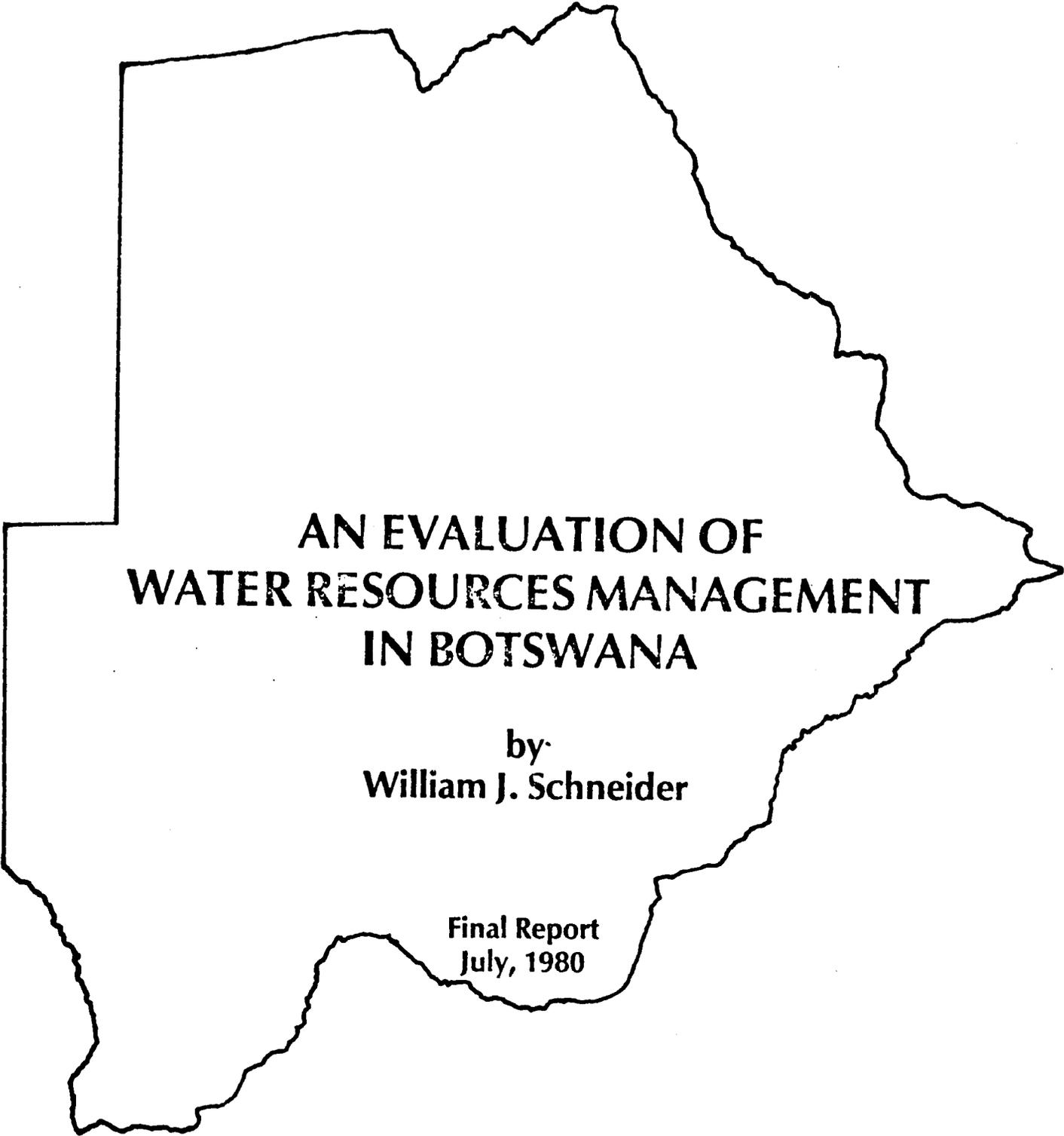


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**AN EVALUATION OF
WATER RESOURCES MANAGEMENT
IN BOTSWANA**

by
William J. Schneider

**Final Report
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**A Report to the
Agency for International Development
Gaborone, Botswana**

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EXECUTIVE OVERVIEW

Botswana today is at a crossroad. The traditional patterns of hunting and nomadic grazing are giving way to more sophisticated patterns of grazing, agriculture, and urban life. With its population increases and external encouragement, Botswana is moving inexorably toward a developed society of managed resources. Although still in its early stages, this movement is even now leading to conflicts in resource management and allocation. The resolution of these conflicting interests within the constraints of limited resources is perhaps the major problem facing the Government of Botswana. Clearly, the key to Botswana's future is the proper accommodation of its limited resources to the increasing demands of an expanding society. Availability of water could well be the limiting factor in this transition from a country of apparent abundant resources to one in which limited resources must be managed for optimum benefits.

Commonly, resources are considered separately and managed individually, as evidenced by the standard organization of government functions that assigns individual resources to separate departments or ministries. However, in the environment such resources are not conveniently separated, nor can exploitation be confined exclusively to a single resource. All resources are interlinked in the total environment. For example, the link between water and soil in agriculture requires coordinated management of both to prevent erosion and avoid pollution of water resources from herbicides and chemical fertilizers. Furthermore, these linkages exist in chain reactions. Long range planning is necessary both for managing the water resources and for anticipating impacts resulting from the interactions of the resource if undesirable ecologic and economic consequences are to be avoided.

The basic responsibility for development and management of water resources in Botswana is within the Ministry of Mineral

Resources, with operational responsibilities assigned to the Geological Survey and the Department of Water Affairs. Although the responsibilities of each differ, there is coordination between them.

The Government of Botswana advantageously includes its responsibilities for the development of its mineral and water resources in the Ministry of Mineral Resources and Water Affairs. There is a strong awareness of water problems in both Ministry level and at Departmental operational levels in the Ministry. Planning in this Ministry is rapidly progressing from support of immediate need to comprehensive long-range planning. For example, the Department of Water Affairs has suggested to the Department of Towns and Planning that its proposal to expand Mahalapye as a major village be shifted to nearby Palapye because of more favorable prospects of supplying adequate water for the proposed expansion. The full range of Ministerial awareness is evident in a current tentative proposal for major village water planning (see Appendix C).

Although in its formative stages, this proposal if fully developed and enacted could provide a needed catalyst in the Government of Botswana to move towards long-range comprehensive planning based upon natural resource considerations. Early results from this project could influence a significant shift from planning which is currently based on demographic and socio-economic considerations toward a more realistic one which considers the natural resources, especially the limited availability of water, as essential components in the planning process.

This project, if implemented, could provide strong impetus to the needed transition from immediate development to effective long-range resource management. USAID can play a major role in this Ministerial effort through encouragement of the Ministry in this approach and direct support of the Major Village Water Studies. Although the transition will not be easy, it must take place if Botswana is to achieve self-sufficiency and, more importantly, long-term stability. USAID's full support of this effort would undoubtedly produce far more long-range benefits in overall resource management than scattered support of varied projects.

The overall competence exists within the Ministry to administer and conduct this potential program. Both the Geological Survey and the Department of Water Affairs are staffed by professionals, predominately expatriates, who in general are qualified and competent. Personnel shortages and some problems do exist in both Departments. Some of these can be overcome through technical assistance on short-term details of months rather than years.

At the present time, there are also three general sets of proposals and projects related to water resources development and management in Botswana. These are (1) projects included in

Botswana's Draft National Development Plan, 1979-85, (2) other proposals and projects developed in the Ministry of Mineral Resources and Water Affairs (including those of the Geological Survey and Department of Water Affairs), and (3) projects proposed by two U.S. Geological Survey Study Teams for possible USAID support.

These three sets are not mutually-exclusive. Considerable overlap exists among all three sets. For example, the modified project for major village water planning is a consolidation and expansion of several projects in the Draft National Development Plan. Several of the proposals of the U.S. Geological Survey Study Teams have counterparts in the Draft National Development Plan, while others are components of ongoing or proposed activities in the Department of Water Affairs and Geological Survey.

Of these proposals, the following are recommended for USAID support:

- o Major Village Water Supply Studies

Provides for comprehensive study of major village water systems for long range planning. Includes significant aspects of Project WB-14 and Project on Integrated Resource Studies proposed by the Geological Survey. Also could provide significant part of the Hydrometric Network envisioned by the Geological Survey. A multi-year project.

- o Improved Surface Water Data Project

Short-term technical assistance to Geological Survey in design of computer-oriented data storage and retrieval system for groundwater data and to Department of Water Affairs in support of clearing backlog of surface water data. Related to Project WB-20. Provides significant support to hydrogeologic studies under Major Village Water Supply Studies.

- o Acquisition of Equipment

Necessary accessories for full utilization of computer in Geological Survey and needed drafting equipment. Provides significant support to hydrogeologic studies under Major Village Water Supply Studies.

- o Training of Engineers

Scholarship support of additional trainees from Department of Water Affairs as civil engineers. Purpose it to replace counterpart expatriates. A multi-year project.

The following are suggested for possible USAID support as second-priority items:

- o Analytical Support of Heavy Minerals Surveys

Significant additional data on mineral potential at low cost.

- o Preservation of Landsat Interpretive Overlays

Possible support for commercial photographic services to provide working overlays.

- o Controlled Source Seismic Studies of Deep Basins

Expansion of earlier seismic studies. Provides first data available in country on deep basins. An exploratory project with possible significant implications for minerals, and possibly oil and gas.

- o Further Analysis of Aeromagnetic Data

Additional computer analyses of present data not possible on present computer in Geological Survey.

- o Support of Additional Schramm Drilling Rig

Acquisition of third Schramm Drilling Rig to increase drilling capabilities of the Department of Water Affairs. Decision should be based upon demonstrated effective use of present rigs and USAID objectives.

Total cost for five projects suggested for possible support is P658,000.

I.

Introduction

This report presents an evaluation of current status of water resources development and management in Botswana.

A. Purpose and scope

This report has been prepared under USAID Purchase Order No. 147-047 dated April 15, 1980. The terms of reference of the report, as stated in the purchase order, are: to prepare a report on water resources in arid, semi-arid, and delta areas of Botswana. The report is based upon on-site analysis of the Government of Botswana's program to manage soil, water, range, and forestry resources. The purpose of the report is to assist USAID Botswana in determining whether a project implementation document, currently being developed, should focus on the development, management, and conservation of water resources or on strengthening of existing resource conservation activities.

The scope of the report was further defined by Mr. John Pielemeier, Assistant Director for Projects, USAID. Gaborone, Botswana, dated April 22, 1980, outlining the following items of focus:

- (1) An analysis of the present capacity of the Department of Water Affairs and the Geological Survey to carry out their functions effectively;
- (2) A review of two USGS reports which focused on the Botswana Geological Survey and Department of Water Affairs, to determine which of their many recommendations are most appropriate for AID support.
- (3) A study of the recent GOB request for AID capital assistance to their domestic water supply program to determine whether such assistance is warranted and if

so, at what level of funding, based upon present GOB capacity to maintain domestic water supplies and need for related technical assistance;

- (4) A review of GOB capacity to plan, coordinate, and utilize water resources.

Consequently, this report focuses upon these items. Discussions related to coordination and management of other resources are based largely on an ancillary report on overall resource management in the Government of Botswana prepared concurrently by Dr. Gene Wilken and Dr. Herbert Blank.

B. Background

The Republic of Botswana is a land-locked area of about 570,000 square kilometers in southern Africa bordered by Zambia, Zimbabwe, Namibia, and South Africa. The climate is subtropical; temperatures frequently exceed 38° C in the summer, and drop below 0° C in the winter. Rainfall, which normally occurs from October through April, ranges from an average of 64 centimeters annually in the north, to about 23 centimeters in the south, probably even less in the Kalahari Desert where records are exceedingly sparse. Droughts are frequent occurrences.

Botswana's population, estimated at about 800,000 in 1978, is growing at a rate of about three percent per year. Much of the population is concentrated in an urban corridor along the southeast border. Principal industries are livestock grazing and mineral exploitation, and, more recently, farming and some tourism.

Botswana today is at a crossroad. The traditional patterns of hunting and nomadic grazing are giving way to more sophisticated patterns of grazing, agriculture, and urban life. With its population increases and external encouragement, Botswana is moving inexorably toward a developed society of managed resources. Although still in its early stages, this movement is even now leading to conflicts in resources management and allocation. The resolution of these conflicting interests within the constraints of limited resources is perhaps the major problem facing the Government of Botswana. Clearly, the key to Botswana's future is the proper accommodation of its limited resources to the increasing demands of an expanding society. Availability of water could well be the limiting factor in this transition from a country of apparent abundant resources to one in which limited resources must be managed for optimum benefits.

C. Acknowledgements

This report is based principally on available documents and briefings, conferences, and discussions with knowledgeable persons within USAID and the Botswana Ministry of Mineral Resources and Water Affairs. A briefing by Mr. Leonard Pompa, USAID Washington, D.C. provided both an understanding of the basic purpose of this effort and several useful reference documents. Mr. Louis Cohen, Mission Director, and Mr. John Pielemeier, Assistant Director for Projects, USAID Botswana, provided clarification of the scope of the effort and clearly defined its focus.

Within the Ministry of Mineral Resources and Water Affairs, discussions with Mr. Paul Spray, Planning Officer, provided the necessary insight into the organization, function, and objectives of the Ministry. Dr. C. R. Jones, Director, and Dr. G. Goldberg, Principal Hydrogeologist, provided detailed briefings on the goals, objectives, and projects of the Geological survey. Especially helpful were discussions of needs and priorities. Mr. R. Quraishi, Director, and Mr. Brian Wilson, Assistant Director, provided the necessary insight into the operations of the Department of Water Affairs. Subsequent discussions with them and members of their professional staffs answered many questions that arose during the preparation of this report.

Logistic support in the form of office, local transportation, and clerical support were generously provided by the USAID Mission in Gaborone through Mr. John Pielemeier.

II.

The Role of Water in Botswana's Development

Water will likely be a limiting factor in the development of Botswana's resources. Botswana's emerging industries in agriculture, cattle production, and mineral extraction are all water-dependent. The growing urbanization in a corridor from Lobatse to Francistown is even now placing stresses on the resource; problems of water shortages and pollution are already evident.

A. Sources of Water

Water is available in Botswana from both surface and ground-water sources. Except for the Okavango Delta in the north, river flows occur only in the eastern part of the country. Almost all rivers are ephemeral, flowing from only a few days in each year to several months. Effective utilization of these rivers would require large storage dams. The Okavango Delta stores huge amounts of water, with an inflow of approximately 12 billion cubic meters of water annually. Less than two percent of this flows out of the delta, the rest being consumed by evaporation and transpiration. Development of the water of the Okavango Delta would be extremely costly at this time and could seriously alter a delicate and fragile environment.

Except for the areas of surface streams and the Okavango Delta, the rest of Botswana -- about four-fifths of its land area -- is covered by the Kalahari Sands which absorb practically all of the rainfall. Little, if any, rainfall percolates more than a few meters below the surface over much of this area. Water is available from boreholes, and in some places from shallow wells and sand beds of streams, in sufficient quantities for cattle, but is sometimes saline and often at depths exceeding 100 meters. Yields are commonly in the 100-liter-per-minute range. Although there are rivers in eastern Botswana, the major source of water supplies is also from

groundwater at typical depths of from 30 to 100 meters. Except for the major urban areas, notably Gaborone, Lobatse, and Selebi-Phikwe which are supplied from surface reservoirs, some 5,000 boreholes and an unknown but lesser number of shallow dug wells now supply the basic water needs of Botswana.

B. Present and Projected Water Use.

Present water use consists of supplies for urban and industrial (mining) use, supplies for large and small villages, livestock watering, supplies for scattered settlements in lands areas, and some limited irrigation.

1. Urban and Industrial Uses

The largest water demands are from towns and industrial areas, where water use continues to rise at a significant rate as shown in the following table. As indicated in this table, significant expansions of water supplies will be necessary over the next five years to meet these anticipated demands.

Urban Water Demands, 1974-85

Town	Annual Water Use (in million liters)		
	1974-75	1977-78	1984-85 (Projected)
Gaborone	1,943	2,796	7,241
Lobotse	849	1,107	1,493
Francistown	600	814	1,389
Selebi-Phikwe	7,462	10,445	3,445

2. Village Water Supplies

Water demands at village level are generally moderate, ranging from up to 500 cubic meters per day in major villages to as little as 5 cubic meters per day in small villages. As of February, 1980, about 35 percent of the total population located

in 86 villages has reliable water supplies developed under government programs. Under these present programs, all major and rural villages, and many small villages (a total of over 200) will have reliable water supplies serving over 55 percent of the total population. Water demands in the major villages and urban centers are expected to increase by as much as 20 percent annually. Water use will further increase with the stems in additional small villages.

3. Livestock Watering

In 1978, there were about 3 million head of cattle in Botswana, an increase of about 120,000 head over the previous year. Current estimates for 1979 are about 3.4 million. Water demands range from 5 to 50 cubic meters per day, depending upon herd size and water availability. Water is obtained from ephemeral pans and water holes, shallow wells, and boreholes. In past years much of the grazing and watering was concentrated in the semi-arid eastern part of Botswana, resulting in overgrazing and some conflicts in water use. Recently, under the Tribal Lands Grazing Program, cattle owners have been encouraged to relocate herds in more remote western areas, where water is supplied from individual and communal boreholes and from a few small dams. Future demands for cattle watering will likely be in rural areas. Current water use for cattle is about 23 million cubic meters annually, most of which is supplied from some 5,000 boreholes scattered throughout the country.

4. Agriculture

Water demands for agriculture have been largely met in the past from rainfall. There is practically no irrigation at present in Botswana. However, a recent Government effort to establish farms under the Arable Lands Development Program will require water supplies for domestic and draft animal use. These supplies are largely met from boreholes. Future irrigation demands, if any, would likely take place in the eastern part of the country in the vicinity of the Limpopo and other rivers. However, high costs make any agricultural irrigation project unlikely in the near future.

C. Water Resources Management

Several departments and agencies of the Government of Botswana are involved directly or indirectly with water management, including the Ministry of Mineral Resources and Water Affairs, the Ministry of Agriculture, and the Water Utilities

Corporation which is a semi-public entity responsible for water supplies for Gaborone, Francistown, Lobatse, Orapa, and Selebi-Phikwe.

The basic responsibility for management of the water resource is within the Ministry of Mineral Resources and Water Affairs, with operational responsibilities assigned to the Department of Water Affairs and the Geological Survey. The Department of Water Affairs provides basic surface water data needs for development and planning through its Hydrology Section; administers the Water Act through its Water Law Section; locates, drills, and constructs rural village water systems and operates major village water systems through its Water Supply Section; and provides repair service for public and private borehole facilities through its Borehole Repair section. The Geological Survey does field mapping and geotechnical surveys through its Regional Mapping Section; conducts regional hydrogeologic studies and groundwater assessments and evaluations through its Hydrogeology Section; and conducts minerals explorations and issues prospecting permits for the Ministry through its Economic Geology Section.

The Ministry of Agriculture has some responsibility for water management through its Tribal Grazing Lands Program and Arable Lands Development Program. Under the Tribal Grazing Lands Program, the relocations of cattle herds to rural areas requires the development of boreholes for watering. The establishment of small farms under the Arable Lands Development Program requires the development of small supplies for domestic and draft animal needs. The Ministry of Agriculture also builds small dams for livestock watering. To date, four have been completed and five more are contemplated.

D. Conflicts in Water Use and Management

Commonly, resources are considered separately and managed individually, as evidenced by the standard organization of government functions that assigns individual resources to separate departments or ministries. However, in the environment such resources are not conveniently separated, nor can exploitation be confined exclusively to a single resource. All resources are interlinked in the total environment. For example, the link between water and soil in agriculture requires coordinated management of both to prevent erosion and avoid pollution of water resources from herbicides and chemical fertilizers. Furthermore, the linkages exist in chain reactions. An excellent example of this is a drought, where a shortage of physical resource (water) results in a depletion of a biotic resource (cattle and crops) which in turn stresses the cultural resource (social structure and well-being).

Consequently, administrative linkages also exist. Unilateral decisions can readily result in degradation of other resources. For example, developing more boreholes in a given area to increase cattle production could result in range degradation and soil erosion by permitting increases in herds in a given area without increasing vegetation on which they feed. Such linkages are particularly significant in Botswana where periodic droughts intensify the effects of imbalances in the fragile ecosystems. During a series of dry years, which is inevitable in Botswana, the overextended system could collapse catastrophically. Long range planning is necessary both for managing the water resource and for anticipating impacts resulting from the interactions of the resource if undesirable ecologic and economic consequences are to be avoided.

III.

Capabilities of Water Agencies in the Ministry of Mineral Resources and Water Affairs

The basic responsibility for development and management of water resources in Botswana is within the Ministry of Mineral Resources and Water Affairs, with operational responsibilities assigned to the Geological Survey and the Department of Water Affairs. Although the responsibilities of each differ, there is coordination between them.

The Government of Botswana advantageously includes its responsibilities for the development of its mineral and water resources in one Ministry. Originally, all hydrologic programs were carried out by the Geological Survey. A major change in this organizational structure took place in 1977 when responsibility for borehole drilling of water supplies was transferred from the Geological Survey to the Department of Water Affairs. The purpose of this change was to permit the Geological Survey to concentrate its efforts on evaluation of groundwater resources and specific studies of water supply. In this transfer of responsibilities, the Department of Water Affairs assumed responsibility for siting and drilling of production wells.

A. Geological Survey

The Geological Survey does regional mapping, conducts regional hydrogeologic studies and groundwater assessments, conducts minerals explorations and issues prospecting permits for the Ministry.

1. Organization and Structure

The organization and structure of the Geological Survey is shown in Appendix A.

Water resources responsibilities are mainly with the Hydrogeology Division. Support services in cartography and water chemistry are obtained from Branches of the Technical Services Division. The Division's functions include regional hydrogeology and groundwater resources assessment, storing water borehole records, and performing special water supply projects such as the ongoing SG-10 groundwater evaluation project. Work is performed by a staff of 5 hydrogeologists, one of whom is a Botswana. Four are expatriates. In addition to this staff, there are three supernumeraries employed on the GS-10 project. Dr. Goldberg, the Principal Hydrogeologist, has indicated the need for another hydrogeologist on staff. It does not seem likely that the expatriates will be replaced by Botswana in the near future.

Exploration drilling in support of the Division's programs is done by a separate unit which has six drilling rigs with limited capability. The unit is capable of drilling about 100 meters annually in support of hydrogeologic programs. The Department is currently seeking another drilling rig capable of deep drilling. West Germany has offered assistance in obtaining the rig, but not in supporting its operations, which can be supported in the Department.

2. Programs

Currently there is one major project in the Hydrogeology Division -- the GS-10 Groundwater Evaluation. In addition to this, the Division is preparing a series of excellent groundwater reconnaissance maps. Of the 11 proposed sheets in the series, three have been published, one is now being printed, and four more are ready for printing. The remaining three maps will be completed next year. The Department has expressed interest in USAID support development of a data storage and retrieval system, establishment of a hydrometric network, and geologic mapping of the Kalahari Beds with emphasis on mineral potential. According to the Director, it will be necessary to train at least 36 Botswana to replace expatriates. The Geological Survey proposes to do this in Canada and Great Britain. It has expressed no direct interest in USAID assistance at this time.

B. Department of Water Affairs

Unlike the Geological Survey, which also has responsibility for mineral resources, the Department of Water Affairs is responsible only for water-related activities.

1. Organization and Structure

The Department of Water Affairs collects surface water data for development and planning; administers the Water Act; locates, drills, and constructs rural village water systems; operates major village water systems; and provides repair service for public and private borehole facilities. The Department has a permanent staff of 250, supported by as many as 700 to 800 nonskilled workers such as laborers (see Appendix A). Eighteen are professionals, of which nine are civil engineers. Two professionals -- one hydrologist and one hydrogeologist -- are Batswana. Four other Batswana from the Department are enrolled in civil engineering schools in the United States under USAID support, and two more are currently being proposed by the Department for support. Current vacancies in professional positions include two hydrogeologists, one water resources engineer, and one mechanical engineer. The position of Principal Hydrologic Engineer, vacated by Mr. Wilson when he became Deputy Director, is also vacant at this time. The Department also has a new Director, Mr. Quraishi, who is supported by Sweden. Sweden will also likely supply the water engineer sometime this year.

The Hydrology Section gages surface flows in Botswana at 17 sites. These include measurements at seven weirs, four dams, four cableways, one bridge, and one wading site. All of these locations have been identified as potential dam sites.

The Water Supply Section is responsible for all borehole drilling, installation of village water systems, and operation of these systems in major villages. The Section has two Schramm rotary drilling rigs (one supplied by USAID in 1979), seven percussion drill rigs, and one light rig for cleaning boreholes. It also has five newly-acquired small rigs to be used for cleaning boreholes when proper sized bailers are obtained and adequate drilling crews can be trained. The Schramm rigs are capable of drilling about 50 boreholes each per year, compared to 5 to 10 each for the percussion rigs. The Schramm rigs are also capable of drilling to depths in excess of 300 meters; the percussion rigs to about 100 meters. Borehole drilling is in support of the Government's village water supply projects and for private individuals. All the drilling crews are Batswana. The Division also operates the water supply systems at 15 large villages.

The Borehole Repair Service is a recent restructuring of the former Borehole Preventative Maintenance Service. Under the Borehole Preventative Maintenance Service, preventative maintenance of pumps and engines was provided under contract with borehole owners. Under this service, two maintenance visits were scheduled each year. The program was not successful, and in July 1979, emphasis was changed from preventative maintenance to repair. The Section has 19 repair crews and 13 maintenance

crews located at 16 depots throughout the country. The 13 maintenance crews are now being given some training in repair, and will shortly become repair crews. Typically, a repair crew consists of one mechanic, one driver, and three to four laborers. Each crew has a 5-ton truck for transportation; spare parts are stored at each depot. Pumps or engines requiring major overhaul are returned to the Department in Gaborone where work is done mostly by private contractors. To minimize downtime, overhauled pumps and engines are available for the Department on an exchange plus fee basis. Their performance is discussed in the following section.

2. Programs

The Hydrology Section provides ongoing stream gaging at 14 sites on rivers mostly in eastern Botswana. The Section proposes to add 4 to 6 more sites to this network, also at sites recommended as potential damsites in an earlier consultant report. The Department is attempting to recruit two additional hydrologists for this effort. Mr. Wilson, the Deputy Director, has expressed interest in USAID assistance in this effort. There is no present interest in the Department to extend the gaging efforts to small watersheds. The Department clearly sees its role as that of providing data for design of major impoundments, and has expressed firm disinterest in involvement in small catchment areas such as those involved in the Arable Lands Development Program. There is however a real need for data on small catchment areas. Three separate reports by Levine, Wilker, and Blank, and the U.S. Geological Survey Hydrologic Study Team emphasize this. These data could be collected by the Department of Water Affairs as part of an overall hydrologic data collection activity or by an appropriate Department in the Ministry of Agriculture. The activity could best be located in the Department of Water Affairs to insure coordination of the activity with ongoing hydrologic data collection activities.

The Water Supply Section supports the Village Water Supply Programs through drilling of boreholes and installation of water supply systems. It also drills private boreholes. It is capable of drilling about 150 boreholes per year. The Department has expressed a high priority for obtaining another Schramm drill rig in the immediate future, and states that it already has a drilling crew capable of operating it. The success rate of borehole drilling is less than 60 percent, partly because of totally inadequate hydrogeologic information, and partly because of the necessity to drill in unfavorable areas. This rate could even decrease as the drilling program is carried westward to small villages in the Kalahari. Five of the nine drilling crew foremen are Batswana, as are all other drilling crew members.

To date, about 200 villages, including all 15 major villages, have water systems installed by the Water Supply Section.

The Section proposes to install about 40 additional systems each year in small villages as a high priority program. Responsibility for operations and maintenance of village supplies is given to the District Councils under a policy of localization of operations. Several training courses for pumpers were held in 1976, but none have been held since. Some informal training is given by repair crews on visits, but this is limited. The policy of localized operations has not been too successful. Many of the Councils are becoming more aware of the need for maintenance and are establishing operation and maintenance units staffed with a borehold mechanic.

Adequate staffing of these units is a problem. Some Councils have obtained borehole mechanics from the Department of Water Affairs through increased salary inducements. The problem of proper maintenance through District Councils will likely continue for some time. These problems are more fully discussed in relation to the Borehold Repair Service.

The water supply systems of 15 Major Villages (see listing attached to Appendix C) are operated directly by the Department of Water Affairs. Crews stationed in these villages vary from 34 persons at Kanye to 9 persons at Tsabong. There are 10 pumpers on the Kanye and 2 at Tsabong, the number of pumpers being dependent upon the number of operating boreholes in the system. These operations, like those of District operated and private boreholes, are also plagued with problems. Many of the boreholes are old, with unscreened intakes that frequently clog and require cleaning. Breakdowns of pumps and engines are also frequent. At one site, the engine has had to be replaced twice; at another site the bearings burned out in less than one year. Crooked boreholes drilled by contractors also cause problems of frequent pump breakdowns.

The Borehole Repair Service (formerly the Borehold Preventative Maintenance Service) provides repair services to all boreholes at a fee. Service is provided from 16 depots throughout the country by 19 repair crews and 13 maintenance crews, which are being retrained as repair crews. In August, 1979, 11 Peace Corps volunteers were recruited as advisers to repair teams. Four remain. Attrition is attributed to lack of interest in the work, rigors of rural life, and limited background experience. A proposal in the Draft National Development Plan would increase the number of depots presumably by redistributing the converted maintenance crews. From August 1979 through March 1980, the Borehole Repair Service responded to 1,279 requests for repair services. It is not likely that the number of request will reduce over the next few years. Although the repair crews attempt to train local pumpers in simple maintenance procedures, it has not been productive. The pumpers are hired by the District or private owner, mostly illiterate, and not dependable. As a group, they have no appreciation of maintenance, nor do the borehole owners who often do not supply essentials for proper maintenance. There appears to be little that can be done about

this problem. The present emphasis in the Department of Water Affairs on repairs reflects a realism to current attitudes and practices. However, the Department also is not without problems. Among these are the large area to be serviced, poor communications, and inadequately trained mechanics with little interest. To rectify this last problem, the Department hired 17 persons with Junior Certificates and plans to send them to Botswana Polytech for a 4-year course in mechanical engineering technology. These would eventually replace the present chiefs on repair crews who as a group are considered inadequate.

The Department of Water Affairs has an extensive training program to meet its needs at both professional and technical level. Currently, four Batswana are attending engineering colleges in the United States. The Department is proposing to send two more in the near future. To fill all professional posts, the Department will need, according to its estimates, 19 more university-trained people. At the technical level, it would like to train about 12 Batswana per year for 3 years to repalce counter-parts. Technical study, as envisioned by the Department, would consist of practical engineering, including drafting and similar courses, particularly in the field of water supply. Inhouse training is oriented toward needs for technicians and mechanics. There is one ongoing course to train ten drill foremen, with another one for ten more about to start. Additional courses for borehole mechanics and pipefitters are due to start this year. Under the new Director, training will be emphasized. A new training officer will be appointed, and a new training policy will be developed in three months. Currently, 5 out of the staff of 20 professionals and senior technicians are involved in training.

IV.

Current Water Resources Proposals

At the present time, there are three general sets of proposals and projects related to water resources development and management in Botswana. These are (1) projects included in Botswana's Draft National Development Plan, 1979-85, (2) other proposals and projects developed in the Ministry of Mineral Resources and Water Affairs (including those of the Geological Survey and Department of Water Affairs), and (3) projects proposed by two U.S. Geological Survey Study Teams for possible USAID support.

These three sets are not mutually-exclusive. Considerable overlap exists among all three sets. For example, the modified project for major village water planning is a consolidation and expansion of several projects in the Draft National Development Plan. Several of the proposals of the U.S. Geological Survey Study Teams have counterparts in the Draft National Development plan, while others are components of ongoing or proposed activities in the Department of Water Affairs and Geological Survey.

A. Government of Botswana Projects

Current Government of Botswana projects consist of those in the Draft National Development Plan and others currently under development within the Ministry of Mineral Resources and Water Affairs and its two Departments having responsibility for water resources development and management. Only those directly related to water resources development and management are considered. Other projects having linkages to water resources, particularly those in agriculture and range management, are discussed in an ancillary report prepared concurrently by Wilkins and Blank. Fundings shown are those in the Draft National Development Plan.

1. Projects in the Draft National Development Plan

Following is a brief analysis of the water resources development and management projects listed in the Draft National Development Plan, 1979-85. Full descriptions of the projects, as listed in the Plan, are included as Appendix B.

o GS-10: Evaluation of Underground Water Resources

Provides for continuation of current project to inventory groundwater resources for future utilization. Scope of project reduced to limit priority study to major use areas with known productive aquifers. Secondary priority is deep exploratory drilling of possible sandstone aquifers extending westward from the high use areas in to the Kalahari. Previously funded through ODM. Limited USAID assistance may be appropriate to improve data collection, storage, and retrieval through technical assistance. (See U.S. Geological Survey proposal for Designing Data Storage and Retrieval Systems) Funding: P360,000.

o GS-13: Okavango Delta Groundwater Evaluation

Provides for groundwater evaluation of Okavango Delta to determine economic and technical feasibility of utilization. Project, scheduled to start in 1983, has low priority in the Ministry of Mineral Resources and Water Affairs. Funding: P500,000.

o GS-18: Geological Survey Equipment

Proposed purchase of varied equipment in support of overall activities of the Geological Survey. Equipment heavily oriented in support of mineral exploration. Funding: P470,000. See U.S. Geological Survey Team proposal for acquisition of equipment.

o WB-1: Borehole Repair Service

Provides for continuation of maintenance and repair service on boreholes, with shifted emphasis to repair service because of need. Although the effort supports the Tribal Grazing Lands Program, partial private sector support is available through fees for services. Funding: P452,000.

o WB-03: Lands Areas Water Supplies

Goal is improved water supplies for draft animals and domestic use on farms at lands areas. Development of dug wells and catchment tanks is envisioned. Project directly supports the Arable Lands Development Program. Funding: P1,200,000.

o WB-08: Assistance to Private Borehole Drilling

Provides for study of possible establishment of a local borehole drilling industry in the private sector through training and regulation of drillers and establishment of insurance program for drillers and borehole owners. Some USAID participation possible, but larger payoff is possible through support of better hydrogeologic information for borehole sitings. Funding: P440,000

o WB-10: Limpopo Water Utilization Study

Provides for consultant study of potential development of Limpopo River for urban water supply, power generation, and possible irrigation. Commitment of USAID support for consultant study could imply commitment to or approval of future development. Funding: P100,000.

o WB-13: South East Botswana Water Planning Study

Provides for long-term study of water supplies for three towns and eight villages in southeastern Botswana. Funding for project has been committed by the African Development Bank. Funding: P244,000.

o WB-14: Major Village Water Planning

Provides for consultant study to plan for extension of existing water systems in the 15 major villages to meet future demands. Project has high priority in the Ministry of Mineral Resources and Water Affairs, and appears to be part of the revised and expanded proposal by the same title. Funding: P700,000.

o WB-17/26: Major and Rural Village Water Supply

Provides for construction of 17 rural village water supply systems in 1980/81 and 33 in 1981/82. Project has high priority in the Government of Botswana. Project is funded by SIDA at this time except for cost overruns and a shortfall of 10 villages. Funding: P6,987,000.

o WB-20: Hydrologic Support

Provides for installation and operation of four to six river gaging stations to expand present network, and for processing of backlog of nine years of hydrologic data from present stations. Sites selected would provide hydrologic data for design of possible future water impoundments. USAID participation possible, particularly in supplying equipment and technical assistance. Funding: P125,000. See U.S. Geological Survey Study Team proposals for Improved Water Surface Data Project, and for Designing Data Storage and Retrieval System.

o WB-21: Okavango Development

Provides for completion of UNDP mathematical model, construction of experimental levees, and possible pilot irrigation projects. This is an optimistic approach, in view of pessimistic consultant reports on possible uses of Okavango water. Funding: P550,000.

o WB-27: Hydrologic and Ecologic Studies of the Okavango

Provides for completion of several outstanding items in the UNDP-financed Okavango Delta modelling study. Project has low priority. Funding: P14,000.

o WB-30: Small Village Water Supplies

Provides for continued installation of water systems in villages of less than 500 persons. Boreholes are drilled under Project WB-35. Installations of an additional 215 villages is envisioned. Funding for distribution systems is provided by British ODM. Project at point of diminishing return as smaller villages with lesser probability of borehole success are selected.

Although this project has high priority within the Government of Botswana, the continued development of additional rural village water supply systems can only exacerbate future water resource management problems, inasmuch as many will likely be developed in areas of limited groundwater and with minimal hydrogeologic information. Increased numbers of dry boreholes can be expected with a probable success rate well below the present 60 percent now achieved by the Department of Water Affairs. In the overall, the systems become less economical because of increasing numbers of dry boreholes and very limited water demands. The economic risk is high. The project would require capital funding; little opportunity exists of this ongoing program for training of Botswana to eventually replace expatriates. Maintenance of existing systems has been a perpetual problem; many existing systems require repeated repair service because of inadequate maintenance, a situation likely to occur on new systems. Furthermore, the site of the program is beyond the scope of the projected size of currently-developing resource management project. Funding: P3,781,000.

o WB-32: Underground Water Development

Provides for purchase of five light drilling rigs, spare parts for existing rigs, and well casings. The Department of Water Affairs apparently already has these rigs, but they are not operational at this time. Funding: P425,000.

o WB-35: Rural Water Extraction

Provides for drilling of boreholes in support of Project WB-30. Department of Water Affairs ranks this as highest priority for USAID support. Funding: P2,810,000.

o WB-36: Expansion of Government Borehole Drilling

Provides for purchase of one Schramm drill rig and seven percussion drill rigs to increase drilling capability in support of Government programs in rural areas. Possible support for another Schramm rig should be dependent upon overall USAID objectives and demonstrated capability of efficient use of present rigs. This project would consist first of planning studies to provide adequate data bases for arrangement. Under Phase I, available data on population growth, water demands, and sufficiency of present water sources would be analyzed. Additional water sources, to the extent possible would be identified, the adequacy of existing distribution systems to meet future needs analyzed, and data gaps determined. Phase II would consist of hydrologic and hydrogeologic surveys, drilling, and data collection to provide an adequate base for long-range water resource planning. Based upon results of the planning studies, long-range extensions and expansions to existing water supply systems would be designed. Consideration is given to inventories of industrial minerals as part of this proposal.

2. Other Projects

Discussions with officials within the Ministry of Mineral Resources and Water Affairs surfaced three additional water-related projects: There is a proposal within the Ministry on Major Village Water Planning, and two within the Geological Survey on Integrated Georesource Investigations and a Hydrogeometric Network. All three are still in early planning stages. They are discussed more fully in Chapter 5.

The project on Major Village Water Supplies is basically a modification and amplification of Project WB-14 in the Draft National Development Plan. A first-draft project memorandum prepared by the Ministry is attached as Appendix C. The Project is a significant effort toward providing adequate information and data necessary for orderly expansion of major village water supplies and for regional planning. The project will likely include georesource studies to inventory minerals such as clays, sand, and gravel. This georesource component is similar to a counterpart envisioned by the Geological Survey. The project would consist first of planning studies to provide adequate data bases for management. Under Phase I, available data on population growth, water demands, and sufficiency of present water sources would be analyzed. Additional water sources, to the extent possible, would be identified, the adequacy of existing

distribution systems to meet future needs analyzed, and data gaps determined. Phase I would consist of hydrologic and hydrogeologic surveys, drilling and data collection to provide an adequate base for long-range water resources planning. Based upon results of the planning studies, long-range extensions and expansions to existing water supply systems would be designed. Consideration is being given to inventories of industrial minerals as part of this proposal.

The Integrated Georesource Studies as envisioned by the Geological Survey are identical to those of Phases I and II of the Major Village Planning Studies (see Appendix C).

The Hydrometric Network would establish groundwater monitoring at approximately 50 sites in major aquifers and at major use centers to measure groundwater levels, meteorologic data, and water quality. Purpose is to provide reliable information on status of groundwater resources, including recharge and withdrawals, for immediate and long-term management. Once established, the network would become an ongoing activity of the Geological Survey.

B. U.S. Geological Survey Study Team Proposals

Fourteen specific proposals were made by two USGS study teams in 1979. Four were made by the Hydrologic Team and ten by the Geologic Team.

1. Hydrologic Team Proposals

The following projects have been proposed by the Hydrologic Team. They are discussed in detail in Chapter V.

o Deep Drilling Project

Objective is to explore groundwater potential of the Karoo Beds which underlie the Kalahari Sands. Additional benefits accrue from training of technicians in operating drill rigs. Equipment requirements include drill rig with necessary accessories, geophysical logging equipment, and support vehicles, along with a staff of eight. Project would cover a three year period, with USAID furnishing major equipment and salaries. Cost is estimated by USGS Team at P1,800,000.

o Improved Surface Water Data Project

Objective is to expand surface water data network to provide needed data for water management and reservoir design in eastern Botswana. Necessary equipment consists of gaging devices for one watershed and computer facilities for data

processing. Manpower requirements are one hydrologist for three years, another for one year, and one technician for 2-1/2 years to establish the station, operate it initially, and train counter part personnel in the Department of Water Affairs. Cost is estimated by USGS Team at P800,000. Also see Project WB-20.

- o Designing Data Storage and Retrieval System

Objective is to design a computer-oriented system of water storage and retrieval. Alternative manpower requirement in addition to substantial personnel inputs from the water departments, are either consultants on intermittent assignments over a 2-year period or one expert for a continuous period of 18 months. Costs for consultant or expert are estimated by USGS Team at P100,000. Also see Project WB-20.

- o Village Water Supplies Project

Objective is to increase capability of the Department of Water Affairs through augmentation of both staff and equipment. Equipment and manpower needs are similar to those of the Deep Drilling Project. Cost is estimated by USGS Team at P1,800,000.

2. Geologic Team Proposals

The following projects have been proposed by the Geologic Team:

- o Analytical Support of Heavy Minerals Surveys

Objective is to determine magnetic fraction of heavy minerals which cannot be done at this time in the Botswana Geological Survey. Proposal is to have 300 samples analyzed by the U.S. Geological Survey. Cost is estimated by USGS Team at P10,000.

- o Preservation of Landsat Interpretive Overlays

Objective is to obtain reproductions of 33 transparent overlays to Landsat images. Proposal is to have specialist from USGS view the overlays and recommend ways of duplication in color for preservation. Cost is estimated by USGS Team at P5,000.

- o Multicolor National Geographic Map

Objective is to produce a geographic map of Botswana in natural land surface colors at a scale of 1:1 million from computer-enhanced Landsat imagery. Cost is estimated by USGS Team at P240,000.

- o Color Magnetic Maps

Objective is to print a color edition at two scales of eight existing black-and-white aeromagnetic maps to enhance visual perception. Cost is estimated by USGS Team at P80,000.

- o Controlled Source Seismic Study of Deep Basins.

Objective is to explore two very deep basins identified in aeromagnetic surveys by controlled source seismic methods to obtain additional geologic information. Proposal is for use of special USGS equipment and to have professional support. Cost is estimated by USGS Team at P600,000.

- o Acquisition of Equipment

Objective is to supply needed items of equipment to the Botswana Geological Survey. Cost is estimated by the USGS Team at P200,000. Also see Project GS-18.

- o Introduction of Remote Automatic Weather Stations.

Objective is to establish three experimental remote weather stations for satellite transmission of data from platforms. Cost is estimated by USGS Team at P80,000.

- o Quaternary Geology of the Kalahari Beds

Objective is to evaluate the geomorphic and stratigraphic features of the Kalahari Sands in an economic and environmental context. Proposal is for two USGS specialists headquartered at the United States doing field mapping in Botswana for five months each year for five years. Cost is estimated by USGS Team at P744,000. Also see Project GS-17.

- o Further Analysis of Aeromagnetic Data

Objective is to obtain additional analyses of prominent anomalies shown on the national aeromagnetic survey. Proposal is for computer-developed analyses by commercial firms in the United States. Cost is estimated by USGS Team at P40,000.

- o Extension of Seismic Network

Proposal is to establish two additional seismic stations to be located at Francistown and Lobatse. Initial costs are estimated by the USGS Team at P320,000, with subsequent annual operating costs of P288,000.

V.

Discussion and Recommendations

The following discussion and accompanying recommendations are offered for USAID consideration.

A. USAID Program Emphasis

Botswana today is slowly moving from a concept of abundant resources toward a realization of limited resources. This is particularly true of two of its basic natural resources -- land and water. Until recently, the development of these resources -- particularly water -- was in response to immediate needs. Water systems have been developed for all major and many small villages. Government-developed water systems now serve about 55 percent of the population of Botswana, an exceptionally high figure compared to many other similarly-developing countries. Much of this development has been in eastern Botswana, where efforts have been reasonably successful because of relatively reliable groundwater aquifers and moderate rainfall.

This emphasis on immediate development, however, has not been without problems. During drought years herds of cattle have been driven from rural areas to eastern Botswana where water was available from boreholes. In many cases, these concentrations of cattle around boreholes has resulted in overgrazing and in some cases, pollution of the water supply itself. Towns and villages also are not without problems. At Lobatse, groundwater has been polluted from the operation of a large abattoir; at Molepolole, from pit latrines, where a tracer placed in a pit latrine was detected only four hours later in the water supply.

There is a strong awareness of these water problems at Ministry level and at Departmental operational levels in the Ministry of Mineral Resources and Water Affairs. Planning in this Ministry is rapidly progressing from support of immediate need to comprehensive long-range planning. For example, the

Department of Water Affairs has suggested to the Department of Towns and Planning that its proposal to expand Mahalapye as a major village be shifted to nearby Palapye because of more favorable prospects of supplying adequate water for the proposed expansion. The full range of Ministerial awareness is evident in a current tentative proposal for major village water planning (see Appendix C).

Although in its formative stages, this proposal if fully developed and enacted could provide a needed catalyst in the Government of Botswana to move towards long-range comprehensive planning based upon natural resource considerations. Early results from this project could influence a significant shift from planning which is currently based on demographic and socio-economic considerations toward a more realistic one which considers the natural resources, especially the limited availability of water as essential components in the planning process.

USAID can contribute significantly to the future growth and stability of the Government of Botswana by assuming a significant role in this major policy direction of the Ministry of Mineral Resources and Water Affairs. Although the recommendations in the ancillary report by Wilken and Blank for support of a series of across-the-board proposals for resource management are valid, a strong and major support for the one vital component now recognized as perhaps the critical component in resource management -- water -- offers the opportunity for greatest payoff in supporting the Government of Botswana in its efforts toward orderly growth and self-sufficiency.

RECOMMENDATION 1

USAID encourage the far-sighted policies of the Ministry of Mineral Resources and Water Affairs in its efforts to expand the scope of its efforts from the concept of development in support of immediate needs to that of long-range comprehensive planning in which natural resources are a key component.

RECOMMENDATION 2

USAID encourage early refinement of the preliminary proposal of the Ministry of Mineral Resources and Water Affairs as shown in Appendix C to a formal proposal stage, with USAID support for Phase I of this effort to the extent that subactivities are not part of other ongoing activities. Although no definitive levels of support can be made until the preliminary proposal is considerably refined, support of about P2 million to about P4 million over a five-year period seems reasonable at this time. The identified needs for support at this time are mainly fiscal support, and one hydrogeologist on contract. No equipment needs are foreseen at this time.

B. Government of Botswana Projects

Proposed projects in the Draft National Development Plan have been discussed previously, with comments on possible support for each. Several of the U.S. Geological Survey Study Teams proposals represent aspects of these and are considered later.

RECOMMENDATION 3

USAID may wish to consider some support within its budget and overall objectives of those components of the projects suggested for possible assistance. Consideration should be secondary to Recommendations 1 and 2, and support prioritized on a basis of applicability and value to the proposed Major Village Water Planning Study.

The establishment of a Hydrometric Network to monitor groundwater, as proposed by the Geological Survey will be necessary for long-range water resources planning. Only with hydrometric data can withdrawals and replenishments of aquifers be determined, and safe yields projected. A significant part of this effort could be a byproduct of the Major Village Water Planning Studies, in that selected wells of those drilled for hydrogeologic data under this program could be instrumented for long-term monitoring. Until this proposal is refined further, and its adaption to the activities of the Major Village Water Planning Studies is determined no firm costs can be developed. USAID support for this effort possible in supplying monitoring equipment.

RECOMMENDATION 4

USAID encourage the establishment of a hydrometric network by the Geological Survey through coordination of further development of the network composition with the refinement of the hydrogeologic requirements of the Major Village Water Planning Studies. USAID should postpone a definite commitment to this project until decisions are made on the Major Villages Water Studies, and the utilization of present boreholes and those developed under the study can be analyzed to determine the need and cost, if any, for additional drilling.

C. U.S. Geological Survey Study Team Proposals

The fourteen proposals of the U.S. Geological Survey Study Teams can be divided into two general groups: those related to

immediate needs of the Department of Water Affairs and Geological Survey, and those directly related to the expertise of the U.S. Geological Survey. This expertise can contribute significantly to the advancement of hydrology and geology in Botswana if the efforts are chanelled directly to needs in the Government of Botswana. All of the proposals of the two study teams have validity and would either contribute to the advancement of knowledge or provide products for activities or programs. However, both their costs and their applicability to the USAID's goals and objectives in Botswana need to be considered. Following is a discussion of these proposals.

- o Deep Drilling Project

Although this project has merit from a geologic viewpoint, its cost estimated at P1.8 million would divert funds from other high priority items. There would be few direct beneficiaries of this study.

RECOMMENDATION 5

USAID not support this proposal at this time.

- o Improved Surface Water Data Project

The proposal for full support, including personnel, is not realistic. Surface water is not only limited in Botswana, but reasonable capabilities for gaging already exist in the Department of Water Affairs. The Department does propose to install from 4 to 6 gages under NDP Project WB-20 and has expressed interest in assistance in locating proper sites for the gages, inasmuch as the targetted rivers offer few conventional sites. Although Wilken and Blank have recommended that the surface water network be expanded to include small catchment in support of ALDEP, the Department of Water Affairs does not see this as part of its present role in water resources. This would support Project WB-20.

RECOMMENDATION 6

USAID provide short-term (1 to 2 month) technical assistance to the Department of Water Affairs of a surface water expert to assist in appropriately locating the proposed gages. Estimated cost is P20,000. Since much of the equipment in current use is not of U.S. origin, it is not recommended that U.S. equipment be supplied because of duplication in stocking spare parts and in servicing.

- o Designing Data Storage and Retrieval Systems

Currently there are data both in the Geological Survey and in the Department of Water Affairs that are simply stored and

not filed, indexed, or catalogued in orderly form for ready retrieval or use. Both Departments have expressed the desire to process these data for more efficient storage and retrieval. The Geological Survey has already acquired a Hewlett-Packard Model 9845S computer capable of handling all their current and anticipated data. Systematic computer storage and retrieval of past borehole data would greatly facilitate its use in proposed projects (see Recommendation 2). This would also support Project WB-20.

This can be accomplished by experts in data storage and retrieval on short-term (1 to 2 month) details to assist in the process at key times. These experts could be obtained through a PASA with the U.S. Geological Survey. Two types of assistance are needed. First, an expert in data utilization should assist in establishing a usable format for the data, followed by a computer specialist when the data has been formatted to assist in programming an efficient data storage and retrieval system. The expert in data utilization should also have a working knowledge of computerized storage and retrieval systems. The Botswana Geological Survey has plans to train one chemist and one geologist in operation of the Hewlett-Packard Computer.

RECOMMENDATION 7

USAID provide short-term assistance to both the Geological Survey and the Department of Water Affairs, in the form of two experts, each on one to two month assignments, to assist in the development of data management systems in the two Departments. Assuming the efforts can be done concurrently, cost is estimated at P40,000.

o Village Water Supplies Project

The Village Water Supplies Project is an ongoing activity in the Department of Water Affairs. The USGS proposal is to increase capability through augmentation of staff and equipment. Cost is estimated by the USGS Study Team at P1,800,000.

RECOMMENDATION 8

USAID not support this proposal. Although this project has high priority within the government of Botswana, the continued development of additional rural village water supply systems can only exacerbate future water resource management problems, inasmuch as many will likely be developed in areas of limited groundwater and with minimal hydrogeologic information. Increased numbers of dry boreholes can be expected with a probable success rate well below the present 60 percent now achieved by the Department of Water Affairs. In the overall, the systems become less economical because of increasing numbers of dry boreholes and very limited water demands. The economic

risk is high. The project would require funding; little opportunity exists in this ongoing program for training of Botswana to eventually replace expatriates. Maintenance of existing systems require repeated repair service because of inadequate maintenance, a situation likely to occur on new systems. Furthermore, the size of the program is beyond the scope of the projected size of the currently-developing resource management project.

- o Analytical Support of Heavy Minerals Surveys

The analysis of 300 samples would provide highly useful information at a modest cost.

RECOMMENDATION 9

Although this is not a water-related proposal, USAID may wish to consider funding this because of its low cost, estimated at P10,000.

- o Preservation of Landsat Interpretive Overlays

Proposal is to provide services of a specialist from USGS to view and advise on methods of duplicating 33 original color overlays.

RECOMMENDATION 10

USAID may wish to consider some support to this proposal for the photographic reproduction. Capability of cartographic reproduction exists within the Geological Survey. The cartographic reproduction can be reproduced photographically for use with the Landsat images by the Agfa Photo Lab in Johannesburg. Cost is estimated at P8,000.

- o Multicolor National Geographic Map

A national geographic map in natural land-surface color would be an attractive wall map and be useful for general educational purposes. However, professional users of Landsat data would undoubtedly prefer using individual Landsat frames selectively processed for their particular needs.

RECOMMENDATION 11

USAID not support production of this map for technical uses. However, USAID may wish to consider support of this proposal for educational reasons. Costs is estimated by the USGS Study Team at P240,000.

- o Color Magnetic Maps

A color rendition of the present black-and-white maps would enhance their appearance, but not their technical value.

RECOMMENDATION 12

USAID not support this proposal.

- o Controlled Source Seismic Studies of Deep Basins

Project would supply additional geologic information on two deep basins which may have oil and gas potential.

RECOMMENDATION 13

USAID may wish to consider support for this proposal because of the possible oil and gas potential. The proposal, however, has no relationship to other resource development and management. Cost is estimated by the USGS Study Team at P600,000.

- o Acquisition of Equipment

Of the six items listed in the proposal, two -- the drafting equipment, and the accessories for the Hewlett-Packard computer -- have direct applications to the ongoing water-related activities of the Geological Survey. The acquisition of the computer accessories will be valuable in the utilization of data from a computerized data storage and retrieval system. This would support Project GS-18.

RECOMMENDATION 14

USAID support the acquisition of the drafting equipment and the accessories for the Hewlett-Packard computer at an estimated cost of P50,000. USAID may wish to consider support for acquisition of the additional equipment as proposed if funding is available.

- o Introduction of Remote Automatic Weather Stations

Installation of three experimental automatic weather platforms is not warranted at this time. Services of a highly-skilled technician to perform maintenance and repair on this sophisticated equipment would be a major problem. Emphasis rather should be placed on installation of standard equipment in more accessible locations.

RECOMMENDATIONS 15

USAID not support this proposal

o Quaternary Geology of the Kalahari Beds

Under this proposal, maps of the Quaternary deposits -- specifically the Kalahari Sands -- would be compiled in the United States by two geologists from field observations in Botswana over a five year period. The proposal as structured provides no element of training and is completely detached from the Botswana Geological Survey. Any geologic mapping program should be administered and managed by this Department.

RECOMMENDATION 16

USAID not support this proposal.

o Further Analysis of Aeromagnetic Data

Further refinement of the present data is warranted. Additional analyses could be done by the Geological Survey if accessories to the Hewlett-Packard computer are acquired. Some analyses not amenable to this computer could be done by commercial firms.

RECOMMENDATION 17

USAID may wish to consider limited support, estimated at P40,000, for analyses by commercial firms at such time as the Geological Survey undertakes additional analyses on its computer.

o Extension of Seismologic Network

The proposed establishment of two seismic stations is very costly, and would require sustained technical assistance from outside. At present, there are other priorities within the Ministry of Mineral Resources and Water Affairs.

RECOMMENDATION 18

USAID not support this proposal which does not have high GOB priority.

D. Other Considerations

There are two additional items for consideration -- training and acquisition of a Schramm drilling rig.

1. Training

There is a one immediate proposal from the Department of Water Affairs for USAID support of two additional Batswana for college-level training in engineering. Experience with the present four students indicates that they have minimal qualifications for major engineering schools. Consideration should be given to locating appropriate colleges where curriculum may provide more practical levels of training. College-level training will be necessary if Batswana are to fill professional posts held by expatriates. The Department of Water Affairs has indicated a need for 19 additional college-trained personnel. The Department is not seeking any other direct support for training at this time.

The Geological Survey currently has several people being trained in Canada, and had not expressed strong interest in additional training support at this time. It's long-range plan calls for training at least 36 Batswana in Canada and Great Britain.

RECOMMENDATION 19

USAID continue to support college-level training, particularly in engineering, for qualified Batswana. Specifically, USAID provide scholarships for the two trainees proposed by the Department of Water Affairs. Consideration should be given to a program which would provide scholarships in engineering at a rate of perhaps one or two each year, if qualified candidates can be found in the Department. Consideration should also be given to locating an appropriate school where the curriculum would provide more practical levels of training. Cost is estimated at P15,000 per year per student. Total cost for 12 trainees is P820,000.

2. Acquisition of new Schramm Drilling Rig

The Department of Water Affairs has expressed strong interest in obtaining a third Schramm drilling rig to increase its drilling capacity. Presumably the rig would be used to increase drilling capacity in support of the Small Village Water Supply Project.

RECOMMENDATION 20

USAID not support acquisition of the drilling rig per se at this time. A decision on acquisition of the drilling rig should be made in conjunction with decisions related to the Small Villages Water Supply Program and after the Department of Water Affairs has demonstrated it is able to use the present equipment efficiently. Since the second rig has only been operating for a few months, the efficiency of its use cannot yet be determined. Cost of acquisition is estimated at P400,000.

VI.

Conclusions

Botswana is slowly entering a transition from a policy of development of apparent abundant resources to a realization of the need to manage finite resource. Limited available water will be a controlling factor in future development. There is a full awareness of this today in the Ministry of Mineral Resources, both at Ministerial levels and at operational levels in both the Geological Survey and the Department of Water Affairs. This awareness is exemplified in the draft project memorandum on Major Village Water Studies. This project, if implemented, could provide strong impetus to the needed transition from immediate development to effective long-range resource management. USAID can plan a major role in this Ministerial effort through encouragement of the Ministry in this approach and direct support of the Major Village Water Studies. Although the transition will not be easy, it must take place if Botswana is to achieve self-sufficiency and, more importantly, long-term stability. USAID's full support of this effort would undoubtedly produce far more long-range benefits in overall resource management than scattered support of varied projects.

The overall competence exists within the Ministry to administer and conduct this potential program. Both the Geological Survey and the Department of Water Affairs are staffed by professionals, predominately expatriates, who in general are qualified and competent. Personnel shortages and some problems do exist in both Departments. Some of these can be overcome through technical assistance on short-term details of months rather than years. The most serious problem is borehole and water system maintenance. There is probably little that can be done at privately-owned boreholes other than educate the owner on the need for proper maintenance. At the 15 major villages, however, the Department of Water Affairs could play a stronger role in its relationship with the District Councils who have been given responsibility for operations of the systems. There is also a problem with mechanics on repair crews, many of whom

are considered inadequate. There is no easy solution to these problems; remedies will likely take time.

Training of Batswana to assume professional posts has been slow, mainly because of few available who have sufficient qualifications for universities. At present, four from the Department of Water Affairs are attending engineering schools in the United States; two more have been proposed. Although the Department of Water Affairs optimistically feels it can replace most expatriates with Batswana in the near future, it is more likely to be a slow process over many years.

Some possible areas of USAID support have been suggested projects in the Draft National Development Plan. Recommendations have been made for all proposals of the U.S. Geological Survey Study Teams. These recommendations are based upon the two general criteria of support of long-range management of water resources and support of short-term efforts to increase the effectiveness of the appropriate Department. As suggested in several of the recommendations, USAID may wish to reconsider some of the recommendations in regard to mineral activities and other USAID objectives.

In summary, the following are recommended for USAID support:

- o Major Village Water Supply Studies
- o Improved Surface Water Data Project
- o Designing Data Storage and Retrieval Systems
- o Acquisition of Equipment
- o Training of Engineers

The following projects are suggested for possible USAID support as second-priority items, subject to availability of funding:

- o Analytical Support of Heavy Minerals Survey
- o Preservation of Landsat Interpretive Surveys
- o Further Analysis of Aeromagnetic Data
- o Controlled Source Seismic Studies of Deep Basins
- o Acquisition of Schramm Drilling Rig

Total estimated cost of the five recommended projects is P2,930,000 to P4,930,000. These costs can be further refined as the preliminary proposal for Major Village Water Supplies is further refined. Total estimated cost of the five projects suggested for possible support is P658,000.

A tabular detailed listing of these projects, including duration, types of support, and cost estimates is given in Appendix D.

VII.

Reference Documents

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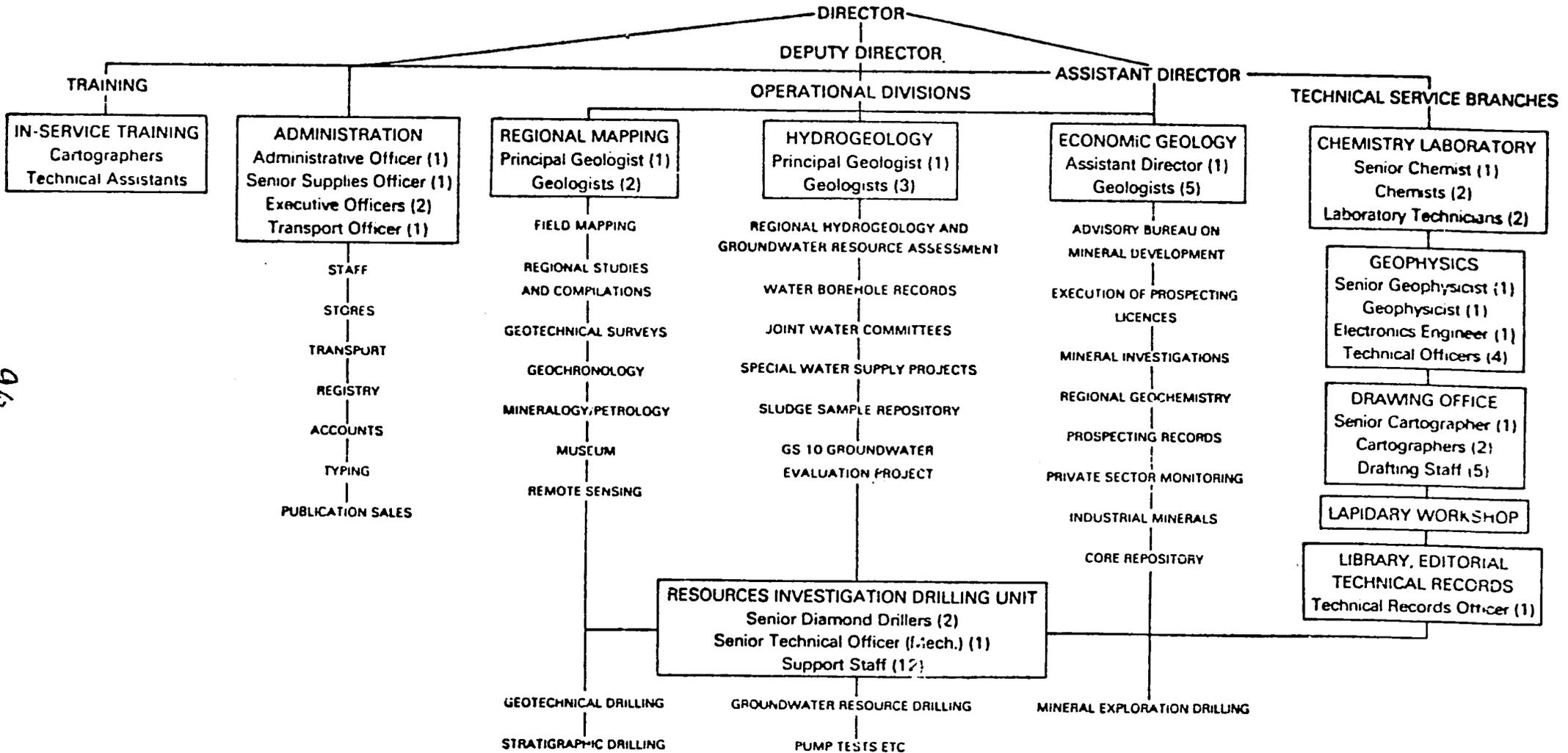
APPENDIX A

Organization and Personnel

**Geological Survey
Department of Water Affairs
within the
Ministry of Mineral Resources and Water Affairs**

APPENDIX I

GEOLOGICAL SURVEY OF BOTSWANA-ORGANISATION CHART

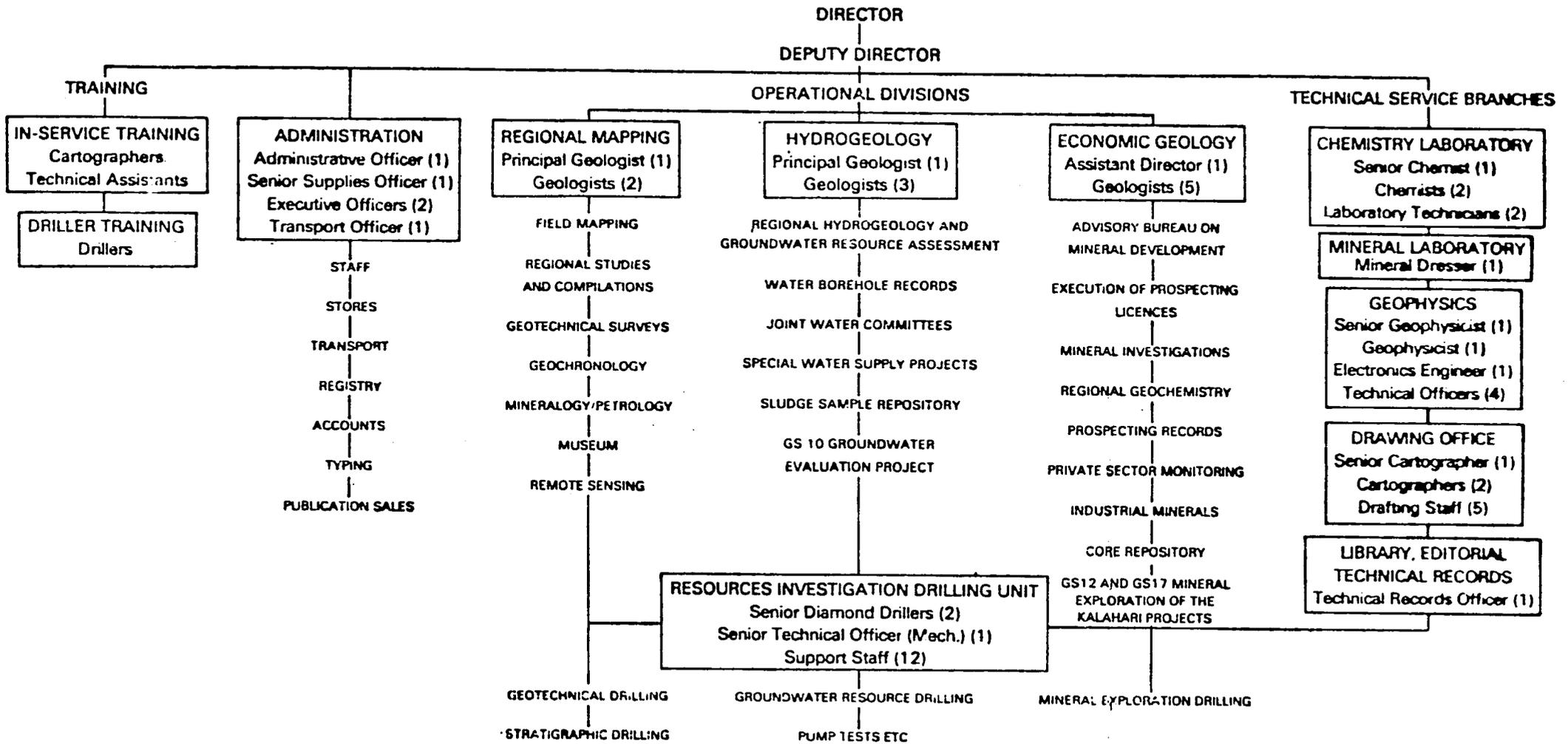


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10/11

FIGURE 1

GEOLOGICAL SURVEY OF BOTSWANA—ORGANISATION CHART 1979



27

BOTSWANA GEOLOGICAL SURVEY DEPARTMENT

PROFESSIONAL, SENIOR TECHNICAL AND SENIOR
ADMINISTRATIVE STAFF LIST AS AT
1st SEPTEMBER, 1979

DIRECTORATE

Director	² C. R. Jones, OBE., AMN., PhD., BSc., FGS., FRGS.
Deputy Director	² R. D. Walshaw, BSc., PhD., MIMM.
Assistant Director (Economic Geology)	² G. C. Clark, BSc., PhD.
Administrative Secretary	¹ L. Botlhole
Senior Personal Secretary	¹ H. M. Isaacs
Personal Secretary	¹ T. M. Matlhaku

OPERATIONAL DIVISIONS

Hydrogeology Division

Principal Hydrogeologist	⁵ G. Goldberg, Dr. rer. nat.
Senior Hydrogeologist	⁵ C. Neumann-Redlin, Dr. rer. nat.
Hydrogeologist	⁹ G. A. G. Nelisse, ING. ² J. Davies, BSc., MSc. ¹ M. Sekwale, BSc.
Supernumerary (GS10 Project)	⁴ J. L. Farr, MSc. (Acting Team Leader) ⁴ J. H. Baron, BSc. (Mrs) ⁴ G. S. Cheney, BSc., FGS.

Economic Geology Division

Principal Geologist (Assistant Director)	² G. C. Clark, BSc., PhD.
Senior Geologist	⁵ W. Gwosdz, Dip. geol., PhD. ² D. Gould, BSc., PhD., FGS.
Geologist	¹ M. P. Modisi, BSc. Vacant 1

44'

Supernumerary (GS17
Project)

West German Team

Japanese Team

⁶G. Lüdtke, Dr. rer. nat.
(Team Leader)

¹¹T. Nakajima (Team Leader)

Field Mapping Division

Principal Geologist

Geologist

Assistant Geologist

²R. M. Key, BSc. PhD.

¹T. P. Machacha, BSc

¹A. Tombale, BSc.

TECHNICAL SERVICES BRANCHES

Geophysics Branch

Senior Geophysicist

Geophysicist

Electronics Engineer

Supernumerary
(GS12 Project)

³D. G. Hutchins, BSc., MSc.

²R. Peart, BSc., MSc.

³E. Milner, BSc.

¹⁰H. Meixner, BSc. (Team Leader)
¹⁰R. M. Marvin, BA.

Laboratory Branch

Principal Chemist

Chemist

Senior Technical Officer

Mineral Dresser

³J. S. Butterworth

⁷P. L. Francks, BSc.,
Vacant 1

¹R. J. Malejane

¹H. Kara

Drawing Office

Senior Cartographer

Cartographer

³K. Jennings

³C. E. R. Bruchwalski
¹²N. R. J. Gohil

Library Records

Technical Records Officer

Library Assistant

Publications Officer

³G. McEwen, BSc.

¹S. Marope (Miss)

¹C. P. Matshaba

Resources Investigation Drilling Unit

Senior Diamond Drillers	³ C. R. Phillips ³ R. Lewis
Senior Technical Officer (Supplies)	Vacant 1
Assistant Driller	¹ M. Motladi

Recruiting Status Notes

- 1 Permanent Establishment
- 2 UK Seconded Officer
- 3 UK OSAS Contract Officer
- 4 UK Technical Cooperation Officer
- 5 West German Seconded Officer
- 6 West German Technical Cooperation Officer
- 7 USAID
- 9 Dutch Aid
- 10 CIDA Technical Cooperation Officer
- 11 Japanese Technical Cooperation Officer
- 12 Local Contract.

C. R. Jones
DIRECTOR OF GEOLOGICAL SURVEY DEPT.

CRJ/HMI
4th September, 1979.

DEPARTMENT OF WATER AFFAIRS

AS AT JANUARY 1980

<u>SALARY</u> <u>SCALE</u>	<u>ESTABLISHMENT</u> 1978-79-1979-80			<u>POST</u>	<u>HOLDER</u>	<u>DATE OF</u> <u>APPOINT</u> <u>MENT</u>	<u>TERMS OF</u> <u>EMPLOY</u> <u>MENT</u>	<u>REMARKS</u>
<u>SUPERSCALE STAFF (2)</u>								
IV	1	1	1	Director of Water Affairs	1 Vacant <i>E.M. Basisthi</i>	-	SLAA	2-3 yrs
V	1	1	1	Deputy Director of Water Affairs	B. H. Wilson	1-7-79	Contr. Offr.	2-3 yrs
<u>PROFESSIONAL STAFF (12)</u>								
PR.1	2	2	2	Principal Water Engineer	P.I. Hamalainen	5-8-77	Contr. Offr. SIDA	2-3 yrs
PR.1				" " "	L. Krayenbuhl	8-4-76	" " "	"
PR.2	2	2	2	Senior Water Engineer	M. Nord	-	" " "	"
PR.2				" " "	Vacant	16-9-77	" " "	"
PR.3	5	4	4	Water Engineer (North)	C. M. Boberg	14-12-76	" " "	"
				" " "	B. Khupe	1-1-78	P & P	Confirm
				" " "	E.M. Bastiampillai	8-3-79	Contr. Offr.	2-3 yrs
				" " "	1 Vacant	-	-	-
PR.1	1	1	1	Principal Hydrogeologist	P. Soderman	-	SIDA	2-3 yrs
PR.2	-	1	1	Senior Hydrogeologist	B. Motsete	1-8-68	P & P	Confirm
PR.1	1	1	1	Principal Hydro. Engineer	1 Vacant	-	-	-
PR.1	1	1	1	Principal Mech. Engineer	A. Olsen	14-12-76	Contr. Offr.	2-3 yrs
					4 Vacant			

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<u>SALARY SCALE</u>	<u>ESTABLISHMENT</u> 1978-79-1979-80			<u>POST</u>	<u>HOLDER</u>	<u>DATE OF APPOINTMENT</u>	<u>TERMS OF EMPLOYMENT</u>	<u>REMARKS</u>
<u>TECHNICAL STAFF (138)</u>								
T.1	6	6	6	Chief Technical Officer	W. I. T. Dewar	27-11-75	Contract Officer OSAS	2-3 yrs
"	"	"	"	"	<i>1 Vacant</i> U. K. W. Burzi <i>Contract</i>	29-10-79	"	"
"	"	"	"	"	G. Waring	25-10-78	"	"
"	"	"	"	"	P. Ravenscroft	4-10-78	"	"
"	"	"	"	"	1 Vacant	-	-	-
"	"	"	"	Drilling Superintendent	Mahtson	-	-	-
"	"	"	"	"	<i>2 Vacant</i>			
T.2	26	17	26	Senior Tech. Officer	M. Gaorutwe	6-6-73	P & P	Confirmed
"	"	"	"	"	F. Olsen	-	Contract	2-3 yrs
"	"	"	"	"	P. P. Mehta	15-3-79	"	"
"	"	"	"	"	P. H. Robinson	30-6-74	Contract OSAS	"
"	"	"	"	"	K. Hagstrom	18-4-75	" SIDA	"
"	"	"	"	"	<i>S. D. H. LUNA</i>	<i>11-01-80</i>	" SIDA	"
"	"	"	"	"	C. G. Hornell	7-10-77	" SIDA	"
"	"	"	"	"	S. Ramorola	15-10-71	P & P	Confirmed
"	"	"	"	"	R. Mangole	1-4-71	"	"
"	"	"	"	"	<i>U. ERICKSON</i>	-	<i>CIDA</i>	<i>2-3 yrs</i>
"	"	"	"	"	G. Anderson	-	CIDA	2-3 yrs
"	"	"	"	"	F. Ndlovu	20-6-69	P & P	Confirmed
"	"	"	"	"	Anderson Eo	-	CIDA	2-3 yrs
"	"	"	"	"	C. P. Greef			
"	"	"	"	"	<i>3 Vacant</i>			

<u>SALARY</u> <u>SCALE</u>	<u>ESTABLISHMENT</u> <u>1978-79-1979-80</u>			<u>ICST</u>	<u>HOLDER</u>	<u>DATE OF</u> <u>APPOINT</u> <u>MENT</u>	<u>TERMS OF</u> <u>EMPLOY</u> <u>MENT</u>	<u>REMARKS</u> <i>S</i>
<u>TECHNICAL STAFF</u>								
T.3	36	26	36	Technical Officer	J. H. Matenge	1-4-58	P & P	Confirmed
				"	C. D. Motlhabai	2-2-73	"	"
				"	C. Yane	-	"	"
				"	C. M. Ntshitang	15-10-71	"	"
				"	K. Moronkwe	1-2-78	"	"
				"	M. J. Gopolang	15-10-71	"	"
				"	G. M. Keloneilwe	1-2-78	"	"
				"	I. C. Sekopecwe	1-4-69	"	"
				"	S. Molefe	1-2-78	"	"
				"	F. P. Kganane	1-4-69	"	"
				"	H. Kgomanyane	1-2-78	"	"
				"	M. Noe	15-10-71	"	"
				"	L. T. S. Matlhabaphiri	1-4-77	"	"
				"	A. Katse	1-4-73	"	"
				"	<i>J. D. KES</i> M. Mokibe	-	<i>Peace Cop</i>	"
				"	M. Mokibe	1-4-75	"	"
				"	A. Lindberg	-	SIDA	"
				"	B. Matsapa	20-3-79	P & P	"
				"	P. Liden	-	SIDA	"
				"	B. M. Ramahosi	19-3-79	P & P	"
				"	C. P. Dorfling	1-4-77	Contract	2-3 yrs

<u>SALARY SCALE</u>	<u>ESTABLISHMENT</u> 1978-79-1979-80			<u>POST</u>	<u>HOLDER</u>	<u>DATE OF APPOINTMENT</u>	<u>TERMS OF EMPLOYMENT</u>	<u>REMARKS</u>
<u>TECHNICAL STAFF</u>								
T.3	36	26	36	Technical Officer	M. Mpho	1-4-77	P & F	Confirmed
				" "	4 Vacant	-	-	-
T.4	24	11	24	Snr. Tech. Assistant	K. Fetanang	1-6-68	P & P	Confirmed
				Snr. Tech. Assistant	S. Kgwarae	15-10-71	"	"
				" " "	L. Lekoko	1-12-72	"	"
				" " "	S. K. Molapisi	27-12-72	"	"
				" " "	K. Motlhasedi	25-10-68	"	"
				" " "	T. M. Segakise	26-5-67	"	"
				" " "	R. Ramoupo	10-10-79	"	"
				" " "	S. Seitshiro	1-4-58	"	"
				" " "	J. S. Mathambo	1-4-77	"	"
				" " "	B. Modisane	23-2-78	"	"
				" " "	C. Monageng	27-9-75	"	"
T.5	80	80	80	Technical Assistant	W. G. Seone	23-4-70	"	"
				" "	D. S. Lekuntwane	1-9-74	"	"
				" "	F. Forembi	1-11-71	"	"
				" "	T. Gopolang	4-10-78	Temporary	2 yrs probatio
				" "	D. O. Gabanakgosi	1-1-73	P & P	Confirmed
				" "	O. Cageng	4-10-78	Temporary	2 yrs probatio
				" "	A. M. Fhiri	22-2-67	P & P	Confirmed
				" "	D. Batsalelwang	26-5-67	"	"

<u>SALARY</u> <u>SCALE</u>	<u>ESTABLISHMENT</u> <u>1978-79-1979-80</u>			<u>POST</u>	<u>HOLDER</u>	<u>DATE OF</u> <u>APPOINT</u> <u>MENT</u>	<u>PERIODS OF</u> <u>EMPLOY</u> <u>MENT</u>	<u>REMARKS</u>
					<u>TECHNICAL STAFF</u>			
T.5	80	80	80	Technical Assistant	M. Busang	30-11-77	P & P	Unconfirmed
				"	D. Kebaitse	<i>P. 22-11-77</i> 30-11-77 31-1-77	"	"
				"	M. Ntshontsi	27-9-75	"	Confirmed
				"	G. Motingwa	30-12-77	"	"
				"	K. Stegling	25-9-75	"	"
				"	D. Matsheng	14-3-77	"	Unconfirmed
				"	M. Morapedi	25-9-75	"	"
				"	G. Mokotedi	30-11-77	"	"
				"	T. Pilane	17-3-77	"	"
				"	W. Mokwaleng	1-12-75	"	"
				"	B. Thipe	30-11-77	"	"
				"	T. Seitshiro	27-2-76	"	"
				"	I. Seodubeng	30-11-77	"	"
				"	R. Dintwa	29-4-76	"	"
				"	T. Balole	30-11-77	"	"
				"	B. Mathethe	14-3-77	"	"
				"	P. Setshedi	15-3-77	"	"
				"	C. O. Mooketsi	14-3-77	"	"
				"	D. Ralebanta	15-3-77	"	"
				"	M. Mooketsi	17-3-77	"	"

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<u>SALARY SCALE</u>	<u>ESTABLISHMENT</u> 1978-79-1979-80			<u>POST</u>	<u>HOLDER</u>	<u>DATE OF APPOINTMENT</u>	<u>TERM OF EMPLOYMENT</u>	<u>REMARKS</u>
<u>TECHNICAL STAFF</u>								
T.5	80	80	80	Technical Assistant	K. Motlhabane	14-3-77	P & P	Unconfirmed
				" "	M. Lekwete	1-10-74	"	Confirmed
				" "	M. Setswalo	1-10-74	"	"
				" "	R. Sebeke	23-3-78	Temporary	2 yrs probation
				" "	J. M. Lebakeng	23-3-78	"	" "
				" "	D. G. Machola	29-11-77	"	" "
				" "	J. L. Molobeng	23-3-78	"	" "
				" "	M. Koapare	9-8-78	"	" "
				" "	A. J. Mhlasi	5-9-78	"	" "
				" "	D. Bopadile	1-4-63	P & P	Confirmed
				" "	M. Rantong	1-4-63	"	"
				" "	G. G. Tahla	11-9-78	Temporary	2 yrs probation
				" "	M. Segokgo	20-3-77	"	" "
				" "	J. Maphanyane	11-9-78	"	" "
				" "	B. E. Mogwase	18-5-77	"	" "
				" "	T. M. Badirwang	20-5-77	"	" "
				" "	L. K. Moroka	11-9-78	"	" "
				" "	L. K. Lekwapa	11-9-78	"	" "
				" "	S. Kgamane	25-4-78	"	" "
				" "	S. G. Sokwane	11-9-78	"	" "
				" "	J. L. Seleke	1-5-77	"	" "
				" "	N. Talenyana	11-9-78	"	" "

T.5 80 80 80

Technical Assistant

" "
" "
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HOLDER DATE OF
APPOINTMENT TERMS OF
MENT EMPLOYMENT REMARKS

TECHNICAL STAFF

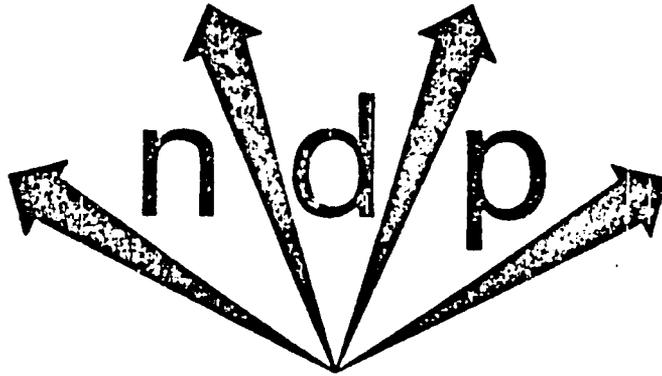
B. O. Mbedumedi	19-10-77	Temporary	2 yrs probation
F. Magibisela	11-9-78	"	" "
A. Senthufhe	19-10-77	"	" "
S. Ikhutseng	5-9-78	"	" "
G. Mhusiwa	19-10-77	"	" "
J. Chakalisa	11-9-78	"	" "
H. B. Mokgethi	5-9-78	"	" "
W. Kgvasiwa	11-9-78	"	" "
M. K. Madziba	19-10-77	"	" "
L. O. Duna	10-10-77	"	" "
L. Ratsatsi	17-2-78	"	" "
G. Maikano	11-9-78	"	" "
J. MADISA	11-2-80	"	" "
10 Vacant		"	" "

APPENDIX B

**Water Resources Project
in the
Draft National Development Plan
of the
Government of Botswana**



REPUBLIC OF BOTSWANA



NATIONAL DEVELOPMENT PLAN 1979-85

PART II

DESCRIPTION OF DEVELOPMENT PROGRAMME

DRAFT

MINISTRY OF FINANCE AND DEVELOPMENT PLANNING

MINISTRY OF MINERAL RESOURCES AND WATER AFFAIRS

<u>Project Number</u>	<u>Project Title</u>
WU01 (110/103)	Francistown - Shashe Pipeline
IO10 (110/124)	Rural Power Supplies
PRO1 (110/131)	Utilisation of Solar Energy
PRO2 (110/135)	Jwaneng Diamond Project Design Phase
GSC8 (110/215)	Geological Survey Buildings
GS10 ✓ (110/218)	Evaluation of Underground Water Resources
GS11 (110/219)	Mineral Dressing Laboratory
GS12 (110/220)	Airborne Magnetic Survey
GS13 ✓ (110/228)	Okavango Delta Groundwater Evaluation
GS17 ✓ (110/233)	Mineral Exploration of the Kalahari
GS16 (110/234)	Okavango Seismicity
GS18 ✓ (110/237)	Geological Survey Equipment
GS02 (110/238)	Diamond Drilling Training
WB10 ✓ (110/301)	Borehole Repair Service
WB36 ✓ (110/302)	Expansion of Government Borehole Drilling
WB03 ✓ (110/303)	Lands Area Water Supplies
WB17/26 ✓ (110/304)	Major and Rural Village Water Supply
WB20 ✓ (110/305)	Hydrological Support
WB06 (110/306)	Windmill Provision
WB27 ✓ (110/307)	Hydrological and Ecological Studies of the Okavango Delta
WB08 ✓ (110/308)	Assistance to Private Borehole Drilling
WB32 ✓ (110/309)	Underground Water Development
WB10 ✓ (110/310)	Limpopo Water Utilisation Study
WB13 ✓ (110/311)	South East Botswana Water Planning Study
WB14 ✓ (110/314)	Major Village Water Planning
WB29 ✓ (110/321)	Sand Rivers Project
WB21 ✓ (110/322)	Okavango Development
WB30 (110/327)	Small Village Water Supplies
WB35 ✓ (110/336)	Rural Water Extraction
PRO3 ✓ (110/403)	Small Mines
GSC6 ✓ (110/413)	Air Pollution Control
ED09 (110/525)	Expansion of Electrical Department

Project WU 01 (110/103)

FRANCISTOWN/SHASHE PIPELINE

The Francistown water supply suffers from very limited water sources and from source pollution. As reporting by Government's consulting engineers has shown that the best means of securing source adequacy is to provide a supply from the Water Utilities Corporation's Shashe Dam, the Corporation has undertaken a Pre-Investment Study for a suitable project. This has now undergone final I.B.R.D. appraisal, and detailed design has been commenced. The project will include a water treatment and pumping plant at Shashe and a pipeline to Francistown together with, perhaps, certain items in Francistown. Target date for project commissioning is September, 1981.

Total Estimated Cost: P2 946 000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	200	1 740	790	216	-	-
Recurrent	(All recurrent costs will be met by tariff revenue, and are therefore not included here).					

Project ID 10 (110/124)

RURAL POWER SUPPLIES

This project will provide electricity to all villages with a population over 5,000. At the same time, the opportunity is being taken to supply smaller villages which are close to existing transmission lines: Tonota - Chashe, Mmadinare, Mogoditshane, Gabane, Thamaga and Moshupa. The main consumers are expected to be institutions such as schools and hospitals, and businesses - both of which categories serve a wide public. The project began in the last Plan period, and considerable progress has been made: Mochudi, Ramotswa, Tlokweng and Gabane are completed, and power stations have been commissioned at Maun and Mahalapye. Work is in progress for all the other villages except Tonota - Shashe and Mmadinare, and it is hoped to complete the entire project in 1980/81.

The project is administered by BPC as an agent of Government. Tariffs are maintained at the Gaborone level, and Government has undertaken to meet the resulting deficits. Particularly large deficits are inevitable in the four villages which depend on their own diesel power stations, rather than a transmission line from one of the BPC's major power stations.

Total Estimated Cost: P1,314,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	198/84	1984/85
Capital	1,000	314	-	-	-	-
Recurrent	121	220	90	-10	-5	-10

Project MR 01 (110/131)

UTILIZATION OF SOLAR ENERGY

This project is first to evaluate and then to propagate the possibilities of using solar, wind and other renewable energy. Prime applications are likely to be for pumping, heating and desalinating water, but other uses such as space heating and cooling, and cooking may be considered. A particular emphasis will be placed on extension work and evaluation of particular services in day to day field use.

Implementation of this project will in part be by non-governmental organizations such as the Rural Industries Innovation Centre, Pelegano Village Industries and the Brigades. Funds will be made available for specific projects. Some applications of solar energy may also be tested by Government departments, such as the Department of Electrical Engineering (the use of solar energy in heating and cooling buildings) and the Department of Water Affairs. The appropriate Technology Centre will be closely involved in the project.

Total Estimated Cost: P1,010,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	6	74	200	200	250	280
Recurrent	-	50	20	50	30	20

Project MR 02 (110/135)

JWANENG DIAMOND PROJECT DESIGN PHASE

This project covers the Government's part in the preparation and design of the Jwaneng diamond mine project. It includes studies of infrastructure such as power and water supplies, survey work, and the Government's administration for the Jwaneng Project. Government expenditure on the town and the Township Authority are excluded.

Total Estimated Cost: P140,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	70	40	30	-	-	-
Recurrent	-	-	-	-	-	-

Project GS 08 (110/215)

GEOLOGICAL SURVEY BUILDINGS

This project was launched in 1972 following a Cabinet decision that the Geological Survey Department Headquarters remain in Lobatse. Since that time a new drawing office, an extension to the chemistry laboratory, and a block of field lockers have been built and various buildings have been improved. This progress, however, has been outstripped by the expansion in staff, with the result that office and laboratory space are still insufficient.

Accordingly the project was replanned and rephased in 1977. Under Phase I of the new Plan, the construction of a new geophysics block and mechanical workshop are being completed. The plot boundary is also being extended to make way for future growth.

Phase II will see the construction of an administration block, a rock and core store, and an extension to the library.

The administration block is meant to bring the various administrative functions under one roof and also to provide more working space. This is essential if Geological Survey is to be relieved of the pressing demand for office accommodation by both existing state and Technical Assistance teams who will be carrying out exploration activities in various parts of the country.

The core store is meant to enable rock samples collected by field geologists to be systematically stored and catalogued to prevent the loss of such valuable material.

There is an urgent need to expand the Library so as to have adequate space for the rapidly growing reports received and generated within the Department. The additional space will assist the Technical Records Officer to exercise more control on the material.

Total Estimated Cost: P750,000

		P'000				
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	229	100	209	212	-	-
Recurrent	-	5	2	4	4	-

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Project GS 10 (110/218)

EVALUATION OF UNDERGROUND WATER RESOURCES

The main objectives of the project were originally a total National Underground Water Resources Evaluation and a compilation of a complete inventory of predicted available reserves for future planning. These objectives had to be rejected because of the high cost of research, including the drilling of test boreholes. Instead the activities of this Project have been directed towards areas where the size of the projected water demand is likely to become substantial. Groundwater Resources Assessment studies have been undertaken in the Kweneng and Serowe areas, which are typical karroo basin regions. Investigations will continue in these two areas. To build up sufficient data on the hydrogeology and geology of Karroo basins, a substantial amount of drilling, pumping, testing and borehole logging has to be undertaken. It is hoped that such studies will assist extrapolation into areas of the Karroo basin elsewhere.

The results of recharge studies indicated the unlikelihood of current recharge through the Kgalagadi sands in the Kweneng. Further recharge studies will be carried out in this area.

In the West of Botswana significant water abstractions have resulted in water quality variations. Saline groundwater is a matter of great concern to cattle ranchers in these places. The GS.10 team will look into the nature of the problem.

Four hydrogeologists are presently engaged in this project full-time. To cope with the growing work load, an additional hydrogeologist will be recruited. The Geological Survey Department provides a counterpart contribution to the project in the form of part-time hydrogeologists, laboratory facilities and assistants and the services of the cartography section.

The present project, to complete these studies and finish past work, will expire in 1981. Because of the appreciable impact of the project to date on government development endeavours, Government is considering its extension.

Total Estimated Cost: P360,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	108	174	78	-	-	-
Recurrent	-	1	-	-	-	-

Project GS 11 (110/219)

MINERAL DRESSING LABORATORY

A contract for the construction of the Mineral Dressing laboratory was let early in 1979/80 and is scheduled to be completed early in the Plan period.

Presently no facilities for laboratory process testing of economic minerals exist in the Geological Survey Department or in any other Government or private organisation in the country. This situation greatly limits the Department's capacity to contribute to and foster the development of local economic minerals, particularly industrial minerals.

The laboratory will have facilities for the testing of clays for pottery and brick making, cement-making materials and other raw materials used in the construction industry— virtually all of which are at present imported. It will also provide a sample preparation service (crushing, grinding, sieving, polishing and sectioning) for all sections of the Department, principally the Chemistry Laboratory and Field Mapping.

Ultimately the laboratory will help to establish a local industrial minerals industry by reducing the risks for private entrepreneurs, BEDU, BDC etc.

A mineral dresser, who will be responsible for the day-to-day activities of the laboratory is due to complete his training abroad in the early years of the Plan.

Total Estimated Cost: P282,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	100	103	79	-	-	-
Recurrent	-	2	4	5	-	-

Project GS 12 (110/220)

AIRBORNE MAGNETIC SURVEY

In pursuit of its policy to explore the mineral potential of the Kgalagadi, the Botswana Government through the Geological Survey Department and with the technical assistance and funding from a donor agency carried out a reconnaissance airborne magnetic survey over 80 per cent of the country where the bedrock is thickly obscured by the Kgalagadi sands. The magnetic data was collected and compiled under Phase I of the project and released in October, 1977.

An interpretation of the magnetic data has now been completed under Phase II and the results, in the form of technical reports and detailed synoptic maps, have been received from the contractors. The main conclusion drawn from the results of the airborne magnetic survey is that the Kgalagadi is a very promising region for prospecting.

However, due to logistical problems of operating in the Kgalagadi, the still existing high risk level, and the need for much confirmatory drilling it is anticipated that initially much of the follow-up will be undertaken by Government with the help of aid agencies.

When local target areas have been outlined, the private sector is expected to take an active role in detailed mineral exploration of the Kgalagadi and the proving of specific deposits.

Total Estimated Cost: P280,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	133	95	52	-	-	-
Recurrent	-	-	-	50	-	-

Project GS 13 (110/228)

OKAVANGO DELTA GROUNDWATER EVALUATION

This project is intended to evaluate the groundwater potential for domestic, agricultural and industrial uses, including mineral development in the Okavango area. Since the Delta contains the largest known supply of water within this area, the eventual utilisation of this resource would have a considerable impact on Northern Botswana. The immediate objectives of the project are to identify all hydrogeological parameters affecting the groundwater basin and to determine both the technical and economic feasibility of utilising groundwater as an alternative method for developing the delta's water resources.

Total Estimated Cost: P500,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	-	-	-	300	200
Recurrent	-	-	-	-	-	-

Project GS 17 (110/233)

MINERAL EXPLORATION OF THE KALAHARI

Owing to the fact that most of Botswana is covered by thick Kgalagadi sands there is little geological information on the sub-Kgalagadi basement. The Airborne Magnetic Survey has yielded much data on the magnetic properties of the deeper rocks, from which certain major structural features and possible rock compositions have been deduced, but a considerable amount of ground follow-up work is required to check the validity of these deductions.

Plans are well advanced for such follow-up by several technical assistance teams whose work will be closely monitored by, and who will receive logistical support from, the Geological Survey Department.

This exercise is essential if the Government is to achieve its objective of completing the national mineral inventory and of spreading mineral development throughout the country.

Total Estimated Cost: P316,000

	1979/80	1980/81	1981/82	1982/83	1983/84	P'000 1984/85
Capital	4	133	133	46	-	-
Recurrent	-	-	-	-	-	-

Project GS 16 (110/234)

OKAVANGO SEISMICITY

The Okavango Delta is a region of pronounced seismic activity. Recent seismological and hydrometric investigations have demonstrated that the majority of earthquake epicentres are located beneath the Delta, and that as a result, the quantity of water flowing in particular channels can change considerably. This could seriously effect water supply to, among others, the Orapa mine, Maun and Lake Ngami.

To investigate this further, it is planned to set up a network of high intensity seismographs spread over the delta, with the aim of zoning the delta in terms of seismic hazard. In January 1979 preliminary discussions were held with the consultants for the project (Uppsala Seismological Institute), focussing on the various aspects of implementation. 7 sites were identified as suitable for location of seismograph stations: Tsodilo Hills, Aha Hills, Bodibeng (alternatively Kgwebe Hills), Drofsky's bridge (alternatively Samadupe), Boteti River east of Makalamabedi, Shinank Hills and Gabatsa Hills. Selection of a permanent seismograph station will be left until after one year of the project's operation. The consultants recommend that the project run over a ten year period to enable sufficient and reliable data to be collected. There is also a proposal, as a Phase II of the project, to leave one seismograph station permanently operational in the region.

Total Estimated Cost: P278,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	-	-	-	130	148
Recurrent	-	-	-	-	15	-

Project GS 18 (110/237)

GEOLOGICAL SURVEY EQUIPMENT

This project is aimed at improving the range of equipment held by the Department of Geological Survey. The equipment is required to support principally the hydrogeology and geophysics section, but also the chemistry laboratory, mineralogical/petrological laboratory, and the drawing office.

If such equipment is made available, Geological Survey will become more versatile and reliance on outside organisations in achieving the National Development Plan aims will be reduced.

The Department is aware of the need to strike a balance between the expertise and the equipment available in order to tap maximum benefit from both.

Notwithstanding the need to establish a balance, the range of equipment required by the survey geologists is not constant but needs to be modified as

- (i) Knowledge of the geological environments of particular mineral prospects is improved.
- (ii) New equipment and techniques become available.
- (iii) World demand for particular minerals fluctuates.

These factors combined produce a situation which demands periodic changes in the range of equipment required in the survey. With the availability of such equipment the department can more effectively perform its role of compiling a national inventory of mineral resources.

Total Estimated Cost: P470,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	100	170	200	-	-
Recurrent	-	-	5	8	10	-

Project GS 02 (110/238)

DIAMOND DRILLING TRAINING

Although most diamond drilling in Botswana is at present undertaken by the private sector under prospecting licences, there is a need for the Geological Survey to have a certain amount of drilling capacity in order to carry out limited research in certain areas of the country.

At present the operational machines in the department are wholly manned by expatriate drillers, who must ultimately be replaced by locals. The primary objective is to create a strong group of local (T3) diamond drillers so that more effective use may be made of the range of available equipment in the department.

The training will be run by an instructor supplied on technical assistance terms by a donor agency and is expected to run for a maximum of 4 years and produce 4 trained drillers.

Total Estimated Cost: P191,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	35	92	39	25	-
Recurrent	-	-	-	-	12	-

Project WB 01 (110/301)

BOREHOLE REPAIR SERVICE

The Government has decided to convert the old Borehole Preventative Maintenance Scheme, which had great difficulty in providing a maintenance service, into a Borehole Repair Service, to concentrate on the more pressing need of repair. All crews, including the existing maintenance crews, have therefore been allocated to repair duties (although a customer wishing for a maintenance visit is still able to receive one on payment of the standard fee). Membership has been abolished, so that the services of the BRS are now available to any borehole owner.

In large part, this change can be accommodated without additional capital expenditure. However, it is also intended to expand the service by selling spare parts to the public at BRS depots. Funds are required for the construction of additional stores at initially seven of these depots. Once the BRS has been in operation for some time, and it becomes possible to gauge the demand for its services, further expenditure to improve services may be needed.

Total Estimated Cost: P452,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	20	87	95	115	135	
Recurrent	-	8	25	15	-	

Project WB 36 (110/302)

EXPANSION OF GOVERNMENT BOREHOLE DRILLING

The Department of Water Affairs at present has 1 Schramm air rotary and 7 percussion rigs drilling. Between them, they can produce 85 holes, 50 successful holes per year at the normal success rate. Demand is expected to be very much greater, perhaps roughly as follows:-

	<u>Total Borehole Needs</u>			
	<u>1979/80</u>	<u>1980/81</u>	<u>1981/82</u>	<u>1982/83</u>
Villages	45	63	58	50
Other	<u>40</u>	<u>40</u>	<u>40</u>	<u>40</u>
TOTAL	85	103	98	90

These demands are entirely for Government development programmes in rural areas, and cover the whole spectrum of rural development. The "Villages" item is for village water supply; "Other" includes various agricultural projects, rural roads, etc.

A project is therefore proposed to purchase a second air rig in 1979/80 (bringing capacity to 80 successes per year); to replace about 5 of the Department's aging percussion rigs and the existing air rig when it comes to the end of its life; and, provisionally, to buy a third air rig at the end of the Plan period when graduates from the Drill Foreman Training course by the Department will be available. Assistance in training, and especially in further training of present drill foremen, will form part of the project.

Total Estimated Cost: P2,570,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	P'000
Capital	570	-	400	850	-	750	
Recurrent	30	80	100	110	-	110	



Project WB 03 (110/303)

LANDS AREA WATER SUPPLIES

One of the main national development programmes during the fifth National Development Plan will be the promotion of arable farming (ALDEP). Shortage of water at critical times of year has been identified as a major constraint. It is thought likely that the most appropriate form of water supply may be small scale: wells and catchment tanks, for example. This is because houses are often very scattered, because year-round reliability is not essential, because maintenance could be undertaken largely at the household level, and because drilling capacity is too short to permit a major additional drilling programme.

Funds are sought for an initial consultancy into the most suitable methods of supply, and thereafter for implementation of a programme, starting in 1981/82. It is expected that the project will be implemented largely by the Ministry of Agriculture, with the Department of Water Affairs in a primarily advisory role, unless further staff can be made available to the Department.

Total Estimated Cost: P1,200,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	-	300	300	300	300
Recurrent	-	-	30	30	30	30

Project WB 17/26 (110/304)

MAJOR AND RURAL VILLAGE WATER SUPPLY

The construction of water supplies to major villages was begun in 1972. At the start of 1979/80, supplies were operating at Kanye, Ramotswa, Moshupa, Tlokweng, Thamaga, Molepolole, Serowe, Palapye, Mahalapye, Tonota/Shashe, Mochudi, Kasane, Maun, Ghanzi and Tsabong. Major villages are operated by the Department of Water Affairs, as agent for the District Council.

Funds are required to complete the remaining village, Letlhakane, with the possible addition of Mogoditshane, scheduled for 1979/80. In addition, extensions are already underway, to fill in gaps in the original design and above all to cater for the expansion of the villages. These extensions are undertaken by the existing water supply staff in the villages. It is important that funds are available every year for small extensions; delay would mean large extensions would be needed later, diverting construction staff from smaller villages new supplies. Later in the Plan period, larger additions to water sources will be needed: see the Major Village Water Planning project.

The rural village component of this project provides for reticulation of villages with a 1971 population over 500 people. The standard is for a standpipe within 400 metres of every household, except in scattered villages. (48) villages of this size have been completed since 1973/74 (a few early ones were not funded under WB 26). The District Councils have operation and maintenance responsibility. Additional capacity will be provided to them under the District Development Support Sector project.

54 village water supplies remain to be constructed in the present phase of the project. It is anticipated that a further 10 to 20 villages would qualify for an extension of the programme. It is hoped to construct approximately 17 village water supplies per year, staff permitting, with an acceleration to 33 in 1981/82 if an additional team can be recruited for construction. The recurrent costs are large and fall on Councils.

This project also covers measures to monitor and act against the pollution of village water supplies; consultancies and trials of new technologies for domestic water supply; and assistance to training.

The phasing of the rural village component of the project is as follows:-

Phasing of Construction (number of villages)

1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
15	17	33	-	-	-

13

Total Estimated Cost: P6,987,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	1,235	1,174	2,430	664	718	766
Recurrent	-	490	465	120	105	125

Project WB 20 (110/305)

HYDROLOGICAL SUPPORT

The basic surface hydrological network for Botswana was established between 1968 and 1972 under the UN "BOT 1" Project, with minor extensions since. The Hydrological Division of the Department of Water Affairs has two professional officers and 15 other permanent and pensionable staff. There is only one expatriate officer, and a considerable amount of training has been organised, both locally and abroad.

The first part of this project is to establish about four to six additional river gauging stations. It may also be necessary to install water level recorders at one or more reservoirs. These requirements follow particularly from the survey of potential dam sites carried out during 1976 and 1977 by consultants. The manpower needs are small, and no additional professional staff are called for. Provision is made for replacement of two vehicles used under the UN Scheme 71/010 (Hydrometrics), but which belonged to the United Nations.

The second part of the project is to assist with the processing of a back-log of hydrological data. About nine years of data has been accumulated, and the Department of Water Affairs has not been able to finalise its processing. The Department can provide two or three hydrological technician counterparts and wishes the maximum amount of work to be done in Botswana by them towards production of hydrological year books and/or hydrological five year summaries. The project request is for one comparatively junior Hydrologist seconded from and supervised by an established hydrological organisation to work with the Department of Water Affairs for a series of periods (amounting to perhaps 12 man-months) until the year books are produced. Once the backlog is cleared and the hydrological technicians experienced in this manner, it is expected that Water Affairs will be able to produce future yearbooks without further help.

Total Estimated Cost: P125,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	P'000
Capital	-	10	40	49	26	-	-
Recurrent	-	-	12	12	-	-	-

10

Project WB 06 (110/306)

WINDMILL PROVISION

The lack of permanent surface water means that nearly all Botswana villages and a high proportion of its cattle are dependent on underground water. In the vast majority of cases the water is brought to the surface by a diesel driven pump. These pumps use an estimated 16.5 million litres per annum, or 14% of the diesel oil consumption of the nation. Considerable difficulties are experienced in maintaining these engines due to the remote areas in which they are situated.

If windmills could be employed, there would be considerable savings in recurrent costs and probably in the employment of skilled maintenance labour. However, in the past the high capital cost of windmills, the shortage of spares, and in some places insufficient wind has prevented the widespread adoption. The Department of Water Affairs is installing 8 windmills on village water supplies and will monitor their performance. The Ministry of Agriculture is also to test some for cattle watering. This project would provide for

- (a) the purchase of perhaps 200 windmills for village water supplies;
- (b) a subsidy on the capital cost of perhaps 200 windmills for purchase by the private sector; and
- (c) assistance with the establishment of maintenance facilities.

A decision on whether to implement this project must clearly await further information. A final decision will be made after adequate testing of Water Affairs and Agriculture's windmills.

Total Estimated Cost: P2,000,000

						P'000
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	-	200	600	600	600
Recurrent	-	-	-	-	-	-

Project WB 27 (110/307)

HYDROLOGICAL AND ECOLOGICAL STUDIES OF
THE OKAVANGO DELTA

The Okavango Delta is the largest body of permanent surface water in Botswana, and a potential major water source. At present the costs of transporting the water to the east are prohibitive. However it is likely to be used in future, and a project was therefore undertaken by UNDP to make a detailed study of the hydrological and ecological aspects of the Delta.

The report of this project was received in 1979. However, some small items arising from the project remain. Expenditure in the current Plan covers finalization of supplementary report, and completion of the mathematical model of the Okavango Delta.

Total Estimated Cost: P14,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	1	13	-	-	-	-
Recurrent	-	-	-	-	-	-

Project WB 08 (110/308)

ASSISTANCE TO PRIVATE BOREHOLE DRILLING

The implementation of the Tribal Grazing Land Policy will lead to considerable demand for new boreholes. This is an opportunity to establish a local borehole drilling industry, particularly as Government rigs will be fully occupied on Government development programmes. However past experience has shown that existing local drillers are under-capital and of dubious technical skill and reliability.

The Ministries of Mineral Resources and Water Affairs and Commerce and Industry will accordingly commission a survey of the potential and actual problems of private drillers, leading to recommendations for support to local drillers, and also to regulation to protect the public from incompetent drillers. Funds are sought for the initial survey and for implementation of any recommendations that are accepted by Government. This might include provision of training and supervisory staff (such as Borehole Inspectors), credit for drillers to purchase equipment, or setting up an insurance scheme against blank boreholes (which are inevitable given the limited knowledge of Botswana's hydro-geology). Details must obviously await the consultancy.

Total Estimated Cost: P440,000

						P'000
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	-	140	150	150	-
Recurrent	-	-	25	25	25	-

78

Project WB 32 (110/309)

UNDERGROUND WATER DEVELOPMENT

The original project provided for drilling rigs for the Department of Water Affairs, which has the responsibility for drilling boreholes for Government development projects.

The remaining project items provide for the following equipment for the Department of Water Affairs:

- (1) Purchase of spares for the original rigs bought under the project;
- (2) Purchase of casing and support equipment to be used by the Drilling Section.
- (3) Purchase of 5 light rigs, to be used by the borehole Preventative Maintenance Service. They will be used both for lifting the rising main whenever a pump has to be inspected, and for cleaning and pump-testing boreholes that have caved in.

Total Estimated Cost: P425,000

	1979/80	1980/81	1981/82	1982/83	1983/84	P'000 1984/85
Capital	335	90	-	-	-	-
Recurrent	-	20	-	-	-	-

Project WB 10 (110/310)

LIMPOPO WATER UTILISATION STUDY

The Limpopo is one of the largest single sources of water in Botswana. It is important, particularly in regard to international water rights, that long term planning for the use of its water be undertaken. In the medium term, one or two dams on the Marico/Limpopo are quite likely to be needed for urban water supply and/or a Morupule power station. It is important that other potential demands, notably for irrigation, also be examined.

A consultancy is sought to list all the general options for the use of the Limpopo/Marico water resources, and to provide a preliminary analysis of the benefits, costs and constraints relating to such development. Stage 1 would be largely a desk study, and would list any field investigations that might be needed for Stage 2. The emphasis of the study is expected to be on irrigation, and would include marketing trends and different criteria of cost/benefit (employment, self-sufficiency, as well as profitability). Stage 1 would also assess whether any additional work was needed on dam site survey, but it is not expected that much would be required.

Total Estimated Cost: P100,000

							P'000
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	
Capital	-	50	50	-	-	-	
Recurrent	-	-	-	-	-	-	

Project WB 13 (110/311)

SOUTH EAST BOTSWANA WATER PLANNING STUDY

The area of Botswana east of longitude 24° and south of the Tropic of Capricorn contains three large sources of water demand, Gaborone, Lobatse and Jwaneng, and eight smaller demands from major villages. At present, water supply to Gaborone, Lobatse, Tlokweng and Mogoditshane is interconnected, and all the rest are independent of each other. For smaller water demands than these, questions of regional co-ordination do not apply, except in the case of dams and reservoirs for urban water supply.

This project provides for long term planning for these eleven demand poles. Phase 1 will be a desk study. It will establish tentative upper and lower limits of demand growth and an inventory of developable water resources and will produce a provisional plan for the order of development of these resources. It is particularly important that it be shown which assumptions, data limitations etc are critical. In the light of this a phased programme of data collection and further investigation and planning will be drawn up. Further phases, to carry out these recommendations and review results will be needed.

Phase 1 is estimated to take 4 man-months. It is probable that the project (including further phases) will be carried out by an established consulting firm. The Department of Water Affairs will be recruiting a Water Engineer (Resources) to supervise this and other planning studies.

Total Estimated Cost: P244,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/5
Capital	-	50	79	65	-	50
Recurrent	-	-	-	-	-	-

81

Project WB 14 (110/314)

MAJOR VILLAGE WATER PLANNING

By the start of 1979/80 15 major village water supplies were in operation, with a further two to be constructed during the year. They are operated by the Department of Water Affairs, which collects data regularly and publishes an annual report. The number of private connections and the volume of water consumed have both been rising rapidly. In four villages, demand & use by more than 20% in 1977/78. The larger of these villages consume in the order of 500m³ per day.

This project will plan for the expansion of water supply for these villages. Phase 1 will review possible demand trends and the adequacy of existing sources and reticulation, and will make a desk study of additional possible sources of water. Phase 2 will consist of investigations - primarily hydrogeological. Phase 3 will draw up a phased investment programme, and Phase 4 will be a review in 5 years time. It may be necessary to examine one or two of the most urgent villages in advance of the main programme.

The project will probably be implemented by an established firm of consultants. However, a Water Engineer (Resources) will be recruited in the Department of Water Affairs to supervise this and other planning studies.

Total Estimated Cost: P700,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	-	50	50	300	300	-
Recurrent	-	-	-	-	-	-

82

Project WB 29 (110/321)

SAND RIVERS PROJECT

The rapid development of eastern Botswana requires an investigation of the more important water resources in the region. This project is designed to survey the extent and potential of water held close to the surface in the beds of sand rivers, and to develop promising sites by installing wells to extract the water for village water supplies.

Studies were carried out between 1976 and 1978 on the Shashe, Tati, Ntshe, Motloutse, Thune, Lobatse, Tutume, Mahalapye, and Metsemotlhabe rivers. Sand river extraction points have been installed at Mahalapye and Makaleng, and are planned for Mmadinare. Studies should be completed on the Limpopo in 1979/80, and the final report written. This project will then be closed, and further construction will be financed under the Rural Village Water Supply or Rural Water Extraction projects, which are both financed by the same donor. The donor will be asked to transfer any remaining funds.

Total Estimated Cost: P131,000

						P'000
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	10	35	43	43	-	-
Recurrent	-	-	-	-	-	-

85

Project WB 21 (110/322)

OKAVANGO DEVELOPMENT

Final reports of the UN project Investigation of the Okavango Delta as a Primary Water Resource for Botswana were received in 1977. The project established that no harm will be done to the Delta by the extraction of the quantities of water contemplated. It recommended various works to be undertaken in the Delta to improve flows.

As a preliminary phase of this Okavango Development project, the services are sought of a specific consultant for 6 man-months to complete work he began during the UN project on a mathematical model of Delta flows. This would be valuable for monitoring the unstable behaviour of the delta, and for forewarning of floods.

The final report of consultants on the possible uses of Okavango water was pessimistic. However, pilot irrigation projects may be started, and engineering work might be needed in the Delta to ensure supplies to existing users (notably Maun and Orapa). This project therefore provides for experimental bunding and other engineering work as recommended in the UN project report. Implementation would be towards the end of the Plan period.

Total Estimated Cost: P550,000

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	P'000
Capital	-	-	-	50	250	250	
Recurrent	-	-	-	25	25	-	

84

Project WB 30 (110/327)

SMALL VILLAGE WATER SUPPLIES

This project provides water for villages with a population of less than 500 in 1971. Normally the supply consists of a borehole, reticulation to a reservoir and then to one or more standpipes centrally located in the village, with connections to primary school and health post (when present). Where a borehole is not already available, one is drilled under the WB 365 Rural Water Extraction project. 14 supplies had been completed by the start of 1979/80.

The present phase of the project will provide for about 85 more villages, but a further 120 or so villages would qualify under an extension of the project. Approximately 20 villages should be covered in 1979/80 and 1980/81. If an additional team can be recruited for one year, this can be accelerated to 40 in 1981/82 and 45 thereafter.

The recurrent costs are large and fall on Councils. The estimate below does not include the running cost of maintenance units purchased under the District Council Support Sector project.

Phasing of construction (Number of Villages)

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
	20	20	40	45	45	45

Total Estimated Cost: P3,781,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/35
Capital	114	365	1,060	747	783	712
Recurrent	55	155	245	235	230	230

Project WB 35 (110/336)

RURAL WATER EXTRACTION

A great many settlements in Botswana are without a permanent water source. Generally a borehole is the only practicable solution, but in some parts of the country hand-dug wells, sand river extraction points and even river extraction points are possible.

This project is primarily an adjunct to the Small Village Water Supplies project WB 30, to provide a water source for those villages where there is not one already. It covers the costs of borehole drilling or construction of an alternative water source. As the WB 30 programme progresses, an increasing proportion of villages will require new water sources. Until the villages are identified and inspected, it is impossible to be certain how many new sources will be needed. There is also a backlog of drilling to be made up if reticulation construction is to proceed as scheduled.

Total Estimated Cost: P2,810,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	200	267	570	540	604	629
Recurrent	-	-	-	-	-	-

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Project MR 03 (110/403)

SMALL MINES

During this Plan the Ministry of Mineral Resources and Water Affairs will be looking at prospects for opening small mines, whose chief benefit will be the employment opportunities they create rather than additional revenue for Government.

Small mine projects, and especially those which might produce industrial minerals, are not attractive to large mining companies because they hardly affect cash flow yet require a disproportionate amount of work in determining viability. Those individuals and small mining companies who could develop and operate the small mines usually lack the capital to do detailed exploration and feasibility studies.

In order that individuals and companies may be fully informed of opportunities for developing small mines, the Mines Department will identify and evaluate small deposits to provide information on potential prospects for developers. It will be necessary that the data be fully supported by independent expert assessment in critical areas such as geology and ore reserves, metallurgy, plant design and marketing.

- a) Mines Department estimates indicate a production potential for export of semi-precious stones of 200 tonnes per year. This industry has achieved average exports of 48 tonnes, which are collected by individuals and sold to licenced dealers in the export market. It is necessary further to develop marketing procedures and techniques that will assist the collectors and dealers of these semi-precious stones.
- b) The Makobaesi Deposit has potential for uranium. However, a metallurgical test program is needed to try to indicate a method whereby the uranium can be recovered economically.

Further provision is made for other unspecified deposits exploited. Gold, kyanite, gypsum, fluorite are examples of products that fall into category.

Total Estimated Cost: P149,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	8	26	25	30	30	30
Recurrent	-	-	-	-	-	-

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Project GS 06 (110/413)

AIR POLLUTION CONTROL

With growth of the mining sector and other industrial processes in Botswana, consideration has been given by the Government to the possible harmful effects resulting from pollution of the atmosphere due to these processes. Active steps have been taken by the Government to control atmospheric pollution from industry in order to maintain a clean and healthy environment in the future.

To ensure that atmospheric pollution would be effectively controlled, the Atmospheric Pollution (Prevention) Act, 1971, was introduced and the Chief Government Mining Engineer was appointed Air Pollution Control Officer. Under this Act the Minister is empowered to declare areas where an industrial process is being carried out a controlled area so that examination may be made and tests carried out to effectively control the process. The Selebi-Phikwe township and mining lease area have been declared a controlled area, and air pollution monitoring stations have been set up in several urban and industrial areas in order that a record of background readings may be obtained against which the extent of future air pollution can be assessed.

Regulations have been introduced pertaining to standards of emissions into the atmosphere of objectionable matter. These standards were determined in consultation with specialists in environmental control problems. Examination of the various industrial processes are continuously being carried out to ensure that constant measures are taken so that no excessive omissions occur, and an Air Pollution Inspector has been engaged to assist in this task. Provision is made to cover the cost of upgrading existing equipment as well as the purchase of additional equipment.

Total Estimated Cost: P22,000

						P'000
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	22	-	-	-	-	-
Recurrent	-	-	-	-	-	-

Project ID 09 (110/525)

EXPANSION OF ELECTRICAL DEPARTMENT

The Department of Electrical Engineering was formed in 1972 when the Technical and Electrical Branch of the Ministry of Works and Communications was divided. However, the Department has never had adequate buildings, and either shares workshop facilities or operates from entirely inadequate premises (such as a hospital corridor in Selebi-Phikwe). In the meanwhile the workload of the Department has considerably expanded, and will continue to do so as a direct consequence of the growth of the Government development programme, since the maintenance and installation of all electrical systems falls to the Department.

To enable it to discharge its functions, the Department will be considerably strengthened and developed. A new Headquarters will be built in Gaborone, and regional workshops constructed at 8 places round the country. Equipment for these workshops will also be acquired.

Total Estimated Cost: P2,437,000

	P'000					
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Capital	72	783	984	198	-	400
Recurrent	-	-	33	44	6	8

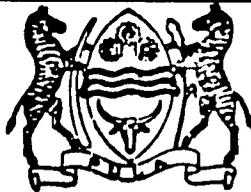
APPENDIX C

**First Draft Project Memorandum
Major Village Water Planning Project
prepared by
Ministry of Mineral Resources and Water Planning**

TELEPHONE: 2812

TELEGRAMS: MIRWA

REFERENCE: WA 8/9 I (7)



MINISTRY OF MINERAL RESOURCES
AND WATER AFFAIRS
PRIVATE BAG 18
GABORONE
BOTSWANA

REPUBLIC OF BOTSWANA

29th April, 1980.

Mr. H. Blank,
USAID Preparatory Mission for
Resource Management Project

Dear Sir,

MAJOR VILLAGE WATER PLANNING PROJECT

You asked for a background document on the proposed project before the imminent end of your mission. I attach one, drawn up in the form of a first draft project memorandum, according to the standard Botswana Government format for such memoranda. I must however make clear that it is just a background document, and not a formal submission of a project memorandum to USAID. Formal submission can only come from the Ministry of Finance and Development Planning, and the project memorandum eventually submitted will no doubt differ from this first draft after consultation with the Department of Water Affairs and Geological Survey, and with other relevant bodies within Government.

In particular, please note that the financial analysis is very sketchy at this stage, and can only be firmed up after the aforementioned consultations. I would hope that the figures quoted are at least the correct order of magnitude.

Yours sincerely,

F.R. Spray

F.R. Spray
for/PERMANENT SECRETARY.

cc: Director of Water Affairs
Director of Geological Survey

Herb,

I'd welcome the chance to talk to you about this before you go. I'm in Parliament all afternoon, but at 10 a.m. this morning (Wed). If I'm not in my office, I'll be in MLGE conference room just upstairs.

PROJECT MEMORANDUM

Title: Major Village Water Planning

Plan Number: WB14

TEDC: P5 800 000

Additional Recurrent Expenditure Arising: P300 000

Background

Botswana's settlement pattern is characterised by a number of very large villages, some of which contain as many as 20 000 people. Despite their size, they are definitely rural rather than urban, as is shown by their dependence on agriculture, the style and layout of housing (generally mud and thatch buildings arranged in family groups), and the level of services. Botswana have lived in very large villages at least since the early nineteenth century.

The Department of Water Affairs operates the water supply at 15 of these major villages (with a further two supplies still under construction). The villages, listed with details in Appendix A, comprise the ten District Headquarters, and seven other villages included because of their large size. These water reticulations have been constructed since 1973 under a Swedish aid project. They are designed to provide 40 litres per person, with a communal standpipe within 400 metres of each household. Water from communal standpipes is regarded as a basic need, and is provided free of any charge. Individual connections to private houses are available in major villages. Water supplied to private connections is metered and charged for at a rate (at present 30t/m³) equivalent to the average urban water tariff. This involves a subsidy, necessary in order to prevent urban areas appearing more attractive than rural areas.

The major villages have been growing very fast during the 1970s: between 1971 and 1978 the total population in these villages increased by about 60%, with some villages doubling in size. It is expected that this will continue. In particular, Government is proposing to adopt a National Settlement Policy which will emphasize the growth of six of the major villages, identified as "primary centres" - Serowe, Mahalapye, Mochudi, Molepolole, Kanye and Maun. Government will actively promote the growth of these villages in order to counterbalance the mushrooming growth of Gaborone, which would otherwise threaten to concentrate the benefits of national development in the Gaborone region. (See Sections 4.56 to 4.70 of the fifth National Development Plan).

This growth in population is matched by a fast growth in water demand, which is expected to continue. Appendix A shows that consumption has increased by more than 20% p.a. in some villages. Consumption will rise markedly as more people take private connections, since a family with a private connection uses several times more water than a family drawing water from a public standpipe.

There is a considerable demand for new private connections, with a backlog of unfulfilled applications.

The increase in water consumption, and the growing number of houses within the major villages, has already necessitated small extensions to the recently constructed water supplies. P95 000 has spent in 1978/79, P110 000 in 1979/80, and P150 000 is scheduled for 1980/81.

Serious bacteriological pollution of groundwater sources was discovered in several major villages in the late 1970's through the research activities of the Department of Geological Survey and later monitoring by the officer recruited in 1978 to fill the new post of Water Engineer (Pollution) in the Department of Water Affairs. Chlorination facilities have been installed in the major villages to remove the pollution, but contamination of the groundwater itself remains a concern. The possibility of forbidding pollution sources (such as pit latrines) within groundwater protection areas surrounding boreholes is being pursued; in some cases this may require relocation of boreholes. More information is needed on the sources of contamination and the flow of groundwater in the area of major villages.

TECHNICAL DESCRIPTION

The project has two elements.

A. PLANNING STUDIES

For each village a planning study will project water demand, estimate available supplies, investigate potential supplies and pollution problems, and recommend a phased investment programme. The scale of investigation will vary between villages depending on the extent of existing knowledge of each village's water resources, and on the extent to which existing supplies are adequate. It is envisaged that this study will be carried out in two phases.

Phase I is a single top/^{desk}study, covering all the major villages. It is possible that considerable work may have been carried out for some villages before the project starts; this should be reviewed. The study will address the following questions, indicating always the degree of reliability attached to the answer:

- (i) the probable upper and lower limits of population in 5, 10, 20 and 30 years' time, together with the scale of industries to be established there (Department of Town and Regional Planning to advise).
 - (ii) the corresponding upper and lower limits of water demand for domestic and industrial consumption, at the same times.
 - (iii) the extent to which the existing sources of supply (general aquifers) are sufficient to meet the expected demands; this should include consideration of the long term effect on the aquifers of pumping large quantities of water.
 - (iv) the extent of pollution of groundwater, and its implication for sources of supply.
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- (v) the location and size of possible additional sources of water in so far as these are seen from (iii) and (iv) to be necessary;
- (vi) the adequacy of the existing reticulation, (including pump, reservoirs and treatment) to meet future demands.
- (vii) proposals for further investigations (including field investigation) to fill gaps in data, and to meet the needs identified in this study. These should be listed in order of priority, so that villages whose water situation are the most critical are studied first. Cost estimates should be provided.
- (viii) proposals as to any investment needed immediately.

PHase II will consist of hydrological and hydrogeological surveys, drilling and data collection, as recommended under (vii) of Phase I. It is anticipated that, in general, each village will be examined in turn, and that the whole programme may take three to four years. Perhaps 7 or 8 of the villages will require major groundwater resource evaluations, taking perhaps 6 months. As investigations of each village are completed, the answers to questions in Phase I will be reviewed and updated for that village, and a phased investment programme proposed.

B. EXTENSIONS TO-WATER SUPPLIES

The planning studies outlined in Section A above will show the impact of growing water demand. Government is determined that these studies should be closely linked, in one project, to provision for undertaking the necessary extensions and modifications to the major village water supplies. Estimates have been made by the Operation and Maintenance Division of the Department of Water Affairs of the work required in 1980/81 (which will be funded from the SIDA village water supply programme) and in 1981/82. These are detailed in Appendix B, and include extensions to the reticulation, with new standpipes; additional reservoirs and boreholes where required; and electrifications of some pumps. However, these estimates are essentially short-term, to meet the immediately foreseen problems. As the planning studies are completed, it is expected that higher levels of expenditure will be needed especially for additional wellfields for some villages in response to the twin problems of a steep growth in water demand and pollution of existing aquifers. It is impossible at this stage, however, to detail what work will be needed, nor in which villages.

C. GEO-RESOURCE STUDIES

Consideration is being given to widening the scope of the project to encompass not merely an evaluation of the water resources available for the major villages, but also a resource inventory of industrial minerals useful to the village - notably clays for brick-making, and sand and gravel for construction. This work would probably be undertaken by the Field Mapping division of the Department of Geological Survey, utilizing the recently constructed Industrial Minerals Laboratory, and could be a major Botswana Government contribution to the overall project.

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PLAN OF OPERATIONS

A. The Planning Studies

Phase I: It is anticipated that Phases I will be carried out by a firm of consultants, responsible to a reference group drawn from the Department of Water Affairs, the Department of Geological Survey, and the Planning Unit of the Ministry of Mineral Resources and Water Affairs. The day to day supervision of the studies, and their co-ordination with related work such as the S.E. Botswana Water Study, will be responsibility of the Water Engineer (Resources) in the Department of Water Affairs.

It is thought that execution of Phase I of the project might take approximately 4 months, The consultants will be expected to consult with the relevant District Authorities and with the Department of Town and Regional Planning. Phase II: Responsibility for the various detailed studies under Phase II would fall to the relevant body within Government, under the continuing co-ordination of the Water Engineer (Resources). Thus the Hydrogeology Division of the Department of Geological Survey would be responsible for groundwater resource evaluation; it is expected that the Division might undertake the evaluation of some villages directly, using its own staff (though funds would still be needed for drilling), and put the work on other villages out to consultants. Any hydrological studies required would likewise be the responsibility of the Hydrological Section of the Department of Water Affairs, who might again have to put work out to consultants or contractors.

It is thought that Phase II might span 3 to 4 years, with a major groundwater resource evaluation of one village taking perhaps 6 months. Of course only some villages will require such detailed study.

B. The Extensions to Village Water Supplies

As at present, the Operation and Maintenance Division of the Department of Water Affairs will draw up in advance a plan for extension work in the coming financial year. (The Botswana financial year runs from 1 April to 31 March). This will increasingly become implementation of the investment programme recommended by the Planning Studies. However, there will continue to be small extensions identified by the Operations and Maintenance Division itself in consultation with local authorities.

Where possible, extension work will be carried out, as at present, by the Operations and Maintenance Division itself, under the supervision of the Officer-in-Charge of the village water supply and employing casual labour as necessary. Government seeks as far as possible to avoid diverting the Department of Water Affairs' Construction Division from its priority task of building new water supplies in small villages which have none at present. However, the drilling of new boreholes will require the services of the Department's Drilling Section, and the design of major new works (such as a pipeline from a new wellfield) will inevitably require the co-operation of the Construction Division.

C. Geo-resource Studies

As indicated under Technical Description, these would be carried out by the Field Mapping Division of Geological Survey.

FINANCIAL ANALYSIS

I. CAPITAL COSTS

At this stage, only very rough estimates are provided.

A. Planning Studies

		<u>Pula</u>
Phase I	8 man months	80 000
Phase II	7 villages groundwater resource evaluation @ P350 000	2 450 000
	Miscellaneous studies	200 000

B. Extensions

The NDP5 figures assumed a gradual rise in spending, for the reasons explained. It was guessed that the P180 000 level in 1981/82 (Appendix B) would rise to P280 000 in 1982/83 and P500 000 in 1984/85, in 1979 prices. These figures, modified only to 1980 prices, are used below.

C. Geo-resource Studies

No figures available yet.

II. PHASING OF CAPITAL COSTS

	<u>Thousand Pula (1980 prices expect last line)</u>				
	80/81	81/82	82/83	83/84	84/85
Studies Phase I	40	40			
Phase II		500	750	750	650
Extensions		210	290	290	575
<hr/>					
Total	40	750	1040	1040	1225
Contingencies @ 10%	4	75	100	100	120
Inflation @ 10% p.a.	-	85	240	380	620
<hr/>					
<u>Rounded Total</u>					
<u>Current Prices</u>	45	900	1400	1500	2000

This gives a total capital cost figure, excluding geo-resource studies, of P5.8 million in current prices.

III. RECURRENT COSTS ARISING

No recurrent costs will arise from the planning studies, other than monitoring work such as possible groundwater level recording and ongoing revision of projections by the Water Engineer (Resources). P1000 p.a. should be ample for this purpose.

Extensions will generate additional costs for the operation of major village water supplies by Water Affairs, although they will be offset partially by additional revenue from new private connections. It was estimated for NDP5 that additional recurrent would be generated each year as follows (omitting 1979/80 and 1980/81):

	<u>Thousand Pula</u>			
	<u>81/82</u>	<u>82/83</u>	<u>83/84</u>	<u>84/85</u>
<u>Additional recurrent each year</u> (79/80 prices)	75	100	100	125
1980/81 prices	85	115	115	140

The total additional recurrent cost by the end of the plan period would therefore be about P450 000 in 1980 prices. However, part of this can be attributed to growth in private connections etc which would occur even without this project, and the estimated recurrent implications of this project may therefore be nearer P300 000 p.a. in 1980 prices.

ECONOMIC AND SOCIAL BENEFITS

No attempt has been made to quantify the benefits that will arise from this project. Some are unquantifiable - such as the benefits that can be expected from reducing the concentration of development in the Gaborone region. An improvement in health levels can be expected as pollution sources are tackled, but more especially as water use per household rises with standpipes within 400 metres and a growing number of private connections. The related USAID-funded Environmental Sanitation project will be important in providing a complementary input of health-related measures. The drudgery of carrying water over long distances - a task which falls mainly to women - will be reduced. A felt basic need will have been satisfied: water was the highest priority of all identified in the District Development Plans produced in preparation for the fifth National Development Plan.

One item that can be very roughly quantified is the number of beneficiaries, taken as the total population of the major villages. In 1978, it was approximately 160 000, or 21% of the national population (Appendix A). The national population growth rate is 3% p.a., but major villages are expected to grow considerably faster than this, so that by 1985 they will almost certainly contain more than 225 000 people.

RELATED PROJECTS

The South East Botswana Water Study (WB13) is concerned with the regional water demands and supplies of the area east of longitude 24° and south of the Tropic of Capricorn. This includes 8 major villages, and its work may therefore overlap especially with Phase I of the Major Village Water Planning project. Its focus is however somewhat different, as a major concern will be to identify any potential conflicts or complementarities between the water needs of the various large centres within the region.

The Major Village Infrastructure project (LG04) is a closely related project to upgrade other services in major villages in pursuit of Government's national settlement policy.

VILLAGE	1980/81	1981/82
KANYE	Equipping one new borehole : P. 5.000	Equipping one new borehole : P 5 000
	Pipe line from new borehole : P 12.000	New pipe line from reservoir to town : P 25.000
	Electrification booster : P 5.000	
	Total Kanye : P 22.000	Total Kanye : P 30.000
RAMOTSWA	Equipping one new borehole : P 5.000	One additional reservoir 90 m ³ : P 15.000
	Pipe line from new BH. to reservoir : P 8.000	Stand pipes for extension of Water Works Area : P 5.000
	New pipe line to Secondary School and Industrial Site Area : P 6.000	
	Total Ramotswa : P 19.000	Total Ramotswa : P 20.000
MAUN	Extension pipe line to new area along Ghanzi Road : P 5.000	Extension of new area west of Maun : P 5.000
TSHABONG	Extension Pipe line to the proposed extended waterworks area : P 7.000	Extension pipe line to the proposed extended water works area : P 4 000
MOSHUPA	Extension pipeline to the proposed extended water works area : P 6.000	- do - : P 6.000
TONOTA	Extension pipe line inside water works area : P 4.000	Electrification of booster : P 7.000
GHANZI	-	-
MAHALAPYE	Extension within water works area : P 8.000	Equipping new well point : P 8.000
PALAPYE	Equipping one new borehole : P 5.000	-
KASANE	-	-
MOCHUDI	Construction of low reservoir and booster station : P 35.000	Construction new raising main to reservoir : P 40.000
	New stand pipes within water works : P 5.000	Extension pipe line to new areas : P 15.000

The Environmental Sanitation Programme (LG 51) will provide a complementary programme of health education.

The Major Village Water Supplies project (WB17) provides for the construction of the remaining two water supplies, at Letlhakane and Mogoditshano. It should be noted that expenditure on extensions to major villages, here included in the present project, were included in NBP5 under the WB17 project.

VILLAGE	1980/81	1981/82
MOCHUDI	Total Mochudi ; P 40.000	Total Mochudi : P 55.000
MOLEFOLOLE	Electrification booster and BH. : P 6.000 Extension pipe line within Water Works Area : P 8.000 Total Molepolole : P 14.000	Extension pipe line within water works area : P 15.000
SEROWE	Extension pipe line near airport : P 16.000 Electricity Supply : P 4.000 Total Serowe : P 20.000	Electrification booster : P 10.000 Extension pipe line within Waterworks: P 15.000 Total Serowe : P 25.000
THAMAGA	-	Equipping one new borehole : P 5.000
LETLHAKANE	-	-
MOGODITSHANE	-	-
	Total for 1980/81 : P150.000	Total for 1981/82 : P180.000

LE/MGM

APPENDIX D

**Project Recommended for
USAID Support**

APPENDIX D

PROJECTS RECOMMENDED FOR USAID SUPPORT

PROJECT	DURATION	TYPE OF ASSISTANCE	ESTIMATED COST
<u>RECOMMENDED</u>			
° Major Village Water Supply Studies	4-5 years	Financial Support	P2-4,00,000
° Improved Surface Water Data Project	short-term	Technical Assistance	P20,000
° Designing Data Storage and Retrieval Systems	short-term	Technical Assistance	P40,000
° Acquisition of Equipment	short-term	Financial Support	P50,000
° Training of Engineers	long-term	Scholarships	P820,000
<u>SUGGESTED FOR CONSIDERATION</u>			
° Analytical Support of Heavy Mineral Survey	int-term	Financial Support	P10,000
° Preservation of Landsat Interpretive Surveys	short-term	Financial Support	P8,000
° Further Analysis of Aeromagnetic Data	short-term	Financial Support	P40,000
° Controlled Source Seismic Studies of Deep Basins	int-term	Technical Assistance	P600,000
° Acquisition of Schramm Drilling Rig	short-term	Financial Support	P400,000