal and related structures

Existing Studies:

(1) Selection of Irrigation Area

Location map of irrigation area is attached to the all feasibility study reports, but the following consideration is not enough in each report:

PMO-SWIM: - Potentiality of area
- Present irrigation condition
- Extent of irrigable area

NIA : - Potentiality of area

BSWM : - Potentiality of area
- Present irrigation condition

(2) Irrigation Water Requirement

Method of estimation of irrigation water requirement is different among the three agencies. The standard value and

method used in the estimation are as follows:

Item	PMO-SWIM	NIA	BSWM
Calculation Basis	Monthly	Monthly	10-day
Evapotranspiration	from evaporation	by Penman method	from evaporation
Percolation Rate	2 mm/day	2 mm/day	1 mm/day
Land Preparation	200 mm to 300 mm	200 mm to 300 mm	Not included
Effective Rainfall	from daily balance method	from daily balance method	80% dependable rainfall
Irrigation Efficiency	40% to 70%	40% to 60%	50% to 55%
Water Requirement	1.1 to 2.8 l/s/ha	0.7 to 1.9 l/s/ha	0.7 to 3.6 l/s/ha

In the estimation of irrigation water requirement, there are some characteristics among three agencies as follows:

PMO-SWIM: - Crop coefficient is not considered for calculation of crop water requirement.
- Diversion water requirement is estimated, but water requirement for design of irrigation facility is not estimated.

NIA : - Crop coefficient is not considered.

BSWM : - Crop coefficient is considered.
- Land preparation requirement is not counted in estimation of water requirement, but it is considered at water balance study.
- Rainfall with 80% dependability is used as effective rainfall.

(3) Design of Irrigation Facility

Design water requirement for irrigation facility is not clearly mentioned in the reports. Design of irrigation facility is not made in the feasibility studies.

BSWM conducts the detailed engineering design just after the feasibility study, and the design of irrigation facility is included in the detailed drawings. The design of irrigation facilities is typicalized in the drawings.

3.2.3 Estimation of Agricultural Benefit

Based on the agricultural and irrigation development plans, the incremental agricultural benefit shall be estimated in both financial and economic basis:

Explanation:

Financial agricultural benefit of the project shall be estimated using market prices for both products and inputs, by subtracting without-project benefit from with-project benefit as following procedure:

(1) Without-project benefit

For estimating without-project benefit, present condition shall be applied. Net benefit shall be calculated as follows:

Net Benefit = (Gross Benefit) - (Production Cost at present condition)

where,

Gross benefit = {Cropped area (ha)} x {Unit yield of crop (tons/ha)} x {Unit price of crop at farm gate (₱/ton)}

Production cost = Total costs for labor, animal, machinery, seed, fertilizer, and agro-chemicals

(2) With-project benefit

In the estimation of with-project benefit, the condition on proposed development plan shall be applied. Net benefit shall be calculated as follows:

Net Benefit = (Gross Benefit) - (Production Cost at proposed condition)

where,

Gross benefit = {Cropped area (ha)} x {Unit yield of crop (tons/ha)} x {Unit price of crop at farm gate (₱/ton)}

Production cost = Total costs for labor, animal, machinery, seed, fertilizer, and agro-chemicals

(3) Estimation of financial incremental benefit

Financial incremental benefit of the project shall be obtained by subtracting without-project benefit from with-project benefit.

For obtaining economic incremental benefit, all prices or costs in financial basis shall be converted into those in economic basis, adopting conversion factors issued by National Economic Development Authority (NEDA). Calculation shall be made in the same way as the above.

Existing Studies:

Incremental benefit is estimated in all the projects under DPWH, NIA and BSWM.

3.3 Mini-hydropower

3.3.1 Formulation of Mini-hydropower Development Plan

In case that the priority of water utilization is given to other water demands than the mini-hydropower, the mini-hydropower development shall be formulated so as to utilize diversion water for irrigation, water supply, etc.

Explanation:

(1) Mini-hydropower generation is of dam/reservoir type. However, in case that hydropower generation is considered as secondary benefit, the reservoir capacity will not include the capacity to be utilized only for power generation. The mini-hydropower development shall be formulated with regulated outflow for irrigation, water supply, etc. and ineffective water from dam (surplus water). In this case, the firm energy can not be expected.

In case that the mini-hydropower is the main purpose of the project, the most suitable scale of power generation shall be firstly determined considering power demand in the vicinity area. Then the other development shall be formulated using remaining water resources.

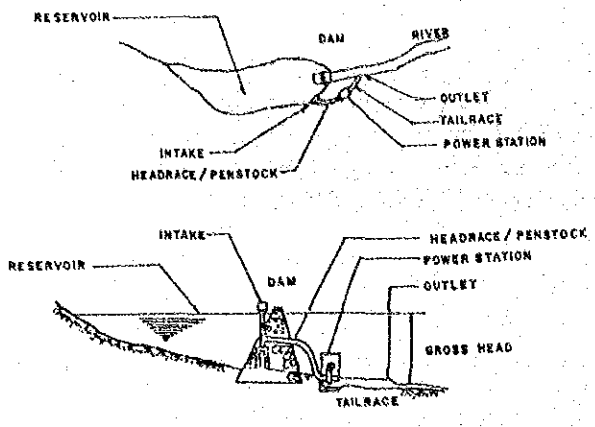


Fig.E.3.6 DAM TYPE POWER STATION

Existing Studies:

Most of the mini-hydropower development plans set forth in the existing studies are the secondary purposes of the projects.

3.3.2 Determination of Scale of Mini-hydropower

In order to determine scale of mini-hydropower development, the followings shall be examined:
(1) Reservoir water level
(2) Net head
(3) Maximum turbine discharge
(4) Selection of turbine type and output
(5) Annual possible power generation energy

Explanation:

(1) Reservoir water level

(a) Maximum water level for power generation

In principle, maximum water level is determined by the allowable range of discharge variation of the hydraulic turbine so as to maintain the maximum output. As a rule, maximum water level is selected to be the normal full water level.

(b) Weighted average water level

Weighted average water level is determined from reservoir operation calculation and is basis for design head to determine the dimensions and characteristics of the turbine.

(c) Minimum water level for power generation

Minimum water level is determined by the allowable range of discharge variation of the hydraulic turbine (refer to (3) of Item 3.3.2) and equal to or higher than the low water level of the reservoir.

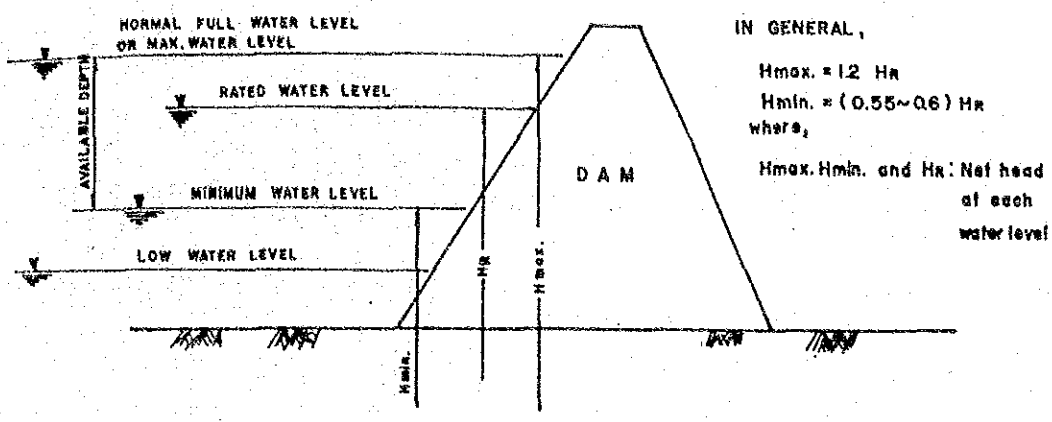
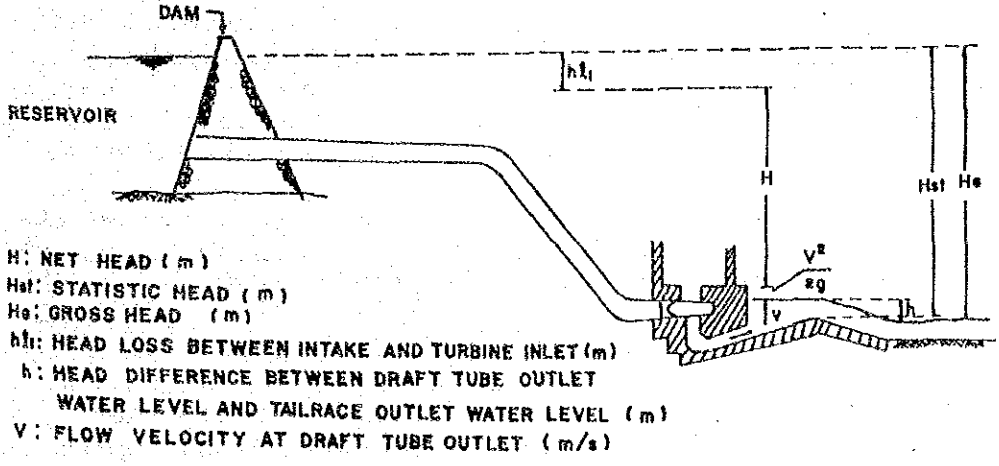


Fig.E.3.7 RESERVOIR WATER LEVEL FOR POWER STATION

(2) Net head

Net head is the gross head less all hydraulic losses except those chargeable to the turbine. Net head is the head available for doing work on the turbine. The intake and penstock losses are not included in the net head, but the spiral case and draft tube losses are considered chargeable to the turbine and are included in the net head as shown in Figs.E.3.8 and E.3.9.



$$H = H_e - h_{l1} - \frac{V^2}{2g} - h$$

Fig.E.3.8 NET HEAD IN CASE OF REACTION TURBINE

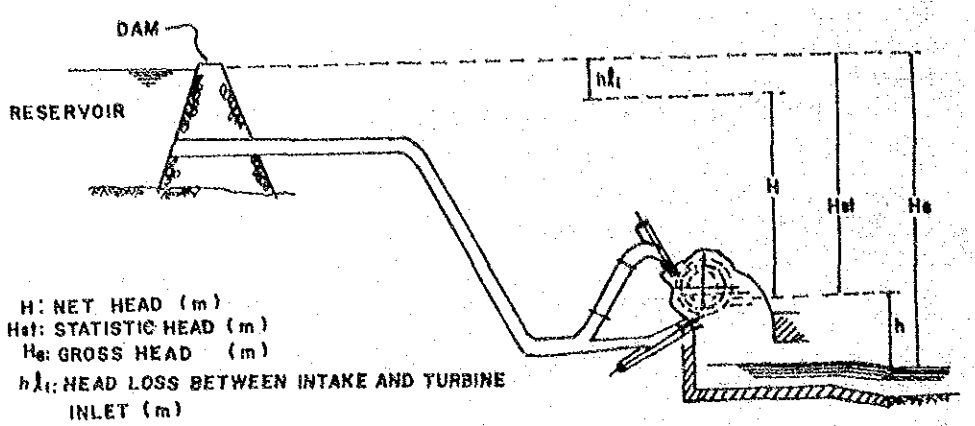


Fig.E.3.9 NET HEAD IN CASE OF IMPULSE TURBINE

(3) Maximum turbine discharge

(a) To determine the maximum discharge of the turbine, it is necessary to consider the situation of the power station and examine the annual fluctuation in the discharge available for power generation.

In general, the maximum discharge is determined from economical view point, estimating the annual possible power generation with consideration of the fluctuation of discharge.

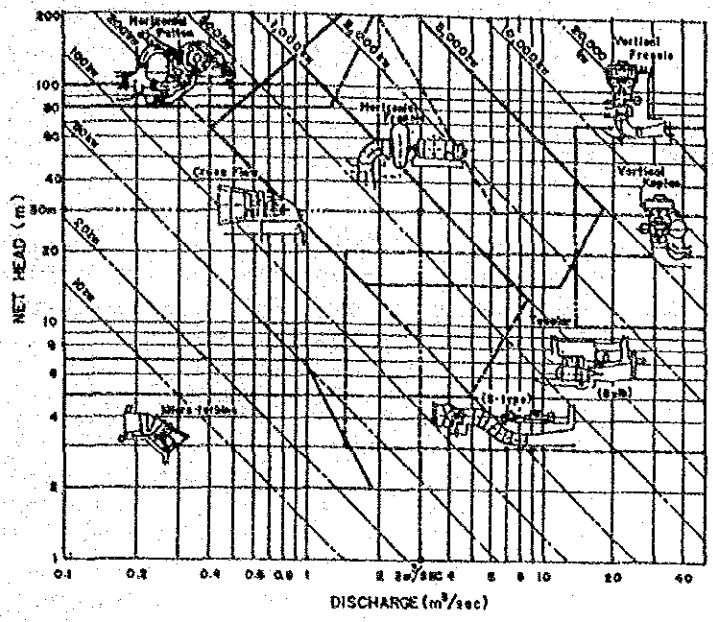
(b) In case a large value of Q_{max} is adopted, the turbine efficiency decreases in the drought period, and sometimes it is required to stop turbine operation due to occurrence of cavitation. In general, the allowable range of discharge variation is as shown below.

Francis turbine	100-40%
Partial load runner of Francis turbine	100-25%
Tubular turbine (adjustable vane)	100-25%
Pelton turbine	100-20%
Cross flow turbine (with divided guide vane)	100-15%

(c) Comparing a plant of single unit with that of plural units, the former plan will reduce the equipment cost. However, in the case of large annual fluctuation of the available discharge, a plan of plural units with smaller unit capacity will produce more energy and thus may become more economical.

(4) Selection of turbine type and power output

(a) After determination of net head and maximum turbine discharge, selection of turbine type can be made by use of Fig.E.3.10.



REMARK,

1. This Figure is derived from Engineering Manual for Irrigation And Drainage, Small-Scale Hydro-Power Generation, Vol.I, MAR.1987, Japanese Institute of Irrigation and Drainage.

Fig.E.3.10 TURBINE SELECTION DIAGRAM

(b) Then, after selection of turbine type, efficiency of turbine and generator can be estimated. Power output can be calculated as follows:

$$P = 9.8 \times Q \times H \times E_t \times E_g \times n$$

where,

P : Power output (kW)
Q : Discharge (m^3/s)
H : Net head (m)
E_t : Turbine efficiency (in general, 0.80 to 0.85)
E_g : Generator efficiency (in general, 0.95)
n : Number of plant (nos)

(5) Annual possible power generation energy

Annual possible power generation energy is the energy that can be generated during one year assuming no stoppage or power operation due to failure, maintenance or repair.

This possible power generation is a basic value for economic evaluation of the power generation.

$E = \Sigma(P_i \times h_i)$

where,

E : Annual possible power generation energy (kWh)
P_i : Power output (kW)
h_i : Duration hours of P_i (hours)

Existing Studies:

Items	DPWH	NIA
Installed capacity	-Capacity is decided based on the results of economic analysis or decided to utilize all available water.	-Same as DPWH
No.of plant	-Same as above	-Same as DPWH
Plant factor	-Range: 29-82% -Average: 57%	-Range: 41-71% -Average: 58%

3.3.3 Facility Design of Mini-hydropower

The facilities required for mini-hydropower development shall be preliminarily designed and those results shall be incorporated in the report.

Explanation:

The preliminary design of the required facilities shall be made for the mini-hydropower development. The design shall be made considering the followings:

(a) Surge tank/Penstock
- Static water pressure including pressure rise due to sudden load rejection
- Size and length

(b) Powerhouse
- Type and size

(c) Tailrace
- Type and size

(d) Hydraulic turbine and generator
- Type
- No. of plant

(e) Power transmission line/Sub-station
- Capacity and length
- Space

In the report, the following drawings shall be incorporated:

- General plan including all structures
- Plan, profile and sections of each structure

Existing Studies:

The preliminary design are made in the existing reports.

3.3.4 Estimation of Mini-hydropower Benefit

Economic power benefit shall be estimated based on the mini-hydropower development plan.

Explanation:

For estimation of economic power benefit, an alternative power plant shall be assumed. Then, assuming that the load to be generated by the proposed mini-hydropower plant is undertaken by the alternative power plant, the annual cost shall be calculated and this value is considered to be a benefit (B) of the proposed mini-hydropower plant. In the SWIM project, the same scale diesel power plant as the proposed mini-hydropower plant shall be considered as alternative power plant.

Thus, Benefit (B) = kW value{(firm power output of the proposed mini-hydropower plant) x (fixed annual cost per kW of the alternative power plant) x (adjustment factor for kW)} + kWh value{(annual possible power generation energy of the proposed mini-hydropower plant) x (variable annual cost per kWh of the alternative power plant) x (adjustment factor for kWh)}

where,

(a) As for fixed annual cost per KW and variable annual cost per kWh of the alternative power plant, refer to Item 2.3.2.

(b) Considering the difference in cost and loss of power transmission between hydropower and diesel

power, the above fixed annual cost per kW and variable annual cost per kWh of the alternative power plant shall be adjusted or increased. For reference, calculation of adjustment factor is shown below.

Item	Hydro (%)	Diesel (%)
Transmission line loss	5.0	1.0
Forced outage	0.5	6.0
Station use	0.3	5.0
Scheduled outage	2.0	10.0

Adjustment factor for kW

$$= \frac{(1-0.05)x(1-0.005)x(1-0.003)x(1-0.02)}{(1-0.01)x(1-0.06)x(1-0.05)x(1-0.10)} = 1.16$$

Adjustment factor for kWh

$$= \frac{(1-0.05)x(1-0.003)}{(1-0.01)x(1-0.05)} = 1.01$$

Existing Studies:

Items	DPWH	NIA
Method of estimation	-Alternative diesel plant cost	-Same as DPWH
Fixed cost	-Average: US$ 972/kW Range : 427-1,723	-Average: US$ 488/kW Range : 431-530
Variable cost		
Fuel consumption rate	-Average: 0.34 lit/kWh Range : 0.26-0.44	-not mentioned
Fuel cost	-Average: 0.41 US$/lit Range : 0.24-0.53	-Average: 0.35 US$/lit Range : 0.31-0.37