CRIDF

KAZA Zimbabwe: Feasibility Report

KAZA Water Infrastructure for Livelihoods Intervention

December 2015

CRIDF

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List of Acronyms

Acronym	Long-Form
AEO	Agricultural Extension Officer
AEW	Agricultural Extension Worker
BCR	Benefit Cost Ratio
AGRITEX	Department of Agricultural Technical and Extension Services
CBA	Cost Benefit Analysis
CCRA	Climate Change Risk Assessment
CHC	Community Health Club
CRIDF	Climate Resilient Infrastructure Development Facility
CWR	Crop Water Requirements
DA	District Administrator
DAEO	District Agricultural Extension Officer
DDC	District Development Committee
DDF	District Development Fund
DFID	Department for International Development
DWSC	District Water and Sanitation Co-ordinator
EHT	Environmental Health Technician
EIA	Environmental Impact Assessment
ENPV	Economic Net Present Value
ERR	Economic Rate of Return
EMA	Environmental Management Agency
ESA	Eastern and Southern Africa

FAO	Food and Agricultural Organisation
FAN	Food, Agriculture & Nutrition
FNPV	Financial Net Present Value
FRR	Financial Rate of Return
FSLP	Food Security and Livelihoods Program
GESI	Gender, Equality and Social Inclusion
GDP	Gross Domestic Product
GOZ	Government of Zimbabwe
HBC	Hygiene Behaviour Change
HRDC	Hwange Rural District Council
HWC	Human Wildlife Conflict
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IP	Implementing Partner
IRWSSP	Integrated Rural Water Supply and Sanitation Project
KAZA TFCA	Kavango Zambezi Transfrontier Conservation Area
KLO	KAZA Liaison Officer
MAAT	Mean Annual Air Temperature
MEWC	Ministry of Environment, Water and Culture
MOHCC	Ministry of Health and Child Care
NGO	Non-Governmental Organisation
O&M	Operation and Maintenance
ODF	open defecation free
RCT	Randomised Control Trial

RDC	Rural District Council
PEA	Pre-Expenditure Assessment
PPF	Peace Parks Foundation
PRP	Protracted Relief Programme
RWASH	Rural Water, Sanitation and Hygiene
RWP	Rural WASH Programme
SADC	Southern African Development Community
UK	United Kingdom
UNICEF	United Nations Children's Fund
USDA (SCS)	United States Department of Agriculture - Soil Conservation Service
VHW	Village Health Worker
VIP	Ventilated Improved Pit
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WPC	Water Point Committee
WSS	Water Supply and Sanitation
ZFU	Zimbabwe Farmers' Union
ZINWA	Zimbabwe National Water Authority
ZPWMA	Zimbabwe Parks and Wildlife Management Authority
ZUNDAF	Zimbabwe United Nations Development Assistance Framework
ZIMSTAT	Zimbabwe National Statistics Agency
ZimVAC	Zimbabwe Vulnerability Assessment Committee

Executive Summary

Since 2013, CRIDF has worked closely with the KAZA Secretariat to address one of their primary objectives '...to develop and implement programmes that enhance the Sustainable Use of Natural and Cultural Heritage Resources to improve the livelihoods of Local Communities within and around the KAZA TFCA and thus contribute towards poverty reduction'. Specifically, the Project aims to establish permanent water provision for communities whose livelihoods are stressed by unreliable, inadequate water supplies and by human-wildlife conflict, which is exacerbated by the need to move livestock long distances to water. In addition to this, the Project will also improve the livelihoods of members of the community through a range of benefits which include health improvements, crop and livestock gains, climate resilience and time savings. Time savings and health impacts have a concentrated impact on the livelihoods of women and children, thus having a strong impact on gender equality in these vulnerable communities.

This potential has so far been explored in selected areas of the TFCA in Namibia (Phase I), Zimbabwe (Phase II) and Zambia (Phase III). This report details all aspects of the feasibility study carried out for Phase II - seven settlements that are situated in the Hwange district of Zimbabwe. These sites were identified through initial consultations with Zimbabwe KAZA Liaison Officer (KLO) and the Hwange Rural District Council (RDC) and further adjusted during consultation with the Chief Executive Officer of the RDC; all seven settlements were identified due to their urgent need for improved water supply and sanitation.

Design recommendations

A selection of infrastructure options were assessed against a range of criteria (including investment costs, O&M requirements, environmental issues, need for social and institutional support etc.), where the final design comprised of:

- Provision of water storage tanks;
- Provision of limited water reticulation infrastructure from the water source to delivery points for livestock watering and irrigated gardens;
- Provision of communal-use standpipes;
- Provision of fenced community vegetable gardens that will derive water from the developed water sources;
- Promotion of sanitation improvements in the communities; and
- Agricultural extension support.

Institutional Analysis and Stakeholder Endorsement

Prior to finalising the feasibility study, the Project designs were presented, discussed and ultimately endorsed by Zimbabwe's Ministry of Environment, Water and Climate, the Zimbabwe Parks and Wildlife Management Authority, the Hwange District Administrator, the Hwange District Water and Sanitation Co-ordinator and other key local representatives. All of this engagement was the culmination of several missions to site, where institutional, social and environmental experts also engaged extensively with the beneficiaries and local

institutions to better understand community structures, their roles and responsibilities, and the need for capacity building support to ensure the long term sustainability of the scheme.

Environmental & Climate Change Risk Assessment

Findings from the EIA Expert's assessment confirmed that no significant environmental impacts were foreseen as a result of the proposed intervention. However, engagement with an EMA official in Hwange indicated that, prior to receiving EMA's official endorsement an environmental prospectus must be complied and submitted to EMA, outlining the proposed infrastructure. This should be carried out during Financial Closure.

The Track 1 CCRA showed that the Project brings a number of high resilience benefits to the project recipients – including improved health and nutrition, livelihoods and safety (against wildlife). The review also identified a number of risks in relation to the associated infrastructure: **Drought** is a known and recurrent issue in the area and is likely to intensify with climate change. Prolonged drought could reduce recharge rates of groundwater reservoirs and levels of sustainable yield. It is therefore important to explore what sustainable yields could look like depending on precipitation levels in the area under future climate change scenarios. In addition, the risk of **fires** in the area could also intensify due to climate change (as a result of increased temperatures and drought) and it will therefore be important to ensure that maintenance tasks include vegetation clearing on either side of the proposed wooden fencing.

Economic and Financial Analysis

On a standalone basis the Project is not commercially viable; however, the revenue generated by the beneficiary communities is sufficient to cover the on-going costs. External grant financing of GBP 464, 545 will therefore be required to cover the capital investment to make the project viable. Should this be secured, the CBA indicates that the project is operationally sustainable and result in significantly improved livelihoods for 422 households. Of this total grant amount, GBP 349,632 is specifically for the capital costs of the project. In addition to this, further provision of GBP 114,822 has been made for the funding of other project start-up costs (the establishment of Community Health Clubs (CHCs) the Agricultural Extension (AE) programme) as well as Operations and Maintenance (O&M) costs for the two years of operation.

The results of the quantitative economic appraisal show that the Project is economically viable and beneficial. At a 10% discount rate, the project's ENPV is GBP 399,203 and the BCR is 2.01; at a 3.5% discount rate, the ENPV is GBP 904,677 and the BCR is 2.68. The ERR at both discount rates is 25%. It is important to note that these results are an understatement of the full complement of economic benefits that stem from the intervention as a number of the benefits are qualitative and therefore not included within the quantitative results. The combination of quantitative results, bolstered by the significant qualitative benefits, provides a robust justification for the project from a socio-economic perspective.

Next Steps

This report provides an overview of each element of the detailed feasibility design study undertaken by CRIDF, and endorsed by ministerial and local level Zimbabwean stakeholders. Before proceeding with the Financial Closure and Implementation stages, CRIDF must first seek to identify an acceptable project owner with a mandate in Zimbabwe. Secondly, an assessment must be undertaken to determine the finance route for the project: whether it is a project suited to CRIDF direct funding of the works, or one where an external funder may be better placed to take the project forward. Discussions with the KAZA Secretariat, DFID Zimbabwe and other key stakeholders are on-going in an effort to move this process forward.

1. Introduction

1.1 Background to KAZA

The Kavango Zambezi Trans Frontier Conservation Area (KAZA TFCA) was formalised by the Heads of State of Angola, Botswana, Namibia, Zambia and Zimbabwe who signed its Treaty on 18 August 2011. The process of establishing this TFCA, however, dates as far back as 2003 when the Tourism Ministers of the five countries agreed in principle to establish a major new TFCA (with emphasis on conservation and tourism development) in the Okavango and Upper Zambezi River Basins. In 2006, the Ministers of Environment, Tourism, Natural Resources and Wildlife of Angola, Botswana, Namibia, Zambia and Zimbabwe signed a Memorandum of Understanding, agreeing to establish the KAZA TFCA.

Covering approximately 444,000 km², the KAZA TFCA is the world's biggest conservation area, encompassing 36 formally proclaimed protected areas, comprising national parks, game reserves and game/wildlife management areas as well as conservancies and communal areas. It is also home to an estimated three million people, many of whom live in poverty and most of whom are dependent on agriculture and other natural resource use for their livelihoods. A recent socio-economic baseline survey of the KAZA pilot area found that human-wildlife conflict is a major livelihood problem, causing annual losses of 32% of crops, 14% of cattle and 50% of goats.

KAZA is therefore committed to enhancing the livelihoods of those who live in the area, with particular emphasis on those most directly affected by wildlife. In some areas, KAZA is working to facilitate biodiversity conservation through the enhancement of wildlife movements in dispersal areas between protected areas in the various countries. Those living in or near these areas are often badly affected by wild animals eating their crops and their livestock. Some, including a number of communities in the Zambezi Region of Namibia, prefer to adjust their residence and land use patterns to reduce their proximity to the wildlife areas and cut their crop and livestock losses. KAZA wishes to support these adjustments, where possible and appropriate.

1.2 Strategic Context to working with KAZA

The KAZA TFCA is just one of several conservation areas that lie within transboundary river basins throughout SADC – all of which are populated by communities who face similar issues of increased vulnerability to climate change and intense human-wildlife conflict. Due to the fact that the KAZA Secretariat is relatively advanced in terms of engagement and endorsement from all member states and activity/presence in the area, CRIDF targeted KAZA to collaborate with as a first step towards supporting communities living within TFCA's across the region. Importantly, KAZA is a SADC-sanctioned transboundary organisation that has (through its treaty) the mandate and mechanisms to *deliver infrastructure* in member states. This mandate is not held by most SADC RBO's. The potential for replication, expansion and scale up across the region is considerable.

Though KAZA it is a transboundary conservation intervention, it was only off the back of CRIDF's initial engagement with the KAZA Secretariat in 2013 that KAZA recognised[1] that water is the key to the improvement of livelihoods for communities living in the TFCA, as well as for long term, sustainable conservation outcomes.

KAZA and CRIDF are in the process of formalising their relationship through a formal Memorandum of Understanding entitled 'Collaboration on strategic transboundary planning and promoting appropriate water infrastructure to enhance livelihoods in the Kavango Zambezi Trans frontier Conservation Area'. Within the overall joint mandate to conceive, plan and deliver transboundary water infrastructure in a changing climate, for the benefit of the poor, CRIDF and KAZA have collaboratively developed a pilot plan for providing water infrastructure and related initiatives to a limited number of communities in the KAZA TFCA.

These interventions have been phased on a country-by-country basis. Through engagement with the KAZA Secretariat and KAZA Country Liaison Officers in late 2013, it was decided that the work would be staggered as follows:

- Phase I – Delivery to communities in Eastern Zambezi region in Namibia and planning for Zimbabwe
- Phase II – Delivery to communities adjacent to the Hwange National Park, Zimbabwe and planning for Angola, Botswana and Zambia
- Phase III – Delivery to communities in Angola, Botswana and Zambia

1.3 Scoping for Phase II Zimbabwe

In July 2014, the Activity Lead, Environmental Infrastructure Expert and Zimbabwe KAZA Liaison Officer undertook a scoping mission in the Zimbabwean portion of the KAZA TFCA. The purpose of the trip was to identify communities most in need of CRIDF-KAZA support, and thereafter define the specific infrastructure requirements per site. This was achieved through a series of site visits and consultations, both with beneficiaries and local institutions. Table 1 and Figure 1 show the 7 sites identified during the mission:

Table 1: Proposed sites in Hwange Rural District

Village Community	Geographic Reference	Ward Name	Ward No
Mphakati 2	18°26'40.55"S 26°55'26.37"E	Lupote	16
Mphakati1	18°25'52.57"S 26°56'17.88"E		
Nabushome - Mpopoma	18°32'18.51"S 27° 6'2.40"E	Mabale	17
Simkululwe	18°33'43.00"S 27° 1'54.00"E		
Kasibo	18°15'13.94"S 26°22'23.66"E	Mashala	9

[1] This strategic nature of water as well as the (new) emphasis on livelihoods were officially endorsed in the recently published Master Integrated Development Plan for the KAZA TFCA (September 2015).

Bahani	18°22'37.02"S 26°43'39.14"E	Nekatambe	13
Bhale	18°18'2.38"S 26°47'57.34"E		

The above communities are situated adjacent to the Hwange National Park (which falls under the jurisdiction of the Hwange Rural District Council (HRDC) – specifically in the area east of the park and *Victoria Falls-Bulawayo* Road. See Figure 1. The area experiences relatively low rainfall, averaging 630 mm per year, and soil fertility is generally low.

Figure 1: Google Earth Satellite Image of all sites

All of these communities are regularly affected by wildlife moving out of the National Park, including those using corridors between the park and the Zambezi River. Crops are often damaged or completely destroyed by elephants and other animals, and predation on livestock is widespread. At the same time, water supplies for human and livestock consumption are grossly inadequate. A number of dams have silted up and old village water supplies have broken down. Other communities have never had a functioning borehole or pump. As a result:

- many people must travel several kilometres to obtain water from (usually seasonal) dams, rivers or the nearest functioning borehole;
- in some cases, people are obtaining domestic water from dams that are also used by livestock;
- the dams that still hold water (although partially silted up) typically dry up during the winter, forcing people and livestock to travel greater distances;
- especially in winter, some people must share water supplies with wildlife; and
- there are few opportunities to supplement inadequate rainfall with irrigation water for garden crops.

Based on the above issues, the team proposed the following interventions per site:

Table 2: Proposed interventions

Project element	LUPOTE WARD (16) - Mphakati 1 village	MABALE WARD (17) – Nabushome/Mpopoma village & Dopota Dam	MABALE WARD (17) –Simkululwe village	MASHALA WARD (9) –Kasibo village	NEKATAMBEWARD (13) – Bahani village	NEKATAMBE WARD (13) – Bhale village
Borehole, pump and tank with reticulation to max. 3 standpipes	✓	✓	✓	✓	✓	✓
Reticulation to max 2 garden sites	✓	✓	✓	✓	✓	✓
Fencing of garden(s) (max 0.5 ha each)	✓	✓	✓	✓	✓	✓
Small-scale irrigation equipment	✓	✓	✓	✓	✓	✓
1 year extension inputs on gardening, conservation agriculture	✓	✓	✓	✓	✓	✓
1 livestock watering trough with reticulation from tank	✓	✓	✓	✓	✓	✓
Latrine construction (max 10)	✓	✓	✓	✓	✓	✓
Deepening/expansion of existing dam for livestock water provision	✓	✓				✓

Project element	LUPOTE WARD (16) - Mphakati 1 village	MABALE WARD (17) – Nabushome/Mpopoma village & Dopota Dam	MABALE WARD (17) –Simkululwe village	MASHALA WARD (9) –Kasibo village	NEKATAMBEWARD (13) – Bahani village	NEKATAMBE WARD (13) – Bhale village
Construction of a new dam	✓					
Initial stocking of dam with fish and provision of 1st year's feed	✓	✓				✓
1 year extension inputs on fish production	✓	✓				✓

The findings from this scoping Activity informed the development and roll-out of a full Feasibility Study in early 2015.

1.4 Aims and outputs of the Bankability Study

This Activity consisted of 3 key components:

1. Designing WSS and small-scale irrigation infrastructure (including EIA and economic analysis) for the 6 identified sites;
2. Developing necessary support systems – including an O&M plan for each site, irrigation and WASH advisory support to communities etc.; and
3. Confirmation of ministerial and local level endorsement of the planned interventions.

The planned outputs of the study have been broken down into the following, which are presented in detail in the chapters that follow.

Milestone
Hydrological / Water Resources Review
Engineering Assessment and detailed options analysis
Outline Design
Environmental Analysis
O&M Plan
Procurement Strategy
Climate Vulnerability Assessment
Institutional Assessment
Cost Benefit Analysis
Risk Assessment
Stakeholder Analysis and Endorsement
Final Bankability Report – including CRIDF's Project Development Monitoring Plan and Feasibility Screening Tool

2. Technical Analysis

Introductory notes

Building on the work of the scoping mission, the technical assessment mission identified a number of issues that have subsequently been reviewed by CRIDF and KAZA, leading to decisions as shown below.

- Although two communities (Mphakati and Bhale) would benefit from the deepening of their dams, this would be a costly exercise, adding significantly to the overall cost of this first phase of CRIDF-facilitated support.
- At all sites except Mpopoma in the Nabushome area of Mabale ward, there is potential for more detailed planning and larger-scale investment that would establish adequate water supplies for bigger areas. In some cases, these might involve raised storage tanks and reticulation to a number of water points distributed across the community. In the case of Simkululwe, the local leadership is keen to develop a water system that would also serve the emerging commercial centre at Cross Mabale, and had identified a vlei in a nearby forest conservation area as a possible source. In all these cases, however desirable the wider-scale developments might be, budget constraints dictate that this first phase of CRIDF-facilitated support will focus only on the original concept of one or two boreholes at each of the seven identified sites, without any wider reticulation within communities.

The proposed water infrastructure therefore consists of the following:

- drilling of new boreholes and fitting them with pumps;
- provision of limited water reticulation infrastructure from the water source to delivery points for livestock watering and irrigated gardens;
- provision of fenced community vegetable gardens that will derive water from the developed water sources; and
- promotion of ventilated improved pit (VIP) latrines to improve the sanitation of the communities.

2.1 Hydrogeology, technical options and cost implications

Significance of groundwater in the region

Rural communities in Zimbabwe mainly rely on groundwater sources for most of their water requirements. Most of the water sources are used for multiple purposes ranging from domestic use, stock watering, gardening and brickmaking. These competing uses from the same water sources often result in compromise of the water quality unless adequate protections mechanisms are put in place. 70% of the population of Zimbabwe lives in rural areas although recent trends suggest a high rural-to-urban migration ratio, resulting in rapid urbanisation and fewer people in rural areas. About 35% of the rural population in Zimbabwe depends on traditional water resources, which include stagnant pools, rivers and unprotected wells. The government of Zimbabwe launched the National Water Policy in 2013, which also covers aspects of groundwater use and development. Prior to that, the National Water Act (1998), the National Master Plan for Rural Water Supply

and Sanitation (1986) and the Integrated Rural Water Supply and Sanitation Project (IRWSSP) (1987) confirmed the government's commitment to guarantee access to safe drinking water and within reasonable walking distances to water points.

Over time, populations have increased resulting in new and more scattered settlements while some established water points broke down due to age or inadequate maintenance. The impressive water supply and sanitation coverage that had been achieved under the IRWSSP has significantly deteriorated.

Matabeleland North province lies in a generally drier part of Zimbabwe with a poor river network and a flat terrain. The only major rivers are the Gwayi and Shangani, while the smaller rivers generally dry up soon after the rainfall season. Communities therefore depend more on groundwater for their water requirements. This also extends to the vast Hwange National Park where about 100 boreholes have been drilled for animal use in dry seasons.

Geology of Hwange District

The geology of the district is dominated by the Kalahari system (Aeolian sands and sandstone) and, to some extent, Upper Karoo (basalts, rhyolites, grits and sandstone) and Lower Karoo (Madumabisa mudstones, Wankie sandstones and coal measures) systems. The sands comprise deep, unconsolidated and well-drained tertiary sands of Aeolian origin. Generally the soils derived from these systems, in combination with a flat terrain, result in high permeability rates with poor runoff. This largely explains why the rivers are only seasonal.

Observations on the ground and examination of the hydrogeological map of Zimbabwe indicate that Bhani, Bhale Simkululwe, and the Mphakati area lie in the Kalahari sand/ sand stone belts, while Kasibo and Mpopoma fall within the upper Karoo sequence which occurs north of the Hwange National Park and Hwange town.

Groundwater potential

The groundwater potential in the area is generally low due to the sandy formations. From data compiled from 40 boreholes that were recently drilled in the district, average borehole yields of 3.8 m^3/hr are obtained as presented in Table 3.

Table 3: Borehole yields in Hwange Rural District

	Depth (m)	Yield (m^3/hr)
Average	55	3.8
Minimum	40	1.1
Maximum	100	18
Median	49	2.9

Comparable yields (averaging 3.17 m^3/hr) have been observed in the Karoo and Gneiss formations in the neighbouring Binga District. However, most of the boreholes on which these averages are based were comparatively shallow, intended for use with hand pumps only.

It should be emphasised that the actual yield of a borehole can only be determined after capacity tests have been conducted for 24-72 hours on a drilled hole. Before that, the planning figures used are merely guidelines.

Water supply situation in the district

Communities rely on groundwater for water supply for most of the time. Many boreholes dry up during the peak of the dry season and people (mainly children and women) are forced to walk longer distances (in some cases of more than 5 km one way) to access water points. A few dams are reported to also hold water up to dry seasons but this water is highly compromised from a water quality perspective due to the competition for water between livestock, wild animals and human beings. Efforts have been made to drill boreholes to improve water access by the communities. From interviews held with communities, these boreholes are too few as the settlements are scattered.

During the field visit, existing boreholes close to proposed borehole sites were inspected and water quality samples were taken for analysis. All the visited boreholes were equipped with bush pumps. Where possible, the productivity of the borehole was estimated using the bucket method. The collected data is presented in Table 4.

The existing boreholes are low-yielding (below 2 m^3/hr). This may also be attributed to the low efficiency of the hand pumps that have been fitted. What is, however, clear is that the recharge rates are also low, as people have to wait for long periods after extensive pumping periods to allow for recharge.

Table 4: Details of some existing boreholes in the targeted villages

Ward	Ward no.	Village	Co-ordinates of existing borehole site	Estimated borehole yield m^3/hr
Lupote	16	Mphakati	N26^{0}55’51.1” S18^{0}27’10.7”	0.6
Mabale	17	Nabushome		
		Simkululwe (Mpopoma)	N27^{0}05’15.4” S18^{0}32’20.7”	
Mashala	9	Kasibo	N26^{0}22’05.9” S18^{0}13’46.6”	1.8
Nekatambe	13	Bahani	N26^{0}44’07.4” S18^{0}22’27.1	
		Bhale	N26^{0}48’01.3” S18^{0}18’00.3”	1.8

This project therefore intends to improve the quality of life among the communities through improved access to water. Chances of striking water are high in the area with reports of average success rates of 60%. This rate can be substantially improved by high tech siting (e.g. resistivity sounding) methods complemented by appropriate drilling techniques.

From a practical perspective, it would be advisable to drill more boreholes than the minimum target number of seven, considering the costs of moving drilling rigs and access to some of the identified sites. However, it is recognised that budget limitations may preclude this during the initial phase of this CRIDF-facilitated intervention.

Feasibility of using motorised boreholes

All boreholes that were visited in the targeted villages are equipped with hand pumps. Hand pumps do not require additional energy in the form of fuel and/or electricity. They are generally appropriate where yields or recharge rates are low. From interviews with locals, recharge rates are generally low and, hence, it may be more appropriate to fit the boreholes with hand pumps. However, water levels recede to deeper levels in the dry season leading to drying up of some boreholes that are not very deep. For sites with deeper wells, abstraction of water becomes a challenge, as the pumping depth would be too deep for hand pumping. In such cases, communities abandon the boreholes and turn to other sources, which may involve greater walking distances and/or compromise in water quality. In such cases, motorised pumps would be recommended. Experience from the Hwange National Park indicates that maintenance costs are lower with motorised boreholes. Windmill pumps are one option but the area, and the country in general experience low wind speeds thus making that option less favourable. Diesel pumps are also not viable due to high fuel and maintenance costs as well as comparatively shorter lifespans.

Solar pumps are increasingly being promoted due to their energy efficiency, especially in this part of the world where sunshine is abundant. In the Hwange National Park, solar pumps have been installed on a trial basis and are proving to be viable even for yields in the range of 4m^3/hr. One such pump is shown in Figure 2.

The panel is mounted on a 6m high pole that is designed to withstand pressure from animals. The height also discourages tampering from human beings. Proposed improvements against human abuse include incorporation of a screen at about 4m height to deter climbing to the level of the panels.

Figure 2: Typical solar panel for motorised borehole in Hwange National Park

Implementation options and costs

In Zimbabwe, drilling of boreholes can be done using public or private facilities. The District Development Fund (DDF) and the Ministry of Environment, Water and Climate, through the Zimbabwe National Water Authority (ZINWA), drill boreholes mainly in rural areas and, generally, with a non-profit making objective. Naturally, boreholes may not be drilled at desired times as priorities may be set elsewhere and attendance to breakdown of rigs may not be as efficient. However, these organisations are generally viewed as cheaper compared to private companies. DDF have an office in Hwange but they do not seem to have drilling rigs available to drill boreholes.

ZINWA offers borehole drilling and maintenance services. ZINWA was established through the ZINWA Act (1998) with a view to taking over the commercial aspects of the Department of Water Development. At the moment, ZINWA charges $8,000 for full borehole services i.e. siting, drilling, casing, capacity testing and equipping with a standard hand pump. At completion a washing stand and cattle trough, drainage canal and fence should also be part of the works. The major advantage of this package is that the client only pays for successful boreholes. ZINWA also have experience in drilling countrywide and have drilled more than 70 boreholes at the Nyamandhlovu aquifer for water supply to Bulawayo. The aquifer lies on similar geological formations requiring expert drilling skills. Again, since ZINWA is a quasi-government institution, priorities may be set elsewhere and implementation is dependent on availability of rigs at particular times.

The Hwange District Council recently drilled 40 boreholes in Hwange District through UNICEF assistance. For this purpose, a private company, Chisipite Borehole Drillers, based in Harare, was engaged. The District Engineer has indicated that the company is highly professional and have the expertise and equipment required to drill in Karoo sand formations. They also offer siting services and all the 40 drilled holes were successful.

Indicative fees charged by drilling and siting companies are presented in Table 5.

Table 5: Indicative borehole drilling costs

Activity	Unit Cost (US$)	Units
Siting	400	Per borehole
Drilling	60	Per metre
Capacity testing	60	Per hour
Plain casing	20	Per metre
Mileage for siting	1	Per km
Mileage for drilling	4.50	Per km

The fees charged to UNICEF for the 40 boreholes drilled by Chisipite Borehole Drillers are presented in Table 6.

Table 6: Drilling services fees for recently drilled boreholes in Hwange district

Activity	Total cost USD
Mobilisation and demobilisation (Harare-Hwange-Harare) and siting	5,511
Siting	400
Drilling, testing, equipping & completion	4,210

Material and labour	4,830
Total cost (excluding VAT)	**14,951**

Considerations for solar pumping

The Zimbabwe Parks and Wildlife Management Authority is carrying out a pilot study on solar-powered boreholes in Hwange National Park. Three boreholes have been installed with solar pumps at the moment and the results are positive. A solar pump unit (including motor, panels, stand and battery) costs approximately $8,000.

Experiences from trial solar pumps fitted in the Hwange National Park show that the solar option is viable with pumping rates of between 2 and 4 m^3/hr and boreholes operating between 6 and 11 hours per day.

Table 7: Solar pumping data for existing boreholes in Hwange National Park

Bore site identity	Pumping Rate m^3/hr	Average daily operational hours
Ngweshla 1	3.2	9.8
Ngweshla 2	3.1	10.7
Kennedy 1	4.0	11.1
Kennedy 2	3.4	10.9
Makwa	2.9	9.7
Mabuya-Mabema	2.6	7.8
Sinanga	3.2	6.2

If the solar pumping option is adopted, the costs for equipping with hand pumps will be replaced by the costs indicated in Table 8.

Table 8: Cost estimates for solar panel pumping unit

Item	Estimated cost USD
Pump	2,900
Solar panels	2,400
Panel Mounting	1,500
Accessories & fittings	1,200
Pressure tank	600
Security plate	180
Low water probe	80

Data module	150
Plastic tank and stand	1,500
Estimated cost of installation of solar pump per borehole	**10,510**

Conclusions and recommendations

a. Boreholes can be drilled in the targeted villages with average expected safe yields of approximately 5. m^3/hr. However, the fragile geological formation of Kalahari sands and Karoo sandstones calls for expert drilling companies.
b. Combined contracts for siting are recommended. While only a few organisations offer such services, the liability of failed holes moves to the contractor as the client only pays for successful work.
c. The minimum depth of good boreholes in the area is 80m. Given that water tables are receding (possibly due to climate change), it is recommended that the boreholes be drilled to deeper depths.
d. Recharge rates are generally low but motorized pumps are still feasible as evidenced by the trial project in the National Park.
e. Solar powered boreholes are recommended as they are more environmentally sustainable and cheaper to operate in the long term. They also use 'smart energy', which is in line with CRIDF objectives.
f. The water quality is generally good although frequent monitoring is recommended.

2.2 Settlements, population and water demand

Settlements

In general, settlements in all the project areas are rural in nature and characterised by scattered homesteads. This settlement pattern, which is typical of rural settlements in Matabeleland, is not conducive for the cost-effective provision of piped water supply infrastructure. Agricultural fields are also scattered, making it difficult to develop centralised irrigation schemes that cater for a large number of households, without the necessity to relocate households.

Population estimates

Population estimates for all the project sites have been undertaken based on the number of households in the vicinity of the proposed sources of water in combination with the household sizes given in the 2012 census report. The estimates have been used as a basis for the analysis of water demand at each site. Table 9 below gives a summary of the population at each site.

Table 9: Population in the project area

Village	Ward No	Household Size	No of Households	Population

Mphakati 2	16	4.6	35	161
Mphakati 1	16	4.6	29	133
Bhale	13	4.6	36	166
Bhahani	13	4.6	130	598
Simkhulule	17	4.6	112	515
Mpopoma	17	4.6	40	184
Kasibo	9	4	40	160

The estimation of livestock population in the project areas has been based on average number of cattle per household in the district. Information from the veterinary services department indicates that there are 54,000 cattle in Hwange rural district, which gives an estimated average of 4 cattle per household based on a total of 14,890 households in the district. The population of other domestic animals is insignificant compared to cattle. Table 10 below gives the population of livestock cattle for each of the project areas.

Table 10: Estimated No of cattle livestock in the project area

Project Area	Household	No of cattle
Mphakati 2	35	140
Mphakati 1	29	116
Bhale	36	144
Bhahani	130	520
Simkhulule	112	448
Mpopoma	40	160
Kasibo	40	160

Domestic and livestock water demand

The estimated domestic and livestock water demand in the project areas, has been based on a capita consumption of 20 l/d/person and 30 l/unit respectively, and is summarised in Table 11 below.

Table 11: Human and Livestock water demand

Project Area	Water Demand in m^3/day		
	Human	**Livestock**	**Total**
Mphakati 2	3.2	4.2	7.4
Mphakati 1	2.7	3.5	6.1
Bhale	3.3	4.3	7.6
Bhahani	12.0	15.6	27.6
Simkhulule	10.3	13.4	23.7
Mpopoma	3.7	4.8	8.5
Kasibo	3.2	4.8	8.0

Garden irrigation water demand

Irrigation water demand analysis has been carried out based on a variety of crops and sprinkler irrigation systems. A review of the situation indicates that sprinkler irrigation would not be ideal for the small irrigation plots due to the following reasons.

- The allotments per household will be too small to allow for individual operation of sprinklers, which normally have a wetted perimeter of about 15 m on average. Cropping preferences and variability by irrigators would create numerous operational problems.
- The proposed configuration of the water supply system will consist of pumping from a borehole into an elevated tank with a maximum height of 7 m using solar power. The use of wind power for pumping has been discounted due to reported low wind speeds in the region.

Appropriate types of irrigation systems for the small gardens could be either simple hosepipe connected to stand pipes, or drip irrigation systems. The former will be simpler and cheaper to implement for the small gardens, with exceedingly less operational problems.

Notwithstanding the above observations, garden irrigation water demand has been based on that computed for sprinkler irrigation systems. Assuming an average allotment per household of approximately 20 m x 20m garden patch, Table 12 below gives the sizes of garden areas required for each settlement based on the village population.

Table 12: Proposed total sizes of irrigation gardens per settlement

Village settlement	Total Size of garden
	ha
Mphakati 2	1.5
Mphakati 1	1
Bhale	1.5
Bhahani	4
Simkhulule	4
Mpopoma	1.5
Kasibo	1.5

The large garden areas for Simkhulule and Bhahani are due to the large sizes of the villages coupled with the high population densities in the respective areas. In view of the need to reduce walking distances to water it will be necessary to drill two boreholes for each of the two locations, with irrigation garden land identified in the vicinity of each borehole.

Irrigation water demand for each area based on the analyses undertaken for the agronomy component is summarised in Table 13 below.

Table 13: Irrigation water Demand

Village	Water Demand
	m^3/hr
1. Mphakati 2	4.968
2. Mphakati 1	3.312
3. Bhale	4.968

4. Bhahani	
4.1. Borehole Area 1	6.624
4.2. Borehole Area 2	6.624
5. Simkhulule	
5.1. Borehole Area 1	6.624
5.2. Borehole Area 2	6.624
6. Mpopoma	4.752
7. Kasibo	4.968

Total water Demand

Total water demand includes domestic, livestock and irrigation water demand and is summarised in Table 14 below.

Table 14: Total water demand

Village	Water Demand
	m^3/hr
1. Mphakati 2	5.8955
2. Mphakati 1	4.0805
3. Bhale	5.922
4. Bhahani	
4.1. Borehole Area 1	8.3465
4.2. Borehole Area 2	8.3465
5. Simkhulule	
5.1. Borehole Area 1	8.108
5.2. Borehole Area 2	8.108
6. Mpopoma	5.812
7. Kasibo	5.968

2.3 Provision and Maintenance of Water Supply Infrastructure

It is proposed to drill boreholes at all the seven sites to provide water for small-scale garden irrigation, domestic and livestock consumption. Analysis of groundwater potential at each of the sites based on the occurrence of an upper Karoo sand stone aquifer in the Mpopoma and Kasibo areas, and Kalahari sand aquifers at the remaining 5 sites, against estimated water demand at each site indicates that boreholes of up to 80 m deep will be adequate to supply the required yield.

All boreholes in the Kalahari sand aquifer will be gravel packed, with a diameter of 500 mm. A 150 mm diameter internal casing will be provided to house the pump, and a Johnson type stainless steel well screen fitted to the bottom of the casing over a distance of approximately 12 m. Graded gravel and course sand will be filled into the annulus between the outside and inside casings. The grading of the gravel and sand will be designed to prevent fines from being washed from the Kalahari layer into the borehole. The procedure for drilling boreholes in Kalahari aquifer to avoid the collapse of casing is as outlined in the sub-section above.

At each site, water will be pumped from the borehole using a solar powered submersible pump and delivered to elevated storage. The water will gravitate from the elevated storage to supply small irrigation gardens, standpipes for domestic consumption and livestock watering troughs for cattle and other small domestic animals. Fencing will be provided around each garden.

Due to the limited garden areas and small individual plot allotments, coupled with low installed gravity head from the overhead tank, the operation of sprinkler irrigation system may not be feasible. It is proposed to install either drip irrigation systems or ordinary garden taps for the delivery of water to the crops. The latter would be equipped for connecting to hosepipes.

The number of standpipes provided from domestic water supplies will be based on 1 standpipe per 25 households. Cattle trough storage has been based on 1/3 the total herd daily requirement.

A description of the proposed infrastructure at each site is outlined in **Annex 1.**

Preliminary cost estimates; drilling and equipment of water points

Preliminary cost estimates have been based on the drilling of large diameter gravel packed boreholes at the five sites occurring in Kalahari sand, while for the two sites in sandstone formations, costs have been based on normal 150 mm diameter boreholes. Equipment costs for all sites have been based on the installation of solar powered pumps and drip irrigation systems. These high level cost estimates have been developed in the absence of surveys and detailed design of components of the scheme.

Solar powered borehole pump units have been specified by a reputable local supplier, solar quest, based on preliminary design data, and have been commercially priced, inclusive of installation.

It is estimated that the KAZA project, exclusive of the provision for start-up, will cost USD 530,245 broken down as summarised below. They are summarised below.

Table 15 Cost estimates per site

Project Area	Cost
	USD
Mphakati 2	50,175.00
Mphakati 1	48,480.00
Bhale	48,980.00
Bhani A	72,110.00
Bhani B	72,400.00
Simkhulule A	72,890.00
Simkhulule B	82,180.00
Mpopoma	41,195.00
Kasibo	41,835.00
Total	**530,245.00**

Operation and Maintenance

In Zimbabwe the maintenance of all rural water points in communal areas is the responsibility of Rural District Councils through the District Development Fund (see also section 7 'Analysis of Stakeholders and Institutions'). The District Councils are meant to hold and control maintenance budgets for all water points in communal areas. However, current fiscal constraints in Zimbabwe mean that little or no such funding may be available. The alternative open to rural water users – constrained in turn by widespread poverty – is to establish a local water management structure that collects and saves maintenance funds that the users contribute to.

The solar systems proposed for this CRIDF intervention are virtually maintenance free if properly installed and fitted with a lightning arrester and surge protector. The only maintenance required is cleaning of solar panels at regular intervals of say one month. A worst-case scenario is damage to the pump controller, which would be very rare if the pump unit is properly protected. The pump itself is very robust and is unlikely to suffer damage provided the boreholes are sand free. Gravel packing the boreholes in Kalahari sands and their adequate development before pump installation should ensure sand free operation.

Infield equipment for drip systems are likely to require regular maintenance due to the accidental damage of plastic pipe fittings during land preparation, weeding etc.

Table 16 below presents a conservative estimate of the likely maintenance costs for the entire scheme over two years. It includes the cost of an average one site visit per month by a fitter from the District Development to carry out any necessary repairs. The maintenance budget would only be required once the retention period on the installation contracts has expired.

It is proposed that CRIDF will fund the first two years' potential maintenance costs while the sanitation and agricultural extension programme works with user communities to establish local structures that can take over responsibility for collecting and managing maintenance funds. These may be the Community Health Clubs established to promote sanitation in the target communities (section Sanitation sub-section below).

Table 16: Operation and maintenance budget for water infrastructure: all sites: two years

Description	Quantity	Unit	Rate	Cost
Borehole pump				**USD**
Spare pump controller	1	no	1,100	1,100
Total for	**9**	**units**		**9,900**
Drip irrigation system per ha.				
Dripline	2	roll	380	760
Connectors	500	no	0.4	200
16 mm dia poly pipe	200	m	0.3	60
Rubber gaskets	100	no	0.1	10
Solvent cement	4	500 ml bottle	8	32
Allowance for misc. piping	sum			150
Sub total				1,212
Total for	**23**	**ha**		**27,876**

Domestic water supply				
25 mm brass tap	44	no	20	880
Ball valve for trough	9	no	120	1,080
Ball valve for reservoir	9	no	120	1,080
Total for	**9**	**systems**		**3,040**
Visits by DDF fitter				
Visit to a site	24	visits	200	4,800
Total				**45,616**

2.4 Sanitation

Introduction

In order for CRIDF to ensure that the provision of improved access to safe drinking water for rural communities will lead to 'climate resilience', together with improved health and livelihood outcomes, there is an obvious need to also address the Water, Sanitation and Hygiene (WASH)-related challenges. This section describes an innovative approach to enhance community mobilisation in order to ensure satisfactory WASH outcomes that will also improve livelihoods and food security. This is clearly an important component in most water-related infrastructure development programmes such as the one now being proposed for the KAZA-CRIDF programme in Hwange district.

Inadequate personal, domestic and communal (i.e. environmental health) practices have to be transformed in order to gain value from the convenience of improved access to safe water provision. It is also vitally important to ensure improved local food security and nutrition as these aspects also contribute to the strengthening of climate resilience of poor rural communities. This holistic and integrated approach requires close engagement with the local beneficiary communities in order that they may become 'empowered' towards achieving maximum long-term benefit from any such CRIDF intervention.

Wherever possible, income-generating opportunities within the context of climate resilience and the overarching challenge of rural poverty should be considered in order to better sustain and maintain the water infrastructure that is being provided. Clearly value for money considerations would be considerably enhanced through a more holistic and integrated approach.

In order for such significant, long-term gains to be won by CRIDF, it is going to be necessary to strengthen the social cohesion and trust within and between the beneficiary communities (i.e. by building social capital). The approach that has been well proven and capable of achieving all of these gains is the Community Health Club (CHC) model that is advocated here.

In Zimbabwe, the National Water Policy (2013) states that "every village and rural institution will have a functional health club" (page 31). In addition, the National Sanitation and Hygiene Strategy: Accelerating

Access to Sanitation and Hygiene (July 2011-June 2015) states that “CHCs have been successful in Zimbabwe … CHCs foster exchange of information among householders and between community groups on many health matters (including home hygiene and construction of sanitation facilities). CHCs have also been known to assist vulnerable groups to construct toilets”.

Recently the Minister of Health for Zimbabwe, Dr David Parirenyetwa, together with a delegation of Departmental Directors from the Ministry of Health & Child Care (MOHCC), visited CHCs in Manicaland to witness for themselves the impact that the CHCs were making. The Minister has subsequently called for an accelerated roll-out of CHCs across Zimbabwe because they prevent diseases.

Formation of Community Health Clubs

CHCs are established at local level by district Environmental Health Technicians (EHTs) who are district-based extension staff from the MOHCC. The EHTs in turn supervise Community-Based Facilitators (or Village Health Workers (VHWs)) who are selected from the beneficiary communities and who live with ‘their’ communities in the same villages. Twenty health topics (one topic per week over a period of about 20 weeks) are covered as per the sample ‘CHC Membership Card’ shown in Figure 3 below that each member from every household is issued with at the beginning of the process. This CHC Membership Card is key to the whole approach as it sets out the complete syllabus of training that will be covered over the twenty-week period together with the ‘homework’ in the form of improved hygiene facilities in the homestead that each and every household is expected to achieve (all at absolute minimal cost). Selection of the topics is done in close collaboration with MOHCC to ensure that all topics are relevant to the local situation regarding preventative health.

A detailed household Inventory is captured at the beginning and this is maintained and kept by the Executive Committee of each CHC. In this way behaviour change is tracked over time using proxy indicators. This paper-based inventory is then cross-checked by the EHT who takes random samples of households using a mobile phone method of data capture. In Zimbabwe the Mobenzi platform is utilised that analyses 10 ‘Golden Indicators’ for measuring Hygiene Behaviour Change (HBC). These data are in turn uploaded and used at national level by the MOHCC and others.

When every CHC member has completed all 20 topics listed on the CHC Membership Card together with the associated ‘homework’ (e.g. building latrines, tippy-taps, bath shelters, fuel-efficient stoves, clean open defecation free (ODF) compounds with solid waste management etc.) then every CHC member is awarded a certificate during a colourful graduation ceremony attended by local dignitaries. Other than this certificate, no household receives any form of subsidy for their home improvements.

Successful EHTs and 'their' CHCs depend on the four 'T's: Trainers, Training, Training Materials and Transport. These are the basic requirements linked to the EHTs that, as mentioned above, will supervise the start-up and running of their respective CHCs through the VHWs. Both EHTs and VHWs are already in place and so it is simply a matter of working within local government institutional arrangements. This in turn significantly reduces costs while ensuring the long-term sustainability of this behaviour change approach. Transport is in the form of a motorcycle for each EHT to enable him or her to get out to the villages that are within the catchment area of the Health Centre where the EHT is normally located.

No.	Topic	Date	Signature	Homework	Signature
1.	Safe Water Chain			Safe storage & use of water	
2.	Safe Food Chain			Pot rack; hanging basket etc.	
3.	Sanitation Ladder			Avoid faecal: oral diseases	
4.	Sanitation Planning			Improve household latrines	
5.	Diarrhoea ORS			Improve Sanitation facilities	
6.	Hand washing			Hand washing Facility	
7.	Cholera/ typhoid			Water Source Clean-up + San	
8.	Skin/eye disease			Bedroom & personal hygiene	
9.	Worms			De-worming	
10.	Nutrition			Nutrition gardens & orchards	
11.	Hygienic kitchen			Fuel-efficient stove +ventilation	
12.	Drama and songs			Practice health drama & songs	
13.	Environment			Garbage pits & faecal-free yard	
14.	Malaria			Drainage & clearing	
15.	Coughs and colds			Mats and ventilation	
16.	Bilharzia			Bathing Shelter	
17.	TB			Community Project	
18.	HIV/AIDS			Community Project	
19.	Home based Care			Community Project	
20.	KAZA-CRIDF planning			Community Project	

Figure 3: A typical CHC membership card

A typical CHC has between 50 and 150 members, with each CHC member representing a household made up of an average of five family members. So an average CHC of say 100 members will represent 100 households x 5 family members = 500 beneficiaries. An EHT with transport (i.e. a motor cycle) should be able to supervise at least five CHCs at a time over a period of six months (i.e. the time it takes to complete all 20 health topics at a rate of one topic per week). Thus in a period of twelve months a single EHT should have been able to facilitate at least ten CHCs with a combined total of around 5,000 beneficiaries.

Based on Africa AHEAD's extensive experience in the design and roll-out of CHC programmes throughout Zimbabwe, the overall expected cost of running such a CHC programme is expected to cost around USD 3.00 per beneficiary.

CHC Members can progress towards establishing what are known as FAN Clubs (Food, Agriculture and Nutrition Clubs). The food security that can be achieved through the FAN Clubs provides a way to address climate resilience. This is the proposed approach to delivering agricultural extension services for the small irrigated gardens to be developed as part of this CRIDF intervention, as explained in section the Cop and Livestock Production section below – which also presents a combined budget for the sanitation and agricultural extension programme.

2.5 Crop and livestock production

Introduction

To enhance the livelihood benefits of the proposed community water supplies, small areas of irrigated land will be developed at each site. The intention is to make land use more efficient, reduce production risks by improving assurance of water supply, as well as by increased utilisation of agricultural products and support services. In particular, the following improvements are expected:

- increased water use efficiency and conjunctive water use for multiple uses (irrigation and potable water);
- expansion of area allocated to irrigation production area in the region;
- reduction of risks in crop production;
- intensification of land use through irrigation;
- expansion of alternative cash crops in the area;
- farmers' direct involvement in the market economy, through production of cash crops;
- direct injection of capital into the area, through employment creation at implementation and during operation, through agricultural support services;
- mushrooming of agro-based industries as a result of stable crop production, especially of horticultural crops;
- reducing human and wildlife conflicts;
- complementing Government of Zimbabwe (GOZ) initiatives in water supply.

Zimbabwe is divided into five natural regions on the basis of soil type and climatic factors as shown in Figure 4 below. Natural regions I, II and III are suitable for intensive crop cultivation and livestock raising, while regions IV and V offer limited scope for crop agriculture but are suitable for livestock raising on a large scale. The provinces of Mashonaland (West, Central and East), Midlands and Manicaland are under regions I, II and III, while Matabeleland (North and South) and Masvingo Provinces are under natural regions IV and V.

Crops and yields

Crops are grown around Hwange District mostly under rain-fed conditions. These include maize, sorghum, millet, watermelons and various nuts. Intercropping is common as a drought risk mitigation strategy common in subsistence farming. Where water has been dammed, as at Bhale, farmers have gardens where they produce horticultural crops and some tropical fruits like mangoes.

Crop yields in the area are generally low due to the low and erratic rainfall and poor soils in the area, since it is Agro-Ecological region V. Should water supplies be improved, then one risk factor would have been mitigated against.

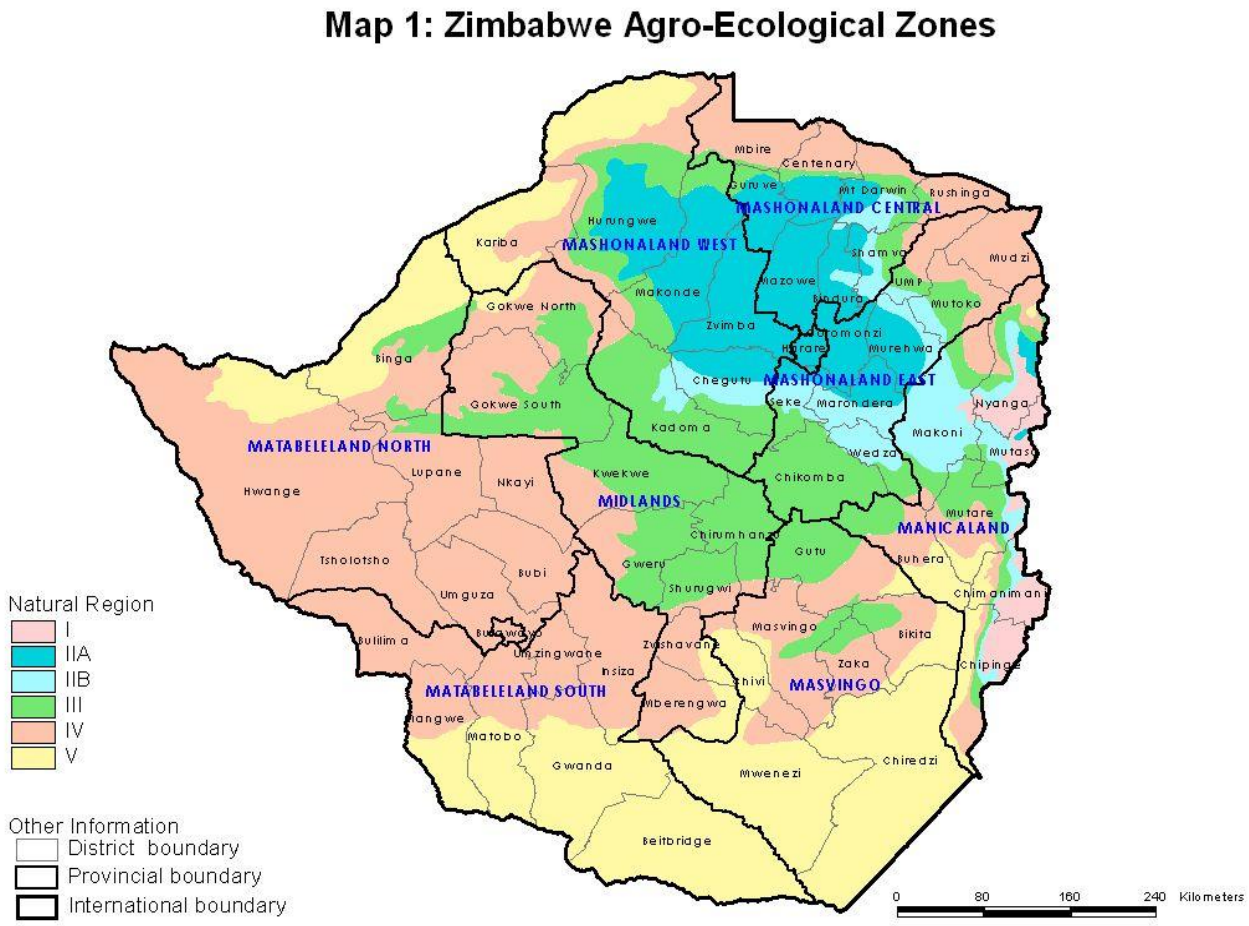


Figure 4: Zimbabwe agro-ecological zones

The other reason for below optimum yields was cited as limited access to inputs, particularly seed, fertilisers and chemicals. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) reports that lack of seed production and poor distribution is the major bottleneck in pearl millet varietal spread and productivity increase in Eastern and Southern Africa (ESA). Information from Agritex officials attested to this, with indications that input suppliers are few in Hwange and Victoria Falls. Farmers at the small-scale irrigation schemes operational in the district source inputs from Bulawayo and sometimes from Zambia.

Table 17 shows estimates of current average yields by crop, and those envisaged under optimum management conditions.

Table 17: Current yields and those expected under optimum management

Crop	Current average yield (kg/ha)	Potential yields (kg/ha)
Maize	1,200	7,000
Sugar beans/ soybeans	No estimate	1,800
Millet	Less than 1,000	2,500
Sorghum	Less than 1,000	5,500
Water melons	No estimate	No estimate
Groundnuts	600	2,500

It is noted that the small-scale irrigated area in the district is miniscule, being only 58 hectares in five irrigation schemes.

Proposed cropping programme

The crops desired by the farmers are shown in Table 18. This is the basis on which a cropping programme is recommended, building upon farmer's preferences, but also being cognisant of the cultural limitations. The list of crops recommended are detailed below and justified on the following grounds.

i. Green maize is a cash crop with high demand and low risk in production, with which farmers have experience.
ii. Sugar beans have a steady market throughout the year.
iii. The main crops have a long shelf life to reduce losses due to spoilage arising from marketing problems.
iv. Horticultural crops, primarily edible crops, are important for local consumption.
v. Groundnuts and beans are nitrogen fixers, which can be sold fresh or be dried should markets not be forthcoming.
vi. Leaf vegetables help with nutritional requirements, while also being cash crops.

Table 18: Possible crops for vegetable gardens at project sites

Crop family	Preferred crops for irrigation	Cultivation scenario/purpose
Cereals/ grasses	Green maize	• Rotation crop in summer and winter
Legumes	Beans, groundnuts, peas	• Legumes for rotation and fertility build up
Solanum	Potatoes, tomatoes, okra, egg plant	• Market gardening

Crop family	Preferred crops for irrigation	Cultivation scenario/purpose
Citrus	Oranges	• Planted on boundaries of gardens
Tropical fruits	Banana, pawpaw, mangoes	
Leaf vegetables and other fresh vegetables crops,	Carrots, cucumber crops	• Gardens at homesteads with water provided as part of potable water project
Brassicas/cucumber	Cabbage, kale, cauliflower, spinach, lettuce	
Onions	Onions, Garlic	

The crops were selected based on the following factors:

1) prevailing farm conditions – biotic, topographic, soil properties. Noted that Hwange soils are generally sandy. Kasibo is in hilly country, with fractured rock;
2) climatic factors – such as prevailing climate type, temperature, rainfall, relative humidity, incidence of light, and frequency of storms;
3) crop or varietal adaptability;
4) marketability and profitability;
5) resistance to pests and diseases;
6) available technology;
7) farming system;
8) security – against both human and animal entry, particularly in Hwange area where there is human and wildlife conflict.

The suggested crops were used to devise a cropping programme on which the estimation of irrigation water requirements is based. More information on the cropping programme can be found in **Annex 2.**

Irrigation water demands

Irrigation water demands were estimated for the projects based on the cropping programme. The Penman-Monteith method was used to calculate ETo values based on long-term data available in the FAO ClimWAT.

Table 19: Meteorological stations and estimates of irrigation water requirements

Project site	Ward	Applicable meteorological area	Calculated peak crop evapotranspiration (mm/day)	Net irrigation demand (m^3/annum)	Gross irrigation demand (m^3/annum)	flow (l/s)	Flow (m^3/hr)
Mphakati 1 and 2	Lupote	Hwange	5.02	12 176	16 235	0.92	3.3
Mphakati Dam		Hwange	5.02	12 176	16 235	0.92	3.3
Bhale borehole	Nekatambe	Hwange	5.02	12 176	16 235	0.92	3.3
Bhani borehole	Nekatambe	Hwange	5.02	12 176	16 235	0.92	3.3
Kasibo	Mashala	Hwange	5.02	12 176	16 235	0.92	3.3
Mpopoma	Mabale	Hwange Main Camp	4.79	10 479	13 972	0.88	3.2
Dopota Dam	Mabale	Hwange Main Camp	4.79	10 479	13 972	0.88	3.2
Simkululwe	Mabale	Hwange Main Camp	4.79	10 479	13 972	0.88	3.2

The following criteria were applied.

i. Monthly data were used for estimation of irrigation water requirements.
ii. Crop factor values were taken from FAO publication 24 and other relevant literature.
iii. Those crops with the highest demand for water expected to be planted were used in the estimation of irrigation water requirements.
iv. The estimate is weighted based on the area occupied by the crop.
v. Effective dependable rainfall was calculated using the FAO/ALGW method, which tends to be more conservative than the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) method.
vi. Leaching requirements were not included as no chemical soil analyses for electrical conductivity were conducted. Also upward flow into the root zone was assumed to be minimal and excluded due to the predominant sandy texture of the soils at the project sites.

vii. Due to the sandy soils of the area that would require frequent light irrigations. Given the limitation of pressure sprinklers are unlikely to work and drippers would require too much maintenance so simple hose systems are recommended.

viii. Effects of wind would be managed by the real-time scheduling and the planting of fruit trees around the boundaries of the irrigation blocks.

Outline costing for economic assessment

The projects outline costs based on the proposed crops are given in Table 20.

Table 20: Outline costing for financial assessment

Crop	Land Allocation %	Yield	Unit	Unit price	Gross Income	Variable Costs	Gross Margin/ha	Proportional GM
Onions	25%	20000	kg	0.25	5 000.00	2 738.31	2 261.69	565.42
Green maize	25%	30000	cobs	0.08	2 500.00	1 216.92	1 283.08	320.77
Sugarbeans	25%	1800	kg	1.20	2 160.00	1 500.96	659.04	164.76
Leaf vegetables/ Cabbage	25%	30000	kg	0.15	4 500.00	2 888.87	1 611.13	402.78
Groundnuts	25%	1000	kg	0.85	850.00	498.50	351.50	87.87
Carrots/Peppers/ leaf vegetables	25%	30000	kg	0.15	4 500.00	2 888.87	1 611.13	402.78
Cucumbers/ Melons/Grain maize intercropping. Budget for grain maize	25%	6	tonne	275.00	1 650.00	1 369.37	280.63	70.16
Tomatoes/ Potatoes	25%	60000	kg	0.16	9 600.00	6 638.10	2 961.90	740.48
	200%							
Total income per hectare based on proportionate allocations								**2 755**

Plot sizes and agronomic practices

Irrigated land plot size

The plot size is expected to be affected by the following:

- Historical plot size allocation in the area;
- land availability for gardens;
- water availability to match the land;
- population settled around the scheme;
- cultural influences;
- number of people interested in market gardening in the village;
- historical plot allocation.

Hwange District has five small-scale irrigation schemes with an area of 58 hectares, benefitting 202 farmers. The land holding per farmer decreases with decreasing scheme size. The range of size of irrigation gardens proposed is at most 1 hectare, suggesting land allocation is about 20m x 20m per household. Hence the scheme design approach must take this into account as one of the design criteria.

Layout

Criteria for the layout are as follows.

1. Minimize disturbance to existing conservation structures and water supply network.
2. Each irrigator allocated independent hose line
3. Minimise the length of run of pipe to reduce capital costs.
4. Accord maximum flexibility in operation to suit different annual crop production plans that may be required as per economic dictates, and water supply variations.
5. Avoid sharing of hydraulic control units between plots.
6. Minimize repair and maintenance costs arising from equipment wear. To this end, a system that minimises equipment movement is adopted.
7. Minimize labour requirements for equipment movement, to accord more time to direct production aspects of crop production.
8. Allow farmer operational independence at field level.

Table 21: Layout criteria for infield designs

Order	Limit
1	Boundary with predominant parallel slope ▪ As much as possible, fields to be configured for placement of the irrigation lateral parallel to the slope. ▪ The field bounds for irrigation drawn on perpendiculars from this slope.
2	Irrigation limits ▪ The irrigation limits are set within the boundaries of the marked fields, to give a net irrigation area slightly less or more than the gross marked on the boundaries. ▪ Were possible, areas are accommodated using extra hose length. The limits are multiples of lateral spacing on the perpendicular, and hose length on the lateral. ▪ The baseline boundary and the perpendicular are the main boundary lines considered in design. Sub-mains are designed on the given areas.
3	Regular perpendicular side ▪ The size of lateral was based on the field side with the most regular shape perpendicular to the parallel base line in order 1 above. ▪ The irregular side is adjusted and stepped in or out of the irrigated area on a common multiple of the lateral spacing. For design purposes, this is adopted as the peak flow condition, aligned to the peak crop water requirements.

Water distribution and rotations

This section is concerned with the organisation and operation of the system of water supply and delivery to the field for the Hwange schemes. In irrigation systems, the three most common water supply schemes are continuous flow, rotation, and on demand. Each of these has numerous variations that can be developed to suit local conditions, but these basic techniques are recognised. The systems provide varying degrees of control over water supplies.

The system recommended for the schemes in Hwange is on-demand as primary, with rotation as secondary due to temporal water shortages that may result as the system is based on ground water pumping. A separate feed line will be provided for the agricultural operations.

The on-demand (primary) with fixed schedule rotation control (secondary) affords a flexible method of water delivery, since it allows the supplies to be ordered at the convenience of farmers, particularly where irrigation units are clearly individualised to the farmer's holdings. The responsibility for managing supplies passes from an operator to the farmer, giving flexibility in the system on cropping, water management, use and disposal. Water measurement will be an integral part of management for efficiency and equity.

Storage tanks

These tanks will be provided as pressure control devices for irrigation and for on-demand management. The storage capacity will be determined on the basis of water availability and sources.

On-farm management

The on-farm water management in this respect is the farmer plot arrangement. The system designed must be inherently passive, not requiring a strong organisational structure to control flow of water into plots. The hydraulic set up allows a given flow to pass the off-take. Past this off-take, in the field, the farmer has freedom of choice on water use. Cropping patterns and therefore irrigation schedules are the decision of the farmer, limited by the maximum flow possible past their off-take, due to design pressure.

This system was adopted to provide independence of operation. The water meter or totaliser at the head of the field provides a means of monitoring water use.

Monitoring water flow

The scheme supply is metered for equity in the distribution of the water, efficiency and effective utilisation of water in the field. Further, prevention of pollution of the soil and other water retention media and prevention of health hazards in water use are some of the broad objectives of water utilisation in the scheme. The farmers will appoint a water bailiff to record water use on a regular basis for returns to the Zimbabwe National Water Authority, as well as in scheme comparisons against the area irrigated.

Typical design parameters

The design parameters used are as follows:

Crop water requirement	=	5.2 mm/day
AWC	=	80 mm/m
Management allowable depletion	=	50%
Average root zone depth for vegetables	=	0.70 m
Readily available moisture (RAM)	=	28 mm
% Wetland area	≥	100%
Gross depth applied	=	37 mm at 75% efficiency
Irrigation Frequency	=	**5 days**

Irrigation hydraulic design

The design criteria are:

- limit infield pressure variation, and hence discharge to 10% either side of mean discharge;
- any applicable low pressure system;
- utilise pipe size to reduce available system pressure, or head available from gravity, where possible;

2.6 Provision of agricultural support services

Extension services

In Hwange district, the public sector is involved in providing support services for the water and sanitation as well as the agricultural sectors at various levels of intensity as detailed in the following sections.

The Department of Agriculture and Extension (AGRITEX)

This is a long-established organisation that has operated under various names with the role of providing technical advice to farmers in agricultural practice. Field extension workers are stationed within or near project areas, as shown in Table 22. Their role is to facilitate imparting of knowledge, skills and attitudes that promote best practices in farming. During the field visits and site inspections, interviews were held and contact was made with the department of Agritex responsible for providing extension services in the area.

Table 22: Names of agricultural extension workers in the affected wards

Ward	Name (Surname and name)	Sex
Lupote Ward	Sibanda Mercy	Female
Mabale Ward	Ndlovu Sitshengisiwe	Female
Mashala Ward	Ndlovu Tariro	Male
Nekatambe	Sibanda Josephine	Female

It is important from a gender perspective that water management is mainstreamed across genders, and so it is encouraging that the responsible extension workers in three of the wards are female. The capacity of Agritex to deliver is compromised financially, negatively impacting operations due to lack of office and field equipment and lack of operational budgets.

Department of Irrigation

Both farmers and extension workers need to have knowledge and skills in irrigation. The Department of Irrigation has a role to ensure that training in relevant aspects of irrigation is given to extension workers and farmers. They will also follow up on repairs and maintenance. They will monitor water use efficiency and offer technical assistance on general aspects of water management and irrigation management.

Department of Livestock Production

Provides support for livestock production activities. In Hwange, livestock complements crop production. Livestock also provides draft power and eases labour demand during land preparation.

Department of Agricultural Engineering

This Department's role is to train extension workers in conservation of soil and water, as well as in tillage techniques and farm machinery and post-harvest technology, and to provide requisite back up services that would facilitate adoption by farmers. There are no personnel on the ground for this department. Support must be provided through Agritex

Zimbabwe Farmers' Union (ZFU)

Most of the farmers in the project areas are members of this organisation. The Union's role is to represent farmers and articulate their needs at different fora. The envisaged role of the Union in the project areas will be to mobilise and train farmers on group formation, cohesion and maintenance, and to advocate policies favourable for this sector.

NGO Support

Given to constraints of funders supporting government agencies it may be more appropriate to use the support of an NGO. The approach advocated for WASH is to develop CHCs. This approach can be extended to deliver Food and Nutrition (FAN) Clubs that would be able to provide agricultural support services. It is therefore proposed that services be the primary method of supplying agricultural support services as these organisations could be more readily funded.

Infrastructure, ancillary and administrative services

Hwange Rural District Council

Farmers in Mphakati 1 and 2, Bhale, Bhani, Kasibo, Mpopoma and Simkululwe experience difficulties in attracting transport to carry their produce to the markets. The same is true with regard to problems in bringing inputs like seeds, fertilisers and chemicals. This is due to poor access roads. Hwange Rural District Council has

a role to play in ensuring that areas under its jurisdiction are well served with feeder roads to improve the efficiency of transportation and marketing.

The HRDC plays a role in identifying and prioritising development projects in the district. The projects under discussion were identified through the HRDC.

The District Development Fund

The DDF plays a central role in rural development in Zimbabwe in sectors like small to medium water resources development (dam and borehole construction), water supply, rural roads development and maintenance, and provision of tillage services. Under its mandate, it had access to plant and equipment that could be provided for construction. It has a repository of information on design norms and standards for activities under its mandate. Infrastructure put up would have to comply with standards as set out by the DDF and ZINWA. For this reason, the water supply projects will benefit from liaison with DDF working with an agricultural support service provider as well, particularly to strengthen the water committees.

Zimbabwe National Water Authority

This organisation is responsible for regulation of all water use in the country. Hence it would ensure that farmers are issued with permits to draw water for irrigation purposes. It would also ensure that farmers are fully aware of the laws governing the use of water, particularly for irrigation purposes. Given the low volumes it is unlikely that permits would be required (see EIA Section).

Zimbabwe Parks and Wildlife Management Authority (ZPWMA)

The ZPWMA, under the Ministry of Environment and Natural Resources Management, oversees the activities related to ten national parks, nine recreational parks, four botanical gardens, four safari areas, and three sanctuaries. One of these parks is the Hwange National Park, part of the Kavango-Zambezi Transfrontier Conservation Area (KAZA).

The Hwange National Park was established in 1929 with an area of 14,650 km^2. It is the largest park and game reserve in Zimbabwe. It lies on the main road between Bulawayo and the Victoria Falls near the project sites. Hwange National Park offers the lead for ZPWMA in co-ordination and engagement on developments affecting communities living adjacent to the park.

Farmer training

A farmer training programme will support the irrigation development. This will be through an integrated community mobilisation and training approach to sanitation and to enhanced nutrition through garden production from the proposed small areas of irrigated land. The approach is based on the introduction of Community Health Clubs and Food, Agriculture and Nutrition Clubs (FAN Clubs), as explained in the Sanitation section above.

The FAN Club gardening and nutrition training programme spans 12 months. Each community identifies a volunteer Community Based Facilitator who is guided and supported by the Project Officer assigned to the initiative, together with personnel of Agritex. The involvement of the Project Officer will be gradually reduced so that Agritex can take full responsibility for longer-term extension support following the 12 month FAN Club establishment period.

The budget presented below is for the integrated sanitation and agricultural extension programme, establishing Community Health Clubs and FAN Clubs at scale in Hwange Ward rather than only in the communities targeted for the new water supplies – as explained in the sanitation section above.

Table 23: Sanitation and agricultural extension: combined budget

Description	FTE/units	Months/ days	Unit cost USD	Budget USD	Budget notes
Personnel					
Country Director	0.2	12	3,500	8,400	Entry and exit protocols, Monitoring and Reporting, Stakeholder engagement
Finance Officer	0.2	12	1,200	2,880	Financial management
Project Officer	1.0	12	1,200	14,400	National staff salaries and wages [100%] for 2 Project Officers
Total Personnel				**25,680**	19%
Travel					
Domestic travel and per diem	36.0	1	100	3,600	Per diem and other travelling expenses
Vehicle service	1.0	4	500	2,000	Vehicle service x 2 for project use
Motorbike service	8.0	4	100	3,200	Servicing Agritex and EHT motor Cycles for the 12 months
Vehicle fuel	1.0	12	300	3,600	Fuel expenses associated with motor vehicle usage.
Motorbike fuel	8.0	12	100	9,600	Fuel expenses associated with motorbike usage.
Total Travel				**22,000**	**17%**
Programme Activities					
CHC and FAN training for Community Based Facilitators (CBFs)	1.0	2	4,200	8,400	Training of trainers workshops for CBFs
Training Materials -PHHE and FAN Toolkits	72.0	1	115	8,280	Toolkits for training and facilitation by SBFs and CBFs
SHC Training Workshops and School Agriculture Masters	1.0	2	4,200	8,400	Training of trainers workshops for School Based Facilitators(SBFs)
Garden fencing materials	42.0	1	320	13,440	Fence for 42 community gardens, will be reinforce with live fencing/trees and hedges
Initial seed input	42.0	1	50	2,100	Variety seed pack procurement
Garden tools start up	42.0	1	100	4,200	A start-up kit of basic garden tools for each garden
Transportation of fencing and tools	1.0	1	500	500	Lorry hire to ferry materials around wards for garden set ups
Facilitator's meetings Allowances	62.0	8	5	2,480	CBFs and SBFs allowances
Visibility	600.0	1	12	7,200	Printing of T-shirts and bags and hats for facilitators and stakeholders once at the beginning and at the end with CRIDF and AAZ logos
Competitions CHCs and FAN Clubs	62.0	1	100	6,200	Competitions at household, Club and Ward levels
Graduations	62.0	1	100	6,200	Graduations for CHC and FAN club members in schools and communities
Total Programme				**67,400**	51%

Description	FTE/units	Months/ days	Unit cost USD	Budget USD	Budget notes
Activities					
Other costs					
Advertising	1.0	1	200	200	Jobs openings-recruitment
Office rent and utilities	2.0	12	250	6,000	Office Rent, Tel-fax, e-mails maintenance etc.
Office supplies	1.0	12	100	1,200	Stationery and other consumables
Printing and photocopying	1.0	12	100	1,200	Professional printing, typesetting and photocopying services.
Banking and cash handling fees	1.0	12	75	900	Fees incurred for banking transactions, including transaction fees, check books and statement fees. Also includes cash handling fees, such as money trader fees and currency exchange service charges.
Total Other Costs				**9,500**	7%
TOTAL DIRECT COSTS				**124,580**	
INDIRECT COSTS				**8,721**	7%
GRAND TOTAL				**133,301**	
Cost per club				**1,851**	
Cost per household				**39**	
Cost per beneficiary				**8**	

3. Procurement Options

Whilst the scope of the KAZA Zimbabwe project is very similar in nature and scale to the KAZA Namibia works currently in procurement, a modified procurement approach is required here due to the sensitivities associated with doing business in Zimbabwe.

The political relations between the UK and Zimbabwean Governments require a considered approach to project funding and business engagement. All UK funding is required to comply with UK policy. It is essential that the UK funding investment reaches the intended beneficiaries and is not compromised by political interference or other undesired practices. An open tender process, such as is being carried out for the KAZA Namibia works, can be particularly susceptible to these risks in Zimbabwe. Additionally, the UK Government has restrictive measures against certain organisations and individuals in Zimbabwe that preclude any UK funds being under their control. The PEA carried out for similar CRIDF works in Zimbabwe confirmed this as a significant risk and consequently an open tender approach under the ownership of a Zimbabwean ministry or department must be ruled out.

To move forward then, an acceptable project owner with a mandate in Zimbabwe must first be identified. Secondly, an assessment must be undertaken to determine the finance route for the project: whether it is a project suited to CRIDF direct funding of the works, or one where an external funder may be better placed to take the project forward at implementation stage. The chosen finance route will have a strong bearing on how a suitable in-country partner or contractor is selected to carry out the works.

On the first point, the KAZA Secretariat is already mandated to work across the five KAZA TFCA partner countries to facilitate project implementation and is the obvious body with whom to engage on this project. It should be noted that the KAZA Secretariat are not yet legally constituted and cannot therefore enter into legal contracts. However, the Peace Parks Foundation (PPF) has been mandated by the partner countries to act as a nominee signatory and custodial employer on behalf of the KAZA Secretariat. Under KAZA Phase 1, CRIDF entered into an Agreement with PPF and the KAZA Secretariat for provision of administrative support of CRIDF interventions in the KAZA TFCA, thus providing a mandated entity through which CRIDF projects can be delivered. This Agreement already specifically covers the planned works in Zimbabwe and thus provides the framework for engagement going forward.

At this stage it is too early to confirm the project finance route. Detailed discussions will be required with KAZA Secretariat, DFID Zimbabwe and others before this can be fully assessed and decided upon. However, in terms of the procurement route the Zimbabwe country procurement system will not be used. The CRIDF procurement procedure will be utilised if direct CRIDF funding is favoured, or an alternative procurement approach selected by an external funder may be used if that is the finance route chosen.

In terms of identifying a service provider with whom to negotiate to deliver the implementation phase, a review of the main actors in Zimbabwe, which encompassed a wide variety of organisations with a presence in Zimbabwe (private consultancies and contractors, NGOs, statutory organisations, multi-lateral organisations, financing and auditing institutions) was undertaken for previous similar work by CRIDF - ‘Infrastructure Finance in Zimbabwe’. If direct CRIDF funding is chosen, a similar review will be conducted to identify a suitable delivery partner.

4. Environmental Assessment

The Environmental Analysis and conclusion for this Project can be found in **Annex 3**. It includes records of engagement with EMA and a draft ToR outlining the tasks required to develop a full Environmental Impact Assessment Prospectus Report - to be carried out in advance of implementation, once funding has been secured.

The Analysis is summarised in the table below:

Table 24: Environmental Analysis

Project element	Likely Impact	Mitigation	Environmental requirements	Remarks
Borehole, pump and tank with reticulation to max. 3 standpipes	Water available to communities all year round +ve Risk of theft and damage by animals –ve +ve Clean water available Women and girls will not travel the long distances to fetch water	Provide secure installations- get communities involved	Primary water afforded under Water Act Storage not to exceed 5000 litres and use to be below 10000 litres per day	No permission or authority needed Proper siting and drilling techniques may be necessary
Reticulation to max 2 garden sites	+ve Will increase food security -ve Will attract wild animals and livestock	Gardens to be fenced off	No legal requirements	
Fencing of garden(s) (max 1ha each)	+ve Reduces animal destruction	Communities to maintain the fence	No legal requirement	Communities should undertake to repair damaged fences
Small-scale irrigation	May result in water over abstraction	To be controlled based on	This intervention may qualify Project as First	Require to be secured

equipment	Can have negative impacts on water yields. Can affect soils positively or negatively based on farming practices	water availability The size of irrigated land and crops have to match water availability Relevant soils management has to be practised	schedule and May need to be cleared by EMA	against vandalism
1 year extension inputs on gardening, conservation agriculture	+ve Better food security +ve Good start off for the communities		No legal requirements	No environmental concerns
1 livestock watering trough with reticulation from tank	+ve Reduces fouling of water by livestock +ve Reduces potential conflicts with wildlife		No legal requirements	No environmental concerns
Latrine construction (max 10)	+ve Improved sanitation +ve Increased access to better sanitation +ve Improved health of community		No legal requirements Fulfils the environmental policy and strategy	No environmental concerns
Deepening/expansion of existing dam for livestock water provision	+ve Water available all year round -ve Increased loss of water to evaporation +ve Increase water availability -ve Expanding will increase evaporation surface	Only deepening recommended	If area is not expanded no need for an EIA	Long term practices to reduce dam siltation to be instituted by council and EMA

Construction of a new dam	+ve Increased water availability -ve Several dam impacts on the environmental and hydrological aspects	A full EIA would be required unless an exemption is given by EMA	First schedule Project would require an EIA	The letter written to EMA requesting EIA exemption excluded this intervention
Initial stocking of dam with fish and provision of 1st year's feed	+ve Nutrition from fish -ve Fish food adds nutrients to the water body and increases chances of eutrophication	Fish would feed from natural plankton. Stocks would be replenished on a regular basis	No legal requirement	Recommend that the Project stocks fish but does not provide feed.
1 year extension inputs on fish production	See above			

Concluding remarks

Based on this analysis – construction of boreholes in all the areas would not require any permits except for the one in the Forest Area. No formal requirements are necessary except perhaps authorization from the RDC to go ahead with the Project as they will eventually need to take stock of the infrastructure and help with maintenance.

Dams fall into a special category and require EIA studies to obtain a permit from EMA. Considering that an EIA study is interdisciplinary, expensive and protracted – we recommended omission of these particular interventions and if need be provide additional boreholes for water for livestock. The design used in the Hwange National parks for providing water for elephants and other wildlife may be used for livestock, with a pump that is self-regulating.

All the other interventions are benign and would contribute to the communities' livelihoods.

5. Climate Change Risk Assessment

5.1 Scope of Review

The scope of this review includes the following project components and outcomes.

Climate risk screening on the following project components:

- Borehole, pump and tank with reticulation for potable water
- Small-scale irrigated gardens
- Fencing of garden(s)
- Small-scale irrigation equipment (hoses, sprinklers)
- Livestock watering trough (with reticulation from tank)

Identification of resilience benefits of the following project outcomes:

- Assured, quality water supply for potable water and irrigation
- Fencing of garden(s)
- Livestock watering trough (with reticulation from tank)
- 1 yr. extension sanitation support
- 1 yr. extension inputs on gardening, conservation agriculture
- 1 yr. extension of water infrastructure O&M

5.2 Climate vulnerability mapping

All projects supported by CRIDF are required to include dimensions of climate resilience. As part of the programme's inception phase, a climate change vulnerability assessment tool was developed, to help prioritise investment in projects that best align to the CRIDF mandate. A bespoke rapid climate vulnerability assessment tool can inform CRIDFs approach to undertaking Track 1 climate risk and resilience screenings.[2]

Climate Vulnerability Tool Indicators

Table 25 below presents the level of the climate vulnerability indicators for the project area according to the climate vulnerability assessment tool. For some indicators a range is presented, which reflects the differences in vulnerability amongst sites.

Table 25: KAZA Zimbabwe Climate vulnerability indicators

Indicator	Outcome
Future risks to people	4. Moderate

[2] The CRIDF Climate Vulnerability Assessment is available online at: http://geoservergisweb2.hrwallingford.co.uk/CRIDF/CCVmap.htm

Water risk under climate change	5. High
Climate change pressure	5. Very high
Baseline risks to people	3. Medium – 2. Low
Resilient population	2. Low
Population density	0.0 - 17.0 (people per km2)
Household and community resilience Groundwater stress	0.68 More resilient
Groundwater stress	1. Low (<1)
Upstream storage	No major reservoirs
Drought severity	3. Medium to high (30-40) - 4. High (40-50)
Flood FREQ MINM	0.94736844 0.95 Low
Seasonal variability	4. High (1.0-1.33)
Inter-annual variability	4. High (0.75-1.0)
Baseline Water Stress	1. Low (<10%)
CRIDF Basin	ZAMBEZI

The above indicators show that the project is located in area with high to very high drought risks. The area also suffers from high seasonal and inter-annual variability and the lack of upstream storage (no major reservoirs) exacerbates these problems. The baseline water stress according to the tool is low in the area, primarily due to the groundwater resources in the area (groundwater stress indicator is low). However, the technical reports in the feasibility study indicate that there are major problems with water reliability due to challenging geological conditions. The project contributes on reducing drought risks by making effective use of groundwater resources for the local population.

5.3 Climate projections

This section presents on overview of the latest climate trends and projections that were used to inform the climate change scenarios developed for the project area. This Track 1 review makes use of CRIDF's regional projections and impact table to understand how the future climate change might impact the project.

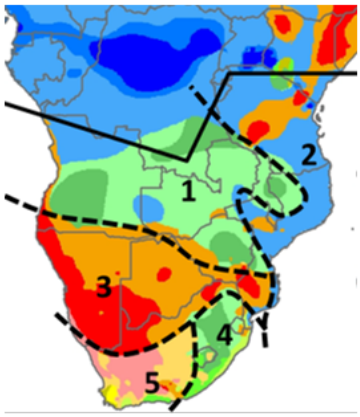


Figure 1: Climatic Zones in SADC

- **Region 1, Summer ITCZ (Intertropical Convergence Zone) region**. Angola, Zambia, and Malawi, central and NE Zimbabwe - This is a temperate/tropical region with dry winters (subtropical high pressure cells) and rainy summers (tropical lows driven by seasonal migration of the ITCZ).
- **Region 2, Summer Indian Ocean cyclone/monsoon zone.** Mozambique, Tanzania - Tropical/seasonal monsoon climate characterized by incoming cyclones from the Indian Ocean.
- **Region 3, Arid descending arm of Hadley cell.** Namibia, Botswana, SW Zimbabwe, S Mozambique - This region has a negative hydrological balance, low and variable precipitation and seasonally high temperatures.
- **Region 4, Temperate cyclonic zone**. E South Africa, Swaziland, and Lesotho - This region has a wet summer regime with thunderstorms and subtropical cyclones.
- **Region 5, Semi arid/winter rainfall zone.** W South Africa - This region is characterized by a steppe climate inland with winter rainfall and fog at the coast.

Figure 5: Climatic Zones in SADC

Climate Trends Overview

The project falls under region 3 and the following impacts presented in Table 26 have been identified

Table 26: KAZA Zimbabwe Climate projections for project area

Parameter	Impact by 2025	Impact by 2055
Precipitation variability	Continuing aridity of desert and semiarid environments. For planning purposes, it is best to work on decreased annual rainfall, especially to the west, with any decrease perhaps reaching 20% in parts; increases are unlikely in the west but may reach 10% in the east.	Continuing aridity of desert and semiarid environments; increased wind erosion, migration of sand dunes, decreased air quality and pollution, health effects, due to land surface aridity; episodic thunderstorms may result in soil erosion, flooding, especially in coastal areas; increased borehole extraction will result in decreased groundwater table, some ephemeral rivers will become permanently dry, perennial rivers may become ephemeral. Groundwater recharge will be reduced under all scenarios. For planning purposes, it is best to work on decreased annual rainfall, especially to the west, with any decrease perhaps reaching 20%, or even 30%, in parts; increases are unlikely in the west but may reach 10% in the east. Water supply will decrease under all future scenarios.
Temperature variability	Continuing trend of increased MAAT. Likely increase of MAAT by 0.5^{o}C to 2.0°C, but lower/higher values cannot be excluded; some increase in length of warm/drought spells and reduced frequency of cold periods.	Continuing trend of increased MAAT, heatwaves inland, increased thunderstorm activity. Likely increase of MAAT by 0.5^{o}C to 4.0°C, but lower/higher values cannot be excluded; almost certain increase in length and severity of warm/drought spells and reduced frequency of cold periods.
Extreme events	Increased frequency of drought and heatwave events.	Increased frequency and magnitude of drought events and soil moisture anomalies, which will have significant impacts on agricultural systems and sustainability.
Agriculture	Food insecurity arising from climatic instability	Increased aridity may result in increased food insecurity, spread of invasive plant and insect species, locusts, loss of rainfed agriculture and

Parameter	Impact by 2025	Impact by 2055
		subsistence agricultural systems become less viable, decreased food production in some areas
Health	Health effects mainly as a result of short term problems with food production due to climatic variability.	Health and nutrition effects, mainly as a result of longer term decreases in food production due to increased aridity, deflation of dry soils from the land surface, episodic soil erosion; food and water insecurity will increase, may be health impacts of increased pests and diseases; health impacts due to decreased water and air quality. Decreased surface water availability results in increased health and sanitation risk.

5.4 Review results

Climate Risks

The project comprises of a number of physical components, that were identified and screened at a high level against a series of relevant climatic threats for the area such as flooding, drought, cyclones (where applicable), sea level rise (where applicable) etc. An overview of the project's components along with the threats that the team screened the project against are presented in the following Table.

Table 27: KAZA Zimbabwe Project components and climate threats

Project component	Climatic threats
• Borehole, pump and tank with reticulation • Small-scale irrigated gardens • Fencing of garden(s) • Small-scale irrigation equipment (hoses, sprinklers) • Livestock watering trough (with reticulation from tank)	• **Flood**: There is small flood risk in the area, likely to intensify with climate change • **Drought**: Drought is an issue in the area and is likely to intensify with climate change • **Fire**: Prolonged drought and higher temperatures due to climate change will make fires more likely

A summary of the outcomes of the process is presented in the following table along with a series of risk management options.

Table 28: KAZA Zimbabwe Climate Risk Matrix

Project component	Flood	Drought	Fire	Risk mitigation options
Borehole, pump and tank with reticulation	**Low**: Low exposure / not much flooding in the area	**High**: Prolonged drought can reduce recharge rate of groundwater reservoirs and levels of sustainable yield	**Low**: Some fires in the area but unlikely to impact infrastructure as area is clear	**Drought**: Explore what sustainable yields could look like depending on precipitation levels at the area under future climate change scenarios
Small-scale irrigated plots	**Low**: Low exposure / Project component away from flooding area	**Low**: Amount used is very small compared to water available	**Low**: Some fires in the area but unlikely to impact infrastructure as area is clear	
Fencing of garden(s)	**Low**: Low exposure / not much flooding in the area	**Low**: Low sensitivity	**Medium**: Fire is prevalent in the area and wooden fencing materials could be damaged	**Fire**: Ensure that maintenance involves clearing vegetation a few meters each side of the fence
Small-scale irrigation equipment (hoses, sprinklers)	**Low**: Low exposure / not much flooding in the area	**Low**: Amount withdrawn from reservoir is very small compared to water available	**Low**: Some fires in the area but unlikely to impact infrastructure as area is clear	
Livestock watering trough (with reticulation from tank)	**Low**: Low exposure / not much flooding in the area	**Low**: Low sensitivity	**Low**: Some fires in the area but unlikely to impact infrastructure as area is clear	

Resilience benefits

The project delivers a series of outcomes that enhance the resilience of project recipients to climate change. An overview of the project's outcomes along with a list of resilience benefits that the project delivers are presented in the following Table.

Table 29: KAZA Zimbabwe Project outcomes and resilience benefits

Project outcomes	Resilience benefits
• Assured, quality water supply for potable water • Irrigation • Fencing of garden(s) • Livestock watering trough (with reticulation from tank) • 1 yr. extension sanitation support • 1 yr. extension inputs on gardening, conservation agriculture • 1 yr. extension of water infrastructure O&M	• Livelihoods • Safety • Health • Governance • Gender • Education

A summary of the outcomes of the process is presented in the following table.

Table 30: KAZA Zimbabwe Climate Resilience Benefits Matrix

Project component	Livelihoods	Safety	Health & nutrition	Governance	Gender	Education	Environment
Assured, quality water supply	Not applicable	**High**: Less likely to have significant encounters with wildlife	**High**: Enables access to sufficient quantity and quality water, lower incidences of diarrhoea and water related diseases	**Medium**: Some level of community ownership and management in place for the programme	**High**: It will reduce burden of women to fetch water. Also water supply supports sanitation needs of women during menstruation	**High**: It will save time for children to go to school instead of fetching water	**Low**: Fewer disturbances in collecting water from open watercourses and informal sand extraction from these rivers and streams has environmental benefits
Irrigation	**Medium**: It enables a small amount of cash crop production / reduces need for alternative seasonal employment and increase of local social capital	Not applicable	**High**: increases the availability of more nutritious foods e.g. vegetables	Not applicable	Not applicable	Not applicable	Low: Reduces reliance on rain-fed cropping, hence clearing large areas of land for crops, with associated

Project component	Livelihoods	Safety	Health & nutrition	Governance	Gender	Education	Environment
							erosion and soil loss.
Fencing of garden(s)	**High**: Increased production due to lower losses from wild animal damages	**High**: Less likely to have significant encounters with wildlife	**Medium**: side benefits of nutrition due to decreased production losses	Not applicable	Not applicable	Not applicable	Not applicable
Livestock watering trough (with reticulation from tank)	**Medium**: Increases livestock production and avoids losses due to climate shocks	**High**: Decreases likelihood of death of livestock due to wildlife encounters	**High**: Decreases likelihood of contamination of water supply / tap stands. Health impacts from lower wildlife/livestock disease transmission (contact)	Not applicable	Not applicable	Not applicable	High: Manage livestock and grazing more effectively thereby reducing degradation in riverine

Project component	Livelihoods	Safety	Health & nutrition	Governance	Gender	Education	Environment
							areas and around natural water bodies.
1 yr. extension sanitation support	Not applicable	**Low**: Less likely to have significant encounters with wildlife from defecating in the bush	**High**: Lower incidence of diseases	**Low**: Community health clubs have been established	**Medium**: Women, who are usually tasked with hygiene and sanitation, are better equipped to manage issues	**Medium**: Less incidences of diseases mean children (especially girls) are more likely to attend school	Not applicable
1 yr. extension inputs on gardening, conservation agriculture	**Medium**: Increased production	Not applicable	**Medium**: Increased yields translate to higher nutritional value	Not applicable	Not applicable	Not applicable	**Medium:** Conservation agriculture comes with environmental benefits

Recommendations and Next Steps

The Track 1 CCRA showed that the project brings a number of high resilience benefits to the project recipients for most resilience categories. The review also identified a number of risks in relation to the associated infrastructure and risk-mitigating actions which if implemented will improve the resilience of the project itself to climate change risks. The Project Director is responsible for ensuring that the actions below are implemented.

Drought

Drought is a known and recurrent issue in the area and is likely to intensify with climate change which gives rise to the following risks:

- Prolonged drought can reduce recharge rate of groundwater reservoirs and levels of sustainable yield.

Actions and Next Steps

- Explore what sustainable yields could look like depending on precipitation levels at the area under future climate change scenarios.

Fire

Fire is a known and recurrent issue in the area and is likely to intensify with climate change (increased temperatures and drought) which gives rise to the following risks:

- Wooden fencing materials could be damaged from fires.

Actions and Next Steps

- Ensure that maintenance involves clearing vegetation a few meters each side of the fence.

6. Cost Benefit Analysis

The CBA provides a holistic and multi-faceted assessment of the feasibility of the project. For a project of this nature, it is unlikely that it will be financially viable on a standalone basis; however, should the economic and social rationale for the project be clearly demonstrated, external financial support for the project can be justified. The CBA is conducted from the perspective of the local communities. They will become the effective owners of the infrastructure - accruing direct benefits through domestic, agricultural and livestock use, whilst also being responsible for its operation and maintenance costs in the medium and long term. As it is a rural water supply project, the communities will not be charged water tariffs but will instead need to collect user tariffs associated with either domestic or enterprise consumption to cover the on-going costs of the project.

The revenues collected through the proposed user tariffs are expected to be utilised by the community for the on-going costs associated with the agricultural and livestock improvements. Comparing these to the annual O&M costs, the financial appraisal indicates that the project considered in isolation is not financially viable. At an 8% discount rate, the Financial Net Present Value (FNPV) is negative (-GBP72,292) and the Financial Benefit Cost Ratio (FBCR) (0.93) is below 1. This is to be expected, given that water and sanitation provision is largely a public good. Excluding the initial capital investment required, the project's operational cost recovery is positive. Annual operating cash-flows (annual revenue less annual Operation & Maintenance costs) have a positive FNPV of GBP 64,847 and a FBCR of 3.72. The minimum external grant finance that is required in order to achieve the break-even point (FNPV of zero and a rate of return equal to the discount rate) is GBP 189,699.

A sensitivity analysis conducted on the financial appraisal indicates that the above results are robust to variations in the project's main parameters. A 20% reduction in capital costs would be required to generate a positive FNPV. However, it is important to note that the project's operational sustainability also remains robust to sensitivities in the project parameters.

The economic appraisal component of the CBA assesses a wider spectrum of costs and benefits relative to the financial appraisal. Both quantitative and qualitative costs and benefits are included within the appraisal in order to provide a holistic view of the expected net socio-economic impact of the project. The benefits that are included within the economic appraisal include: the time savings to households, the positive impact on the health and improved food security due to the water and sanitation infrastructure. The qualitative benefits of the project include: increased tourism, lower human wildlife conflict, gender impacts and enhanced climate resilience of the impacted communities. These qualitative benefits are also discussed.

The results of the quantitative economic appraisal show that the project is economically viable and beneficial. At a 10% discount rate, the project's ENPV is GBP 399,203 and the BCR is 2.01; at a 3.5% discount rate, the ENPV is GBP 904,677 and the BCR is 2.68. The ERR at both discount rates is 25%. It is important to note that these results are an understatement of the full complement of economic benefits that stem from the intervention as a number of the benefits are qualitative and therefore not included within the quantitative results. The combination of quantitative results, bolstered by the significant qualitative benefits, provides a robust justification for the project from a socio-economic perspective.

In summary, whilst, on a standalone basis, the project is not commercially viable, the revenue generated by the beneficiary communities is sufficient to cover the on-going costs. External grant financing will therefore be

required to cover the capital investment to make the project viable. Should this be secured, the CBA indicates that the project is operationally sustainable. Grant funding of GBP 464, 454 should be secured in order for the successful implementation of the project. Of this total amount, GBP 349,632 is specifically for the capital costs of the project. In addition to this, further provision of GBP 114,822 has been made for the funding of other project start-up costs (the establishment of Community Health Clubs (CHCs) the Agricultural Extension (AE) programme) as well as Operations and Maintenance (O&M) costs for the two years of operation.

The below table provides an executive summary of the CBA results. The full Cost Benefit Analysis is attached as **Annex 6.**

Executive Summary Table

Budget	
Capex	£ 349,632
Break-even investment	£ 189,699
Beneficiaries	
Direct beneficiary households	422 (2015)
Project sites	Households per site • Mphakati 2 (35) • Mphakati 1 (29) • Bhale (36) • Bahani (130) • Simkhulule (112) • Mpopoma (40) • Kasibo (40)
Indirect beneficiary households	Rural households in the Hwange district will all benefit from the implementation of the scaled-up agricultural extension training programme
Assumed number of people per household	4.6 (Kasibo is assumed to be 4)
Lifespan of benefits	20 years, in line with CRIDF KAZA Namibia Feasibility Report
Direct Economic Benefits	

Food security	Non-market benefits from crops and livestock, the economic benefit of food security includes draught power, milk, manure, hides, a store of wealth, along with crops grown for subsistence use
Time savings	Time savings associated with less distance required to travel to fetch water. The benefits flow mainly to women and children as they are responsible for fetching water each day
Health	Health impacts that stem from this project are expected to be large due to the fact that the project provides adequate supply of clean, safe drinking water for communities whose water supplies at present are inadequate. Additionally, the project aims to run a sanitation programme at scale in the Hwange district taught through Community Health Clubs. Improvements in hygiene practices as well as sanitation infrastructure are expected to reduce the incidence of water-borne sanitation illnesses such as cholera and typhoid.
Indirect Economic Benefits	
Lower wildlife conflict	As a result of permanent water supply and thus reduced movement into wildlife dispersal zones, lower wildlife conflict results in fewer livestock and even human losses, as well as lower costs associated with wildlife-conflict prevention.
Cash injections into the rural economy	Many of the rural communities within the KAZA area have no formal income and survive from subsistence crops alone. Being able to sell additional agriculture and livestock provides a valuable cash injection to the community, which in turn has multiplier effects in stimulating further growth and development in the area
Tourism	Fewer HWCs will result in long-run tourism benefits, with fewer wildlife losses through poaching as well as fewer losses through the transmission of sickness between livestock and wildlife
Reduction in crop failure risk	Crop failure due to environmental shocks, especially drought, is a very real risk in the KAZA area. Crop failure can have dire effects on the community; however, permanent water supplies will ensure that crop failure risk is reduced

Reduction in seasonal migration costs	Permanent water supply and access to water for livestock would reduce the costs associated with seasonal migration toward water sources in the dry season	
Positive gender impacts	Inadequate water and sanitation has disproportionally large impacts on women in communities through health and time savings impacts	
Climate resilience	At present the population of KAZA Zimbabwe has limited resilience to climate shocks such as floods or droughts. Improved sanitation as well as permanent, safe water supply will have significant benefits to the local communities. Improved water supply will improve the climate resilience of the communities' livestock production, as well as facilitating improvements in vegetable production.	
Financial appraisal performance indicators		
Financial Net Present Value (FNPV)	- £72,292	
Financial Rate of Return (FRR)	5%	
Financial Net Benefit/Investment Ratio (F-N/K Ratio)	1.33	
Economic appraisal performance indicators		
	(3.5% SDR)	**(10% SDR)**
Economic Net Present Value (ENPV)	£ 904,677	£ 399,203
Economic Rate of Return (ERR)	25%	25%
Economic Benefit-Cost Ratio (EBCR)	2.01	2.68
Sustainability		
The project appraisal was conducted from the perspective of the local communities as they will become the project owners, accruing project revenues that stem from improved water supply. They will also, however, be responsible for the on-going O&M. This is due to the fact that limited budgets in government institutions have served as a constraint and resulted in a lack of on-going rehabilitation and maintenance of water infrastructure in the area. Therefore, it is proposed that the community form a Community Health Club (CHC), which is responsible for sanitation training in the community, along with the maintenance and operation of the		

infrastructure. It is thus vital that the community is able to afford to pay for these on-going costs so that the project is able to run for its full 20 year life span.

In isolation, the project is not financially viable due to its significant capital cost and would require grant funding to cover the capital investment. However, operationally, the project is sustainable as annual revenues that accrue exceed the annual O&M costs of the infrastructure. This is only the case, however, if grant finance is sought for CHC capacitation and for the costs of running this and the agricultural training for the area.

7. Analysis of Key Stakeholders and Institutions

The **Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA)** is an initiative of five member states of SADC. Its activities in each of those countries thus have a SADC mandate and fall under the authority of the respective governments.

7.1 Water infrastructure, ancillary and administrative services

In Zimbabwe, the **Ministry of Environment, Water and Culture (MEWC)** is responsible for KAZA activities – and also for national water policy, standards and programmes. MEWC has delegated direct operational responsibility for KAZA activities to the **Zimbabwe Parks and Wildlife Management Authority (ZPWMA)**, whose area office is in Bulawayo (covering Matabeleland North and South), with local offices at Hwange National Park Main Camp (where a community relations officer is based) and Victoria Falls. The Hwange National Park was established in 1929 with an area of 14,650 km^2. It is the largest park and game reserve in Zimbabwe. It lies on the main road between Bulawayo and the Victoria Falls near the project sites. Hwange National Park offers the lead for ZPWMA in co-ordination and engagement on developments affecting communities living adjacent to the park.

The **Zimbabwe National Water Authority** is responsible for regulation of all water use in the country. Hence it would ensure that farmers are issued with permits to draw water for irrigation purposes. It would also ensure that farmers are fully aware of the laws governing the use of water, particularly for irrigation purposes.

The **District Administrator (DA)** is the senior Government of Zimbabwe official in Hwange District. Local services are the responsibility of the **Hwange Rural District Council (HRDC)**, which has offices outside the town that are headed by a **Chief Executive Officer**. (The Hwange and Victoria Falls urban areas fall within Hwange District but have separate local government authorities.) The HRDC has a **Social Services Department** that is responsible, *inter alia*, for rural water supplies.

The **District Development Committee (DDC)**, chaired by the DA, has oversight of development initiatives in Hwange District. Its members were present at the endorsement meeting held in Hwange on 21 October 2015.

There is a **District Rural Water Supply Sub Committee** under the DDC with direct responsibility for this sector.

The **District Development Fund (DDF)** is a longstanding institution intended to undertake infrastructural development and maintenance. It remains the central source of technical capacity for rural water supplies in local government in Hwange district, and used to be capable of drilling and equipping boreholes. As its operating budget has been greatly reduced, it now has very little capacity for maintenance work, let alone construction of new infrastructure.

The **coal mining industry** in Hwange district has earth moving and related equipment. The HRDC is sometimes able to arrange the services of this equipment at no, or reduced, cost: for example, the owners might just ask for fuel and a driver's allowance, if a road needs to be repaired.

Hwange District is divided into **wards** that elect **Councillors** to the HRDC. The HRDC plays a role in identifying and prioritising development projects in the district. The KAZA sites under discussion were identified through the HRDC. Mabale, one of the four wards within which the seven proposed KAZA-CRIDF water scheme sites are located, is represented by the **Chairperson of the HRDC**.

At community level, **chiefs and headmen** are still important leaders who should be consulted and engaged in local development initiatives. KAZA has been active in its engagement of Chief Dingani of Mabale ward, one of the most influential leaders in the area, during planning of the water schemes and other initiatives.

According to national water policy, each water point should have a **Water Point Committee**, with a constitution, that should be responsible for the operation and maintenance of the facility. The committee should collect a contribution from users – often set at ZAR 5/household/month –in order to cover operation and maintenance costs.

Water infrastructure installed by KAZA and CRIDF should therefore be handed over to these Water Point Committees, under the auspices of the HRDC. Future maintenance will depend on the efficiency and competence of the committees in collecting and managing user fees. In the current budgetary conditions of Zimbabwe, the ability of the DDF to provide maintenance support will be limited.

Informants confirm that the **Community Health Club (CHC)** approach has been officially adopted for the promotion of sanitation and hygiene in Hwange district. **DFID** is funding a programme for sanitation and hygiene in four wards in the district, through **UNICEF**, which provides technical supervision to the **Mvuramanzi Trust**, a leading water, sanitation and hygiene (WASH) NGO in Zimbabwe that implements the programme at community level. At that level, **Environmental Health Technicians** have been appointed to help facilitate the initiative. Households fund latrine construction themselves.

One of the four wards where Mvuramanzi is working is Mabale, where two of the proposed KAZA-CRIDF sites are located. The current UNICEF/Mvuramanzi programme is not operating in the other wards where KAZA-CRIDF sites are proposed. The chairperson of the HRDC stated that her ward, Mabale, has been declared Open Defecation Free (ODF). In total, about six villages have achieved ODF status so far in the Mvuramanzi programme area. The target is to achieve ODF throughout those wards.

A potential strategy for the KAZA-CRIDF initiative would be to secure funding for Mvuramanzi to extend the current CHC WASH programme to the other three wards where proposed KAZA-CRIDF water schemes are located.

In Hwange district, the public sector is involved in providing support services for the water and sanitation as well as the agricultural sectors at various levels of intensity as detailed in the following sections.

7.2 Extension services

The Department of Agriculture and Extension (AGRITEX)

This is a long-established organisation that has operated under various names with the role of providing technical advice to farmers in agricultural practice. Field extension workers are stationed within or near project areas. Their role is to facilitate imparting of knowledge, skills and attitudes that promote best

practices in farming. During the field visits and site inspections, interviews were held and contact was made with the department of Agritex responsible for providing extension services in the area.

It is important from a gender perspective that water management is mainstreamed across genders, and so it is encouraging that the responsible extension workers in three of the wards are female. The capacity of Agritex to deliver is compromised financially, negatively impacting operations due to lack of office and field equipment and lack of operational budgets.

Department of Irrigation

Both farmers and extension workers need to have knowledge and skills in irrigation. The Department of Irrigation has a role to ensure that training in relevant aspects of irrigation is given to extension workers and farmers. They will also follow up on repairs and maintenance. They will monitor water use efficiency and offer technical assistance on general aspects of water management and irrigation management.

Department of Livestock Production

Provides support for livestock production activities. In Hwange, livestock complements crop production. Livestock also provides draft power and eases labour demand during land preparation.

Department of Agricultural Engineering

This Department's role is to train extension workers in conservation of soil and water, as well as in tillage techniques and farm machinery and post-harvest technology, and to provide requisite back up services that would facilitate adoption by farmers. There are no personnel on the ground for this department. Support must be provided through Agritex

Zimbabwe Farmers' Union (ZFU)

Most of the farmers in the project areas are members of this organisation. The Union's role is to represent farmers and articulate their needs at different fora. The envisaged role of the Union in the project areas will be to mobilise and train farmers on group formation, cohesion and maintenance, and to advocate policies favourable for this sector.

8. Stakeholder Engagement

8.1 Consultation and Management Meeting with Government of Zimbabwe on Proposed CRIDF-KAZA Interventions in Hwange

Subject	Consultation and Management Meeting : CRIDF – KAZA – Government of Zimbabwe	**Date of Meeting**	9th October 2015
Location	Department of Environment, Ministry of Environment, Water and Climate, Harare	**Time**	09h00
Present	Dr Kunene – Director, Environment, MEWC (partial)		
	Mr Tanyaradzwa Mundoga – Parks and Wildlife Management Authority, Board Member, KAZA Counterpart		
	Ms Veronica Gundu – Deputy Director, Climate Change, MEWC		
	Ms Yvonne Chingarande – KAZA Support Desk, MEWC		
	Dr Morris Mtsambiwa – Director, KAZA Secretariat		
	Leonard Magara (LM) – Chief Engineer / Zimbabwe Country Director, CRIDF		

Item	Text
Agenda	a) Introductions b) Introduction to CRIDF c) KAZA – Zimbabwe Activities supported by CRIDF
1.1	The meeting chair, Mr Mundoga introduced all present.
1.2	**Introduction to CRIDF** LM gave a brief introduction on CRIDF. The highlights were: 1. CRIDF – the Climate Resilient Infrastructure Development Facility - is GBP25.4m Facility set up by DFID and SADC to support development of small-scale water infrastructure in SADC Member States. 2. Projects that are eligible for funding by CRIDF have to satisfy the following three minimum criteria, among others: a. they have to be transboundary – in nature, location, dimension etc. b. they have to build climate resilience to the beneficiary c. they have to be pro-poor

	CRIDF has a long-standing working relationship with the Department of Water and ZINWA in Zimbabwe. A number of projects are already under implementation.
1.3	**KAZA – CRIDF Cooperation** CRIDF and KAZA have agreed on a program of support to local communities in the KAZA TFCA as follows: 1. Phase 1: KAZA – Namibia. This phase 1 comprises design and construction of small-scale water infrastructure to communities that currently compete and conflict for water with wildlife, in the Namibian part of KAZA TFCA. This phase is now going to tender, with construction expected to commence early 2016. 2. Phase 2: KAZA – Zimbabwe: This phase comprises the design of small-scale water infrastructure in Hwange district. The project seeks to provide solar powered borehole water and livelihoods (gardens, livestock water) projects for the communities. With CRIDF officially expected to end early 2017, this phase will not be built during this current program. CRIDF will thus fund the preparatory work involving designs. 3. Phase 3: This phase and other subsequent phases will cover similar projects in Zambia, Botswana and Angola. **The meeting discussed general CRIDF modalities of working in Zimbabwe, including UK government policies and conditions that guide CRIDF interventions.**
1.4	**Conclusions** 1. The Government of Zimbabwe fully supported the CRIDF work with KAZA in Zimbabwe. 2. The Government of Zimbabwe asked CRIDF to ensure they work closely with Godfrey Mutare, the KLO for Zimbabwe. 3. The meeting agreed to hold a coordination meeting with the Department of Water, Mr T Mutazu, to ensure maximisation of synergies.
1.5	**Documents** 1. CRIDF undertook to provide copies of the feasibility reports for the interventions in KAZA Zimbabwe to Mr Mundoga's office. The following documents are provided: a. KAZA Water Infrastructure for Livelihoods – Technical Analysis and Support Systems Reports b. KAZA Zimbabwe Cost Benefit Analysis 2. The Government handed the following documents to CRIDF for reference: a. Zimbabwe's National Climate Change Response Strategy (2015). (Provision of irrigation infrastructure is one of the key response strategies for rural communities.) b. Zimbabwe United Nations Development Assistance Framework (ZUNDAF) 2016-

	2020, Supporting Inclusive Growth and Inclusive Development
1.6	**Closure** The meeting agreed to maintain open communications and hold regular updates where necessary.

8.2 DFID Zimbabwe Meeting Memo

On 29th October 2015, Leonard Magara met with Colin Benham (DFID Zimbabwe) in Harare to discuss several of CRIDF's planned and on-going Projects in Zimbabwe. One such Project was the proposed CRIDF-KAZA Interventions in Hwange, where options/potential to mobilise part of DFID Zimbabwe's existing funds for implementation were discussed. Key points from the meeting are detailed below:

i. DFID Zimbabwe currently funds two major programs of interest. The FSLP – Food Security and Livelihoods Program (GBP12m) and the Rural WASH (US$50m). The former is managed by the FAO while the latter is managed by UNICEF, and both with the Zimbabwe Government acting as the facilitator. The fact that both are managed 'by others' means DFID does not have absolute control on decision-making, and can merely aim to influence decisions.

ii. Rural WASH:
DFID has provided £34 million (around US$ 51 million) from 2012-2015 to support the rural water, sanitation and hygiene (RWASH) sector in 30 districts of 5 provinces of Zimbabwe (Matabeleland North, Matabeleland South, Masvingo, Midlands and Mashonaland West). The Rural WASH Programme (RWP) is managed by UNICEF and includes improved sanitation facilities at 1,500 schools. UNICEF is implementing the RWP as part of its Country Programme of Cooperation in Zimbabwe and in partnership with ten Implementing Partners (IPs) that gained prior WASH delivery experience in Zimbabwe as a result of the Protracted Relief Programme II (PRP II). CRIDF wished to explore if part of this could fund KAZA Zimbabwe (Hwange is in Mat North), albeit KAZA includes a livelihoods component. Considering this implementation structure, this may be a more protracted process. The UK Parliament is also mobilising a review team w/c 26th October to review progress. No new issues are being entertained until the findings from this review are finalised.

iii. DFID Zimbabwe Renewable Energy Initiative:
DFID Zimbabwe was extremely interested to hear that both CRIDF's Ntalale and Kufandada Projects are now solar powered schemes – especially as the current grid power situation in the country is grossly unreliable. There is a high possibility for accessing funding from the Country Renewable Energy Initiative for the solar components on these two Projects. DFID Zimbabwe requested that a paper be put together by CRIDF to request funding. Considering that the KAZA Zimbabwe schemes are also solar powered, this Project should also be included in the application.

8.3 Hwange Meeting Memo

Introductory Session	
DA	• Our district is facing serious water challenges and we need to employ innovative strategies and engage with partners to overcome these. • The district is experiencing extremely low levels of rainfall and severe challenges of human-wildlife conflict. • We need to develop all-encompassing interventions that address all issues associated with water and livelihoods, but we also need to be realistic in what we can achieve and when. • We need to improve data collection (and communication of this data) within the local authorities so that we have an up-to-date status of the current water infrastructure situation at all times.
Godfrey Mutare	• KAZA partners with a range of likeminded players in the TFCA to tackle the challenges faced by resident communities, district councils and local authorities, and tourism facilities – and is working with CRIDF specifically on 'water for livelihoods' interventions in each of the 5 KAZA partner countries. The work that CRIDF will present shortly therefore falls under the 'KAZA umbrella'. • Co-ordinating the work that KAZA does with relevant authorities in the district is very important. The process of developing these interventions is iterative and we aim to consult with all relevant parties throughout the planning, design and implementation processes.
DWSC	• It's very encouraging to see partners coming together to assist Hwange's water crisis. We are part of a rural WASH programme that covers 33 districts in the country. The programme concentrates on: water point committee training, borehole drilling and rehabilitation, and latrine construction. • We have a rural WASH information management system. This comprises a database that captures WASH facilities in the district and assists us with planning future activities and identifying areas most in need. • The database captures operational and non-functional WASH infrastructure in communal areas - including boreholes, water points/tap stands, latrines and rubbish disposal pits. The data collection process is on-going, and there is still no/little data available in some areas of the district. • Two key areas of concern are i) many boreholes are drying up or collapsing; and ii) we invest in drilling new boreholes are then realise the yield is too low for the target population (this is specifically affecting schools and clinics). • There are 20 wards in the district, and some are facing a water crisis. Bhale is one

	of those.
Zim Parks Official	• Although we have approximately 95 boreholes in the park, we still face a major challenge of boreholes collapsing due to the Kalahari sands. • Because elephants consume a high volume of water, we pump 24 hours per day – which means the boreholes require quite a lot of maintenance. • We are transitioning from using diesel pumps, to solar pumps. • The area of the park near the Botswana border has no assured water supply – if we can't resolve this quickly there is a huge risk that the existing infrastructure and vegetation in the area will be damaged and destroyed due to overuse.
CRIDF Presentations	
R. Gillett	See Annex A
S. Turner	See Annex B
Discussion, Q&A	
R. Mukuwe	As mentioned by the DWSC earlier, there is a risk of drilling a borehole which provides insufficient yield that cannot adequately cater for humans and livestock. For your intervention, what will do you do in this instance?
S. Turner	*Our hydrogeologist advised that the standard drilling contract in Zimbabwe is such that a contractor is responsible for identifying a site with adequate yield. If he fails to do this at first, he is responsible (as part of his contract) to drill again.*
Madam Chair	During your scoping mission we had discussed the water supply challenges associated with the Growthpoint development. How do you suggest we secure water – considering this development doesn't fall within your planned interventions, and you raised concerns about environmental restrictions associated with the nearby forest are?
S. Turner	*For a commercial development like this to prosper, it needs an assured water supply. However it's on too large a scale for KAZA to take on. The focus of our intervention is on meeting the small scale needs at a household/community level.* *The Environmental Specialist did state that to proceed with installing a water supply at the Growthpoint, a detailed environmental assessment will need to be undertaken and the ZEMA approval process may take some time.*
A. Moyo	I'm pleased to hear you are planning to operate the boreholes using solar pumps.

S. Turner	Have you had success using them on the other projects you're running? *KAZA hasn't used solar panels yet – but we know from our scoping and feasibility missions that the technology does work in this area (which the ZimParks representative reiterated earlier). Although the start-up costs are high, the operating costs are low – and this is therefore a more sustainable option for the communities. Some communities were concerned about issues of theft, but our Engineer has confirmed that the panels can be welded and bolted down – making them basically impossible to steal.*
R. Mukuwe *S. Turner*	If the best yield point is 10km away from the community, what do you do? *We need to find sources closer to the community for the scheme to be viable. A yield point 10kms away requires too much pumping. Our Hydrogeologist believes the drilling contractors should be able to locate yield points in close proximity to the target communities.*
P. Utete *F. Dipotso* R. Gillett	What timeline are you looking at to reach implementation? It seems like the time just to go from scoping to detailed designs is already lengthy, and these communities cannot wait for so long. *Everyone is obviously aware of the bureaucratic issues in Zimbabwe at the moment. Unfortunately this is a challenge we cannot solve ourselves and is dependent on many other factors beyond our control. CRIDF is supporting KAZA to source funding for this Project in Zimbabwe. At least now that the detailed design work has been done, meaning implementation can move quickly as soon as funds have been sourced and committed.* *We hope we will be given the green light soon, to mobilise the KAZA funds set aside for work in Zimbabwe. We understand that it is difficult to keep discussing these issues with Godfrey, when there is no tangible infrastructure on the ground. We are engaging other donors in other countries that may not have the same limitations as our current donors regarding funding projects in Zimbabwe. We understand your frustrations – we know Godfrey is also very frustrated. KAZA aims to serve all 5 countries and we will strive to do so.* We would also like to see this process shortened. Because we are not direct funders, this is not something we can implement ourselves. Our finance team is already trying to identify external funding sources and we will report any progress back to Godfrey

	and the DA.
Z. Ndlovu *R. Gillett*	What if we think there are other points in Hwange with water needs that are as (or more) critical than your identified communities? *These sites were selected based on Godfrey's extensive consultation with the District Council and community representatives. We are treating these sites as Pilots. If the model proves successful, and if funds are made available to KAZA, they will push to implement similar schemes in other communities in the district that are also in need. We first need to see how successful the Pilot schemes are in terms of supporting livelihoods and reducing pressures on wildlife movement. Then we will be better positioned to leverage money for more projects.*
F. Lumano *R. Gillett*	What happens if other donors come along and are ready to implement projects before you manage to source funds? *We don't own these studies. We would be happy to provide them to another donor if they are able to implement them faster than we can. We have left copies of the detailed designs with the DA. All we ask is that we are notified about interest from other donors - so that we can engage with them, as appropriate.*
DA	To summarise: we fully endorse what KAZA and CRIDF have proposed today, and commit to cooperating and supporting the project when it proceeds to implementation. We also agree that the technical proposals can be utilised by other donors if they have funds readily available; CRIDF and KAZA will be notified if this happens.
Madam Chair	Thanks to all for attending. We commend KAZA, CRIDF and Stephen, and hope one day soon things will improve in Hwange.

Note on Endorsement:

The Hwange District Development Committee (DDC) plays a key role in the planning, approval and management of development initiatives in the District. Although the meeting was constituted by the DA and not the DDC, the DDC's attendance of the meeting was significant as they effectively endorsed the proposal too. A record of this support will be of particular importance when the Project moves to implementation, as the DDC will need to be actively involved in the process.

Post-meeting discussion

After the main meeting, R. Gillett and S. Turner had a discussion with R. Mukuwe, Project Supervisor for the Mvuramanzi Trust in Hwange district. He co-ordinates the Rural WASH programme, funded by DFID and implemented through UNICEF by the Trust in Hwange district. The progamme is operating in four wards in this district (and the trust also implements it in five other districts): Mabale, Kamativi, Silewe and Matetsi. It thus covers one of the wards (Mabale) where the KAZA initiative is proposed. In these four wards (and a couple of other places in the district), the programme has drilled a total of 40 boreholes and rehabilitated 245, using hand pumps. All this work is co-ordinated by the Mvuramanzi Trust. The programme includes a school WASH initiative, which also provides wheelchair access.

Promoting Open Defecation Free status for participating communities is part of the programme, through the Community Health Club approach. The Environmental Health Technicians who work on the sanitation and hygiene element were originally trained by the Africa AHEAD NGO. According to Mr Mukuwe, the Community Health Club approach is now mainstreamed in Zimbabwe. So far about six villages are ODF; the target is that all should achieve this status. The programme trains builders to make latrine slabs, pit lining (important in Kalahari sands) and superstructures.

Mr Mukuwe expressed willingness to maintain contact with KAZA and CRIDF as the initiative proceeds.

9. GESI Assessment

Background to the GESI Assessment

The KAZA Zimbabwe Bankability Pitch was designed, presented and approved in December 2014 prior to the GESI Guidelines being formally rolled-out. As such, when the team was deployed to site in February 2015 they were not in a position to undertake a GESI analysis that aligned with CRIDF's (now standard) protocol. That being said, the work undertaken by the Economist and WASH Expert did consider the needs of women and girls – specifically with respect to sanitation issues, and time-intensive tasks associated with collecting and carrying water – which were factored into the proposed WASH Community Health Club and FAN Club approach, and the Cost Benefit Analysis, respectively.

In October 2015, the Project Director, Activity Lead and CRIDF Manager returned to Hwange to re-engage with key stakeholders in the District. The purpose of the visit was to present the Project designs and proposed support systems to 40 attendees that live and work in Hwange, with the aim of gaining their endorsement and support.

During this trip, the CRIDF Manager facilitated a break-out session with 15 of the female attendees. The aim of the session was to discuss the gender disparities in the District and consider the implications that the proposed CRIDF-KAZA interventions could have on these imbalances. While most of these women held positions of influence (i.e. the HRDC Chairperson, the DWSC and the EMA official are all women with considerable levels of authority within the District), they all grew up in rural Hwange wards and were acutely aware of the challenges faced by the female beneficiaries of the proposed CRIDF-KAZA intervention. The key points raised during this session are detailed below, and were subsequently used to populate CRIDF's **GESI Rating of Operations Table** (along with supporting gender disaggregated data collected through desk-based research). Although this process was completed retrospectively (i.e. only after the Project designs were developed), the female attendees *unanimously agreed that the proposed interventions would address, and ultimately improve, the key issues identified below*.

Key challenges faced by women and girls in Hwange

Women and girls living in Hwange wards where boreholes are either non-existent or non-functional are expected to collect water 2-3 times per day (covering distances of +5km's per trip). Not only are their lives at risk as a result of the severe human-wildlife conflict at these water sources, but they have also voiced their concerns about the effect that this daily responsibility has on the current gender imbalances within their community. Female beneficiaries in Hwange were interviewed during a stakeholder engagement event in October 2015. Specific areas of concern included:

Education: Girls are expected to collect water each day before and after school – meaning they have less time to commit to their studies outside of school hours. Because of this, they do not achieve the same results as their male counterparts – limiting their employment prospects after school, and exacerbating the (already significant) gender imbalance in the District.

Marriage eligibility: Girls are expected to carry extremely heavy vats of water from a young age, which can stunt their growth permanently. This effect on their external appearance limits their ability to attract potential husbands. In addition, with limited water availability, grooming oneself and up-keeping hygiene routines is a major challenge – this was noted as another factor affecting young ladies' marriage eligibility.

Child health: Access to a safe, potable water supply is intrinsically linked to improved nutrition and food security at a household level. Women are solely responsible for monitoring their children's diets, and malnutrition has become increasingly prevalent in the Hwange wards where boreholes are no longer functional.

Elderly and disabled: Women of all ages are expected to manage household water collection and utilisation (including those in poor health and old age) because most of their husbands spend majority of the year living and working in South Africa. If a woman is physically unable to do so, the responsibility falls on her female relations in the community. This has a trickle-down effect on other aspects of these women's lives – because it means even less time is available for gardening, livestock watering, household chores and education.

Desk-based research findings

Demographic data for Hwange is limited; even more so for the areas of the District classified as *rural* (i.e. CRIDF's target area). The most recent census[3] (2012) indicated that the population for 'Hwange District Rural' was 62,670 – but this has not been disaggregated by sex, age or location (i.e. ward). The most recent sex disaggregated data available was published in 2008[4] - where the population was of a similar size to the 2015 census (61,397) and the gender split was 50.7% females to 49.3% males. This study also highlighted the biggest challenges as seen by communities in rural Hwange – where 'lack of/low levels of education' and 'HIV/ADS' were ranked by 74% and 89% respectively as the biggest problems faced by females. It is believed that these education and health issues are intrinsically linked to inadequate water supply (a point also noted during the break-out session conducted by CRIDF in October 2015 – see above).

A 2011 evaluation report[5] on the UN and UNICEF's ZIMWASH programme in Zimbabwe (focussing specifically on 6 Districts, including Hwange) presented interesting gender disaggregated findings relevant to the CRIDF-KAZA WASH component of the proposed intervention. These include:

Majority of the Water Point Committee members are women, however positions of leadership and authority within the WPC's are held by men

In Community Health Clubs women are the majority, and take on the lead roles.

[3] http://www.geohive.com/cntry/zimbabwe.aspx - displaying information sourced directly from Central Statistical Office, Zimbabwe (2015)

[4] K Singh et al; PLACE in Zimbabwe: Identifying Gaps in HIV Prevention among Orphans and Young People in Hwange District; MEASURE Evaluation, Caroline Population Center, USA; 2008

[5] Bresmo Business Consultants, ZIMWASH Project: End of Term Evaluation - Addressing water and sanitation needs of the rural poor in the context of HIV and AIDS in Zimbabwe, 2011

At the district level the DWSSC comprised of both men and women. Overall, statistical analysis indicates that more women benefitted from the different project activities – primarily because they were more engaged during the process, because they are seen as the primary users, providers and managers of household water

A major concern identified was that male domination is prominent where income-generating WASH activities are concerned – i.e. more men participate as Village Pump Mechanics s and latrine builders which are paying activities. The evaluators believed that this can be attributed to socio-cultural values and practises which inhibit women from partaking in tasks typically seen as a man's responsibility. However, female respondents were confident that they were equally competent to undertake the tasks if their husbands would allow.

The GESI Ratings and Operations Tool was completed, and is attached as **Annex 5.** The overall the 'significance' scoring was high(10 out of a possible 12) - indicating that overall the feasibility study has i) adequately analysed and assessed GESI issues in Hwange through a combination of research and face-to-face engagements; ii) factored these GESI findings into the final Project design and Cost Benefit Analysis; and iii) taken into consideration the need to monitor the development and success of the CHCs and Fan Clubs, with a specific focus on collecting gender disaggregated data – using the formalised AfricaAHEAD structures already in place in Zimbabwe.

10. Risk Register for Financial Closure and Implementation

Risk Event	Potential Impact	Current Risk Level			Risk Management Strategy	Responsibility
		L	C	I		
Management Risks						
Funding for the KAZA Zimbabwe activities cannot be identified	If no funders are identified then the project cannot proceed and any potential impact of these pilots will not be achieved.	3	4	H	CRIDF Finance team will identify potential funding agencies that are able to commit funds in Zimbabwe. DFID Zimbabwe will be kept informed of progress and may offer potential solutions to funding these projects. KAZA is in similar position in that it cannot fund activities in Zimbabwe at present due to restrictions imposed by their funders.	PMU
The project pilots do not demonstrate an acceptable approach to improving livelihoods for the beneficiaries	The pilots will not be replicated by KAZA and other organisations seeking to identify ways of improving climate resilience of impoverished communities	3	3	M	The implementation of the projects will be monitored by KAZA and CRIDF. Support will be given to the communities and key stakeholders to ensure that that the projects are operational and sustainable.	KAZA, CRIDF, Hwange DC
Technical Risks						
Procurement of suitably qualified drillers cannot be identified who are prepared to drill at these sites	The projects will not be implemented or be done by people who are insufficiently qualified.	3	3	M	Work with UNICEF and other knowledgeable stakeholders who have undertaken similar work in Hwange to help identify suitable drillers who understand the difficulties of working in this area.	Procurement, Contractors
Failure/theft of the solar panels or pumps affect the delivery of water	Failure to deliver water will mean that communities are unable to benefit fully from the projects	2	3	M	During procurement quality products will be sourced. The community will be trained in maintenance of the panels and the pump and an initial support contract will be part of the supply contract. Suitable protective measures will be put in place deter theft of solar panels (as described in Technical Report).	Procurement, Contractor
Water yields and quality do not match those anticipated in the feasibility study	Potable water is insufficient for all of the potential demands. Household water is limited and there is insufficient water for the	2	3	M	Ensure that water yields and quality are adequately tested during drilling. Conditions are included in drilling contract to ensure these are met.	Procurement, Contractors

Risk Event	Potential Impact	Current Risk Level			Risk Management Strategy	Responsibility
		L	C	I		
	agricultural production.					
Problems in establishing CHC in communities	This will limit the health impact of the project and limit the ability of the community to manage the sanitation and hygiene component of the water supply intervention.	1	1	L	Two organisations have worked in the area supporting the development of CHC. This is unlikely to be a serious risk.	PMU, Africa AHEAD
Agricultural production through the gardens is limited by low yields	Production levels do not reach their full potential and economic returns fail to meet the needs to cover operational costs	3	3	M	Support the communities with agricultural extension advice during the initial phases. This is most likely to be through the same organization that provides CHC development. Training in the production of suitable cash crops and how to market excess production need to be given to the communities.	PMU, Africa AHEAD
Social Risks						
Community unable to raise sufficient funds to cover the O&M of the schemes	The water supply ceases and the benefits cease	3	3	M	Community needs to be supported in saving sufficient funds to cover O&M. This will link into the production of suitable cash crops.	KAZA, CRIDF, Africa AHEAD
Land available for small gardens insufficient to meet communities desires	Tensions arise in the community over who has access to the garden plots.	2	2	M	Engage community as fully as possible during design phase to ensure project addresses as many of the communities concerns as is possible given the constraints of the project.	KAZA, CRIDF, Africa AHEAD, Water Committee
Women feel that they are excluded from the benefits of the garden plots	Female headed households are excluded and don't benefit	2	2	M	Engage community as fully as possible during design phase to ensure project addresses as many of the communities concerns as is possible given the constraints of the project.	KAZA, CRIDF, Africa AHEAD

Key:

L - Likelihood
C - Consequence

I – Impact

				Temporary delay Resource Intensive	Short period, isolated impact	Impacts across a number of activities	Suspension of program Loss of creditability	Termination of Program
				Consequence				
				Insignificant	**Minor**	**Moderate**	**Major**	**Severe**
	Expectation:			**1**	**2**	**3**	**4**	**5**
Likelihood	Is expected to occur in most circumstances	**5**	**Almost certain**	**M**	**H**	**H**	**E**	**E**
	Will probably occur at some stage	**4**	**Likely**	**M**	**M**	**H**	**H**	**E**
	Might occur at some time in the future	**3**	**Possible**	**L**	**M**	**M**	**H**	**E**
	Could occur but doubtful	**2**	**Unlikely**	**L**	**M**	**M**	**H**	**H**
	May occur but only in exceptional circumstances	**1**	**Rare**	**L**	**L**	**M**	**M**	**M**

E - Extreme risk – Unacceptable – detailed action plan required

H - High risk - Unacceptable – requires attention from MC

M – Medium risk – Acceptable – management aware of risk

L – Low risk – Acceptable – manage by routine procedures

Annex 1: Description of infrastructure at each site

A description of infrastructure at each site is outlined in the following sections.

Mphakati 2

Mphakati 2 project area consists of 35 households. Several households travel 2.2 km to the nearest borehole which has a poor yield, to fetch water for domestic use.

Mphakati 2 is located in Kalahari sands. Based on the estimated total water demand of 5.89 m^3/hr, a minimum borehole depth of about 72 m will provide the required yield. It is proposed to drill an 80 m deep, gravel packed borehole at Mphakati 2 at a site to be confirmed by a geophysical survey. Water will be pumped from the borehole to an elevated tank from where it will gravitate to a fenced garden, public standpipes and a cattle trough.

The project will consist of the following components:

1. 1 No 500 mm diameter, 80 m deep gravel packed borehole
2. 1 No solar powered submersible pump rated at 50 m^3/day.
3. 1 No 10 m^3 elevated tank
4. 1.5 ha fenced garden.
5. Drip irrigation system or series of standpipes to irrigate 1.5 ha
6. No standpipes for domestic water supplies
7. No cattle 1 m^3 cattle trough

The above project will benefit all the 35 households in the area.

Mphakati 1

There are 29 households around the Mphakati 1 project area. At present, villagers fetch water for domestic use from shallow wells dug in the Mphakati River bed. The proposed borehole site was pegged by a local diviner.

Mphakati 1 is located in Kalahari sands. Based on the estimated total water demand of 4.08 m^3/hr, a minimum borehole depth of about 70 m will provide the required yield. It is proposed to drill an 80 m deep, gravel packed borehole at Mphakati 1 at a site to be confirmed by a geophysical survey. Water will be pumped from the borehole to an elevated tank from where it will gravitate to a fenced garden, public standpipes and cattle troughs.

The project will consist of the following main components:

1. 1 No 500 mm diameter, 80 m deep gravel packed borehole
2. 1 No solar powered submersible pump rated at 50 m^3/day.
3. 1 No 10 m^3 elevated tank
4. 1.0 ha fenced garden.
5. Drip irrigation system or series of standpipes to irrigate 1.0 ha
6. No standpipes for domestic water supplies

7. 1 No 1 m3 cattle tough

The above project will benefit all the 29 households.

Bhale

Bhale project area has 36 households. The existing borehole, which initially had a good yield collapsed leading to a drastic reduction in yield. There is an existing excavated pan that is used for the irrigation of a small patch of gardens. It dries out around September.

Bhale is located in Kalahari sands. Based on the estimated total water demand of 5.99 m^3/hr, a minimum borehole depth of about 70 m will provide the required yield. It is proposed to drill an 80 m deep, gravel packed borehole at a site to be confirmed by a geophysical survey. Water will be pumped from the borehole to an elevated tank from where it will gravitate to a fenced garden, public standpipes and cattle troughs.

The project will consist of the following main components:

1. 1 No 500 mm diameter, 80 m deep gravel packed borehole
2. 1 No solar powered submersible pump rated at 50 m3/day.
3. 1 No 10 m3 elevated tank
4. 1.5 ha fenced garden.
5. Drip irrigation system or series of standpipes to irrigate 1.0 ha
6. 2 No standpipes for domestic water supplies
7. 2 No 1 m3 cattle troughs

Bahani

The Bahani project area straddles the main road to Hwange. It is densely populated, with one borehole towards the eastern edge of the village supplying water for 130 households. Some households in the western part of the village travel up to 3 km to fetch water for domestic use. The existing borehole, which was originally drilled to 60 m, collapsed, and is now only 30 m deep. This has drastically reduced its yield.

Bahani is located in Kalahari sands. Total water demand for the area is estimated at 16.7 m^3/day, including livestock.

The proposed site for a new borehole which was selected by the villagers is not centrally located, with some homesteads in west still too far from it, at distances of up to 2 km. It is proposed to re-site the location of the proposed borehole by shifting it towards the west.

The reconfigured project will consist of an 80 m deep gravel packed borehole at the new centrally located site, and a second similar borehole at the site of the existing borehole to supply the eastern villages. Water will be pumped from each borehole to elevated tanks from where it will gravitate to fenced gardens, public standpipes and cattle troughs.

The project will consist of the following main components:

1. 2 No 500 mm diameter, 80 m deep gravel packed boreholes
2. 2 No solar powered submersible pump rated at 70 m^3/day.

3. 2 No 10 m^3 elevated tanks per site
4. Two No 4 ha fenced gardens, one for each borehole site.
5. Drip irrigation system or series of standpipes to irrigate 4.0 ha of each garden
6. 3 No standpipes for domestic water supplies per site
7. 3 No 1 m^3 cattle troughs per site

Simkhulule

Simkhulule project area has 112 households located to the north of Hwange National Park. There are a number of boreholes to the north of the project area, with the nearest reported to be more than two km from centre of the village.

It is proposed to shift the original borehole site selected by villagers by about 200 m towards the south west in the vicinity of land suitable for the establishment of gardens. It is also proposed to drill an additional borehole at the nearby growth point located at the junction of the Hwange main road and the Gwaai mine Road, and to establish gardens approximately 300 m to the east of the growth point. The general layout of the proposals is shown in the Google Earth image below.

The project area is located on Kalahari sands, where the yield of the aquifer will be adequate to cater for a total irrigation, domestic and livestock water demand of 8.1 m^3/hr required from each of the two borehole. A minimum borehole depth of about 70 m will provide the required yield. It is proposed to drill an 80 m deep, gravel packed boreholes at both sites, to be confirmed by a geophysical survey. Site 1 will supply the western part of the village, irrigated gardens and part of the livestock population, while Site 2 will cater for the business centre, the eastern part of the village, irrigated gardens and the rest of the livestock. The two boreholes can be used in future as a source of water supply for a centralised piped scheme covering the growth point and surrounding villages.

Water will be pumped from each borehole to elevated tanks from where it will gravitate to the fenced gardens, public standpipes and cattle troughs.

The project will consist of the following main components:

1. 2 No 500 mm diameter, 80 m deep gravel packed boreholes
2. 2 No solar powered submersible pump rated at 70 m3/day.
3. 2 No 10 m3 elevated tank
4. A 300 m long 110 mm pipeline from growth point borehole to the irrigated garden.
5. 2 No 4 ha fenced garden.
6. Drip irrigation system or series of standpipes to irrigate 2 No 4.0 ha gardens
7. 3 No standpipes for domestic water supplies located at each borehole
8. 3 No 1 m3 cattle troughs located at each borehole

Mpopoma

Mpopoma village is located just north-east of Simkhulule village. The proposed borehole will benefit 40 households. The area is situated in the Karoo sequence where minimum borehole depths of about 70 m will be adequate to cater for the estimated total water demand of 5.8 m^3/hr. the proposed site for a new borehole selected by the villagers is located on the eastern side of the settlement where the maximum distance to water will be just under 2 km.

It is proposed to drill 80 m deep borehole at the selected site. Water will be pumped from the borehole to an elevated tank from where it will gravitate to a fenced garden, public standpipes and cattle troughs.

The project will consist of the following main components:

1. 1 No 150 mm diameter, 80 m deep borehole.
2. 1 No solar powered submersible pump rated at 50 m3/day.
3. 1 No 10 m3 elevated tank
4. 1 No 1.5 ha fenced garden
5. Drip irrigation system or series of standpipes to irrigate 1.5.0 ha
6. 2 No standpipes for domestic water supplies.
7. 2 No 1 m3 cattle troughs

Kasibo

Kasibo village is located just north-east of Hwange town. There are five existing boreholes to the north vicinity of the project area, and another one located at Kasibo Gander approximately 1 km east of the proposed site. These existing sources of water were located by GPS under an ongoing programme being implemented by the District Council. The accuracy of the siting has not been confirmed. Indications are that the co-ordinates supplied by Hwange District for the Gander borehole are incorrect since findings from the recent visit established that the nearest borehole is at Kasibo school, some 2 km from the project area. There is no information on the yield of the borehole at Kasibo Gander.

Kasibo area is situated in the Karoo sequence where minimum borehole depths of about 70 m will be adequate to cater for the estimated total water demand of 5.96 m3/hr. The proposed site for a new borehole selected by the villagers is located on the eastern side of the settlement. The borehole will benefit 40 households,

It is proposed to drill 80 m deep borehole at the selected site. Water will be pumped from the borehole to an elevated tank from where it will gravitate to a fenced garden, public standpipes and cattle troughs.

The project will consist of the following main components:

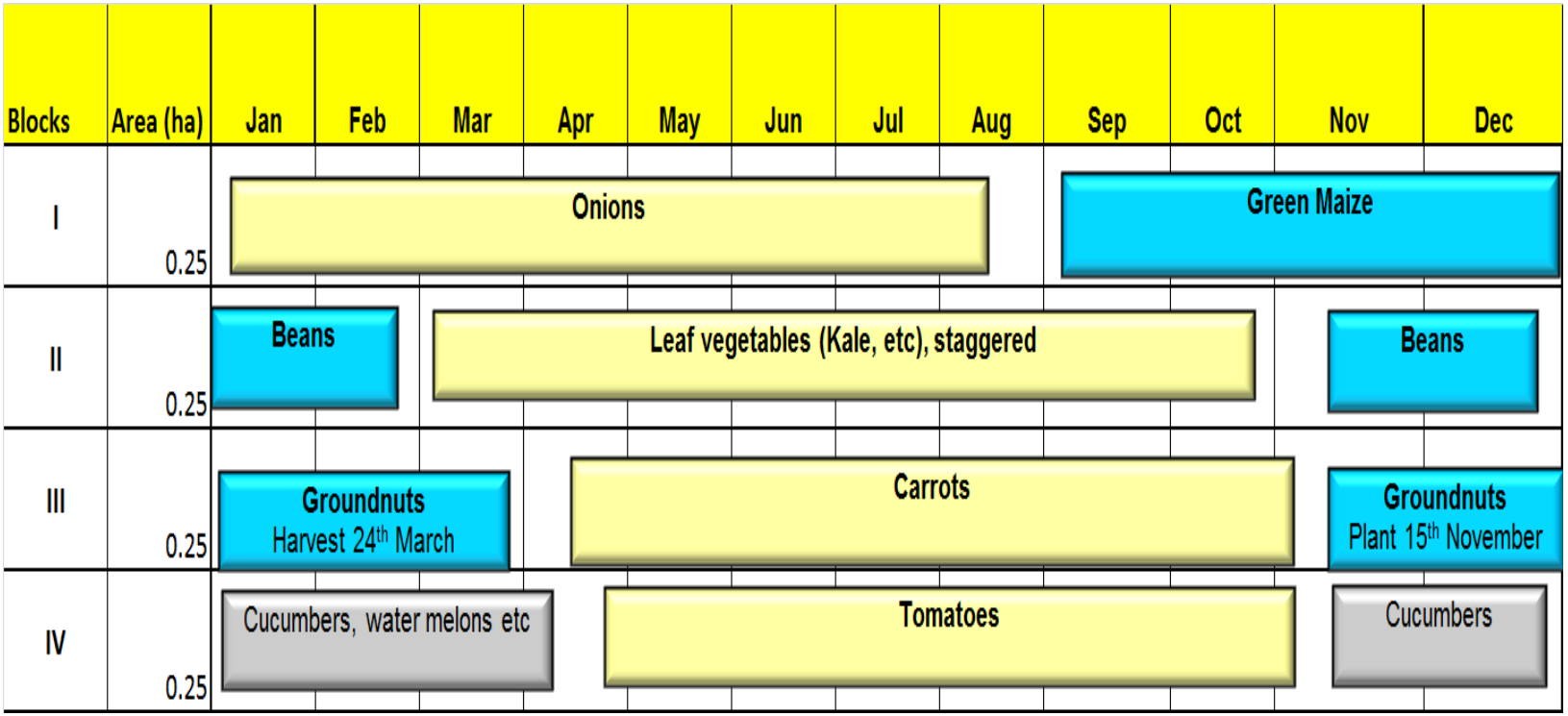
1. 1 No 150 mm diameter, 80 m deep borehole.
2. 1 No solar powered submersible pump rated at 50 m^3/day.
3. 1 No 10 m^3 elevated tank
4. 1 No 1.5 ha fenced garden
5. Drip irrigation system or series of standpipes to irrigate 1.5.0 ha

6. 2 No standpipes for domestic water supplies.
7. 2 No 1 m^3 cattle troughs

Annex 2: Cropping programme

The figure below shows the cropping programme used for estimation purposes. Crops actually grown will depend on how the small area of irrigated land is allocated and operated – as several individual plots, or as one group holding.

The cropping programme has two systems, one for the vegetables in winter and legumes and grains in summer. The four lines in the programme entail a sub-division of land into four blocks to accomplish rotations. This is replicated at an individual farmer plot level.



Annex 3: Environmental Assessment

Salient Environmental Issues

Boreholes pump and tank with reticulation to max. 3 standpipes.

Provision of boreholes has positive impacts and will help in providing safe water access. It is one of the objectives of the environmental policy and strategy. There are currently very little activities in the Project areas that are likely to harm the quality of underground water and hence it is likely that the quality of water meets the recommended standards for drinking water. Final assessment will be done based on the hydrogeologist's water quality results from samples taken from nearby existing boreholes.

However, the Hwange district lies on Kalahari sands that are highly permeable and it is difficult to both drill and case boreholes using modern technologies. It is therefore important that borehole siting is carefully done and that drilling uses the appropriate technology.

To comply with the Water Act on the provision of primary water, the water storage tanks should not exceed 5000liters and usage should be less than 10000 liters a day. Anything exceeding these requirements would necessitate obtaining a water permit from ZINWA.

Drilling a borehole for Cross Mabale business center, across the near a 'vlei' on Forestry Commission land, is not recommended for the following reasons;

- The Forestry area is not under the jurisdiction of Hwange District council. Permission would be required for this. While communities were allowed to graze their cattle during years of drought we were made to understand that the permission was limited to drought years.
- Secondly EMA permit may be needed if water is being abstracted from a wetland.
- Detailed studies would be required to assess the impact of the abstraction on the water table. It is likely that the geological water is far below the surface table.
- Lastly, this site is far from the business center and the communities and will increase reticulation costs as well as security costs to erect barriers that prevent wildlife destruction.

It is recommended that an alternative site outside the Forestry area be sought.

Reticulation to max 3 gardens

There are no legal requirements to establish communal gardens. If the garden size is reasonable and does not require extensive clearing of land (such as will be the case in Mashala ward), environmentally it is deemed innocuous. All the sites we were shown have adequate land for potential gardens. Soils quality can be improved through good nutrient addition regimes and implementation of soil conservation. The sizes have to be commensurate with the available water and watering monitored so that field water capacity is well maintained. Concerns exist with the Mashala site in terms of soils and terrain.

Fencing of Gardens

This is necessary to protect the produce from being eaten by livestock and wildlife. There are no legal requirements or environmental concerns.

Small scale Irrigation equipment

The only concern with this is the amount of water that will be abstracted by the equipment.

One year Extension inputs on gardening and conservation agriculture.

The intervention is important to assist farmers with inputs and skills to better manage their farming practice. This has long-term positive impacts toward food security.

Livestock watering trough with reticulation from tank

Again this is a positive intervention and there are no environmental concerns.

Latrine construction (max 10)

This is very important as it will improve access to sanitation and in turn the general health of the recipients. Many other NGOs are interested in providing sanitation facilities. It may be necessary to tap into existing programmes to avoid unnecessary duplication and make the interventions cost effective.

Deepening/expansion of existing dam for livestock water provision

Two dams in Lupote and Mbale ward are targeted for expansion and deepening. The Dopota dam has already been deepened. The current dams lose a lot of water to evaporation. The potential annual evaporation rates are higher than rainfall in this area. It is recommended that only deepening of the dams is undertaken to avoid increasing the surface area exposed to evaporation. Without expanding the inundated area this work will not require clearance from EMA.

Construction of new dam

Dam construction is listed under the First schedule of Projects that must undertake environmental impact assessment studies. Unfortunately, the legislation does not provide for thresholds on the dam sizes so the assumption is that all dams would require an EIA. The process is costly and protracted. It is therefore recommended that the Project omits construction of dams until a performance assessment of the existing dams and boreholes is done and maybe implement this as a second phase intervention.

Initial stocking of dam with fish and provision of 1st year's feed

Fish farming is normally successful where there is a lot of water and while it makes sense to stock the dams with fish it is recommended that species be used that grow well in the natural feeding on plankton. Adding of fish stock in a dam that is not aerated and that loses water relatively fast is not advisable, as that would pollute the water very fast.

Contact with EMA

Rudo Sanyanga met with the EMA official in Hwange - Mrs Kombo.

The Project was discussed and she recommended the following:

- That the Project writes to EMA requesting for an EIA waiver. The letter would be send to the provincial office for determination.
- As far as the Project is concerned it a community development Project that does not require an EIA and boreholes and gardens are not listed in the First Schedule of Projects.
- An EIA officer may be asked by the provincial office to go and visit the Project sites before an exemption letter is given.
- Following this the National Parks Regional manager in Bulawayo wrote a letter to the Bulawayo regional office. We have been informed that the letter has been sent to the EMA head office in Harare for determination.
- EMA's response is copied below.

ENVIRONMENTAL MANAGEMENT AGENCY

All communications should be addressed to "The Director General"
Makombe Complex, Block I,
Harare Street / Herbert Chitepo Avenue,
P.O. Box CY 385, Causeway, Harare, Zimbabwe
Telephone (04) 705671/3 /705661/3 Fax 793123

E-mail: ema@ema.co.zw,

17/1/1/3A

20 APRIL 2015

THE REGIONAL MANAGER

WESTERN REGION

P.O.BOX 2283

BULAWAYO

ATTENTION: MR A MUSAKWA

CONTACT: 236-9-63646-7

EMAIL: info@zimparks.co.zw

REF: APPLICATION FOR WAIVER OF FULL EIA ON WATER INFRASTRUCTURE DEVELOPMENT AT HWANGE DISTRICT

The Agency acknowledges receipt of your letter dated 08 April 2015 on the above subject matter.

We request that you submit a prospectus giving a detailed description of the nature of the water infrastructure development works for an informed decision to be made.

Thank you

ENVIRONMENTAL MANAGEMENT AGENCY
ENVIRONMENTAL PROTECTION DEPARTMENT
EIA AND ECOSYSTEMS PROTECTION
20 APR 2015
No. 6 CNR FALDING DRIVE, KG VI HARARE
Email, as Name on file
Website www.ema.co.zw

P. SHOKO

DIRECTOR – ENVIRONMENTAL PROTECTION

FOR: DIRECTOR GENERAL

RECEIVED BY: ..... DATE: .....

DESIGNATION: ..... I.D NUMBER: .....

CONTACT NUMBER: .....

Draft EIA Terms of Reference

Objectives

The primary objective of this Activity is to produce the Environmental Impact Assessment Prospectus report that will be submitted to EMA to determine whether the Project will require a full EIA or not. The Prospectus must be produced to in line with the EMA requirements and standards.

Scope of Work

The EIA specialist is expected to use both secondary and primary data obtained during the scoping mission carried out in March/April 2015 to produce the prospectus report. This work will involve a desk study of available information already collected by the other specialists as follows:

a) Demographic information, maps and coordinates (from team leader)
b) Climate and seasonal variation data (secondary and primary data)
c) Access level for sanitation in the area and current interventions from the WASH expert
d) Full description of Project (including equipment to be used) and proposed design from the engineer
e) Description of proposed vegetable gardens, size, soil types, crops and water requirements for proposed cropping- from the agronomist
f) Assessed water yields, water quality from existing boreholes, scale of potential amounts needed by humans and livestock – by hydro geologist
g) List of consultation meetings (from team leader)

The outcome of the consultancy will be a Prospectus report giving details of the proposed Project, likely impacts and proposed method for carrying out an EIA.

Approaches and Deliverable

1. Field surveys have already been conducted and these constitute enough data for a prospectus.
2. A limited desk review on the existing data, topographical maps, satellite images, existing studies and borehole site investigations in the area, geological reports and maps (if available), borehole and surface water records, etc. to be conducted. To be included in the analyses are ongoing practice and plans to roll out the Project.
3. Copy of standard chemical water quality test results to be attached.
4. A list of people and organization consulted and dates of consultations to be appended.
5. Supporting letter from the Council and DDF will add value.
6. List of potential impacts to be included in the report.
7. Compilation, analysis, and evaluation of the gathered data and information.
8. The Activity deliverable will constitute a copy of the EIA Prospectus.

Consultancy Period

The number of days set for the EIA Expert for this assignment is 5 working days, including one day for the development of an EIA terms of reference if the EMA so requests.

Reporting

The final report to be submitted to EMA will be a comprehensive prospectus with the following outline.

- Introduction, review of previous studies and environmental background
- Project descriptions, social, geophysical, design
- Methods for an EIA investigations
- Description of likely impacts and protection
- Conclusion and recommendations
- References
- Appendices

Budget Estimate

The estimated budget for this Activity is £5,900. It includes 5 consultancy days for the EIA expert, 1 day of input from the Activity Lead and 0.5 day support from the Portfolio Manager, communications costs (including printing and binding of documents), and EMA submission fee.

Annex 4: Cost Benefit Analysis

Key Assumptions

The CBA analysis is premised on a number of key input assumptions. The assumptions are drawn from the technical report, observations by the project team in the KAZA Zimbabwe area, peer-reviewed publications and international benchmarks. The table below provides the detail of the assumptions that form the basis for the CBA analysis.

Assumptions	
Financial Discount Rate	8.3% &
Exchange Rate	USD 1.00 = GBP 0.656
Constant Versus Current Prices	Constant 2015 prices
Project lifespan	20 years
Number of Households	422
Average Household Size	4.6 for 6 project sites, and 4 for one of them
Population size	1917
Social Discount Factors	3.5% and 10%
Farm gate cost of a cow	USD 150
Income per hectare of land under irrigation	USD 2,755

The CBA is carried out on a with- and without-project basis and hence includes only incremental values for the costs and benefit inputs. This is in an effort to include only the incremental costs and benefits of the project, including variables such as time spent collecting water in the current system versus time spent in the new system. In terms of the financial appraisal, the project sites currently do not have any formal operation and maintenance costs, although the community is sometimes responsible for the repair of the hand-pumps should they break. Hence, the O&M costs of the new system are included in their entirety.

In terms of agriculture, it is reasonable to assume that dry-land agriculture is practiced on some of the land that has been identified for irrigation. However, as other production inputs such as water and fertiliser serve as constraints on production, rather than labour and land, the entire irrigated agricultural development is included as an incremental benefit. Rain-fed agriculture is assumed to be able to move to adjacent land if necessary.

Financial Appraisal

The purpose of the appraisal is to identify the financial return to the project infrastructure investment and the operational sustainability of the infrastructure. In the absence of water tariff revenues, the financial appraisal is conducted from the perspective of the local communities, who will be the effective project owners, and will be responsible for the operation and maintenance of the infrastructure in the medium and longer term. The community will also be the direct recipient of the financial benefits which are expected to flow from the infrastructure.

This approach is useful for two reasons: firstly, the assessment provides a view of the operational sustainability of the project in respect of the local communities by comparing the annual costs of project with the incremental revenue streams associated with the intervention. By showing that the latter covers the former it is understood that, with the correct institutional design, the community will be able to afford the on-going costs of the project. Hence if the communities take effective ownership of the water facilities (and, hence, their costs), they should have enough revenue to sustainably operate them. Secondly, the approach shows what grant funding is necessary for the project to be financially sustainable to the communities.

The costs considered in the financial appraisal include the capital investment for the water supply infrastructure, including domestic, agricultural and livestock use, along with O&M costs and a sanitation and agricultural extension programme run in year 0 of the project. The financial benefits considered include the monetary increase in the value of crops and livestock to the community. Assessing the financial return of the project over its lifespan against the capital and operational costs yields a financial return to the project. The following indicators represent the key outputs of the financial appraisal:

- Financial net present value – the discounted flow of expected investment and operating costs deducted from expected return
- Financial internal rate of return – the financial return on the project. The financial rate of return should be above the cost of capital (discount rate) for the project to be considered financially viable
- Financial net benefit cost ratio – the ratio of the present value of the returns on the project set against the project's costs.

Importantly, should the project not be financially viable on its own, the financial appraisal will set out the amount of subsidy the project will require to make it financially viable. The project's costs and benefits are set out below, before the financial appraisal results are outlined.

Two scenarios are laid out below:

Scenario One: *Potential* financial revenues from infrastructure development, where communities are responsible for on-going O&M costs as well as a once-off sanitation and agricultural training programmes for their settlements;

Scenario Two: *Realistic* revenues from infrastructure development, where communities are responsible for on-going O&M costs as well as a once-off sanitation and agricultural training programmes for their settlement; and

These scenarios will be explained in more detail in the section below Grant funding, based on the results of Scenario 2 are then presented.

Project Costs

The total project capex required for all seven of the settlements is GBP 349,632. This includes the material, equipment and labour costs for both acquisition and installation:

- 9 boreholes with solar pumps
- 9 water storage tanks
- fencing for 23 hectares of vegetable garden
- 23 hectares of drip irrigation equipment
- 13 communal standpipes, and
- 14 cattle troughs

The cost of materials and installation for one borehole is approximately GBP 6,899, while the estimated cost of one solar pump is GBP 9,814.

Capex, Per Project Site, GBP

Project Site	Cost
Mphakati 2	33,116
Mphakati 1	31,997
Bhale	31,997
Bahani A	47,593
Bahani B	47,784
Simkhulule A	47,784
Simkhulule B	54, 239
Mpopoma	27,189
Kasibo	27,611
Total	**349,632**

Source: CRIDF (2015). Technical Report: KAZA Zimbabwe

Annual O&M Costs

O&M costs for the water supply infrastructure comprise the borehole infrastructure, drip irrigation, standpipes and annual visits by District Development Fund (DDF) fitters. Table below gives a detailed indication of the total O&M costs that can be expected over a two year period for all 7 sites.

Total O&M Costs for Water Infrastructure, Two Years

Description	Quantity	Rate (GBP)	Cost (GBP)
Borehole pump			
Spare pump control	1	722	722
Total	**9**		**6,499**
Drip irrigation system per ha.			
Dripline	2	249	499
Connectors	500	0.3	131
16 mm pipe	200	0.2	39
Rubber gaskets	100	0.1	7
Solvent cement	4	5.3	21
Allowance for misc. piping			98
Sub total			1,212
Total	**23**		**18,298**
Domestic water supply			
25 mm brass tap	44	13	578
Ball valve for trough	9	79	709
Ball valve for reservoir	9	79	709
Total	**9**		**1,996**
Visits by DDF fitter			
Visit to a site	24	131	**3,151**
Total			**29,944**

Source: CRIDF (2015). Technical Report: KAZA Zimbabwe

O&M costs are driven to a large extent by maintenance of the drip irrigation infrastructure, which accounts for over 60% of the on-going costs per year. These high O&M costs are due to the fact that infield drip systems are likely to require regular maintenance due to the accidental damage of plastic pipe fittings during land preparation and weeding. They indicate that it may be worthwhile re-visiting the options for irrigation infrastructure in an attempt to lower these particular costs.

In Zimbabwe the maintenance of all rural water points in communal areas is the responsibility of Rural District Councils through the District Development Fund. The District Councils are meant to hold and control maintenance budgets for all water points in communal areas. However, current fiscal constraints in Zimbabwe mean that little or no such funding may be available. The alternative open to rural water users – who are constrained by widespread poverty - is to establish a local water management structure that collects and saves maintenance funds that the users contribute to. This is the envisaged plan for the communities identified in this project.

Sanitation and Agricultural Extension

Inadequate sanitation and sanitation practices need to be transformed in order to gain value from improved access to safe water provision as described above. A vital part of the project that will contribute to the success of the intervention is the establishment and/or strengthening of Community Health Clubs (CHCs) in the area. CHCs, as an approach to building social cohesion while improving sanitation practices and knowledge in rural Zimbabwe, have proven capable of building resilience in communities and drastically improving health in areas where they currently exist. Run as once-off interventions, they have been shown as capable of creating cost-effective, sustainable solutions to sanitation needs in rural communities in Zimbabwe.

UNICEF reports that at present, 48% of the rural population in Zimbabwe practices open defecation and that improved sanitation coverage can be as low as 10% in some rural districts. To this end, the WASH-centred programme is proposed, with an estimated cost of around GBP 2.00 per beneficiary over a 12 month period. The total annual cost of such a programme is thus GBP 3,776 for all seven sites.

In terms of the agricultural component of the infrastructure, it is proposed that a once-off training programme is necessary for the success of the scheme, implemented in year 0 of the project while the infrastructure is being implemented. This can be integrated into the CHC approach, where the community is mobilised with agricultural extension (AE) support and training. The approximate cost per beneficiary for the agricultural support and training programme is GBP 3.30 over a 12 month period. It is important to note that these costs may be under-estimation due to the fact that the per-beneficiary cost is approximated from the programme at scale. Economies of scale would not apply in the same way on a smaller level, therefore increasing this cost.

12 Month Sanitation & Agricultural Support Costs, Per Project Site

Project Site	Population	CHC Cost (GBP)	AE Cost (GBP)
Mphakati 2	161	317	528

Mphakati 1	133	263	438
Bhale	166	326	544
Bhahani	598	1,178	1,963
Simkhulule	515	1,015	1,691
Mpopoma	184	362	604
Kasibo	160	315	525
Total	**1,917**	**3,776**	**6,293**

Source: Source: CRIDF, 2015

Table below shows a summary of the capital and annual operational project costs included in the appraisal. Capital costs consist of drilling and testing costs for each site, and water infrastructure costs for each site.

Summary of Project Costs, Per Project Site, GBP

Project Site	Total Capex	Annual O&M
Mphakati 2	32,936	1,266
Mphakati 1	31,824	1,001
Bhale	31,824	1,266
Bahani A	47,335	2,260
Bahani B	47,526	2,260
Simkhulule A	47,847	2,260
Simkhulule B	53,945	2,260
Mpopoma	27,042	1,200
Kasibo	27,462	1,200
Total	**349,631**	**14,972**

Source: CRIDF, 2014

Financial Benefits

Financial benefits to the communities include income generated from agriculture and livestock due to the implementation of the project.

Agriculture

Agriculture falls under two broad categories: subsistence agriculture and cash crops (which, for the purpose of this report, are classified as crops which are not consumed by the household which grows them, but are rather sold/traded). Financial benefits are thus only derived from cash crops, while subsistence agriculture provides a range of economic benefits (such as food security): Economic Appraisal. As these crops do not generate any direct monetary gains for the community, they are excluded from the Financial Appraisal.

Through discussions with the local communities it was ascertained that land and labour were not the constraints facing the communities in terms of what is grown and sold in the market, but rather inputs such as water and fertiliser served as production constraints. It is thus assumed that whatever rain-fed agriculture is displaced by the irrigated gardens will move elsewhere. All drip irrigated agriculture will be fenced, indicating that no losses to HWC will have an impact on the cash crops.

It also became apparent that the market for fresh produce exists in the area – especially in communities that are close to the mining villages or are located close to the main roads in the area. Selling produce alongside the road is a common occurrence. It was thus assumed that all sites (with the exception of Bhale and Mpopoma) would be able to sell all of their crops grown through drip irrigation. Bhale and Mpopoma, however, have significantly poor access to major roads, and it is thus estimated that they will only be able to sell 50% and 75% of their irrigated produce respectively.

In order to value the potential monetary gains from irrigated agriculture, an economic costing was created which demonstrated the total income per ha of land under irrigation, coupled with enhanced agricultural management practices (see the CRIDF KAZA Zimbabwe Technical Report for detailed breakdown of the margins per hectare). An income value of GBP 1,809 was applied per ha as potential revenue for the local communities

Proposed Sizes of Irrigation Gardens, Per Project Site

Project Site	Size of Gardens (ha)	Potential Financial Gains (GBP)
Mphakati 2	1.5	2,713
Mphakati 1	1	1,808
Bhale	1.5	2,713
Bhahani	4	7,234
Simkhulule	4	7,234

Mpopoma	1.5	2,713
Kasibo	1.5	2,713
Total	**23**	**27, 127**

Source: CRIDF, 2015

Livestock

Part of the infrastructure design is the provision of cattle troughs to all seven sites. At present cattle must often travel over 5 km each way to reach drinking water that is suitable for livestock. Improvements in water supply to livestock are expected to result in improved quality of the herd, a larger herd over time and fewer losses due to wildlife. Livestock are negatively impacted by poor water quality. Cattle that drink poor-quality water will drink less water and have a diminished feed intake, resulting in lower weights and eventually, low financial returns when the cattle are sold. Cattle that drink less water due to the water's poor quality are also more prone to heat stress and will spend more time in shade rather than grazing. Improved quality will be associated with more time to graze rather than walk to water, as well as more water available to be drunk at more regular intervals by the animal. A growing herd over time is associated with healthier cattle due to more water available for consumption, which in essence has increased the carrying capacity of the land –which is currently low due to water shortages. In terms of reduced wildlife losses, the permanent water supply suggests that communities will no longer have to make seasonal movements into wildlife dispersal zones to find water with their cattle, while also reducing the amount of high-risk wildlife conflict time spent travelling to water throughout the year. Part of these benefits, which are under-valued in the financial appraisal due to difficulty in monetising them, are the benefits from lower livestock-wildlife transmission of diseases such as Foot and Mouth Disease.

Scenario 1

Scenario 1 shows the potential financial benefit flows for each of the project sites. The capital, annual recurrent O&M costs, as well as once-off sanitation and agricultural extension are included as the project costs in the analysis.

A summary of the financial appraisal for Scenario 1 is presented in Below.

The net benefit/cost stream (Net B/C) yields a financial rate of return (FIRR) by year 20 of 11% and a financial net present value (FNPV) over 20 years at 8% discount of GBP78,295. At constant 2015 prices and a real financial discount rate of 8%, the project financial model yields viable returns. Being high risk in nature, however, it is unlikely to be able to attract private finance with a 12% return.

Financial Appraisal Results for Scenario 1, GBP, 2015 Prices

Financial Appraisal Results (8% discount rate)	
Financial Rate Of Return (FRR) Over 20 Years	**12%**

Financial Net Present Value (FNPV) 20 Years	**90,4505**
Financial Benefit to Cost Ratio	**1.28**
Financial N/K Ratio	**1.79**

Source: CRIDF, 2015

Operationally, the project shows significant return to the local communities, with an FNVP of GBP 117,876 over its 20 year life span, indicating that there are large monetary benefits to the community over the life of the project. It must be noted that a large portion of the operational revenues stem from improvements in the livestock potential of the community, and would therefore be realised only if the communities sold their livestock. In reality, however, it is unlikely that these communities will do so – animals take a number of years to mature and it is custom in the area to keep cattle as a store of value until necessity dictates that they are sold. Discussions with communities suggest that cattle are only sold in years of hardship or when there is a large and unusual payment due.

While the above table demonstrates that there are potential financial gains to be made from the implementation of the project, it is more accurate to analyse the financial gains from the project that realistically account for the incremental benefits to the community that occur through agriculture and livestock gains realistically assumed to be converted into money.

Scenario 2

Scenario 2 represents the same agricultural gains assumed in the above scenario, but livestock gains have been reduced. Based on discussions with local communities, it has been conservatively assumed that only 20% of livestock are actually sold in the market. Thus, while the potential gains indicated in Financial Appraisal table above still accrue to the communities, only 20% of the livestock gains are actually converted into money.

Since the financial analysis aims to measures the financial return of the investment to the local beneficiaries and the degree to which there is a financial incentive for them to invest, at least in on-going operational costs, taking this more conservative approach represents the communities' ability to pay for the infrastructure rather than the hypothetical approach represented in Scenario 1. Table below shows Financial Appraisal Results for Scenario 2.

Financial Appraisal Results for Scenario 2, GBP, 2015 Prices

Financial Appraisal Results (8% discount rate)	
Financial Rate of Return (FRR) Over 20 Years	**5%**
Financial Net Present Value (FNPV) 20 Years (GBP)	**- 72,292**
Financial Benefit to Cost Ratio	**0.93**

Financial N/K Ratio	**1.33**

Source: CRIDF, 2015

This analysis shows a negative FNPV and low FRR of 5%. Including the actual monetary benefits from the project demonstrates that the project is not viable from a financial perspective. Therefore, if the community were to pay for the project themselves, they would make a loss on their investment. It is important to note that Bhale, one of the smaller project sites, shows only limited ability to pay for the on-going costs and sanitation & agriculture training component of the project under this scenario. With net annual on-going financial benefits of less than GBP500, it is likely that this community will be unwilling to cover its sanitation and agricultural extension programme costs as these do not lead to direct financial gains.

Net Financial Benefits for Scenario 2, GBP, 2015 Prices

Site	Annual O&M Costs (GBP)	Once-off CHC & AE Costs (GBP)	Annual Financial Revenues (GBP)	Net Financial Benefits (GBP)
Bhale	1,266	874	1.531	393

Source: CRIDF, 2015

The operational sustainability of the project requires that the revenue stream that is realised by the community (as a result of the intervention), be more than the annual costs of running the intervention. However, sanitation and agricultural extension training programmes have been included in the financial appraisal in year 0 as they are a necessary enabler that will be required for the community to be able to realise the full gains from the infrastructure (both in terms of making full use of the irrigation developments, as well as from additional water supply for domestic purposes).

It should be noted that these costs are significant – over 65% of one year's O&M costs. While the costs are necessary for communities to realise the full benefits from the infrastructure, they are not necessary for the continued operation of the infrastructure.

Grant Funding

Based on the results from Scenario 2 which indicates that communities may experience difficulty in paying for their CHC and agricultural extension training, a strong argument is made that the sanitation and agricultural training costs should be covered by a grant or subsidy and not by the communities themselves. A strong argument is also made in the CRIDF KAZA Zimbabwe Technical Report that it is much more cost effective to run these training programmes at scale – i.e. for the whole of the Hwange district, as economies of scale with project costs such as vehicle transport and EHT trainers can be shared by larger areas. While there will be some on-going costs associated with these programmes, it is recommended that these are funded externally throughout the project's working life. In this scenario, only the at-scale sanitation and agricultural training in year 0 is included.

Additionally, it is suggested that grant funding is provided to cover two years of O&M costs to ensure the sustainability of project finance. It is reasonable to assume that there will be a time-lag between the implementation of the infrastructure and the realisation of monetary benefits to the community. It is unfeasible to expect the community to pay during this time. Additionally, if the community faces affordability constraints in paying for the O&M costs of the infrastructure, they may need to access funding from the local District Council. The second year of grant funded O&M costs thus acts as a buffer to allow for communities to apply for this funding.

Including the grant funding suggested above, the Financial Appraisal demonstrates operational sustainability to all seven settlements. Thus, while the project is not financially viable due to its significant upfront capital costs, in terms of its ongoing financial sustainability the projected operational cost-recovery of the infrastructure is positive. This implies that the project infrastructure will be financially sustainable should external financing be secure for the required initial capital investment, two years of O&M costs and a once-off, 12 month-long sanitation and agricultural extension training programme.

The project is unlikely to attract commercial funding as it will not generate the quantum of returns to attract commercial investors. Concessional finance (e.g. interest-free loans) paid back over the life of the project are also not feasible given the significant capital costs relative to financial benefits that stem from the project. These revenues generated by the project are insufficient to pay back these costs over the 20 year time frame. The project will therefore require grant funding to proceed.

The table below indicates the financial return on the project investment when varying degrees of external grant funding are leveraged. Importantly, this includes a capital grant, the sanitation and agricultural training programme done at scale in year 0 of the project and two years of O&M costs. There may need to be follow up finance accessed for further training done, however, this is excluded from Table below.

Project Funding Scenarios

Scenarios	FNPV (GBP)	FIRR (%)
Project alone	- 72,292	5%
Full grant funding	292,924	34%
Break-even grant funding (GBP 189,699)	0	8%

Source: CRIDF, 2015

The minimum finance required for the project to have a FNPV of 0 and a rate of return equal to the discount rate (8.3%) – that is, the 'break-even' point of the project - is GBP 189,699. It is suggested that a donor funder is sought for the full capital investment of the project as the FIRR is too low to align with the appetite of commercial investment. If additional capital is sought from the Zimbabwean state budget it is expected that there will be a delay in the project's implementation. Concessional finance (e.g. interest-free loans) paid back over the life of the project are also not feasible given that the revenues generated by the project are insufficient

to pay back these costs over the 20 year time frame. The project will therefore require grant funding in order to proceed.

Sensitivity Analysis

A sensitivity analysis is an important way to analyse whether the key input assumptions for the project have a material impact on its outcomes, particularly those of its overall viability. The objective is to identify the factors that have the largest impact on the project's sustainability and returns. The sensitivity analysis looks at the main factors that could impact the project's costs, as well as the factors affecting the project's revenue generation.

The relatively large upfront costs of the project result in its poor overall financial outlook. Increasing the upfront costs of the project by 10% sees a material impact on the project's NPV from – GBP 72,292 to – GBP107,066. The associated change in the FIRR is from 5% to 4%. The project would require capex costs to decrease by 25% for there to be a positive FNPV. In this case, the FNPV would be GBP 14,643, with a FIRR of 9% and a FBCR of 1.12. These results suggest that capital costs play a fundamental role in the overall financial viability of this project but that a relatively large change is needed to make the project financially viable.

While capital costs play a role in determining the overall financial viability of the project, it is also necessary to do a sensitivity analysis on the operational sustainability of the project. This is particularly the case for projects that are funded by an external source but will need to rely on operational sustainability for their on-going success. In this case, a sensitivity analysis was carried out on the operational flows of the proposed intervention in isolation of the capital costs.

As reflected in the Table below, changes in the O&M costs have some bearing on the B/C ratio; however the B/C ratio remains strongly positive with a 10% increase in the O&M costs. This is indicative of the strong revenues generated by the project which far outweigh the operational costs. The operational FNPV of the project is GBP64,847 , with a B/C ratio of 3.72 .

Sensitivity Analysis – Cost Parameters

Parameter	Change	Net operational FNPV after change (GBP)	B/C after change
Increase in O&M costs	+10%	61,069	3.41
Decrease in O&M costs	-10%	68,625	4.10

Sensitivity Analysis – Revenue Parameters

Parameter	Change	Net operational FNPV after change (GBP)	B/C after change
Increase in value of a cow	+10%	66, 292	3.77

Decrease in value of a cow	-10%	63,401	3.67
Increase value of agriculture	+10%	74,487	4.04
Decrease in value of agriculture	-10%	55, 207	3.40

Source: CRIDF, 2015

The sensitivity analysis confirms that operational sustainability of the project is robust – with a B/C ratio significantly higher than 2, the project is able to recover its operation and maintenance costs.

Economic Appraisal

The economic benefit of the water and sanitation services that are created through the implementation of the project must be quantified within the economic appraisal at its real value to society, as opposed to the financial revenues that could accrue direct financial benefit to the project beneficiaries. The purpose of the economic appraisal is thus to determine the economic feasibility of the project, i.e. whether the implementation of the project results in a net benefit for the entire population. This benefit is split into the benefits which can be quantified and valued (these are included in the quantitative analysis and directly compared to quantitative costs); and the benefits which can either not practically be quantified or valued in monetary terms (these are discussed in the qualitative analysis).

The economic feasibility of the project is determined by consideration of both the quantitative and qualitative analysis. The diagrams below provide a short description of the quantitative and qualitative economic benefits that can be attributed to the intervention.

Quantitative Benefits (Measurable)

Health	• Improved water supply and sanitation training is expected to decrease the incidence of water-borne diseases and hence have a positive impact on the overall health of the impacted communities
Time savings	• New infrastructure is associated with time savings due to the fact that new water sources are closer than they were before and thus reduce the time taken to walk to collect water
Food security	• In addition to the monetary benefits associated with agriculture and livestock, food security also includes food eaten by the community itself, along with additional uses the community gets from livestock, such as draught power, milk, manure and other non-monetary benefits

Qualitative Benefits (difficult to measure objectively)

Wildlife conflict reduced	•As a result of fenced agriculture, as well as permanent water supply and thus reduced movement into wildlife dispersal zones, lower wildlife conflict results in fewer crop, livestock and even human losses, as well as lower costs associated with wildlife conflict prevention
Economic activity	•Many of the rural communities within the KAZA area have no formal income and survive from subsistence crops alone. Being able to sell additional agriculture and livestock provides a valuable cash injection to the community, which in turn has multiplier effects in stimulating further growth and development in the area
Tourism	•Fewer HWCs will result in long-run tourism benefits, with fewer wildlife losses through poaching as well as fewer losses through the transmission of sickness between livestock and wildlife
Crop failure reduced	•Crop failure due to environmental shocks, especially drought, is a very real risk in the KAZA area. Crop failure can have dire effects on the community; however, permanent water supplies will reduce crop failure risk. This also has an indirect impact on building climate resilience in the community
Gender impact	•Inadequate water and sanitation has disproportionally large impacts on women in communities through health and time savings impacts
Climate resilience	•At present the population of KAZA Zimbabwe has limited resilience to climate shocks such as floods or droughts. Improved sanitation as well as permanent, safe water supply will have significant benefits to the local communities

Source: CRIDF, 2015

Quantitative Analysis

Economic Costs

Shadow pricing should be applied where possible to account for market distortions. A conversion factor lower than one suggests that the market price is higher than the true value of that input, a good example being the case of a labour surplus. Conversely, if the conversion factor is higher than one, then the observed price is lower than the shadow price, meaning that the opportunity cost of that good is higher than that captured by the market. Excess demand for foreign exchange in the economy would indicate a conversion factor larger than one and would indicate that the true value of tradable goods is higher than their financial prices.

In this quantitative economic appraisal, the financial capital costs were retained as the economic project costs without shadow pricing, as the composition of cost data available precluded this. In the absence of further information, it is thus best to retain financial costs as the proxy for economic costs. However, an argument can be made that adjustments would not have been significant as the conversion factors for unskilled and semi-skilled labour[6], which would be discounted in line with unemployment in the area, should annul the inflation factor applied to imported goods due to an excess demand for foreign exchange in the economy.

Economic Benefits

As shown in the diagrams on the previous page, the economic benefits included in the quantitative analysis of the infrastructure project are health benefits, time savings and food security. These are the holistic benefits that the communities accrue from the infrastructure in terms of agriculture and livestock that are not captured in the financial appraisal.

- **Health Benefits**

The sanitation status quo in KAZA Zimbabwe is poor. Most houses use unimproved pit latrines or practice open defecation. Additionally, water supplies are often shared with livestock or wildlife. According to ZimVAC data, the infant mortality rate of 57/1000 births remains above the desired MDG 2015 target of 22/1000 births, and this is due in large part to poor sanitation. Diarrhoea is a primary indicator of the many sanitation-related diseases that are a challenge in the KAZA area, particularly faecal-oral diseases such as cholera, dysentery and typhoid. KAZA Zimbabwe is particularly vulnerable to sanitation-related illness, as Masvingo and Matabeleland, both part of the KAZA area, have high (over 35%) proportions of households that access water from unimproved sources. Matabeleland North (69%) and Masvingo (52%) had the highest proportion of households practicing open defecation while Manicaland (49%) and Matabeleland South (48%) had the highest proportion of households accessing improved sanitation facilities.

Exposure to diarrhoea-causing agents is frequently related to the use of contaminated water and to unhygienic practices in the preparation of food and disposal of excreta, and the World Health Organisation (WHO) and Stockholm International Water Institute (SIWI) find that improved water supply can decrease diarrhoea morbidity by up to 25%; and hygiene interventions and drinking water quality can reduce the number of diarrhoeal cases by up to 45% and 39% respectively. Population growth in these water-stressed areas will further exacerbate the poor sanitation and hygiene situation in the absence of any water supply improvements.

The World Bank Water and Sanitation Program (WSP), in conjunction with Water and Sanitation for All, have calculated the economic costs of poor sanitation in Zimbabwe; it found that Zimbabwe loses GBP 128 million annually – or GBP 11 per person annually – due to inadequate water supply and poor sanitation. These figures comprise the following costs:

- The cost of time saved by people practicing open defecation – which falls disproportionately on women – in finding a private location to defecate. Open defecation is a significant problem in KAZA Zimbabwe;
- The cost of premature death due to illness attributed to poor water, sanitation, and hygiene (predominantly diarrhoea). As indicated above, diarrhoea is already a prevalent challenge in KAZA Zimbabwe;
- The cost of productivity losses while sick or accessing health care. This is again related to further opportunity costs of time; and
- The cost of healthcare treatment for related diseases. This burden can fall directly on households, or places a significant burden on the state in the case of public care.

The economic cost estimate of poor sanitation is used as a basis to estimate the health benefits (or avoided cost) of the project on the resident population. Some of these costs are borne by the state in terms of the fiscal cost related to healthcare treatment, and some of these costs fall on individuals either in the form of direct treatment costs and/or a loss of productive days. Table below provides a summary of the estimated health benefits of the project for selected years.

Estimated Health Benefits

Site	Population per site	Value of health costs avoided (GBP)
Mphakati 2	161	789
Mphakati 1	133	654
Bhale	166	812
Bahani A	299	1,465
Bahani B	299	1,465

Simkhulule A	258	1,262
Simkhulule B	258	1,262
Mpopoma	184	902
Kasibo	160	784
Total	**1,917**	**9,395**

Source: CRIDF, 2015

Important to note is that WSP argues that the estimate of GBP 128 million is very likely an underestimation of the true cost of the current sanitation situation, as some costs have been excluded from the analysis due to the difficulty associated with their estimation. These costs, which are also relevant in KAZA Zimbabwe, include:

- The cost of epidemic outbreaks. The economic implications of a cholera outbreak go far beyond the immediate health system response to include productivity losses, premature death, diversion of expenditure, and losses in trade and tourism. This risk in KAZA Zimbabwe is particularly acute given its significance as a transboundary tourism area;
- The cost of reduced long-term cognitive development which is a result of early childhood diarrhoea and associated under-nutrition, stunting and wasting;
- The cost of funerals, which are borne directly by households and are particularly significant in African culture;
- The cost of water pollution and the adverse impact of excreta disposal on water resources. WSP found that such figures are not available for Africa specifically; however, as there are no large rivers near the project sites, this cost is not assumed to be important in the area;
- The cost of the negative impact of inadequate sanitation on tourism. The sanitation status of a country is one of the key factors that contribute to travel and tourism competitiveness. This is particularly relevant in the case of KAZA Zimbabwe given the surrounding tourist attractions. As such the potential positive impact of the project on the tourism sector is considered in the qualitative section below.

- **Domestic Time Savings**

In addition to the time savings mentioned above as a result of avoided illness there are expected to be additional savings in terms of the time currently spent collecting domestic water from limited public access points, the river, or other water sources.

Households are an average of 4.6 people in size, with a number of these being children. If it is assumed that the average adult living in rural Zimbabwe consumes 20 litres of water per day and that a 20 litre bucket of water can be fetched per trip, as well as accounting for the fact that young children require less water per day, then it can conservatively be assumed that households make an average of 3 trips to collect water per day.

In order to calculate the time savings per household, the average distance to the current water source is compared to the proposed average distance under the new design. Thus for example, for Mphakati 2, time savings will be half of current time spent collecting water due to the fact that average walking distances are decreasing from 2 km to 1km (a decrease of half). Using the conservative agricultural minimum wage of GBP 42 per month, multiplied by the labour conversion factor of 64%, the real value (opportunity cost) of time savings was estimated. This labour conversion factor reduces the value of labour down from the minimum wage in the area due to the fact that there is a surplus of labour in the community. It is thus unrealistic to assume that the opportunity cost of fetching water is formal agricultural labour. The table below provides a summary of the estimated domestic time savings of the project for selected years.

Estimated Annual Domestic Time Savings

Project Site	Households per site	Proportion of time saved	Value of time savings (GBP)
Mphakati 2	35	50%	2,457
Mphakati 1	29	50%	2,036
Bhale	36	33%	3,370
Bahani A	65	33%	3,370
Bahani B	65	33%	3,042
Simkhulule A	56	50%	3,931
Simkhulule B	56	50%	3,931
Mpopoma	40	50%	2,808
Kasibo	40	50%	3,744
Total			**26,688**

Source: CRIDF, 2015

Local business time savings are not included as there are very few formal institutions in the area and therefore, the proposed infrastructure has been designed specifically for domestic use to the exclusion of water supply for commercial use. However, one of the boreholes in the Simkhulule area would be ideally situated close to its business centre which currently is not serviced by a water supply infrastructure. If this is the case, then there will be additional time savings for local businesses which have not been included in the estimation of time savings above. It is recommended that this quantification be undertaken, if appropriate and relevant, when the project sites are finalised. However, as will be discussed below, the project shows strong economic justification, even in the absence of the quantification of time savings that are specific to local businesses.

It is also important to note that the economic benefits that are derived from improved health and time savings are largely concentrated toward women and children, as these are the members in the community responsible for fetching water. The project will thus directly impact the lives of women and children in the project sites and thus aid in improved living standards for both women and children who reside within the project sites.

- **Food Security**

The market value of crops only captures the monetary value of the resource, however there is additional value that can be derived from the resource but will not be traded in the economy. At present, crops grown around Hwange District are mostly grown in rain-fed conditions and serve subsistence agricultural purposes. Under the proposed infrastructure, communities will receive both irrigation infrastructure and agricultural extension support.

In the financial appraisal, revenues generated from agricultural and livestock improvements were included as financial benefits to the communities insofar that it could be realistically be assumed that these products could be sold and thus generate tangible financial flows. The full economic value of this enhanced agricultural produce should instead capture the benefits which are not traded in the market, such as milk, manure and subsistence crop use. Additionally, as the project is expected to result in fewer livestock and crop losses due to wildlife damage, especially if the CHC curriculum includes a section on building fences for rain-fed agriculture. While these benefits, although they will fall on the non-market components of the crops, should also be captured in this economic value, it is impossible to quantify them given the uncertainty of the CHC programme and the difficulty associated with building fences.

- **Livestock Benefits**

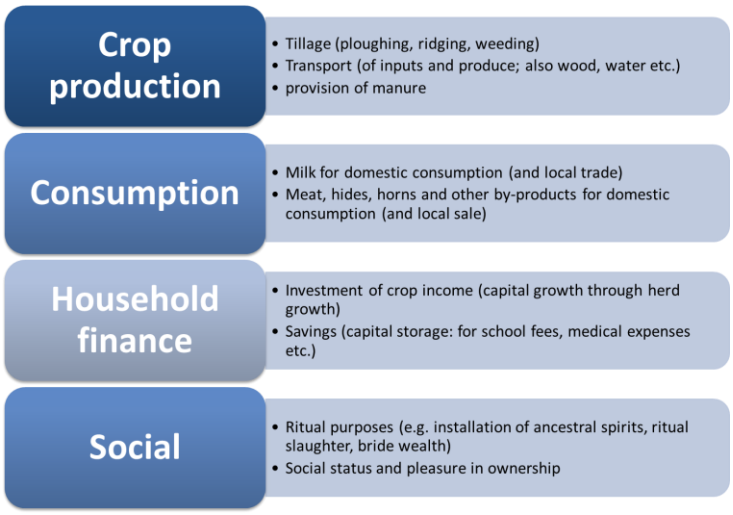
Although commercial offtake in Zimbabwe's rural communities is low, communal farmers are productive and rational in their cattle herd management. This is because farmers get a multitude of benefits from their livestock. The economic rationale for cattle ownership is firstly to provide draught power and manure for cultivation and secondly to provide milk and meat for local consumption for households who own the cattle.

Barrett (1991) argues that the contribution of communal livestock to the rural economies of Zimbabwe has not been fully recognised. This is partly because cattle production is closely interrelated with crop production. Cattle provide draught power for tillage, manure and transport as inputs to crop production, while also consuming crop residues such as stover. Additionally, cows provide food to the local community which is thus not captured by revenue flows to the community. Cows provide milk to their communities - an important protein-providing nutrient in diets which largely consist of maize. A significant proportion of slaughter takes place within the local community, providing meat and animal by-products.

Only a few cattle are actually sold in the market and often, this occurs in times of crisis or when large amounts of money are required by a homestead (e.g. for school fees, medical bills or crop inputs). In this way, cattle represent a store of value for their owners – an important benefit and source of financial security to remote rural communities with limited access to formal financial institutions such as banks. Investment of crop income in

cattle ownership leads to capital growth as the herd grows through reproduction. In principle, all of the above values can be quantified and included within the economic valuation of livestock.

Economic Benefits Associated with Cattle Production



Source: Barrett (1991). The economic role of cattle in communal farming systems in Zimbabwe. Zimbabwe Veterinary Journal

Quantifying the economic value of livestock presents substantial problems in that many of these benefits are not final outputs (as is the case with manure and draught power), while consumption of milk and meat from local slaughter also takes place largely within the household. There are no observed market prices for these inputs. In line with Barret's (1991) methodology, it is assumed in the economic appraisal that the monetary value of livestock sold in the market accounts for roughly 20% of the total value to the communities.

Thus the full value of the livestock improvements attributed to the implementation of the project is four times more than the potential market revenues of the herd. However, in order to avoid double counting, the financial values associated with an increase in the number of livestock over time, the quality of the meat of the herd and lower livestock losses due to wildlife, are removed from this estimation.

Annual Economic Benefits Derived from Improved Livestock

Project Site	Annual economic value of livestock (GBP)
Mphakati 2	9,069
Mphakati 1	7,991
Bhale	6,124
Bahani A	10,992
Bahani B	10,992

Simkhulule A	9,101
Simkhulule B	9,101
Mpopoma	7,782
Kasibo	6,810
Total	**68, 893**

Source: CRIDF, 2015

Quantitative Results

The results of the quantitative economic appraisal, as summarised in the table below, indicate that the project is economically desirable at both a 3.5% and 10% discount rate, with positive ENPVs.

The economic rate of return (ERR) for the overall project is 25%.

At a 10% social discount rate, the project has an ENPV of negative GBP 399,203 and BCR of 2.01. At a 3.5% discount rate, the ENPV amounts to positive GBP 904, 677 and the economic BCR is 2.68. These results show a very strong social justification from the project at both of the discount rates recommended by the CRIDF CBA Guidelines even before the qualitative impacts of the project are included. The project meets the requirements in that the ENPVs are strongly positive, the ERR is larger than the discount rate of 10% and importantly, the Benefit Cost Ratio is greater than one. A BCR of over 2 demonstrates that the social benefits to the project are more than double as large as the costs of the project.

Economic Appraisal Results Summary

Indicator	3.5 % discount rate	10 % discount rate
ENPV (GBP)	904,677	399,203
ERR (%)	25%	25%
EBCR	2.68	2.01

Source: CRIDF, 2015

The project has potential to accumulate economies of scale, especially in terms of the sanitation and agricultural extension training programmes. It is thus expected to have larger benefits to the whole of the Hwange district. The above analysis does not capture the non-quantifiable benefits to the project, as will be discussed below, which would make these results even stronger.

- **Sensitivity Analysis**

Two important factors in the estimation of economic benefits are that of the length of time taken to fetch water as well as the incidence of diarrhoea-related cases at the clinic. The impact of these assumptions is investigated in Table below.

Economic Sensitivity Analysis

Parameter	Change	FNPV after change GBP	FIRR after change	B/C after change	N/K [7] after change
Increase in time taken to collect water (3.5% SDR)	+10%	945,778	26%	2.8 2	4.5 5
10% SDR		423,823	26%	2.09	2.83
Decrease time taken to collect water (3.5% SDR)	-10%	906,133	25%	2.74	4.33
10% SDR		400,075	25%	2.03	2.76
Increase in health-related illness reduction (3.5% SDR)	+10%	936,236	25%	2.81	4.43
10% SDR		419,904	25%	2.08	2.82
Decrease in health-related illness reduction (3.5% SDR)	-10%	912,674	25%	2.76	4.35
10% SDR		403, 994	25%	2.04	2.77

Source: CRIDF CBA

While changing the parameters of time saved and the incidence of water-related sickness avoided due to the intervention, the BCR changes from 2.01 to 2.09 and 2.08 respectively, which are only marginal changes. A change in magnitude of 10% in either direction thus does not pose a major change in the economic outcomes of the appraisal. The outcome of the proposed intervention is thus relatively robust to changes in these two important parameters, suggesting that the project provides a positive net benefit to society.

Qualitative Project Benefits

A project of this nature, which includes welfare impacts such as time savings along with enterprise benefits such as irrigated vegetable production is associated with a wide range of fundamentally important impacts for the local communities as well as further afield, given the transboundary nature of the KAZA area. The next section aims to give a description of some of the most important of these qualitative benefits which are excluded from the quantitative appraisal due to challenges associated with their objective and robust monetisation. While these benefits are not valued in monetary terms, they provide very real and impactful enhancement to the local communities.

- **Human Wildlife Conflict**

HWC is a global problem that occurs in many countries where human and wildlife requirements overlap, as well as regions where there is the potential for direct contact between humans and wildlife. This is particularly the case in the communities in KAZA Zimbabwe, who often rely on the same water source as wildlife. Conflicts between people and wildlife are encountered by communities residing in close proximity to protected areas containing large animals such as elephant and hippopotamus. Human-wildlife conflicts are contentious because they cause crop losses, livestock losses and cause a real cost to the residents of these areas. A recent socio-economic baseline survey of the KAZA pilot area found that human-wildlife conflict is a major livelihood challenge, causing overall losses of 32% of crops, 18% of cattle and 50% of goats.

The proposed scheme aims to provide permanent water supplies to these communities, thus avoiding potential conflict over scarce water.

- **Tourism**

The process of establishing this TFCA was initiated by the Tourism Ministers of the five countries in recognition of the areas significance as a centre for tourism. Tourism is, however, directly and indirectly affected by the health of the local communities. Healthy local communities with improved sanitation and water supplies will have less impact on the natural resources that they relied on in the absence of irrigated agriculture and designated livestock water. In turn, tourism will benefit from improved environmental management. Additionally, lower seasonal movement of the local communities is expected to decrease the transmission of sickness between livestock and wildlife, thus avoiding tourism losses due to losses in wildlife. Lastly, it may be possible to

create supply chains that connect produce from local communities with eco-lodges, thus providing tourism benefits in the sense that the lodges are able to access eco-friendly and locally produced food, while communities are likely to be able to fetch higher prices for the agricultural produce and a guaranteed market. It is strongly suggested that more work to this end is done following the completion of the Feasibility Report for KAZA Zimbabwe.

- **Climate Resilience**

At present the population of KAZA Zimbabwe has limited resilience to climate shocks such as floods or droughts. The three communal shallow wells are prone to water supply variability, with the reported drying up of the one well in winter. Additionally, a significant portion of the population uses traditional pit latrines. Open defecation is practiced by some of the local community. In the case of a flood, these ablution practices are severely detrimental to the health of the population through their contamination of the water supply. The compounding pressures of growing populations and climate change, which sees a decrease in the average rainfall to the area while simultaneously more variable rainfall, suggests the urgent need for better water infrastructure.

Sustainability Analysis

The project appraisal is conducted from the perspective of the local communities as they will become the project owners, accruing project revenues that stem from improved water supply. They will also, however, be responsible for the on-going O&M costs. This is due to the fact that national structures and a lack of fiscal budgets have prevented water improvements in the area being carried out by state institutions. Instead, what is proposed is that the community form what is known as a Community Health Club (CHC), which is responsible for sanitation training in the community, along with the maintenance and operation of the infrastructure. It is thus vital that the community is able to afford to pay for these on-going costs so that the project is able to run for its full 20 year life span.

In isolation, the project is not financially viable due to its significant capital cost and would require grant funding to cover the capital investment. However, operationally, the project is sustainable as annual revenues that accrue exceed the annual operation and maintenance costs of the infrastructure over its project lifespan. The operational sustainability of the project is strengthened if grant finance is accessed for the community health club and agricultural training programmes, along with two years of O&M costs. The sustainability of the project relies strongly on revenue generating parameters such as the value of livestock and agricultural produce, along with the ability of the community to sell this produce. Sustainability also relies on the on-going cost parameters of the project, including the operation and maintenance costs of the proposed intervention.

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Conclusions and Recommendations

The KAZA area provides a valuable opportunity to demonstrate that livelihoods and wildlife can co-exist. However, challenges facing the area such as water scarcity have resulted in highly vulnerable communities and high HWC. The proposed design includes the implementation of permanent water supplies to seven vulnerable communities and is associated with financial gains in the form of resultant agriculture and livestock improvements.

Overall, the project is economically viable at both the 10% and 3.5% social discount rate. Moreover there are significant qualitative and long-term benefits from the project as a whole, which have not been fully quantified and valued. As a pilot project (or phase one of a larger intervention in the KAZA) with the specific aim of creating a demonstration effect to stakeholders in KAZA, it is concluded that there is sufficient socio-economic justification for the implementation of the project.

The 20-year financial CBA appraisal indicates that the financial returns from the project infrastructure are inadequate to cover the capital costs – that is, without any financial support the project is not financially viable. However, the project demonstrates strong operational sustainability – the additional revenue generated from the enhanced economic activity is sufficient to cover on-going annual O&M costs. Moreover it is expected that there will be adequate public support to the community to ensure sustainability. With a minimum grant of GBP 182,661 the project therefore achieves financial viability, however given the immediate financial vulnerability of the communities, it is also recommended that the first two years of O&M costs be subsidised along with the sanitation and agricultural extension training programme. These are necessary if the project is to achieve its full potential.

It is therefore recommended that a total grant of GBP 464,454 be sourced and committed in order to successfully implement the project. Of this total amount, GBP 349,632 is specifically for the capital costs of the project. In addition to this, further provision of GBP 114,823 has been made for the funding of other project start-up costs (the establishment of CHCs the AE programme) as well as O&M costs for the first year of operation.

Annex 5: GESI Rating Operations Table

DIMENSIONS	CRITERIA: THE ACTIVITY ….	CHECKLIST: DOES THE PROJECT ……	CHECK	SCORE	RATING
Analysis	Includes analysis and/or consultation on gender related issues	• Identify and analyse gender issues *relevant* to the project objectives or components?	✓		
		• Report findings of country/regional gender diagnostics (gender assessment, poverty assessment, etc.) as part of a social, economic and/or environmental impact assessment	✓		
		• Reflect the result of consultations with women/ men/ girls/ boys/ indigenous groups/marginalised groups and/or NGOs that focus on these groups and/or their specific line ministries?	✓		
			If at least one check above (yes)	**YES**	
Significance rating (relevant, evidence-based & numerical/proportional significance) (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)					**4**
Actions	Is expected to narrow gender disparities, including through specific actions to address the distinct needs of women/ girls and/or men/ boys/ and/or marginalised or vulnerable groups and/or to have positive impact(s) on gender	• Include specific or targeted actions that address the needs of women	✓		
		• Propose gender specific and/or social inclusion safeguards in a social/environmental assessment or in a resettlement framework	×		
		• Show how interventions are expected to narrow existing gender disparities	✓		

	equality and/or social inclusion				
If at least one check above (yes)				**YES**	**3**
Significance rating (relevant, evidence-based & numerical/proportional significance) (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)					
Monitoring & Evaluation	Includes mechanisms to monitor gender impact and facilitate gender disaggregated analysis	• Include specific gender and sex-disaggregated indicators in the results framework?	✓		
		• Propose an evaluation which will analyse the gender specific impacts of the project?	×		
			If at least one check above (yes)	**YES**	
Significance rating (relevant, evidence-based & numerical/proportional significance) (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)					**3**
RATINGS					
Overall Score	In how many dimensions does the project score 1?			**3/3**	
GESI-informed	Does the document score in at least one dimension			**Y**	
GESI significance	In how many dimensions does the project demonstrate a contribution to GESI results				**3/3**

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