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Government of Kenya

Ministry of Environment, Water and Natural Resources
State Department of Water

Kenya Water Security and Climate Resilience Project
(KWSCRP)

Improvement of Flood Water Structures along the Lower Reaches of River Nzoia – Budalangi, Kenya

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

DRAFT

Notice

This report was produced by Environmental Safeguards Consultants Ltd for *Ministry of Environment, Water and Natural Resources, State Department of Water, Government of Kenya* for the specific purpose of Assessing the Environmental and Social Impacts, and seek National Environmental Management Approval for the Proposed Improvement of Flood Water Structures along Lower Reaches of River Nzoia-Budalangi, Kenya.

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Client signoff

Client	Government of Kenya, Ministry of Environment, Water and Natural Resources
Project	Improvement of Flood Water Structures Along the Lower Reaches of River Nzoia
Document title	Environmental and Social Impact Assessment Final Report
Document reference	Final-ESIA Project Report-Nzoia Levee

Declarations

I, **Liya Mango**, submit this Environmental and Social Impact Assessment (ESIA) Project Report, for the **Improvement of Flood Water Structures along the Lower Reaches of River Nzoia-Budalangi, Busia County**. The EIA has been carried out in accordance with the Environmental Management and Coordination Act, 1999 and the Environmental (Impact Assessment and Audit) Regulations, 2003.

Signed at **NAIROBI** *on this* *day of* *2013*

Signature:

Designation: ***EIA/AUDIT LEAD EXPERT REG. NO. xxx***

I, **S.G. Mwangi,** on behalf of **Minsitry of Environment, Water and Natural Resources/State Department of Water,** submit this ESIA Project Report for the **Improvement of Flood Water Structures along the Lower Reaches of River Nzoia-Budalangi, Busia County.**

Signed at **NAIROBI** *on this* *day of* *2015*

Signature:

Designation: **Project Manager, KWSCRP**

1 EXECUTIVE SUMMARY

The Government of Kenya (GoK) has planned a large-scale water investment program to address the challenges in water sector and to close the massive infrastructure gap that has been estimated at US$ 5 – 7 billion in various existing and ongoing studies. The Water Sector Strategic Plan (2010) and the draft Water Harvesting and Storage Management Policy (2010) focus on reducing the water infrastructure gap through single and multipurpose storage. This approach is in line with a recent World Bank report that found substantial opportunities for multi-purpose storage to secure reliable water supply, manage floods, provide irrigation, and generate hydropower.[1] Further, a Climate Change Response Strategy was developed in 2010 that identified soil and water conservation, construction of dams, and expanded irrigation as key actions to increase climate resilience.

The National Policy for Disaster Management and the National Disaster ResponsePlan (both issued in 2009) highlight the need for mainstreaming disaster risk reduction and establish additional roles and responsibilities for mitigating residual risks in the water sector. To address some of challenges and to fill some of the gaps, the Government of Kenya is implementing the Kenya Water Security and Climate Resilience Program (KWSCRP), to be implemented in phases. This program is focused on achieving water security and resilience to climate variability and change.

Kenya Water Security and Climate Resilience Program

Transforming Kenya's water sector to achieve water security and climate resilience for economic growth and development requires a dedicated, long-term commitment, but also a practical approach that addresses the needs in a realistic manner and at several stages where critical limitations have been identified. Further, the enormous challenges related to reversing the massive water sector investment gap and transitioning through a potentially complex reform process require a comprehensive, multi-pronged approach that addresses key infrastructure, institutional and information/analytical limitations in order to support Kenya's growth and development agenda.

The design of the program reflects these needs by financing critical investments and supporting the progressive enhancement of the water investment program, while at the same time building an enabling legal and institutional foundation for the water sector.

Currently, WSCRP has two projects, the Kenya Water Security and Climate Resilience Project (WSCRP-1) (P117635) and the Coastal Region Water Security and Climate Resilience Project (WSCRP-2) (P145559). Additional Financing is being considered for WSCRP-1 (P151660).

[1]World Bank, 2012, Towards a Strategic Analysis of Water Resources Investments in Kenya

The objective of the program is to support the institutionalization of processes and water-related investments to strengthen climate-resilient water resources development and management in Kenya. To this end, the KWSCRP I will support the higher level objectives of inclusive green growth as a pathway to sustainable development. In particular, the KWSCRP I and II will foster growth that is efficient in its use of natural resources, clean in that it minimizes environmental impacts, and resilient in that it reduces social vulnerabilities and accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters.

The Environmental and Social Management Framework (ESMF) for the KWSCRP remains the key instrument to ensure initial project safeguards at this stage principally because the exact locations, scope, designs and nature of sub project investments remains unknown. The ESMF is aimed at ensuring that implementing institutions in this project use it in order to ensure that the Bank's environmental safeguard policies as outlined in Operational Policy OP 4.01 (Environmental Assessment) are adequately complied with.

There are 3 other safeguards instruments that compliment the ESMF for the KWSCRP: Resettlement Policy Framework (RPF) provides standards and procedures for compensation for any land acquisition, assets, or restriction of access to resources that this project and associated investment may require, in accordance with World Bank OP 4.12 – Involuntary Resettlement. The other safeguards instruments are the Vulnerable and Marginalised Groups Framework (VMGF) in accordance with World Bank OP 4.10 and the Integrated Pest Management Framework (IPMF).

Western Kenya Flood Mitigation Project/Dykes

The design of the Improvement of Flood Water Structures along the Lower Reaches of River Nzoia, as well as the first draft of this ESIA, were prepared under the Western Kenya Community Driven Development and Flood Mitigation Project (WKCDD FMP) became effective on August 7, 2007. The project has three Components: (i) Community Driven Development (US$37.1million); Flood Mitigation Component (US$32.9million) and; Implementation Support (US$15.7million).

Flood Management Program (FMP)

The Flood Mitigation Component envisages developing Flood Management structures within the Nzoia River Basin. The lower flood plain areas within Nzoia Basin, experiences flooding and destruction each year due to degraded upper catchment, high levels of sedimentation leading to reduced river carrying capacity, land use and lack of control structures to manage the damaging effects of the Nzoia River waters.

This sub component was designed to support flood plain management in Budalang'i in Western Kenya through rehabilitation and strengthening of the existing dykes. Studies were initiated with the objective of assessing the integrity of the existing dykes and these are now completed and rough cost elements determined, at US$54 million. This component has the highest potential to enhancing achievement of the objective of reduction of vulnerability of communities caused by floods.

The FMP works will be located at the Lower reaches of Nzoia River downstream of Rwambwa Bridge (about 24km South West of Bumala). From Rwambwa Bridge to the mouth of the river is approximately 17.5km, but the river meanders and distance along the channel is approximately 40km. The study area lies in Bunyala Sub-county of Busia County. The sub-county covers an area of 306.5km2, out of which 120km2 is under permanent water surface of Lake Victoria. The proposed construction works will take place within the flood plain in the Lower Nzoia River at Budalang'i, Bunyala sub-county. The works will entail improvement and realignment of the existing flood protection structures, which comprises of two dykes - southern and northern – each approximately 17km along the Flood Plain as the river discharges to Lake Victoria. The existing dykes were constructed in 1980s.

Further review and optimization of the FMP designs are to be undertaken before the works are implemented, through proposed additional financing for the KWSCRP-1. In addition, the KWSCPR-1 plans to harmonize the designs for FMP project with the Lower Nzoia Irrigation Project (LNIP), for which financing has been awarded. The LNIP and FMP works will need to have integrated drainage structures, construction plans, and overall coordination, and any cumulative impacts identified. This ESIA and the ESIA for the LNIP will be updated, in accordance with the ESMF for the overall KWSCRP,to include any needed design changes and finalized once the integration of the designs for the projects is complete.

Project Benefits and Rationale

The proposed Project is positive in the overall, being in line with the locals' aspirations and national objectives for enhancement of social and economic development. The existing dykes along the downstream (of Rwambwa Bridge) River Nzoia are now beyond their design lifespan. Despite on-going efforts to effect repairs on the dykes, they have increasingly been breached with increasing frequency of flood incidences. This has led to increased socioeconomic losses in the project area and exposes it not only to losses of life and livelihoods but also the government in terms of emergency response expenditure.

Despite the fact that the proposed combination of interventions was the best in meeting the project objectives, the construction, operation and decommissioning phases are likely to have certain adverse impacts on the local community and the immediate surrounding environment given the nature of the project environment. The major activity in the project will be earthworks. Each of the anticipated impacts has been assessed and where feasible, appropriate mitigation measures proposed and the following can be concluded:

During design and planning phase the significant impacts identified were positive and included job creation and an opportunity for the community/stakeholders' engagement and inputs in formulation of flood management interventions.

The project area's natural environment is a mix of natural aquatic, riparian and wetland habitats. Review of documented flora and fauna species did not reveal any species of special conservation concerns. Even though it has no gazetted wetland, consultations revealed that plans are underway by both NEMA and Nile Basin Initiative to have the

wetland areas gazetted thereby calling for more precaution while undertaking any activities. It is however, notable that interventions which would have posed greatest negative construction environmental impacts on the habitats were eliminated during the optimal appraisal stage.

Numerous positive impacts other than the key project objective put forward by the proponent are anticipated during operation. Some of these include: facilitation of reliable agriculture; attraction of more development investment into the floodplain; ensuring educational calendars are not interrupted by floods; promotion of transport linkages between communities to the south and to the north of the Nzoia River; and other numerous benefits were identified by the beneficiary community.

Project Design and Benefits

The project earthworks during construction will require an estimated fill material of 586,000 cubic metres for the northern dyke and 637,000 cubic metres for the southern dyke. Construction of the broader and higher dykes will also necessitate additional strip of land adjoining the existing dykes. Even though the design has been optimised to minimize the associated impact, some properties located and even families whose structures are built right at the foot of the existing dykes will have to be relocated. The community members were informed through stakeholders workshop and there was consensus that some few individuals will be affected by the project meant to benefit the entire community. Profiling and valuation of affected properties including land has been undertaken to ensure adequate and prompt compensation of affected persons. The proponent is also undertaking a comprehensive Resettlement Action Plan (RAP) to identify and enumerate individual households/PAPs, and inventory affected assets to facilitate compensation. The RAP will among others establish a cut-off date and develop a grievances settlement mechanism, which will assist in minimising potential project implementation setbacks.

Environmental and Social Impact Assessment Study Objectives

The objective of this study was are to analyze the socio-economic and environmental impacts of the proposed project on project affected areas during pre and post construction, assessing the Government's capacity to implement the proposed mitigation measures, and make appropriate recommendations, including potential capacity building and training needs and their costs, identification of projects potential environmental and social impacts resulting from the projects and proposing mitigation measures, developing a work program, budget estimates, schedules, staffing and other necessary support services to implement the mitigation measures, preparation of emergency response measures to accidents as appropriate e.g.: entry of raw sewage to river systems, flood damages and designing Environmental and Social Management Plan (ESMP).

A scoping study was undertaken at the beginning of the study. This process involved consultation with the client, and all the relevant key stakeholders who were identified through stakeholder identification process. After the scoping process, a detailed literature review on the existing baseline information and research undertaken in the projects area was collected. The review of available data sources helped in describing the

environmental and social set up of the area. After the literature review, a field survey was undertaken.

Potential Beneficial Impacts

Flood Control

The spread of water into the farms will control floods downstream by distributing excess water during heavy rains. Flood control effects of the project will free more land for farming as well as prevent destruction of food crops for those farmers who cultivate floodplains during the dry season. This indirect impact will help achieve food security especially for rain depended crops. This is an immediate impact that will be realized during wet season when floods occur.

Job Creation

The proposed flood management activities are expected to create temporary direct and indirect employment opportunities during construction. The construction activities will require the direct employment of local and international staff, both professional and casual. These include engineers, surveyors, project managers, safety advisors, equipment operators and their assistants among others. Indirect employment opportunities shall also be created off-site where construction materials are sourced, or in procurement of non-core services by the professional staff. The use of local labor is expected to positively impact on the local economy with additional potential of skills transfer.

Creation of Market for Construction Materials and Associated Goods

The Project will require supply of building materials (e.g. fill/borrow materials, cement, steel, fuel etc.), construction equipment and workers' food supplies. Most of these will be sourced locally in Kenya, Busia County and its surrounding areas. This will provide a ready market for building suppliers such as quarrying companies, hardware shops and individuals with such materials.

Increased Revenue for Suppliers and the Exchequer

Closely related to the above, the purchase of construction materials from suppliers and purchase of consumables shall all result in increased revenue for suppliers and other vendors, and tax remitted to the exchequer.

Improvement of Infrastructure

This project will include improvement of existing infrastructure in the project area. It will entail grading of existing roads with murram of up to 200mm. As a result of this improvement communication and transportation especially of farm products will be improved enhancing incomes and productivity. The project area currently has a road network that is usually impaired by weather conditions. There is an all-weather road (tarmac) from the Busia Road junction at Bumala, which ends about 15km from the project area. Transportation of products both agricultural and fisheries are usually hampered by poor conditions of roads particularly during the rainy seasons and when flooding of the River Nzoia occurs. Improvement of the road network will ensure that products from both sectors are easily accessible to markets. It will also reduce

inconveniencies to population movements to public utilities such as schools, government offices and hospitals.

Increased crop and livestock farming activities

Enhanced defence against floods is anticipated to reduce flood- associated crop and livestock losses. This will in turn encourage more investment by farmers as they will be assured of safety of their investments. Increased floodplain area will likely be brought under cultivation as well as increased stocking of livestock to realise more agricultural production in the area. Improved drainage of the northern floodplain will also provide the opportunity for improved agriculture in this area.

Increased fish stock in the lake

Fish stocks in the lakeshore downstream is likely to increase as more nutrient rich water together with migratory/riverine fish usually carried by flood waters into the floodplains will be directed to the lake. This will benefit fishermen who fish from the beaches in the area.

Enhanced potential of fish farming

Protection of the flood plains is also likely to make it safer for fish farming promotion whose potential in the area has not been fully realised due to risks from unpredictable floods. With fishponds, the agricultural and fishing community will not only realize more stable livelihoods but also produce affordable protein for their nutritional benefits.

Improved Public Health and Sanitation

One of the major impacts of flooding identified by community participants during consultations is that it is associated with outbreaks of water borne diseases. Floods contaminate wells and boreholes- the common domestic water sources in the community- and destroy pit latrines exposing the community to unhygienic conditions. Such incidences will be significantly reduced with the reliable flood defense structures.

Reliable Linkage between the South and North Communities

With the rehabilitated embankment to Sigiri boat crossing, it will have increased capacity to easily facilitate passage of floodwaters in between the dykes. This will in turn assure communities both to the south and to the north of the river a reliable shorter transport linkage with potential multiplier effects of increased trade, especially with Port Victoria center, and social interactions.

Protection of Families from Property Losses and Unplanned Expenditure

From the social survey of the area, majority of respondents indicated loss of properties, food and destruction of homes as a major problem during flooding. This will be reduced with the containment of larger floods by the higher and stronger dykes. Families will therefore not have to spend much of their low income to replace expensive household assets and other properties lost to floods.

Better Growth of Women and Children

Children and women are usually the most socially affected by flooding incidences. Some of the social setbacks to children in Budalangi that will be significantly be mitigated once the new structure are in place include: inability to attend school regularly, early marriage of the girl child, drowning to death in floods, malnutrition, child labour, moral decay in camps, flood caused trauma, confinement to camps and lack of play grounds.

Women will benefit from reduced incidences of household food insecurity, destruction of houses, cooking energy insecurity and both emotional and physical exhaustion from reconstruction works necessitated by floods.

Attraction of Further Developments

Increased protection from flooding is likely to attract more investors, who would otherwise be hesitant to invest in the area due to high flood risks. This will give rise to increased general socio economic development in the floodplain areas. It is noted that although the improved dykes will protect against larger floods, the possibility of flooding that causes damage behind the dykes still exists. It is recommended, therefore, that development in the floodplain should be controlled to minimize the impact of possible future events.

Reduction in Flood induced Pollution

Commissioning of the proposed new dykes will go a long way in arresting some of the existing environmental problems associated with floods in the project area. These include air (foul smells from stagnant/ponded waters) and water pollution, destruction of crops and other vegetation cover, water logging among others.

Reduced Flood Erosion

Higher stronger dykes are anticipated to protect many floodplain farms from flood induced soil erosion. Soil erosion is both an agricultural and environmental challenge to most farmers in the area. It negatively affects productivity of the farms by washing away the nutrient rich topsoil.

Stable and Sustainable Livelihoods

With increased protection from flooding there is likelihood of increased development in the natural floodplain behind the dykes. The developments like subsistence farming – the main livelihood accounting for 72.2% of the community farmers- will be less affected by flooding (although a reduced possibility will still exist) thus improving stability of the various livelihood of the area's community.

Potential Adverse Impacts

While the project objectives will be achieved, there are potential adverse impacts that will emanate from the project activities. It should be noted that all these impacts can be effectively be mitigated through a design, management, policy, capacity building and proper planning. The study proposes measures for mitigating the identified adverse impacts while promoting the benefits. The potential adverse impacts and mitigation measures include:

Soil Erosion

During the preparation of the land for the infrastructure, clearance of vegetation from the area will expose the soils to agents of erosion mostly water. This impact will occur during project construction and operational phase. The magnitude of this impact will include reduction in soil productivity and siltation of shores of Lake Victoria downstream. This impact will be long term and will manifest after a long period. Soil erosion could occur during the construction phase when lose soil is swept by waters and during the operational phase during irrigation and field preparation.

Mitigation

Soil erosion can be avoided during the construction and operational phase of the projects. To avoid soil erosion a number of measures are proposed. These are;

- Avoiding vegetation clearance that will expose soil to agents of erosion during construction phase.
- Revegetating the cleared sites with local species of vegetation
- Only clear areas earmarked for construction and
- Mitigation of soil erosion during cultivation will be through terracing of the critical areas of the land and plating of napier grass along the canals.

Surface and Ground Water Pollution

Construction works will involve employment of certain hazardous and harmful materials. These will include but not limited to fuels, solvents and cement. Accidental entry of these substances into the river or the ground would result in deterioration of ground and river water qualities, with potential detrimental impacts on both terrestrial and aquatic flora and fauna. Any accidental spillage into the river, in extreme case, might also end up being washed into the lake. It is also notable that the area community uses underground and river water for domestic purposes, which can be of concern.

Mitigation:

- Ensuring any potential hazardous materials to be used during construction is held in bunded areas and stored under cover;
- Amounts of these substances held on site at a particular time will be limited as far as feasible;
- Spill response kits will be maintained on site; and
- All efforts will be made to prevent spillage of the substances through contractor's' documented spill prevention procedure and response plan. These will include creating awareness among the concerned construction staff and posting appropriate labels and notices.

Exposure to Flood Risks

Floods in the project area result from episodes of heavy rainfall in the upstream regions of the Nzoia catchment. During construction activities, the area may be exposed to flooding when it rains upstream and the construction team is unaware especially when sections of the existing dykes are being re-aligned. This could result in localized flooding with negative consequences depending on its magnitude with sections being worked on acting like river outlet points.

Mitigation:

- Realignment works will be planned such that the new alignment is constructed before the old one can be removed for safety against flood; and
- Construction team will liaise, throughout the construction period, with the flood monitoring and early warning teams both at community and national levels.

Topsoil Stock Piles

During the construction phase, excavation earth from the weir in addition canals and drainages will create a pile up of soil. These activities may result in the increased erosion in areas where vegetation has been stripped and stockpiled. This could lead to increased suspended solids being deposited into the streams, Nzoia River and Lake Victoria at the mouth of the river.

Mitigation

Stockpiles should be adequately secured through installation of soil traps until they can be moved elsewhere for reuse. Where possible, such soil stockpiles should be used to rehabilitate stripped and excavated zones so as to reduce incidences of stagnant water and pools which would be a safety risk for people as well as breeding grounds for mosquito.

Siltation of Water Bodies

The source of water for this project is the River Nzoia. It feeds into the Lake Victoria and in extension the Nile Basin hydrology. Already, siltation is of major concern among all major rivers feeding into the Lake Victoria. The main source of such siltation has been catchment activities that have resulted in poor soil management, deforestation and apparent soil loss. So far, siltation is one of the major factors blamed for bank bursting and flooding along River Nzoia. Irrigation on the lower Nzoia will contribute to siltation of the river mouth into Lake Victoria increasing the problem of flooding.

Mitigation

To prevent siltation of the River Nzoia, a catchment rehabilitation process should be up scaled to protect the soil from water runoff. This measure should be supported by creating buffer zones downstream of the area to trap the silt. Wider consultations and engagements should be sought by NIB to improve catchment management in the entire basin.

Disruption of Irrigation Infrastructure

The proposed dyke strengthening (raising with broader base) will necessitate realignment of a section of an existing irrigation canal in Bukhoba village. The canal developed and maintained by National Irrigation Board (NIB) runs parallel to river and is very close to the existing northern dyke at this location. The works will also disrupt the yet to be completed installation of irrigation pump and associated piping on the southern dyke near Busagwa village. This will disrupt the irrigation of farms fed by the canal.

Mitigation:

- Liaison with NIB to harmonize the new dyke design and construction with the affected section of the canal and ongoing works; and

- If needed, inclusion in the Resettlement Action Plan for the provision for potential loss of livelihoods from this dissruption, in line with the ESMF and the RPF for the KWSCRP program.
- Timely disclosure of any planned disruption of the canal operations to the affected farmers downstream the affected area.

Loss of floodplains natural fertility

Raised and stronger dykes will mean a reduced incidence of overtopping. Overtopping has been a source of fertile silt deposition into the floodplain farmlands and this will reduce natural fertility of the floodplains. Consequently, farmers would potentially have to use more fertilizer applications to sustain their yields thus creating cumulative negative impacts.

Reduction in sand harvesting

Floods usually deposit sand in the lower reaches of the River Nzoia after having been carried by waters flowing from the upper catchment areas. Following dyke failure this facilitates easy sand mining activities on the floodplain, which will be reduced by prevention of dyke failure. In turn, this will reduce the incomes associated with sand harvesting at these times. However, very few members of the community conduct such activities and the overall benefits cannot be compared to those the community stands to benefit following protection from floods.

Demand for borrow materials

The new structures will require periodic maintenance, which will create demand for more borrow materials. However, this is expected to be of relatively small quantities.

Visual impact

Once commissioned, the dykes will be broader and higher than existing structures creating a slightly different image in the immediate surroundings. Depending on the individuals' perception, some visual impacts will be generated. However, given the area already has dykes and the existence of vegetation cover of varying heights (from shrubs to trees will hide the dykes), this impacts may only be localised to the immediate villages.

Construction Impacts

Dust, noise and oxides will be generated and emitted during excavation/earthworks and aggregate handling including transportation to and around the site, and carting away of wastes from site. This is likely to affect site workers and any nearby homesteads. Construction vehicles and machinery are also likely to emit oxides of carbon, nitrogen, and sulphur, further compromising the local air quality. During dry weather, fugitive dust generation is likely to be very high. In extreme situations, these can lead to respiratory health problems.

Mitigation:

- Given the nature and scale of the anticipated works, exhaust emissions of oxides of carbon, nitrogen, and sulphur will be minimal and only localised. However, the

proponent shall commit the Contractor to implementing measures that shall reduce air quality impacts associated with exhaust emissions during construction.

Fisheries Impacts

The project's structures are not going to pose any significant adverse impacts to fisheries in Nzoia River with impacts expected during the construction phase having low and temporal impact significance. During the construction, acquatic resources maybe affected by civil works including noise and machinery that is likely to disturb and chase away acquatic resources during this period. Construction material could also block the river during construction if they end up into the river as well as accidental spills of oil and other construction lubricants, which could contaminate the water and impact on the acquatic resources. Literature show that the fish species in River Nzoia include Tilapia and *Rastrinesbola argentea* popularly called Omena. Other types include *Protopterus aethiopicus* (mudfish) and *Clarias spp*. (catfish) and three Oreochromis niloticus (O. *variabilis, O. esculentus, and O. niloticus*,) and the *Haplochromis spp.* ("Fulu"). These are not categorised as threatened fish species having any global significance but are however a source of food and economic growth to the local communities.

The proposed project site has no known breeding/spawning points for the fish species identified above which could be affected by construction activities. Known fish breeding sites are found in the wetlands downstream of the project site including Lake Kanyaboli and Yala Swamp. Lake Kanyaboli, a satellite lake of Lake Victoria, part of Yala swamp forms the mouth of Rivers Nzoia and Yala, also one of the most important riparian lakes around Lake Victoria.

There are no significant impacts expected on the hydrology of the river as a result of the project. This is because, there exixts dykes in the project area built to control perennial floods and these structures run or are aligned parallel (on either sides of the river bank) to the River Nzoia and in effect they do not block flow of water and fisheries which flow downwards/downstream into the Lake Victoria. Therefore, the rehabilitation and strengthening of these structures will not impede migration and movement of fisheries and other acquatic resources or affect significantly the hydrology of the river.

The project is not going to lead to the loss of habitat along or within the project arrears and in the riverine ecosystem this is because the objective is to strengthen already existing structures, which are weak requiring rehabilitation, and activities will be along the banks of the river.

Mitigation:

Ecological flow recommendations

Flow events deemed ecologically important, following consideration of the identified ecological values of resident fish species in the river and current scientific knowledge of the water requirements of these values include the following:

Fish passage flows

Based on previous fish surveys in River Nzoia conducted by Kenya Marine and Fisheries Research Institute (KEMFRI), fish passage flows are required with a minimum threshold depth of 10 cm over perceived obstacles for the cross-section to allow movement of the small bodied species such as *Rastrinesbola argentea and Haplochromis spp*. Large bodied Tilapia, *Protopterus aethiopicus* (mudfish) and *Clarias spp*. (catfish) and three Oreochromis niloticus (O. *variabilis, O. esculentus, and O. niloticus*,) would require a minimum threshold depth of 20 cm. Hydraulic analysis and observance of environmental flows would have to be performed to determine discharge that achieve the above threshold, calculated as a minimum threshold depth for the reach.

Disturbance of Wildlife and Possible Illegal Hunting

Fauna within the project area, especially those habiting the river and the riparian vegetation sandwiched between the southern and the northern dykes will be impacted. The impact will be due to dyke construction related noise, vibrations and in minor cases, vegetation removal. Site workers may also be enticed to hunt wildlife encountered in the course of their work or in some cases kill the animals. The majority of the activities requiring clearance will be limited to the already existing dykes and a limited amount of vegetation clearance close to and in between the dykes.

Mitigation:

- Vegetation clearing should be limited as far as possible;
- Contractor's personnel should be warned against illegal hunting and made aware of the need to protect any wildlife encountered; and
- Use of machinery will be limited to demarcated construction site and hours to minimize related noise and vibrations.

Introduction/spread of Invasive Species

Use of substantial quantities of borrow materials is envisaged. Depending on the sources, these materials can possibly introduce seeds of plants not originally from the area and with time, establish to the extent of thwarting the growth of area's natural riparian and even wetland vegetation. However, most of the materials are anticipated to be sourced from the project area's neighborhood and introduction of such species is unlikely.

Mitigation:

Formulate and implement a weed eradication program during and after construction activities.

Increased Demand for Energy and Water Resources

Construction activities will create additional demand for energy and water resources to meet construction machinery and workforce water requirements. Construction will especially see increased demand of fossil fuel supply and the workforce will increase demand for domestic energy requirements at contractor's camp. These may have some negative impacts on the availability and supply of the resources in the project area if no proper management interventions are put in place. Alternatively, local suppliers can benefit through enhanced capacities to meet demand, especially of diesel and petrol.

Mitigation:

- Ensure that water is used efficiently at the site by sensitising construction staff to avoid irresponsible water use;
- Water consumption shall be metered where feasible and records maintained for monitoring purposes;
- Proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts unnecessarily; and
- Monitor energy use during construction and set targets for reduction of energy use.

Construction Health and Safety Risks

Both occupational and general public Safety hazards are likely to be created by the proposed construction activities resulting in possible accidents involving construction workers and or the general public. The construction works will expose workers to occupational health and safety risks and injuries resulting from accidental falls while working at heights/raised grounds/in excavated areas, accidents involving equipment and machinery employed, chemical spills/contact, falling objects or injuries from use of hand tools and other construction equipment. The general public, mainly community members, will also be exposed to similar risks apart from those associated with handling equipment. This impact can in worse scenario result in disabilities or even death.

Mitigation:

- Proponent shall commit the contractor to Site Occupational Health and Safety requirements as stipulated in the Occupational Safety and Health Act, 2007; and
- The Contractor shall provide all workers on site with the necessary and appropriate Personal Protective Equipment (PPE). This will be incorporated as part of the contractual agreement between the contractor and the proponent.
- In addition, to facilitate the welfare of workers, the proponent through the contractor shall ensure the following on site and at the camp:
- All site personnel to be provided with an adequate supply of safe drinking water, which should be at accessible points at all times;
- Provision of conveniently accessible, clean, orderly, adequate and suitable washing facilities within the site; and
- Suitable, efficient, clean, well-maintained and adequate sanitary conveniences (preferable mobile) shall be provided for construction workers.

Construction Waste Generation

Site preparation, contractor's camp and construction will generated various kinds of waste. These will likely include earth debris, top soil, papers used for packing cement, plastics, reject materials and domestic wastes among others. Harmful/hazardous wastes like used oil grease and associated parts will also be generated from construction machinery. Improper waste management at the site may interfere with the aesthetic status of the surrounding and lead to creation of health and safety hazards. Improper disposal of the wastes off-site could also cause nuisance, health and safety hazards, create breeding grounds for vermin and river pollution.

Mitigation:

- The Contractor shall on behalf of the Proponent meet the requirements of the Waste Management Regulations. Wastes will be disposed at licensed facilities only by use of licensed waste handlers if necessary;
- Develop and implement project waste management plan covering the project site and contractor's camp;
- The contractor will be bound not to dispose any wastes into the river or riparian land;
- Where necessary, all machinery servicing shall be done off site and for regular maintenance waste, appropriate receptors held in the camp;
- Construction waste shall be recycled or reused as much as possible to ensure that materials that would otherwise be disposed off as waste are diverted for productive uses. In this regard, the Proponent will ensure that construction materials left over at the end of construction are used in other projects rather than their disposal; and
- Careful budgeting of construction materials requirements to ensure that the amount of construction materials left on site after construction is kept minimal.

Pressure on Social Structures

Construction activities will require a well established workforce. The labor required may not necessarily be available from among the local communities and some workers will be sourced from outside the project area. Additionally, some people are likely to move to the area in search of job opportunities. The migrant workers could have an impact on the local social structure for the duration of the construction works. Threats of HIV/AIDS and other Sexually Transmitted Diseases (STDs) may also arise with such influx.

Mitigation:

- Community and workers sensitization through HIV/AIDS campaigns to remind the people about the scourge; and
- Ensure as many casual workers as feasible are source from the project area to reduce influx of workers into the area.

Population In-Migration

Due to minimal economic activities other than subsistence agriculture and livestock keeping, many people have moved from rural settings to urban centres in search of employment. With increased socioeconomic activities and increase income from existence of project there is set to be increase in population of people within the catchments. The operationalization of the project will attract people to those areas in search for employment and settlement. The effect of this impact will be felt in the health sector through increased rates of HIV/AIDs infection and other diseases that are spread through demographic changes and in environmental sector in terms of degradation. This impact will put pressure on social facilities including heath care, water, energy, sanitation and land. The construction activities of sub project investments may require recruitment of "foreign" skilled and unskilled labour that could trigger conflict, resentment and tension by the local communities over perceived inequities in distribution of job opportunities by the local communities.

Mitigation:

There are no measures for preventing population influx into the project areas. However the government in these respective areas should control settlement in fragile areas including wetlands and steep hills through existing legislations such as the Water Act. During construction phase of the project, the contractors should have employment policy, which gives preference to the local people. By employing the locals, this would discourage population influx to the area.

During final project layout designs, the engineers should ensure that canals and feeder canals are well positioned to limit unnecessary exposure to the public. Where possible especially along footpaths and roads, buffers of natural bush should be erected so as to provide clear markings of where the canals are and therefore prevent accidents. Similarly, public awareness campaigns should be engendered into the project to ensure that the public is aware of risks the canal pose and will therefore take precautionary measures when travelling or working near them.

Resettlement/Displacement

Displacement is defined here as referring to physical, economic or cultural displacement (or deprivation). Acquisition of land for infrastructure, drainage and roads to the project sites will lead to displacement of the services that are provided by the area i.e. housing, grazing, growing fodder, source of domestic water and brick making.

Efforts have been made in the project design as far as feasible to minimize requirements for resettlement. This issue is planned to be further examined through the further optimization of project designs, under the KWSCRP-1 Additional Financing, before the project is implemented. However, the proposed project activities will lead to displacement of a number of families who have encroached onto the existing dykes and have houses built either right at the foot of or in close proximity to the dykes. Relocation is thus necessary to accommodate dykes' rehabilitation to achieve desired strength. The affected households will be assisted through a compensation package, to either be relocated to different locations/parcels of land or will only require relocating affected structures within the same land parcels. Villages in which some families may be affected

include: Galalani, Burangasi, Makhoma, and Rugunga along the southern dyke; and Sibanze, and Nerera along the northern dyke. Preliminary estimates have identified forty three (43) homesteads[2] that will be affected by the proposed project works.

Through consultations on the pre-feasibility, feasibility and design of the FMP works, some community members have noted that they were not compensated for the taking of land and or materials for the construction or repair of the existing dykes. The RAP under preparation will further examine this issue, and will outline grievance redress mechanisms if needed.

Mitigation

The mitigation measures of this impact will be addressed in the Resettlement Action Plan (RAP) for compensating those who are displaced from the areas earmarked for development and construction of water infrastructure. The RAP will take into consideration the investment undertaken in the sites and alternative areas be identified for these people. Alternatively, the people who traditionally farmed the project area should be integrated into the project beneficiaries associations.

Loss of Ancestral and Farm Lands

Stronger and higher dykes will require additional land strip on the landside of the existing dykes. Both resettlement of homesteads and uptake of unsettled land for wider and higher dykes will mean that the affected families and land owners lose some portions of their ancestral land, some of which are their farms (used for either grazing or cultivation). The community in the area have a strong attachment to ancestral land hence this will negatively impact on the affected individuals.

Loss of Access to Fisheries

Fishing is important economic activity in Budalangi and is undertaken by men in Lake Victoria but sometimes women and children participate in fishing along the banks of River Nzoia and in receding floodwaters. Fishing is mainly for subsistence and economic gains with women being mostly responsible for trading the fish products. Dyke improvements could also see some affected individuals lose easy access to fishing grounds specifically those fishing along the banks and in receeding floodwater. With the dykes strengthened, the spill over that occurs when the dykes are destroyed hence providing fishing grounds will be no more. However, those fishing in the river will only be affected during the construction phase of the project since civil works may disturb fish resources and send them further downstream. This situation is expected to be temporal and only felt during the construction phase. The on going social assessment and RAP will quantify this impact further.

Disruption of Transport Linkages

Raising and strengthening works to the existing dykes will disrupt the currently short linkages along existing dyke crests and between the villages to the south and the north of river Nzoia as the dyke crests may remain inaccessible on a temmprary basis till

[2] A homestead usually consists of several houses/structures and households of the same lineage.

construction works are completed. Replacement of culverts at Sigiri crossing (Chainage 12.0km) will also disrupt the communication between villages to the south and the north of river Nzoia during construction, but will improve this in the longer term. The Sigiri crossing provides an important access to and from the major trading centre of Port Victoria. The disruption will be temporary, being limited to the new culverts installation, and an alternative exists down the river in the Narera area.

Mitigation

Informing the community of in-accessibility in advance before works at the Sigiri crossing begins. This should include erecting public notices at key crossings approach points from both the north and south of the river; and planning construction activities such that resultant disruptions are as minimal as possible.

Noise and Vibration Impacts

Construction activities could result in significant noise impacts so as to impact on general well-being, health and functioning. Large scale infrastructure developments involve the use of heavy equipment (graders, drilling equipment, trucks, blasting equipment, tractors, and excavators) for among others rock blasting, excavation, asphalt mixing plant operations and vehicular movement that emit incessant noise usually harmful to the environment. Introduction of new sources of noise is an issue in areas where ambient noise levels have been low.

Mitigation

This impact is unavoidable and will be mitigated using machinery that minimise noise emissions, construction will be avoided at night.

Environmental Monitoring Plan

An Environmental Mitigation and Monitoring Plan has been prepared for this project complete with the key indicators and cost for monitoring. The plan integrates the local communities as part of the monitoring and a strategy for capacity building.

Public Consultation

Public consultation meetings were held for the proposed project in order to capture the concerns associated with the project from all stakeholders. The stakeholders who were targeted were members of the local community, local leaders, and officers from the County Government, officers of the National Government, business owners, religious leaders, NGOs and transporters, among others. There was an earlier mobilization meeting whose purpose was to introduce the ESIA team to the area, inform the local communities about the proposed road project and identify key stakeholders for interviews and public consultation meetings. Public consultation meetings were used to explain to stakeholders the benefits of the proposed road project, potential adverse impacts, measures to mitigate negative impacts, and arrangements to compensate project affected persons. Stakeholders were thereafter given the opportunity to give their views, opinions and suggestions on the most appropriate considerations during the construction and operation of the road.

Summary Of Public Consultation Meetings

Village	Location	Date	Number of Participants
Makhoma	Khajula	16th February 2015	58
Nanjomi	Bunyala Central	19th February 2015	67
Mumbira	Bunyala East	19th February 2015	45
Narera	Bunyala West	19th February 2015	54
Total			**224**

Consultations with stakeholders were carried out among the people living and carrying out their daily livelihood activities within the environs of the project. The aim of the consultations was to ensure that interests and concerns of all stakeholders are identified and incorporated in the project development, construction and operation.

The study employed three main methods of consultations to get the data presented in this report. These are:

- Meetings and discussions with Key Stakeholders;
- Questionnaire administration and interviews;
- Convening of Public Consultation Meetings within the project area.

Implementation and Management

The implementing agency for this project is the MEWNR, which will establish a Project Managament Unit (PMU) specifically for this project. The PMU will include full time staff from based at the project site level and will include specialists in environment, social and community development, engineers, agronomists etc. Key community representatives, members of IWUA, staff from key minsitries with responsibilities in ensuring the effective implementation of the ESMP will also form part of the PMU. The executing agency will conduct periodic monitoring while key institutions like Water Resources Management Authority (WRMA), National Environment Management Agency (NEMA) will equally conduct routine monitoring as provided for by the legal framework.

Capacity Building

The capacity of the relevant stakeholders responsible for implementing the recommednations in the ESMP will be strengthened through field trainings, short courses, workshops and seminars among others.

Recommendations and Conclusion

The proposed Project is positive in the overall, being in line with the locals' aspirations and national objectives for enhancement of social and economic development. The existing dykes along the downstream (of Rwambwa Bridge) River Nzoia are now beyond their design lifespan. Despite on-going efforts to effect repairs on the dykes, they have been breached with increasing frequency of flood incidences. This has led to increased socioeconomic losses in the project area and exposes it not only to losses of life and livelihoods but also exposes the government in terms of emergency response expenditure.

The Ministry of Environment, Water and Natural Resources (the Proponent), through the Kenya Water Security and Climate Resilience Project seeks to promote economic

empowerment of local communities and their organizations in flood prone regions of western Kenya, through support to local initiatives and efforts that understand and mitigate the adverse effects of poverty.

The proponent commissioned the consultants to undertake an Assessment of Levee Integrity and Floodplain Condition and Final Design of Improvement of Flood Water Structures along the Lower Reaches of River Nzoia-Budalangi. It envisages developing flood management in the Nzoia River basin. Several intervention alternatives were identified- both by the experts and the community members amongst other stakeholders - during the planning and design phases of the proposed project. The alternatives were investigated and comparatively appraised individually and in combinations using agreed criteria incorporating technical viability, community acceptance, sustainability, environmental impacts, safety, cost and hydraulic assessment of associated flood reduction benefits/risks. One of the key environmental considerations was the sensitivity of the project environment characterised by riparian and associated wetland habitats. A greater portion of the project area has however been disturbed by earlier flood management interventions and human settlements. Following the appraisals a combination of raising and strengthening the existing dykes and realignment of few sections was adopted for implementation. In addition, to improve flow of floodwaters, existing culverts at Sigiri crossing point will be replaced with larger ones.

Despite the fact that the proposed combination of interventions was the best in meeting the project objectives, the construction, operation and decommissioning phases are likely to have certain adverse impacts on the local community and the immediate surrounding environment given the nature of the project environment. The major activity in the project will be earthworks. Each of the anticipated impacts has been assessed and where feasible, appropriate mitigation measures proposed and the following can be concluded:

- During design and planning phase the significant impacts identified were positive and included job creation and an opportunity for the community/stakeholders' engagement and inputs in formulation of flood management interventions;
- The majority of negative impacts anticipated during construction will either be of medium or low significance, which can further be reduced through implementation of recommended mitigation measures;
- Review of documented flora and fauna species did not reveal any species of special conservation concerns. Even though the project area has no gazetted wetland, consultations revealed that plans are underway by both NEMA and Nile Basin Initiative to have the wetland areas gazetted thereby calling for more precaution while undertaking any activities. It is however, notable that interventions which would have posed greatest negative construction environmental impacts on the habitats returned negative appraisal results against the adopted criteria and were eliminated. These were interventions involving either significant river channelization or dyke extension to the lake;
- The project earthworks during construction will require an estimated fill material of 586,000 cubic metres for the northern dyke and 637,000 cubic metres for the southern dyke;

Construction of the broader and higher dykes will also necessitate additional strip of land adjoining the existing dykes. Even though the design has been optimised to minimize the associated impact, some properties located or even families whose structures are built close to the foot of the existing dykes will have to be relocated. Community members were informed through a stakeholders workshop and there was acceptance that some few individuals will be affected by the project meant to benefit the entire community. Preliminary profiling and valuation of affected properties including land has been undertaken to guide adequate and prompt compensation of affected persons. The proponent is also at advanced stages of undertaking a comprehensive Resettlement Action Plan (RAP) to identify and enumerate individual households/PAPs, and inventory affected assets to facilitate compensation. The RAP will among others establish a cut-off date and develop a grievances settlement mechanism, which will assist in minimizing potential project implementation setbacks;

Numerous positive impacts other than the key project objective put forward by the proponent are anticipated during operation. Most of these will be indirect impacts and include: facilitation of more reliable agriculture; attraction of more investment into the project area; ensuring educational calendars are not interrupted by floods; promotion of transport linkages between communities to the south and to the north of the Nzoia River; and other numerous benefits were identified by the beneficiary community;

No major significant negative environmental impacts are anticipated during operation given that project activities in this phase will be limited to dyke maintenance works only. Losses predicted by the community once the new dykes are operational e.g., reduced availability of cheap fishing following flood incidences, loss of flood aid and loss of silt deposition are relatively insignificant and can be compensated by anticipated positive impacts; and

Complete decommissioning of the proposed works is not anticipated. However, in the event that partial decommissioning is to be done, the anticipated negative impacts can be readily mitigated.

From the foregoing, no adverse environmental and social impacts are anticipated that cannot be adequately mitigated. Environmental monitoring shall be carried out during the construction phase to enable identification and rectification of unforeseen impacts. Any unforeseen project impacts shall be immediately brought to the notice of an environmental expert to ensure they are immediately addressed and mitigated. Closer liaison with relevant key stakeholders including WRMA, NEMA and National Irrigation Board within project area should be maintained throughout the project's implementation.

The Consultant recommends the project approval and an Environmental Impact Assessment license be issued by NEMA based on the environmental management measures contained in this ESIA Project Report.

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ACRONYMS AND ABBREVIATIONS

ACZ	Agro-climatic zones
AIDS	Acquired Immune Deficiency Syndrome
AMSL	Above Mean Sea Level
ASCV	Agricultural support and Chain Value
ASDS	Agricultural Sector Development Strategy
CAACs	Catchment Area Advisory Committees
CBS	Central Bureau of Statistic
CDD	Community Driven Development
CoK	Constitution of Kenya
CSO	Civil Society Organizations
DDP	District Development Plan
DEC	District Environmental Committees
DOHS	Directorate of Occupational Health and Safety (DOHS)
DOHS	Directorate of Occupational Health and Safety
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FS	Feasibility Study
GDP	Gross Domestic Product
GIS	Geographical Information System
GOK	Government of Kenya
Ha	Hectares
HIV	Human Immunodeficiency Virus
HVC	High Value Crops
I&AP	Interested and Affected Parties
ICT	Information and Communication Technologies
IE	Impact Evaluation
IKS	Indigenous Knowledge Systems
IWUAs	Irrigation Water Users Associations
KFS	Kenya Forest Service
KIHBS	Kenya Integrated Household Budget Survey
KMD	Kenya Metropolitan Department
Ksh	Kenyan Shilling
KWS	Kenya Wildlife Services
KWSCRP	Kenya Water Security and Climate Resilience Program
KWSCRP-1	First Project in the KWSCRP
KWSCRP-2	Second Project in the KWSCRP
M&E	Monitoring and Evaluation
MCM	Million Cubic Meters
MDGs	Millennium Development Goals
MEWNR	Ministry of Environment, Water and Natural Resources
MoA	Ministry of Agriculture
MOF	Ministry of Finance
MoH	Ministry of Health
NEMA	National Environment Management Authority
NET	National Environmental Tribunal

NGO	Non-Governmental Organization
NIB	National Irrigation Board
NMK	National Museums of Kenya
NRS	National Rice Strategy
OP/BP	Operational Policy/Bank Policy
OSHA	Occupational Safety and Health Act
PAD	Project Appraisal Document
PHO	Public Health Officer
PIC	Public Information Center
PMP	Pesticide Management Plan
PMU	Project Management Unit
PPE	Personal Protective Equipment
PRA	Participatory Rural Appraisal
PRSP	Poverty Reduction Strategy Paper
RAP	Resettlement Action Plan
SEA	Strategic Environmental Assessment
SERC	Standards and Enforcement Review Committee
TOR	Terms of Reference
UNCBD	United Nations Convention of Biological Diversity
UNEP	United Nations Environment Programme
US$	United States Dollars
VCT	Voluntary Counselling and Testing
WASREB	Water Services Regulatory Board
WaSSIP	Water and Sanitation Service Improvement Project
WB	World Bank
WHO	World Health Organization
WKCDDP	Western Kenya Community Driven Development Project
WRMA	Water Resources Management Authority
WRUA	Water Resources Users Association
WSB	Water Services Board
WSCRP	Water Security and Climate Resilience Project
WSP	Water Services Provider
WSTF	Water Services Trust Fund
WUAs	Water Users Associations

2 INTRODUCTION

2.1 PROJECT NEED

The Ministry of Environment, Water and Natural Resource/State Department of Water (the Proponent), through the First Kenya Water Security and Climate Resilience Project (KWSCRP-1) seeks to promote economic empowerment of local communities and their organizations in flood prone regions of western Kenya, through support to local initiatives and efforts that understand and mitigate the adverse effects of poverty.

A consultancy contract was originally awarded to WS Atkins International in association with Howard Humphreys (East Africa) Limited for the Assessment of Levee Integrity and Floodplain Condition and Final Design of Improvement of Flood Water Structures along the Lower Reaches of River Nzoia-Budalangi. This was one of the packages within the World Bank funded Western Kenya Community-Driven Development and Flood Mitigation Project then implemented by Minisitry of Special Programs. The project, which envisages developing flood management in the Nzoia River basin, has now been taken up by Kenya Water Security and Climate Resilience Project.

The solution currently under consideration entails development of a system of multi-purpose flood control, including flood control structures. The current study considers works to be implemented in the short to medium term in the lower reaches of the River Nzoia, that is, between Rwambwa Bridge and Lake Victoria in Budalang'i, where the majority of the flooding problems occur. The intention is that these works will be augmented by the provision of multi-purpose flood storage reservoirs, also being investigated in the middle and upper catchment in the medium to long term, but outside the scope of KWSCRP-1.

2.1.1 Project Details

2.2 STUDY OBJECTIVES

The objective of this study was to undertake an Environmental and Social Impact Assessment (ESIA) for the proposed project in line with Kenya's Environmental Impact Assessment and Audit regulation as well as the Environmental Management and Coordination Act (EMCA) and also with the Bank's OP 4.01. The objectives of this study were to:-

- Analyze the socio-economic and socio-environmental status of the affected areas during pre and post construction and thus justify development of the irrigation project through cost/benefit analysis and recovery of capital investment.
- Assess the capacity to implement the proposed mitigation measures, and make appropriate recommendations, including potential capacity building and training needs and their costs.
- Based on the survey, prepare a draft Environmental and Social Management Plan ESMP that outlines:-

1. Potential environmental and social impacts resulting from the proposed improvements
2. Proposed mitigation measures;
3. Reviewing institutional arrangements, training requirements and responsibilities for monitoring implementation of the mitigation measures with proposed monitoring indicators;
4. Proposed work program, budget estimates, schedules, staffing and other necessary support services to implement the mitigation measures;
5. Preparation of emergency response measures to accidents as appropriate e.g., flood damages, etc.
6. Assess the projects impacts on existing infrastructure and social amenities

3 STUDY SCOPE AND METHODOLOGY

This chapter describes the spatial and temporal scope of the study as well as the approach and methods that were applied in undertaking this study, developing the project ESMPs and involving the public.

3.1 STUDY METHODOLOGY

3.1.1 Baseline Assessment

The study team undertook a baseline assessment of biophysical and socio-economic of the study area and related parameters. The assessment was undertaken in the following ways as discussed below.

3.1.1.1 Literature Review

Desktop Studies

Desktop studies were conducted to review available published reports, development plans and maps, and other study reports on the general area, in order to compile relevant baseline biophysical and socio-economic information about the study area.

The biophysical information was compiled on environmental aspects such as flora, fauna, topography, drainage, soils, geology, hydrogeology, and climate. On the socio-economic environment, the studies compiled information on aspects such as population, economic activities and land use. Desktop analysis of secondary data was undertaken to review past research done on the project area. Documents that were reviewed included among other documents:

- Feasibility studies for Improvement of Flood Water Structures along the Lower Reaches of River Nzoia-Budalangi.
- Western Kenya Community Driven Development and Flood Mitigation Project (WKCDDP) documents
- District Development Plans for Siaya, Bunyala and Ugenya
- Government of Kenya Census Reports (2010)
- Environmental and Social Management Framework for WSCRP
- World Bank Draft Project Appraisal Document for WSCRP
- Resettlement Policy Framework-Water Security and Climate Resilience Project
- Environmental and Social Management Framework- WSCRP
- Environmental Management and Coordination Act, 1999
- Environmental Impact Assessment and Audit regulations for Kenya
- Various legislative documents in Kenya relevant to this project
- Wold Bank safeguard policies and procedures

3.1.1.2 Ecological Survey

Transect drives and field walk through the project area was undertaken to collect data on fauna and flora types as well as the ecological characteristics of the project area. Ecosystem characteristics covering land cover, vegetation clusters, endemic and endangered species were identified. Geographical Information Sytem (GIS) technology was used to plot and analyse spatial distribution of vegetation within the project area.

The fieldwork consisted of checking photo interpretation boundaries and description of actual vegetation of representative areas. The actual vegetation was extrapolated for areas under cultivation. Generally an area of about one hectare was selected as the sampling point. All the tree, shrub, herb and grass species present were recorded on a vegetation description form. The percentage cover of each species was estimated, and also the physiognomic class and other site characteristics as vigour of vegetation, land use and drainage were also recorded.

3.1.1.3 Socioeconomic Survey

For socioeconomic survey, 15 enumerators were recruited within the project area. The criterion for recruiting the enumerators was that they had to be Form Four (4) graduates, being a resident of the project area and residing in one of the villages within the project area. Therefore all the villages had at least one (1) enumerator. The enumerators were then trained for half a day and dispatched to the respective villages to test the questionnaire in order to evaluate the responsiveness of the tool and the understanding of the enumerators when administering the questionnaire. During the second day, the tools were adjusted according to the understanding the team got from the trial test.

3.1.2 Project Alternatives

The study team analyzed the various project alternatives available to achieve the project's objectives but with the least adverse environmental impacts. The alternatives were identified and evaluated determining impacts and cost implications of each alternative. Alternatives assessed during this process included;

a) Project technology
b) Project scale and design.
c) Site alternatives in project location particularly with regards to location based impacts and land use conflicts.
d) Project construction, phasing, operations and maintenance.
e) No Project alternative.

3.1.3 Public Consultation

Public consultation was conducted through public barazas. The local chiefs and sub-chiefs in the respective locations and sub-locations organized the barazas. Being a community driven development project, consultations have been part and parcel of the development of the proposed flood management interventions.

Consultation is the foundation of any community driven process, particularly since one of the project objectives is for the community to take over responsibility for future operation and maintenance of the flood management works. The communities within the project area must, therefore, develop a sense of ownership of the selected interventions. Consultations were undertaken throughout the three phases of the project study and at various levels, and in particular:

- The local community (village) level;
- The Sub County/District level; and

- The national level.

The consultations were meant to give the community and other stakeholders an opportunity to have inputs right from the initiation to the ultimate stages of the development of new flood management mitigation interventions. Further, the consultations gave an indication of whether the Project interventions were welcome and other perceptions held by the Interested and Affected Parties (IAP) on the project.

The consultations were conducted through workshops both at the local and national levels, direct questionnaire administration and personal interviews.

The aim of these barazas was to explain to the local community and other stakeholders about the project objectives, the proposed activities including, construction and operations and expected outputs.

This exercise was critical in assisting the team to understand the local conditions and use of Indigenous Knowledge Systems (IKS) existing and inherent within the local communities and institutions in the project area. The stakeholders' consultation also helped in highlighting the serious socio-economic and environmental concerns and impacts that could arise from the project and was instrumental in helping to come up with feasible mitigation measures. The views of the barazas attendees were captured and noted on the Stakeholder Issues and Response format.

3.1.4 **Impact Prediction and Evaluation**

Various methods and techniques were applied in impact identification, prediction and evaluation. The consultants with the help of stakeholders identified and analysed potential impacts linking these with specific project activities and phase. First the task was to consider both positive and negative impacts of the project. While considering the impacts, the study examined them in light of their characteristics i.e. nature (positive or negative), extent (spatial), occurrence (one-off, intermitted or constant), magnitude, whether reversible or irreversible, direct or indirect, probability of occurrence and significance with and without mitigation. The exercise also examined the cumulative effects of impacts and particularly on land use and water quality.

A number of tools were applied to identify and assess impacts. A simple structure checklist was used to identify environmental impacts while a matrix was used identifying activities-impacts relationship. An impacts network was used to identify indirect and cumulative networks.

3.1.5 **Environmental and Social Management Plan**

This plan identified the measures (that is the environmental protection and limitation measures) to be undertaken at all the stages of the project including the design, construction, operation and decommissioning. Based on the identified potential adverse impacts an Environmental and Social Management Plan that encompasses a monitoring schedule was developed. The management plan highlights all anticipated impacts and their areas of occurrence. It also provides the mitigation measures to be undertaken and

the duration within which such measures are to be instituted. The plan also identify the personnel responsible for implementing particular action plans as well as give an indication of the approximate costs of these activities.

4 PROJECT DESCRIPTION

This chapter describes the technical aspect of the project as well as project layout and activities to be undertaken during the preparation and operation of the project. The chapter also describes the inputs and outputs of the project during the project life cycle.

4.1 THE FLOODING PROBLEM

Prior to the construction of the existing dykes river Nzoia flowed through the Budalangi area within a natural levee system raised above the surrounding floodplain. The first recorded incidence of flooding was in 1937, although it is probable that this had been happening regularly prior to this point. Records indicate that there was frequent flooding, on average every 2 years through the late 1950's and 1960's, which may have been exacerbated by the significant increase in Lake Victoria levels that occurred in 1961. Flooding in the project area occurred with or without dykes. Different reports show flooding occurred in the years 1947, 1951, 1957/58, 1961/62, 1963 and 1975. This was before the construction of dykes was finalized.

The existing dykes were constructed on top of the natural levees between 1965 and early 1986, initially to protect the Bunyala Pilot Irrigation Scheme, and subsequently the remainder of the north and south bank.

The dykes were successful in prevention of flooding from the time of construction up to 1997. Since then, despite Government of Kenya (GoK) efforts to effect repairs there have been many failures. The most recent occurrences were in November 2008 and December 2011. The increased frequency of levee failure and breaching has resulted in communities within the floodplain increasingly suffering the effects of flooding, resulting in damage to dwellings, livestock and crops, and risk to human life. People, their villages, crops and livestock are affected by these incidences and threats. It has been estimated that the average annual cost of the damage is in the order of US$800,000 plus a further US$1,000,000 (both at 2004 prices) to provide emergency relief and rehabilitation for around 12,000 people.

The dykes and natural levees impede the natural drainage of the floodplain. This prevents runoff from draining to the river, creating localised flooding and extensive areas of marshland next to the dyke. Soils of the alluvial plain are typically of low permeability. They therefore do not allow floodwaters to seep away naturally and areas of standing water can remain for up to 6 months after flooding occurred. This causes public health problems including malaria and cholera and prevents people from returning to their homes.

4.2 PROJECTS ACTIVITIES

The proposed new flood management interventions will be implemented along both sides of the Nzoia River, downstream of Rwambwa Bridge (located about 24 km south west of Bumala) to its confluence with Lake Victoria. The area is commonly known as Budalangi and has old flood protection dykes on both north and south of the river referred to as northern dyke and southern dyke respectively. Rwambwa Bridge to the mouth of the

river is approximately 17.5km, but given the river meanders, the distance along the channel is approximately 40km.

Following evaluation and appraisal of various alternatives, a preferred combination was selected for implementation. The adoption of the proposed activities to the management of flood in the study area was endorsed by the WKCDD&FMP and stakeholders at the workshop held in Nairobi on 13 September 2012. The structural works proposed to WKCDD&FMP are to:

- Improve the dykes to provide a greater level of flood protection;
- Improve conveyance of flood flow by realigning some sections of the dykes;
- Provide larger culverts through the road crossing dyke at Sigiri/Rugunga; and
- To improve floodplain drainage by providing two drainage structures that will allow flow drainage for the northern dyke (east of Sigiri).

Further details of the proposed arrangement are as follows:

Dyke Improvements

Proposed dykes improvements will involve a combination of new higher and stronger dykes and raising and strengthening existing dykes. These will mainly involve earthworks comprising compacted fill of sandy clay with a 300mm thick sand filter to the landward side. A description of the interventions considered appears in Appendix C.

On the northern dyke, a greater section (90%) of the existing dyke will be retained and improved (through raising and strengthening) while localised areas at Sibanze and Sigiri will be replaced with new higher and stronger dyke on new alignments.

On the southern dyke, about 80% of the existing structure would be retained and improved (intervention B2) while the remainder will be replaced with a new dyke. Higher and stronger dykes on new alignments (intervention B1) will be constructed as detailed in **Table 1.**

Table 1. Locations Proposed for New Alignments

South Dyke (total 4.020km)	North Dyke (total 1.300km)
Burungasi Ch 7+980 to 8+475 (0.495km) Makhoma Ch 10+550 to 10+900 (0.350km) Makhoma Ch 10+945 to 11+385 (0.440km) Makhoma Ch 11+625 to 11+750 (0.125km) Galalani Ch 12+250 to 12+580 (0.330km) Khayinga Ch 12+665 to 13+490 (0.825km) Khayinga to Rugunga Ch 13+965 to 14+265 (0.750km) Khayinga to Rugunga Ch 14+865 to 15+265 (0.400km) Rugunga Ch 15+365 to 15+670 (0.305km)	Sibanze Ch 10+900 to 11+400 (0.500km) Siginga Ch 16+100 to 16+600 (0.500km) New Extension dyke at: Ch 0-300 to 0+000 (Total 0.300km)

New drainage outlet as a means of conveying drainage and flood flows across the line of the dyke from the north floodplain will also be provided at chainage 11300 and 12400 - Intervention D15. The flow will be controlled by use of a flap valve/spindle.

In order to maintain the durability of the dykes, the following will be implemented:

- Provision of special crossing points with hard surfaces to stop erosion of crest.
- Cattle crossing ramps will be provided near homesteads or at intervals of approximately 1km to enable cattle crossing to watering points. The ramp will be 250mm thick concrete and 6m wide with a finish of rough concrete laid on a fabric mesh (A393);
- Protection of dykes from erosion by the use of gabion mattresses where the river meanders have shifted closer to the dykes.
- Provision of roads along dyke crests (surfacing only, not a public road). The roads will consist of 300mm thick compacted gravel course with kerbs and toe drains; and
- Keeping dykes free of trees to avoid long-term problems and protect against excess grazing by livestock

Detailed design drawings of the proposed works are included in Appendix D. However, it is important to note that further work will be done to optimize these designs, as well as to integrate them with the designs for the First Phase of the Lower Nzoia Irrigation Project, which is scheduled to be implemented through the KWSCRP-1, in the Southern Bank of the Nzoia River.

River Channel Improvements

The proposed river channel improvement activities include:

- Realignment of the southern dyke at Rugunga (chainage 15.0 Km) to remove the constriction between the dykes;
- Replacement of 13nr. DN900 culverts along Sigiri crossing (Chainage 13.6km) with triple 5m x 1.2m high box culverts 7 nr. Sets; and
- Detailed design drawings showing the proposed arrangement of structural works are contained in Appendix D.

In addition, the following activities will be included as part of the project management:

- Coordination with NIB on drainage issues, particularly on the northern flood plain, in light of the proposed Lower Nzoia Irrigation Development Project planned for implementation in 2014/2015. The informal discussion with NIB agreed in principal that the 4km long irrigation canal will be shifted away from the rehabilitated Northern dyke while the two new drainage outlet structures on the Northern dyke would serve only as outlets for natural drainage, with the effluent from the proposed irrigation works on the Northern floodplain being handled separately by NIB; and

- Consultation with the relevant Roads Authority has been undertaken concerning any future plans to undertake bridge crossing at Sigiri including improvement of

the road. The current status is that design studies are being procured for the Lake Victoria Ring Roads (our project falls within this proposed study area). Since there are no immediate government works at this area in the near future, our work is moving independently - replacing existing culverts and rehabilitating the crossing to 7m width.

Figure 2: Proposed Works' Locations within the Study Area-separate attachment

4.3 PROJECT DESIGN CRITERIA

The project was appraised and costs for dyke construction estimated using design flows of 500 cumec, 750 cumec and 1000 cumec. However, following hydraulic modelling, which showed that the 500-cumec flow provides little more benefit in terms of in-dyke capacity than the existing dykes, this was dropped and the current design for Phase III is 750 cumec.

Box 1. Civil / Infrastructure designs shall be carried out on the basis of the following design Codes and Standards:

BS 8005: Part 1:1987 Guide to New Sewer Construction;
Ministry of Water Development – Design Manual for Water Supply in Kenya, 1986;
BS 5911: Part 100:1988 – Specification for Unreinforced and Reinforced Pipes and Fittings with Flexible Joints;
KS 06-149 – Specification for uPVC Pipes for Cold Water Services;
KS 06-217 – Specification for uPVC Pipes for Buried Drains and Sewer Pipes;
BS 3505 – Specification for uPVC Pressure Pipes for Cold Potable Water;
Rainfall Frequency Atlas of Kenya, Ministry of Water Development, 1978;
WHO Report No. 9 – Selection and Design Criteria for Sewerage Projects;
WHO Report No. 4 – Design and Selection Criteria for Community Water Supplies
The Traffic Act, Chapter 403, Laws of Kenya;
Road Design Manual, Parts I & III, Ministry of Public Works & Housing (MOPW&H), Kenya, Jan. 1979 and May 1987 respectively;
Surface Water Drainage – Design Manual by John Keenan, Oct. 1975;
Nairobi City Council Adoptive Standards for Infrastructure Works;
ECA TRRL – Report on Flood Hydrology Symposium, Nairobi 21-24 October 1975;
BS 1387/67 & KS 06:259 Steel tubes and tubular; and
MOPW&H Manual for Civil Works Details – 1983.

The above references shall be used in a complementary manner. Where requirements of two or more codes or standards are found to conflict, the more stringent of them is adopted for the purpose of this project.

Sedimentation Allowance

It is acknowledged that the project area is subject to the deposition of sediment from the Nzoia River, causing an increase in flood levels over time. The design of the dykes includes an allowance for sedimentation of 25mm per year for 10 years.

4.4 CONSTRUCTION MATERIAL AND EQUIPMENT

Construction materials will include;

- Fill material for dykes – this will comprise cohesive material for dykes. This will be obtained from existing sections of dyke being realigned and borrow pits within and close to the project area;
- Aggregate, cement and steel-for construction of culverts and drainage structures will be purchased from quarries and hardware/supplies; and Bentonite- for the seepage cut-off walls will be sourced from suppliers.

- A lot of fill materials will be required in the dykes construction. It is estimated fill material of 586,000 cubic metres for the northern dyke and 637,000 cubic metres for the southern dyke will be used. The materials will be of the following preliminary specifications.

Table 2. Fill Material Specifications

Preliminary Fill Specification	**Max**	**Min**
Liquid Limit %	60	35
Plasticity index %	30	15
% Passing 0.075mm sieve		50
% Lab maximum dry density (2.5kg Hammer)		98
Moisture content relative to OMC (%)	Plus 3%	0%

It is envisaged that a crest width of 5m will be suitable to sustain the current level of usage, that is, occasional vehicles (mainly for routine maintenance and sand harvesting), livestock, motorcycles and pedestrians. Additionally, 5m is considered a minimum working width to safely accommodate plant and labour for construction of the dykes. The location and frequency of vehicle access points has been carefully considered in consultation with the community-through use of traffic barriers to ensure only maintenance vehicles use the dykes. Limiting vehicular traffic will help to maintain the integrity of the dykes for the primary role of flood defence.

Seepage Control

Seepage is known to be a problem in a number of areas along both north and south dykes, which are founded on a broad alluvial plain comprising a shallow layer of soft to firm clay overlying permeable sands and gravels. The highly permeable layer extends at least 5m below the foundation level of the dykes, proven by the geotechnical investigations.

Seepage gives rise to standing water or waterlogged ground on the landward side of the dykes, which can be a nuisance to local communities as the land cannot be used. More critically in relation to flood risk, seepage under the dyke can lead to:

- Instability due to increased pore water pressures in the foundation; and
- Erosion of the dyke toe.

Natural streams draining to and from the River Nzoia (north and south sides respectively) were severed by the original dyke construction and it appears that no cut off was

provided. There is evidence that there is still hydraulic connectivity between these streams and the main channel, resulting in 'weak points' along the dyke during flood conditions.

To minimise the risk of dyke failure, seepage control for the full length of the dyke will be instituted. The reduction of the hydraulic gradient through the foundation of the dyke will be achieved either by seepage control through the filter drain within the dyke and provision of a seepage berm on the landside. Other areas will involve construction of bentonite cut-off walls below the dyke on the riverside to control the hydraulic flow. These methods are aimed at increasing the seepage path length under the dyke thereby dissipating the driving head over a longer distance. The bentonite cut off wall at the riverside toe will be 10m deep.

A seepage berm is the alternative option to a cut off and, by comparison, simpler to construct, requiring the same materials and plant as for the main dyke construction. The seepage berm would comprise a layer of compacted fill material, typically 1m deep and extending variably from one section to another between 5m and 15m from the landward toe. However, the seepage berm considerably extends the overall footprint required for the dyke construction (approximately doubling to (up to 48 metres), and from site inspections there are some settlements in close proximity to the existing dyke which would be affected. To further reduce the risk of piping through the dyke the design includes a sand filter and toe drain on the landward slope.

For stability under hydraulic loading (in flood conditions) the dyke slope gradient will range between 1:2.25 for heights less/or equal to 3.5m and 1 in 2.5 for height greater/or equal to 3.5m. The foundation width of the new dyke (excluding seepage berm) is likely to be up to 10m greater than the existing foundation (up to 33 metres).

Slope stability is dependent on the type of soils available and at it is assumed a material will be available similar to the existing silty clay which was locally sourced at the time of construction and for recent repair work.

In some locations, the course of the river channel has migrated close to the existing dyke, leading to erosion of the toe, or risk of erosion if left unchecked. In these locations it is proposed to realign the dyke to the landward side. Erosion control measures will be incorporated into the design, although in flood conditions velocities are high and on-going maintenance and/or repair is likely to be required, to ensure these measures remain effective.

Once the structural form of the dyke is complete, the slopes will need to be trimmed and prepared for protection against erosion by planting suitable grass/vegetation and the crest of the dyke will be filled with 300mm of murram to allow a vehicle surface ride.

Dyke Maintenance

It will be important to regularly maintain both the slope and the crest surfaces to ensure that the durability of the dyke is maintained. This will be achieved by:

- Planting and maintaining suitable grass cover on the dyke slopes. No trees/bushes will be planted on the dykes and the Community shall ensure the cattle crossing ramps are used;
- Ensure controlled traffic via barriers to avoid unauthorized traffic; and
- Regular inspection and timely patch repairs before minor damage develops into significant impact.

Culverts & Drainage Structures Construction

Box 2. Materials for culvert and drainage structures construction will include:

Gravel; Crashed stone for scour control; Blinding materials (class 15); Flap gates; and Penstocks Steel reinforced concrete;

Box 3. Erosion Control Materials

Suitable grassing of dyke slopes; Stone pitching at cattle crossings and for scour control; Gabion boxes and mattresses; and Rock armour.

Construction Methods and Equipment

Dyke construction will require plant typically deployed for road construction work. Compaction will be closely supervised, as it is critical to the long-term performance of the flood defence and requires materials to be placed at optimum moisture content for compaction. Some of the equipment to be deployed will include:

- Earth movers including; excavators, dump trucks, road roller; backhoe excavators and loaders;
- Concrete mixers;
- Bentonite slurry wall equipment; and
- Staff vehicles.

Contractor's Camp

To facilitate the dyke construction activities, it is envisaged that the selected contractor(s) will need to set up a residential camp within the project area for easier mobilisation of both equipment/materials and human resources. The camp will host staff, machinery/equipment and be used for minor equipment servicing/workshop. It will have its waste handling system including use of septic tanks for domestic wastes.

Planning/Phasing of Construction Activities

The sequencing of construction will need careful consideration as flood defences will need to be maintained to at least the current standard of defence during periods of high flows. The contractor will need to sequence works accordingly. It is preferable that in locations where new dykes (Type A) are proposed, the new structure should be built landward of the

existing (that is, where there is sufficient space avoiding settlements). This approach would allow work to progress for an extended period of time throughout the year, other than during particularly wet conditions, which would prevent compaction of materials to the required specification. The existing dyke could either be left in place (providing some secondary/temporary protection against erosion) or later excavated and compacted on the landward side to form a seepage berm (or the material reused elsewhere).

If there is not sufficient area to build the new dyke behind the existing (and resettlement is to be avoided) then the dyke will need to be constructed on the same line during periods of low flow or with a temporary flood defence in place on the river side. The seasonal timing of floods appears to have become less predictable, as witness by the devastating December 2011 floods. Therefore this approach will need to be planned with a good degree of caution, with necessary trigger levels and contingency plans put in place to restore flood defences promptly.

In locations where Type B Dykes (raise and strengthen existing dykes) are proposed, construction methods will need to ensure that the new material placed bonds well with the existing material to form a homogeneous structure. Except in areas where erosion is a problem, the dyke will remain on the same line, limiting the additional land take required, although additional land (nominally 10-20m) will be needed for the seepage berm. Where dense settlements are located near to the existing dykes, the use of a bentonite wall cut off will be considered as an alternative to the seepage berm, to minimise the requirement for resettlement. Construction of the dyke on line should eliminate the need to construct a temporary defence or the need to restrict construction to periods when low flows would normally be expected.

Construction Period

The construction period has been has been estimated to be approximately twenty-four months.

Project Operation and Decommissioning

The main operational activity on the dykes and associated works will be to allow drainage from the culverts. Other activities during operation will be maintenance tasks. These will be community driven as the project will be implemented with their ownership in mind. Activities will include; trimming and cutting of grass on dykes, removal of bushes, saplings or any woody vegetation that start to grow anywhere on the dykes, repair of erosion damage or damage from grazing animals among others. Some of these activities may be too large for the community to complete unaided, in which case external assistance, e.g. using a contractor, will need to be provided.

Decommissioning of the proposed works is considered unlikely. Should the need arise following realisation of new flood control/management measures upstream, the dykes or their sections could be decommissioned following technical appraisals. Decommissioning activities will be guided by management plans provided in the report.

It is expected that machinery will be used in the construction of the main and secondary canals together with the main drains. This will be due to expected earth volume to be moved. Choice will therefore be made for the proper equipment required for the execution of the relevant work. Among the works is the excavation, loading, hauling, spreading and compacting.

5 PROJECT ALTERNATIVES

This section describes and examines the various alternatives available for the project. Alternatives examined during the study included alternative technology, site alternatives in project location particularly with regards to location based impacts, biodiversity loss, wetland functions loss and land use conflicts was assessed. Finally a No Project alternative was also assessed to determine the impact of this No Project Scenario. Details, including descriptions of the interventions considered, are presented in Appendix C.

Following rigorous analysis, a feasible option (combination of alternatives) as outlined in the previous section was identified to ensure that the project is not only technically sound and cost effective, but also has the least negative impacts on the receiving biophysical and socio-economic environment.

Consideration and Analysis of Alternatives

A range of interventions was considered by the proponent to optimally meet the project objectives and purpose. Detailed analysis and presentations are captured in the Floodplain Management Plan (FMP) prepared by the Proponent, sections of which are annexed to this report - Appendix C. The referred appendix presents considerations including;

- ***Formulation of Alternatives***: presents short-listing of initial interventions incorporated into the development of FMP, including dyke improvements, river improvements and floodplain management improvements;
- ***Feasibility Assessment***: presents a detailed assessment of short listed interventions to identify and appraise most viable works. The assessment describes hydraulic modelling, detailed assessment of interventions, and summarises interventions for optimal appraisal; and
- ***Optimal Appraisal***: describes process of developing and appraisal of most viable interventions with the most significant impact on flood risk.

Consideration of Options to Extend Dykes Towards Lake Victoria

The project involves improvement of river dyke structures along the lower leaches of River Nzoia. Environmental, social and safety impacts have been analysed and evaluated. Adequate and realistic mitigation measures have been developed to ensure successful implementation and operation.

The option of extending the dykes to Lake Victoria was considered and evaluated. This was not feasible due to limited benefits and significant environmental impacts in addition to the high cost implication. This area is a wetland and plans are underway to gazette the area. Any human activities including settlement will lead to habitat loss and fragmentation. Moreover, natural topography and existing dykes prevent backflow around the embankment ends threatening significant human settlement. Thus most homesteads upstream will be protected from flooding which would be occasioned by backflow.

Project activities on the wetland would result in the following impacts:

- Risk of pollution hazards during construction and/or maintenance e.g. accidental oil/ fuel spills;
- Air and noise pollution is also likely to affect biodiversity negatively;
- Encourage human settlement. Agricultural activities on the wetland would increase, and pesticides and fertilizers likely to be used would be leached to the wetland and Lake Victoria; and
- A robust foundation comprising of rock fill, layer of geotextile, excavation of soft spots among others would be required incurring high capital cost.

Improvement of the dykes will go a long way in reducing problems for the community caused by floods and promote economic empowerment of the local population as well as achieving national goals.

5.1 ALTERNATIVE PROJECT SITE

Through the Wastern Kenya Community Driven Development Project, other project alternatives were considered, including the construction of upstream multipurpose reservoirs to mitigate high water flows during flood periods. However, these projects would have a long development timeline, several reservoirs would be required, and are much more costly than the FMD works. While these reservoirs would mitigate some of the flooding in the lower Nzoia area, because they are upstream of some tributaries, they cannot alone reduce the flooding risk in the Lower Nzoia River to a level that was acceptable to those consulted. For this reason, this alternative was rejected in the immediate term. Please see **Appendix C** for further description of alternatives considered.

5.2 NO PROJECT ALTERNATIVE

A No project option will mean that the anticipated positive and adverse impacts do not occur and the status quo remains. The No Action alternative refers to not embanking on the proposed project at all. It would mean that the current status quo is maintained without the proposed new works. It is important to note that this alternative is the baseline against which all the other alternatives and development of the proposal is assessed.

When considering this alternative, the both positive and negative impacts associated with any specific alternatives or the development proposal would not occur and in effect the impacts of this alternative are inadvertently assessed by assessing the other alternatives.

In summary, the no action alternative implies that flooding in the lower zones of river Nzoia will continue unabated, periodically causing associated havoc and sufferings to developments and settlements in the area. It will also deter any promotion of economic empowerment of the local communities as envisaged locally by the WKCDD&FMP and broadly by the national goals.

Based on the direct and indirect project benefits, a No project option is not a viable alternative for this project. Considering the fact the potential project impacts can be avoided or mitigate effectively, the project benefits outweigh the costs in terms of adverse impacts. Based on the above considered factors, a “no-project scenario” is not an attractive alternative.

6 CHAPTER SIX. PROJECT AREA DESCRIPTION

This chapter describes and assess the existing project area environment to set the benchmark upon which the impacts can be measured and eventually monitored. The chapter gives an overview description of the general Western Province and then narrows to the specific project area describing the environmental setup in detail.

6.1 PHYSICAL ENVIRONMENT

6.1.1 Location

The project is located in Busia County, in western Kenya. Busia County borders Lake Victoria to the South West, the Republic of Uganda to the West, North and North East. The county constitutes seven (7) constituencies namely; Teso North, Teso South, Nambale, Matayos, Butula, Funyula and Budalang'i. In relation to neighbouring counties, Busia borders Bungoma and Kakamega to the East, and Siaya to the South East and South. Busia County covers an area of 1,695km and has a population of 488,075. The proposed project is sited in Bunyala District, Budalangi constituency. Bunyala District covers an area of 306.5km², out of which 120km² is under permanent water surface of Lake Victoria. The District has lies between Latitude 0° 1' 36" South and 0° 33' North and Longitude 33° 54' 32"East and 34° 25' 24" East.

Table 3 below shows the names of the six administrative locations and administrative sub- locations of Bunyala district. Figures 3 and 4 overleaf show maps of the six administrative locations and a map for Bunyala Sub-locations boundaries respectively.

Table 3. Administrative Units within Bunyala District and their Location Relative to River Nzoia

Name of Administrative Sub-location	Administrative Location	Location with Respect to River Nzoia
Siginga	Bunyala West	Northern side of River Nzoia
Bukani		
Bukoma		
Bulemia	Bunyala North	
Sisenye		
Mundere		
Budalangi	Bunyala East	
Mudembi		
Rwambwa		
Mabinju	Khajula	Southern side of River Nzoia
Lugare		
Rugunga		
Mabinju		
Magombe East	Bunyala Central	
Magombe Central		
Magombe West		

Rukala	Bunyala South	
Ebulwani		
Obaro		

Figure 3: Bunyala Adminsitrative

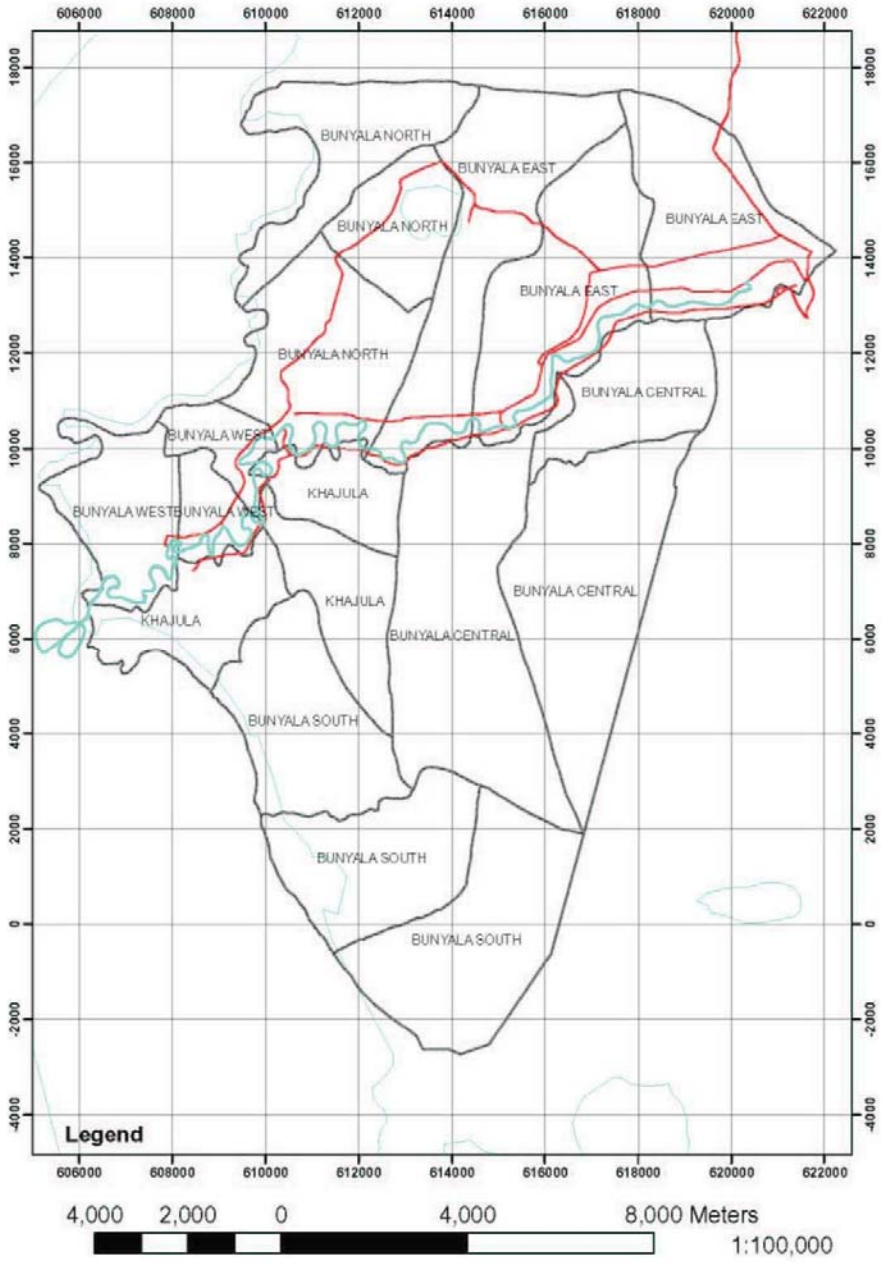
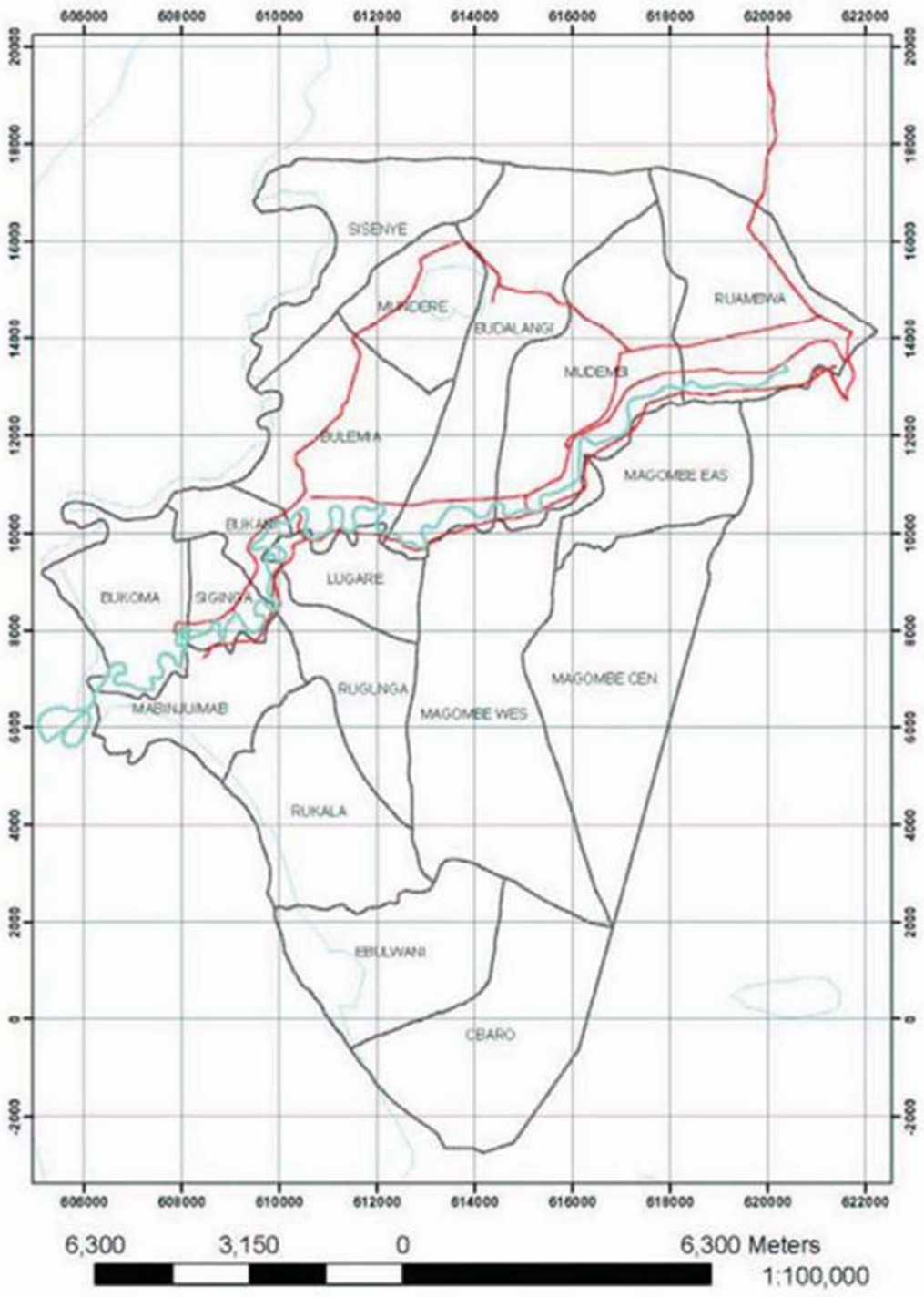


Figure 4: Bunyala Sub-locations Boundaries



The proposed project is part of the Nzoia catchment but limited to the Nzoia River downstream of Rwambwa Bridge and the areas, which may be affected by flooding from

that section of the river. The area of the Nzoia catchment upstream of Rwambwa Bridge is about 12,500km² with a distance of about 300km to the upstream end of the system.

Existing Infrastructure

Current infrastructure affected by the project comprises of;

- *Dykes* - running along both banks of river from Rwambwa to Namabusi. The dykes have a total length of 34.09km comprising of 17.0km on the southern and 17.09km on the northern side. Visual inspection revealed dykes are almost entirely bare of grass or other low level vegetative cover, degradation as a result of erosion of crest and banks, crest settlement in some places on the Budalangi dykes;
- *Access Roads* – two no. dykes on which lie the access roads exist across the levee section, providing access to boats across river during periods of flooding. The farthest downstream, connecting the village of Mau Mau to the boat crossing point at Siginga, runs along the side bank of river inside of floodplain. The other connects the road running west from the Bunyala irrigation scheme to the derelict vehicle ferry on the western side of Munsojo Hill;
- *Culverts* – dyke across levee section is equipped with culverts to allow flood flows to pass through the dyke; and water pumping station-for the rice plantation scheme.

6.1.2 Hydrology of Lower Nzoia

Lower Nzoia area lies in Lake Victoria drainage basin, and specifically Bunyala District which was recently created from part of Busia District. Bunyala District covers an area of 306.5km^2 of which 120km^2 is part of the Lake Victoria waters. A number of significant swampy areas exist in the area including Mundere Swamp to the north of the river and Yala Swamp to the south. Yala Swamp is fed by River Yala and is one of the largest swamps in the area as it drains into Lake Victoria via a number of small channels including Ndekwe stream, which also carries drainage from Bunyala pilot irrigation scheme. The Nzoia River, which emanates from the western side of Keiyo escarpment and the Cherengani Hills has meandering alignment on a flood plain that runs between levees. The river has an approximate length of 315km and drains a total catchment area of 12, 696km^2. The size of Lower Nzoia basin is 2593km^2. A significant delta has been formed downstream of the river where it discharges into Lake Victoria. This flat area is for the most of the part marshy and covered in dense reed growth.

6.1.2.1 Nzoia River

The Nzoia River and its tributaries provide a permanent water source but with varying flows throughout the seasons of the year. The River Nzoia emanates from the western side of the Keiyo Escarpment and the Cherangani Hills in well-defined channels from an elevation of approximately 2,286 metres above sea level (m.a.s.1). The river has several tributaries with an average basin elevation of 1,917m, m.a.s.l. The tributary with the highest elevation (4,300m, m.a.s.l) flows from the slopes of Mount Elgon. The River flows from a north-easterly to south-westerly direction with a mean slope of 0.010% from source to discharge into Lake Victoria at about 1,000m, m.a.s.l, (ITALCONSULT, 1981). The River Nzoia enters Lake Victoria a short distance to the north of the Yala Swamp. The plains at the downstream reaches of this River are susceptible to floods. The water

quality of Nzoia River varies as per the discharge. As shown on the **table 4** below, during seasons of high discharge/rainy season upstream, there is marked increase in total suspended solids, nutrients and electrical conductivity as well as sediment load.

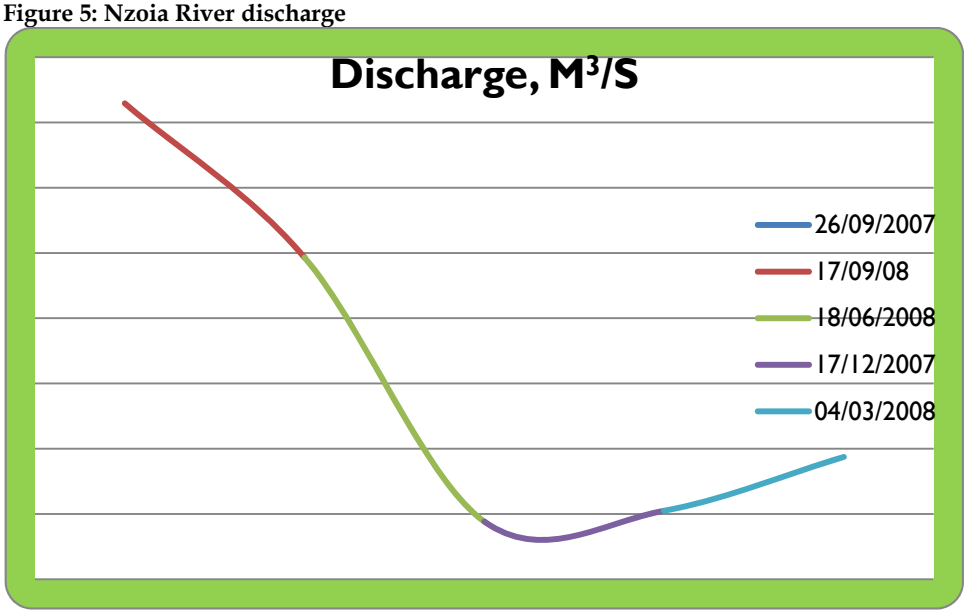
Table 4. Table Nzoia River Water quality analysis

Monitoring Station	Nzoia at Rwambwa	Nzoia at Rwambwa	Nzoia (Rwambwa)	Nzoia at Rwambwa	Nzoia at Rwambwa
Date Sampled	26/9/07	17/09/08	18/06/2008	17/12/2007	04/03/2008
Altitude (masl)	1153	1153	1153	1153	1153
Electrical conductivity (µs/cm)	130	115	105.1	145.5	110
Ph	7.5	7.42	7.55	7.95	7.7
Temp (^{0}C)	22.8	23.3	21.8	26.1	28.5
Dissolved Oxygen (mg/l)	3.8	6.8	7.46	4.2	5
Total Susp. Solids(mg/l)	190	210	70	70	600
Turbidity(NTU)	193		115.7	102	368
Nitrate (mgNO_3/l)	2.64		12.02	2.8	2.2
Discharge, M^3/S	364.577	246.455	44.169	52.46	93.69
Sediment Load, Tonnes/day	5984.896032	4471.67952	267.134112	317.27808	4856.8896

Source. Water Resources Management Authority, 2010

Since Nzoia River is not able to accommodate all the waters especially during high flows of the river more than often the river bursts its banks in the lower region of the catchment flooding large tracks of land. The **figure 5** below shows Nzoia discharge.

Figure 5: Nzoia River discharge



Source. Water Resources Management Authority, 2010

The monthly flow of Nzoia River is as shown on the **table 5** ***below.***

Table 5. Monthly reliable flows (RGS 1EF01 at Ruambwa)

Month	Mean monthly Flow (m3/s)
January	68.4
February	45.8
March	47.4
April	100
May	172
June	139
July	148
August	186.4
September	165.8
October	135
November	126.4
December	93.1

Available flows (Q80 and Q95) at RGS 1EF01 at Ruambwa)		
Month	**Q80 flow (m^3/s)**	**Q95 flow (m^3/s)**
January	20.82	15.86
February	14.57	6.87
March	10.98	1.31
April	14.21	8.28
May	36.00	11.18
June	58.05	24.39
July	58.27	27.38
August	70.29	42.89
September	60.02	38.91
October	43.34	31.60
November	41.81	23.48
December	27.90	17.76

Source: Final Design Report by Design Consultant (December 2011)

6.1.2.2 Ground water resource

Kenya has three rock types and hydro-geological area classified as volcanic, metamorphic basement and intrusive rocks and sedimentary rocks. Hydro geological regions can be simplified as shown in the map below. The main ground water aquifers are closely linked with the above three major rock systems. Ground water would be the last alternative to be considered in this region as there would be a need for number of boreholes. Potential groundwater depth is at an average depth of 30m. The main restriction to boreholes in the project area is the salinity of water from the boreholes and their low yields. A remedy to water shortage if it occurred would be to introduce water harvesting culture and watershed management to ensure that water soil and land resources are properly managed.

6.1.2.3 Lake Victoria

The project area borders Lake Victoria to the east. With a surface area of 68,000Km^2, it is the second largest freshwater lake in the world. Lake Victoria is a habitat of over 300 endemic species of fish, 26 of which are threatened

Lake Victoria basin offers livelihood to about 11.5 million people. Nzoia is one of the major rivers that drain into Lake Victoria. Nzoia River discharges an average of 115.3 m^3/s annually contributing to 14.8 % of the Lake Victoria waters. The Lake is under threat from many processes. The most important threat to the lake is pollution**.** Sediment and nutrient loads from the lake catchment discharges into the lake every day. Farms are some of the sources of sediment and nutrients into the lake.

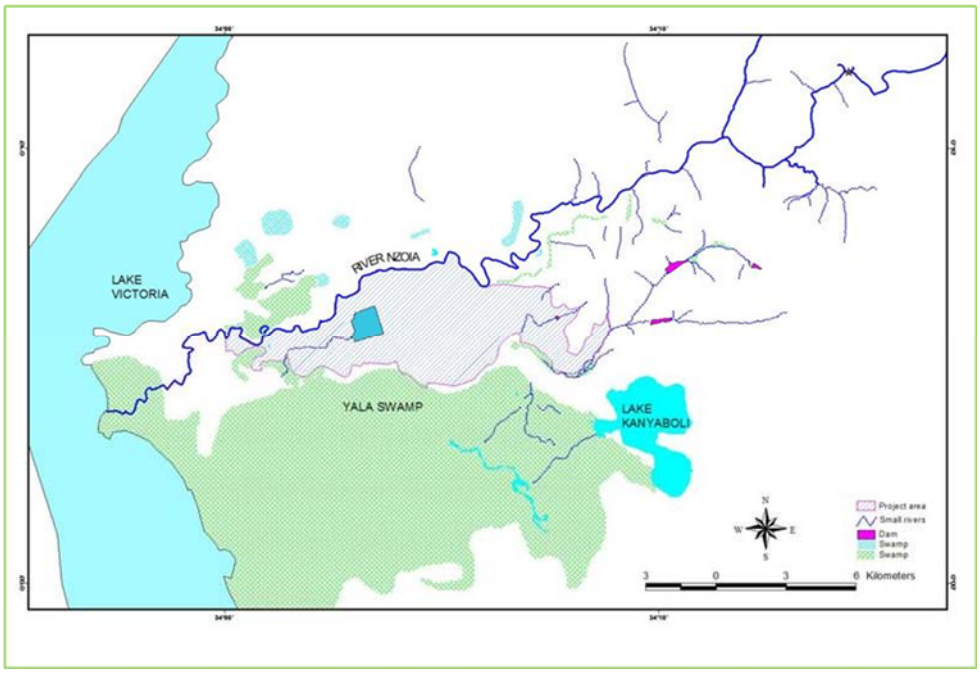


Figure 6: Hydrological map of the area.

6.1.3 **Water Rights**

Water rights in Kenya are held by WRMA with authority to give permits to water users. In the project location, Nzoia River is used by many with and without permit from WRMA. Many of these users are small scale thus no action has been taken by the authority. In Bunyala Irrigation Scheme, the IWUAs members are supposed to pay for the water they use from Nzoia. However this has not been the case mostly because WRMA is new and lack monitoring capacity. Though there are talks between NIB and WRMA on how to collect water fees from the farmers.

6.1.4 **Climate and Meteorology**

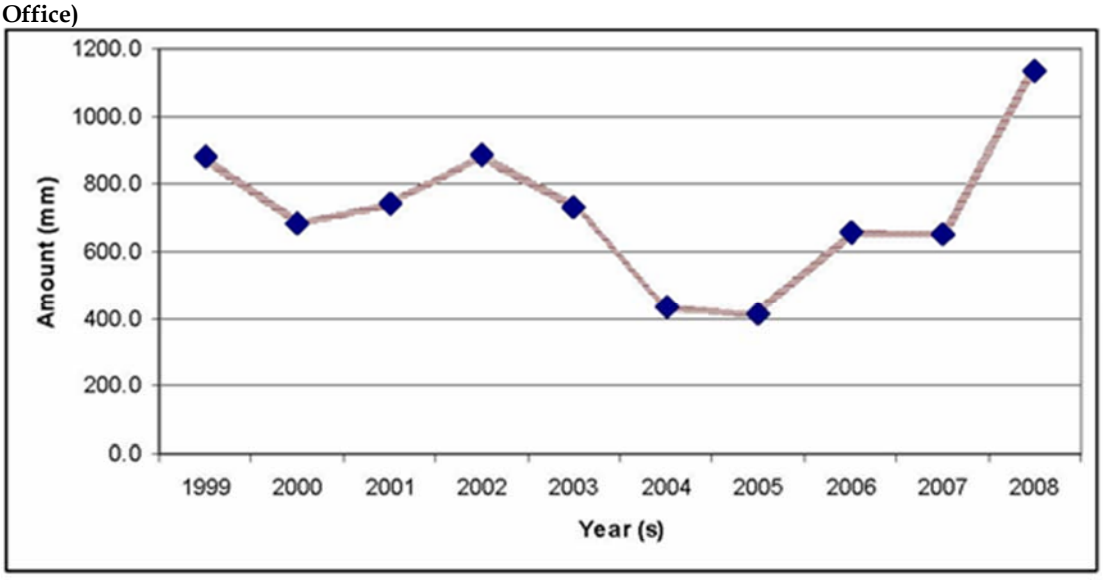
According to Nile Basin Capacity Building Network (2005) the lower plains of the Nzoia basin, where the project area lies, receives a mean annual rainfall of 1,260mm and most of which falls between March and May and a smaller peak between September and November. Extreme droughts occur in January and February. Severe convectional rains occur near the shores of Lake Victoria and the highest recorded intensity has been 23mm during a five-minute period in 1961. The mean annual maximum temperature ranges between 25^0 and 30^0C while the minimum is between 9^0 and 18^0C. The discharge varies from lows of $28m^3/s$ to maximum of $930m^3/s$. The annual runoff amounts approximately 310mm with a runoff ratio of 21.7% (Nile Basin Capacity Building Network, 2005).

The Nzoia River Basin Management Initiative a public private partnership programme 2006-2011, (2006) describes the climate of the Nzoia river basin where project area lies as tropical humid and that the area receives four seasons annually due to the inter-tropical convergence zone (ITCZ) and that the local relief and the Lake Victoria also modify the local weather pattern.

6.1.4.1 Rainfall

The rainfall pattern in Bunyala District is mainly bi-modal (two rainfall seasons in a year). The major season occurs in March to May (the long-rains season) while the other season (short-rains) occurs in October to December. However some areas receive significant rainfall in August and September. The period June-July is generally dry unlike other areas in western Kenya, which observe a major rainfall peak during the period. The months of January and February are also generally dry though occasional wet conditions may occur especially in January. The amount of rainfall received varies with years as shown in **Figure 7** below.

Figure 7: Rainfall data from Sisenye Meteorological Station (Source: Bunyala District Agricultural Office)



Lower Nzoia monthly rainfall totals showed a bimodal distribution with the highest peak occurring during March/May (long rains), August /September (short rains). The rain gauge at Busia suggests that short rains are more intense than long rains in the Lower Nzoia region.

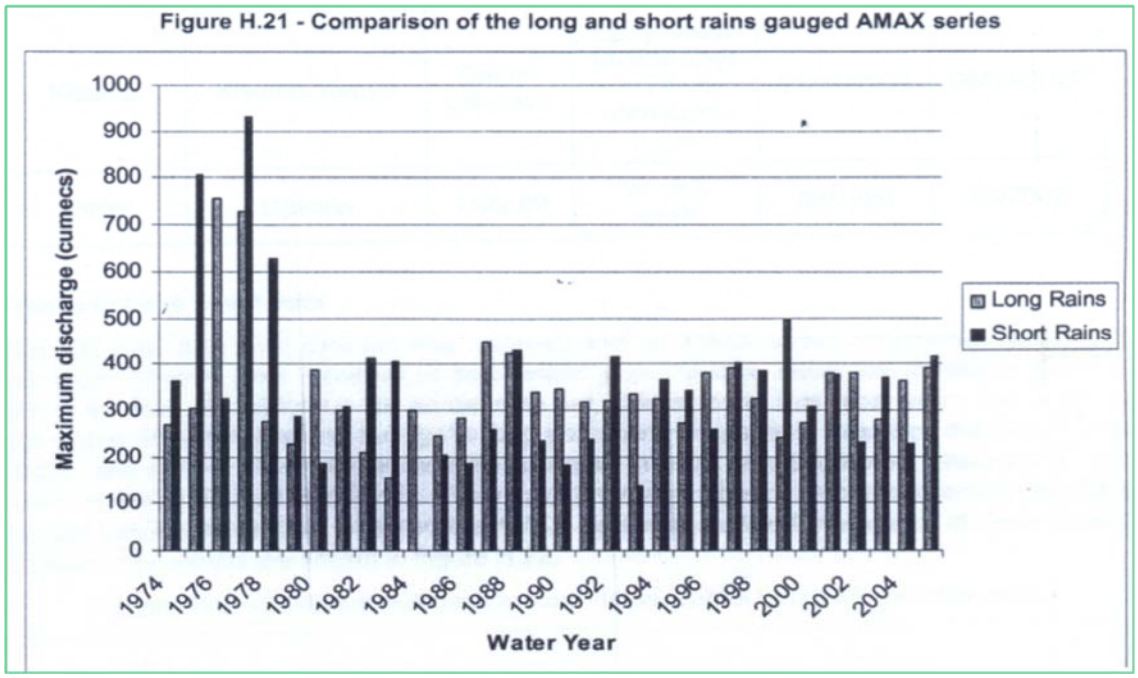


Figure 8. Rainfall Pattern; Source

6.1.4.2 Temperature

The annual maximum temperatures range from 26°C and 30°C while minimum temperatures vary between 14°C and 18°C. The region records high rates of evaporation of between 1800mm and 2000mm per year.

6.1.5 Drainage

The principal drainage trend follows the general slope to the southwest towards Lake Victoria. Along the Nzoia River there are swamps and streams that arise from both sides of the river. In the lower reach as the river approaches Lake Victoria, Busia and part of Siaya districts the basin has a flatter topography; hence the Government has been undertaking construction of drainage works, mostly to keep off floods. Along the river the slope reduces from 0.5% in the upper reaches to 0.04% in the lower reaches over the last 30km, which is in the area of the project (Nile Basin Capacity building Network, Flood Management Research Cluster 2005). They also describe the discharge as varying from lows of 28m^3/s to maximum of 930m^3/s and that the highest river discharges occur between May and September while the lowest discharges occur between January and March.

6.1.6 Topography

The topography of the project area is relatively flat, being mostly made up of the alluvial plain of the Nzoia River. The ground generally slopes gently to the south west. A ridge running north- eastward from Port Victoria prevents the north bank flood plain from draining directly towards Lake Victoria.

A number of significant swampy areas exist in the area, including Mundere to the north of the river, and the Yala swamp to the south. The latter, fed by the river Yala (and, formerly, flood flows from the Nzoia), is one of the largest swamp areas in Kenya and drains to Lake Victoria via a number of small channels including the Ndekwe stream which also carries drainage from the Bunyala Pilot Irrigation Scheme.

River Nzoia has a meandering alignment, and runs between levees. A significant delta has been formed at the downstream end of the river where it discharges into Lake Victoria. This flat area is for the most part marshy and covered in dense reed growth.

6.1.7 **Geology and Soils**

The soils of the project area are developed mainly on alluvial deposits and mudstones. According to ITALCONSULT (1980) the soils (Based on: FAO-UNESCO recommendations, Kenya Soil Survey and Reconnaissance Land Classification Survey USBR method of 1953) of the Upper Nzoia (18,000 ha) and Lower Nzoia (12,000 ha) respectively are mainly laterized and deep of alluvial origin. In the Lower Nzoia Area the soils are clay in texture.

The soils of the uplands within the surveyed area are developed on granites and mudstones. The soils developed on granites (UGm) are well drained, moderately to extremely deep, strongly weathered, red to strong brown, sandy clay, in places fairly rocky and bouldery (Ferralsols, Plinthosols and Acrisols). The soils developed on mudstones are well drained, shallow to extremely deep, rather strongly weathered, red to strong brown clay, in places petroplinthite at the surface. The soils classified as Acrisols and Plinthosols). The soils of the minor valleys (VXC) are developed on various undifferentiated parent materials. They are well drained to poorly drained, shallow to very deep soils of varying colour, consistence and texture. The soils are classified as Verti-Eutric Fluvisols and DystricGleysols, sodic phase; Eutric Planosols and Vertisols; Ferralic Cambisols, rudic phase and Eutric Plinthosols. The soils of the project area are developed on alluvium and colluvium derived from various parent materials. They show a wide range of characteristics and include relatively little weathered and stratified alluvial and colluvial soils (**figure 8**).

River terraces and floodplains found along the Nzoia River and along the fringes of the Yala swamp possess soils, which are developed on recent alluvial deposits. The soils consist of somewhat excessively drained to poorly drained, deep to very deep, dark reddish brown to dark brown, mottled, loose to very firm, stratified sand to clay. In places the soils are slightly saline and slightly sodic and they are formed of cracking clay. These soils are prune to salinization due to the salinity and poor drainage characteristics. The soils are shown on the **figure 9** below as SA1, SA2, SA3, SAC1 and SAC2 (Kenya Soil Survey1991).

This study also placed the lands in classes 2, 3 and 6 of classification system of US Bureau of Reclamation and methodology. There was no Class 1 because as they all suffer from some limitations. Class 4 was not considered since it has no provision for this at reconnaissance level. The study observed that both the upper and Lower Nzoia

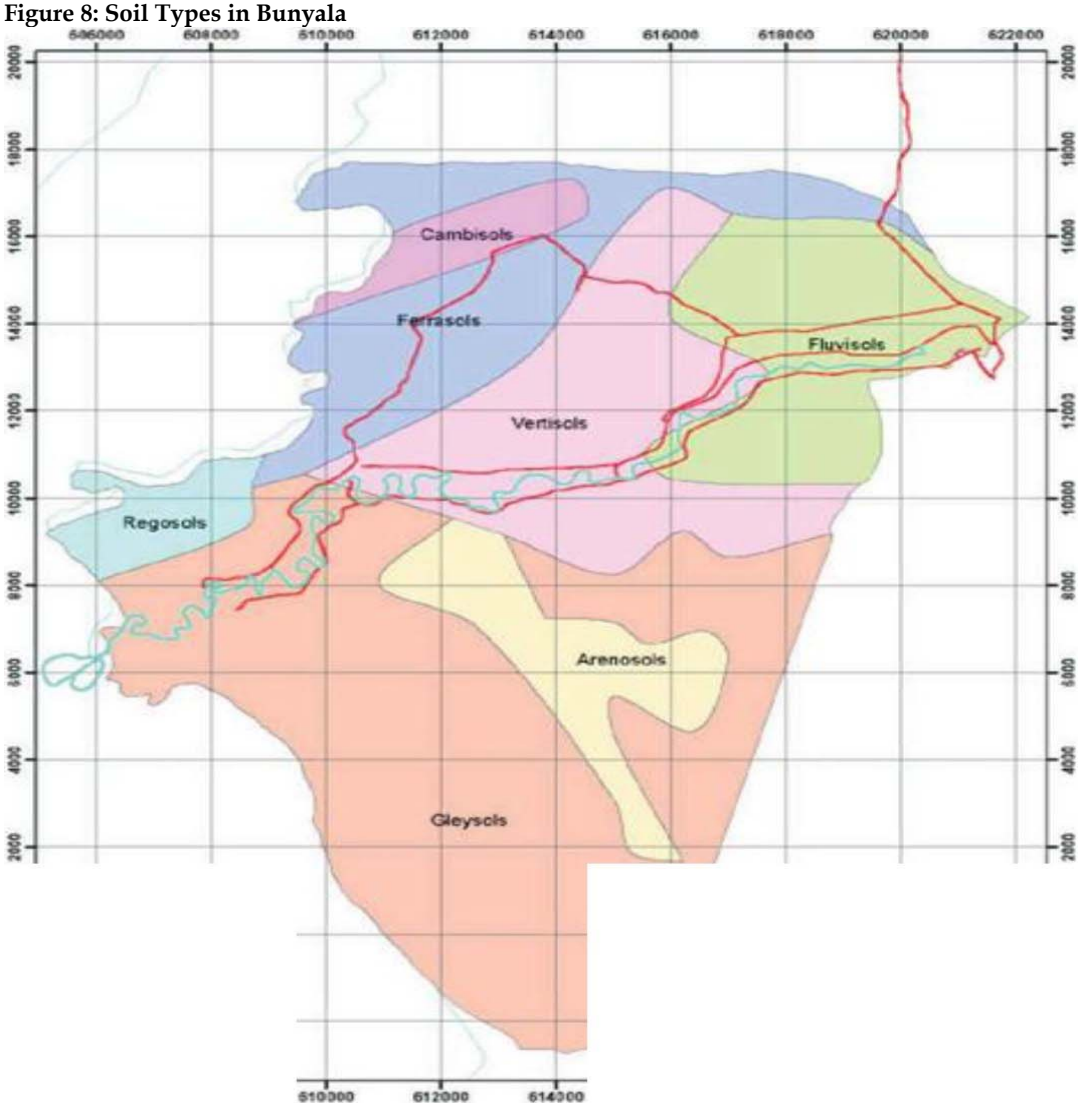
could support irrigation and that the soils were generally poor in mineral and organic fertility.

The project area generally covers Agro-Climatic Zones (ACZ) I, II, III and IV (Jaetzold and Smith, 1982) from the upstream-proposed two water intake sites to areas adjacent to Lake Victoria, an indication of increasing climatic aridity towards the Lake. Though ACZ IV and III could be the areas for irrigation to be considered, these areas within the project area are prone to flooding and water logging due to the flat to very gently undulating relief of the area.

Soils and land cover in Bunyala

Soils and their characteristics have direct/indirect effect on land cover and economic activities of an area. A range of soils are found in Bunyala District. In some parts of the district there are poorly drained and mainly clay type of soils due to frequent flooding. In the swampy areas also are heavy clay types – (near Yala swamp) which are very difficult to cultivate when dry or when wet. Some areas have good soils, well drained that can support cultivation. The different types of soil found in Bunyala District include: cambisols, ferrasols, regosols, arenosals, gleysols,vertisols and fluvisols. Gleysols and rrenosols which are found on the Southern side of Nzoia River; cambisols, ferrasols and regosols which are found on the Northern side of Nzoia River and Fluvisols and Vertisols are found on both the Northern and Southern Sides of Nzoia River. Figures 8, 9 and 10 show the Bunyala soil types and land cover respectively.

Figure 8: Soil Types in Bunyala



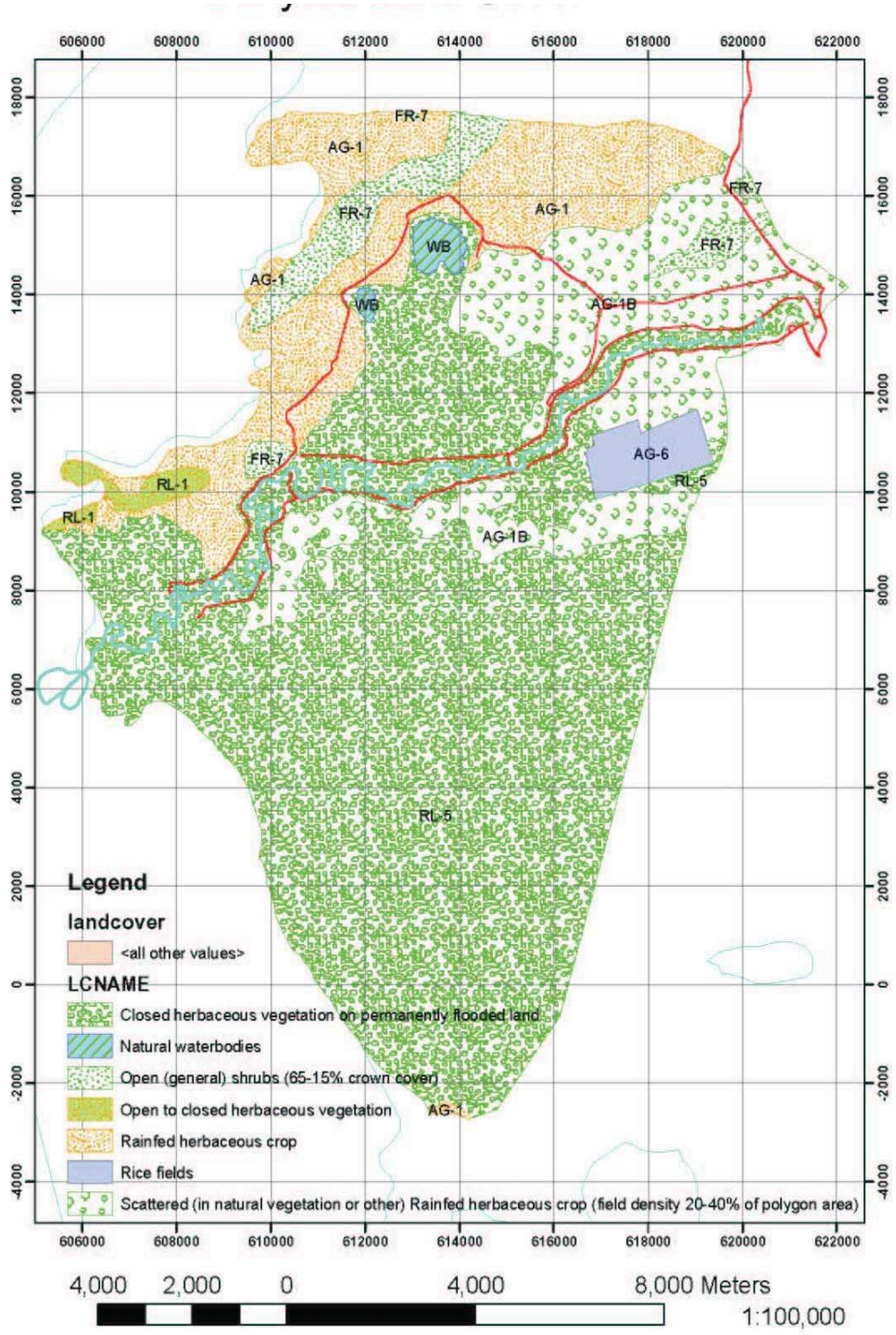
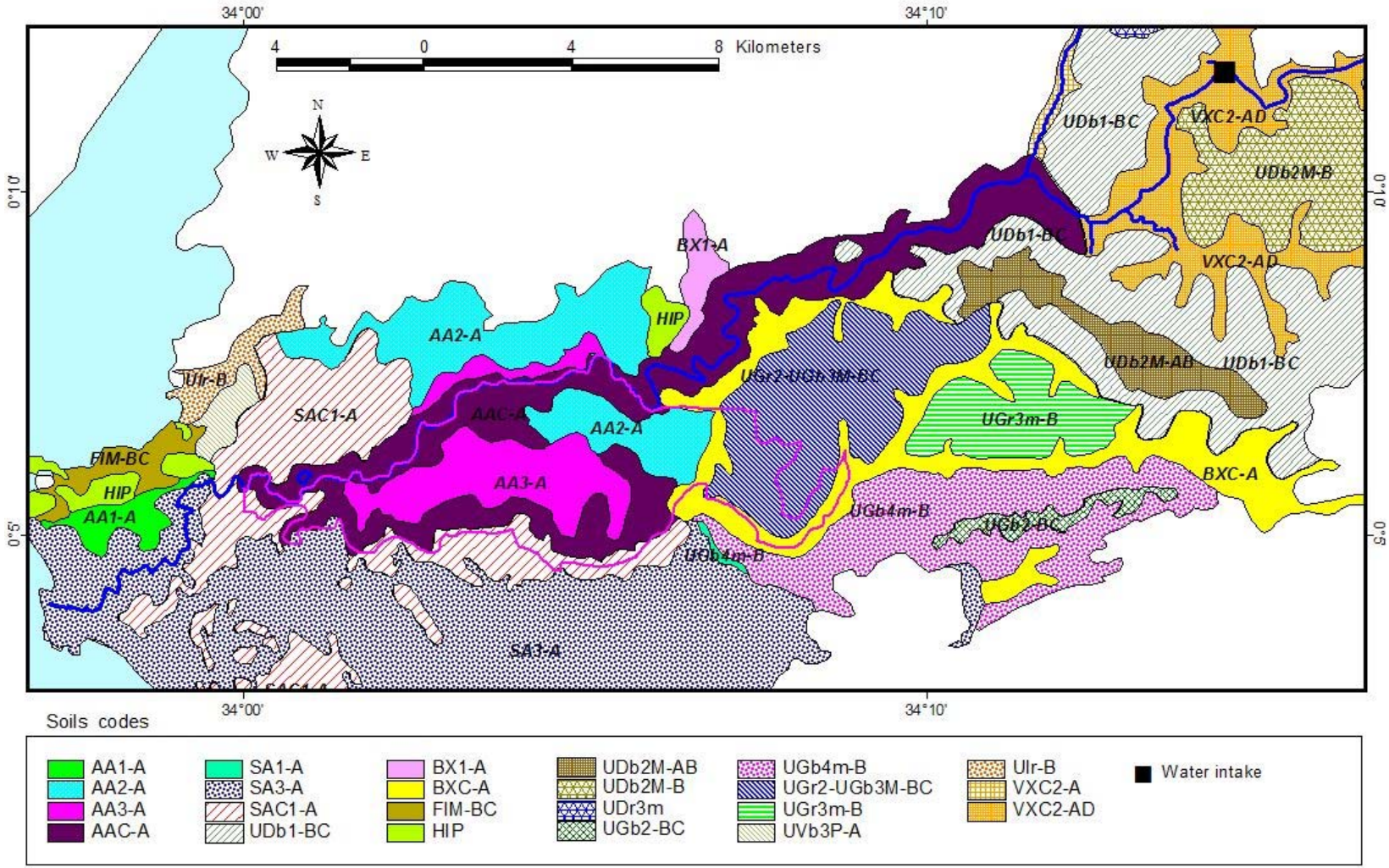


Figure 9: Landcover in Bunyala

Figure 10: Soil types in the project area



6.1.8 **Land Tenure and Use**

There are three categories of land ownership in the project area, i.e. government land, trust land and community and private land. According to Land Adjudication Office Siaya and Survey of Kenya Nairobi, most of the land in the project area is categorized as community or private free hold. 67% of the farmers' possessed documents to prove land ownership. Even for those who did not have documents, it was because succession may not have been done and such ownership was not in dispute.

The project has a gross command of 5780 ha. Of this area 30% is covered by settlements, infrastructure, fallow for bushes and shrubs and trees. Of the remaining 4000ha, 72% is under rain fed agriculture. The average land size for individual Project Affected Persons households is 2 acres. The average number of structures per parcel of land is 4.

The gross area of the Lower Nzoia Basin is estimated at over 25,000 ha. This area has swamps, shrub land and agricultural land (cropland, pasture and fallow) as the main uses. It is estimated that about 17,000 ha is available for agriculture. It is also estimated that the present land use is in the order of less than 30% by the farming community.

Despite being a floodplain area for Nzoia River, the area has various types of vegetation are recognized in the area. Evergreen or semi evergreen tree bushes and grasses generally cover the hilly lands. The lowland is mostly grassland with shrubs and is often seasonally swampy.

Traditionally, the economy of the people is dependent on agriculture and on animal husbandry mainly at the subsistence level. The main crops are maize and sorghum, which are extensively cultivated. Other common crops are peas, beans, groundnuts, sweet potatoes, cassava and bananas.

The original landscape can be described as an area divided by slightly higher, better drained ridges, covered by bush land ,swamps and marshes, covered by papyrus, reeds and sedges. The upper part of the study area has higher ground altitude with better rainfall and therefore able to support natural bush land vegetation. The lower area being an estuary of the Nzoia and the Yala rivers is lower and prone to flooding, forming wetland before the Lake Victoria shores. Three major landscape types are distinguished:

1. The "settlement area", slightly higher, better-drained land. The village or homestead areas have farmhouses encircled by hedges, woodlots and roads are found in these areas.
2. The "cropping area", this area is the transition zone from the higher ridges to the depressions. The area has better drainage than the depressions and therefore allows the growing of "dry feet" crops, mainly food crops. The food crops in these areas are normally intercropped as follows:

- Maize/sorghum; Maize/sorghum/cowpeas; Maize/sorghum/beans
- Maize/sorghum/green grams; Maize/cotton; Maize/cassava
- Sugar Cane/Maize

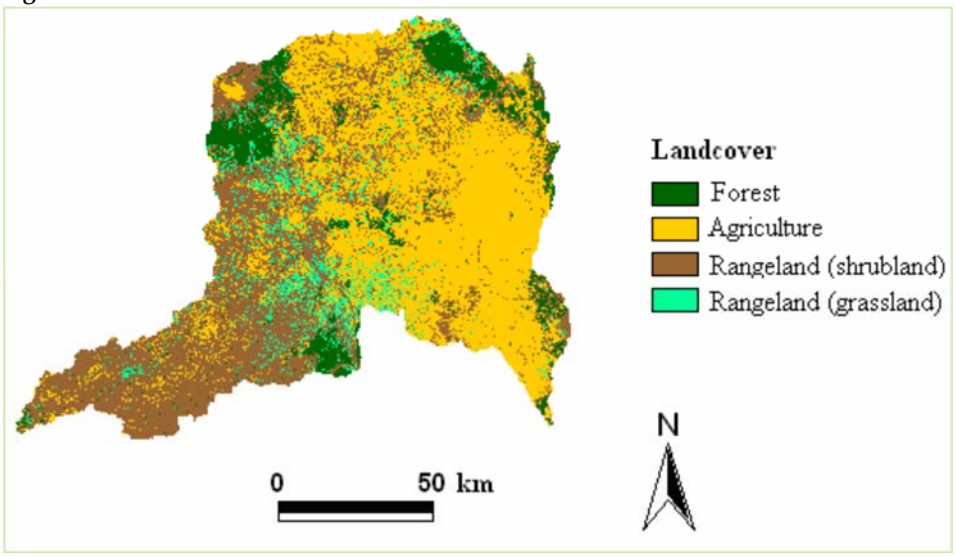
The dominant land use in the region is agriculture and the main food crops include maize. This cropping area runs into the wetter area bordering the depressions ensuring that the risk of crop failure due to drought during a dry year and towards the end of the rainy period. In an extremely wet year, the dry areas perform better.

The "swamp area", the very wet areas are covered by permanent or seasonal swamps. This land use is found on the shores of Lake Victoria, the banks of Nzoia River and on the southern part of the project area, which is Yala swamp. These bottomlands and swamps occur at altitudes ranging from 1140-1260 m with relief intensity of less than 5 m and slopes *of* less than 2%. The main swamp is found in the southwest of the survey area (Yala Swamp). River Nzoia also has swamps along part of their courses. The bottomland occurs in the north-eastern corner of the survey area and on the eastern side of the Yala swamp.

Less than 10% of the project area is cultivated with maize and sorghum. The interviewed survey raised reasons for the low cultivation intensity in the area which evolved around inadequate rainfall and floods. The project areas experiences severe flooding and as a result flood control measures are constantly being implemented in the area. Once these efforts are controlled, the project area may be able to increase in expand irrigated rice production and irrigated sugar cane farming. Presently, the major undertakings of the people of the area are rice farming (on tenant basis) in the Bunyala Irrigation Scheme, part-time fishing and temporary keeping of cattle, goats, poultry and sheep.

The other 90% of the area has been left fallow due to floodwater. Within the project area there are no natural habitats. The lack of natural vegetation is due to floods and cultivation of the area when the floodwater recedes. As shown on the **figure 11** below, the project area is shown as shrub land.

Figure 11. Land cover of Nzoia catchment



6.2 BIOLOGICAL ENVIRONMENT

6.2.1 Flora

The project area is a flat expanse with characteristic scrubland and savannah conditions. This vegetation is scanty with poor start grasslands around homesteads whereas the grazing fields are a mixture of tufted grasslands with thick bushes and scrub. There is reed vegetation where water floods during the rains, mostly resulting from the River Nzoia overtopping its banks rather than from the rains flooding the plains.

From site observations and literature review, some of the dominant species within the project area include *Cyperus papyrus, C. latifolius and Phragmites mauritianum*. Other common species were *C. articulatus, C. dives, Echinochloa pyramidalis, Leersia hexandra, Mimosa pigra, Persicaria decipiens, P. setosula, Acacia spp, Lantana camara, Albizia gunmmifera* and *Typha domingensis*. Most of the species are herbaceous while shrubs and trees or woody climbers are few. Herbs constituted the largest proportion of species. *L. camara* is an invasive weed species

It is notable however, that the areas natural vegetation cover might have been seriously modified through the developments of settlements and farms with the farms even being found in between the existing dykes. Natural vegetation cover and diversity in the area is thus limited to isolated patches within and along the dykes/river but with increasing density towards the lake, where reeds are the dominant species.

Farms and homes in the project area also have mixture of both exotic and indigenous woody species distributed in either clusters (few woodlots), along farm/homestead boundaries or scattered within the farms/homes. Some of the notable species identified were *Persium guajava, Mangifera indica, Makhamia lutea, Casuarina equisetifolia, Jacaranda mimosifolia* and *Cassia spectabilis*.

The plant diversity of the area's wetland is of economic importance. Some of the uses include being sources of handcraft materials, medicinal herbs, vegetables, grazing of livestock, thatching materials for house construction and firewood.

Bunyala has forest area in various hills in the district. There are also forestry resources on farms through agro-forestry and individuals woodlots practices. Agricultural crops also form part of the area's flora and these include paddy rice, maize, sorghum, sweet potatoes, cowpeas, beans, kales, oranges, avocados, bananas, cassava and melons and cotton. According to agricultural assessment conducted in the area, beans, maize, cassava, sweet potatoes and sorghum are the major crops in Budalangi. Notably maize, sorghum and millets are not grown in the short rain season due to flooding and the fact that they would not mature if planted after the floods recede. Instead, the most suitable crops for this season are early maturing tubers and pulses (cassava and sweet potatoes). In particular the tuber crops benefit from moisture and sediment deposits left after flooding.

The shoreline of Nzoia River is lined with the belt of papyrus (Cyperus papyrus) and other wetland grasses. Toward Lake Victoria the wetland comprises a mixture of

Cyperus papyrus in most inundated places and Phragmites mauritianus in the drier and higher grounds. In areas where flood water has not receded, secondary vegetation of papyrus reeds have started colonising these areas. Figure 10 shows the distribution of ecosystems in the area.

6.2.1.1 Forestry

Bunyala district has forest area in various hills in the district. The main forest activity is community based agro-forestry and individuals' woodlot practices where the local farmers are encouraged to plant trees in their home compounds and farms especially those trees that add nitrogenous compounds to the soils and those which provide fodder. Agro-forestry plays the dual role of enriching the soil, while providing protective vegetation cover and wood fuel for domestic energy supply. Exotic trees such as the Blue gum, *agravena* sp, among others, have been planted in the farms. The district has no gazetted forests apart from a few hilltops where trees have been planted by the forest department, such as Mbaga hill, Akala hill and Odiedo hill. The forestry programmes have been concentrated on hilltops where catchment afforestation is done for environmental conservation and provision of firewood and timber for construction purposes. Several other non-gazetted hilltops in the district are being encroached upon by individuals due to very high population pressure and resultant excessive cultivation. The area is also characterised by increasing land degradation and decrease in forest areas due to human related activities mainly excessive logging, There is also a poor attitude among the community towards environmental issues and little agro-forestry is practiced in the farms. There is still need to gazette some of the hilltops and enforce environmental compliance.

Within the project boundaries there are no forests due to human settlements and floods. As indicated above, the population have planted exotic tree species. Figure 12 below provides ecosystem types around the project area.

Figure 12: Ecosystem types

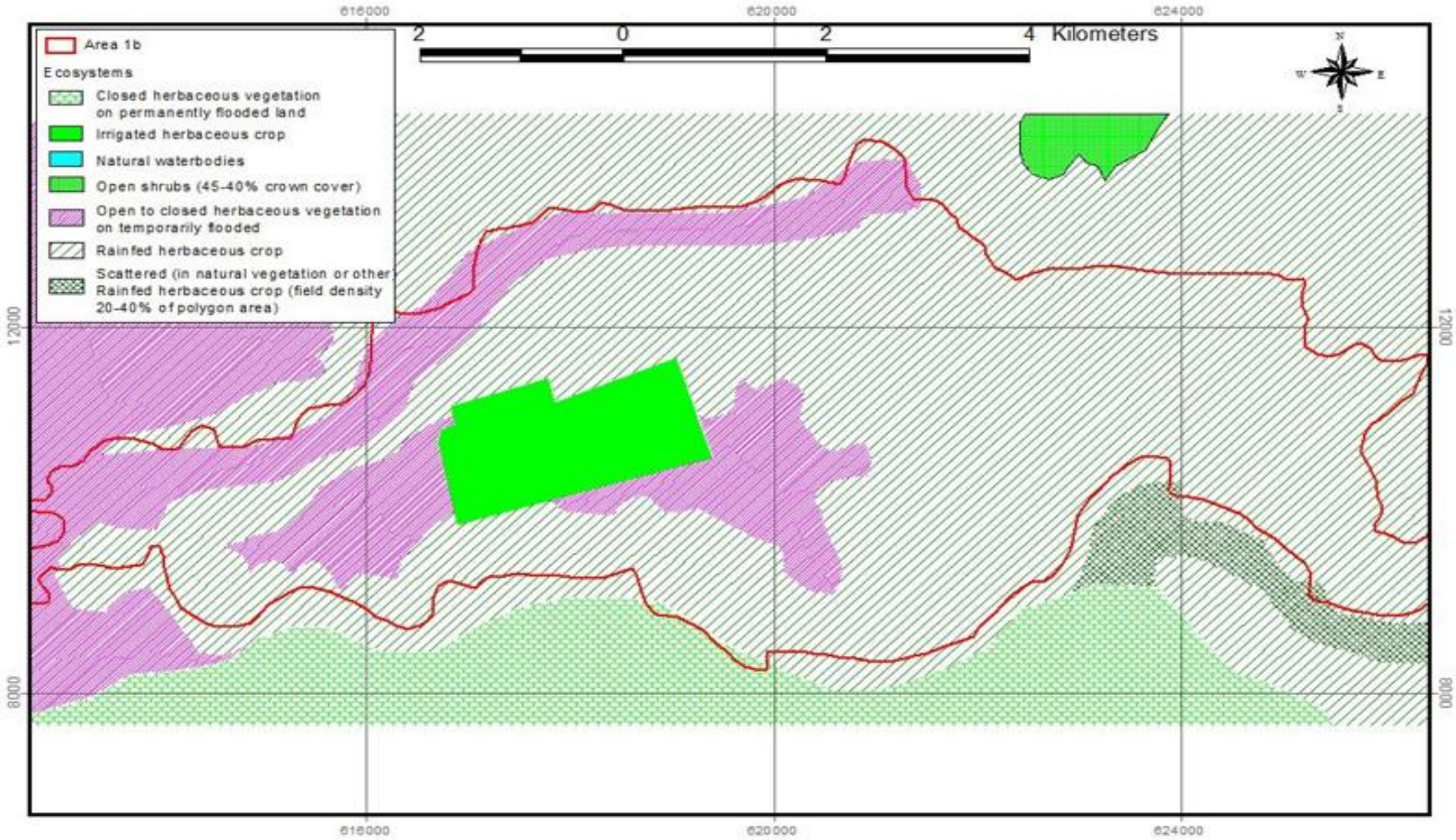


Table 6. Ecosystem types around the project site

LCID	LANDCOVER	AREA	PERIMETER	ACRES
AG-2	Irrigated herbaceous crop	2960951.554	7768.715	67.974
RL-5	Open to closed herbaceous vegetation on temporarily flooded	2592942.592	10343.800	59.526
RL-5	Open to closed herbaceous vegetation on temporarily flooded	1832290.473	7258.978	42.064
RL-6	Closed herbaceous vegetation on permanently flooded land	11211217.175	28101.297	257.374
AG-1B	Scattered (in natural vegetation or other) Rain fed herbaceous crop (field density 20-40% of polygon area)	3255500.829	15964.260	74.736
WB	Natural water bodies	100332.974	1277.206	2.303
FR-7	Open shrubs (45-40% crown cover)	749945.143	4074.687	17.216
FR-7	Open shrubs (45-40% crown cover)	13357.738	564.825	0.307
RL-5	Open to closed herbaceous vegetation on temporarily flooded	22930822.260	44021.326	526.419
AG-1	Rain fed herbaceous crop	67306394.671	108254.064	1545.142

The ecosystem types around the project area in comparison to the national ecosystem type are as shown on the **table 7** below.

Table 7. National Ecosystem type

NATIONAL COMPARISION			
LCID	**LANDCOVER**	**AREA**	**PERIMETER**	**ACRES**
RL-5	8212648436.455	16757164.130	188536.463
RL-6	1430051751.925	4603831.392	32829.472
AG-1B	20533944137.043	28593861.874	471394.493
WB	13309425425.519	9618186.601	305542.358
FR-7	33688448791.346	43245592.078	773380.386
AG-1	49022301370.466	42221420.424	1125397.183

6.2.2 Fauna

There are no animal species, which require special attention in terms of conservation within the project boundary. However the neighbouring swamps of Yala on the southern and marshy areas of Lake Victoria inhabit wild animals.

The common animals in the periphery of the swamp include: water buck (*Kobus defassa*), bushbuck (*Tragelaphus scriptus*), sitatunga (*Tragelaphus spekei*), reed buck (*Redunca*), warthog (*Phacochoerius*) and velvet monkey (*Cercopithecus aethiops*). Warthog is a serious menace in this area as it destroys crops planted in the cleared areas. Other wildlife animals found within the swamp are: crocodiles, hippos, hyenas, wild pigs, leopards, baboons, jackals, gazelles, impala and porcupine.

6.2.2.1 Avifauna

White-faced whistling ducks, African open-billed Stork, White-faced tress ducks, Comb duck or Knob billed ducks, Egyptian Geese, Spur-winged Geese, Doves, Pigeons, Black-chested snake eagles, Eurasian Marsh Harrier, Black-shouldered Kite, Wahlerg's eagle and the Western Banded Snake-eagle are among the bird species that are found in the project area. These are found in Yala swamp (see section 5.4.1). The swamp is recognised as an Important Bird Area (IBA) due to its rich diversity of birds by Bird Life International (Retrieved September 14, 2010 from http://www.birdlife.org/datazone/sites/index.html?action=SitHTMDetails.asp&sid=6431&m=0) (**Table 8**). Some of these bird species can be sighted in the project area especially within the Bunyala Irrigation Scheme.

Table 8. Common Birds of the Yala Swamp and its Environs

Common Name	Scientific Name
Squacco Heron	*Ardeola ralloides*
Purple Heron	*Ardea purpea*
White necked Cormorant	*Phalacrocorax carbo*
Egret	*Egretta sp.*
Hammer Kop	*Scopus umbretta*
Black kite	*Milvus migrans*
Crested Eagle	*Lophaetus occipatilis*
Fish eagle	*Haliaettus vocifer*
Harrier Hawk	*Polyboroidus typus*
Mouse bird	*Colius striatus*
Swift	*Apus sp.*
Wagtail	*Motacilla flava*
Grey Headed Gull	*Larus cirrocephalus*
Guinea fowl	*Numida meleagris*
Riparia	*Riparia sp.*
Black headed Gonolo	*Laniarius erythrogaster*
Weaver Birds	*Ploceus sp.*
Crested Crane	*Balearica regulorum*

Source: Field Assessment

Environmental Sensitivity

The wetland habitat in the project area hosts numerous bird species (as listed above). Many birds use wetland vegetation for shelter, feeding and breeding. Any activity that might lead to substantial wetland portion's modification or in extreme case, clearance is thus likely to result in significant environmental impact.

To further check for the area's biodiversity sensitivity, the various flora and fauna species recorded above were subjected to conservation status search. A review of any critical habitats or species was done against the IUCN Red Data List of Threatened Species (<www.iucnredlist.org>.) and The Lake Victoria Basin Aquatic Biodiversity Meta-Database. These did not reveal any species or habitats of critical concern and most of the genera are either of stable status or have not been assessed for the IUCN Red Data List. Hunting (of sitatunga whose population has been on the decline) and reclamation have however, been identified as major threats to the Nzoia wetland ecosystem.

From consultation with NEMA's Busia county office, plans are underway - being championed by both NEMA and the Nile Basin Initiative (NBI) - to gazette the area's

wetland and which will also give it an Important Bird Area (IBA) status. However, the exact geographical extent to be gazetted is yet to be clearly defined. Precautionary principle will be invoked in undertaking any activities in the area which may have negative consequences to the planned conservation goals. No areas or features of special biodiversity were established at project site.

6.3 SOCIO-ECONOMIC ENVIRONMENT

6.3.1 Population and Demography

The Nzoia Irrigation project traverses sixteen sub-locations. According to the 2009 Kenya population census, these sub-locations had a total population of 54,201. 46.1% of the populations are male while 53.9% are females. The ratio of male to female is 1.133:1. 53% of the Project Affected Persons (PAPs) are below 20 years while about 10% are above 60 years. There are a total of 13,273 households and the average population density is 299 persons per km2. The average household size is 5.9 with Kalkada Uradi having the highest number of 7.5 members and Kochieng B having the lowest number of 4 members per household.

On average a household head has 10 dependents, made up of one wife and 6 children. The composition of the population shows that young people below 19 years make over 50% of the total population. The District Development Plans (DDPs) in Siaya and Bunyala indicate that 40% and 66% respectively are classified to be experiencing absolute poverty is rural areas.

6.3.2 Settlement Patterns

Siaya district has a total land area of 1,520 km2 while Bunyala has 306.5 km2. Of this total land area, the arable area in Siaya district is 80.1% but reduces to 60.7% in Bunyala district. Despite high percentages of arable land areas, land use in the districts is below optimal as the practices disregard the need to conserve the soils and renew the soil fertility. Land is publicly and privately owned in the project districts. In Siaya district, 90 per cent of the land has been adjudicated and 197,325 title deeds issued.

The area is densely populated along the lake region due to pronounced fishing activities in the district. Plains of Bunyala are characterized by scarce population because it is prone to periodical flooding. Most of the population is concentrated in the urban areas of Port Victoria due to increased number of immigrants from the neighbouring districts to carry out lucrative fishing. Table 9 below summarizes housing building materials in the project districts:

Table 9. Housing building materials in the project districts

District	HH distribution by main wall materials					HH distribution by main Roofing materials		
	Stone	Brick/Block	Mud/Wood	Mud/Cement	Other	Corrugated Iron Sheet	Grass	Other
Bunyala	0.7	7.2	85.4	6.0	0.7	59.0	40.8	0.2
Siaya	2.7	9.5	73.1	14.3	0.5	63.7	34.5	1.7

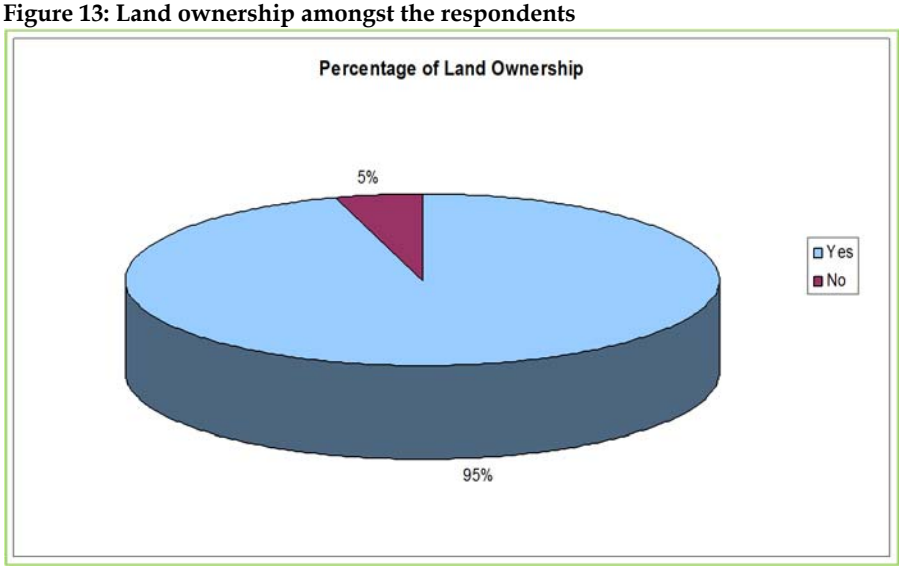
Source: Kenya Integrated Household Budget Survey, 2005/06 and District Plans

Houses are constructed with the exterior ground raised above adjacent ground level to prevent shallow floodwater from entering. The raised part is usually well compacted against the wall and the ground level. Also houses in the flood prone areas are made of thicker walls than those in higher parts of this area. During walling, properly mixed mud is placed from exterior side of the wall, so that when damaged, mud that cave from the wall piles at the outside part of the house. There are two construction techniques practiced in this area; houses constructed to resist damage by floodwater and those constructed temporarily.

6.3.3 Land Tenure System

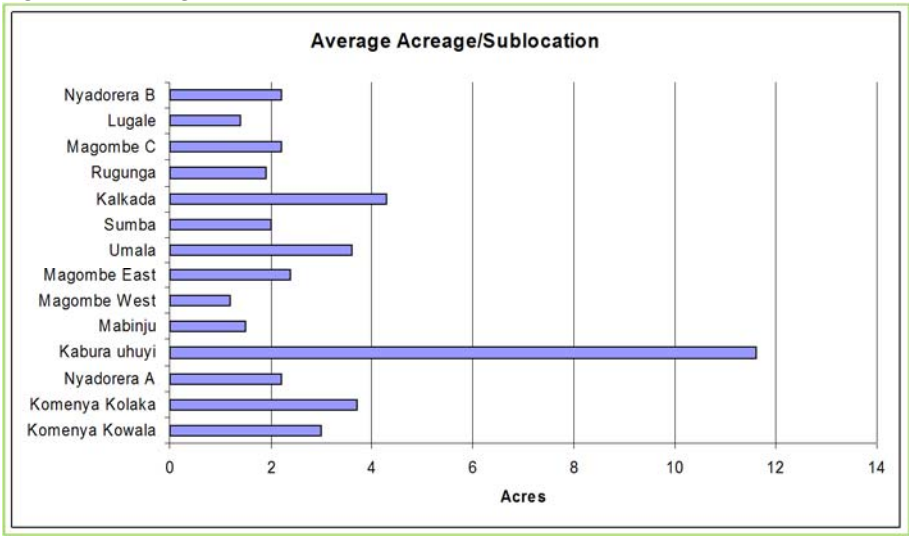
There are three categories of land ownership in the project area, i.e. government land, trust land and community and private land. According to Land Adjudication Office Siaya and Survey of Kenya Nairobi, most of the land in the project area is categorized as community or private free hold. 67% of the farmers' possessed documents to prove land ownership. Even for those who did not have documents, it was because succession may not have been done and such ownership was not in dispute. Land in the project area is either private owned land with free hold title or registered land owners with Ministry of Lands while waiting provisions of the title deeds. According to the socioeconomic survey, 95% of the respondents own the land in the area as shown on figure 13 below.

Figure 13: Land ownership amongst the respondents



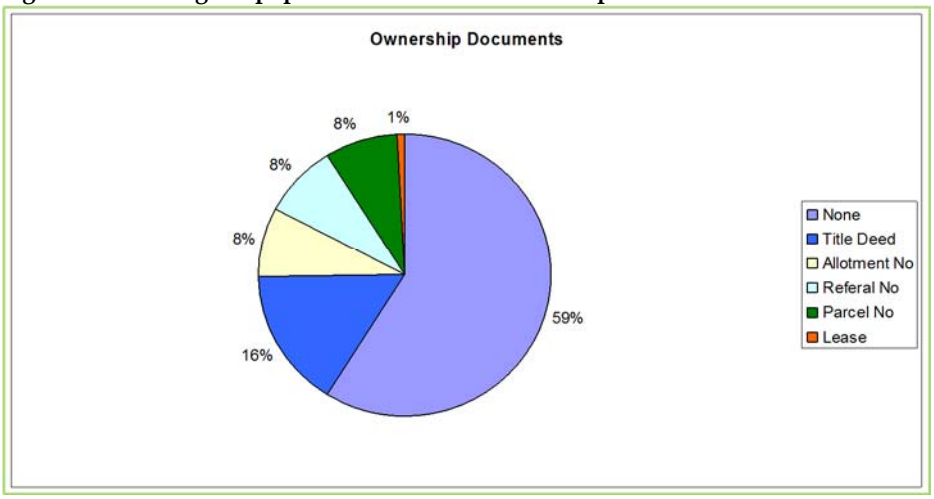
The remaining 5% lease the land for cultivation. Kabura sub location has the largest parcels of land per household in the project area as shown on **figure 14** below. The average land ownership in Kabura is 11.8%. Magombe West has the minimum land holding with an average of 1 acre per household.

Figure 14: Average land ownership per household



Half of the sampled population have no legal land ownership documents. 16% have title deeds, 8% have allotment letters, and same percentage has referral letters while another 8% have parcel number. One percent leases the land (figure 15).

Figure 1: Percentage of population with land ownership documents



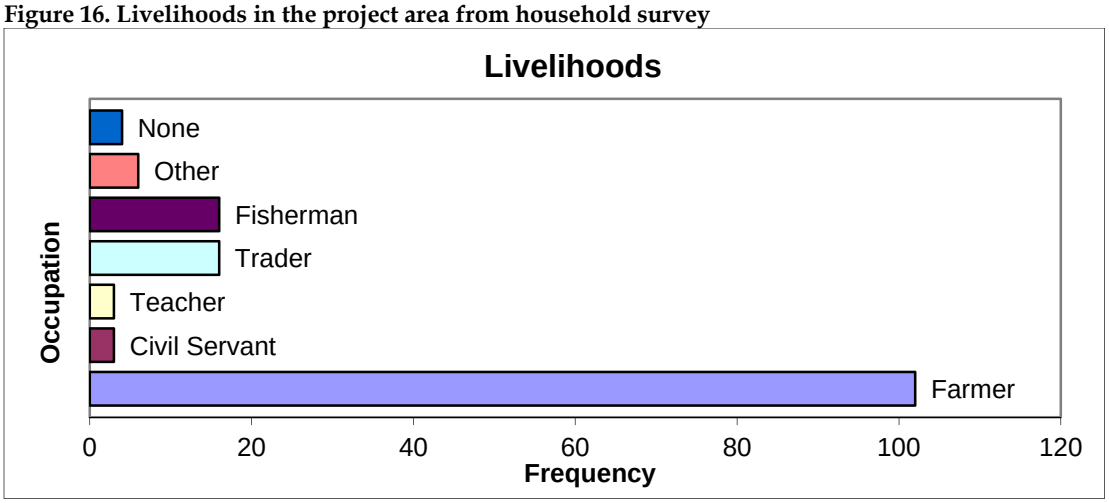
Due to frequent flooding of the land, land adjudication in the area was not completed. This is the reason for high number of the population without title deeds.

6.3.4 Livelihoods

There are various livelihoods means in the area. The household survey revealed that most of people in the project area are farmers with a frequency of 100, followed by traders and fishermen at 15, with a small fraction employed either as teachers or civil servants as illustrated in the figure 16 below. The three most important livelihood strategies in the study area are crop farming, livestock rearing and casual labor in the rice fields or in other people's farms. Other livelihood strategies in Bunyala that were found to be important are business, craftsmanship and formal employment to a lesser extent.

Rice farming is ranked as the most important economic activity in the area, which is sustained by a wide market in their local communities as this is their staple food, as well as in the adjacent regions and in neighboring towns both near and far. Rice from Bunyala is sold to communities and centers as Kampala and Bungoma.

Figure 16. Livelihoods in the project area from household survey



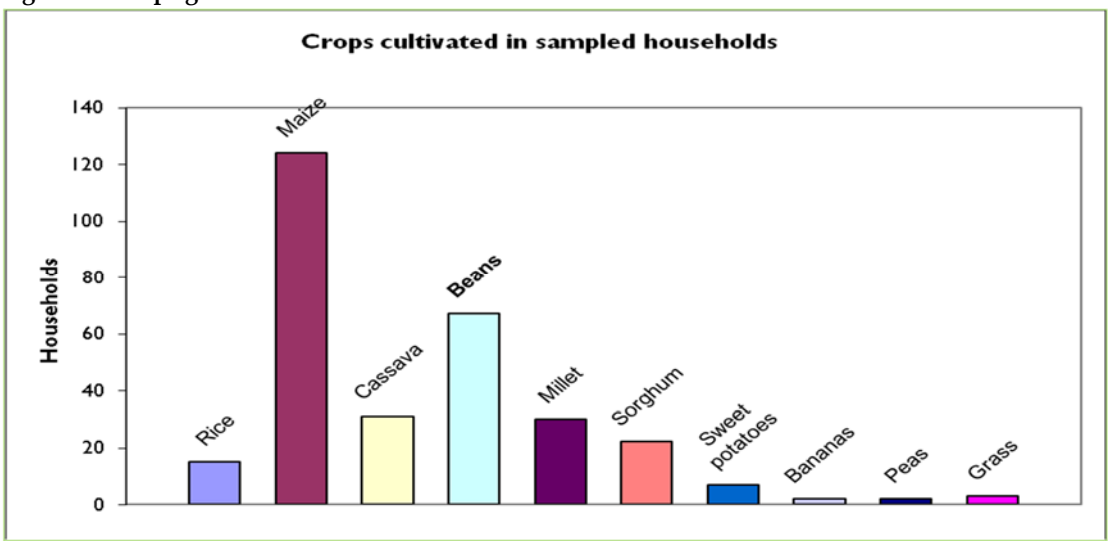
6.3.4.1 **Agriculture**

Both drainage and irrigation agriculture is practiced in the area where small scale farming dominates with average farm sizes varying from 1.02 Ha in Siaya to 2.5 in Bunyala. Interviews in the project area revealed that only 10% of the population used irrigation in crop growing and the rest (90%) relied on rain fed agriculture.

Bunyala district has a total approximate area of 300ha under irrigation benefiting approximately 2000 people against a potential of 40,000 people. Siaya district has approximately 1000 ha under irrigation against 3,000 ha, of potential area. Anyiko (Siaya district), is the only irrigation scheme within the proposed project area rice irrigation scheme to increase irrigable area from 50 ha to 80 ha.

The main food crops produced in the districts are maize, sorghum, finger millet, beans and cassava. Traditionally, cotton, bananas, sugarcane and tobacco have been the main cash crops. However, Irrigated rice, palm oil, chilli and grain amaranth have emerged as major alternative cash crops and are increasingly gaining prominence. According to the survey, maize is the most cultivated crop in the area followed by beans shown on the figure 17 below.

Figure 17: Crops grown in the area



Other crops grown in small scale include sugarcane, sweet potatoes; Green vegetables (kale and indigenous greens) grow with partial irrigation. Farmers use kitchen water, spring water and intricate systems of trenches for catching rainwater to irrigate, mostly by hand.

Pests and disease control is becoming increasingly an important aspect of production in the study area. Some of the pests and diseases facing production of crop in the study area

- Hailstones: They were reported in pockets of the District during the long rains season.
- Quelea Quelea birds: These are serious pests in the rice fields and also on the sorghum fields.
- Cassava Mosaic Disease
- Wilt of Tomatoes
- Maize Streak diseases
- Panama disease of Bananas
- Armyworms
- Greater Grain Borer

Agricultural sector is the highest overall contributor to household incomes in the project districts as presented on table 11 below.

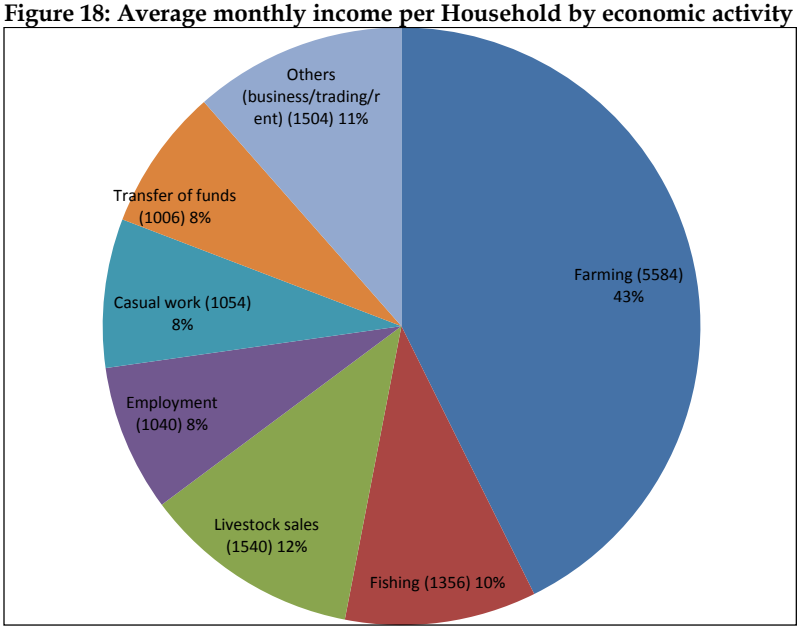
Table 10. Sectoral contribution to Household incomes

	Sectoral contributions to house hold income (%)	
Sector	**Siaya**	**Bunyala**
Agriculture	65.6	38.2
Urban self-employment	15.3	3.8
Rural Self-employment	8.8	39.1
Wage employment	9.2	10.2
Other	1.1	5.7

Source: District Development Plans (2008-2012), Siaya and Bunyala

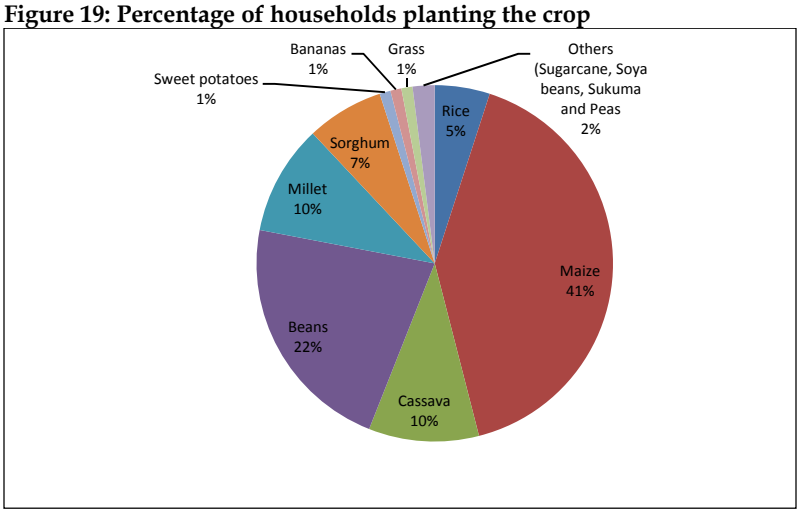
In the project area, residents earn their livelihoods from diverse economic activities including farming, employment (civil servant, teacher), trading, fishing and doing other jobs including electrical, motorcycles (Bodaboda) and security. The commonest source of livelihood is farming (70%), followed by fishing and trade (11% each) and employment (4%) as presented on **figure 18** below.

Figure 18: Average monthly income per Household by economic activity



Source: Field assessment

Figure 19: Percentage of households planting the crop

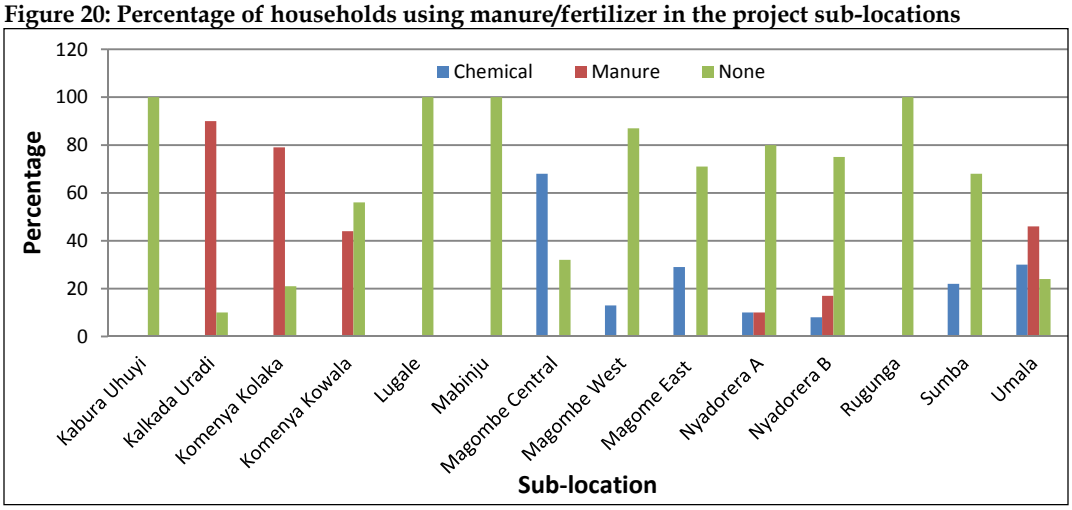


Source: Field Assessment

Food in the area is mainly stored on-farm in traditional granaries and/or off-farm in National Cereals and Produce Board (NCPB). The total population working in the agriculture sector is over 80%. Crop farming is faced with few challenges like flooding that destroy crops.

In the project area, household interviews revealed that a large proportion of people (69%) do not use any fertilizer. Further most households use manures (22%) than those who use chemical fertilizers (9%).

Figure 20: Percentage of households using manure/fertilizer in the project sub-locations



Source: Field Assessment

There is more use of chemical fertilizer in Magombe Central location while manure is commonly used in Magombe West, Komenya and Kowala and majority of the people in Lugale location do not apply either manure or chemical fertilizer.

Table 11: Cropping calendar

Crops	Jan	Feb	Mar	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Maize												
Cotton												
Finger Millet												
Sorghum												
Paddy												
Horticulture												
Fruit tress												
Napier grass												
Cassava												
Sweet potatoes												
Pulses												

Source: Feasibility Study Report.

6.3.4.2 Livestock Keeping

Local breeds make up most of the livestock with the main animals kept in the project districts being Zebu, dairy cattle, goats and local poultry. Other livestock are also reared in the districts including sheep, pigs and rabbits. Livestock products in the project districts include milk, beef, mutton, poultry meat, egg, honey and pork. In the past, land was plenty and animals were left to graze freely. However, with reduced land availability, animals are tied up to graze in small grassy areas or kept at home for zero-grazing. The average family in the 2 districts has only 3 cows.

In the project area, domestic animals found to be most common are chickens followed by cattle, goats, ducks and sheep as presented in the **table 12** below.

Table 12: Domestic Livestock in the area

Livestock	Total number from household survey	Number per household
Cattle	396	2.6
Goats	194	1.3
Donkeys	13	0.1
Sheep	91	0.6
Pigs	36	0.2
Rabbits	8	0.1
Chickens	1041	6.9
Ducks	121	0.8
other poultry	226	1.5

Source: Field Assessment

Culturally, livestock plays a very important role in the study area including production of milk, dowry, meat, gifts for funerals, and these acts as a savings. Livestock is mostly grazed on the natural grassland or fallow field after harvest and managed using traditional techniques. The livestock is also grazed in the wetland areas especially as the floodwaters recede or during exceptionally dry years when the swamp areas shrink i.e. during the period when the Lake Victoria level fell substantially leaving the fringes dry.

6.3.4.3 Fishing

Fishing is traditionally practiced among the lakeshore communities (Luos) and could be found along the Lake Victoria, Lake Kanyaboli, and River Nzoia and within the wetlands. It is an activity that provides an exit option for local communities when the local farming activities are depressed. Within the project area fishing is mainly done in the lake but also along the Nzoia River and the wetlands such as Sifuyo and Mahawa swamps on the right/left bank of River Nzoia. These are second to agriculture apart from petty trade and remittance from those working outside the area.

The Luos and the Abanyala; who in many cases share traditional practices pertaining to fishing which include, men's dominance in the physical removal of the fish in the said water bodies and women basically does the sales. There are no organized organizations that facilitate the sale of the fish; hence the middlemen expose fishermen to exploitation.

The major nearby fish collection and sales points include Sio Port and Port Victoria. The project area is characterized by a number of water ponds of different sizes and which as suggested could be transformed into fishponds. The project could also encourage this attribute by increasing the number of ponds. This will contribute in meeting ever-increasing demand for fish.

The common fish species catch being Oreochromus Osculentus (*Ngege),* Catfish *(mumi,* Nile perch, Omena, and Protopterus acthiopus *(kamongo).* In 2008, there were 3364 fishermen who mostly composed of strong energetic men leaving agriculture for the old men, women and children hence creating food insecurity. Land beaches are 18 and total

Production from Capture Fishery was 62,469 metric tonnes, which fetched Kshs. 59,325,642.

6.3.4.4 Sand Harvesting

Brick making/granite mining and sand harvesting is observable along the road reserves, wetlands and on arable cropland normally carried out by men. The sand harvesting is mainly carried out in specific pockets of the river which include; Wadh Mbare and Ajuke in Simur Kondiek sub-location, Adeda, Nyadenda and Lwanga in Siranga sub-location, Central Ugenya has 6, 3 places in West Ugenya location while Bunyala North and Khajula locations have 4 each. It is an activity mainly for the youth though it is hampered by poor state of roads.

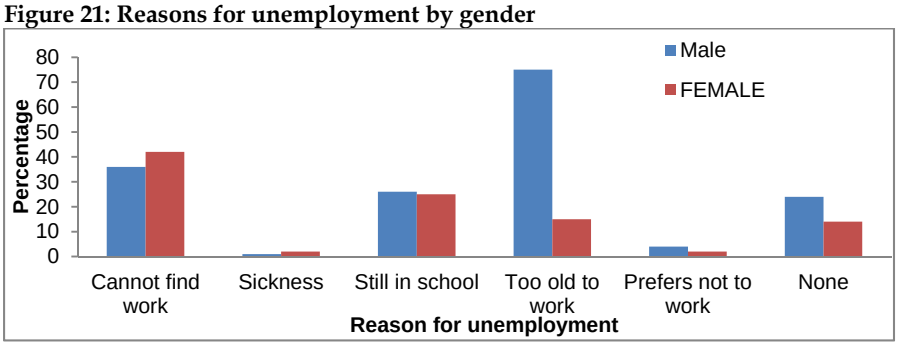
6.3.4.5 Brick Making

The study area is endowed with black soils that enhance brick making, though the product is minimally utilized exclusively within neighbouring towns such as Kisumu, Siaya, Mumias and Busia. Houses, institutions and offices built out of bricks are less than 20% where as a greater percentage are semi permanent. This occupation though helps the community members. However, when put together with the need for firewood for basic cooking, brick making activity causes a concern of deforestation that should be addressed within the context of the project development. Energy saver 'Jikos' are not in use except in West Ugenya location where it is being introduced.

6.3.4.6 Employment

The labour force (15-64) in the two districts in 1999 was 280,298 (Bunyala 25,182 and Siaya 255,116) and is expected to continue increasing. Over 70 percent of labour force is engaged on family farms. The remaining over 25 per cent is distributed over other economic activities such as fishing, trading and employment in the formal and informal sectors. The rate of unemployment in the districts is 73 percent. The household survey revealed that 52% of the males and 48% of the females in the project area were unemployed. Majority of those employed worked in Nairobi (23%) followed by Mombasa (15%) and Kisumu (14%) while the rest worked in various other towns. The reasons advanced for unemployment included: cannot find work (39%), Sickness (2%), still in school (26%), too old to work (11%) and prefers not to work (3%) while the rest did not give reasons for not being in a gainful employment. **Figure 21** below presents an overview of reasons for unemployment in the project area.

Figure 21: Reasons for unemployment by gender



Source: Field Assessment

6.3.5 Health

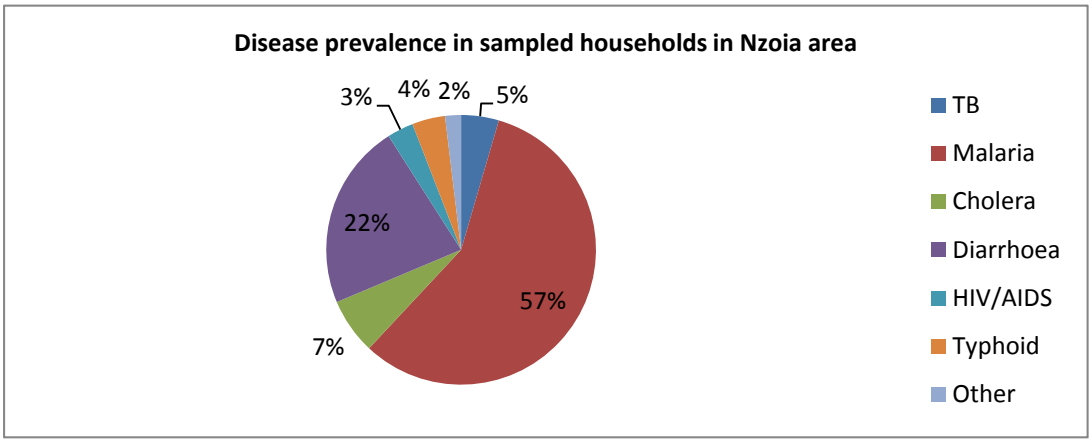
6.3.5.1 5.3.5.1Diseases

The commonest diseases in the project area was malaria accounting for 58% of the morbidity rates, followed by Diarrhoea (23%), Cholera (7%) and others (TB – 5%, Typhoid – 4% and HIV/AIDS – 3%) order of prevalence as shown in the figure 16 below. Many of these diseases are water related. The project area lies between Siaya and Bunyala districts each having specific backgrounds to disease outbreaks and prevalence. The life expectancy in Siaya is 36.9 and 43 years for male and females respectively while it is higher in Bunyala standing at 40 for males and 46 years for females. In Bunyala District, according to the Regional Assessment Team from Kenya Food Security Steering Group (KFSSG), in 2007 the district immunization coverage was 70.1%. Floods along the Nzoia river basin increase the cases of water-borne diseases such as cholera and increase the breeding grounds for mosquitoes leading increased cases of malaria. Flooding also leads to outbreaks of livestock diseases. The district also has latrine coverage of 46% according to KFSSG (2007), which poses a serious health hazard due to contamination of underground and open water sources from solid and waste disposal.

HIV/AIDS prevalence rates in the districts are 19.2% (15.4% in Bunyala and 24% in Siaya district). Thus implies that HIV/AIDS is a major health concern in the project area. The project area experiences annual flooding which brings many water borne diseases that attacks the already weakened immune system. Flooding means the loss of crops, creating hunger. Other factors contributing to rapid spread of HIV/AIDS are:

- Engaging in unprotected sex
- Ignorance on safe sex practices
- Unwillingness to use condoms
- Ignorance on HIV status
- Commercial sex workers
- Extensive traditional use of herbal medicine.
- Negative cultural beliefs and unhygienic practices that facilitate the spread of HIV/AIDS including deliveries routinely performed by Tradition Birth Attendants and wife inheritance and/or sharing amongst age mates

Figure 22: Disease prevalence in the area



Source: Field Assessment

6.3.5.2 5.3.5.2 Health Facilities

The project districts have 78 health facilities (Bunyala 7 and Siaya 71) including hospitals, health centres, nursing homes, dispensaries and clinics. These are either public or private. The districts have 19 Voluntary Counselling and Testing (VCT) centres and 20 facilities offering Antiretrovirals (ARVs).

6.3.6 Transportation and Communication

The area is served with all-weather road are impassable during rainy season. Matters become worse when Nzoia River breaks its banks causing severe flooding that render the roads unusable and delinking areas like Mau Mau from the rest of other areas. The length of roads (earth, murrum, bitumen etc.) in both districts is tabulated below.

Table 13. Length of roads in Siaya and Bunyala districts

District	Nature of road (Kms)			
	Bitumen	Murrum/ Earth	Gravelled	Total
Bunyala	0	92	-	92
Siaya	97.9	667.2	400	1165.1
Total	97.9	759.2	400	1257.1

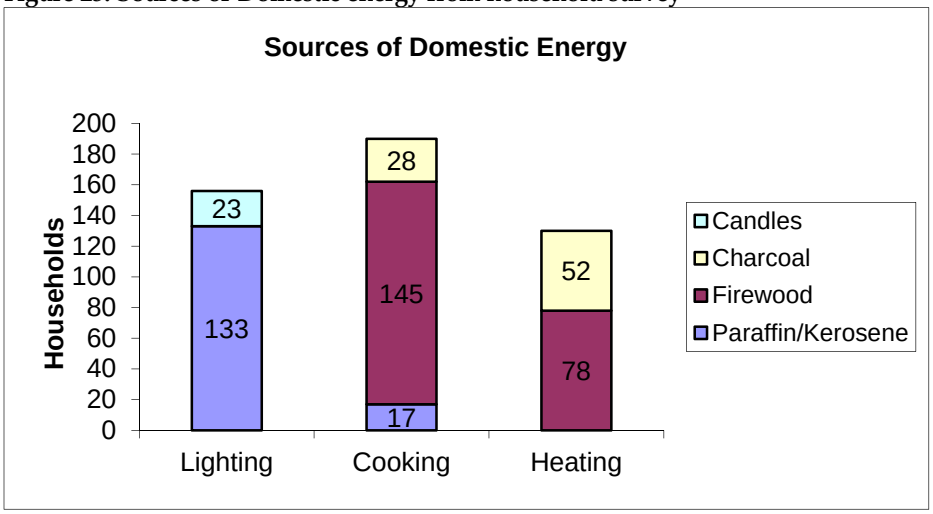
Source: Siaya and Bunyala District Development Plans, 2008-2012

Other transport infrastructure includes airstrips, waterways (only in Bunyala) and railway (only in Siaya district). The main communication facilities in the districts include mobile phone, post /sub post offices, telephone booth, private courier services, radios and cyber cafes.

6.3.7 Energy and Domestic Water Sources

The major energy sources within Siaya and Busia Districts with respect to quantity are fuel wood, paraffin, petroleum gas and electricity. Charcoal is the most popular within the urban centres such as Busia and Siaya Township; this is also mirrored by the upcoming urban centres (**Figure 23).**

Figure 23: Sources of Domestic energy from household survey



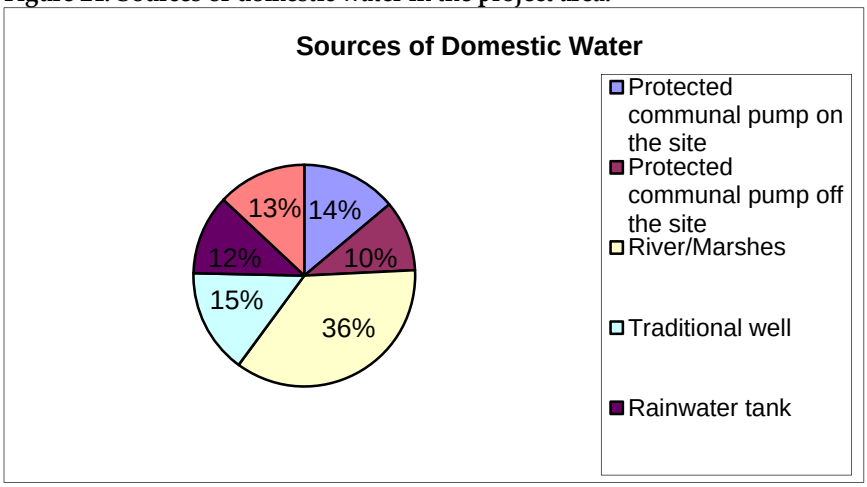
Source: Field Assessment

The main source of energy in rural Kenya today, inclusive of the Nzoia river basin is wood fuel. It is used for all the basic rural energy requirements, apart from Kerosene, which is used for lighting within most of the rural homes.

The principle sources of domestic water for drinking and cooking are wells and bore holes. Lake water is primarily used for recreation and fishing while Nzoia river water is used for washing and irrigation. The river and its tributaries provide permanent water but with varying flows through the seasons of the year. Major water reticulation systems in this region are found in urban centres abstracting water from the river and its tributaries. This shows that the Nzoia flood plain has good water resources that can be used in a sustainable way.

The major water reticulation systems are only available in the urban centres abstracting water from the river and its tributaries. Otherwise water reticulation schemes for the rural masses are few. The bigger hindrance to this development is the high cost of operation and maintenance. The organizational capacity of the rural masses in this respect is also in doubt. It was however observed that shallow wells exist within the study area. For the potential selected irrigation area, therefore water for human consumption should be an important consideration with respect to quality and quantity. Information from the household survey was used to plot the pie chart in **figure 24** below.

Figure 24: Sources of domestic water in the project area.



Source. Field Assessment

6.3.8 Water Access and Sanitation

The study area is relatively well endowed with water resources. The water sources in the study area include River Nzoia and its tributaries, swamps, few earthen dams on the tributaries and potential for ground water, Nzoia being the largest. The average distance to the nearest potable water point for many is within 2 km. Investigations revealed that the water is basically used for domestic use, drinking for both humans and livestock and about 3% of the population use it for irrigation of crops especially horticultural crops. Piped water is available only within the urban centres and effort should be made to

extend this benefit to the rural areas. This would bring direct benefit to the women who otherwise must make a choice between the effort and time involved in fetching and boiling water or facing the risk associated with consuming untreated and boiled water.

It was established that all locations have an average of 10 shallow wells because the Government and NGOs are promoting safe water supply in the area. There are few piped water systems in the area i.e. townships and only in West Ugenya location and Bunyala North location. Other sources include ponds, springs and rain water. It should be noted that relatively good impression was obtained on the enthusiasm of the inhabitants of the project area on utilization of river Nzoia water for irrigation.

A number of households still lack sanitation facilities (latrines, toilets) due to poverty and presence of alternative defecating areas (bushes). This constitute one of the principal pathways for infection which can kill people once the human wastes are swept by running water into the water bodies. This is coupled to the notable long distance to health centres.

6.3.9 Education and Literacy levels

The project districts have a total of 1072 education institutions (pre-primary schools – 455, primary schools – 425, secondary schools – 118, other training institutions – 8 and adult classes 66). Majority of these are located in Siaya district. Literacy levels are higher in Siaya (78.2%) than in Bunyala (62.5%) district. In both districts, literacy levels for males (81.6%) is higher than for females (59.9%) as presented in the **table 14** below**.**

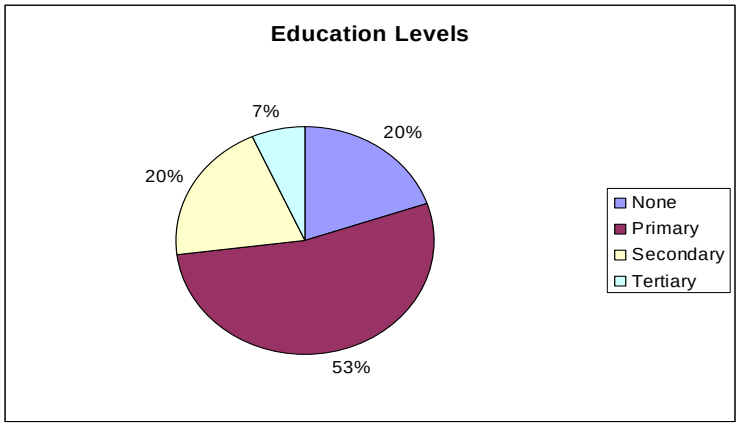
Table 14: Education institutions and literacy levels in project districts

Type of institution		**Number of institutions per district**		**Total**
		Bunyala	**Siaya**	
Number of educational facilities	Number of pre-primary schools	28	427	455
	Number of primary schools	34	391	425
	Number of secondary schools	7	111	118
	Number of other training institutions:	4	4	8
	Number of adult classes	18	48	66
Literacy levels (%) by sex	Male	73.9	89.2	81.6
	Female	51.1	68.7	59.9
	Total	62.5	78.2	70.4

Source: Siaya and Bunyala District Development Plans, 2008-2012

The household assessment results showed that majority of the population (53 % have at least attained primary school level. However, there were a small percentage of these proceeding to secondary (20%) and even fewer reaching tertiary institutions (7%). The remaining 20% was found to formal education (**figure 25**).

Figure 25: Literacy Levels in the project area



Source. Field Assessment

6.3.10 Gender and Inequality

50.4% of all households in Siaya are female headed households while children headed households are 4.4%. Bunyala district has 13,749 households of whose average size is 4.5%. The high number of female-headed households may be explained by single parenthood and high male mortality rates.

Gender roles related to livelihood activities were also very clear. For instance, land preparation, maintenance of water levels and cutting of rice stalks is done by men, while both genders could do land-levelling and bird scaring. Women exclusively do transplanting, weeding, and threshing. In all other farming activities, a similar trend is duplicated, with men doing the harder manual work such as clearing and ox-ploughing, while women did hand digging, planting, weeding and harvesting. Men are also employed in construction sites and digging of water channels. Weaving and livestock rearing is done by both gender, even though men also do undertaken spraying of cattle or take to the dip. Very few of both genders from the same household are involved in formal employment.

6.3.11 Poverty

The project area lying between Siaya and Bunyala districts faces deprivation associated with poverty that is characteristic throughout the two districts. The Lower Nzoia basin straddles the Siaya and Busia districts both of which have 60-70% of their population living below the poverty line.

The KIHBS 2005/06 revealed that the absolute poverty in Siaya district was 39.3% (Rural 40% and Urban 38.6%) with Food Poverty being 34% and the district contributed 0.013% to National poverty. The absolute poverty in Bunyala district was 68% while food poverty was 62% and the district's contribution to national poverty was 2.43%. Bunyala district has 50.5% male and 49.5% of females who are poor while similar figures for Siaya district are 46.9% male and 50.7% of females (CBS, Well Being in Kenya – A socio- Economic Profile, 2008).

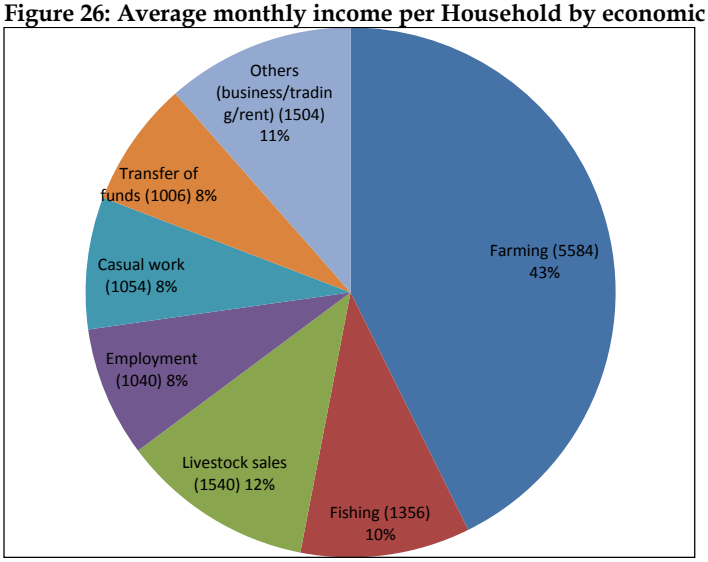
There are many factors that have caused poverty to spread including population growth, shifting land use systems and ownership from common to individual, pressure on natural resources such as trees (for firewood and building), deforestation leading to soil erosion and desertification and a decrease in soil fertility. Other causes include increasing expenditures on education and healthcare. Though there are many development initiatives in the project area, poverty is still a major challenge. Most families live on less than a dollar a day. Poverty hits hardest in areas facing low rainfall levels and poor soil fertility, such as the lower Ukwala, Uranga and Karemo divisions. According to the household survey the main challenges that the residents around the project area face are food shortages, education and fees, money and income, clothing, diseases and healthcare facilities shortages, shelter and employment, in respective order of magnitude.

6.3.12 Income

Agriculture is the most adopted means of livelihood and as such it's the highest source of income in the area at 43% followed by livestock keeping and fishing as shown on **figure 26** below.

The average monthly income for the household head is Kshs. 5,200. The survey that was conducted during design indicated that farm incomes from crops the previous year was Kshs. 16,108 that translated to approximately Kshs.1, 300 per month. The average annual income from livestock and agricultural wages was Kshs. 13, 571(Kshs.1, 100) per month. This depicts that for the bigger populace crop production generate more income compared to livestock. However, it was noted overall annual income was generally low. Only a small percentage4% indicated have permanent jobs with an average income of Kshs. 61,019, while over a quarter 28% had small scale business with average annual income of Kshs. 15,566. By and large, farming and other agricultural related activities are more important as a source of income for the local community and should be given more emphasis for the development of the area. Most expenses go to education which has a mean of Kshs. 8,538 per month.

Figure 26: Average monthly income per Household by economic activity

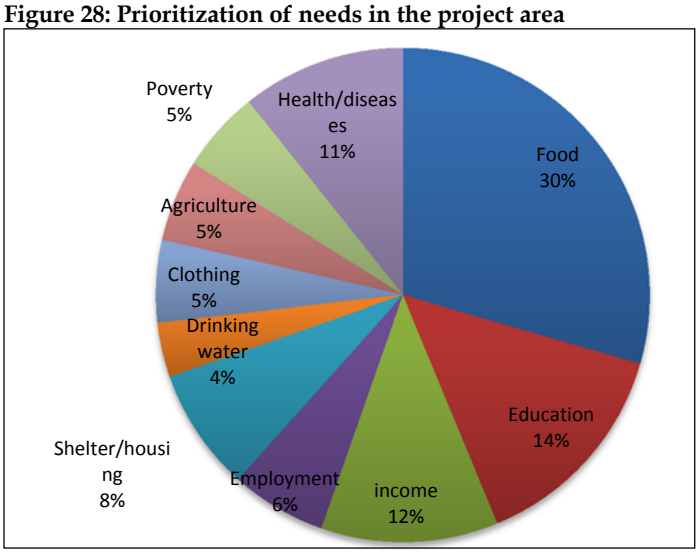


Source. Field Assessment

6.3.13 Challenges and needs in the project area

Prioritization of needs and assessment of coping mechanisms was conducted to assess the values locals attached to various issues, specifically agriculture. From the interviews conducted, food is the major challenge/need accounting for 30% of all the needs. This is closely followed with education, incomes and health respectively. The irrigation project aims at primarily addressing the two issue of food security (30%) by extension poverty (income and employment – 18%) and agriculture (5%), which combined accounted for 53% of all the needs in the project area. This is a clear justification for the project implementation.

Figure 28: Prioritization of needs in the project area



Source: Field Assessment

Residents in the project area have adopted various strategies to cope with each of the above needs as follows:

- Health- visiting the local clinic, taking medicine or going to a doctor, using Herbal medicine, using NHIF funds, maintaining healthy standards and doing without medicine when on falls sick
- Education - Seeking assistance from schools, letting children dropout of school, borrowing from friends/relatives, getting Bursaries/community raise fees/harambee, assistance from charitable institutions and paying fees in bits
- Employment - doing casual work
- Food - engaging in farming, Buying food, relying on relatives, diversifying crops grown, growing resistant crops and depending on food aid form GOK and NGOs
- Poverty, Income and employment- engage in business activities or casual labour to generate income, Pray to God, foregoing non-basic necessities and borrowing from neighbours
- Other strategies are getting loans from society, engaging in income generating activities and relying on children and handouts from relatives
- Water - boil water, using untreated/unsafe water and searching long distances for water

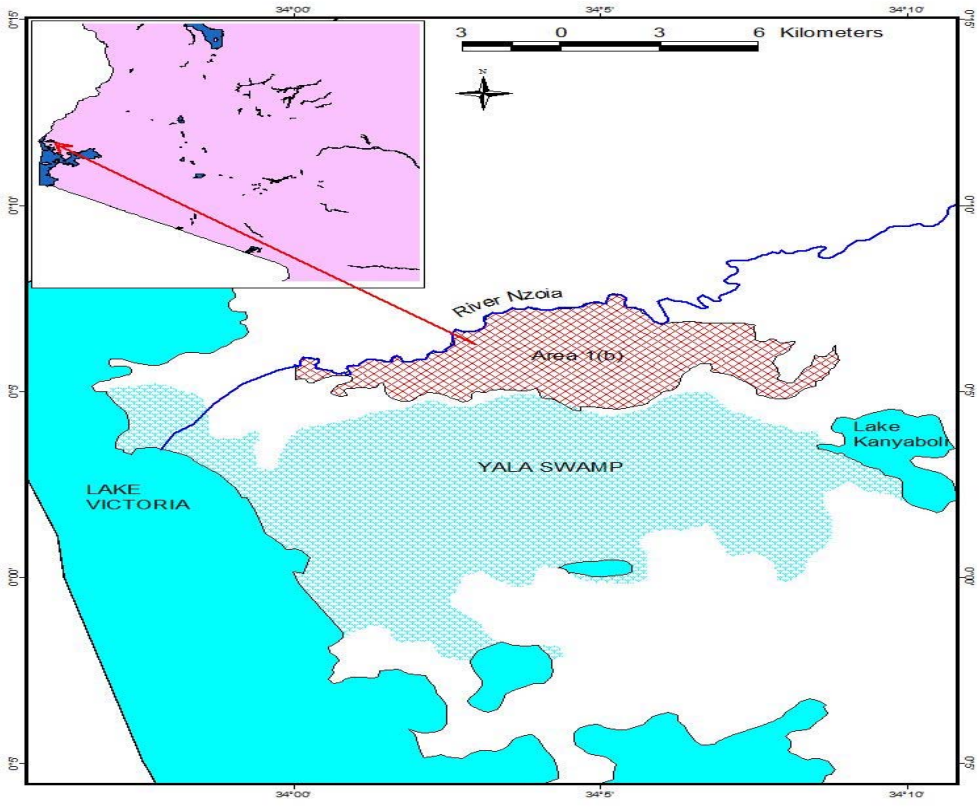
- Shelter and housing - constructing more houses as a preferred strategy and living/sharing their houses with their livestock.
- Agriculture (labour, ploughing and inputs shortages in farms) - use hand digging, local seeds and relying on family labour.
- Clothing - buy second hand clothes.

6.4 SENSITIVE ECOSYSTEM

6.4.1 Yala Swamp

The Yala Swamp is south to the project area and bounded to the north by the Nzoia River and to the south by the Yala River. The swampland covers an area of about 17,500 hectares (ha) in Siaya, Bondo and Busia district that is home to nearly 1.2 million people. This is Kenya's largest wetland, a very delicate ecosystem, and the habitat of some rare flora and fauna, including endangered fish species. The swamp serves the adjacent communities as a source of fish, water, agricultural land, pastures, wild animals, plants for constructing houses, source of wood fuel and medicinal plants.

Figure 30: Yala swamp location relative to the project area



6.4.2 Nzoia River

The meandering of River Nzoia has created swampy areas along its banks. These swamps are a source of fish, water for irrigation and natural products that are harvested by local community. Mud fish is common in these flooded areas and provide a source of

nutrition. Papyrus is also harvested for mat making and thatching of houses as well as weaving baskets, which is sold for income by both men and women.

6.5 ENVIRONMENTAL AND SOCIAL TRENDS

6.5.1 Poverty

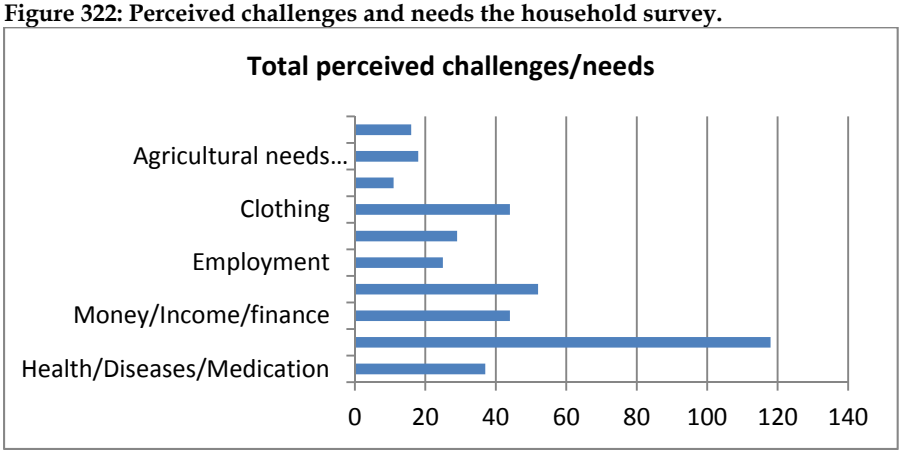
The project area lying between Siaya and Bunyala districts faces deprivation associated with poverty that is characteristic throughout the two districts. The Lower Nzoia basin straddles the Siaya and Busia districts both of which have 60-70% of their population living below the poverty line.

The KIHBS 2005/06 revealed that the Absolute poverty in Siaya district was 39.3% (Rural 40% and Urban 38.6%) with Food Poverty being 34% and the district contributed 0.013% to National poverty. The Absolute poverty in Bunyala district was 68% while food poverty was 62% and the district's contribution to national poverty was 2.43%. Bunyala district has 50.5% male and 49.5% of females who are poor while similar figures for Siaya district are 46.9% male and 50.7% of females (CBS, Well Being in Kenya – A socio-Economic Profile, 2008).

There are many factors that have caused poverty to spread including population growth, shifting land use systems and ownership from common to individual, pressure on natural resources such as trees (for firewood and building), deforestation leading to soil erosion and desertification and a decrease in soil fertility. Other causes include increasing expenditures on education and healthcare. Though there are many development initiatives in the project area, poverty is still a major challenge. Most families live on less than a dollar a day. Poverty hits hardest in areas facing low rainfall levels and poor soil fertility, such as the lower Ukwala, Uranga and Karemo divisions.

According to the household survey the main challenges **(figure 32)** that the residents around the project area face are food shortages, education and fees, money and income, clothing, diseases and healthcare facilities shortages, shelter and employment, in respective order of magnitude.

Figure 322: Perceived challenges and needs the household survey.



Kristjanson P., Krishna A., Radeny M. & Nindo W. in the study *Pathways out of Poverty in Western Kenya and the Role of Livestock* (2004) by International Livestock Reserch Institute (ILRI) describe Siaya District as having 47% percent of its population below the rural poverty line in 1994 and this increased to 64 percent in 1999. They then add that in the last 25 years (since 2004) that 8% percent of households climbed out poverty while 25% percent became impoverished during the same time. The main strategies form their survey for escaping poverty (poverty eradication) include diversification of income, diversifying on farm income through cash crop production and livestock ranging from cattle to poultry. The main reason in their findings for households falling into poverty was poor health and the high cost health related expenses which was the case in 77% of the households they surveyed in Siaya. They also find that the four main reasons for household remaining poor are poor health and related health expenses, heavy funeral expenses, low level of education and unproductive land.

Bunyala district which formerly part of Busia district has high poverty levels of 64% which when coupled with the HIV prevalence rate threaten food security in the district (KFSSG, 2008). There are not many studies on the poverty levels, causes and maintaining factors in Bunyala District however it shares similar characteristics with the surrounding districts of Busia and Siaya and this also presents an opportunity for a comprehensive study to be carried out in the wider Bunyala district.

There are a number of poverty eradication schemes in the two districts and the rice irrigation scheme by National Irrigation Board is one of them in Bunyala district. There is pressing need to eradicate poverty in the area to improve standards of living, agricultural productivity, food security and general wellbeing of the people.

6.5.2 Population Increase

According to the latest national household and population census (1999) the total number of people and households within the Lower Nzoia Basin, the project area is estimated at 183,312 and 37,859 respectively. The average annual growth rate in the area is about 3%. The population census gives the working population on family farms (15-64 years old) in the country as about 74 % of the total population. This means that 3.9 persons are available for family labour on an average (116,156 persons/21,891 households x 74% = 3.9 persons/household).

With improved food security, improved infrastructure and resources to improve them, creation of employment and socio-economic improvement that can result from the project then it is expected that population will increase by reducing infant mortality, increasing life expectancy and people will migrate into the area in seek of employment.

6.5.3 Soil Erosion

The types of soil that exists in some parts of the project area particularly the downstream region of Nzoia River is a major contributor of increased floods. The existing soil does not allow water to drain easily so the soil becomes waterlogged leading to flooding. Due to frequent flooding, soil erosion occur leading to the top fertile soil being washed away to other areas. People living in the area have experienced erosion problems along the

riverbanks, drains along the roads, and in canals and drains associated with the Budalangi Rice Scheme.

6.5.4 Deforestation

Deforestation in the upper catchment leading to degradation of forests is common, and is a major contributor to increased flooding in the downstream region of Nzoia River. The situation is worsened by the absence of vegetation that used to lower the speeds of running flood water upstream leading to excess water flowing into River Nzoia, causing it to burst its banks and result in floods.

6.5.5 Floods

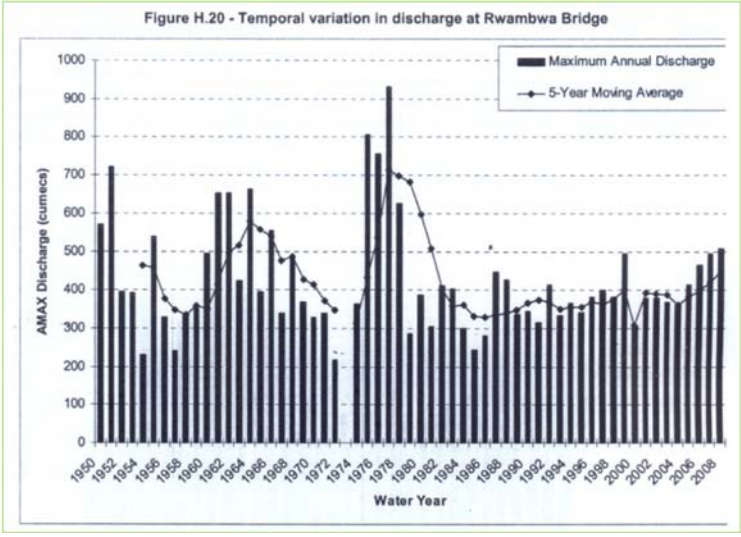
Heavy rainfall in the upper catchment areas coupled with the decreased vegetation to intercept and increase rainfall water infiltration leads to the increase in runoff hence increasing the volume of water in the Nzoia River consequently flooding in downstream areas.

The major causes of flooding in Lower Nzoia region are meanders developed on the Nzoia River that cause its discharge rates to reduce due to reduction in the river velocity and thus leading to the river bursting its banks and flooding the lower areas. Other factors include deposition of silt at the mouth of River Nzoia at the Sango area, soil types of the region does not allow water to drain easily and fast enough, old dykes and the general geographical formation of the area.

Dykes have been built to help control the floods but in some cases they prevent draining of water into the river hence also causing floods. River flow gauge on the Nzoia River is located at Rwambwa Bridge. A 58 year flow record shows that the river flow is characterized with bimodal distribution, with two discharge peaks each year. The peaks occur during the long rains (March/May) and short rains (late August/ November).

The **figure 33** below shows the annual maximum discharge with a five year moving average. The graph shows that the three highest discharge peaks occurred at the beginning of the gauged record from 1975-1977 and the range of discharge was between 757-930m^3/s. the discharge after 1978 was significantly lower. Trend showed by the graph suggests that there were high flows during 1950s which fell and begun picking up in early 1960s. From the graph below, it appears that the maximum discharge has been increasing slowly over the last two (2) decades. This comes out clearly as shown by the graph from year 2004. High flow peaks in the 1970 could be explained by the fact that rating curve at Rwambwa Bridge was changed from 1979. The previous rating curve was much flatter and was changed from 1979.

Figure 33: Variation in discharge at Rwambwa station



6.5.6 Irrigation

There are a number of irrigation schemes in the project districts including Bunyala Rice Scheme, Rwambwa Mudembi, Nahasyongo Muluwa, Muuri, Neboka, Bubasi, Munaka, Yala Swamp, Syamungu and Busagwa. In the project area the major existing irrigation scheme is the Bunyala irrigation scheme (280ha) which is under the management of the NIB. Because of the presence of the scheme in the area, farmers within the vicinity have developed interest and the scheme has expanded to covering mudembi (Mudembi irrigation, which is being developed with the assistance of NIB and Plan International, an NGO) and Muluwa areas (Anyiko) which has expanded the coverage area to over 300ha. Bunyala irrigation scheme was also developed as pilot scheme and abstracts water from River Nzoia through pumping.

Altogether these schemes are currently cultivating about 700 acres of rice but at different times of the year. Both the scheme farmers (about 132 households) and out-grower farmers (about 620 families) grow rice and rice irrigation is ranked as the first livelihood strategy in the area.

However, it should be noted that the first phase of the Lower Nzoia Irrigation Project (LNIP) is scheduled to be constructed along the Southern Bank of the Nzoia River through the KWSCRP-1 project.

6.5.7 Human Wildlife Conflict

The lower reaches of the proposed irrigation area, experiences warthogs and hippopotamus invasion into the farms. Hippo families are found on the lower parts of Nzoia and Yala rivers and from Lake Vitoria wetlands and the adjacent Yala swamp. This occasional invasion has created human wildlife conflict in the area.

6.5.8 Farming in Flooded Areas

Flood water of Nzoia River carry silt from the catchment and deposits this silt in the flood plain areas and the banks of the river channel. The presence of water and fertile

grounds caused by the silt has lead to cultivation of these marginal areas by the local population.

7 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This section of the report outlines and reviews the existing legislations, policies and institutions and identifies requirements as well as gaps and conflicts of the relevant legal and institutional arrangements that would hinder or guide the development of the project in line with the national and international laws applicable to constrction of dykes. Kenya being a signatory to various international conventions and laws, it's important that national projects are in line with these laws and as such some of the relevant international conventions are reviewed in this chapter.

7.1 LEGISLATIVE FRAMEWORK

7.2 THE CONSTITUTION OF KENYA

Section 69 of the Constitution part (a) ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits; (f) establish systems of environmental impact assessment, environmental audit and monitoring of the environment; (g) eliminate processes and activities that are likely to endanger the environment.

7.3 ENVIRONMENTAL MANAGEMENT AND COORDINATION ACT, EMCA 1999

This is an Act of Parliament that provides for the establishment of an appropriate legal and institutional framework for the management of the environment. Prior to its enactment in 1999, there was no framework environmental legislation. Kenya's approach to environmental legislation and administration was highly sectoral and legislation with environmental management components had been formulated largely in line with natural resource sectors.

EMCA (1999) was developed as a framework law, and this is due to the fact that the Act is thus far, the only single piece of legislation that contains the most comprehensive system of environmental management in Kenya. The Act provides for the establishment of an appropriate legal and institutional framework for the management of the environment in Kenya and for matters connected therewith and incidental hereto. The Act is based on the recognition that improved legal and administrative co-ordination of the diverse sectoral initiatives is necessary in order to improve national capacity for the management of the environment, and accepts the fundamental principle that the environment constitutes the foundation of our national, economic, social, cultural and spiritual advancement.

Section 3 of the Act enunciates the General Principles that will guide the implementation of the Act. Every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. It is worth noting that the entitlement to a clean and healthy environment carries a correlative duty. Hence, there is not only the entitlement to a clean and healthy environment, but also the duty to ensure that the environment is not degraded in order to facilitate one's own as well as other persons' enjoyment of the environment.

EMCA section V provides for the protection and conservation of the environment especially in the case of rivers, lakes or wetlands in all processes of irrigation development. It states that an environmental impact assessment must be undertaken when erecting, reconstructing, altering, extending, removing or demolishing any structure or part of any structure in, or under the river, lake or wetland. All irrigation developments fall under the 2nd schedule and these are agricultural projects that must require an EIA before commencement.

Environmental (Impact Assessment and Audit) Regulations 2003

The Environmental (Impact Assessment and Audit) Regulations 2003 state in Regulation 3 that "the Regulations should apply to all policies, plans, programmes, projects and activities specified in Part III and V of the Regulations'' basically lists the guidelines of undertaking, submission and approval of the ESIA Reports.

Environmental Management and Coordination, Conservation of Biological Diversity (BD) Regulations 2006

These regulations are described in Legal Notice No. 160 of the Kenya Gazette Supplement No. 84 of December 2006. These Regulations apply to conservation of biodiversity which includes Conservation of threatened species, Inventory and monitoring of BD and protection of environmentally significant areas, access to genetic resources, benefit sharing and offences and penalties.

Environmental Management and Coordination (Fossil Fuel Emission Control) Regulations 2006

These regulations are described Legal Notice No. 131 of the Kenya Gazette Supplement no. 74, October 2006 and will apply to all internal combustion engine emission standards, emission inspections, the power of emission inspectors, fuel catalysts, licensing to treat fuel, cost of clearing pollution and partnerships to control fossil fuel emissions used by the Contractor. The fossil fuels considered are petrol, diesel, fuel oils and kerosene.

Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulations 2009

These regulations provide for the protection and management of wetlands, riverbanks, lakeshores and sea shore management and detail guidelines on the same.

Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

These regulations prohibit making or causing any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. It also prohibits the Contractor from excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment or excessive vibrations which exceed 0.5 centimetres per second beyond any source property boundary or 30 metres from any moving source. Under the regulation the Contractor will be required to undertake daily monitoring of the noise levels within the Project area during construction period to maintain compliance.

7.4 WATER ACT

The Water Act is an act of parliament that provides for the effective management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services.

This Act establishes and provides legislative for the state run Water Resource Management Authority (WRMA) by stipulating the following:

- Water apportionment and allocation,
- Catchments protection and conservation,
- Water resource assessments and conservation,
- Delineation of catchments areas,
- Gazetting water protected areas,
- Protection of wetlands,
- Gazetting water schemes to be state and community owned,
- Establishing Catchments Management Strategies (CMS) and
- Collecting fees for water use and effluent discharges.

The Water Act 2002 also created the operations of WRMA which are carried out through six regional offices set up at river basin levels and is supported by Catchments Area Advisory Committees and Water Resource Users Associations (WRUA). The WRMA provides for community involvement in water resource management and in conflict resolution through the WRUA's by introducing a system of user fees to be levied on the abstraction and use of raw water to fund the costs for WRMA.

7.5 THE PUBLIC HEALTH ACT (CAP 242)

The Public Health Act (Cap 242) aims at protecting and promotes human health and the prevention, limitation or suppression of infectious, communicable or preventable diseases within Kenya. This Act provides the impetus for a healthy environment and gives regulations to waste management, pollution and human health.

On sanitation, the Act borrows from the common law doctrine of nuisance which makes it an offence for any landowner or occupier to allow nuisance or any other condition liable to be injurious or dangerous to health to prevail on his land. A medical health officer, once satisfied of the danger, may issue an order requiring the owner or occupier of the land to remove the nuisance. Any person who fails to clear such a nuisance is guilty of an offence under the Act. In addition, the Minister, on the advice of the Central Board of Health, may make rules and confer powers and impose duties for the carrying out of environmental health matters.

7.6 THE PHYSICAL PLANNING ACT

This Act provides for the preparation and implementation of physical development plans for any development or infrastructure. It establishes the responsibility for the physical planning at various levels of Government in order to remove uncertainty regarding the responsibility for regional planning.

It provides for a hierarchy of plans in which guidelines are laid down for the future physical development of areas referred to in a specific plan. The intention is that the three-tier order plans, the national development plan, regional development plan, and the local physical development plan should concentrate on broad policy issues.

The Act also promotes public participation in the preparation of plans and requires that in preparation of plans, proper consideration be given to the potential for socio-economic development needs of the population, the existing planning and future transport needs, the physical factors which may influence orderly development in general and urbanization in particular, and the possible influence of future development upon natural environment.

7.7 LAND ACT 2012

The Land Act is Kenya's framework legislation regulating compulsory acquisition of real property (i.e. land, houses, easements etc.).

Actions preliminary to the Acquisition

Under the LA, the Government can carry out land taking for reasons of "defence, public safety, public order, public morality, public health, town and country planning or the development or utilization of any property in such manner as to promote the public benefit," and when such necessity justifies the hardship that the intended acquisition may cause to any person having interest in the land. The LA requires the Minister to be satisfied that such necessity exists before setting in motion the process and directing in writing to the National Land Commission to acquire the land compulsorily. Under the LA, public participation in eminent domain decisions is limited to the public hearing scheduled to determine legitimate claims, and the value of land and compensation. The opinion of the landowner on whether or not the government should acquire the land is not considered. Such objections by the owner are deemed irrelevant and it is an offense to wilfully oppose or impede the State's taking of the land.

7.8 OCCUPATIONAL HEALTH AND SAFETY ACT, 2007

This is an Act of Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected purposes. The Act has the following functions among others:

- *Secures safety and health for people legally in all workplaces by minimization of exposure of workers to hazards (gases, fumes & vapours, energies, dangerous machinery/equipment, temperatures, and biological agents) at their workplaces.*
- *Prevents employment of children in workplaces where their safety and health is at risk.*
- *Encourages entrepreneurs to set achievable safety targets for their enterprises.*
- *Promotes reporting of work-place accidents, dangerous occurrences and ill health with a view to finding out their causes and preventing of similar occurrences in future.*
- *Promotes creation of a safety culture at workplaces through education and training in occupational safety and health.*

Failure to comply with the OSHA, 2007 attracts penalties of up to KES 300,000 or 3 months jail term or both or penalties of KES 1,000,000 or 12 months jail term or both for cases where death occurs and is in consequence of the employer. The Occupational Safety and Health Act (OSHA) 2007 repealed the Factories and Other Places of Work Act. Anything done under the provisions of the Factories and Other Places of Work Act including subsidiary legislation issued before the commencement of the OSHA 2007 shall be deemed to have been done under the provisions of this Act.

The Factories and Other Places of Work Act had over the years passed several subsidiary rules and regulations for effective implementation of the Act. All shall, as long as it is not inconsistent with OSHA 2007 remain in force until repealed or revoked by subsidiary legislation under the provisions of OSHA 2007 and shall for all purposes be deemed to have been made under this Act.

These regulations include:

- *The Factories (Cellulose Solutions) Rules 1957;*
- *The Factories (Wood Working Machinery) Rules 1959;*
- *The Factories (Dock) Rules 1962;*
- *The Factories (Eye Protection) Rules 1978;*
- *The Factories (Electric Power) (Special) Rules 1978;*
- *The Factories (Building Operations and Works of Engineering Construction)*
- *The Factories and Other Places of Work (Health & Safety Committees)*
- *The Factories and Other Places of Work (Medical Examination) Rules 2005;*
- *The Factories and Other Places of Work (Noise Prevention and Control)*
- *The Factories and Other Places of Work (Fire Risk Reduction) Rules 2007;*
- *The Factories and Other Places of Work (Hazardous Substances) Rules 2007.*

The scope of OSHA 2007 has been expanded to cover all workplaces including offices, schools, academic institutions and plantations. It establishes codes of practices to be approved and issued by the Director, Directorate of Occupational Health and Safety (DOHS) for practical guidance of the various provisions of the Act.

Other parameters within the Act relevant to the project include:

- *Duties of employers, owners or occupiers of workplace;*
- *Establishment of safety and health committees;*
- *Annual safety and health audit of workplaces;*
- *Safety and Health obligations for persons who may come to premises for work and are not employees of that particular workplace;*
- *Reporting of any accident, dangerous occurrence or occupational poisoning caused in the workplace to the area Occupational Health and Safety Office. These incidents should be entered in the General Register. In case of fatal accident information to the area Safety and Health Office should be within 24 hrs. and a written notice to the same within 7 days;*
- *The duties of manufactures, designers, importers and suppliers to ensure that all articles and substances for use at workplace are safe and will not cause injury to health and the environment;*
- *Duties of self-employed persons;*

- *Duties of employed persons;*
- *Prohibition of interference or misuse of any appliance, convenience or any other facility provided to secure Safety, Health and Welfare at work by any person (occupier, self-employed person or employed);*
- *The administration of the Act is the responsibility of a Director and other appointed and gazetted officials (Occupational Health and Safety Officers);*
- *The registration of all workplaces by the Director Directorate of Occupational Health and Safety (DOHS) forming the basis of his work statistics;*
- *Machinery safety to include:*
    - *Safe use of machinery, plant and equipment;*
    - *Prime makers and transmission machines;*
    - *The maintenance, construction of fencing safeguards;*
    - *The statutory requirements of various machines, plants and equipment (hoists and lifts, chains and ropes, cranes, steam receivers and containers, air receivers, cylinders for compressed liquefied and dissolved gases and refrigeration plants).*

Chemical safety including:

- *Handling, transportation and disposal of chemicals and other hazardous substances;*
- *Importance of Materials Safety Data Sheets (MSDS);*
- *Labelling and marking of chemical substances;*
- *Classification of hazardous chemicals and substances;*
- *Establishment and adoption of exposure limits on hazardous substances in a workplace;*
- *Control of air pollution, noise and vibrations;*
- *Redeployment on medical advice.*

7.9 The Wildlife Conservation and Management Act, Cap 376

The Wildlife (Conservation and Management) Act, Cap 376 of 1976, as amended in 1989, covers matters relating to wildlife in Kenya including protected areas, activities within protected areas, control of hunting, import and export of wildlife, enforcement and administrative functions of wildlife authorities. The 1989 amendment specifically established the Kenya Wildlife Service (KWS) as the parastatal charged with implementation of the provisions of the Act.

The Act specifically provides for the protection and regulation of protected animals, game animals and game birds as defined in three schedules. The first schedule includes game animals mostly mammals, although the list also includes crocodile and ostrich. The second schedule lists game birds, and the third schedule lists protected animals, which comprise primarily mammals, although it also includes two species of marine turtles, while in 1981 it was amended to include several species of reptiles, amphibians and butterflies. Apart from the protection provided to plants within National Parks and National Reserves, plants receive no further protection under this Act outside the protected areas.

Specific provisions of the Act allow for the establishment of National Parks (Section 6), National Reserves (Section 18), and local sanctuaries (Section 19). The National Parks

are managed by KWS. Strict regulations prohibit various activities within National Parks, unless they are subject to the written consent of the Minister or, in other cases, the Director of KWS. No such prohibitions are specified for National Reserves or for local sanctuaries.

7.10 POLICY FRAMEWORK

7.10.1 Vision 2030

Kenya Vision 2030 is the country's new development blueprint covering the period 2008 to 2030. It aims to transform Kenya into a newly industrializing, "middle-income country providing a high quality life to all its citizens by the year 2030".

The Vision 2030 is founded on economic, social and political pillars anchored on macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; science, technology and innovation (STI); land reform; human resources development; security as well as public sector reforms.

Vision 4 of the paper is adding value to products and services. Under this vision, the country envisions raising incomes in agriculture, livestock and fisheries. The strategy proposes processing and adding value to her products before they reach the market. This is to be accomplished through an innovative, commercially oriented and modern agriculture, livestock and fisheries sector.

These interventions are expected to generate an additional KSh.80-90 billion increase in GDP, mainly through better yields in key crops, increased smallholder specialization in the cash crop sector (2-3 crops per plot), utilization of a million hectares of currently uncultivated land, and new cultivation of up to 1.2 million hectares of newly-opened lands. Specific strategies are to transform key institutions in agriculture and livestock to promote household and private sector agricultural growth and increase productivity of crops and livestock.

The Vision recognizes that Kenya is a water scarce country. The economic and social developments anticipated by Vision 2030 will require more high quality water supplies than at present. The strategy therefore, proposes water conservation and starting of new ways of harvesting and using rain and underground water. The goal of the vision for 2012 is to promote agricultural productivity and increase area under irrigation and drainage from 140,000 to 300,000 hectares.

Specific projects to achieve this vision include constructing multi-purpose dams with storage capacity of 2.4 billion m3 along rivers Nzoia and Nyando, and rehabilitate and expand the major irrigation schemes (Bura, Hola, Kano Plains, Nzoia, Pekera, Kerio Valley, Mwea, Taita Taveta, Ewaso Nyiro North and Ngurumani) among others. This project will therefore contribute to the overall achievement of the different sectors of the vision 2030.

7.10.2 **Poverty Reduction Strategy Paper**

The Poverty Reduction Strategy builds on the Interim Poverty Reduction Paper (IPRSP) for the period 2000-2003, which was launched in June 2000. The strategy outlined measures aimed at revamping economic growth and poverty reduction by focusing on facilitating sustained and rapid economic growth; improving governance and security; increasing the ability of the poor to raise their income levels; improving the quality of life of the poor; and improving equity and participation.

One of the sectors outlined in the PRSP is agriculture and rural development. The strategy recognizes the important role of agriculture in poverty alleviation in Kenya. Furthermore, agricultural growth can catalyze growth in other sectors, with an estimated growth multiplier of 1.64, compared to 1.23 in non-agriculture (GOK, 2000).

To alleviate poverty, the strategy requires the agriculture sub-sector to grow at about 4-6% per annum. For this to happen, the strategy proposes implementing sound land use, water and environmental policies, facilitating long term investments in farm improvement, protecting water catchment areas by developing forest plantations and to improve small scale irrigation investments undertaken in poverty stricken areas among others.

7.10.3 **Wetland Policy**

In recognition of wetlands importance and values, the threats facing them and the need to take concrete steps to safeguard their functionality for posterity, the Government of Kenya adopted the National Policy for the Conservation and Management of wetlands to ensure that they are sustainably managed and used wisely for the benefit of the present and future generations.

The policy objectives are to, establish an effective and efficient institutional and legal framework for integrated management and wise use of wetlands which will provide an enabling environment for the participation of all stakeholders, enhance and maintain functions and values derived from wetlands, protect biological diversity and improve essential processes and life-support systems of wetlands, promote communication, education and public awareness among stakeholders to enhance their participation in wetland conservation, carry out demand driven research and monitoring on wetlands to improve scientific information and knowledge base, enhance capacity building within relevant institutions and for personnel involved in conservation and management of wetlands, establish a national wetlands information management system and database including tools and packages to targeted groups, promote innovative planning and integrated management approaches towards wetlands conservation and management in Kenya and promote partnership and cooperation at regional and international levels for the management of transboundary wetlands and migratory species.

National Wetlands Conservation and Management Policy are guided by principles which include wise use of wetlands, precautionary principle: Where information is inadequate for decision making, the precautionary principle will apply. Lack of full scientific certainty should not prevent implementation of measures to minimise/ manage wetland

degradation, participatory approach and having global dimension of environmental impacts of actions and policies should be recognised and considered.

7.10.4 National Food Policy

The rapid expansion of the population and a shortage of arable land in the main high potential areas were beginning to expose a potentially dangerous imbalance in the relationship between the national supply of and demand for food. In these circumstances, there was a clear need for a national policy which will set guidelines for decision- making on all major issues related to food production and distribution. The overall objective of this policy was to:

- Maintain a position of broad self-sufficiency in the main foodstuffs in order to enable the nation to be fed without using scarce foreign exchange on food imports;
- Achieve a calculated degree of security of food supply for each area of the country; and
- Ensure that these foodstuffs are distributed in such a manner that every member of the population has a nutritionally adequate diet. The project is in line with the National food policy.

7.11 INTERNATIONAL REGULATIONS

Kenya is a signatory to a number of conventions on sustainable development and is a member of various bilateral and multilateral organizations. Some of the relevant development partners in this project are the World Bank and a number of United Nations agencies.

7.11.1 World Bank Safeguard Policies

World Bank Operational Policies (OP) and Bank Procedures (BP) Environmental Assessment – BP 4.01 and OP 4.01 require environmental assessment of projects proposed that are deemed to have potential adverse impacts upon the environment to help ensure that they are environmentally sound and sustainable.

Environmental Assessment is one of the 10 environmental and social Safeguard Policies of the World Bank. World Bank Environment and Social Safeguard Policies aim at improving decision making, to ensure that project options under consideration are sound and sustainable, and that potentially affected people have been properly consulted.

The World Bank's environmental assessment policy and processes are described in Operational Policy (OP)/Bank Procedure (BP) 4.01.

In accordance with the Bank guidelines, the Lower Nzoia Irrigation Development Project has been classified as category B[3]. The following safeguards are triggered:

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[3] While the Western Kenya Flood Mitigation Project/Dykes is category B, the overall Kenya Water Security and Climate Resilient Growth Project is a Category A. This sub-project classification is consistant with the ESMF for the Kenya Climate Resilience and Water Security Program.

Environmental Assessment (OP 4.01), Natural Habitiats (O.P. 4.04), and Projects on International Waterways (OP 7.50).

7.11.2 Environmental Assessment (OP 4.01)

This policy requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. The EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed civil works under the MIS improved water management project. The EA process takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and cultural property) and trans-boundary and global environmental aspects.

Operational Policy 4.01 further requires that the ESMF which is a safeguard tool/ document prepared when OP 4.01 is triggered must be disclosed as a separate and stand-alone document by the Government of Kenya and the World Bank as a condition for bank appraisal of this improved water management project. The disclosure should be both in Kenya where it can be accessed by the general public and local communities and at the Info shop of the World Bank and the date for disclosure must precede the date for appraisal of the program.

The World Bank system assigns a project to one of three project categories and the project has thus been screened and assigned an EA Category B[4]. This category of projects are defined as projects likely to have potential adverse environmental impacts on human populations or environmentally important areas including wetlands, forests, grasslands, and other natural habitats and are less adverse than those of category A projects. These impacts are site specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for Category A projects. The EA process for Category B projects examines the potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

7.11.3 Natural Habitats (OP 4.04)

This policy aims at the conservation of natural habitats, like other measures that protect and enhance the environment. The policy is essential for long term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats.

Natural Habitats are land and water areas where the ecosystems' biological communities are formed largely by native plant and animal species, and human activity has not essentially modified the areas primary ecological functions. The policy recognizes the important role of biological, social, economic, and existence value of natural habitats.

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[4] It should be noted that the project under which the flood protection works are being considered for finance (KWSCRP-1 and the Additional Financing considered for it) are category A projects. However, this sub-project is considered to be a Category B project for the reasons listed above.

Natural habitat policy covers habitats in the tropical humid, dry, and cloud forest; temperate and boreal forest; Mediterranean-type shrub lands; natural arid and semi-arid lands, mangrove swamps, coastal marshes, and other wetlands; estuaries, sea grass beds, coral reefs, freshwater lakes and rivers; alpine and sub alpine environments, including herb fields, grasslands, tropical and temperate grasslands.

Therefore, the Natural Habitats policy is only triggered in certain cases because the investments proposed under may have potential adverse impacts on adjacent rivers, and forests which are located within the project catchment of some of the site and immensely contribute to the sustainability of critical ecosystems. The natural ecosystems of the wetlands, rivers and forests are known to support varying degrees of natural complexities of flora and fauna.

This OP requires that any activities that adversely impact these ecosystems are successfully mitigated so that the balance of the ecosystems are maintained or enhanced. Though the project area lacks any natural habitat as the area has been cultivated before, the presences of Yala swamp bordering the project area might be affected by secondary impact from land owners who would form part of the out growers outside the project area. This would require NIB to design appropriate conservation and mitigation measures to remove or reduce adverse impacts on these ecosystems or their functions, keeping such impacts within socially defined limits of acceptable change. Specific measures may depend on the ecological characteristics of the affected ecosystem. Such measures must include provision for monitoring and evaluation to provide feedback on conservation outcomes and to provide guidance for developing or refining appropriate corrective actions.

As this safeguard was triggered for the Parent Project (KWSCRP-1), it is also triggered here. However, as described in section 5.2, the proposed area for the project is already developed and dykes have been developed at the project site already.

7.11.4 **Forests (OP 4.36)**

This operational policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development. The policy recognizes the role forests play in poverty alleviation, economic development, and for providing local as well as global environmental services. Success in establishing sustainable forest conservation and management practices depends not only on changing the behaviour of all critical stakeholders, but also on a wide range of partnerships to accomplish what no country, government agency, donor, or interest group can do alone.

The forest strategy suggests three equally important and interdependent pillars to guide future Bank involvement with forests including harnessing the potential of forests to reduce poverty, integrating forests in sustainable economic development, and protecting vital local and global environmental services and forest values.

This policy applies to the World Bank-financed investment projects that have or may have impacts on the health and quality of forests, projects that affect the rights and

welfare of people and their level of dependence upon or interaction with forests and projects that aim to bring about changes in the management, protection, or utilization of natural forests or plantations, whether they are publicly, privately, or communally owned. This safeguard will not be triggered as there are no forests within the project boundary that will be affected.

7.11.5 Physical Cultural Resources (OP 4.11)

The bank operational policy on safeguarding cultural properties aims at protecting cultural assets and knowledge of communities in bank financed project areas. Safeguarding cultural property policy requires the determination of what is known about the cultural aspects of the proposed project site. The policy calls for consultation involving all parties including scientific institutions and NGOs as part of this process. The policy defines cultural property as sites having archaeological, paleontological, historical, religious and unique natural value. These sites, when stumbled upon, require that the authorities are informed and the site is demarcated and protected.

As identified in section 5.1.6, the area earmarked for development is individual farms that are cultivated occasionally when there are no floods and as such there is potential for physical cultural resources being found in the areas where the civil works of the project will be carried out.

7.11.6 Projects on International Waterways (OP 7.50)

This policy recognizes the importance of cooperation and good will of riparian's as essential for the efficient utilization and protection of international waterways and attaches great importance to riparian's making appropriate agreements or arrangements for the entire waterway or any part thereof. Projects that trigger this policy include hydroelectric, irrigation, flood control, navigation, drainage, water and sewerage, industrial, and similar projects that involve the use or potential pollution of international waterways.

This policy relates to the relations between the riparian states. In the absence of such agreements or arrangements, the Bank requires, as a general rule, that the prospective proponent notifies the other riparian of the project. The policy lays down detailed procedures for the notification requirement, including the role of the Bank in affecting the notification, period of reply and the procedures in case there is an objection by one of the riparian to the project.

The policy applies to any river, canal, lake, or similar body of water that forms a boundary between, or any river or body of surface water that flows through, two or more states, whether World Bank members or not. It also includes any tributary or other body of surface water any bay, gulf, strait, or channel bounded by two or more states or, if within one state, recognized as a necessary channel of communication between the open sea and other states and any river flowing into such waters.

The policy recognizes prior riparian states agreements/arrangements such as the Nile Basin which the project falls under. The policy also calls for notification of riparian states by parties that proposes to undertake project that affects international waters.

This safeguard will be triggered as Nzoia River is within the Nile River basin that is shared by 8 riparian countries thus the need to notify other riparian countries. A notification to the riparian states is being prepared by GOK under the MEWNR – Transboundary Projects Department.

7.11.7 Involuntary Resettlement (OP 4.12)

This policy covers direct economic and social impacts that both result from Bank-assisted investment projects, and are caused by; involuntary taking of land resulting in relocation or loss of shelter; loss of assets or access to assets, or loss of income sources or means of livelihood, whether or not the affected persons must move to another location; or the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons. For project activities that impact people and livelihoods in this way, MEWNR will have to comply with the requirements of the disclosed RPF and this is why a RAP is also being prepared to comply with this policy. The policy is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts.

The objective of this policy is to avoid where feasible, or minimize the resettlement, exploring all viable alternative project designs. The policy calls for sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share project benefits and to improve their livelihoods. The standards of living should be restored, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

To address the impacts covered under this policy, a resettlement plan or a resettlement policy framework is needed to mitigate against effects of displacement. This framework should cover the development of a resettlement plan which must include measures to ensure that the displaced persons are informed about their options and rights pertaining to resettlement. The displaced persons are consulted on, offered choices among, and provided with technically and economically feasible resettlement alternatives and provided prompt and effective compensation at full replacement cost for losses of assets attributable directly to the project.

If the impacts include physical relocation, the resettlement plan or resettlement policy framework includes:

- Measures to ensure that the displaced persons are provided assistance (such as moving allowances) during relocation;
- Provided with residential housing, or housing sites, or, as required, agricultural sites for which a combination of productive potential, locational advantages, and other factors is at least equivalent to the advantages of the old site.

Where necessary to achieve the objectives of the policy, the resettlement plan or resettlement policy framework should also include measures to ensure that displaced

persons are offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living and provided with development assistance such as land preparation, credit facilities, training, or job opportunities, in addition to compensation measures.

The World Bank Safeguard policy OP 4.12 will be triggered because the project will cause land acquisition for the infrastructure.

7.11.8 Projects in Disputed Areas (OP 7.60)

This policy is triggered in circumstances where there are territorial disputes between countries. The proposed site for the proposed project is not under any dispute for Kenya's neighbouring countries hence it is not triggered. The policy calls for a no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection. The policy details those special circumstances. The project area is not under any dispute as far as this study is concerned. The project will be undertaken in private land whose title owners consent will be sort.

7.11.9 Indigenous Peoples (OP 4.10)

This policy recognizes that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. The policy aims to protect the indigenous peoples as many a time economic, social and legal status often limits their capacity to defend their interests in, and rights to, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. They are particularly vulnerable if their lands and resources are transformed, encroached upon by outsiders, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also be under threat. These characteristics expose Indigenous Peoples to different types of risks and severity of impacts, including loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and disease.

The policy makes a connection between the identities and cultures of Indigenous Peoples and establishes the inextricable links to the lands on which they live and the natural resources on which they depend. These distinct circumstances expose Indigenous Peoples to different types of risks and levels of impacts from development projects, including loss of identity, culture, and customary livelihoods, as well as exposure to disease. Gender and intergenerational issues among indigenous peoples are also complex. As social groups with identities that are often distinct from dominant groups in their national societies, Indigenous People are frequently among the most marginalized and vulnerable segments of the population. The policy recognizes that Indigenous Peoples play a vital role in sustainable development and that their rights are increasingly being addressed under both domestic and international law.

The policy stipulates that if a proponent proposes to locate the project on, or commercially develop natural resources located within, traditional or customary lands under use and adverse impacts can be expected on the livelihoods, or cultural,

ceremonial, or spiritual use that defines the identity and community of the Indigenous Peoples, then the proponent must ensure that as part of the free, prior, and informed consultation process the affected communities are informed of (a) their rights to such resources under statutory and customary law; (b) the scope and nature of the proposed commercial development and the parties interested or involved in such development; and (c) the potential effects of such development on the Indigenous Peoples' livelihoods, environments, and use of such resources. Thus the Resettlement Action Plan and the Resettlement Policy Framework must take this into consideration and adequate public consultation must be undertaken. There are no known or identified IP in the wider project area hence this policy is not triggered.

A summary of the World Bank's environmental and social safeguard policies to be triggered by the project are as described in the Table 15 below.

Table 15: Summary of the Operational Policies that will be triggered by the project

Operational Policy	Status	Comments
Natural Habitats	Triggered	This has been triggered, as it was triggered for the parent project. However, it is not expected that there will be any major impacts, as detailed in this ESIA and as project area is already developed.
Environmental Assessment	Triggered	The project falls EA, category 'A' projects
Forests	Not triggered	The project is not in a forested area
Physical Cultural Resource	Triggered	The project is likely to encounter physical cultural resources
Involuntary Resettlement	Triggered	Several target areas for civil works and the project's infrastructure are in use and owned by several landowners thus there will be both economic and physical displacement
Indigenous peoples	Not Triggered	The area is not known to have Indigenous People.
Safety of Dams	Not Triggered	The project does not involve the construction of any dams
Projects on International Waterways	Triggered	R Nzoia part of the Greater Nile Basin
Projects in disputed areas	Not triggered	The project is not in a disputed territorial area by another country

7.12 INTERNATIONAL CONVENTIONS

Kenya is a signatory to some of the international conventions that are relevant to the ESIA its imperative that we review some of the conventions within which the study and the project is carried out.

7.12.1 United Nations Convention on Biological Diversity

The three goals of the United Nations Convention of Biological Diversity (UNCBD) are to promote the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. Kenya being a signatory of this convention it's supposed to work towards the

achievement of the three goals. Agriculture based activities could have both adverse and beneficial impacts on crop genetic diversity.

The convention calls for the adoption of national strategies, plans and programmes for the conservation and sustainable use of biological diversity into their relevant sectoral and cross-sectional plans, programmes and policies. One of the tools that are prescribed for the management of biodiversity is environmental assessment. Article 14 of the convention deals with impact assessment and minimizing of adverse impacts of activities that are likely to cause significant adverse effects on biological diversity, (Glowka, L, et al, 1992).

7.12.2 Ramsar Convention on Wetlands

The Convention on Wetlands is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 160 Contracting Parties to the Convention, with 1897 wetland sites. The Convention calls for governments to provide framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. However there are no Ramsar sites in the project area thus the convention does not apply.

7.12.3 Convention on the Conservation of Migratory Species

The convention on migratory species (CMS) was adopted to conserve migratory species of wild animals given that migratory species are seen as an international resource. Such species may be terrestrial or marine. The conventions agreement on the conservation of African-Eurasian migratory water birds is specific on the need to protect the feeding, breeding and wintering habitats, the main ones being wetlands and open water bodies. The convention is relevant due to presence of migratory bird species and other aquatic organisms.

7.12.4 EAC Protocol on Environment

The protocol was signed by the Partner States of the East African Community on 29th November 2003. It has relevant provisions for environmental and social management for the project; Article 5: Paragraph 4 provides that Partners States should promote sustainable utilization of water resources while taking into consideration factors such as ecology, geographic, climatic, hydrologic factors among others; the social and economic needs of each Partner State; the population dependent on the water resources; existing and potential uses of the water resources.

Article 6: Paragraph 1 identifies the protection and conservation of the basin and its ecosystem with emphasis on improving water quality and quantity; preventing the introduction of invasive species; conservation of biological diversity and forest resources; protection and conservation of wetlands and fisheries resources conservation. Part 2 of the article provides for the harmonization of laws and policies for stakeholder participation in protection, conservation and rehabilitation. Sustainable agriculture and land use practices to achieve food security and rational agricultural production is provided for in Article 9.

Article 12 of the Protocol urges Partner States to develop national laws and regulations requiring project proponents to undertake EIA and review of EIA reports to be done by all the Partner States if the potential impacts are likely to be trans-boundary and the same to apply for Environmental Audits in Article 13.

Partner states should ensure control of pollution from non-point sources through legal, economic and social measures. This is provided for in Article 20 which further states that pollution control measures should promote sustainable forestry practices, appropriate agricultural land use methods, sanitation and hygiene within the basin. Public participation is provided for in Article 22 which should be enhanced to influence government decisions on project formulation and implementation.

Article 23 of the Protocol provides that Partner States should promote Community involvement and mainstreaming gender concerns at all levels of socio-economic development especially in decision making, policy formulation and implementation of projects and programmes.

7.13 INSTITUTIONAL ARRANGEMENTS

The main institutions with responsibility for environment protection in the project are the: National Environment Management Authority (NEMA), Ministry of Environment and Water and Natural Resources (MEWNR), Water Resources Management Authority (WRMA), Ministry of Lands, Ministry of Health among others. The overall institution is NEMA which has the power to control, monitoring and evaluation of the integration of environmental concerns in all development projects or activities in Kenya.

7.13.1 National Environment Management Authority

The National Environment Management Authority (NEMA) is established under Section 7 of the Act. NEMA is the institution with the legal authority to exercise general supervision and co-ordination over all matters relating to the environment, and is the principal instrument of the Government charged with the implementation of all policies relating to the environment. NEMA was established in 2001, and is headed by a Director General appointed by the President. The Director General is assisted by several directors in charge of Enforcement, Education, and Policy, who in turn are assisted by Assistant Directors and Senior Officers. To facilitate coordination of environmental matters at a District level, EMCA 1999 allows for the creation of County Environmental Committees.

7.13.2 Ministry of Environment, Water Natural Resources

The Ministry is the parent institution for this project and has its fundamental goal and purpose as conserving, managing and protecting water resources for socio-economic development. Its aim is to improve the living standards of people by ensuring proper access to available water resources.

7.13.3 Ministry of Health

The Ministry of Health through the Public Health Division is involved in the provision of preventive health-care through mobilizing and sensitizing of communities on water and sanitation matters through identification, planning and selecting appropriate.

Technologies, water quality surveillance, water supply improvement at household and small group's levels, water quality monitoring and prosecution of offenders and environmental sanitation and hygiene promotion. The Ministry of Health lays emphasis on promotion of preventive health and hygiene and in this regard, management of water quality and adequate sanitation are given prominent consideration.

7.13.4 Ministry of Agriculture

The mandate of the Ministry of Agriculture is to promote and facilitate production of food and agricultural raw materials for food security and incomes; advance agro based industries and agricultural exports; and enhance sustainable use of land resources as a basis for agricultural enterprises. Some of the relevant functions of the Ministry in regards to the project are formulation, implementation and monitoring of agricultural legislation's, regulations and policies, provision of agricultural extension services, supporting agricultural research and promoting delivery, development, implementation and coordination of programmes in the agriculture sector, regulating and quality control of inputs, produce and products from the agriculture sector, management and control of pests and diseases in crops and promoting management and conservation of the natural resource base for agriculture.

7.13.5 Water Resources Management Authority

The Water Resource Management Authority (WRMA) is a state corporation under the Ministry of Water and Irrigation established under the Water Act 2002 and charged with being the lead agency in water resources management. The duties of WRMA include;

- Water apportionment and allocation, catchment
- Catchment protection and conservation,
- Water resource assessments and conservation,
- Delineation of catchment areas,
- Gazetting water protected areas,
- Protection of wetlands,
- Gazetting water schemes to be state and community owned,
- Establishing Catchment Management Strategies (CMS)
- Collecting water use and effluent discharges.

The water Act provides for decentralized and stakeholder involvement. This will be implemented through regional offices of the Authority based on drainage basins (catchment areas) assisted by Catchment Area Advisory Committees (CAACs). At the grassroots level, stakeholder engagement will be through Water Resource User Associations (WRUAs).

7.13.6 Nile Basin Initiative

The Nile Basin Initiative (NBI) through is implementing basin wide Integrated Water Resources Management activities with the Lake Victoria Basin where the project falls. Activities of the project could complement the activities of the project in the areas of planning and monitoring as well as economic development. According to the Nile Basin charter, the proponent need to inform other stakeholders of the Nile basin who depend on the waters of the Nile.

Table 16: Institutional Capacity of ESMP Implementing Agencies

Institution	Focus	Strengths	Weakness	Recommendations
National Environment Management Authority (NEMA)	Implementing environmental management	Political support Autonomous Strong legal foundation and institutional support	Inadequate manpower at the national and lack of control in the districts Inadequate enforcement of policies and legislation	Decentralise operations to the lower level of administration
Water Resources Management Authority	Water resources management.	Decentralised management system and focus on catchment as a system.	Lack of enforcement of rules and regulations such as water permits and lack of monitoring capacity	Need to monitor water resources abstracted from Nzoia River. Enforce water abstraction permit. Open district offices
Ministry of Agriculture	Facilitating production of food and agricultural raw materials for food security and incomes; advance agro based industries and agricultural exports; and enhance sustainable use of land resources as a basis for agricultural enterprises.	Presences of National Agricultural and Livestock Extension Program Supported by strong research arm (KARI)	Lack of resources for field work Inadequate local level extension workers Lack of pesticide policy Inadequate technical staff at the district level	Establish Integrated Pest Management program Transfer research knowledge to the farmers
Ministry of Health	Public Health and Sanitation Services	*7.13.6.1.1.1 Presence of public health personnel at the divisional level. Implementing programme on indoor residual spraying and free issuance of treated nets*	Lack of resources for field work Lack of capacity and manpower to supervise public healthcare and sanitation projects	Promote preventive health care as opposed to curative i.e. eradication of mosquitoes as opposed to provision of TBN

Institution	Focus	Strengths	Weakness	Recommendations
Ministry Environment, Water and Natural Resources	***7.13.6.1.1.2*** *To improve health by; enabling partnerships, provision of leadership information and education concerning the suppression of vectors, rodents and vermin, for accelerated development of methodologies that increase the effective and efficient utilization of vectors, rodents and vermin control services.*	***7.13.6.1.1.3*** *Presences of autonomous WRMA to deal with water resources issues*	Lack of resources for field work. Lack of resources to monitor public health issues at the community level. Delinked from agriculture which is part of irrigation Lack of irrigation personnel in the ministry. Focus has been more on provision of drinking water	Ministry of Water and Agriculture should complement each other to promote irrigated agriculture

8 CHAPTER EIGHT. POTENTIAL ENVIRONMENTAL & SOCIAL IMPACTS & PROPOSED MITIGATION MEASURES

Flood mitigation and control projects are known to lead to a number of environmental benefits, interactions and consequences. As with most water development projects, general hydrological disturbance and the risk of diseases are there. This section of the report discusses the potential environmental and social impacts of the proposed project and is based on international experience of irrigation development projects. The impacts described are both beneficial and adverse occurring on physical, biological and socio-economic environment during construction and operational phase.

In undertaking this environmental impact identification for the proposed irrigation development potential sources of risk to the ecological and social environment were first identified. Each source of risk identified was described and its potential environmental impact considered.

8.1 BENEFICIAL IMPACTS

8.1.1 Physical Impacts

8.1.1.1 Flood Control

The spread of water into the farms will control floods downstream by distributing excess water during heavy rains. Flood control effects of the project will free more land for farming as well as prevent destruction of food crops for those farmers who cultivate floodplains during the dry season. This indirect impact will help achieve food security especially for rain depended crops. This is an immediate impact that will be realized during wet season when floods occur.

8.1.2 Socio-Economic Impacts

The project will have a number of positive social and economic impacts in the area and beyond. It will act as a vital pillar for socio economic improvement in the region contributing to growth and livelihood improvement. Identified positive socio-economic impacts are described below.

8.1.2.1 Poverty Alleviation

The Lower Nzoia basin straddles the Siaya and Busia districts both of which have 60-70% of their population living below the poverty line. These figures are among the highest in the country. The two districts have a population of 784,000 out of which 509,000 are poor. The poverty gap, which is the difference between the existing economic status of the population and the poverty line, ranges between 20-30% for the two districts and therefore there the government targets to intervene through the project in a manner that will have a significant and immediate impact on poverty reduction on a sizeable portion of the population of the two districts.

Kenya Poverty Reduction Strategy Paper (PRSP, Kenya, 1999) identifies agricultural development as one of the key drivers of eradicating poverty in the country and ensuring

food security. Based on the Kenya RRSP, the project is in line with the objective of tackling poverty through promotion of agriculture.

At the local level, the infrastructure project will promote increased agricultural productivity, diversification of agricultural crops and commercialization of agriculture from subsistence. Improvement in crop productivity will raise the income for the rural poor above the poverty line of less than a dollar a day. This is an indirect impact that will take a long process that will be felt after many years. Directly the project will benefit an estimated 20,000 people.

8.1.2.2 Job Creation

The proposed flood management activities are expected to create temporary direct and indirect employment opportunities during construction. The construction activities will require the direct employment of local and international staff, both professional and casual. These include engineers, surveyors, project managers, safety advisors, equipment operators and their assistants among others. Indirect employment opportunities shall also be created off-site where construction materials are sourced, or in procurement of non-core services by the professional staff. The use of local labor is expected to positively impact on the local economy with additional potential of skills transfer.

8.1.2.3 Creation of Market for Construction Materials and Associated Goods

The Project will require supply of building materials (e.g. fill/borrow materials, cement, steel, fuel etc.), construction equipment and workers' food supplies. Most of these will be sourced locally in Kenya, Busia County and its surrounding areas. This will provide a ready market for building suppliers such as quarrying companies, hardware shops and individuals with such materials.

8.1.2.4 Increased Revenue for Suppliers and the Exchequer

Closely related to the above, the purchase of construction materials from suppliers and purchase of consumables shall all result in increased revenue for suppliers and other vendors, and tax remitted to the exchequer.

8.1.2.5 Improvement of Infrastructure

This project will include improvement of existing infrastructure in the project area. It will entail grading of existing roads with murram of up to 200mm. As a result of this improvement communication and transportation especially of farm products will be improved enhancing incomes and productivity. The project area currently has a road network that is usually impaired by weather conditions. There is an all-weather road (tarmac) from the Busia Road junction at Bumala which ends about 15km from the project area. Transportation of products both agricultural and fisheries are usually hampered by poor conditions of roads particularly during the rainy seasons and when flooding of the River Nzoia occurs.

Improvement of the road network will ensure that products from both sectors are easily accessible to markets. It will also reduce inconveniencies to population movements to public utilities such as schools, government offices and hospitals.

8.1.2.6 Increased crop and livestock farming activities

Enhanced defence against floods is anticipated to reduce flood- associated crop and livestock losses. This will in turn encourage more investment by farmers as they will be assured of safety of their investments. Increased floodplain area will likely be brought under cultivation as well as increased stocking of livestock to realise more agricultural production in the area. Improved drainage of the northern floodplain will also provide the opportunity for improved agriculture in this area.

8.1.2.7 Increased fish stock in the lake

Fish stocks in the lakeshore downstream is likely to increase as more nutrient rich water together with migratory/riverine fish usually carried by flood waters into the floodplains will be directed to the lake. This will benefit fishermen who fish from the beaches in the area.

8.1.2.8 Enhanced potential of fish farming

Protection of the flood plains is also likely to make it safer for fish farming promotion whose potential in the area has not been fully realised due to risks from unpredictable floods. With fishponds, the agricultural and fishing community will not only realize more stable livelihoods but also produce affordable protein for their nutritional benefits.

8.1.2.9 Improved Public Health and Sanitation

One of the major impacts of flooding identified by community participants during consultations is that it is associated with outbreaks of water borne diseases. Floods contaminate wells and boreholes- the common domestic water sources in the community- and destroy pit latrines exposing the community to unhygienic conditions. Such incidences will be significantly reduced with the reliable flood defense structures.

8.1.2.10 Reliable Linkage between the South and North Communities

With the rehabilitated embankment to Sigiri boat crossing, it will have increased capacity to easily facilitate passage of floodwaters in between the dykes. This will in turn assure communities both to the south and to the north of the river a reliable shorter transport linkage with potential multiplier effects of increased trade, especially with Port Victoria center, and social interactions.

8.1.2.11 Protection of Families from Property Losses and unplanned Expenditure

From the social survey of the area, majority of respondents indicated loss of properties, food and destruction of homes as a major problem during flooding. This will be reduced with the containment of larger floods by the higher and stronger dykes. Families will therefore not have to spend much of their low income to replace expensive household assets and other properties lost to floods.

8.1.2.12 Better Growth of Women and Children

Children and women are usually the most socially affected by flooding incidences. Some of the social setbacks to children in Budalangi that will be significantly be mitigated once the new structure are in place include: inability to attend school regularly, early marriage of the girl child, drowning to death in floods, malnutrition, child labour, moral decay in camps, flood caused trauma, confinement to camps and lack of play grounds.
Women will benefit from reduced incidences of household food insecurity, destruction of houses, cooking energy insecurity and both emotional and physical exhaustion from reconstruction works necessitated by floods.

8.1.2.13 Attraction of further Developments

Increased protection from flooding is likely to attract more investors, who would otherwise be hesitant to invest in the area due to high flood risks. This will give rise to increased general socio economic development in the floodplain areas. It is noted that although the improved dykes will protect against larger floods, the possibility of flooding that causes damage behind the dykes still exists. It is recommended, therefore, that development in the floodplain should be controlled to minimize the impact of possible future events.

8.1.2.14 Reduction in Flood induced Pollution

Commissioning of the proposed new dykes will go a long way in arresting some of the existing environmental problems associated with floods in the project area. These include air (foul smells from stagnant/ponded waters) and water pollution, destruction of crops and other vegetation cover, water logging among others.

8.1.2.15 Reduced Flood Erosion

Higher stronger dykes are anticipated to protect many floodplain farms from flood induced soil erosion. Soil erosion is both an agricultural and environmental challenge to most farmers in the area. It negatively affects productivity of the farms by washing away the nutrient rich topsoil.

8.1.2.16 Stable and Sustainable Livelihoods

With increased protection from flooding there is likelihood of increased development in the natural floodplain behind the dykes. The developments like subsistence farming – the main livelihood accounting for 72.2% of the community farmers- will be less affected by flooding (although a reduced possibility will still exist) thus improving stability of the various livelihood of the area's community.

8.1.2.17 Improved Public Health and Sanitation

One of the major impacts of flooding identified by community participants during consultations is that it is associated with outbreaks of water borne diseases. Floods contaminate wells and boreholes- the common domestic water sources in the community- and destroy pit latrines exposing the community to unhygienic conditions. Such incidences will be significantly reduced with the reliable flood defense structures.

8.2 POTENTIAL ADVERSE IMPACTS

8.2.1 Physical Environment

8.2.1.1 Soil Erosion

During the preparation of the land for the infrastructure, clearance of vegetation from the area will expose the soils to agents of erosion mostly water. This impact will occur during project construction and operational phase. The magnitude of this impact will include reduction in soil productivity and siltation of shores of Lake Victoria downstream. This impact will be long term and will manifest after a long period. Soil erosion could occur during the construction phase when lose soil is swept by waters and during the operational phase during irrigation and field preparation.

Mitigation

Soil erosion can be avoided during the construction and operational phase of the projects. To avoid soil erosion a number of measures are proposed. These are;

1. Avoiding vegetation clearance that will expose soil to agents of erosion during construction phase.
2. Revegetating the cleared sites with local species of vegetation
3. Only clear areas earmarked for construction and
4. Mitigation of soil erosion during cultivation will be through terracing of the sloppy areas of the land and plating of napier grass along the canals.

8.2.1.2 Surface and Ground Water Pollution

Construction works will involve employment of certain hazardous and harmful materials. These will include but not limited to fuels, solvents and cement. Accidental entry of these substances into the river or the ground would result in deterioration of ground and river water qualities, with potential detrimental impacts on both terrestrial and aquatic flora and fauna. Any accidental spillage into the river, in extreme case, might also end up being washed into the lake. It is also notable that the area community uses underground and river water for domestic purposes, which can be of concern.

Mitigation:

- Ensuring any potential hazardous materials to be used during construction is held in bunded areas and stored under cover;
- Amounts of these substances held on site at a particular time will be limited as far as feasible;
- Spill response kits will be maintained on site; and

All efforts will be made to prevent spillage of the substances through contractor's' documented spill prevention procedure and response plan. These will include creating awareness among the concerned construction staff and posting appropriate labels and notices.

8.2.1.3 Exposure to Flood Risks

Floods in the project area result from episodes of heavy rainfall in the upstream regions of the Nzoia catchment. During construction activities, the area may be exposed to flooding

when it rains upstream and the construction team is unaware especially when sections of the existing dykes are being re-aligned. This could result in localized flooding with negative consequences depending on its magnitude with sections being worked on acting like river outlet points.

Mitigation:

- Realignment works will be planned such that the new alignment is constructed before the old one can be removed for safety against flood; and
- Construction team will liaise, throughout the construction period, with the flood monitoring and early warning teams both at community and national levels.

8.2.1.4 Topsoil Stock Piles

During the construction phase, excavation earth from the weir in addition canals and drainages will create a pile up of soil. These activities may result in the increased erosion in areas where vegetation has been stripped and stockpiled. This could lead to increased suspended solids being deposited into the streams, Nzoia River and Lake Victoria at the mouth of the river.

Mitigation

Stockpiles should be adequately secured through installation of soil traps until they can be moved elsewhere for reuse. Where possible, such soil stockpiles should be used to rehabilitate stripped and excavated zones so as to reduce incidences of stagnant water and pools which would be a safety risk for people as well as breeding grounds for mosquito.

8.2.1.5 Siltation of Water Bodies

The source of water for this project is the River Nzoia. It feeds into the Lake Victoria and in extension the Nile Basin hydrology. Already, siltation is of major concern among all major rivers feeding into the Lake Victoria. The main source of such siltation has been catchment activities that have resulted in poor soil management, deforestation and apparent soil loss. So far, siltation is one of the major factors blamed for bank bursting and flooding along River Nzoia. Irrigation on the lower Nzoia will contribute to siltation of the river mouth into Lake Victoria increasing the problem of flooding.

Mitigation

To prevent siltation of the River Nzoia, a catchment rehabilitation process should be up scaled to protect the soil from water runoff. This measure should be supported by creating buffer zones downstream of the area to trap the silt. Wider consultations and engagements should be sought by NIB to improve catchment management in the entire basin.

8.2.1.6 Disruption of Irrigation Infrastructure

The proposed dyke strengthening (raising with broader base) will necessitate realignment of a section of an existing irrigation canal in Bukhoba village. The canal developed and maintained by National Irrigation Board (NIB) runs parallel to river and is very close to the existing northern dyke at this location. The works will also disrupt the yet to be

completed installation of irrigation pump and associated piping on the southern dyke near Busagwa village. This will disrupt the irrigation of farms fed by the canal.

Mitigation:

- Liaison with NIB to harmonize the new dyke design and construction with the affected section of the canal and ongoing works through the KWSCRP-1; and
- Inclusion in the Resettlement Action Plan for the provision for potential loss of livelihoods, in line with the ESMF and the RPF for the KWSCRP program.
- Timely disclosure of any planned disruption of the canal operations to the affected farmers downstream the affected area.

8.2.1.7 Loss of floodplains natural fertility

Raised and stronger dykes will mean a reduced incidence of overtopping. Overtopping has been a source of fertile silt deposition into the floodplain farmlands and this will reduce natural fertility of the floodplains. Consequently, farmers would potentially have to use more fertilizer applications to sustain their yields thus creating cumulative negative impacts.

8.2.1.8 Reduction in sand harvesting

Floods usually deposit sand in the lower reaches of the River Nzoia after having been carried by waters flowing from the upper catchment areas. Following dyke failure this facilitates easy sand mining activities on the floodplain, which will be reduced by prevention of dyke failure. In turn, this will reduce the incomes associated with sand harvesting at these times. However, very few members of the community conduct such activities and the overall benefits cannot be compared to those the community stands to benefit following protection from floods.

8.2.1.9 Demand for borrow materials

The new structures will require periodic maintenance, which will create demand for more borrow materials. However, this is expected to be of relatively small quantities.

8.2.1.10 Visual impact

Once commissioned, the dykes will be broader and higher than existing structures creating a slightly different image in the immediate surroundings. Depending on the individuals' perception, some visual impacts will be generated. However, given the area already has dykes and the existence of vegetation cover of varying heights (from shrubs to trees will hide the dykes), this impacts may only be localised to the immediate villages.

8.2.1.11 Construction Impacts

Dust, noise and oxides will be generated and emitted during excavation/earthworks and aggregate handling including transportation to and around the site, and carting away of wastes from site. This is likely to affect site workers and any nearby homesteads. Construction vehicles and machinery are also likely to emit oxides of carbon, nitrogen, and sulphur, further compromising the local air quality. During dry weather, fugitive dust

generation is likely to be very high. In extreme situations, these can lead to respiratory health problems.

Mitigation:
Given the nature and scale of the anticipated works, exhaust emissions of oxides of carbon, nitrogen, and sulphur will be minimal and only localised. However, the proponent shall commit the Contractor to implementing measures that shall reduce air quality impacts associated with exhaust emissions during construction. In order to control exhaust emissions that are likely to occur during the construction of the proposed Project, the following measures shall be implemented;

- The Contractor shall maintain equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions;
- The Contractor shall use environmentally friendly fuels such as low sulphur diesel;
- The Contractor shall minimise the idling of machinery; and
- Ensure that no burning of waste is done on site.

To mitigate the generation of dust at the site and the vicinity, sprinkling of all active construction areas as and when necessary, will be done. Other measures to maintain good air quality during construction include:

- Enforcing speed limit for vehicles in the project area;
- Rehabilitation of any disturbed areas once completed;
- Tarpaulins will be used to cover all trucks hauling sand, ballast and other loose materials or require all trucks to maintain at least two feet of freeboard; and
- Proper planning of transportation of materials to ensure that the number of trips done or the number of vehicles used is as minimum as possible.
- The Contractor shall also provide appropriate Personnel Protective Equipment such as dust masks to site workers.

8.2.2 Biological Environment

8.2.2.1 Fisheries Impacts

The project's structures are not going to pose any significant adverse impacts to fisheries in Nzoia River with impacts expected during the construction phase having low and temporal impact significance. During the construction, acquatic resources maybe affected by civil works including noise and machinery that is likely to disturb and chase away acquatic resources during this period. Construction material could also block the river during construction if they end up into the river as well as accidental spills of oil and other construction lubricants, which could contaminate the water and impact on the acquatic resources. Literature show that the fish species in River Nzoia include Tilapia and *Rastrinesbola argentea* popularly called Omena. Other types include *Protopterus aethiopicus* (mudfish) and *Clarias spp*. (catfish) and three Oreochromis niloticus (O. *variabilis, O. esculentus, and O. niloticus*,) and the *Haplochromis spp.* ("Fulu"). These are not categorised as threatened fish species having any global significance but are however a source of food and economic growth to the local communities.

The proposed project site has no known breeding/spawning points for the fish species identified above which could be affected by construction activities. Known fish breeding sites are found in the wetlands downstream of the project site including Lake Kanyaboli and Yala Swamp. Lake Kanyaboli, a satellite lake of Lake Victoria, part of Yala swamp forms the mouth of Rivers Nzoia and Yala, also one of the most important riparian lakes around Lake Victoria.

There are no significant impacts expected on the hydrology of the river as a result of the project. This is because, there exixts dykes in the project area built to control perennial floods and these structures run or are aligned parallel (on either sides of the river bank) to the River Nzoia and in effect they do not block flow of water and fisheries which flow downwards/downstream into the Lake Victoria. Therefore, the rehabilitation and strengthening of these structures will not impede migration and movement of fisheries and other acquatic resources or affect significantly the hydrology of the river.

The project is not going to lead to the loss of habitat along or within the project arrears and in the riverine ecosystem this is because the objective is to strengthen already existing structures, which are weak requiring rehabilitation, and activities will be along the banks of the river.

Mitigation:

Ecological flow recommendations

Flow events deemed ecologically important, following consideration of the identified ecological values of resident fish species in the river and current scientific knowledge of the water requirements of these values include the following:

Fish passage flows

Based on previous fish surveys in River Nzoia conducted by Kenya Marine and Fisheries Research Institute (KEMFRI), fish passage flows are required with a minimum threshold depth of 10 cm over perceived obstacles for the cross-section to allow movement of the small bodied species such as *Rastrinesbola argentea and Haplochromis spp*. Large bodied Tilapia, *Protopterus aethiopicus* (mudfish) and *Clarias spp*. (catfish) and three Oreochromis niloticus (O. *variabilis, O. esculentus, and O. niloticus*,) would require a minimum threshold depth of 20 cm. Hydraulic analysis and observance of environmental flows would have to be performed to determine discharge that achieve the above threshold, calculated as a minimum threshold depth for the reach.

8.2.2.2 Disturbance of Wildlife and Possible Illegal Hunting

Fauna within the project area, especially those habiting the river and the riparian vegetation sandwiched between the southern and the northern dykes will be impacted. The impact will be due to dyke construction related noise, vibrations and in minor cases, vegetation removal. Site workers may also be enticed to hunt wildlife encountered in the course of their work or in some cases kill the animals. The majority of the activities requiring clearance will be limited to the already existing dykes and a limited amount of vegetation clearance close to and in between the dykes.

Mitigation:

- Vegetation clearing should be limited as far as possible;
- Contractor's personnel should be warned against illegal hunting and made aware of the need to protect any wildlife encountered; and
- Use of machinery will be limited to demarcated construction site and hours to minimize related noise and vibrations.

8.2.2.3 Introduction/spread of Invasive Species

Use of substantial quantities of borrow materials is envisaged. Depending on the sources, these materials can possibly introduce seeds of plants not originally from the area and with time, establish to the extent of thwarting the growth of area's natural riparian and even wetland vegetation. However, most of the materials are anticipated to be sourced from the project area's neighborhood and introduction of such species is unlikely.

Mitigation:

Formulate and implement a weed eradication program during and after construction activities.

8.2.2.4 Increased Demand for Energy and Water Resources

Construction activities will create additional demand for energy and water resources to meet construction machinery and workforce water requirements. Construction will especially see increased demand of fossil fuel supply and the workforce will increase demand for domestic energy requirements at contractor's camp. These may have some negative impacts on the availability and supply of the resources in the project area if no proper management interventions are put in place. Alternatively, local suppliers can benefit through enhanced capacities to meet demand, especially of diesel and petrol.

Mitigation:

- Ensure that water is used efficiently at the site by sensitising construction staff to avoid irresponsible water use;
- Water consumption shall be metered where feasible and records maintained for monitoring purposes;
- Proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts unnecessarily; and
- Monitor energy use during construction and set targets for reduction of energy use.

8.2.3 Social Environment

8.2.3.1 Construction Health and Safety Risks

Both occupational and general public Safety hazards are likely to be created by the proposed construction activities resulting in possible accidents involving construction workers and or the general public.

The construction works will expose workers to occupational health and safety risks and injuries resulting from accidental falls while working at heights/raised grounds/in excavated areas, accidents involving equipment and machinery employed, chemical spills/contact, falling objects or injuries from use of hand tools and other construction equipment. The general public, mainly community members, will also be exposed to

similar risks apart from those associated with handling equipment. This impact can in worse scenario result in disabilities or even death.

Mitigation:

- The project site shall be registered as a work place with the Busia County DOSH's office;
- Mandatory safety induction and training shall be conducted to all contractors' staff as part of contract requirements;
- Safety warning signs shall be posted at strategic locations within the site;
- Active construction sites shall be barricaded from the general public with appropriate warning posters;
- Proponent shall commit the contractor to Site Occupational Health and Safety requirements as stipulated in the Occupational Safety and Health Act, 2007; and
- The Contractor shall provide all workers on site with the necessary and appropriate Personal Protective Equipment (PPE). This will be incorporated as part of the contractual agreement between the contractor and the proponent.
- In addition, to facilitate the welfare of workers, the proponent through the contractor shall ensure the following on site and at the camp:
- All site personnel to be provided with an adequate supply of safe drinking water, which should be at accessible points at all times;
- Provision of conveniently accessible, clean, orderly, adequate and suitable washing facilities within the site; and
- Suitable, efficient, clean, well-maintained and adequate sanitary conveniences (preferable mobile) shall be provided for construction workers.

8.2.3.2 Construction Waste Generation

Site preparation, contractor's camp and construction will generated various kinds of waste. These will likely include earth debris, top soil, papers used for packing cement, plastics, reject materials and domestic wastes among others. Harmful/hazardous wastes like used oil grease and associated parts will also be generated from construction machinery. Improper waste management at the site may interfere with the aesthetic status of the surrounding and lead to creation of health and safety hazards. Improper disposal of the wastes off-site could also cause nuisance, health and safety hazards, create breeding grounds for vermin and river pollution where disposal is done on the river.

Mitigation:

- The Contractor shall on behalf of the Proponent meet the requirements of the Waste Management Regulations. Wastes will be disposed at licensed facilities only by use of licensed waste handlers if necessary;
- Develop and implement project waste management plan covering the project site and contractor's camp;
- The contractor will be bound not to dispose any wastes into the river or riparian land;
- Where necessary, all machinery servicing shall be done off site and for regular maintenance waste, appropriate receptors held in the camp;

- Construction waste shall be recycled or reused as much as possible to ensure that materials that would otherwise be disposed off as waste are diverted for productive uses. In this regard, the Proponent will ensure that construction materials left over at the end of construction are used in other projects rather than their disposal; and
- Careful budgeting of construction materials requirements to ensure that the amount of construction materials left on site after construction is kept minimal.

8.2.3.3 Pressure on Social Structure

Construction activities will require a well-established workforce. The labor required may not necessarily be available from among the local communities and some workers will be sourced from outside the project area. Additionally, some people are likely to move to the area in search of job opportunities. The migrant workers could have an impact on the local social structure for the duration of the construction works. Threats of HIV/AIDS and other Sexually Transmitted Diseases (STDs) may also arise with such influx.

Mitigation:

- Community and workers sensitization through HIV/AIDS campaigns to remind the people about the scourge; and
- Ensure as many casual workers as feasible are source from the project area to reduce influx of workers into the area.

8.2.3.4 Fire Hazards

It is anticipated that a lot of fossil fuel will be used to power the construction equipment. Storage of such fuels is anticipated to pose hazards of fire, which could get out of control resulting in damage to riparian vegetation, farms among other properties.

Mitigation:

- Contractor to formulate and implement an emergency response plan;
- Carry out a detailed review of area condition in relation to wild fire incidences;
- Locate camp and workshop/garage facilities in area less prone to fires;
- Provide fire breaks at camp/ workshop and where equipment are temporarily parked;
- Liaise with the local communities in fire incidence management and abatement;
- Routinely remove materials that could fuel fires along the Project area; and
- Upgrade fire preparedness and plan as necessary.

8.2.3.5 Population In-Migration

Due to minimal economic activities other than subsistence agriculture and livestock keeping, many people have moved from rural settings to urban centres in search of employment. With increased socioeconomic activities and increase income from existence of project there is set to be increase in population of people within the catchments. The operationalization of the project will attract people to those areas in search for employment and settlement. The effect of this impact will be felt in the health sector through increased rates of HIV/AIDs infection and other diseases that are spread

through demographic changes and in environmental sector in terms of degradation. This impact will put pressure on social facilities including heath care, water, energy, sanitation and land. The construction activities of sub project investments may require recruitment of "foreign" skilled and unskilled labour that could trigger conflict, resentment and tension by the local communities over perceived inequities in distribution of job opportunities by the local communities.

Mitigation:

There are no measures for preventing population influx into the project areas. However the government in these respective areas should control settlement in fragile areas including wetlands and steep hills through existing legislations such as the Water Act. During construction phase of the project, the contractors should have employment policy, which gives preference to the local people. By employing the locals, this would discourage population influx to the area.

8.2.3.6 Safety Hazards

Risks to safety will be in two fronts. The first is during the project implementation phase. During construction of the irrigation infrastructure there is risk of injury to employees undertaking the work as well as community members around the construction activity especially small children. Injury or death could result from falling into excavated areas, drowning in flooded pit holes and canals as well as injury or death from vehicles, heavy machinery and equipment. The second risk to human safety is during the operational phase. This entails falling into dykes leading to injury or death due to drowning. This is an impact more prone to small children and to community members travelling during dark periods (at night) particularly when drunk.

Mitigation

It will be necessary for the project team to ensure that proper working equipment and attire are provided during the construction phase to minimize chances and incidences of death or injury. Similarly, proper warning signage should be appropriately erected especially where there are heavy machines and equipment moving or around excavated areas so as to forewarn any nearby persons of the dangers eminent. Intensive awareness programmes before and during the construction periods on public safety should be undertaken to reduce the chances of this impact manifesting. Where heavy or specialized equipment is in use, the project managers should ensure that it is only qualified personnel that are engaged and allowed to operate these. Strict measures should be provided to avoid unrestricted access to such.

During final project layout designs, the engineers should ensure that canals and feeder canals are well positioned to limit unnecessary exposure to the public. Where possible especially along footpaths and roads, buffers of natural bush should be erected so as to provide clear markings of where the canals are and therefore prevent accidents. Similarly, public awareness campaigns should be engendered into the project to ensure that the public is aware of risks the canal pose and will therefore take precautionary measures when travelling or working near them.

8.2.3.7 Displacement

Displacement is defined here as referring to physical, economic or cultural displacement (or deprivation). Acquisition of land for infrastructure, drainage and roads to the project sites will lead to displacement of the services that are provided by the area i.e. housing, grazing, growing fodder, source of domestic water and brick making.

Efforts have been made in the project design as far as feasible to minimize requirements for resettlement. However, the proposed project activities will lead to displacement of a number of families who have encroached onto the existing dykes and have houses built either right at the foot of or in close proximity to the dykes. Relocation is thus necessary to accommodate dykes' rehabilitation to achieve desired strength. The affected households will be assisted through a compensation package, to either be relocated to different locations/parcels of land or will only require relocating affected structures within the same land parcels.

Villages in which some families may be affected include: Galalani, Burangasi, Makhoma, and Rugunga along the southern dyke; and Sibanze, and Nerera along the northern dyke. Preliminary estimates have identified forty three (43) homesteads[5] who will be affected by the proposed project works. The detailed RAP currently under preparation will provide a comprehensive estimated land take by the project.

Through consultations on the pre-feasibility, feasibility and design of the FMP works, some community members have noted that they were not compensated for the taking of land and or materials for the construction or repair of the existing dykes. The RAP under preparation will further examine this issue, and will outline grievance redress mechanisms if needed.

Mitigation

The mitigation measures of this impact will be addressed in the Resettlement Action Plan (RAP) for compensating those who are displaced from the areas earmarked for development and construction of water infrastructure. The RAP will take into consideration the investment undertaken in the sites and alternative areas be identified for these people. Alternatively, the people who traditionally farmed the project area should be integrated into the project beneficiaries associations.

The RAP should consider resettling the displaced by providing land and investment and not just providing cash to the affected as this will create a squatter problem if the displaced misappropriate the money given as settlement for their land.

The project should also develop chance find procedures for displacement of cultural resources and it should do so in consultation with the community members and the National Museums of Kenya. The RAP should also include adequate mitigation measures, procedures and considerations for cultural heritage when encountered at the domestic and community level.

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[5] A homestead typically consists of several houses/structures and households of the same lineage.

8.2.3.8 Loss of Ancestral and Farm Lands

Stronger and higher dykes will require additional land strip on the landside of the existing dykes. Both resettlement of homesteads and uptake of unsettled land for wider and higher dykes will mean that the affected families and land owners lose some portions of their ancestral land, some of which are their farms (used for either grazing or cultivation). The community in the area have a strong attachment to ancestral land hence this will negatively impact on the affected individuals.

8.2.3.9 Loss of Access to Fisheries

Fishing is important economic activity in Budalangi and is undertaken by men in Lake Victoria but sometimes women and children participate in fishing along the banks of River Nzoia and in receding floodwaters. Fishing is mainly for subsistence and economic gains with women being mostly responsible for trading the fish products. Dyke improvements could also see some affected individuals lose easy access to fishing grounds specifically those fishing along the banks and in receeding floodwater. With the dykes strengthened, the spill over that occurs when the dykes are destroyed hence providing fishing grounds will be no more. However, those fishing in the river will only be affected during the construction phase of the project since civil works may disturb fish resources and send them further downstream. This situation is expected to be temporal and only felt during the construction phase. The on going social assessment and RAP will quantify this impact further.

8.2.3.10 Disruption of Transport Linkages

Raising and strengthening works to the existing dykes will disrupt the currently short linkages along existing dyke crests and between the villages to the south and the north of river Nzoia as the dyke crests may remain inaccessible. Replacement of culverts at Sigiri crossing (Chainage 12.0km) will also disrupt the communication between villages to the south and the north of river Nzoia during construction, but will improve this in the longer term. The Sigiri crossing provides an important access to and from the major trading centre of Port Victoria. The disruption will be temporary, being limited to the new culverts installation, and an alternative exists down the river in the Narera area.

Mitigation

Informing the community of inaccessibility in advance before works at the Sigiri crossing begins. This should include erecting public notices at key crossings approach points from both the north and south of the river; and planning construction activities such that resultant disruptions are as minimal as possible.

8.2.3.11 Noise and Vibration Impacts

Construction activities could result in significant noise impacts so as to impact on general well-being, health and functioning. Large scale infrastructure developments involve the use of heavy equipment (graders, drilling equipment, trucks, blasting equipment, tractors, and excavators) for among others rock blasting, excavation, asphalt mixing plant operations and vehicular movement that emit incessant noise usually harmful to the

environment. Introduction of new sources of noise is an issue in areas where ambient noise levels have been low.

Mitigation

This impact is unavoidable and will be mitigated using machinery that minimise noise emissions, construction will be avoided at night.

8.2.3.12 Decommissioning Phase Impacts

Decommissioning of the proposed works is considered unlikely given that the enhanced flood defences are likely to make further developments and settlements in the protected floodplain more attractive. By the time the design lifespan of the new works elapses, development and settlement density in the area may have increased necessitating a continuing presence of flood protection interventions. As noted above, it is strongly recommended that development in the floodplain is controlled so that additional population and infrastructure is not put at risk from larger flood events which could overtop the improved defences.

Should the need arise following realisation of new flood control/management measures, the dykes or their sections could be decommissioned following technical appraisals. Some of the likely impacts include the following:

8.2.3.13 Floodplain rehabilitation

Decommissioning the dykes will stop the artificial interventions in the river's morphological processes leaving natural forces to continue. This will allow its natural rehabilitation with time as no artificial interventions will be in place to direct the river movement, arrest flooding or any other processes. Although wider flooding of the floodplain would be more frequent, its severity would be mitigated by greater use of floodplain storage and, after a time, impacts would be reduced by the population's sensitisation to the likelihood and effects of flooding – possibly resulting in their desire to relocate to other areas.

8.2.3.14 Exposure to floods

Removal of the dykes will leave the floodplain area exposed to any subsequent floods. Given that more developments would have been established, the resulting losses including loss of lives could be both socially and economically significant.

8.2.3.15 Air pollution

Decommissioning earth works and transfer of dyke materials will generate a vibration, dust and noise related pollution similar to construction activities. This will affect the villages/ homes immediate to the project area and along the material hauling routes.

8.2.3.16 River pollution

Fuel and oil spills/leaks from decommissioning machinery may pollute the receiving grounds and in extreme cases be washed into the river thereby polluting it. This can be

harmful to riverine biota and any pollutant may also end up being washed into the lake downstream creating extended effects.

Mitigation:

- Ensuring fuel and oil to be used during decommissioning is held in banded areas and stored under cover;
- Amounts of fuel/oil held on site at a particular time will be limited as far as feasible;
- Spill response kits will be maintained on site by the decommissioning crew; and
- All efforts will be made to prevent spillage of the substances through contractor's' documented spill prevention procedure and response plan.

8.2.3.17 Disruption of fauna

Decommissioning activities generating noise and dust will likely create disturbances to area fauna, especially birds in the adjoin vegetation cover. Decommissioning crew may also be tempted to engage in illegal hunting.

Mitigation:

- Limit decommissioning activities to day time only;
- Limit idling time of decommissioning equipment and restrict them to project area only; and
- Sensitize crew against illegal hunting and unnecessary harm to any wildlife encountered.

8.2.3.18 Soil erosion and river sedimentation

Dykes removal will expose strips they cover to erosion agents. The remnant soil/earth materials from decommissioning works will also, following rainfall episodes, be washed into the river resulting in its siltation.

Mitigation:

Disturbed areas shall be re-vegetated as soon as reasonably possible

8.2.3.19 Summary of Impacts Characterization

The anticipated impacts above have varying degree of significance. Depending on their nature, duration, potential spatial extent, anticipated magnitude (based on likelihood of occurrence relative to the receiving environment), the characterisation has been summarised in Table 17. The characterisation has been based on consultants' professional judgement and experience following site visits, consultation of published information and review of specialist agricultural and social studies on the project area.

Table 17: Summary of adverse impacts characteristics

Impact	Extent	Occurrence	Significance	Nature	Mitigation
Changes in Hydrology	Lower Nzoia Basin Domestic water	Potential	Medium	Cumulative	Control and management of abstraction
Soil erosion	Site specific	Potential	Low	Cumulative	Soil conservation measures
Water logging and salinization	Site specific	Certain	Low	Cumulative	Plant deeprooted crops.
Sub-surface water contamination	Site specific	Potential	Medium	Cumulative	
Soil salinity	Site specific	Potential	Medium	Cumulative	Create adequate drainage/frequent flushing
Reduced water flow downstream	Downstream	Potential	Low	Cumulative	
Flooding	Downstream	Potential	High	Cumulative	Creation of buffer areas
Siltation of water bodies	Downstream	Potential	Low	Cumulative	Catchment conservation
Population influx	Project area	Certain	Low	Indirect	Managing population by protecting fragile areas and provision of basic amenities
Water borne diseases	Localised	Potential	Low	Cumulative	Introduction of fish in the canals and awareness creation Provide safe drinking water sources
Safety hazards	Canals	Potential	Medium	Indirect	Provision of community watering points and culvert public areas
Movement obstruction due to construction of dykes	Site specific	Certain	Medium	Direct	Use of culverts and construction of access roads

Impact	Extent	Occurrence	Significance	Nature	Mitigation
for both animals and human					
Food security and subsistence	Regional	Potential	Low	Indirect	Promote intercropping and rotational farming
Displacement	Localised	Certain	Low	Direct	Compensate the displaced as per the RAP findings
Fisheries Impact	Localised	Certain	Low	Direct	Maintain minimum environmental flows to maintain fisheries
Loss of livelihoods	Localised	Potential	Low	Direct	Compensate as per the RAP findings
Human Wildlife Conflict	Localised	Certain	High	Cumulative	Provision of a trench running on the southern part of the project area

9 CHAPTER NINE. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

This ESMP is a detailed program of work, which defines what mitigation measures and monitoring activities that will take place, when and by whom. The plan includes estimates of costs of implementation. The persons and institutions responsible for implementing the plan will include farmers/water users associations NEMA, World Bank, Ministry of Environment, Water and Natural Resources and contractors. Potential mitigation measures considered in the Environmental Social Management Plan (ESMP) include:

- Environmental management plans and programmes;
- Social and economic investment programmes;
- Engineering design solutions;
- Alternative approaches and methods to achieving an activity's objective;
- Operational control procedures; and
- Management systems approach.

9.1 ESMP OBJECTIVES

The objectives of the Environmental and Social Management Plan (ESMP) are:

1. To bring the project into compliance with applicable national environmental and social legal requirements and the World Bank's environmental and social policies as stipulated under the various safeguard operational policies and Bank procedures;
2. To outline the mitigating/enhancing, monitoring, consultative and institutional measures required to prevent, minimize, mitigate or compensate for adverse environmental and social impacts and/or to enhance the project beneficial impacts;
3. To address capacity building requirements to strengthen the Proponent's environmental and social capacities if necessary.

9.2 ESMP IMPLEMENTATION

This ESMP will be implemented by several institutions, which are directly or indirectly involved in this project. These institutions are the World Bank as the lender, MEWNR as the project implementer or proponent, MoH, MoA, MoL, WRMA, IWUAs members, design engineers, contractors who will be commissioned to construct the irrigation infrastructure.

9.2.1 World Bank

World Bank will undertake periodic monitoring of the implementation of the ESMP during the appraisal and review missions at least twice every year.

9.2.1.1 Project Management Unit (PMU)

For effective management of the project, a PMU will be established that will compose of the stakeholders identified in the ESMP. This PMU will be meeting at the project location to address the issues that will arise during the project implementation.

The PMU will comprise a project manager; a deputy manager/; an engineer; a community development officer; together with administrative, accounting and procurement staff.

9.2.1.2 Role of other stakeholders in the PMU

In addition to the PMU, membership would include – on an ***as needed basis*** - local representatives of agencies key to project implementation:

- The County Administration, which will need to support community mobilization
- The District Gender and Social Development Office
- The District Health Officer, whose support will be essential to the implementation of the health activities under the ESMP
- The District Engineer, to coordinate the development of road infrastructure linked to the scheme roads network
- The local NEMA Branch, to support implementation of the ESMP
- The District Lands Office, to accompany implementation of the RAP
- The District Agriculture Office, to support the agricultural development programme and to coordinate implementation of the watershed protection activities in the ESMP
- NGOs and CBOs locally active in relevant fields would also be invited to attend.

9.2.2 National Environment Management Authority

National Environment Management Authority being the oversight authority over the environment in Kenya, its role will be reviewing of the ESMP, approval, monitoring of environment indicators as identified in this monitoring plan and advising on environmental issues related to this ESMP.

9.2.3 Project Beneficiaries

The project beneficiaries being the people on the ground will have the role of executing some of the mitigation measures, collecting and monitoring the identified indicators and practicing sustainable farming as well as catchment rehabilitation and management.

9.2.4 Water Resources Management Authority

Water Resources Management Authority will develop an integrated catchment management plan for the project area. The integrated catchment management and restoration will involve soil erosion through afforestation, soil and conservation measures including terracing and agro-forestry on the sloppy areas.

A catchment approach would best mitigate environmental problems. The main elements of a catchment approach are to (i) buffer zones of natural vegetation created at intervals to control water flow, reduce downstream impact, help filter out effluents from other activities, and provide fodder for livestock and materials for thatch; and (ii) zoning of areas and restricting cultivation of habitats that are critical for water storage or breeding habitats for wild animals.

9.2.5 Contractors

The contractors will be in charge of designing and constructing the infrastructure according to the findings and recommendations of this ESIA report and the ESMP, restoring the degraded areas, ensuring the safety of the users and others. The

contractor(s) will be responsible for the complete implementation of design mitigation measures in the ESMP.

9.2.6 Ministry of Health

Due to existing health impacts especially malaria and bilharzias in and around the project area, the role of Ministry of Public Health and Sanitation will be to promote environmental health, health prevention methods including sleeping in treated nets, indoor residual spraying and monitoring incidences of malaria, cholera and bilharzias.

ENVIRONMENTAL MANAGEMENT PLAN

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
Increased demand for borrow materials	Procure earth materials from registered and approved quarries and sand mining areas which have undergone satisfactory environmental impact assessment/audit and received NEMA approval; For realignments, reuse existing dyke materials as far as feasible to reduce demand; Implement stringent inventory management mechanisms and only source for materials after a fairly accurate estimation of actual requirements; and	Environmental approval status of borrow points; Quantities of reused dyke materials; No excess materials left on site at end of construction.	Review Licenses for borrow sites Review of materials inventories	Contractor	1,200,000

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	Formulate rehabilitation plans for new borrow sites acquired for the project purposes only. Such plans could incorporate transformation of such sites into fishponds.				
Land uptake and Resettlement of families	The proposed design has minimized the need for land uptake. In addition, the following actions shall be undertaken: Formulation and implementation of resettlement action plan (RAP) ahead of project implementation; Identification of affected families, consultation and	Documented RAP; Grievance mechanism; Resettled PAPs.	Review of RAP implementation progress; Complaints from PAPs; Site inspection.	MEWNR	To be determined by RAP Budget.

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	incorporation of their views; Where feasible (given safety				
Soil erosion and river siltation	Demarcate construction areas to avoid unnecessary land surface disturbance; Compression of dyke materials will be done as soon as reasonably feasible; Limit machinery movements to predetermined paths; and Any disturbed surfaces will be re- vegetated.	Extents of cleared/devegetated areas	Visual inspection; Sediment presence in storm channels; Daily visual inspection of work sites; and Inspection after significant rainfall.	Contractors	Soil erosion and river siltation
Exposure to flood risks during construction	Realignment works to be planned such that the new alignment is constructed before the old one can be removed;	Phasing of realignment works; Construction progress and completed works;	Review of work plan and feedback from emergency authorities	Contractors	Exposure to flood risks during construction

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	Construction team to liaise with the flood monitoring and early warning teams both at community and national levels throughout the construction period.	Possession of flood forecast/ warning data.			
	Liaise with the flood monitoring and early warning teams both at community and national levels to compliment contractors' data and information throughout the construction period.	Possession of flood forecast/ warning data and liaison schedules.	Review of work plan and feedback from emergency authorities	MEWNR	Liaise with the flood monitoring and early warning teams both at community and national levels to compliment contractors' data and information throughout the construction period.
Air quality degradation- generation of dust and exhaust emissions	Dampen work areas materials heaps and mulch bare ground to minimize dust emissions; Maintain construction equipment and machinery to manufacturers'	Lack of complaints /Complaints from community and workers; Reports/Log book entries; Erected vehicle speed limit signs;	Daily/periodic site inspections Review of equipment maintenance records	Contractors	Air quality degeneration- generation of dust and exhaust emissions

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions; Use environmentally friendly fuels such as low sulphur diesel; Minimize the idling of machinery; Ensure that no burning of waste is done on site; Enforce speed limit for vehicles in the project area; Rehabilitation of any disturbed areas once completed; In very dry and windy weathers, cover all trucks hauling sand, ballast and other loose materials or require all trucks to maintain at least two feet of freeboard; and	Records of regular servicing for machinery			

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	Proper planning of transportation of materials to ensure that the number of trips done or the number of vehicles used is as minimum as possible.				
Wildlife disturbance and illegal hunting	Limit vegetation clearance as far as possible; Warning contractor's personnel against illegal hunting and awareness creation on the need to protect any wildlife encountered; and Use of machinery should be limited to demarcated construction site and hours to minimize related noise and vibrations	Presence/absence of birds in proximity to project site; and Reported wildlife deaths.	Observation and comparison with baseline data	Contractor	50,000
Disruption of irrigation infrastructure	Timely notice of any planned disruption of the canal operations to	Condition of affected canal during	Inspection of works	Contractor	100,000

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	the affected farmers downstream the affected area.	and after construction Complaints log			
	Liaison with NIB.	Complaints log	Liaison records	MEWNR	50,000
Exposure to construction safety and health hazards (occupation and general public)	The project site shall be registered as a work place with the Busia County DOSH's office; Formulation and implementation of project safety and emergency response plans; Mandatory safety induction and training shall be conducted to all contractors' staff as part of contract requirements; Safety warning signs shall be posted at strategic locations within the site; Active construction sites shall be	Work place registration certificate Project safety and emergency response plans Records of incidences/ accidents/fatalities Health and safety awareness among staff	Daily inspection of work sites; and Toolbox meetings' records.	Contractor	800,000

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	barricaded from the general public with appropriate warning signs/posters; Provision of appropriate Personal Protective Equipment (PPE); All site personnel to be provided with an adequate supply of safe drinking water, which should be at accessible points at all times; Provision of conveniently accessible, clean, orderly, adequate and suitable washing facilities within the site; and Suitable, efficient, clean, well-maintained and adequate sanitary conveniences (preferable mobile) shall				

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	be provided for construction workers.				
	Proponent shall commit the contractor to Site Occupational Health and Safety requirements as stipulated in the Occupational Safety and Health Act, 2007.	A binding safety and health agreement.	Regular inspections and reports	WKCDD&FMP	200,000
Waste generation	The Contractor shall meet the requirements of the Waste Management Regulations. Wastes will be disposed at licensed facilities only by use of licensed waste handlers if necessary; The contractor will be bound NOT to dispose any wastes into the river or riparian land; All machinery servicing shall be done off site and for regular	Wastes' documentation; and Presence/ no waste at work sites except in approved and marked holding locations.	Regular site inspections; and Review of waste disposal documentation.	Contractor	300,000

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	maintenance waste, appropriate receptors held in the camp; Re use of construction materials left over at the end of construction in other projects rather than their disposal; and Careful budgeting of construction materials requirements to ensure that the amount of construction materials left on site after construction is kept minimal				
Pressure on social infrastructure and spread of HIV/AIDS	Workers sensitization through HIV/AIDS campaigns to remain safe; and Ensure as many casual workers as feasible are source from the project	Health records and awareness materials.	Assess workers awareness; Proportion of unskilled labour sourced from locality	Contractor	400,000

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	area to reduce influx of workers into the area.				
	Community sensitization through HIV/AIDS campaigns to remind the people about the scourge;	Community feedback/complaints	Assess community awareness.	MEWNR	500,000
Fire hazards	Contractor to formulate and implement an emergency response plan; Carry out a detailed review of area condition in relation to wild fire incidences; Locate camp and workshop/garage facilities in area less prone to fires; Provide fire breaks at camp/ workshop and where equipment are temporarily parked;	Storage of potential fuels; Fire preparedness; and Fire incidences.	Fire occurrences; Regular inspection of work sites; Review of fire preparedness plans; Awareness/ drills; and Review of construction activities.	Contractor	Fire hazards

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	Liaise with the local communities in fire incidence management and abatement; Routinely remove materials that could fuel fires along the Project area; and Upgrade fire preparedness and plan as necessary.				
Increased demand for energy and water resources	Ensure that water is used efficiently at the site by sensitizing construction staff to avoid irresponsible water use; Water consumption shall be metered where feasible and records maintained for monitoring purposes; Monitor energy use during construction and set targets for reduction of energy use. A separate	Resource use plans; and Resource use trends.	Review of consumption data; and Observation.	Contractor	100,000

Anticipated Impact	Action Plan	Performance Indicators	Monitoring Means	Responsibility	Indicative Cost (KSh.)
	electricity meter shall be installed for use by the contractors; Proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts unnecessarily; and Monitor energy use during construction and set targets for reduction of energy use.				

DECOMMISSIONING PHASE

Activity	Adverse Impacts	Mitigation Measure(s)	Implementation Schedule	Responsibility	Budget (US$)
Civil works	Burrow pits that could provide vectors habitat	Rehabilitate through levelling and planting of vegetation	During decommissioning construction	MEWNR	

	Abandoned dykes could predispose communities to hazards.	Fill or where otherwise level and introduce vegetation	During decommissioning	MEWNR	

10 MONITORING PLAN

This monitoring plan defines and identifies monitoring activities that will take place during development and implementation of the project. It defines timelines and responsibilities as well as identifies the indicators and data collection methods to be applied. The plan also identifies the training and capacity building needs of the institutions and persons to implement it.

As indicated in the monitoring schedule below, monitoring will be done by numerous institutions and persons but coordinated by KWSCRP/PMU.

To ensure effective and reliable data collection, the key persons from the institutions to be involved in the monitoring will be trained on the indicators to be monitored, sampling methods, and data collection techniques to be used. The KWSCRP/PMU will organize a 2-day training program in one of the project sites and train the participants. The key resource persons for this training will be the Environmental Officer and the M&E coordinator. Participants for this training will be from the institutions involved in implementation of the monitoring plan which are NIB environment and social department, Environmental Officer, Water engineers, District Environmental Officer-Bunyala/Siaya, IWUAs members, District Agricultural Officer, District Water Officer, District Irrigation Officer and the District Public Health officer

10.1 MONITORING SCHEDULE

Impact	Parameter	Indicator	Method	Frequency of Measurement	Responsibility	Costs Estimates
Physical Environment						
Reduced Waterflow	Quantity	Percentage of water abstracted to be kept, Adhere to Environemntal Flows, Flow Rates Per Second	Water meter at the intake weir	Monthly	WRMA	WRMA already has a programme for water flow monitoring. 1000 Per Year
Water logging and soil salinization	Salt build up in soil	Soil salinity	Sample soil pH testing	Yearly	MEWNR and MOA	USD 20,000 for procurement of sampling kits and training of farmer units.[6]
Soil erosion	Soil	Soil productivity, gullies, water turbidity, siltation of the canals, units and lines	Observation and look out for siltation and reduced retention capacity	Continuous	MEWNR and MOA	Should be integrated into cooperative activity collecting information from appointed members.

[6] The farmer units should then be responsible for undertaking soil analysis on a yearly interval while NIB should collect and collate this data.

Impact	Parameter	Indicator	Method	Frequency of Measurement	Responsibility	Costs Estimates
Biological Environment						
Emergence of water weeds	Water weeds	Presence of water weeds	Water bodies with water weeds	Continuously	MEWNR and IWUAs	25,000
Socio-Economic Environment						
Population influx	Population	Change in total human population within the 10 km radius of project area	Census reports	Continuous	Local Administration	Part of the 275 Million for Participatory Irrigation Management
Water-borne diseases	Water-borne diseases	Increased cases of malaria and bilharzias among other waterborne diseases	Review of health records at the divisional level health centres	Quarterly	MEWNR (Environmental Officer) Ministry of Health Public Health Office	50,000
Safety Hazard	Accidents	Incidences and accidents occurrences	Review and evaluation of incidents and accidents register	Monthly	MEWNR (Social Officer & IWUAs members	Part of the project M&E budget 5,000 per year

Impact	Parameter	Indicator	Method	Frequency of Measurement	Responsibility	Costs Estimates
Movement obstruction	Complaints	Incidences and accidents occurrences	Review of complaints	Continuous	MEWNR and the contractor	50,000
Human-wildlife conflict	Conflict	Incidents reported	Incidents review	Monthly	MEWNR IWUAs and KWS	30,000

11 PUBLIC CONSULTATION

Public consultation and disclosure of information about Project took place through household surveys and focused group meetings. The first public consultation exercise was conducted during the month of March to April 2013 in the project area when the enginnering consultants were preparing the feasibility study report.

11.1 ISSUES FROM STAKEHOLDERS CONSULTATIONS (DURING DESIGN AND FEASIBILITY STUDY)

The following issues were identified and raised by stakeholders during the public consultations conducted at the time of design and feasibility studies development. According to the community, the following benefits are associated with the floods downstream of River Nzoia.

Sediment deposits, which fertilize the land It was established that one of the benefits enjoyed by the community in the downstream area of River Nzoia is the deposit of alluvial soils, which are very fertile. This encourages farming as the land becomes fertile and the crops grow well. However, the dykes have prevented the spread of sediment onto the wider floodplain, except when breaches occur.
Fishing Inexpensive fishing activity was encouraged by flooding in the downstream region of River Nzoia. According to the respondents, floodwaters come with varieties of fish species from upstream of the river that are very nutritious. As a result fishermen benefit, as they are able to catch fish easily and sell them.
Water for irrigation of small farms Small-scale farmers benefit from the floodwater as they use the water to irrigate their farms. This enables them to stop using fuel to pump water from the river to irrigate their land, especially for rice growing.
Assistance from the government and other organizations It was established that floods do enable the community to benefit from relief food and other goods such as clothing, tents etc. However, these are short-lived as they are only given to the affected community during flooding.
Creates seasonal job opportunities Floods also create seasonal job opportunities to some of the communities enabling them to earn income, which they use for subsistence and other activities. According to the respondents, there are people who work on the river crossings and assist the commuters to cross the river from one side to the other. However, during floods they increase the fee, hence increasing their income.
Seminars on agriculture It was also stated that due to the floods the Government has conducted seminars to enable the communities to learn how they can make use of the floodwater for agriculture and other profitable pursuits.
Availability of water for domestic use The respondents also stated that floods make water available for domestic use. However, the water requires proper treatment before use.
Sand harvesting As mentioned earlier, floodwaters deposit sand in the downstream region of River Nzoia. Some of the community members harvest this sand for selling after floods have receded, hence generating income.

Environmental and Socioeconomic Problems Created by Floods in the

Downstream Region of Nzoia River The following were stated by the respondents to be the problems created by floods in the downstream region of Nzoia River.
Displacement of People Floods in the project area cause displacement of people as homes are swept away or become submerged with water. As a result the affected people move to stay with relatives located in the upper areas or end up staying in camps at the Health Centres, Schools and other areas on higher ground.
Destruction of crops Floods in most cases occur when the communities within the project area have cultivated and planted crops in the farms. These crops are washed away or submerged by floods and then are left to rot. This has a negative impact in the local economy as it leads to food insecurity in the region.
Destruction of homes and property In the downstream region of Nzoia River, floods were mentioned to be destroying homes and property leading to people losing their property and at the same time being displaced. These people end up staying in camps at the upper grounds where life is reported as not always comfortable.
Infrastructure damage Floods damage roads and other infrastructure, rendering them unusable. This leads to transportation problem within the project area leading to the community not receiving the necessary goods in good time or not receiving the goods at all. This also hinders movement of pupils/students, employees from reaching schools and offices in time.
Water logging Most of the land in the downstream region of Nzoia River was said to become water logged as a result of flooding. This limits some of the human activities such as farming as the land become water logged for long periods.
Soil erosion Flood was said to be causing soil erosion in some areas in the downstream region, leading to the top fertile soil being washed away to other areas. The Nzoia riverbank is also eroded by the floodwater, which contributes to siltation of the river bed. This has a negative effect in that the deposited silt raises the depth of the river and reduces capacity of the channel for passing of floodwaters.
Loss of grazing land The respondents stated that floods interfere with the grazing land in the downstream region of Nzoia River. This leads to livestock suffering as they can only afford to graze in small areas.
Destruction of vegetation Floods were stated to be destroying vegetation in the downstream region of Nzoia River. Some of the vegetation is uprooted while some dry up as they are not able to thrive in areas with too much water. This, in turn, causes an environmental problem downstream. Young tree seedlings and flowers are also destroyed by floods in the process of flooding. Those displaced by floods to stay in camps also tend to cut down firewood for cooking. This leads to destruction of vegetation in the area.
Destruction of habitats for animals and birds

The respondents stated that floods destroy the habitats for some of the animals and birds. This leads to these animals being displaced to look for other areas where they can settle in.
Loss of lives Some people and animals are killed by floods or their after effects.
Interruptions of learning Floods disrupt learning in some of the schools at the downstream region of Nzoia River. Floods damage schools while some become submerged in water. Some of the pupils/students are also not able to reach their schools due to the roads being impassable.
Hardening of farm land after drying It was noted that after floods recede the farmlands dry out and become hard. This is due to the type of soil that is present within the region. This makes it hard for the farmers to plough once the land is dry. Floods lead to the outbreak of diseases such as Cholera, Malaria and other water borne diseases in the region. This is a result of the floodwater destroying and washing out pit latrines leading to water pollution. The accumulated flood water also act as breeding grounds for mosquitoes leading to the spread of malaria in the area. In addition floods lead to increased livestock diseases.
Poor sanitation and diseases outbreak Floods lead to poor sanitation in the downstream region of the Nzoia River. This is as a result of the sanitary facilities such as pit latrines being destroyed and the areas becoming unclean due to the conditions at the camps used by the displaced people.
Idleness among the community Floods were mentioned to be creating idleness among the community as they are unable to continue with their daily activities. This at times leads to some of the community engaging in activities that are not good and which they would have not engaged in if they were not idle.
Space for burying the dead It was stated that space for burying the dead becomes a problem during floods downstream because the land becomes submerged with water and the digging of graves becomes a problem.
Snakes and wild animals bites and injure people It was stated that floods do force wild animals including snakes from their habitats leading to snakes and other wild animals respectively biting and injuring people within the region.
Foul smell due to stagnant water It was noted that the stagnant water on the ground produces a foul smell that pollutes the environment.
Social conflicts It was established that floods lead to conflicts among the communities. This is as a result of floods destroying the boundaries established by the community. The conflicts do arise immediately after floods and when the land has become dry.
Breeding place for fish affected It was noted by the respondents that floods affect the breeding places for fish and the eggs are washed down stream. However, it is noted by the Consultant that this can enhance the fish population of the wider area e.g. Lake Victoria.
Overcrowding of people at certain areas The respondents stated that floods interfere with the planning of settlements in that people are forced to concentrate on higher ground areas. Overcrowding of people at

these areas is risky in that when there is an outbreak of diseases, many people get affected.
Contamination of borehole water The boreholes were stated to be getting contaminated by the floodwater. This is as a result of the floodwater carrying earth, rubbish and human waste into the boreholes. This leaves the community with unsafe water to drink.

Positive Impacts of Existing Dykes

Management of Floods Though the existing dykes have outlived their design period, the community acknowledged that they have contributed to managing floods in the downstream region of Nzoia River to some extent and especially the reinforced/repaired areas. It is against this background that the community support the proposed new rehabilitation works
Used of Dykes as Roads Both the southern and the northern dykes are being used as roads from one place to another. They are short cuts that are used by the community from one village to another. They also assist in monitoring the water level of River Nzoia.
Impeded Spread of Sediments The dykes prevent the spread of sediment from the river onto the wider floodplains, except when breaches occur. This has lead to the sediments being deposited within the levee section of the floodplain and respondents suggested that this may lead to the reeds growing in large numbers on the river banks.
Yala Swamp Historically, some flood flows from the Nzoia passed south to Yala swamp (and still do if the dykes get breached). It was suggested that the existing dykes may therefore have had an impact on the ecology of the swamp.
Soil Erosion It was noted that the dykes are being eroded especially in the areas that are used as access routes to the farms or to the River. This is seen to make the dykes weak and vulnerable to breaching.
Deteriorating Infrastructure The community perceives that a lack of systematic and routine maintenance of the flood dykes make them susceptible to breaches even during floods of relatively low magnitude than their design capacity.
Construction of dykes on peoples' land Most of the respondents complained that the dykes were constructed on their land and they were not compensated. It was also stated that most of the community members were forced to move to other areas to allow for the construction of the dykes. In addition, the dykes were constructed on land that some of the community were using for farming and, as a result reduced the size of the farming land.
Land disputes during demarcation It was mentioned that construction of the existing dykes led to land disputes during demarcation especially by those who were displaced as they wanted to get the same size of land that they had previously had. In addition, the disputes came as a result of people wanting to be demarcated to fertile and good areas. Land wastage after construction of the dykes The respondents noted that the land that remained on the river side after construction of the dykes became wasted, in that they are submerged by the floods and that crops

cannot be grown. This was seen as being due to the dykes interfering with the flow of the floodwater.
Materials borrow sites turn into wastelands The community experience is that land parcels that were used as borrow sites for dyke construction and maintenance become wasteland. The sites were not rehabilitated and cannot be used for farming or any other economic activity.
Impeded drainage It was noted that the dykes have stopped rain water from draining into the river in certain areas leading to the crops being submerged by water and being destroyed. According the respondents, the dykes were constructed in a way that they interfered with the natural drainage system
Land disputes during demarcation It was mentioned that construction of the existing dykes led to land disputes during demarcation especially by those who were displaced as they wanted to get the same size of land that they had previously had. In addition, the disputes came as a result of people wanting to be demarcated to fertile and good areas.
Soil used to repair the dykes It was stated that the soil used to repair the dykes is taken from people's land and that this interferes with the land as pits are left on the land without being rehabilitated. In addition, farming on these areas also ceases as the top soil that is fertile is removed
Inaccessibility of the dykes during rainy seasons It was stated that one of the problems of the existing dykes is that they become inaccessible during rainy seasons since they become very muddy. This hinders the movement of people from one place to another unlike before when the dykes had not been constructed.
Dykes harbour living organisms It was also stated that the existing dykes harbour rodents and dangerous reptiles, which are harmful to human beings and even livestock. The respondents also stated that the existing dykes harbour living organisms, which weaken their texture. The dykes were also thought to facilitate the movement of ants and termites, which directly attack the communities and vegetation in the area.

Summary of Consultations Outcomes

It is notable that the development of the proposed project activities has had the engagement of project stakeholders including the immediate community members in the project area. They have been engaged in identification of numerous alternatives, which were considered in different appraisal processes. The outcomes were also shared to justify elimination of some of their suggestions and carrying forward of others.

During a community workshop held on 18 October 2012 to present the draft Flood Management Plan (FMP), there was overall support for the proposed arrangement and an acceptance from the community representatives that some impact on a limited number of individuals would be necessary (e.g. resettlement of those living very near to the dykes) to provide benefits to the wider community. The community representative stressed that any resettlement process must be properly managed, that those affected should be informed well in advance and compensated adequately.

Participants in the workshop expressed the desire for the embankments to be extended to the Lake. The consultant had considered this option but it was not considered

feasible due to limited benefits, significant environmental impacts and high cost. The area is a wetland and human activities including extending the embankment would lead to detrimental impacts on the habitat reduction. Moreover, natural topography and existing dykes prevent backflow around the embankment ends threatening significant human settlement. Thus most homesteads upstream will be protected from flooding which would be occasioned by backflow. The community and stakeholders at large were urged to conserve the wetland and their environment at large to realize development. The proposed final design has incorporated community feedback as far as feasible including providing solutions to problems they experienced with the old dykes. The consultation records are appended as Appendix B.

11.2 ISSUES AND CONCERNS DURING CONSULTATIONS FOR UPDATING THE ESIA

In 2015, February, an independent consultant was contracted by MEWNR to review and update the ESIA. Part of the review and update entailed conducting a second round of public consultations in the project area.

Public consultation meetings were held for the proposed project in order to capture the concerns associated with the project from all stakeholders. The stakeholders who were targeted were members of the local community, local leaders, and officers from the County Government, officers of the National Government, business owners, religious leaders, NGOs and transporters, among others. There was an earlier mobilization meeting whose purpose was to introduce the ESIA team to the area, inform the local communities about the proposed road project and identify key stakeholders for interviews and public consultation meetings. Public consultation meetings were used to explain to stakeholders the benefits of the proposed road project, potential adverse impacts, measures to mitigate negative impacts, and arrangements to compensate project affected persons. Stakeholders were thereafter given the opportunity to give their views, opinions and suggestions on the most appropriate considerations during the construction and operation of the road.

Approach to Stakeholder Consultations
Stakeholder consultations occurred at two levels.

The first level involved in-depth interviews and discussions with institutional stakeholders, such as the provincial administration, County Government, Government departmental heads and Civil Society, NGOs and CBOs representatives. The interviews were intended to share information on the project with them, and solicit their opinions and recommendations.

The second level involved public meetings with the general public, particularly the local communities, their leaders, pastoralists, farmers, transporters and the business community to discuss the proposed road project and obtain their opinion and recommendations about the project. A total four meetings were held between 16th and 23rd Februrary 2015 at different venues along the proposed project site as shown in **Table 18** below.

The target groups for the Public Consultation Meetings were:

- Project area community

- Local Administration
- Business community within the project area
- CBOs and NGOs
- Government Agencies
- Local leaders

Table 18: Summary Of Public Consultation Meetings

Village	Location	Date	Number of Participants
Makhoma	Khajula	16th February 2015	58
Nanjomi	Bunyala Central	19th February 2015	67
Mumbira	Bunyala East	19th February 2015	45
Narera	Bunyala West	19th February 2015	54
Total			**224**

Consultations with stakeholders were carried out among the people living and carrying out their daily livelihood activities within the environs of the project. The aim of the consultations was to ensure that interests and concerns of all stakeholders are identified and incorporated in the project development, construction and operation.

The study employed three main methods of consultations to get the data presented in this report. These are:

- Meetings and discussions with Key Stakeholders;
- Questionnaire administration and interviews;
- Convening of Public Consultation Meetings within the project area.

Key informants included County Leaders and representatives from various Government Departments, CBOs and NGOs. The rest of this report identifies the critical issues emerging from the proposed project.

Purpose of Stakeholder Consultation

The main purpose of carrying out stakeholder consultation was to obtain views, concerns and opinions of the project area community and other interested parties regarding the project so as to incorporate their contribution into the project development to safeguard the environment, the interest of key stakeholders particularly the local community, project area leadership and agencies directly or indirectly affected by the project.

All issues, comments, suggestions and information contributed by stakeholders either by way of focus group meetings or informal meetings are compiled into an Issues Report. The report is categorized in different disciplines. The issues raised during the consultation process are highlighted below.

Table 19: Summary Of Public Consultation Meetings

Issues Raised	Responses
Will the project generate noise, which would be harmful to our health?	There will be construction related impacts but minimal/moderate but tolerable from the heavy machinery.

I am concerned about soil erosion impacts and how it will be managed	An Environmental Impact Assessment report under preparation will identify mitigation measures
How will the project mitigate impacts associated with vegetation since heavy machinery tramples and destroys surrounding vegetation (trees and plants) in their way	An Environmental Impact Assessment report under preparation will identify mitigation measures
Poor air quality due to dust especially because construction will occur during the dry season	An Environmental Impact Assessment report under preparation will identify mitigation measures
Hydrology Seepage through the dyke walls is a concern to me. Percolation of water under the dyke to people's lands from water gathering in the deep borrow pits where soil is excavated from. In some places like Galalani Village this has created a swamp. This affects boreholes and toilets.	An Environmental Impact Assessment report under preparation will identify mitigation measures
Our cows and goats and other livestock sometimes slide and get injured or sometimes die in the current dykes. They need ramps where to climb the dyke.	We will request the engineers and project management to consider this aspect
Public Health and Sanitation The dust generated during the construction is likely to cause coughs and respiratory ailments and eye infections. Water borne diseases from stagnant water collecting in the pits e.g. Malaria, Bilharzia. Drowning in the deep pits.	An Environmental Impact Assessment report under preparation will identify mitigation measures
Fisheries The fish will be affected naturally and the fish ponds within the dykes will be affected.	An Environmental Impact Assessment report under preparation will identify mitigation measures
The residents feel that the project is long overdue and should start immediately before the rains start	It is understood and it is important that it goes through the right process such as going through ESIA so that it is implemented properly and does not result in adverse effects
The project implementers should involve the locals so as to take advantage and harness the local knowledge of the dyke's weak points. Previously, it has not been done and has resulted in constant breaking of the dyke.	Your sentiments have been noted and will be put in the report as one of the recommendations. It is also important that those local people with the knowledge come out and contribute to the project without reservations.
The residents would like employment for the local youth on the project	Your sentiments have been noted and I assume that local youth who are qualified will be employed to work on the project just like they have been recruited to work as Research Assistants on this ESIA study
Sand harvesting is a problem and needs to be dealt with as it is eroding the landscape and causing problems of instability.	This concern is noted and the catchment management plan will address this issue
Will the people to be resettled be compensated or will they just be evicted?	Yes, the people to be resettled will be done in a fair and considerate manner with

	adequate compensation and assistance. A RAP report is under preparation
The Project should employ local people especially the youth when they begin the works.	Your sentiments have been noted and local youth will be employed to work on the project
The locals know the weak points, which should be concentrated on during the improvement and rehabilitation of the dyke, and the Project implementers should make use of them during the project.	NOTED
The residents want the dyke to be repaired using gabions and not just soil as the soil gets swept away when the floods come	NOTED
The residents of Nanjomi want the river to be canalized in order to reduce the excess flood water that breaks the dyke and floods the area.	NOTED
There is a huge borrow pit that was left after soil was dug for the dykes at Nanjomi Primary school and is a huge risk for the children and adults alike	NOTED
Will those earmarked for resettlement be compensated and when will it start?	YES, those PAPs that have to be resettled will be compensated and proper procedures will be followed to ensure that they get their property's worth. A RAP is under prepartaion
The project implementers should involve the locals so as to take advantage and harness the local knowledge of the dyke's weak points. Previously, it has not been done and has resulted in constant breaking of the dyke.	Your sentiments have been noted and will be put in the report as one of the recommendations. It is also important that those local people with the knowledge come out and contribute to the project without reservations.
What is the size of the buffer or safety zone for the dyke?	It is marked as 50m however, when the Resettlement team and Surveyors come they will mark the zone properly and inform everyone adequately.
We have had many projects in the area that do not materialize. What happened to the Gravity Water project that was supposed to be carried out in the area?	I cannot comment on that as I do not know about it. However, the Government of Kenya is serious about this project and this is one of the steps of implementation of a project of this magnitude.
More steps should be taken to reduce walking on and damage to the dyke.	NOTED
The residents want the weak points on the dyke to be repaired using gabions and not just soil as the soil gets swept away when the floods come. They also want the dyke to be dug deeper	NOTED
Insecticide should be applied to prevent termites from making holes in the dyke.	NOTED
We want compensation for our land in between the dykes along the river bank but the government tells us that is "No man's land"	A RAP including census survey and asset valuation is planned to be conducted soon including addressing land tenure issues

There are people's graves in the land enclosed by the dykes	This is noted and a RAP is being prepared and will address this concern
The people of Mumbira have no title deeds yet people of other neighbouring areas were issued with their title deeds.	We wil present this concern to the National Land Comission
The 50m-safety zone is a big issue especially when the dykes themselves sit on the residents' farmland that extends all the way to the riverbank. We have also heard that the Canal has a safety zone of 10 m, how does this work?	The dyke's safety zone extends along the dyke, the canal's safety zone will run alongside the canal though the canal will also run inland.
The engineers and surveyors should let the residents know where the dyke and canal will pass and use beacons and markings to do so and let the residents be prepared psychologically in case they will have to move.	This will be done in good time and the residents will be duly informed.
The dyke and the canal combination have potential to eliminate the flooding problem for good. For the residents, the improvement of the dyke is a priority before the canal and they hope that the canal will not interfere with the dyke.	NOTED
The dyke should be built anew because it is weak at the bottom	NOTED: Engineers have taken this into consideration.
The locals know the weak points which should be concentrated on during the improvement and rehabilitation of the dyke and the Project implementers should make use of them during the project.	NOTED
With regards to compensation, how will that work out for those of us who do not have title needs but only plot numbers?	A plot number or allotment letter will suffice or other form of proof of ownership of the land so long as you also have a valid form of identification to prove your identity.
It would be good if everyone's views were heard on this matter.	YES. It is the reason we have called for this *baraza* and we encourage you to air and exhaust your views on the matter.
When it rains the whole area floods and is impassable and inaccessible. The residents ask that proper roads are built whether on the dyke or somewhere else in order to ensure they are not cutoff from the surrounding areas.	NOTED
The results of these studies should be made public as the residents are constantly summoned for *barazas*, and answer questionnaires that in their opinion do not result in anything. This also makes them hostile to researchers/interviewers.	The ESIA report will be made public in all the affected villages, County and in the website of MEWNR
Mumbira gets the floodwater with the most force and so when the Project begins, it should start from Nakhasiongo (downstream) moving upstream to ensure the areas that are	NOTED

hardest hit are protected first before the onset of the floods.	
The residents feel that the dyke management committees should be empowered and involved in maintenance of the dyke.	NOTED
The project should consider providing pumps so that the local area residents to irrigate their crops during the drought.	NOTED
The people working on the project should be more friendly and polite. They are very forceful and they take soil from the residents' farms/land by force.	NOTED
Some people lay claim to land that is not theirs. How will this be solved when seeking compensation?	It is not a problem provided the rightful owner has the proper documentation to show proof of ownership. A RAP report will identify all the affected persons
The engineers and surveyors should let the residents know where the safety zone extends to and use beacons and markings to do so and let the residents be properly informed.	This will be done in good time and the residents will be duly informed.

12 RECOMMENDATIONS AND CONCLUSION

The proposed Project is positive in the overall, being in line with the locals' aspirations and national objectives for enhancement of social and economic development. The existing dykes along the downstream (of Rwambwa Bridge) River Nzoia are now beyond their design lifespan. Despite on-going efforts to effect repairs on the dykes, they have been breached with increasing frequency of flood incidences. This has led to increased socioeconomic losses in the project area and exposes it not only to losses of life and livelihoods but also exposes the government in terms of emergency response expenditure.

The Ministry of Environment, Water and Natural Resources (the Proponent), through the Kenya Water Security and Climate Resilience Project seeks to promote economic empowerment of local communities and their organizations in flood prone regions of western Kenya, through support to local initiatives and efforts that understand and mitigate the adverse effects of poverty.

The proponent commissioned the consultants to undertake an Assessment of Levee Integrity and Floodplain Condition and Final Design of Improvement of Flood Water Structures along the Lower Reaches of River Nzoia-Budalangi. It envisages developing flood management in the Nzoia River basin. Several intervention alternatives were identified- both by the experts and the community members amongst other stakeholders - during the planning and design phases of the proposed project. The alternatives were investigated and comparatively appraised individually and in combinations using agreed criteria incorporating technical viability, community acceptance, sustainability, environmental impacts, safety, cost and hydraulic assessment of associated flood reduction benefits/risks. One of the key environmental considerations was the sensitivity of the project environment characterised by riparian and associated wetland habitats. A greater portion of the project area has however been disturbed by earlier flood management interventions and human settlements. Following the appraisals a combination of raising and strengthening the existing dykes and realignment of few sections was adopted for implementation. In addition, to improve flow of floodwaters, existing culverts at Sigiri crossing point will be replaced with larger ones.

Despite the fact that the proposed combination of interventions was the best in meeting the project objectives, the construction, operation and decommissioning phases are likely to have certain adverse impacts on the local community and the immediate surrounding environment given the nature of the project environment. The major activity in the project will be earthworks. Each of the anticipated impacts has been assessed and where feasible, appropriate mitigation measures proposed and the following can be concluded:

- During design and planning phase the significant impacts identified were positive and included job creation and an opportunity for the community/stakeholders' engagement and inputs in formulation of flood management interventions;

- The majority of negative impacts anticipated during construction will either be of medium or low significance, which can further be reduced through implementation of recommended mitigation measures;

- Review of documented flora and fauna species did not reveal any species of special conservation concerns. Even though the project area has no gazetted wetland, consultations revealed that plans are underway by both NEMA and Nile Basin Initiative to have the wetland areas gazetted thereby calling for more precaution while undertaking any activities. It is however, notable that interventions which would have posed greatest negative construction environmental impacts on the habitats returned negative appraisal results against the adopted criteria and were eliminated. These were interventions involving either significant river channelization or dyke extension to the lake;

- The project earthworks during construction will require an estimated fill material of 586,000 cubic metres for the northern dyke and 637,000 cubic metres for the southern dyke;

- Construction of the broader and higher dykes will also necessitate additional strip of land adjoining the existing dykes. Even though the design has been optimised to minimize the associated impact, some properties located or even families whose structures are built close to the foot of the existing dykes will have to be relocated. Community members were informed through a stakeholders workshop and there was acceptance that some few individuals will be affected by the project meant to benefit the entire community. Preliminary profiling and valuation of affected properties including land has been undertaken to guide adequate and prompt compensation of affected persons. The proponent is also at advanced stages of undertaking a comprehensive Resettlement Action Plan (RAP) to identify and enumerate individual households/PAPs, and inventory affected assets to facilitate compensation. The RAP will among others establish a cut-off date and develop a grievances settlement mechanism, which will assist in minimizing potential project implementation setbacks;

- Numerous positive impacts other than the key project objective put forward by the proponent are anticipated during operation. Most of these will be indirect impacts and include: facilitation of more reliable agriculture; attraction of more investment into the project area; ensuring educational calendars are not interrupted by floods; promotion of transport linkages between communities to the south and to the north of the Nzoia River; and other numerous benefits were identified by the beneficiary community;

- No major significant negative environmental impacts are anticipated during operation given that project activities in this phase will be limited to dyke maintenance works only. Losses predicted by the community once the new dykes are operational e.g., reduced availability of cheap fishing following flood incidences, loss of flood aid and loss of silt deposition are relatively insignificant and can be compensated by anticipated positive impacts; and

- Complete decommissioning of the proposed works is not anticipated. However, in the event that partial decommissioning is to be done, the anticipated negative impacts can be readily mitigated.

From the foregoing, no adverse environmental and social impacts are anticipated that cannot be adequately mitigated. Environmental monitoring shall be carried out during the construction phase to enable identification and rectification of unforeseen impacts. Any unforeseen project impacts shall be immediately brought to the notice of an environmental expert to ensure they are immediately addressed and mitigated. Closer liaison with relevant key stakeholders including WRMA, NEMA and National Irrigation Board within project area should be maintained throughout the project's implementation.

The Consultant recommends the project approval and an Environmental Impact Assessment license be issued by NEMA based on the environmental management measures contained in this ESIA Project Report.

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Appendix A: Project Area's Selected Photo Log

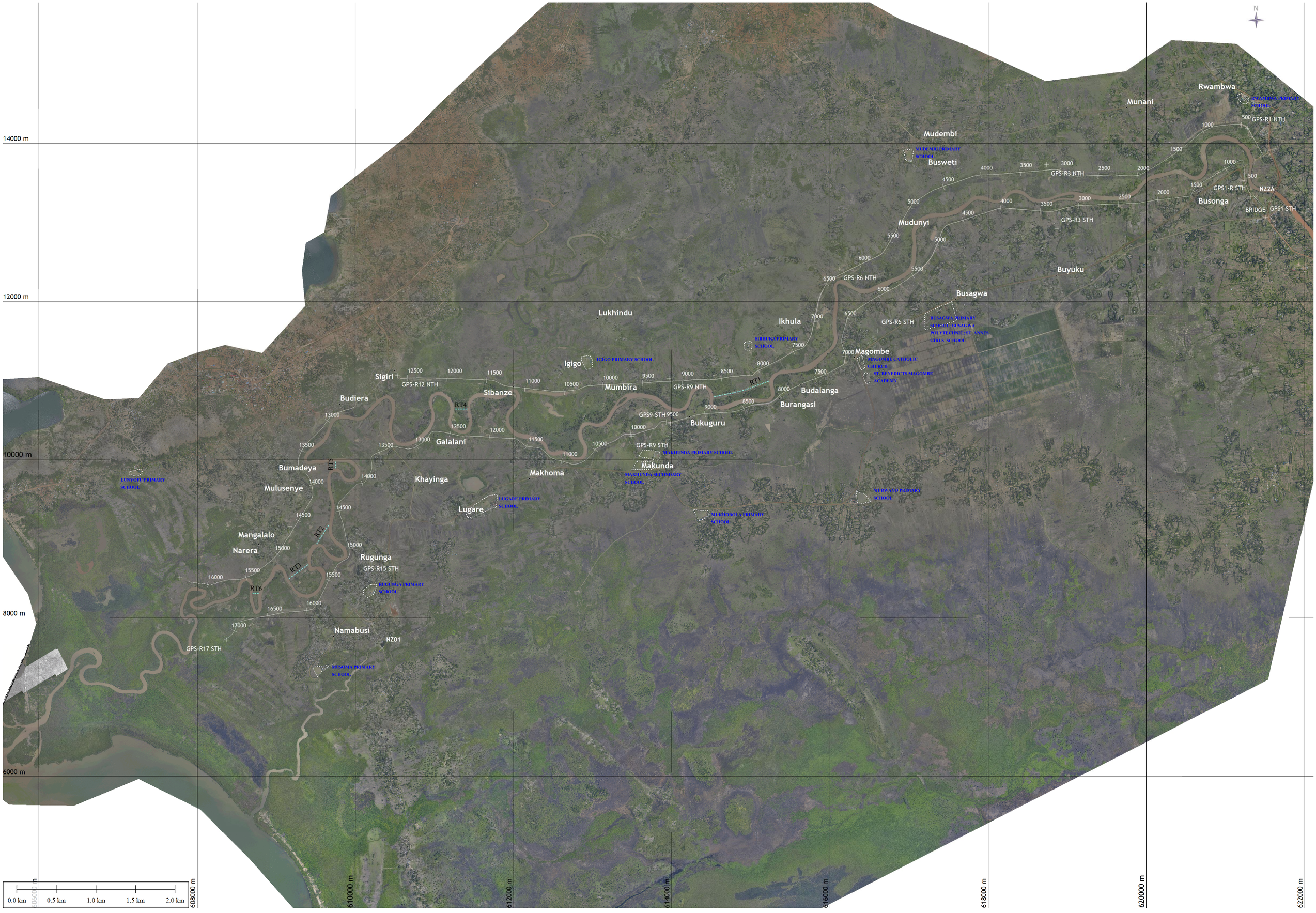
Appendix B: Project Consultation Records

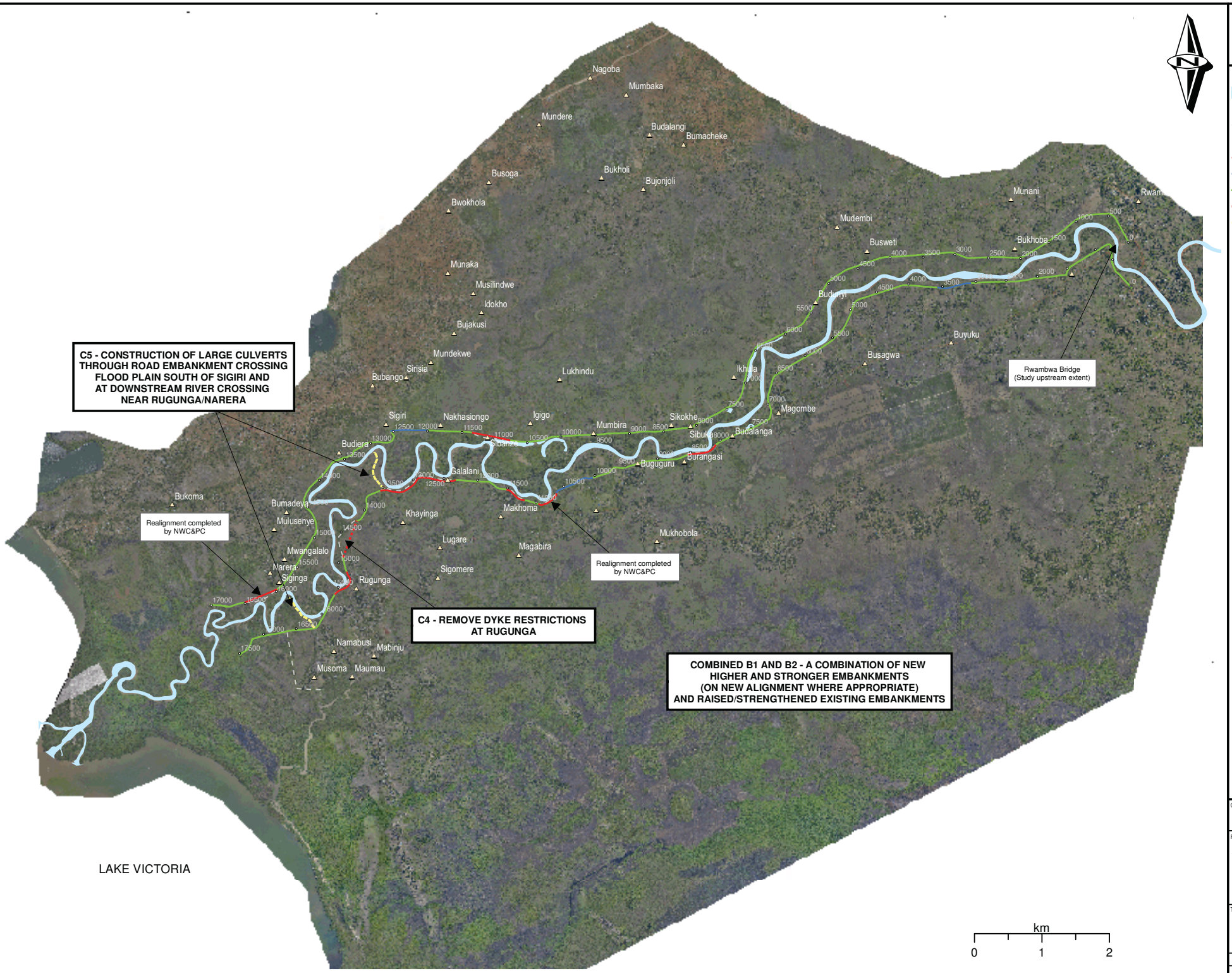
Appendix C: Phase II Report: Analysis of Interventions

- Initial Interventions
- Feasibility Assessment
- Optimal Appraisal

Appendix D: Drawings for the Proposed Nzoia Flood Protection Works

Lower Nzoia Photography





ATKINS

Legend

- River Alignment
- Villages
- Existing Dykes
- Chainages
- B1 New Realigned Dykes
- B1 Existing Dykes Replaced with New
- B2 Existing Dykes Improved
- C4 Realigned Pinch Point
- C5 Culverts

CLIENT
Government of Kenya

PROJECT
Assessment of Levee Integrity and Floodplain Condition and Final Design of New Flood Protection Works in the Downstream Region of the Nzoia River

TITLE
Figure 2
Proposed Works Location Within The Study Area

SCALE	DATE	DRAWN
1:50,000 at A3	Oct 2012	PM

Appendix A: Project Area's Selected Photo Log

Plate 1: A view of section of the floodplain with river meanders between the existing dykes. Note the planted vegetation cover around settlements

Plate 2: Section of main river channel and immediate riparian vegetation cover. The dominant species are reeds, *Typha* and *Phragmites spp*.

Plate 3: Typical household structures and planted vegetation at the toes of existing dykes. Where these exist, they will be affected by higher and stronger dykes requiring broader base.

Plate 4: Section of embankment and culverts south of Sigiri boat crossing point. This will be replaced with larger culverts to enhance flow of floodwaters between dykes.

Plate 5: Section of an irrigation canal (RHS) next to the existing northern dyke parts of which may be affected by broadening the dykes.

Plate 6: Typical remnant patches of natural vegetation between the existing dykes. These are not likely to be affected by the project activities

Appendix B. Consultation Records

MINUTES FOR CONSULTATIVE MEETING AT MAKHOMA, KHAJULA LOCATION ON MONDAY 16/2/2015 AT 2.00 PM.

A consultative meeting on the Project (Updating Environmental and Social Impact Assessment for Improvement of Flood Mitigation Structures on Lower Nzoia River) was held as part of the Agenda of the weekly Baraza hosted by the Chief of the Khajula Location held at Makhoma on 16/2/2015 at 2.00 pm.

Attendance

1. John Owuor - Area Chief
2. Daniel Ingekhi - Assistant Chief
3. Jacob Ndagwa - Informant
4. Liya Mango - Consultant
5. Area Residents (See Participation List)

Meeting

The consultant took the opportunity to inform the residents of the location that the project is due for implementation and hence it was necessary to update the ESIA since there might have been changes since the last study was done. The Consultant duly informed them the purpose of the ESIA is to identify Environmental and Social Impacts, offer mitigation measures to the anticipated impacts and to propose updates to the design to increase sustainability of the project.

After this update, the Consultant proceeded to ask the attendees a few questions on the likelihood of adverse impacts affecting various components of the environment such as Noise, Soil Erosion etc.

When asked about adverse impacts in terms of Noise Quality, the residents responded that there will be noise caused by the heavy machinery working on the dykes but it was tolerable in that it was moderately loud and also due to the fact that the works normally take place during the day.

With regards to soil erosion, the residents noted that it mostly occurs during construction when the wind blew the soil away and during the rains especially when grass is not planted on the dyke walls to hold the soil firm.

In terms of how vegetation will be affected by the project, it is noted that the heavy machinery removes/uproots trees and bushes and tramples on vegetation on its way to the site area and in the site area.

Air quality was a component that according to the residents will be affected as the wind-blown dust causes a reduction in the air quality and is more since the works is usually carried out in the dry season hence.

In terms of the effect on the hydrology, it was noted that regardless of the works, water still seeps through the dyke walls and this water affects boreholes and toilets as it infiltrates and floods these facilities affecting the water supply and sanitation.

The residents their livestock will be affected as currently, the cows need ramps to climb up the dykes and when it rains and it becomes slippery cows slip and injure themselves some even die. The raising of the dyke may make this problem even worse.

Wildlife in the opinion of the residents will be affected because of THE NOISE AND disturbance to the vegetation and their habitat. Wildlife in the area is mostly monkeys, reptiles and birdlife such as egrets and herons.

With regards to waste resulting from the Project, there will be no waste as the works involve mostly regular earth material such as soil and rock that may spill minimally.

Public health and sanitation is a major concern. The dust causes respiratory ailments and eye infections. The “borrow pits” where the machines excavate the soil/earth material from are left as open pits that are deep and are a hazard as people may fall in. These pits also fill up with water when it rains and stagnates providing a breeding ground for mosquitoes and other waterborne diseases.

Fisheries will be affected in their natural environment and also those in the fish ponds will be affected.

Agriculture is significantly affected as the machinery will trample crops and affect the farms especially closest to the dyke and affect production significantly.

<u>Additional Comments</u>

- The residents feel that the project is long overdue and should start immediately before the rains start

- The residents ask that project implementers involve them so as to take advantage and harness their local knowledge of the dyke's weak points. Previously, it has not been done and has resulted in constant breaking of the dyke.
- A resident pointed out that seepage from the dyke walls has created a swamp in Galalani Village, we ask that the project takes care of such occurrences as this is on my farm and has limited me from benefitting from producing on my land.
- A resident noted that sand harvesting is a problem in Magavira Village and needs to be dealt with as it is eroding the landscape and causing problems of instability of the ground.
- Another observation from the residents was that in the dry season, termites burrow through the dyke walls and weaken it which makes it susceptible to leakage and breakage.
- The residents would like employment for the local youth on the project

Q: Will the people to be resettled be compensated or will they just be evicted?

A: Yes, the people to be resettled will be done in a fair and considerate manner with adequate compensation and assistance.

MINUTES FOR CONSULTATIVE MEETING AT NANJOMI, BUNYALA CENTRAL LOCATION ON THURSDAY 19/2/2015 AT 2.00 PM.

A consultative meeting on the Project (Updating Environmental and Social Impact Assessment for Improvement of Flood Mitigation Structures on Lower Nzoia River) was held specifically as a Baraza hosted by the Chief of Bunyala Central Location held at Nanjomi Village on 19/2/2015 at 2.00 pm.

Attendance

1. Christopher Sicha - Area Chief
2. Alex Ogeya - Assistant Chief
3. Liya Mango - Consultant
4. Area Residents (See Participation List)

Meeting

The consultant took the opportunity to inform the residents of the location that the project is due for implementation and hence it was necessary to update the ESIA since there might have been changes since the last study was done. The Consultant duly informed them the purpose of the ESIA is to identify Environmental and Social Impacts, offer mitigation measures to the anticipated impacts and to propose updates to the design to increase sustainability of the project.

After this update, the Consultant proceeded to ask the attendees a few questions on the likelihood of adverse impacts affecting various components of the environment such as Awareness of the Project, Noise, Soil Erosion etc.

When asked whether they were aware of the project, the residents said they were aware of the project.

When asked about adverse impacts in terms of Noise Quality, the residents responded that there will be noise caused by the heavy machinery working on the dykes but it was tolerable in that it was moderately loud.

With regards to soil erosion, the residents noted that it was mostly wind-blown dust occurring during the works.

The residents stated that the heavy machinery removes/uproots trees and bushes and tramples on vegetation on its way to the site area and in the site area.

Air quality will be affected as the wind-blown dust causes a reduction in the air quality and the exhaust smoke from the machines.

In terms of the effect on the hydrology, it was noted that oil leakage from the machines' oil may their groundwater sources. Water still seeps through the dyke walls and this water affects boreholes and toilets as it infiltrates and floods these facilities affecting the water supply and sanitation. The borrow pits are so deep that when they fill with water the water seeps right under the dyke to the other side waterlogging and flooding areas.

The residents said their livestock will not be affected in any way.

Wildlife in the opinion of the residents will also not be affected.

With regards to waste resulting from the Project, it involves mostly regular earth material such as soil and rock which have minimal impact.

Public health and sanitation is a major concern. The dust causes respiratory ailments and eye infections. The leftover pits also fill up with water when it rains and stagnates providing a breeding ground for mosquitoes and other waterborne diseases.

Fisheries will not be affected as they will be in their natural environment.

Agriculture is significantly affected as the machinery will trample crops and affect the farms. Also, those living next to the dykes will have to move and may lose their farmland.

<u>Additional Comments</u>

- The Project should employ local people especially the youth when they begin the works.
- The residents ask that project implementers involve them so as to take advantage and harness their local knowledge of the dyke's weak points. Previously, it has not been done and has resulted in constant breaking of the dyke.
- The residents want the dyke to be repaired using gabions and not just soil as the soil gets swept away when the floods come
- There is a huge borrow pit that was left after soil was dug for the dykes at Nanjomi Primary school and is a huge risk for the children and adults alike
- Q: Will those earmarked for resettlement be compensated and when will it start?
- A: YES, those PAPs that have to be resettled will be compensated and proper procedures will be followed to ensure that they get their property's worth. The resettlement will come after the ESIA that I'm doing and that is if the Project itself is found not to have an adverse social and environmental effect as proper procedures have to be followed.

- Q: What is the size of the buffer or safety zone for the dyke? A: It is marked as 50m however, when the Resettlement team and Surveyors come they will mark the zone properly and inform everyone adequately.
- Q: We have had many projects in the area that do not materialize. What happened to the Gravity Water project that was supposed to be carried out in the area? A: I cannot comment on that as I do not know about it. However, the Government of Kenya is serious about this project and this is one of the steps of implementation of a project of this magnitude.

MAKHOMA #1

STAKEHOLDER CONSULTATION FORM

PROJECT	UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER
VENUE	MAKHOMA VILLAGE LUGALE S/LOC. KHAJULA LOCATION
DATE	16/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
Christopher Onyango	KHAJULA	LUGALE	32953062	07182951[illegible]	[signature]
DAN WANDEGA	//	//	5680712	0714066443	[signature]
KONA MUKULU	//	//	0768391798	—	
BENOIT OMBUTO	//	//	O—	0712228839	
Stephen Simoga	//	//	61211747	0710509179	[signature]
LICE MUGENI	//	//	7509447	0707480788	
DESLA TAKA	//	//		0734[illegible]677	
JAMES KWANGA	//	//	28553925	0705065929	
REBECA OKUKU	//	//	20877447	071[illegible]3957	
MAGRESE WANDERA	//	//			
WILKISTER NIGHT OCHIENO	//	//	29723212	0797932613	[signature]
BEATRICE KADOGO	//	//	~~0718~~	0718322845	KADOGO
SARAH TAKA WANGIRA	//	//	21469407	0715243085	[signature]
CHRISTABELL OTETE	//	//		0732030792	[signature]
Brenda Ouma Wandera	//	//	30358087	0731236842	[signature]
Susan Anyango	//	//	2064071	0703946304	
EUNICE OJANDI	//	//		0701888785	
RODA MGHS	//	//			
GRACE AKUKU	//	//			
PETENIA OLOO	//	//			
Rosemary Mugoni Ojiambo	//	//	27962824	0706798397	[signature]
SELINA AGUTU	//	//			
Austin Ouma	//	//		0726127296	[signature]
Austine Ombere	//	//	12685836	0701354519	

MAKHOMA # 2

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	MAKHOMA VILLAGE,
DATE	16/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
KIMBUJE DELELE	KHAJULA	LUGALE			
EUNICE AKOICH	"	"			
MARISELA NAKUDI	"	"	28537438	0706067404	
PATRICK KANOTI	"	"			
SAMASI WANDERA	"	"	14779182	0729736599	
GEORGE KHWANGYI	"	"			
EMMANUEL NANGINGI	"	"			
MICHAEL MAKOKHA	"	"	4210974	0	
DANICAN WANDERA	"	"			
SIPHEN OTETE	"	"	25235589	0703477987	
BENARD WANDERA	"	"	25953532		
SYLVANUS WAIKA	"	"	2011802		
MART AKUKU	"	"		0705909304	
WILKISTER ANDERA	"	"	9104437		
SAMWEL OKHALO	"	"			
THOMAS SONGA	"	MABINJU	0116790		
EMMANUEL KHAMAKO	"	MAGABERA	11924666	0715779492	
CLEMENT WANGA	"	RUBUNGA			
JOHN OSANTA	"	LUGALE	4211438		
FRANCIS OSORE	"	"	4211499		
ALFRED MAKID	"	"	7358012	0715541692	
JAMES OKOISI	"	LUGALE	23334494	0713671427	
ERIC OKUMU	"	"	27149429	0704964169	

NANJOMI #1

STAKEHOLDER CONSULTATION FORM

PROJECT	UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER
VENUE	NANJOMI MARKET CENTRE, BURANGASI VILLAGE, BUNYALA WEST LOCATION
DATE	19/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
CHRISTOPHER O. VICHA	B) CENTRAL	MAGUMBE W	5684968	0707 59 4923	
ALEX O. OLUETA	"	"	20080753	0713834733	
PETER O. OPIYO	"	"	0659300	0729026567	
AMBROSE MADINGO NAMAYE	"	"	2261612		
MUGUBI MADINGO ROMARN	BUNYALA CENTRAL	MAGUMBE WEST	96409642	0714530744	
GODFREY ATALIA OJIAMBO	"	"	–	0715863376	
WILFRED NYONGESA OKOME	"	"	13168297	–	
JOHN ALWANGA OUMA	"	"	2145212	0717439653	
ROBERT OJIAMBO MALINGU	"	"	28994666	0702897830	
MICHAEL OJIAO MALINGU	"	"	29009411	–	
CHRISTOPHER OJUKU MUNANDI	"	"	23352906	0723729294	
THOMAS OLABA	"	"	27406815	0702591080	
PAUL MALOBA	"	"	27907302	0711413926	
GODFREY OKWARO	"	"	"	0726035872	
PAUL KDIRA DAUDI	"	"	5683176	0715585050	
JOHN BEDA	"	"	12778804	0722406350	
STEPHEN AYIYA	"	"	–	+254715788324	
JULIUS OPIYO	"	"	–	0715676605	
JAMES OKWAKO	"	"	5942118	–	
FRANCIS WANYAMA ANDEREA	"	"			
CHARLES NAMABA	"	"	1121347	0722270010	
JOHN MUKHADA OKUMU	"	"	4008037	–	
JOSEPHINE KHARENDE	"	"	30216885	0715755759	
ELIZABETH LUJALA	"	"	–	–	

NANJOMI #2

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	NANJOMI MARKET CENTRE, BURANGASI VILLAGE, BUNYALA WEST LOCATION
DATE	19/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
DANIEL OLOEH	B. CENTRAL	M. WEST	—	—	
ROSELYNE KWAMBO	B. CENTRAL	〃	—	—	—
FREDERICK NABWIRE	〃	〃	—	—	FN
LUCY PAMBA	〃	〃	〃	〃	—
EVERLYNE AKINYI	〃	〃	〃	0708283772	—
DENNIS OUNDO	〃	〃	〃	0713375849	
FLORA MAKANGA	〃	〃	〃	—	—
JOHN DASIA	〃	〃	—	—	—
ELMEDA ADONGO	〃	〃	—	—	—
FLORIA NABWIRE	〃	〃	—	—	—
ROSELINE BULUMA	〃	〃	—	—	—
STEPHEN ODIRA	〃	〃	9104524	0712591353	
OPEKI OGERA	〃	〃	—	—	—
REGULA APONDI	〃	〃	—	—	—
MICHAEL OMEDO	〃	〃	8694441	0724222742	
PETER LUJALA	〃	〃	—	—	—
SILAS MASAI	〃	〃	929984	0725473604	
TOM KECHULA GONZO	〃	〃	33283325	0721301348	
BEDA PAMBA	〃	〃	—	0704937417	
DENNIS DONDO	〃	〃	—	0704233340	
NICHOLUS ODINDO	〃	〃	22550041	—	—
JIMMY KABETI	〃	〃	—	0700375984	
ROMANUS DAMBI	〃	〃	22713939	—	DR
THOMAS OKONGO	〃	〃	11769046	0728649468	

NANJOMI #3

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	NANJOMI MARKET CENTRE, BURANGASI VILLAGE, BUNYALA WEST LOCATION
DATE	19/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
EZEKIEL NWICHANDA	B. CENTRAL	M. WEST	—	—	—
REGULA AKELLO	〃	〃	〃	〃	—
PETER MADONGI	〃	〃	11789005	0713924364	
Patrick Bwire	〃	〃	N/A	0722339155	
PATRICK OPIYO				0739817498	
FABIAN NAKA	〃	〃	SB869732	0710 151086	—
ALFRED ODONGO OUMA	〃	〃	5737922	0729381957	—
ISAAC MBLINGU	〃	〃	5663002	0705962743	
DAUD MALOBA SIRO	〃	〃	—	0708814126	
ERICK OKOTA	〃	〃	—	0752121955	
PASCAL AKELLO	〃	〃	25871660	0729498992	
MARGRET OSAMBAGA	〃	〃	4609677	0712025987	
LEVINA NEKESA	〃	〃	—	0707289487	
MENDRIKA AJIAMBO	〃	〃	—	—	—
ELIZABETH ODOMBO	〃	〃	—	—	—
LUCY AKINYI	〃	〃	—	—	—
ELMEDA NABWIRE	〃	〃	—	—	—
RACHUSTA WANGA	〃	〃	—	—	—
JACINTA ADALA	〃	〃	—	—	—

~~IGIGO~~ #1
MUMBIRA

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	~~IGIGO~~/MUMBIRA, BUNYALA EAST LOCATION
DATE	19/2/2015

	NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
1	ABEYI OKELLO AUGUSTINE	BUNYALA EAST	BUDALANGI	0589869	0717907488	
2	ELIAS NYONGESA MUSIOLA	"	"	21096787	0727872933	
3	JOSEPH NAMULI OBARE	"	"	5681300	—	
4	John Okumu	"	"	34514116	0733835342	
5	Emmanuel odwory Nabwang	"	"			
6	Michael James Adelwa.	"	"	"	—	
7	Steven Busine George	"	"		-	
8	Jancinta Namude.	"	"		-	
9	Jancinta ouma Onionge	"	"	4228399	0716859640	
10	Elizabeth Nabwire Okello	"	"			
11	Rosemary Nerima	"	"			
12	Mousine Maloba	"	"		0714487319	
13	Heilen Akinyi	"	"			
14	Topista Amyango	"	"	13875722	0708162398	
15	Linet Oburi	"	"			
16	Christine A. Mango	"	"	22288358	0707361856	
17	Christine Amyango	"	"	24850586	0714857542	
18	Judith Amyango Okiono	"	"		—	
19	Gladys Abangi	"	"	26582363	0705362858	
20	Petronilla Muchacci	"	✓		0714558627	
21	Eunice Adidi	"	"	-	0704506796	
22	Judith Tabu	"	"		✓	
23	Consolata Amyango	"	"		0714679469	-
24	Koleta Ogola	"	"			

~~1GIGO~~ #2
MUMBIRA

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	~~1GIGO~~ / MUMBIRA, BUDALANGI SUB. LOCATION, BUNYALA EAST LOCATION
DATE	19/2/2015

	NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
25	Violet Namaba.	B/ East	Budalangi	9908950	0780619816	
26	Beatrice Akumu.	"	"	22766384	0715061626	Akumu.
27	Nafuna Fatuma	"	"		0712464803	
28	Jentrix Nabwire	"	"		0763294643	
29	LILIA ALUMA	"	"	26089799	0720753725	
30	Scovia Ajambo	"	"	"	"	
31	Josephine Ajambo	"	"			
32	Chrispinus Juma.	"	"	21908890	0728 011578	
33	Peter odowa Bwire	"	"			odowa
34	Nicholous Musese	"	"	11344483	0700915167	
35	Thomas Mango	Bunyala		10907036	0721312637	
36	WILLIAM NAFULA BARASA	BUNYALA EAST	BUDALANGI	3436465	0726264506	
37	MUSIOLA ISANDE PITAYISE	BUNYALA EAST	BUDALANGI	14530670	0724730168	
38	JACOB WANJEYI WABONEB	BUNYALA EAST	BUDALANGI	0358265	0719180798	Wanjeyi
39	James Ogola Ogenga	BUNYALA FIST	BUDALANGI	20415242	0725636157	
40	David Okumu Aiula	Bunyala East	Budalangi	9606869	0713181490	
41	BONVENTURE Okumu	Bunyala East	Budalangi	"	0734906019	
42	Benard Odowa	Bunyala East	Budalangi	29149559	0708892303	
43	FREDRICK VITUNJA Sala	Bunyala East	Budalangi	20909654	0708062630	
44	Peter Nangwe	Bunyala East	Budalangi	"	"	
45	Rosa Idward	Bunyala East	Budalangi	"	"	

NARERA #1

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	NARERA VILLAGE, SIGINGA SUB-LOCATION, BUNYALA WEST LOCATION
DATE	19/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
ALFRED NAMWAKIRA	BUNYALA WEST	BUKOMA	11717284	0711313396	
ZACHARY O. APERE	BUNYALA WEST	SIGINGA	11031185	0720125468	
MARTIN MAWASO ODWARO	BUNYALA WEST	BUKANI	13168821	0726176930	
ROSEMARY OCHIEMO	BUNYALA WEST	BUKOMA	7420867	0700571249	
CORNEL KEGI	BUNYALA WEST	BUKOMA	0256714	0702287165	
MATHILIDA MALINGU	BUNYALA WEST	SIGINGA	1720604		
Alphonce Ogula	Bunyala West	Bukoma	7509130	0721578555	
BONFACE OUMA MUSOLO	BUNYALA WEST	BUKOMA	5680587	0710313064	
CARO OGUTU	BUNYALA WEST	BUKOMA	9062709	0726952983	MAKECH
CELENTINA NABWIRE	"	"			celentina
MARY N. WEPUKHULU	BUNYALA WEST	SIGINGA	6265172	0714301489	
BARTHOLOMEW ONGANGO	BUNYALA WEST	SIGINGA	9606703	0728723482	
CYRIL OKOTH	B.W	"	1145712	0724781476	
JUSTINE OTOYO	BUNYALA WEST	"	13196215	0712757538	
PAUL ORIYO	"	"	1726691	0711592695	
CORONEL OLOBO	"	"	AR 10597	"	
VICTOR PETER NONGA	"	"	30953001	0718161321	
MOLLY OCHIENG NONGA	BUNYALA WEST	SIGINGA	12681816	0717605665	
MILLS JUMA MALLI	"	"	25421893	0710551368	
LORNA NAFULA	B/W	"	16054273		
LUCAS BWIRE MUGELE	BUNYALA/W	SIGINGA	17277653	0705906739	
PETER OBWORI NYEGA	BUNYALA WEST	SIGINGA	21407307	0703946405	
FLORENCE NAFULA OUMA	Bunyala West	Siginga	6603675	0713305093	
PERUS AGUTU	B/WEST	SIGINGA			

NARERA #2

STAKEHOLDER CONSULTATION FORM

PROJECT	UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER
VENUE	NARERA VILLAGE
DATE	19/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
Paul Makokha	Bunyala West	Siginga	4210165	0714-832387	[signature]
Lucas Onjoro Hamunye	"	"	~~1181815~~	—	
ALEX ODEDE	"	"	1181815	0702754406	odede
SABASTIANE ABAHGI WANYAMA	"	"	—	—	—
Bsp PAUL WANYAMA MWOYA	BUNYALA WEST	SIGINGA	4210137	0720935847	Owmwoya
CLEMENTINA OWADO	"	"	—	—	—
GODFRY MASINDE	"	"	11031096	0701865619	[signature]
CAROLINE LUTA	"	"	24646934	0715457490	CAROLINE
PETER OKELLO JAKONDO	"	"	21538860	0719207821	[signature]
PASTOR HUMPHREY MADARA	"	"	9606128	0700563519	[signature]
CHRISTOPHER ODIKO	"	"	1016168	0715716591	C Odiko
JOHNSON A. WANYAMA	"	"	1181819	0715203666	[signature]
JOSEPH O. JUMA	"	"	4022789o	0720756072	[signature]
PAUL WANDERA	"	"	25466140	0712393260	Paul
Emmanuel Oumer	"	Bukani	1181751	0713689686	[signature]
NYONGESA OUMA	"	"	—	—	—
SABASTIAN Kachuka	"	Bukoma	7857844	07369957	SEBASTIAN
BENJAMIN Bwire	"	Siginga	20696078	0700358402	BWIRE
SAMSON BARASA	"	"		202046004	[signature]
EVERLINE MERIMA	"	SIGINGO	9104734	0716510615	[signature]
EMMANUEL ODWORI	"	SIGINGA	4230970	0726968088	[signature]
EVERLYNE .M. OPETU	"	SIGINGA	24019326	0710237348	[signature]
FREDRICK O. ODEDE	"	Siginga	—	0706769943	Odede

NARERA #3

STAKEHOLDER CONSULTATION FORM

PROJECT	**UPDATING ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR IMPROVEMENT OF FLOOD MITIGATION STRUCTURES ON LOWER NZOIA RIVER**
VENUE	NARERA VILLAGE
DATE	19/2/2015

NAME	LOCATION	SUB-LOCATION	ID NUMBER	PHONE NUMBER	SIGNATURE
ALICE ODUORI	BUNYALA W	SIGINGA	16117997	0710986419	ALICE
GETRUDE MAGADI	BUNYALA WEST	SIGINGA			
PETRONILA ACHOLA NAKITARI	BUKOMA	BUKOMA	7509463	0701983368	P. Nakitari
AUGUSTINE KUBERO OSEO	BUNYALA W	SIGINGA	21616264	0712186605	
JACTER TABU MAKHULO	BUNYALA W	SIGINGA			
GEORGE KHAOTO	BUNYALA W	SIGINGA	0930450	0702280110	
JAMES OKUTI	HAJULA	LUGALE	20334454	0718671427	

B5 Sample of Filled Environmental Assessment Questionnaire

NZOIA LEVEES STUDY

ENVIRONMENTAL ASSESSMENT QUESTIONNAIRE

The existing embankments are being breached with increasing frequency and the Ministry of State for Special Programmes, through the Western Kenya Community-Driven Development and Flood Mitigation Project has appointed WS Atkins International Limited in association with Howard Humphreys (East Africa) Limited to carry out an assessment of the levee integrity and floodplain condition and final design of new flood protection works in the downstream region of the Nzoia River.

The main objectives of this Project are:

- To determine the maximum discharge capacity of the current levee system and to understand the reasons for previous levee failures;
- To determine the optimal cost for restoring the flood protection system on the levied reach;
- To assess the condition of the floodplain on the land side of the levees and the socioeconomic impacts of flooding, and in this context to identify optimal approaches to flood management;
- To prepare a concept level Floodplain Management Plan, including various intervention options, to assess the feasibility of these options and identify the most appropriate combination of viable works for implementation; and
- To prepare the final design and tender documents for implementation of the selected works within the study area.

In this study environment is defined as the surroundings in which an entity operates. This includes air, water, land, natural resources, flora, fauna, humans and their interrelations. The climate, the physical setting and the resulting river flow regimes, set within various ecosystems, with human activities superimposed, determine the environment of a flood plain.

As a requirement of Environmental Management and Coordination Act, 1999 Section 58 on Environmental Impact Assessment, public participation is mandatory in obtaining views of those likely to be affected by the development. We are therefore kindly requesting for your views on the proposed Project.

Please answer the following questions:

1. Where do you reside within Budalangi?

   ..... Mwangalalo .....

2. Have you been directly affected by flooding?

   Yes [√] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [√] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
	Heavy Rains	√			
	River Meanders			√	
	Dyke Maintanance ~~ance~~	√			

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

- Heavy Raingal
- Humans cultivate at the banks of dykes
- Livestock lack grazing
- Transportation is cut down

6. Are there any problems caused by embankments constructed to protect flooding?

Yes [ ] No [✓]

7. If yes in question 6 above, describe the problems below.

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

- They should construct ~~the~~ straight ways for water passing instead of meanders of the river
- They should rise up the height of dykes
- They should ensure that dykes are permanent
- They should build water reserves.

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

- Building of terraces & Gabion t
- ~~construct~~ They should rise up the height of dykes
- They should construct permanent dykes.
- Community involvement

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [ ] No [ ]

11. If yes, which ones?

- Heavy rains which falls at the source of Nzoia River during month April and August.
- Foam which appears on the water
- Changing of water from colourless to dark brown.

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

- Fishing
- ~~people~~ of. Availability of water for domestic use

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [√] No [ ]

14. If yes, how?

- Creates employment
- Help affected people to get some ~~AIDS~~ aids
- ~~As~~ Helps both pupils and students ~~can~~ to proceed in their work/school.
-

15. If No, why?

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

- Maintain dykes
- They should alert the affected people during flood

RESPONDENT'S INFORMATION

Name: Polycarp Bwire ID Number: 26896537

Name of group/organization / institution (if applicable): -

Designation:

Signature: PBwire Date: 27 May, 2009

Address (postal, email, telephone and cell numbers): 10 POFL Victoria,
0729 232 278

THANK YOU FOR PARTICIPATING IN OUR CONSULTATION. YOUR FEEDBACK WILL ASSIST IN THE STRATEGIC DECISION MAKING.

NZOIA LEVEES STUDY

ENVIRONMENTAL ASSESSMENT QUESTIONNAIRE

The existing embankments are being breached with increasing frequency and the Ministry of State for Special Programmes, through the Western Kenya Community-Driven Development and Flood Mitigation Project has appointed WS Atkins International Limited in association with Howard Humphreys (East Africa) Limited to carry out an assessment of the levee integrity and floodplain condition and final design of new flood protection works in the downstream region of the Nzoia River.

The main objectives of this Project are:

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- To determine the optimal cost for restoring the flood protection system on the levied reach;
- To assess the condition of the floodplain on the land side of the levees and the socioeconomic impacts of flooding, and in this context to identify optimal approaches to flood management;
- To prepare a concept level Floodplain Management Plan, including various intervention options, to assess the feasibility of these options and identify the most appropriate combination of viable works for implementation; and
- To prepare the final design and tender documents for implementation of the selected works within the study area.

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As a requirement of Environmental Management and Coordination Act, 1999 Section 58 on Environmental Impact Assessment, public participation is mandatory in obtaining views of those likely to be affected by the development. We are therefore kindly requesting for your views on the proposed Project.

Please answer the following questions:

1. Where do you reside within Budalangi?

   BUSONTOLI

2. Have you been directly affected by flooding?

   Yes [✓] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [✓] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
1.	Out-dated dyke.	✓			
2.	Siltation of River Nzoia which do not allow water to move to the lake.		✓		

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

-> Famine (hunger).
-> outbreak of diseases such as Malaria, cholera etc.
-> Poverty
-> Loss of property's

6. Are there any problems caused by embankments constructed to protect flooding?

Yes [✓] No [ ]

7. If yes in question 6 above, describe the problems below.

- Create some barrel to reach some points of the River which were readable before.

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

- To construct the dyke in good way and by qualified personel.
- Construct Dams.

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

-> Maintaining the dykes at all time.
-> Clearing the bushes in the River Nzoia.

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [ ] No [✓]

11. If yes, which ones?

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12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

N/A.

.....

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.....

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [✓] No [ ]

14. If yes, how?

-> The food production will be high.

-> People will be settled.

-> Easy for you to carry out any project which will earn you money.

.....

.....

15. If No, why?

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.....

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

-> To Consult the Community ~~with~~ to get their views over the flooding.

=> To sponsor the Community to appreciate the various projects to support their life.

.....

RESPONDENT'S INFORMATION

Name: WILFRED OJAMBO ADORA ID Number: 9339960

Name of group/organization / institution (if applicable): APAB

Designation: MEMBER

Signature: Date: 31/5/009

Address (postal, email, telephone and cell numbers): 0728672669

THANK YOU FOR PARTICIPATING IN OUR CONSULTATION. YOUR FEEDBACK WILL ASSIST IN THE STRATEGIC DECISION MAKING.

NZOIA LEVEES STUDY

ENVIRONMENTAL ASSESSMENT QUESTIONNAIRE

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The main objectives of this Project are:

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- To determine the optimal cost for restoring the flood protection system on the levied reach;
- To assess the condition of the floodplain on the land side of the levees and the socioeconomic impacts of flooding, and in this context to identify optimal approaches to flood management;
- To prepare a concept level Floodplain Management Plan, including various intervention options, to assess the feasibility of these options and identify the most appropriate combination of viable works for implementation; and
- To prepare the final design and tender documents for implementation of the selected works within the study area.

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As a requirement of Environmental Management and Coordination Act, 1999 Section 58 on Environmental Impact Assessment, public participation is mandatory in obtaining views of those likely to be affected by the development. We are therefore kindly requesting for your views on the proposed Project.

Please answer the following questions:

1. Where do you reside within Budalangi?

   .....Bugula.....

2. Have you been directly affected by flooding?

   Yes [ ] No [V]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [√] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
	Water Coming out of the River	√			
	Alot of Rain which cause flood and Malaria	√			

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

~~The them Bruding~~

~~Th you~~ They cause Malaria

~~Through~~ cause death

cause migration

6. Are there any problems caused by embankments constructed to protect flooding?

Yes [✓] No [ ]

7. If yes in question 6 above, describe the problems below.

- ~~Some of Rain~~
- ~~Alot of wind~~
- They cause alot of flood.
- People may also use their tacts to break the dyke

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

Buiding of dykes.

~~for~~ Construction of Terraces

Construction of Gabions.

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

- Buid some dykes
- Buid dams
-

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [√] No [ ]

11. If yes, which ones?

- Alot of water which bursts River Nzoia
- Alot of Rain which Rains in higher areas e.g. Kakamega.

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

- Fish
- Alot of sand for building
- Brings Manure in the shamba
-

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [√] No [ ]

14. If yes, how?

- Assist in paying school fees
- Assist in ~~bu~~ planting fruits.
- planting cotton.
- Assist with food infact alot
- Assist beddings

15. If No, why?

- There will be alot of Mosquitoes
- People may die
- There will be lack of food.

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

- Give it a lot of thanks that it may last forever
- It continue assisting people.
- They may need to help them in building of houses.

RESPONDENT'S INFORMATION

Name: Alter Jumah ID Number: 25020522

Name of group/organization / institution (if applicable): Not applicable

Designation: Boda boda

Signature: ✓ Date: 26th may, 2008

Address (postal, email, telephone and cell numbers):

P.O Box 2, Port Victoria

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NZOIA LEVEES STUDY

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Please answer the following questions:

1. Where do you reside within Budalangi?

   Busalamba ki

2. Have you been directly affected by flooding?

   Yes [✓] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [✓] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
1	The land is low thus water from high region flow towards our region.	✓			
2.	Dykes are worn out	✓			
3	Human activities eg grazing		✓		

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

- The beauty of the land is destory
- Water is polluted

6. Are there any problems caused by embankments constructed to protect flooding?

Yes ☐ No ☑

7. If yes in question 6 above, describe the problems below.

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

- Dams to be dug
- Unblock the drainage System

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

Built another dyke

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [✓] No [ ]

11. If yes, which ones?

When the water level increases in the river

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

None

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [✓] No [ ]

14. If yes, how?

- Food banks will be in plenty
- Since Soil is fertile will have
- we will not need support from the governme-nt

15. If No, why?

.....

.....

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

We need them to visit the sight

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RESPONDENT'S INFORMATION

Name: PETER NDANDA ID Number: 6452812

Name of group/organization / institution (if applicable): N/A

Designation: N/A

Signature: Ndanda Date: 27/05/07

Address (postal, email, telephone and cell numbers): 0736140481

BOX 44 PORT VICTORIA

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NZOIA LEVEES STUDY

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Please answer the following questions:

1. Where do you reside within Budalangi?
   BUBANGO VILLAGE
2. Have you been directly affected by flooding?
   Yes [✓] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [✓] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
1.	HEAVY RAINFALL FROM HIGHLANDS	✓			
2.	OVERFLOWING OF RIVER NZOIA WATER	✓			
3.	BREAKAGE OF THE DYKE BY OVERFLOWING WATER	✓			

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

- OUTBREAK OF WATER BORNE DISEASES eg CHOLERA ~~MALARIA~~.
- VACATION OF PEOPLE TO HIGHER GROUNDS
- OUTBREAK OF MALARIA
- DISTRUCTION OF FARMS LEADING TO FAMINE.
- DISTRUCTION OF HOMESTEADS LEADING TO HOMELESSNE

6. Are there any problems caused by embankments constructed to protect flooding?

Yes [✓] No [ ]

7. If yes in question 6 above, describe the problems below.

- POOR METHODS OF REPAIRING LEADING TO PERPETUAL PROBLEMS eg THE DYKE IS REPAIRED AS IF THE CLOTHE IS BEING MENDED WITH PATCHE

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

- FIRST AND FOR MOST THERE SHOULD BE AN EXTRA CHANNEL FOR EXTRA WATER FROM RIVER NZOIA TO PASS THROUGH TO THE LAKE VICTORIA.

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

THE MAJOR IMPROVEMENT IS TO ENSURE THAT NO WATER OVERFLOWS INTO FARMS AND HOMESTEADS. ENOUGH IS ENOUGH LET BANYALA COMMUNITY SETTLE.

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [✓] No [ ]

11. If yes, which ones?

- FILLING OF QUESTIONNAIRES NO MORE.
- REPAIRING OF THE DYKE

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

- FISHING AND ITS SEASONAL.

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [✓] No [ ]

14. If yes, how?

PEOPLE WILL NOLONGER SUFFER FROM FAMINE AND SETTLED LIFE WILL BE LIVED eg ENOUGH FOOD TO EAT AND DAILY PROGRESS WILL CONTINUE.

15. If No, why?

N/A.

.....

.....

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

BEFORE: ENVIRONMENTAL PROBLEMS E.G POLLUTION SHOULD BE CONSIDERED.

AFTER: COMMUNITIES LIVING DOWNSTREAM SHOULD BE EDUCATED ON PROPER FARMING METHODS ALONG THE RIVER BANKS AND THE BENEFITS.

RESPONDENT'S INFORMATION

Name: FREDRICK ONYANGO MANG'ENI ID Number: 27429067

Name of group/organization / institution (if applicable): KENYA MEDICAL TRAINING COLLEGE.

Designation: STUDENT

Signature: [signature] Date: 27TH MAY 2009

Address (postal, email, telephone and cell numbers): P.O BOX 28 PORT VICTORIA

TEL. NO. 0710734615 OR 0714530793

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NZOIA LEVEES STUDY

ENVIRONMENTAL ASSESSMENT QUESTIONNAIRE

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Please answer the following questions:

1. Where do you reside within Budalangi?

   BUMACHRRE.

2. Have you been directly affected by flooding?

   Yes [✓] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [✓] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
1	- Breaking of dyke causing water to come out.		✓		
2.	Heavy rainfall at the highland areas then coming down the reach.	✓			

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

- Lack of Income.
- outbreak of varius diseases such as Typhoid, Malaria and Cholera.
→ Cause travelling problem, you cannot move from one point to another.

6. Are there any problems caused by embankments constructed to protect flooding?

Yes ☐ No ☑

7. If yes in question 6 above, describe the problems below.

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

→ Construction of dams to trap some water uphill.
→ To create furrow system so that the water is used for irrigation.

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

- To construct dyke and maintaining it
- Disilting the sand at the Mouth of River Nzoia to enable water moving to the lake.

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [/] No [ ]

11. If yes, which ones?

- Dyke Management Committee.
-

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

- None.

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [✓] No [ ]

14. If yes, how?

- They will benefit from farming.
- They will use water for irrigation.

15. If No, why?

.....

.....

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

- Consult the community and other stakeholders.
- To start up farming projects among the community.

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RESPONDENT'S INFORMATION

Name: JACOB OMBETA ID Number: 5681802

Name of group/organization / institution (if applicable): BUMACHEKE SELF HELP Group

Designation: C/man

Signature: [signature] Date: 31-5-2009

Address (postal, email, telephone and cell numbers): 0710866965

THANK YOU FOR PARTICIPATING IN OUR CONSULTATION. YOUR FEEDBACK WILL ASSIST IN THE STRATEGIC DECISION MAKING.

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Please answer the following questions:

1. Where do you reside within Budalangi?

   Khulukhunda

2. Have you been directly affected by flooding?

   Yes [✓] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [✓] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
	Heavy Rainfall which falls in Ketale and cause flood.	✓			
	The dyke is too weak that it cannot withstand the speed of water	✓			
	The dyke has some holes which ~~dest~~ makes it break easily	✓			

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

- properties get lost
- Livestock lack where to graze and this cause death
- Disease i.e malaria
- Houses fall'

6. Are there any problems caused by embankments constructed to protect flooding?

Yes [√] No [ ]

7. If yes in question 6 above, describe the problems below.

- The dyke is too low where by it leads to flooding
- The dyke is not permanent Rather Temporary

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

Nothing we can do to protect water from flowing

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

- Open dams
- Construction of permanent

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [ ] No [ ]

11. If yes, which ones?

- Weather change
- It has some months i.e April, August & Nov.
- Dark clouds.

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [✓] No [ ]

14. If yes, how?

We hope you are going to us on our problems So as we may atleast find cyplace & staying

15. If No, why?

.....

.....

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

- Construction of permanent dyke and this will stop flood from harmening us.
- Atleast construct houses to the affected People.

.....

.....

RESPONDENT'S INFORMATION

Name: Aloice Odiero ID Number: 21760000

Name of group/organization / institution (if applicable): _____

Designation: Farmer

Signature: ALOICE Date: 1st June 2009

Address (postal, email, telephone and cell numbers): _____

150 Port Victoria

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Please answer the following questions:

1. Where do you reside within Budalangi?

   Bukwama

2. Have you been directly affected by flooding?

   Yes [✓] No [ ]

3. Do you have any suggestions about the possible causes of the increased flooding?

Yes [✓] No [ ]

4. If yes in question 3 above, fill the matrix below.

S.No.	Causes of increased flooding	Magnitude of impacts (Tick as Appropriate)			
		Major	Minor	Medium	None
1.	Lack of trees and vegetation cover.	✓			
2.	Construction of temporary dykes.	✓			
3.	Too much raintall in the highlands leading to floods in lowlands.	✓			
4.	Lack of knowledge on environmental conservation.	✓			

5. What are some of the environmental problems that are created by floods at the downstream region of Nzoia River?

Water stagnates leading to lots of mosquitoes that cause malaria
The land swallows a lot of water therefore becoming infertile

6. Are there any problems caused by embankments constructed to protect flooding?

Yes [✓] No [ ]

7. If yes in question 6 above, describe the problems below.

Houses and property are washed away.
Some people lose their lives
Crops are swallowed by water.

8. Apart from construction of new flood protection works, what are some of the structural flood management options that you feel should be taken into consideration to control floods in the downstream region of the Nzoia River?

Construction of reservoirs.
Draining of water into the Lake.

9. What would you like to see improved in order to manage floods that has been affecting the community downstream of Nzoia River?

Construction of a permanent dyke instead of temporary dykes.
Educating people or creating awareness about environmental conservation & its importance.

10. Are you aware of any form of flood monitoring currently taking place within the region?

Yes [ ] No [✓]

11. If yes, which ones?

.....

.....

.....

.....

.....

12. What are some of the benefits that are associated with the floods downstream of Nzoia River?

Fishing practises increase.

.....

.....

.....

.....

13. In your opinion, will the proposed Project add any value to the existing environment?

Yes [✓] No [ ]

14. If yes, how?

people will settle peacefully without any fear of migration during rainy seasons.
Agricultural practices will improve hence leading to increased food production.
Spread of malaria will decrease.

15. If No, why?

.....

.....

.....

.....

.....

16. What suggestions do you have that the Proponent needs to take into consideration before and after implementation of the proposed Project?

The community should be educated fully on the project & its importance.

.....

.....

.....

RESPONDENT'S INFORMATION

Name: MARTHA W. ATIENO ID Number: 26075146.

Name of group/organization / institution (if applicable): CHEMSHA UZIMA YG.

Designation: MEMBER.

Signature: ~~MAtieno~~ Date: 28/05/2009.

Address (postal, email, telephone and cell numbers): 0728619723.

THANK YOU FOR PARTICIPATING IN OUR CONSULTATION. YOUR FEEDBACK WILL ASSIST IN THE STRATEGIC DECISION MAKING.

Appendix C: Phase II Report: Analysis of Interventions

(i) Initial Interventions

(ii) Feasibility Assessment

(iii) Optimal Appraisal

3. Initial Intervention Shortlisting

A concept level floodplain management plan (CFMP) was prepared during the initial part of the Phase II studies. This has been developed and incorporated into the FMP presented in this report.

The objectives of the CFMP were to propose the initial short listing of interventions to be studied in more detail as part of the development of the FMP. This initial short-listing of interventions took into account community feedback from the Stakeholder Workshop on the 20 April 2012, during which the Phase I findings were presented and the workshop participants put forward their views on the long list of interventions.

The proceedings of the workshop and stakeholders' feedback are provided in Appendix F, which provides details of the scoring mechanisms adopted.

3.1 Initial Short-listing of Interventions

The following tables set out the long list of interventions presented in the Phase I study report [5], together with the group scoring (and ranking) from the Phase 1 Stakeholder workshop. The proposed short-listing of interventions is shown in the tables along with a summary of the justification for short-listing or elimination of the interventions, as appropriate. This initial shortlist was subsequently agreed with WKCDD&FMP and further developed into the FMP.

Classification of Interventions

For presentational purposes the interventions have been grouped into embankment, river and floodplain improvements; and further categorised into primary, secondary and tertiary interventions, as described below. Interventions are presented within these divisions and ordered by their ranking generated from the stakeholder workshop.

Primary Intervention	Major intervention which alone is likely to have significant impact on reducing flood risk. Likely to be high cost.
Secondary Intervention	Intervention which may have significant impact in reducing flood risk on a local scale. Combination with primary intervention, or other secondary interventions required to have widespread impact. Likely medium / high cost.
Tertiary Intervention	Intervention which alone will not have a significant impact on reducing flood risk, but beneficial when combined with primary and secondary interventions. Medium to low cost (comparatively).

3.2 Embankment Improvements

3.2.1 Primary interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
1	B1	New higher and stronger embankments on new alignment where appropriate.	18	Y	Strong community support. Frequency of failures by breaching and overtopping increasing. Some sections in poor condition.
2	B3	Strengthen embankments with concrete wall and erosion protection for greater durability.	16	N	A concrete wall will not be cost effective and not necessarily provide greater flood protection compared to B1 and B3. Less costly measures can be adopted to increase erosion protection and durability.
3	B2	Raise and strengthen existing embankments.	12	Y	Need to consider as cost effective solution for areas where existing embankment can be improved to give increased level of flood protection.

3.2.2 Secondary Interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
=3	B10	Extend flood embankments to lake to prevent backflow around ends.	17	Y	Potentially high cost and environmental impact but worth investigating further if sufficient benefit from land/villages protected.

3.2.3 Tertiary Interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
1	B7	Keep embankments free of trees to avoid long-term problems and protect against excess grazing by livestock.	20	Y	Good practice to maintain durability
2	B5	Protect embankment from erosion during flood/overtopping using bioengineering measures.	18	Y	Good practice to maintain durability and prevent failure by erosion.
3	B4	Provide special crossing points with hard surfaces to stop erosion of crest.	17	Y	Good practice to maintain freeboard and durability.
4	B6	Provide roads along embankment tops.	15	Y	Provision of hard wearing surface will help to maintain durability. Not intended to encourage more use or heavier vehicles. Needs consideration.

3.3 River Improvements

3.3.1 Primary interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
=4	C4	Enlarge River Channel / Remove Dyke Constrictions / Remove Sediment.	10	Y	Consider localised areas, especially pinch points.
7	C7	Construct another channel from Rwambwa to Lake Victoria (probably via Yala Swamp).	5	N	Unlikely to be cost effective in context of other options considered. Not favoured by community. Concerns over land take, displacement and high cost.

3.3.2 Secondary Interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
1	C5	Construction of large culverts through road embankment crossing flood plain south of Sigiri.	21	Y	Low cost, good community support. Will also consider 'drifts' as could be more effective and lower cost than culverts (i.e. road surface near to surrounding ground level).
=4	C1	Shorten river by cutting the meanders (either by cutting a full channel or by cutting a shallow channel to pass flood flows).	16	Y	Already enacted as flood mitigation measure. Consider additional/augmented works. Evaluate effectiveness through modelling.
=5	C2	Cutting a new channel to the lake near the mouth (southern side).	15	Y	Potential benefit to upstream water levels. Evaluate effectiveness through modelling.
9	C3	Clear the reeds from the area between the embankments (either clearing the whole area or clearing strips aligned upstream - downstream).	7	Y	Not a popular intervention with stakeholders due to high maintenance requirement. However, will increase conveyance and less intrusive than increasing channel size. Focus on investigating (by modelling) specific areas which would bring benefits rather than whole floodplain (which would be unmanageable).
10	C6	Management of Lake Victoria to maintain low water levels.	4	N	Lowering lake levels could reduce flood risk but unable to influence / out of WKCDD&FMP control.

3.3.3 Tertiary Interventions

None

3.4 Floodplain Management Improvements

3.4.1 Primary interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
=4	D2	Provide spillways on embankments at selected locations so there can be overtopping without breaching.	10	Y	If embankments are to be raised, other primary interventions may be needed to limit increases in upstream water levels/dyke levels. Need to investigate suitable areas and model effectiveness.
=4	D7	Relocate vulnerable villages to flood-free locations.	10	Y	Most sustainable intervention. Scored highly by Bunyala North District. WKCDD&FMP may wish to take forward resettlement plan if community support. Recommended but will not form part of further studies.
5	D8	Create raised platforms at existing villages and relocate buildings on them. Also raise critical infrastructure above flood level.	9	Y	Sustainable intervention and recommended for further consideration. Proposals that involve displacement not popular with community. Investigate flood depths and recommend raised ground for new/critical infrastructure and rebuilding of existing homesteads.
6	D10	On-line flood storage within the study area.	8	N	Required storage volumes would be very large, needing considerable area, not possible to accommodate in densely populated floodplain without significant resettlement of the population. Flat topography, would need embankments to contain. Not popular with community.
8	D6	Provide embankments around villages to protect them from flooding.	3	N	Provides some protection but creates increased risk of loss of life if breached due to rapid increase in water level and no escape route. Would block ready access to villages and create drainage problems. Very unpopular with stakeholders.

3.4.2 Secondary Interventions

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
2	D15	Provide new drainage outlet for northern floodplain area.	19	Y	Relatively low cost and will improve drainage following floods. Investigate suitable location(s) and size.
=3	D3	Improve drainage in floodplain areas so that floods become less deep and drain away faster.	17	Y	Relatively low cost and will improve drainage following floods. Investigate ground model and discuss with community to identify areas where improved drainage of benefit.
=3	D4	Improve drainage from Yala swamp to Lake Victoria.	17	N	Agreed with WKCDD&FMP outside of this study scope.
=3	D5	Improve Ndekwe River to carry some Nzoia flood flow.	17	Y	Investigate possible channel alignments and capacity (existing and future requirements).
=4	D12	Provide sluices to enable controlled release of water onto floodplains.	16	Y	Potential benefit for farming etc in addition to flood defence benefits.

Group Rank	Intervention Description		Group Score	Shortlisted (Y or N)	Justification
=5	**D14**	Effective planning and control of development in flood risk areas.	**15**	**Y**	Sustainable solution. Recommended but will not form part of further studies.
=6	**D1**	Control structures to release flood flows through embankments to old channels draining to Yala swamp.	**11**	**N**	Partly covered by D12 and agreed with WKCDD&FMP that interventions involving Yala Swamp are outside of this study area.
=6	**D13**	Trap incoming sediment.	**11**	**N**	Would require ongoing sediment removal and considerable sized storage. Not suitable for this study area. Considerations should be given to interventions in upper catchment (dams and sustainable land use).
7	**D11**	Use of proposed irrigation main canal/drain alignments as flood diversion route.	**9**	**N**	Not feasible to design structures to fulfil both functions. New flood channel required would be considerably larger than for irrigation use and siltation of irrigation channel following floods would be a problem. NIB has reviewed this approach and concurs that it is not feasible.
8	**D9**	Create permanent water bodies for use as fisheries and flood storage (possibly borrow pits for fill material).	**8**	**N**	Not favoured by community and would need to be of significant size and have available capacity if used for flood storage.

3.4.3 Tertiary Interventions

None

3.5 Development of the Shortlisted Interventions

The initial short-listing of interventions summarised above was agreed with WKCDD&FMP and then taken forward for further consideration as part of the Feasibility Assessment presented in Section 5.

Further details of the short listed interventions are presented in Appendix A Figures 5 to 12, together with an appraisal matrix which builds upon the assessment of the interventions made during Phase I.

Feasibility Assessment

The feasibility of the initial shortlist of interventions identified in Section 3 has been assessed in further detail and is presented in this Appendix to the report. A summary is provided in the main body of report (Section 5.3).

The feasibility assessment considers the agreed evaluation criteria set out below and, where appropriate, provides a mechanism for elimination of some of the interventions to focus the appraisal short list on the most viable works.

- Engineering / technical viability
- Benefit - in terms of (i) reduction in flood risk; and (ii) other benefits
- Community involvement and acceptability
- Sustainability (i.e. will the option be operational through the design life of the works, taking into account the capabilities of the local population)
- Implementation Cost
- Environmental impact
- Safety – during flood events, operation and maintenance.

The following table lists the initial shortlist of interventions taken forward for feasibility assessment (refer to Section 3).

Primary Interventions	
B1	New higher and stronger embankments, on new alignment where appropriate.
B2	Raise and strengthen existing embankments
C4	Enlarge river channel / remove sediment
D2	Provide spillways on embankments at selected locations so there can be overtopping without breaching.
D7	Relocate vulnerable villages to flood-free locations
D8	Create raised platforms at existing villages and relocate buildings on them. Also raise critical infrastructure above flood level.
Secondary Interventions	
B10	Extend flood embankments to prevent backflow around ends
C1	Shorten river by cutting the meanders (either by cutting a full channel or by cutting a shallow channel to pass flood flows)
C2	Cutting a new channel to the lake near the mouth (southern side)
C3	Clear the reeds from the area between the embankments (either clearing the whole area or clearing strips aligned upstream - downstream)
C5	Construction of large culverts through road embankment crossing flood plain south of Sigiri
D3	Improve drainage in floodplain areas so that floods become less deep and drain away faster
D5	Improve Ndekwe River to carry some Nzoia flood flow

D12	Provide sluices to enable controlled release of water onto floodplains
D14	Effective planning and control of development in flood risk areas
D15	Provide new drainage outlet for northern floodplain area
Tertiary Interventions	
B4	Provide special crossing points with hard surfaces to stop erosion of crest.
B5	Protect embankment from erosion during flood/overtopping using bioengineering measures.
B6	Provide roads along embankment tops
B7	Keep embankments free of trees to avoid long-term problems and protect against excess grazing by livestock

The following indicators have been used in the assessment of the interventions.

Mainly positive appraisal or negative impacts not significant	
Mixture of positive and negative issues / impacts	
Mainly negative appraisal	

Primary interventions

B1	New higher and stronger embankments on new alignment where appropriate.

Technical Viability	✓

If defending the floodplain is necessary to protect infrastructure, farming and homes, improved embankments are necessary as the existing dykes are no longer reliable as flood defence structures. This intervention is for a complete reconstruction of the dykes, with local realignment where erosion is currently a problem.

Materials are to be sourced locally, wherever possible, and the existing embankment material will be reused to minimise costs.

Plant and equipment will be similar to that adopted for road construction and so should be readily available. Compaction of fill material will need careful supervision.

Stability will be improved with an increased foundation width.

Seepage will be controlled with a sheet pile cut off or seepage berm (the latter could extend for some distance from the embankment), a toe drain and (possibly) a sand filter to reduce the risk of piping.

Sections for realignment have been identified and this will be combined with other measures to control erosion.

The increased foundation width, seepage berm and realigned sections will all require more land. There will be impacts on existing settlements, infrastructure (existing irrigation canal on north side) and vegetation clearance.

Careful planning will be required to ensure that flood protection will be maintained to communities during construction. Flood seasons are less predictable that historically and so contingencies will need to be put in place.

The construction duration is likely to be long (more than 2 years) requiring deployment of significant plant and equipment requirements. This intervention can be implemented in stages.

Benefits in Reducing Flood Risk	✓

Hydraulic modelling indicates that the existing embankments provide a capacity of 410 to 450 cumec

The embankments will need to be raised (on average) by around 0.5m for the 500 cumec flow; and 1.65m for the 1000 cumec flow; although raising will be higher in places where there are existing ‘low spots’ and at peak design water levels. A allowance of 500mm has been allowed for at this stage.

The dykes have been improved in places since 2009 when they were surveyed for this project and a new would be beneficial for better estimation of earthworks quantities.

Containing flood flows within raised embankments will tend to increase water levels in the levee section and upstream. Although this will reduce flood risk in the study area, the consequences of overtopping by a larger flow may be more significant.

The capacity of the river channel is reducing over time with increased sedimentation and therefore the level of flood protection will decrease over time (see Sustainability below).

Other interventions (river channel and floodplain improvements) have the potential to further reduce flood risk and in combination with B1 reduce the amount of embankment raising required.

Community involvement and acceptability	✓

B1 New higher and stronger embankments on new alignment where appropriate.
This intervention is consistent with the approach to flood defence in this region during the recent past and since the defences were built (30 to 50 years ago) there has been increased development in the floodplain, making it less acceptable to return to a more naturalised river basin. The community believe that the defences have reached the end of their design life and despite recent efforts to repair and strengthen the defences, they have failed during significant flood events (notable 2008 and 2011) causing widespread flooding. The community support for new defences is very strong. The benefits of improved flood defence are significant, including more stable and sustainable livelihoods; improved health and sanitation. However the most significant challenge is to balance the need for improved defences with the impact on settlements in close proximity to the existing flood defence. The new defences will inevitably require additional land take and some resettlement will be necessary. This may lead to loss of ancestral land; social conflicts and weakening of family structures. It is possible that a census will be needed to record the land use and populations along the corridor affected to fully assess and quantify the impacts. Community involvement in maintaining the defences will be limited to interventions that help to maintain the integrity of the embankments, such as controlling vegetation, use of livestock ramps and repairs that can be undertaken by hand (the community does not have easy access to mechanised plant and equipment).
Sustainability ✓✗
The proposed Lower Nzoia Irrigation Development Project requires a high level of flood protection and is likely to lead to increased development in the floodplain. The embankments will need regular maintenance to provide ongoing protection and budgets will need to be assigned annually. Sedimentation will gradually reduce the standard of protection provided and interventions are needed in the upper catchment, aimed at reducing runoff and sediment. The possibility of further embankment raising in the future should be recognised. **River Morphology** Construction of embankments will reduce the frequency of floodplain inundation beyond the dykes (reducing sedimentation in this area) whilst potentially accelerating the rate of sedimentation between them. The outcome of this will be a progressively greater height difference between the channel and floodplain. Protecting the embankments from the effect of lateral channel migration using hard bank protection is problematic. The likely response of the river system to the introduction of hard protection is to shift erosion downstream. Energy that would have been absorbed eroding the now protected bank will simply be absorbed through bank erosion further downstream. Accelerated erosion immediately downstream of block protection is a common occurrence in active rivers. Opportunities to reduce negative geomorphological impacts include: set back embankments and allow room for channel to laterally adjust during the lifetime of the scheme. Bioengineering solutions as proposed will help to manage the rate of erosion.
Cost ✓✗
The capital cost is very high (see Section E) but benefits (in terms of damages avoided) will also be high. Maintenance budgets will need to be allocated. It is likely that a combination with Intervention B2 is needed for an affordable solution.
Environmental Impact ✓
The additional land take requirements for the new embankments will require vegetation clearance. Areas adjacent to the existing dykes have vegetation cover of varying density and stages of maturity. Some of the vegetation includes private wood lots mainly of exotic stands (for instance whistling pine (Casuarina equisetelium), Grevillea robusta, Eucalyptus spp, Jacaranda mimosifolia) with both economic and aesthetic values. The initial social survey identified trees as one of the four major local resources held be the community. Sections of this vegetation will have to be cleared to create room for new and broader dykes. No protected species have been identified at this stage. A programme to re-plant cleared vegetation will mitigate the impact in the longer term. Pollution prevention measures will need to be implemented to control other construction related impacts. Borrow pits for new material could potentially cause environmental degradation and will need to be licensed so that appropriate control measures are put in place through environmental management plans.

B1 New higher and stronger embankments on new alignment where appropriate.	
Safety	✓
Embankments will be designed with appropriate dimensions for safety in construction, operation and maintenance. So significant issues identified.	
Shortlisted for Option Appraisal	✓
Yes Significant embankment improvements are required as no other primary intervention is able to provide the increased level of flood protection required. It is likely that a combination of B1 and B2 will be most cost effective, with B1 implemented where embankments are in poor repair and/or in most vulnerable locations (for example seepage problems). The impacts on settlements in close proximity to the dykes requires more detailed assessment, as some resettlement looks inevitable to allow the improvement of the structures to a reliable standard.	

B2	Raise and strengthen existing embankments

Technical Viability	✓

The geotechnical investigations undertaken during Phase I suggest that the embankment material is relatively well compacted, with the exception of the upstream end of the southern dyke, which may have been constructed by hand.

It is feasible that significant sections of the existing embankments can be improved to increase the level of flood protection. The crest level would be raised (as for B1) and the slopes made less steep to improve stability. Importantly, measures to reduce seepage would be implemented, either a cut off or a seepage berm as described in B1. Again, a sand filter may need to be installed to reduce the risk of piping the structure.

The material used for the original dykes is thought to be locally sourced and, from the testing undertaken in Phase I, appears suitable for embankment construction if well compacted. However, it should be noted that the ground investigation undertaken in Phase I was limited in extent and sampling. Further testing will need to be specified before and during the construction phase to ensure that compaction is of a high enough standard for those areas where it is proposed to improve the existing structure. A suitable contingency sum will need to be allowed for in the construction budget to cover the risk that the existing embankment material is found to be not suitable and/or not well compacted, and therefore a complete rebuild (B1) is required.

The design of the structure will be broadly the same as for intervention B1, with additional testing specified to ensure that the existing material is well compacted. This is likely to be the most cost effective approach to providing a more reliable flood defence structure.

Details and construction methods would need to ensure that the new material placed is 'benched in' to the existing material to form a homogeneous structure. Except in areas where erosion is a problem, the embankment will remain on the same line, limiting the additional land take required and eliminating the need to construct a temporary defence or restrict construction to low flow periods only.

Where erosion is a problem this will be address by realignment and/or erosion protection measures as described for intervention B1.

Benefits in Reducing Flood Risk	✓

As for B1.

Community involvement and acceptability	✓✗

Similar to B1.

The objective of the design would be to provide an embankment of equivalent standard of protection as B1. This will be important to communicate to the community, as currently, due to the recent embankment failures, the community has lost faith in the existing structures.

Sustainability	✓✗

As for B1.

Cost	✓✗

Capital cost is high but more cost effective than B1. There may be an need to include for an additional contingency sum to cover the risk of the

Environmental Impact	✓

As for B1, reduced if embankment is constructed on the same line as existing.

Safety	✓

As for B1

Shortlisted for Option Appraisal	✓

B2	Raise and strengthen existing embankments
Yes Significant embankment improvements are required as no other primary intervention is able to provide the increased level of flood protection required. Likely combination of B1 and B2 for cost effectiveness, with B1 implemented where embankments are in poor repair and/or most vulnerable locations.	

C4 Enlarge river channel / remove dyke constrictions / remove sediment

The appraisal of this intervention has been divided into sub categories and each type appraised individually (enlarge river channel, remove dyke constrictions, remove sediment) as each has different impacts.

Enlarge River Channel

Technically Viable	Appreciable Flood Risk Benefit	Community involvement/ acceptability	Sustainable	Cost	Environment impact acceptable	Safety acceptable	Shortlist for Option Appraisal
✓✗	✗	✓✗	✗	✓✗	✓✗	✓	✗

Remove Dyke Constrictions

Technically Viable	Appreciable Flood Risk Benefit	Community involvement/ acceptability	Sustainable	Cost	Environment impact acceptable	Safety acceptable	Shortlist for Option Appraisal
✓✗	✓	✓✗	✓	✓✗	✓✗	✓	✓

Remove Sediment

Technically Viable	Appreciable Flood Risk Benefit	Community involvement/ acceptability	Sustainable	Cost	Environment impact acceptable	Safety acceptable	Shortlist for Option Appraisal
✓✗	✗	✓✗	✗	✓✗	✗	✓	✗

Technical Viability

This intervention is aimed at increasing conveyance through the river channel at localised 'pinch points'. When short-listing the interventions (at the concept FMP stage) it was considered not viable to enlarge the channel on a wide scale, due to the large volumes of material involved and the significant (negative) environmental impact.

Remove dyke constrictions

It is considered feasible to identify specific sections of the levee section channel where improved conveyance would have an appreciable impact on reducing flood levels. In this sense channel conveyance includes the flow area between the dykes when the river is in flood. Initial inspection, to be confirmed by hydraulic modelling, has shown that realignment of the dykes at the following locations could be worthwhile:

- Ch 0 to 1.5km Rwambwa (south dyke)
- Ch 5km Busagwa (south dyke)
- Ch 6.5km to 7km Magombe (south dyke) and Ikhula (7 to 8km)
- Ch 15km Rugunga (south dyke).

The above locations are not an exhaustive list of potential realignment locations, but have been selected in consideration not only of the likely level of hydraulic benefit, but also considering the use of the floodplain behind the dykes and other impacts,. In this context the list above is considered appropriate for the assessment of the effectiveness of this type of intervention in reducing flood risk. It is possible that other sections of dyke could be realigned to improve conveyance of flood flows, but the benefits need to be assessed against the possible impact on communities which are settled near to the existing dykes. This is likely to be the main constraint to implementing this intervention.

River channel enlargement and sediment removal.

Increasing flood capacity could also be achieved through removal of sediment and/or widening the main channel. Particularly in the case of sediment removal this is likely to provide only temporary improvement as continuing deposition of sediment would reduce the benefit over time.

Plant to be used for this work may include the following.

For channel widening:

- hydraulic tracked excavators, as used for embankment construction.

For sediment removal from the channel:

- tracked cranes equipped with a grab bucket
- purpose-made dredgers working in the channel
- specialist long reach excavators.

Specialist plant for sediment removal will most likely need to be imported from overseas. As identified above, sediment removal would be required on a regular basis (probably annually or bi-annually) to maintain the channel capacity. A considerable investment would be needed in purchasing specialist plant or else high mobilisation costs allowed for in maintenance budgets. Areas to dispose of sediment would also need to be identified.

For removal of sediment from the floodplain, the scale of operation would be significant as the floodplain is extensive and densely vegetated over significant areas. The cost would be very high and works would have significant adverse environmental impact. Engineering measures to trap and remove sediment are not viable due to the large storage / stilling area required resulting from the discharge, sediment load and flat topography. Sediment removal further upstream is more viable.

Benefits in Reducing Flood Risk

The hydraulic modelling indicates that by realigning dykes flood levels can be reduced by up to:

200mm for the 500 cumec flow, with most reduction in water level around chainage 6.5km.

380mm for the 1000 cumec flow, with most reduction in water level around chainage 6km

With potential for a greater reduction in flood levels if combined with other interventions.

Community involvement and acceptability

Dyke realignment at Rwambwa would impact significantly on the village of Doho, which would require resettlement. Additionally, the police station, road and power supply and would need to be located as the proposed alignment would leave this infrastructure on the river side of the dyke.

At Magombe, the potential route of the realignment is densely populated.

Impacts at Ikhula, Busagwa and Rugunga affect fewer homesteads.

Any resettlement is likely to be problematic and not gain community support, particularly if benefits are perceived to be relatively small.

For removal of channel sediment there is possible re-use for agriculture or sand harvesting.

Regular dredging operations required may adversely affect fisheries and fish stocks within the river.

Sustainability

Regular maintenance (dredging) will be needed to maintain the benefit of channel deepening.

River Morphology

Removal of pinch-points in the embanked flood channel could be viewed as positive. It expands the area of out of channel storage for floodwaters, and thus recovers at least some of the natural functioning of the river.

Removal of channel pinch-points (assumed to be channel widening, rather than realignment) would probably have minimal geomorphological implications, though some understanding of why a pinch-point exists would be needed before it is removed with confidence. If the natural configuration of the channel is to be narrower at that point, in time, it would simply re-adjust to the narrower configuration.

No significant negative geomorphological impacts are identified.

Cost

For dyke realignment, the construction of lengths of new embankment and resettlement costs for villages and infrastructure may be significant.

For channel dredging, significant mobilisation costs for specialist plant (for sediment removal) and

ongoing regular maintenance dredging will be required (by specialist plant).
Environmental Impact
Works in the river channel, especially dredging works, are likely to have a high environmental impact, dependent on the extent of works and frequency of maintenance activity. Potential impacts include: • Wetland habitat fragmentation: this option is likely to cause damage to riverine habitats, such as fish spawning areas • Water quality issues due to disturbance of sediment (which may contain contaminants) and increased turbidity. • Removal or disturbance of established vegetation on banks causing bank erosion.
Safety
No significant issues
Shortlisted for Option Appraisal
We have not identified any particular in-channel features that have an identifiable and significant impact on water levels during floods. Large or widespread modifications to the main channel would be expensive and would require significant ongoing maintenance as sedimentation features are likely to reoccur naturally and could give rise to other forms of adverse geomorphological change such as increased erosion. This type of work would also have adverse environmental impact. Realignment of dykes to remove constrictions does however show benefit in terms of reducing water levels and warrants more detailed appraisal. The impact on settlements could be significant and needs further consideration.

D2	Provide spillways on embankments at selected locations so there can be overtopping without breaching

Technical Viability	✓✗

Form of construction and materials

The spillway would be formed as a lowered section of embankment crest at carefully selected locations, which will allow releases of flood water for storage in the natural floodplain on the landward side of the embankments.

The crest will be lowered by up to 0.15m below predicted water level (indicative) with ramps formed in the roadway to allow vehicles to pass over. Figure 10 shows a typical arrangement.

The spillway crest will be formed of a hard engineering material resistant to erosion. At this stage it is envisaged lightly reinforced concrete will be used with a hardwearing aggregate. Detailing will be designed to reduce the risk of washout around the concrete structure. The downstream slope of the crest will be formed of concrete or stone pitching bound with a cement mortar, to resist erosion. Rock scour protection will be placed at the toe, also to guard against erosion.

The crest width will vary and be determined by the rate of discharge required (from hydraulic calculations and modelling).

At the location of each spillway, a drainage structure will need to be provided to enable the water to drain back to the river after the flood has passed. See intervention D15 for details of the structure to be provided

Proposed locations and physical constraints

The storage areas will be sized and positioned to reduce the risk of the flood defences overtopping elsewhere along the reach. When combined with interventions to improve the embankments, the use of spillways can potentially reduce the height that the crest needs to be raised to for a particular standard of protection.

The areas identified for possible flood storage have been selected with consideration of:

- Avoidance of critical infrastructure and settlements, where possible, to minimise the damage caused by flood water
- Use of natural topography to minimise the need for secondary embankments which will be costly and need maintaining
- Use of natural drainage paths to allow floodwaters to drain after the flood has passed
- The available storage volume
- Location on the reach which will provide most benefit, with those positioned furthest upstream will have the most benefit (for equivalent size).

As identified for many of the other interventions, hydraulic modelling is used to identify the relative benefits to allow an assessment to be made of whether flood storage areas provide sufficient benefit to warrant further investigation.

Below is a brief description of the proposed locations (See also Figure 10) with commentary on constraints and opportunities (where relevant).

North

- Sibanze / Sigiri (Ch 12km approx)

There is open cultivated land (approximately 200 hectares) with two crops harvested per year (mainly maize and millet). Natural channels drain southwards towards the Nzoia, but drainage has been impeded since embankment construction.

South

- Burangasi (Ch 8km approx)

There is open land (approximately 40 hectares) which appears to be used for grazing. The proposed storage area is bordered to the south by the road to Namabusi. To the west and east of the flood storage area are settlements that would require protection by constructing new secondary embankments.

The irrigation canal from the Bunyala National Irrigation Scheme runs halfway between the road and the river and the impacts on this scheme would need to be assessed further. A control structure

D2	Provide spillways on embankments at selected locations so there can be overtopping without breaching

would need to be built at the outlet. There are some overhead power lines which would require relocation or raising above the flood storage levels.

This location is also proposed for realignment of the flood embankment as the river channel has migrated to the toe of the embankment.

- Galalani to Rugunga (Ch12 to 14.5km approx)

Three separate spillways are proposed for this area with a combined storage area covering approximately 75 hectares. Secondary embankments are needed to protect nearby villages and the road. There are natural streams (Otema and Khajula) draining to Ndekwe River which would allow flood waters to drain from the storage area, although some channel clearance may be required.

Lower Nzoia Irrigation Development Project

We have recently received information on the Lower Nzoia Irrigation Development Project planned within our study area. The stage of the project is currently (at end August 2012) nearing completion of the detailed design with construction to be implemented in stages starting in 2014 (Lower Nzoia south side) and 2015 (Lower Nzoia north side).

The scheme is of a considerable size, with irrigation infrastructure and agriculture planned from Rwambwa to Mau Mau on the south side and to Sigiri on the north. The objectives of the scheme are to increase food production and food security, to bring enhanced standards of living for the local community. This objective is consistent with the overall goal of the agricultural development policy in Kenya.

Flood protection is a key consideration for this irrigation scheme and clearly there is a need for this to be complimentary with WKCDD&FMP. With information on this scheme now gained, it appears that creating flood storage within the floodplain will not allow the objectives of the Lower Nzoia Irrigation Development Project to be met as the infrastructure and value of crops will be adversely affected.

Benefits in Reducing Flood Risk	✓✗

Nominal, modelling indicates up to 0.15m reduction in water levels for the 1000 cumec flood flow, with benefits largely in the downstream third of the study area. 500 cumec levels are such that provision of spillways would require the lowering of existing dyke levels.

Community involvement and acceptability	✗

Likely to be strong opposition, since come communities will be adversely affected.

Secondary embankments could create severance or boundaries between communities

Sustainability	✓✗

Requires maintenance of secondary embankments and spillways.

Detrimental to economic development and food security.

Impact on roads, power and irrigation water supplies passing through flood storage areas.

River Morphology

This intervention will have the effect of maintaining connectivity between channel and floodplain, allowing sedimentation of the floodplain beyond the embankments. A generally positive measure that mimics natural process.

No adverse negative geomorphological impacts identified.

Cost	✗

The spillways are relatively low cost. The length of secondary embankments needed will be relatively high cost. Cost of damages will be high (spoilt crops) and the cost benefit analysis for the Lower Nzoia Irrigation Development Project would need to take account of this in determining economic viability of that scheme.

Environmental Impact	✗

Negative Impact on species (flora and fauna) in the flooded areas.

Safety	✗

Potential safety issues if warning systems fail to notify people affected. Livestock could also be affected. Spilling flow could block access along embankments.

Shortlisted for Option Appraisal	✗

D2	Provide spillways on embankments at selected locations so there can be overtopping without breaching
No Whilst this intervention provides some flood risk benefit, this is outweighed by the negative impact on communities and infrastructure. Unlikely to gain community support.	

D7	Relocate vulnerable villages to flood-free locations

Technical Viability	✓✗
Although the ideal approach from a flood management perspective, this intervention is most viable only on a local scale, identifying those villages most at risk, rather than widescale approach (as the floodplain is densely populated). This intervention needs to be handled at district / community level, including identification of resettlement areas.	
Benefits in Reducing Flood Risk	✓
Eliminates risk for those relocated.	
Community involvement and acceptability	✗
Mixed support. Some communities (such as Bunyala North) will consider this and have shown support, although resettlement within the same community is desired. Those to be relocated would expect significant Government support. Resettlement of homesteads: This requires a fully-fledged re-settlement plan that will involve community consultation and compensation. It is also notable that attachment to ancestral land among the community members is very strong. Could lead to conflict over land. There are no readily identifiable areas for resettlement within the study and so this would require further investigation at district level. Significant disturbance to affected communities could arise. There is also likelihood of conflicts with host community following variation in culture and other social practices. Weakening of family structure: Social linkages and social capital may be significantly deteriorated.	
Sustainability	✓
Most sustainable solution as represents adaptation to natural river and flood processes. Implementation could be local (village level) or on a wider scale. If adopted on a wide scale this would change approach to flood risk management in this area.	
Cost	✓✗
Resettlement costs could be high, but would be a one off cost (no future costs).	
Environmental Impact	✓
Would provide opportunity for naturalisation of the floodplain, including restoration of habitats.	
Safety	✓
Safest solution.	
Shortlisted for Option Appraisal	**N/A**
These types of 'non structural' interventions are suggested as complimentary to the engineering or 'structural' options put forward in this FMP.	

D8 Create raised platforms at existing villages and relocate buildings on them. Also raise critical infrastructure above flood level.

Technical Viability	✓✗
This intervention is technically viable and should be implemented for all new infrastructure, as part of the planning and development process, with appropriate guidance on flood levels provided. Raise platforms should ideally be adopted on a village scale involving remodelling of existing settlements. Temporary camps may be required during works to raise ground levels and rebuild homes and other facilities. Water and sanitation facilities should be raised to reduce the risk of water contamination during floods. Smaller scale raising for individual homesteads is an alternative. During recent flood events in the Lower Nzoia the flood depths have been less than 1m, indicating that even modest sized platforms would considerably limit damage to homesteads. Buildings should also be designed and constructed for flood resilience, whereby the objective is to limit the damages of floods when they do occur. This is necessary, since it is not economically viable to protect against all flood risk, particularly in vulnerable areas such the Lower Nzoia. At some point in time, a flood will occur which is above the designed level of protection. In some countries, buildings in flood prone areas are designed to be supported on 'stilts'; or buildings are constructed with living accommodation and critical services all floors above ground level (first floor or above). Flood resilience is vitally important for all infrastructure in flood risk areas. Many homesteads in the study area are traditionally built mud wall structures, which are severely damaged by flood waters. It would be worthwhile developing an economic design for a typical homestead with improved flood resilience, appropriate to the location and availability of materials. With plans for future economic development in this area (particularly in relation to the proposed Lower Nzoia Irrigation Development Scheme) this could be a focus for future research and development.	
Benefits in Reducing Flood Risk	✓
Does not reduce risk of embankments failing, but limits damages when flooding occurs and provides a 'safe haven' for displaced population.	
Community involvement and acceptability	✓✗
This was not supported by the community but further education is strongly advised. This solution is adopted in many parts of the world including the Netherlands, Bangladesh and more recently Thailand, where after recent floods, new development is planned on platforms raised above predicted flood depths. Could be implemented on local scale (individual homesteads) or more widespread (village scale).	
Sustainability	✓
More sustainable than most interventions. All new infrastructure should be built raised above existing ground level buy at least 1m. Planning policy should be implemented to enforce this.	
Cost	✓✗
Locally sourced materials. Comparatively low cost for platforms. Rebuild costs could be high, other than where infrastructure is already due for renewal. Damages to agricultural land not reduced.	
Environmental Impact	✓
Borrow areas required which should be properly licensed if wide scale approach.	
Safety	✓✗
Improved shelter during floods. Will not prevent flooding or prevalence of disease. Drinking water supplies will continue to be affected by floods. May isolate people, unable to reach food and water supplies in floods as access will be cut off.	
Shortlisted for Option Appraisal	**N/A**

D8 Create raised platforms at existing villages and relocate buildings on them. Also raise critical infrastructure above flood level.
Should be taken forward at a district and community level following further consultation with the community

Secondary interventions

B10	Extend flood embankments to prevent backflow around ends

Technical Viability	✓✗

The embankment construction itself would be similar to that described for intervention B1, however a more robust foundation will be needed on ground that is marshy, with a cut off to prevent seepage under the embankment. The foundation is most likely to comprise a well graded rockfill (up to 250mm diameter), ideally placed on a layer of geotextile for better distribution of loads and to reduce the overall quantity of rock that would otherwise be deeply embedded in the marshy ground. Before laying the geotextile, any unsuitable ground, such as soft spots will need to be excavated. Care needs to be taken to avoid puncturing the geotextile and a finer gravel material may need to be placed between the rock and the fabric to prevent puncturing. The layer thickness will need to be determined by the supervising engineer at the time of construction (as the ground conditions will vary). Construction would need to be scheduled during times when water levels are at their lowest.

It has been reported that in recent years a foundation was laid by NWC&PC to extend the northern dyke, however this work was abandoned for reasons not known.

Figure 7 illustrates possible alignments for extending the embankments.

Alternative Alignments – Northern Embankment

On the northern side, three alternative routes have been identified.

- A lateral dyke immediately downstream of the village of Narera, connecting to the existing dyke at Ch15+250 and tying into the foothills of the higher ground to the north. The extension would be in the region of 2km long and protect the village of Narera which is the most downstream settlement along the river on the northern side. (Note there is one isolated homestead further downstream, accessed primarily by boat).
- A lateral dyke approximately 1km downstream of the village of Narera, connecting to the end of the existing dyke at Ch16+250 and tying into the foothills of the higher ground to the north. The extension would be in the region of 1.5-2km long and protect Narera and the farmland immediately downstream of Narera. This area is farmed by local villagers, but crops are frequently damaged when the ground becomes waterlogged due to backflow around the ends of the dykes.
- An extension of the dyke along the lowest reaches of the Nzoia, extending to the shores of Lake Victoria. The extension would be 2 to 3km in length through very low-lying marshy ground, making it very difficult and costly to construct.

Each of these alignments would require significant capital investment and therefore the benefits need to be clearly identified. Presently, the village of Narera is rarely affected by backflow from around the ends of the existing dykes, with past flooding caused by overtopping or breaches of the dyke further upstream. Therefore, under present conditions, any extension of the dykes would primarily protect the agricultural land to the west of Narera and possibly open up new areas of agricultural or grazing land towards Lake Victoria.

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Alternative Alignments – Southern Embankment

The proposal illustrated in Figure 7 is to extend the existing southern embankment through the low-lying marshy ground to meet the shore of Lake Victoria. There is no higher ground to tie into. Similar to alignment (III) described above for the northern side, this would require significant capital investment and benefits need to be clearly identified.

Currently there are 3 homesteads downstream of the existing embankments. Two are south of Musomo Dyke near to the Ndekwe River. The third is some distance downstream and rather isolated, with access primarily by boat.

The Musumo Dyke is a transverse dyke, extending from Ch16+400 (approx) to the Ndekwe River at Namabusi Beach. The condition and form of construction is not known. There is no vehicular access along the dyke and currently it is impassable on foot due to dense vegetation. There have been no reports of it overtopping or breaching, although backflow can penetrate upstream of the dyke along the corridor of the Ndekwe River. Flooding in these areas has resulted from breaches in the main embankment further upstream.

Similar to the northern dyke, under present conditions there does not appear to be strong justification for extending the southern dyke, or improving the Musumo Dyke, unless the use and flood risk to

B10 Extend flood embankments to prevent backflow around ends	
these downstream areas increases in the future.	
Benefits in Reducing Flood Risk	✓✗
Extending the flood embankments will provide increased protection to settlements experiencing backflow. However, extending flood embankments to Lake Victoria (two of the possible extensions described above) are likely to increase water levels upstream. Possible future conditions should be considered, such as the influence of Lake Victoria levels and increased sedimentation. Future conditions downstream may have greater impact (due to backflow) than present.	
Community involvement and acceptability	✓
Community support mainly localised to those who will benefit most, through increased productivity of agricultural areas in lower reaches (particularly north side) which are permanently or seasonally waterlogged. Food security is an important driver for improving quality of life for this community. Depending on the alignment proposed, some resettlement in previously abandoned lands downstream may result. Some families were forced by floods in the 1960s to abandon their land parcels downstream the Nzoia River. This intervention will enable them the resettle and develop these lands which will also improve their economic status. Increased protection from flooding is likely to give rise to increased development in the natural floodplain behind the extended dykes. Conflicts over land may arise over land previously settled before, floods forced people to relocate. Currently these parcels are fully under dense reed vegetation cover and will require fresh demarcations.	
Sustainability	✓✗
River Morphology This may affect the river course and delta formation in the downstream section of the river. As described in B1, Construction of embankments will reduce the frequency of floodplain inundation beyond the dykes (reducing sedimentation in this area) whilst potentially accelerating the rate of sedimentation within them. The outcome of this will be a progressively greater height difference between the channel and floodplain.	
Cost	✗
Capital cost is very high (see Section 7)	
Environmental Impact	✗
The proposed alignments to extend the flood embankments to Lake Victoria will have the most significant environmental impacts and a full Environmental Impact Assessment is likely to be needed, and the appropriate licences and consents granted before work could proceed. Proposals to extend the embankments to Lake Victoria may not be permitted by NEMA. **Wetland habitat loss and fragmentation** The confluence of river Nzoia and Lake Victoria forms fresh water estuary, an important wetland ecological system. The wetland vegetation (dominated by reeds and other wetland grasses) offers an important habitat to some wetland-adapted fauna, especially birds (avifauna) whose biodiversity in the wetland was conspicuous from field visits. Other animals inhabiting the wetland include reptiles (e.g. monitor lizards, crocodiles and snakes), amphibians (e.g. toads and frogs), arboreal mammals (e.g. monkeys) invertebrates and fish (Ichthyofauna). Wetlands are spawning and recruitment grounds for some ichthyofauna found in the Lake Victoria and river Nzoia. A significant portion of natural wetland will have to be cleared during construction to accommodate dykes extension to the lake. This will result into its fragmentation with detrimental impacts on the above mentioned biodiversity. Further negative impacts can result during operation of the proposed extended dykes as hydrological regime of the remaining wetland sections will be ameliorated significantly. A significant proportion of the wetland may the cut off from regular surface/flood water supply with detrimental impacts on the wetland habitat reduction. As wetland the dries up it will naturally be invaded by plants adapted to dry conditions that will out-compete the wetland plants. Further wetland specialists such as ducks, wading birds and dragon flies will eventually find the wetland unsuitable for their living conditions. They will eventually migrate	

B10 Extend flood embankments to prevent backflow around ends	
to nearby wetlands or no longer survive. Wetlands in Kenya are protected under Environmental Management and Co-ordination Act (EMCA), 1999 and its subsequent regulations- the environmental management and co-ordination (wetlands, river banks, lake shores and sea shore management) regulations, 2009. It is also notable that the wetland is in the process of being gazetted as a protected wetland. This process is supported by NEMA and the Nile Basin Initiative (NBI). This denotes the conservation importance of the wetland resources of Nzoia River floodplain as Trans-boundary natural resources. The area is thus likely to be declared as a wetland of international importance (Ramsar Convention) in future. **Wetland pollution** The proposed dykes extension will pose wetland pollution hazards from accidental oil/fuel spills during construction if diesel powered machines are employed. Any pollution from hydrocarbon compounds will affect the wetland biodiversity by decimating oxygen penetration. Construction activities using such machinery will also lead to air and noise pollution. This is likely to affect biodiversity negatively. This may result in an increased sediment load at the river mouth. Increased agricultural activity in the area is likely to give rise to increased use of pesticides and fertilisers which will be leached to the wetlands and Lake Victoria A full Environmental Impact Assessment would be required to assess the impacts.	
Safety	✓
Embankments will be designed with appropriate dimensions for safety in construction, operation and maintenance. No significant issues identified.	
Shortlisted for Option Appraisal	✓
Yes, on the north side only. The most feasible alignment that would provide most benefit is the lateral dyke approximately 1km downstream of the village of Narera, connecting to the end of the existing dyke at Ch16+250 and tying into the foothills of the higher ground to the north. This would safeguard the downstream settlements and agricultural land, contributing to sustainable communities. Extensions to lake (north and south) are not considered feasible due to limited benefits and significant environmental impacts.	

C1	Shorten river by cutting the meanders (either by cutting a full channel or by cutting a shallow channel to pass flood flows)

Technical Viability	✓

This intervention has already been implemented by NWC&PC in five locations on the river in the aftermath of the 2008 floods. Figure 8 shows these locations, together with proposals for additional works of a similar nature as part of this project. NWC&PC has described how vegetation was cleared (with heavy dozers) and channels excavated measuring 20m wide at the base and 1.5 to 2m deep (approx). It has been reported that the channels are silting up and therefore benefit reducing with time.

The proposed locations for new "loop cuts" or river training channels are shown in Figure 8. Channels proposed for this intervention have been modelled at a depth of 3m and side slopes would be around 1 in 2 gradient. The channel width will need to be kept relatively clear of reeds to maintain the conveyance, but with some planting to control erosion. Channels are likely to require regular maintenance to maximise benefits.

Benefits in Reducing Flood Risk	✗

Negligible. The modelling indicates almost no benefit derived (water levels reduced by 30mm or less) for the 1000 cumec flood flow.

Anecdotal evidence suggests that the relatively shallow existing loop cuts implemented by NWC&PC have a secondary benefit by creating preferential flow paths across the floodplain, reducing flow velocities immediately adjacent to dykes and thereby reducing the risk of scour.

Community involvement and acceptability	✓✗

Regular dredging operations are likely to be required to maintain the capacity, with possible impacts on water quality and fish stocks (see C4).

May impact on accessibility of certain parts of the levee section.

Sustainability	✗

Regular maintenance likely to be needed, using specialist plant, to maintain benefit and appropriate budgets secured.

River morphology

In an active river running through soft materials, such as the Nzoia, this option carries some potentially significant geomorphological risks. There are examples of loop cut failures in the early 20th Century on the lower Mississippi, a river not dissimilar in nature to the Lower Nzoia, in which loop cuts destabilised and openings moved upstream. At a minimum careful design will be required to avoid scheme failure.

Introducing loop cuts will create a local increase in gradient that the natural system will work to remove. Likely adjustments are:

- bed erosion to smooth out the steeper section of bed, to return the river to its original grade
- increased lateral activity (bank erosion) to extend the course of the river and hence reduce grade.

For the latter, armouring may be required to keep the channel in a stable position. It would be preferable to implement such measures at the time of construction before the channel is flooded.

To mitigate the negative impacts design should aim to limit the proportion of flow passing through the loop cut to below the rate at which serious adjustment will occur. Also, erosion control at key weak points in the system (e.g. the upstream entrance to the cut-off), being aware of the risk that this will transfer erosion risk elsewhere.

Cost	✓✗

Comparatively low capital cost but changes due to natural processes will require regular maintenance.

Environmental Impact	✓✗

Vegetation clearance in the floodplain, areas of mature and diverse habitat, as well as reeds.

Wetland habitat fragmentation: this option is likely to cause damage to riverine habitats, such as fish spawning areas.

Water quality issues during maintenance (if dredging required) due to disturbance of sediment (which may contain contaminants) and increased turbidity.

C1	Shorten river by cutting the meanders (either by cutting a full channel or by cutting a shallow channel to pass flood flows)	
Removal or disturbance of established vegetation on banks of main channel and during maintenance causing bank erosion		
Safety		✓
No significant issues		
Shortlisted for Option Appraisal		x
No Provides negligible benefit in reducing flood risk. It has been discussed and agreed with WKCDD&FMP that this intervention can continue to be implemented by NWC&PC as a short term measure, but this intervention will not form part of the further appraisal of flood management options.		

C2	Cutting a new channel to the lake near the mouth (southern side)

Technical Viability	✓✗
An indicative route for a new channel is illustrated in Figure 8. Whilst it has not been possible to gain access to survey this location on the ground (due to dense vegetation and waterlogged ground), aerial photography and Lidar data have been studied, together with information from discussions with local people. The area is a wetland, densely vegetated (most likely with reeds), and is uninhabited. At the mouth of the Nzoia there are settlements inhabited mainly by fishermen (an area known locally as Musango Beach). Construction would be challenging in such wet conditions and further investigation on the ground is needed to identify suitable plant and methodology. Whilst it is feasible that a new channel can be constructed, clearly the cost will be high and environmental impacts likely to be significant, therefore the benefit will need to be clearly demonstrated by the hydraulic modelling.	
Benefits in Reducing Flood Risk	✗
Negligible. The modelling indicates there is no benefit upstream of the cut apart from a very localised reduction in water levels at the extreme downstream end of the embankment (0.19m) for the 1000 cumec flood flow.	
Community involvement and acceptability	✓✗
If shortlisted, the route identified will need ground survey and consultation with local community to assess the potential impacts.	
Sustainability	✗
Sedimentation at the mouth will be difficult to assess. **River morphology** As for C1 a shorter channel will create a local increase in gradient that the system will work to remove. Likely adjustments are: • bed erosion to smooth out the steeper section of bed, to return the river to its original grade • increased lateral activity (bank erosion) to extend the course of the river and hence reduce grade.	
Cost	✗
Moderately high.	
Environmental Impact	✗
Vegetation would need to be cleared to accommodate the new channel. As described for B10 there will be loss of habitat and fragmentation of the wetland with detrimental impacts on the above mentioned biodiversity. Wetlands in Kenya are protected under Environmental Management and Co-ordination Act (EMCA), 1999 and its subsequent regulations- the environmental management and co-ordination (wetlands, river banks, lake shores and sea shore management) regulations, 2009. It is also notable that the wetland is in the process of being gazetted as a protected wetland. This process is supported by NEMA and the Nile Basin Initiative (NBI). This denotes the conservation importance of the wetland resources of Nzoia River floodplain as Trans-boundary natural resources. The area is thus likely to be declared as a wetland of international importance (Ramsar Convention) in future. Pollution risks during construction would be a concern and mitigation measures identified. A full Environmental Impact Assessment would be required to assess the impacts and the appropriate licences and consents granted before work could proceed.	
Safety	✓
No significant issues	
Shortlisted for Option Appraisal	✗
No. Provides negligible benefit in reducing flood risk.	

C3	Clear the reeds from the area between the embankments (either clearing the whole area or clearing strips aligned upstream - downstream)

Technical Viability	✓✗
Clearing reeds from between the embankments would allow better conveyance of flood waters which with the potential to reduce flood risk upstream. Presently, there is dense reed growth covering large areas which will significantly slow the passage of flow water through the floodplain. There have been previous attempts at clearing the reeds growth between the two embankments. This pilot exercise was conducted by NWC&PC in 2010. The clearance was done by the use of hired heavy dozers. The clearance was done in the northern floodplain at Narera, Siginga and Sibukha, the lower reaches of the study area. An area of approximately 20 acres was cleared and subsequently tilled for production of cash crops such as tomatoes and water-melon. However, the reeds re-established quickly and the growth rate is reported to require monthly maintenance. For the hydraulic modelling it was assumed that an area of 0.88 km² is cleared of reeds.	
Benefits in Reducing Flood Risk	✓✗
Some reduction in water levels (100mm or less) for the 1000cumec flood flow	
Community involvement and acceptability	✓✗
The community do not show strong support for this intervention. Community support will be important for maintaining the areas identified for clearance. There does not appear to be a strong commercial driver. When cleared areas are cultivated, crops are vulnerable to damage by flood waters and bare. soils can be eroded during floods. The demand for reeds as a material is not high, being mainly used for roofing and making of furniture. It is considered unlikely that reed clearance could be implemented successfully on a large scale in the study area. In some parts of the world reeds are considered a viable energy crop, and this would be worthwhile considering.	
Sustainability	✓✗
Requires ongoing maintenance. Strong commercial driver needed for community support.	
Cost	✓✗
Moderately low, including maintenance costs if community driven.	
Environmental Impact	✓✗
Whilst reeds are considered a hindrance in terms of flood water conveyance, they provide habitat for riparian and wetland wildlife, including birds and monkeys. It is also worth noting that not all vegetation between the embankments is reed growth. There are very rich and diverse habitats supporting a wide variety of birdlife. Any significant clearance of vegetation would most likely require a detailed environmental impact assessment.	
Safety	✓
No significant issues	
Shortlisted for Option Appraisal	✗
No The challenge of suppressing reed growth suggests this is not feasible without strong community support.	

C5 Construction of large culverts through road embankment crossing flood plain south of Sigiri

Technical Viability	✓

Presently there are two river crossings in use by local communities:

- Sigiri to Khayunga (chainage 13km approx)
- Narera to Rugunga / Namabusi (chainage 15km approx).

In both cases, in the southern floodplain, road embankments have been built to connect the southern dyke to crossing points at the shore. The raised road embankments allow passage to the river crossing during times when the river is out of bank. Both crossings carry only pedestrians.

The crossing at Sigiri is considered the most important of the two crossings, being the shortest route to Lake Victoria and used daily by traders from the south.

The road embankments impede flow during flood conditions and also slow drainage of the floodplain following floods. The hydraulic modelling indicates that the embankment at Sigiri has more influence than the one at Narera, the latter does not appear to have significant impact, therefore has not been considered further.

The crossing at Sigiri has a number of culverts (19 counted) buried beneath the roadway, diameter 900mm and spaced at approximately 100m intervals. The condition of some of the culverts is poor, having suffered damage by flood water and there is some evidence of poor workmanship. Flood water overtops the road embankment leading to erosion, damage to the culvert and road surface. It is recognised that this intervention is needed to replace some (if not all) of the culverts, with details designed to limit damage during floods. The benefits of providing additional capacity are identified by the modelling. The culverts are not only needed for improved conveyance during the floods, but also to drain waters away from the floodplain after the peak flood has passed.

Large reinforced concrete culverts (cast in situ) have been assumed for the outline proposals, with scour protection upstream and downstream. There is an option to replace culverts with bridges if cost effective to do so.

Benefits in Reducing Flood Risk	✓

For the hydraulic model we have assumed larger culverts passing under the embankment at Sigiri than the current arrangement of 0.9m diameter culverts. The model arrangement included 8 no. rectangular culverts 10m by 1.5m high. This provides benefits of reducing water levels by up to 310mm for the 500 cumec flood and 200mm for the 1000 cumec flood.

Additionally, we have modelled a complete removal of the embankment to assess the maximum benefit of increasing conveyance through this section of the reach. The benefits increase significantly to 660mm for the 500 cumec flood and 540mm for the 1000 cumec flood.

The modelling indicates a small increase in water levels downstream of the Sigiri crossing (up to 80mm) for these model scenarios.

Community involvement and acceptability	✓

The crossings are important strategic routes and attract a high level of community support for maintaining and improving. Proposals should ensure access is maintained to allow river crossings, including when river levels are high. New culverts through the embankment are likely to be strongly supported as the current structures are in poor repair. Proposed designs should be robust to reduce the risk of damage by floodwaters.

The impact of completely removing the road embankment from the southern dyke to the river channel should be discussed with the community. It would be possible to construct a new landing place at the southern dyke for access during floods, although the crossing distance would be much greater. Also, dependent on the depth of water in the floodplain it may be difficult to navigate.

Sustainability	✓

The road crossing is important for the local economy.

Improved passage of flood flows and drainage will benefit communities upstream.

Some maintenance will be required and community support needed (eg to remove debris and maintain surfaces).

C5 Construction of large culverts through road embankment crossing flood plain south of Sigiri	
Cost	✓
Comparatively low.	
Environmental Impact	✓
No issues	
Safety	✓
No significant issues	
Shortlisted for Option Appraisal	✓
Yes Beneficial in reducing water levels. Any negative impacts can be mitigated. Renewal of culverts is recommended as these important for drainage and the existing culverts are generally in poor repair.	

D3 Improve drainage in floodplain areas so that floods become less deep and drain away faster

Technical Viability	✓

Northern floodplain

This intervention combines with D15 in recognition that drainage of the northern floodplain has been impeded since the construction of the flood defences. When the embankments were built, the natural streams draining to the Nzoia were cut off and no drainage outlets provided. The land slopes to the southwest and therefore the northern floodplain east of the hill at Sigiri (particularly Ch 10km to 13km) is worst affected as the embankment ties into the hill which prevents drainage both south and westwards.

The local people report that during rainfall the stream beds in the northern floodplain carry water southwest towards the Nzoia which is then prevented from draining away by the embankment, leaving the land behind waterlogged and not suitable for agriculture.

During times of higher river flows the problem is reversed, with water seeping under the embankment through the permeable gravels as no cut off was provided when the embankments were built across through stream beds. This seepage again causes ground to be waterlogged and unsuitable for agricultural or other uses. In the past, when the River Nzoia has flooded the northern floodplain, the area has remained waterlogged for months after the flood has passed.

A typical drainage outlet suitable for the northern floodplain is shown in Appendix B and comprises a reinforced concrete sluiceway, with flap valves attached to the upstream and downstream headwalls of the structure. These flaps act as one way valves, allowing water to drain by gravity through the sluiceway. Flaps can be made of cast iron, steel or more recently High Density Polyethylene (HDPE). Flap valves will need to be maintained regularly (at least quarterly), cleaning and greasing the hinges, removing trapped debris and accumulation of silt at the invert. If the flap valves are not in good repair or are blocked with debris they may fail to close when river water levels rise above the invert and water will flood the area behind the flood defence. As an additional line of defence a penstock can be installed in the sluiceway (recommended) which would normally be in the raised position, but could be lowered in an emergency if the flap valves fail to close during flood conditions.

It is recognised that with increasing deposition of sediment between the embankments, the bed of the river and the adjacent floodplain are gradually being raised whereas the floodplain behind the dyke remains relatively static, apart from occasional deposition when the flood defences fail and there is an inundation of flood water (which will become less frequent with improved embankments). A preliminary analysis of historic water levels suggests that during the rainy season, the river levels could remain high for several weeks at a time which would prevent drainage through the sluices by gravity. To aid drainage during these periods a small pump house could be provided.

Southern floodplain

The topography falls generally to the south west and when the embankments were built, this affected the natural drainage in the floodplain. Some channels have become overgrown with reeds and so the capacity is low.

The channels affected include the Otema Stream and Khajula Stream (and its tributaries the Namarindi and Mhalanga streams)

Both the Otema and the Khajula streams flow into the Ndekwe River discharging to Lake Victoria to the east of Nzoia River. The Ndekwe River also receives flows from the downstream end of the Bunyala Irrigation scheme and from natural streams to the east. The Ndekwe River channel reduces in size considerably upstream of the road bridge at Namabusi. The river downstream of the bridge is popular with fisherman and the vegetation has been kept clear of the channel to allow navigation and fishing. Increasing the capacity of these channels would provide for better drainage of the floodplain during times of flooding.

Channel capacity can be increased by vegetation clearance (with regular maintenance) together with excavation to increase the width and depth. New culverts would be provided at road crossings. It is not envisaged that these small streams could be improved sufficiently to convey flood flows (and thereby reduce water levels in the Nzoia) as the size would need to be considerable.

It is recognised that the Lower Nzoia Irrigation Development Project planned for the study area (for implementation in 2014/15) will also need to provide for drainage of the north and south floodplains. The plans currently indicate extensive networks of irrigation canals and collector drains, extending from Rwambwa to Mau Mau on the south side and to Sigiri on the north. It is possible that if the

D3 Improve drainage in floodplain areas so that floods become less deep and drain away faster	
irrigation project is implemented before WKCDD&FMP, then works may not be necessary under the latter scheme. It is recommended that there is close collaboration in developing a design when meets the objectives of both projects. This will ensure the most cost effective solution.	
Benefits in Reducing Flood Risk	✓✗
No effect on reducing flooding from the Nzoia, but allows quicker recovery. Gated outlets to the southern floodplain represent an increased flood risk as they would need to be closed at the right time to prevent flooding during periods of high Nzoia levels.	
Community involvement and acceptability	✓✗
Strong community support northern floodplain. Impacts to be assessed for proposed southern floodplain improvements as since streams have largely dried up there has been increased development along these corridors. Risk of theft of metal sluice gates and other equipment which would put communities at risk of flooding. Opportunities to involve the community in maintaining the structures and create sense of ownership.	
Sustainability	✓
Helps to restore the natural equilibrium in the floodplain. Opportunity to address these issues collectively with the Lower Nzoia Irrigation Development Project. **River Morphology** The natural channel is likely to sit slightly raised above the floodplain because of the development of levees. This configuration is likely to be accelerated by construction of flood embankments (see notes on B1 and B2 above). Over time it is likely to become more difficult to maintain the gradient necessary to sustain drainage from the floodplain to the Nzoia channel. No negative geomorphological impacts identified.	
Cost	✓
Comparatively low and opportunity to resolve through Lower Nzoia Irrigation Development Project. Need for ongoing maintenance and clearance of channel connection to Nzoia	
Environmental Impact	✓
Low	
Safety	✓✗
Need to restrict access to sluiceways. These would be classified as confined spaces and atmosphere can be affected by noxious gases or lack of oxygen. Could cause harm (even death) if entered without testing atmosphere before entry. Specialist apparatus needed to test atmosphere and/or breathing apparatus and means of escape (eg tripod for lifting) required on standby.	
Shortlisted for Option Appraisal	✓
Yes A drainage solution is needed and this needs coordination with the Lower Nzoia Irrigation Development Project which, at the time of writing, is nearing completion of detailed design with extensive drainage infrastructure planned to support the new irrigation scheme. Other minor improvement works can be implemented at a community level, with evidence of this happening in the past.	

D5	Improve Ndekwe River to carry some Nzoia flood flow

Technical Viability	✓✗
As stated in D3 the capacity of the Ndekwe River downstream of Namabusi Bridge increases significantly (as the vegetation has been kept under control for navigation and fishing) and water drains here from tributaries to the north and east as well as the Bunyala Irrigation scheme. At Namabusi Beach the River is approximately 20 to 30m wide and 5 to10m deep (indicative only). This intervention proposes a new channel from the Nzoia River, downstream of the Musumo Dyke, to join the Ndekwe River downstream of Namabusi Beach. The indicative arrangement modelled at feasibility stage is a high level channel, (40m wide), with invert level at the Nzoia bank level, contained between embankments, and falling to Ndekwe channel. This arrangement would be optimised for outline design if taken forward.	
Benefits in Reducing Flood Risk	✗
Negligible for the 1000cumec flood flow. Likely to increase flood risk from backflow up the Ndekwe.	
Community involvement and acceptability	✓✗
Impacts on communities close to Ndekwe to be further investigated if pursued. May increase flood risk.	
Sustainability	✓✗
Maintenance will be needed to provide capacity into the future. **River morphology** See comments / concerns on loop cut channels under C1 and C2 above. The river is likely to adjust in order to recover the original gradient, possibly through: • deposition at the downstream end of the channel (already reported to be a problem at the mouth of the Ndekwe) • lateral adjustment within the loop cut channel (to increase stream length • bed erosion back from the upstream end of the cut-off channel.	
Cost	✗
High, including maintenance.	
Environmental Impact	✓✗
Vegetation clearance will lead to loss of habitat	
Safety	✓
No issues	
Shortlisted for Option Appraisal	✗
No Negligible benefit in reducing flood risk.	

D12	Provide sluices to enable controlled release of water onto floodplain

Technical Viability	✓✗
See also D2, D3 and D15. This intervention is based the concept of using the wider floodplain outside of the embankments to accept and store water in times of flood (similar to D2). The use of gated control structures to release and regulate flows would aim to avoid accidental overtopping of the dykes. Flows would be routed to areas where the impact of flooding is comparatively less. Areas identified for routing flows would need drainage systems in place (natural or otherwise) to allow flood water to drain and areas to recover as quickly as possible. Figure 11 illustrates potential locations for control structures, locations (as for D3) centred around natural drainage systems and historic stream beds. Control structures may need to be very large to pass the volumes required to achieve potential benefits. The timing of opening the control structures to release floodwater will be critical to success / maximising the benefit. This will need sophisticated forecasting and control systems.	
Benefits in Reducing Flood Risk	✓✗
Benefits would be very dependent on timing of opening, which is difficult to judge correctly even in locations where sophisticated flood monitoring and forecasting exists. Risk of opening too soon or too late and having negligible impact on water levels between the dykes or adverse effect on flooding in the floodplain.	
Community involvement and acceptability	✗
Likely to be strong opposition. Will benefit some and impact others. There is no or little land which is not of value to someone. Isolated homesteads and agricultural land likely to be impacted.	
Sustainability	✗
Risk of disputes and vandalism of structures. Negative impact with respect to food security and economic development.	
Cost	✓✗
Cost of structures relatively low, but cost of damages and/or protection to areas affected could be high.	
Environmental Impact	✓✗
Flora and fauna affected in areas inundated. Mostly agricultural land.	
Safety	✓✗
Warning systems and evacuation required. Livestock could be affected.	
Shortlisted for Option Appraisal	✗
No The floodplain is already too developed and areas with lower density settlements are used for agriculture. Level of sophistication required for control not appropriate for this scheme.	

D14 Effective planning and control of development in flood risk areas	
Technical Viability	✓
This is a 'non-structural' intervention and so does not form part of the feasibility and option appraisal process.	
Benefits in Reducing Flood Risk	✓
Considerable benefits	
Community involvement and acceptability	✓✕
Likely to resist. New irrigation scheme planned for flood risk areas will attract further development in the floodplain, leading to greater damages in flood events.	
Sustainability	✓
The planned Lower Nzoia Irrigation Development Project will attract further development in the floodplain, leading to greater damages in flood events. It is not possible to eliminate flood risk by improving the defences. The risks can be reduced, for a time, until further intervention is needed. There will always be the risk of bigger flood than the design standard of protection. The question is when will it come and how big will it be.	
Cost	✓
N/A	
Environmental Impact	✓
No adverse impacts.	
Safety	✓
Positive	
Shortlisted for Option Appraisal	**N/A**
Planning and development in the floodplain must be controlled, particularly in light of the Lower Nzoia Irrigation Development Project which has potential to attract significant investment and further development in the floodplain.	

D15	Provide new drainage outlet for northern floodplain area

Shortlisted for Option Appraisal	✓

Yes
The feasibility assessment of this intervention is covered in D3. Both D3 and D15 should be considered in parallel and coordination with NIB will be required as they will lead on design of drainage in the floodplain as part of the Lower Nzoia Irrigation development Project.

D15 more specifically considers the outlet structure to be provided, which will be designed under this scheme, but clearly coordination with NIB is required here also.

Tertiary interventions

B4 Provide special crossing points with hard surfaces to stop erosion of crest	
Technical Viability	✓
Crossing points are required for livestock to gain access to the fertile grazing areas and watering holes on riverside of the embankment. Frequent trampling can degrade the surface of the embankment, lowering the crest and damaging the vegetation and soils on the slopes. Provision of a hard surface will reduce damage and maintain the integrity of the flood defence. The embankment slopes at 1 in 2.5 are considered a suitable gradient for ramp access by livestock (typically 1 in 2 is the maximum adopted for road crossings). Ramps in the same plane as the embankment slopes will help to avoid erosion by fast flowing water when the river is in flood. A durable surface is required which will require regular inspection and maintenance to ensure the ramps remain in good condition. Livestock crossing points currently appear to be at approximately 500m intervals and it is assumed a similar interval will be maintained. Existing crossing point have been identified, for example at Mudunyi, Ikhula and Mumbira (all on the north side) usually where drinking water for cattle is readily accessible. It will be important to locate crossing points in consultation with the community to ensure that they are used. Concrete surfacing is typically used for ramps in road construction, lightly reinforced with a non slip finish. Concrete has been assumed at this stage for costing purposes. An alternative surfacing would be a hard-wearing stone pitching with stones tightly wedged and voids filled with a sand & cement mortar.	
Benefits in Reducing Flood Risk	✓
Limited, but improved durability of the flood defences.	
Community involvement and acceptability	✓
Community support, but location will need to be agreed through consultations to ensure sited to maximise use. Education required to ensure used.	
Sustainability	✓
No issues	
Cost	✓
Comparatively low.	
Environmental Impact	✓
Negligible	
Safety	✓
Gradient of ramp (1:2.5) designed for safe access and roughened finish to minimise risk of slips.	
Shortlisted for Option Appraisal	✓
Yes. Good practice. Cost effective design to ensure implementation not prohibited by cost.	

B5 Protect embankment from erosion during flood/overtopping using bioengineering measures

Technical Viability	✓
Slopes will need to be protected to ensure that soil is not eroded by water from the following sources: • Rainfall (direct to the slopes or run off from the crest) • Overtopping (in the event that river water levels reach the embankment design level). Erosion of the slopes is the most likely cause of (progressive) failure of the embankment in flood conditions. Measures for slope protection can include hard surfacing, geotextiles or vegetative cover. In this case the latter is considered more appropriate and cost effective due to the significant surface area involved and the natural setting. Following compaction of the main engineering fill, the slopes of the embankment will be trimmed and a layer of topsoil spread (around 150mm thick) and grass seed sown. The timing of topsoiling and seeding will need to be considered such that the growth has established prior to the flood season. The seed will be selected appropriate to the local climate and soils to provide a dense, even coverage extending to the toe. Shrubs will need to be controlled (preferably eliminated) to prevent shade and root damage. The vegetation will need to be maintained, although it is likely that animals will graze the slopes. Vegetation near the embankments will need to be controlled so that bioengineering measures do not suffer from degradation caused by shading from sunlight.	
Benefits in Reducing Flood Risk	✓
Important for durability of the flood defences.	
Community involvement and acceptability	✓
Strong support	
Sustainability	✓
Regular maintenance required, preferably involving community.	
Cost	✓
Comparatively low.	
Environmental Impact	✓
Positive, as long as suitable indigenous species used.	
Safety	✓
No issues	
Shortlisted for Option Appraisal	✓
Yes. Best practice.	

B6	Provide roads along embankment tops

Technical Viability	✓
The embankment crest is not generally used as a roadway by vehicles, other than those used for maintenance and repair of the embankment, although there are trucks which use the embankment to collect sand harvested in the river. In general, roads on the landward side of the embankment provide access to settlements where required. It would, however, be advantageous to apply a hardwearing surface dressing to the crest of the embankment which would seal the surface and protect the crest. A non-bituminous gravel surfacing similar to material specified for road construction would be acceptable, such as 'murram', an iron rich material with clay content to bind the gravel and hardened by the sun. This surfacing is robust in dry weather, although can degrade if trafficked when wet. Considering the low volumes of traffic this would be a suitable surfacing. As with most structures and materials, regular maintenance will be required. It is not desirable to attract more traffic to the embankments as this could be detrimental, therefore if it may be necessary to install measures to restrict access such as vehicle barriers at entry points.	
Benefits in Reducing Flood Risk	✓
Will improve durability of the flood defences.	
Community involvement and acceptability	✓
Supportive	
Sustainability	✓
Regular maintenance, preferably involving community.	
Cost	✓
Comparatively low	
Environmental Impact	✓
No issues	
Safety	✓
No issues	
Shortlisted for Option Appraisal	✓
Yes. Gravel road surfacing to be incorporated to B1/B2 design. Provide some passing places but limited. Not to be adopted as a public road.	

6. Option Appraisal

The following sections describe the process of developing and appraising the remaining short listed interventions. Works that have the most significant impact on flood risk (Interventions B1, B2, C4 and C5) are considered first, followed by other supplementary works.

6.1 Appraisal of Embankment Improvements B1 & B2

Outline designs have been prepared for both intervention B1 (New higher and stronger embankments) and B2 (Raise and Strengthen Existing Embankments) and cost estimates have been generated for each (see Appendix B & E for details).

The form of construction would be similar for B1 and B2, that is:

- The crest height raised to the level required for the agreed standard of protection
- Stability improved with shoulder slope gradients around 1 in 2.5
- A cut off or seepage berm constructed to control under seepage.

Intervention B2 assumes that the existing embankment will be left in place and the new material placed on top with appropriate 'benching' for placement of new fill. The principal cost saving associated with B2 compared to B1 is the reduction in requirements for imported fill and, with the significant quantities involved, the savings of B2 over B1 are considerable. Design and construction to implement B2 works will include provisions and controls to ensure that this intervention provides an equivalent standard of protection to B1, and should not be seen as a compromise on flood risk, safety or reliability.

The geotechnical investigations undertaken during Phase I indicate that the existing embankment material is generally suitable in type for continued use and is relatively well compacted, with the exception of the upstream end of the southern dyke (Chainage 0 to 1.5km), which may have been constructed by hand. If improvements are to be made to existing embankments further site investigation is recommended, to include sampling and testing of the existing material, to ensure that it is well compacted and suitable for incorporating into the new embankment structure. This further investigation can be incorporated into the early stages of the construction phase. A contingency sum will need to be allowed for in the construction budget for dealing with any unforeseen ground conditions which may involve additional excavation and filling.

Where a berm is required on the landward side of the embankment to control seepage this may be of a significant width and would therefore impact on homesteads and communities located behind the embankment. Relocation may be required to allow this, although the use of a cut off wall / trench in densely populated areas may help to reduce this.

Cost estimates for B1 and B2 are shown in Appendix E with summaries in the tables below. Appendix E includes a list of assumptions made for the cost estimates. The costs presented below do not include for land purchase, resettlement or other costs associated with impacts on the population living close behind the embankments or any of the other interventions shortlisted for option appraisal. Some of these other interventions have the potential to reduce the earthworks quantities required (through reduction in water levels) from those presented here. The costs in Tables 8 and 9 include the following:

- Bulk earthworks (including site clearance, excavating and filling)
- An allowance of 20% for other measured items (surfacing, drainage, slope protection etc)
- An allowance of 20% for general items and preliminaries
- A further 10% has been allowed for contingencies for B1 and 15% for B2 to allow for the increased risk that some existing embankment fill material may be found to be unsuitable.

The tables show that the cost of B2 offers a saving over B1 of around 20 to 30% of the construction costs, dependant on the height of raising adopted. These estimates are based on the 500 cumec and 1000 cumec flood flows.

Table 8 Indicative Cost Comparison of B1 / B2 for a 500 Cumec Flood Flow

Costs in KES M	B1 New higher and stronger embankments	B2 Raise and strengthen existing embankments
Earthworks Base Cost	2,510	1,460
Other Measured Items (add 20% to Base Cost)	502	292
Preliminaries and General Items (add 20% to Base Cost)	602	350
Contingencies 10% (B1) and 15% (B2)	311	272
Total Cost	3,920	2,370
Cost per km (approx)	112	68

Table 9 Indicative Cost comparison of B1 / B2 for a 1000 Cumec Flood Flow

Costs in KES M	B1 New higher and stronger embankments	B2 Raise and strengthen existing embankments
Earthworks Base Cost	4,020	2,970
Other Measured Items (add 20% to Base Cost)	804	594
Preliminaries and General Items (add 20% to Base Cost)	965	713
Contingencies (add 10%) 10% (B1) and 15% (B2)	498	552
Total Cost	6,290	4,830
Cost per km (approx)	180	139

Information gained from site visits and discussions with representatives of WKCDD&FPM and NWC&PC have indicated that for some locations a newly constructed embankment with a seepage berm (B1) would be preferable to B2 due to concerns over the integrity of the existing dyke and its performance during flooding. In some of these locations there would also be benefit in setting back the new works from the existing dyke alignment where the there is an erosion risk due to the close proximity of the channel. The locations where intervention B1 is recommended are:

South embankment (total 4.4 km)

- Buyuku Ch 3 to 3.5km (0.5km)
- Burungasi Ch 8 to 8.400 (0.4km)
- Makhoma Ch 9.9 to 10.9km (1km)
- Galalani (Ch 12.25km to 13.25km (1km)
- Khayinga to Rugunga Ch 14 to 15.4km (1.4km)

North embankment (total 0.7km)

- Sibanze Ch11.2 to 11.4km (0.2km)
- Sigiri Ch12 to 12.5km (0.5km)

Based on visual inspection and results of geotechnical investigations, intervention B2 with a seepage berm or cut off provided is suitable for the strengthening or raising of the remainder of the embankments. A combination of B1 and B2 (as described above) is therefore considered to be the most cost effective way of improving the embankments and, as Option 1 is adopted as a baseline for the consideration of subsequent options. The proposed locations for B1 and B2 in a combined arrangement are shown in Figure 6.

6.2 Appraisal of River Channel Improvements C4 & C5

6.2.1 Combination of Interventions into Options for Appraisal

As described in the sections above, Option 1, a combination of interventions B1 and B2 is recommended as the baseline case for the appraisal of other interventions.

Based on results from the hydraulic model, interventions C4 (Remove dyke constrictions) and C5 (Enlarged culverts at Sigiri) show good potential for reducing water levels, hence reducing the embankment raising needed to achieve an agreed standard of protection. These interventions have therefore been combined with B1/B2 into options for appraisal, including some further division into sub options as outlined below.

The impact on infrastructure and communities of the full implementation of intervention C4 (Remove dyke constrictions) could be considerable particularly for the proposed realignments at Rwambwa and Magombe – see Appendix C (Feasibility Assessment) and Figure 9. Realignment of embankments would also impact on settlements at Ikhula and Busagwa where a number of homesteads are situated along the route of the proposed dyke realignment. Rugunga is the only location of a proposed C4 dyke realignment where impact on settlements should be minimal. Intervention C4 has been split into sub options so that the cost and relative benefit of individual elements can be assessed.

The C4 sub options are described in Table 10 below, showing combinations with C5 to form options for further modelling and appraisal. Intervention C5 comprises providing enlarged culverts through the access embankment at Sigiri, and C5a comprises the complete removal of the embankment at this location.

Table 10 Combination of Interventions into Options for Appraisal[1]

		Interventions Modelled at Feasibility Stage			Combinations of Interventions Modelled for Option Appraisal			
Intervention /Option No.		**2**	**3**	**4**	**5**	**6**	**7**	**8**
Option 1	B1/B2 Embankment Improvements	✓	✓	✓	✓	✓	✓	✓
C4	Remove Dyke Constrictions: Dyke realignment at • Rwambwa (south) • Magombe (south) • Busagwa (south) • Rugunga (south) • Ikhula (north)	✓						✓
C4a	Dyke realignment at • Busagwa (south) • Rugunga (south) • Ikhula (north)				✓		✓	
C4b	Dyke realignment at • Busagwa (south) • Rugunga (south)					✓		
C5	Sigiri culverts enlarged (8 x 16m^2)		✓				✓	
C5a	Sigiri embankment removed			✓				✓

[1] Table 10 is read as follows (for example): Option 2 comprises B1/B1 embankment improvements combined with C4 dyke realignments at Rwambwa, Magombe, Busagwa, Rugunga and Ikhula. Other options read similarly.

6.2.2 Assessment of Hydraulic Benefit and Cost

The hydraulic model has been used to investigate the potential benefits achieved by combining Option 1 with other interventions as described in Table 10 above.

The potential benefit for each combined option (Options 2 to 8) has been assessed in terms of reductions in water levels when compared to the baseline case (Option 1). These water level reductions have the effect of reducing the required design height of the embankments (for the agreed design flood flow), reducing earthworks volumes and potentially giving construction cost savings. The construction costs of implementing Options 2 to 8 have been considered, allowing an overall assessment of the cost effectiveness of the options to be made. The results of these assessments are shown in Tables 11 and 12.

Cost is only one of the evaluation criteria used to appraise the options. The feasibility assessment (Section 5) was based on a range of evaluation criteria which are considered together in the overall appraisal of the options.

Table 11 Modelling Outputs and Cost Appraisal of Options 1-8 for a 500 cumec Flow1

Option No.	2	3	4	5	6	7	8
	Maximum Reduction in water level (in m) compared to Option 1						
North Dyke	0.17	0.25	0.36	0.12	0.08	0.28	0.41
South Dyke	0.20	0.31	0.66	0.13	0.12	0.35	0.74
	Volume Reduction (m^3)						
Total Reduction in Volume of Earthwork compared Option 1 (m^3)	59,283	29,522	40,549	46,651	43,049	57,081	100,723
	Indicative Costs (in KES Million)						
Indicative Embankment Cost Reduction[2] Rate 1320 KES/m^3	78	39	54	62	57	75	133
Indicative Cost of implementing the option[3]	117	92	-	60	30	152	117
Net Cost impact vs Option 1 [4] (Brackets denotes saving)	39	53	(54)	(1)	(27)	77	(16)

[1]Table 11 compares the options for the 500 cumec flow in terms of the benefits in reducing flood risk (maximum water level reduction) compared to the baseline case Option 1;
[2] The estimated cost reduction that would arise (due to lower embankment design level);

[3] The additional cost of implementing the intervention. ; [4] The summation of these costs is the net cost of implementing the option.

Table 12 Modelling Outputs and Cost Appraisal of Options 1-8 for a 1000 cumec Flow

Option No.	2	3	4	5	6	7	8
	Maximum Reduction in water level (in m) compared to Option 1						
North Dyke	0.27	0.16	0.31	0.20	0.18	0.25	0.45
South Dyke	0.38	0.20	0.54	0.22	0.22	0.29	0.71
	Volume Reduction (m^3)						
Total Reduction in Volume of Earthwork compared Option 1 (m^3)	153,260	33,212	50,801	126,891	113,355	104,814	208,659
	Indicative Costs (in KES Million)						
Indicative Embankment Cost Reduction [2] Rate1320 KES/m^3	202	44	67	167	150	138	275
Indicative Cost of implementing the option[3]	117	92	-	60	30	152	117
Net Cost impact vs Option 1[4] (Brackets denotes saving)	(85)	48	(67)	(110)	(120)	13	(160)

[1]Table 12 compares the options for the 500 cumec flow in terms of the benefits in reducing flood risk (maximum water level reduction) compared to the baseline case Option 1;
[2] The estimated cost reduction that would arise (due to lower embankment design level);

[3] The additional cost of implementing the intervention.

[4] The summation of these costs is the net cost of implementing the option.

Notes on costs:

- The costs reported in Table 11 and 12 are indicative only, for the purposes of option appraisal
- Costs are not 'fully inclusive' – they include the principal measured quantities (e.g. earthworks excavation, concrete works) but do not include for general items, preliminaries or contingencies, which would generally be assumed to be a percentage of the base construction cost
- Costs do not include for land purchase, resettlement or other costs associated with impacts on 3rd party infrastructure relocation
- In calculating the construction costs for implementing dyke re-construction on a new alignment, the costs for new dyke construction were used (B1) with the cost of B2 deducted (assuming the dyke would have been improved to B2 standard if the intervention was not implemented). This gave a net cost for implementing options including elements of intervention C4 over and above what would be the cost for Option1
- For Options including intervention C5a a nil cost of implementation was assumed as removing the road embankment at Sigiri would provide material for dyke reconstruction
- Other cost assumptions are detailed in Appendix E.

6.2.3 Assessment of Results

Option 1 B1 & B2 Embankment Improvements

Option 1, a combination of Interventions B1 and B2, provides the most cost effective way of making significant improvements to the reliability of the flood defences by raising the crest level, improving stability and providing a cut off or seepage berm to reduce the hydraulic gradient during flood conditions.

The designs for B1 and B2 will provide an equivalent standard of protection and further testing of the existing embankment material during construction will help to identify any weak spots that need to be replaced with new compacted fill. B1 designs will comprise a new embankment to a raised crest level and slope no greater than 1 in 2.5. For B2 the crest levels will be raised and the slopes made less steep (to the same design standard as B1) with the addition of new compacted material.

Currently it is envisaged that for the majority of the northern dyke, the existing structure will be retained and improved (B2), as the work undertaken for this FMP shows that improving the existing embankments is the most cost effective way of providing a reliable flood defence structure. A localised area at Sibanze will be replaced with a new structure (B1), which has been identified as vulnerable to erosion and so a set back of the alignment is proposed. In addition a section of new embankment is assumed at Sigiri where it is anticipated new drainage structures will be constructed.

For the southern dyke, it is proposed that around 80% of the existing structure is retained and improved (B2) and the remainder replaced with a new embankment. Again, many of the proposed locations for B1 works also provide opportunity to set back and protect from erosion.

These estimates of the extent of sections of new (B1) and improved (B2) embankments above are based on information available at this stage and have been used for derivation of cost estimates for Option 1. Further testing carried out at the start of construction will confirm areas requiring B1 intervention. A contingency sum will be included in the preferred arrangement cost estimate for additional areas requiring new embankment construction.

The new/improved dykes are likely to require measures to control under-seepage, which may take the form of landward berms. These could extend for some distance from the dyke itself and require the population living within this footprint to be relocated. It may be possible to reduce this

impact through the use of sheet piling or a cut off trench to control seepage, although this will be more costly and therefore need to be used only in more densely populated areas. The cost for a sheet pile cut off is given in Section 7.4 as an alternative to the seepage berm.

Option 2

Option 2 combines the dyke improvements identified in Option 1, with the realignment of the dykes at 4 locations on the south side and one location on the north side, to remove constrictions between the dykes which act as 'pinch points' during flood conditions. The proposed locations for these realignments are at:

- Rwambwa (south)
- Magombe (south)
- Busagwa (south)
- Rugunga (south)
- Ikhula (north).

Hydraulic modelling has indicated that water levels could be reduced by up to 0.20m for the 500 cumec flood and 0.38m for the 1000 cumec flood if all of these realignments are undertaken, which would allow embankment crest levels to be lowered in those areas benefiting from a reduction in water levels.

This provides savings by reducing embankment fill quantities, and these savings are proportionally more significant for the larger flood flow of 1000 cumec, as the embankment height (and cross section) is larger. For the 1000 cumec flow, the saving in fill material is calculated to be in excess of 150,000 cubic metres, equating to around KES 200 Million.

When additional costs of construction are taken into account (for a new dyke B1 compared to B2 option) there is still a considerable saving (over KES 80 Million). However, it must be emphasised that these implementation costs do not include for land purchase, resettlement or other costs associated with impacts on 3rd party infrastructure relocation. In the case of Option 2 these are likely to be considerable due to the infrastructure at Rwambwa (road, power, settlement and police station) and also the large settlement at Magombe. Some homesteads at Busagwa and Ikula would also need relocation.

It is considered that these 3rd party costs would exceed the potential saving to be made by reductions in fill quantities. In addition the negative impacts of resettlement are likely to be considerable.

In summary, whilst Option 2 offers an appreciable benefit by reducing direct construction costs, the additional costs associated with infrastructure relocation, and the additional negative impact of resettlement, will be significant.

Option 3

Option 3 combines the dyke improvements identified in Option1, with new enlarged culverts at the Sigiri crossing. The existing culverts are small diameter (0.9m) which restricts the passage of flood waters and the upstream area drains slowly after the peak flood has passed.

By providing considerably larger culverts, modelling has indicated that water levels could be reduced by up to 0.31m for the 500 cumec flood, with less benefit (up to 0.2m) for the 1000 cumec flood as the embankment is significantly submerged. As described for Option 2, this would allow embankment crest levels to be lowered in those areas benefiting from a reduction in water levels.

Comparing the savings in embankment fill (due to lower crest heights) with the cost of constructing large culverts, the net cost of implementing Option 3 is estimated to be in the region of KES 50 Million.

The culverts will need replacement in the near future, as the condition of the existing culverts is poor (having suffered from significant damage and erosion during floods). Considering the

objective of improving drainage in this area, and the strategic importance of the crossing, it is recommended that during the detailed design stage, the culvert design is optimised to reduce the net costs of implementation, whilst providing a durable design and retaining some flood risk benefits. For deriving the cost estimates, it was assumed these enlarged culverts comprised 8 twin box culverts each sized at 4m wide and 2m high (total cross sectional area of 8 multiplied by $16m^2$), such that reinforced concrete cast in situ was the assumed construction technique. Costs could be reduced by specifying a precast culvert section, although these will be considerably smaller and hence the benefits would be reduced.

In summary, the benefits to the community of improved culverts at both this location is strong, and the design can be optimised during Phase III to minimise implementation costs.

Option 4

Option 4 combines the dyke improvements identified in Option1, with a complete removal of the road embankment to the Sigiri crossing, allowing the maximum benefit that could result from removing the constriction caused by the embankment to be achieved.

Modelling results indicate that water levels could be reduced by up to 0.66m for the 500 cumec flood, with less benefit (up to 0.52m) for the 1000 cumec flood, with the greatest reductions in water level at the southern dyke. These water level reductions would lead to net savings of KES 54 Million for the 500 cumec flood flow, rising to KES 67 Million for the 1000 cumec. The construction cost of implementing this option has been assumed at nil (or cost neutral) as whilst there is an excavation cost, this would be offset by reuse of the embankment material for the dyke construction, reducing quantities of imported fill. Removing the embankment would also eliminate the maintenance required to the road and the culverts.

Since the potential savings are significant, this proposal was discussed with the community (at the October 2012 workshop) to assess the impact. This is an important crossing point for the community and is used when the river is in flood. The community gave a clear response that the impacts of removing the embankment would not be acceptable as would limit accessibility to and from Port Victoria.

Option 5

Option 5 combines the dyke improvements identified in Option1 with the realignment of the dykes at 3 locations on the south side and one location on the north side, to remove constrictions which act as ‘pinch points’ during flood conditions. The proposed locations for these realignments are at:

- Busagwa (south)
- Rugunga (south)
- Ikhula (north).

This differs from Option 2 in that the proposed realignments at Rwambwa and Magombe have been removed, in recognition of the particular difficulty of implementing these works as there is a high risk that the Rwambwa realignment is not viable.

The modelling showed that water levels could be reduced by up to 0.13m for the 500 cumec flood and 0.22m for the 1000 cumec flood, indicating that approximately one third of the benefit has been lost (compared to Option 2) by removing the Rwambwa and Magombe realignments.

Option 5 provides net savings, equating to around KES 1 Million for the 500 cumec flood flow and KES 110 Million for the 1000 cumec flood flow when construction savings and implementation costs are both taken into account. As for Option 2, it must be emphasised that the implementation costs do not include for land purchase, resettlement or other costs associated with impacts on 3rd party infrastructure relocation. In the case of Option 5, there are likely to be resettlement costs at Busagwa, and Ikhula, in particular.

The resettlement impacts (human and financial costs) would again be a concern and, as such, caution is exercised when considering take this option forward. However, these results in comparison with Option 2 do show that implementing the realignments at Rwambwa and

Magombe provide no benefit for a 500 cumec scheme and only a small net cost reduction for a 1000 cumec scheme. This is unlikely to offset the significant impact on communities and infrastructure associated with these works (see description of Option 2 above).

In summary, whilst Option 5 offers some benefit by reducing direct construction costs, the additional costs associated with relocation of homesteads, and the negative impact of resettlement, must be considered. Realignments at Rwambwa and Magombe are not cost effective and should not form part of the preferred option.

Option 6

Option 6 combines the road embankment improvements identified in Option 1, with the realignment of the dykes at one location on the south side and one location on the north side, to remove constrictions between the dykes which act as 'pinch points' during flood conditions. The proposed locations for these realignments are at:

- Busagwa (south)
- Rugunga (south).

This differs from Option 5 in that the proposed realignment at Ikhula has been removed, to allow the assessment of the relative benefit which the Ikhula realignment provides.

The modelling showed very similar results to Option 5 with water levels reduced by up to 0.12m for the 500 cumec flood and 0.22m for the 1000 cumec flood, but with different net cost savings (KES 27 Million for the 500 cumec flow) as the implementation costs are significantly lower without the 1km realignment cost at Ikhula. For the 1000 cumec flow a KES 120 Million saving has been calculated.

The modelling indicates that without the realignments at Rwambwa and Magombe, the Ikhula alignment provides little benefit and therefore Option 5 does not present good value.

For option 6 the resettlement impacts (financial and human) would need to be taken into account, particularly for Busagwa, where a number of homesteads and fields would be affected. The proposed realignment at Rugunga will not affect settlements and this is also a location where the existing embankment is susceptible to bank erosion. It is worthwhile taking forward the realignment at Rugunga either in combination with Busagwa or as a standalone option.

Option 7

Option 7 combines Options 3 and 5, that is enlarged culverts at Sigiri with dyke realignments at

- Ikhula (north)
- Busagwa (south)
- Rugunga (south).

The modelling indicated that water levels could be reduced by up to 0.35m for the 500 cumec flood and 0.29m for the 1000 cumec flood. These water level reductions would lead to net cost increase of KES 76 Million for the 500 cumec flood flow, but returning a net saving KES 26 Million for the 1000 cumec flood flow as the cost of the culverts is offset by the savings in earthworks quantities. The resettlement impacts (human and financial costs) would again be a concern and, as such, caution is exercised when considering take this option forward.

Option 8

Option 8 combines Options 2 and 4, that is, removal of the road embankment at Sigiri with dyke realignments at:

- Rwambwa (south)
- Magombe (south)
- Busagwa (south)

- Rugunga (south)
- Ikhula (north).

This option demonstrates the maximum benefits that can be derived from the combinations of C4 dyke realignments and C5 embankment removal.

The modelling indicated that water levels could be reduced by up to 0.740m for the 500 cumec flood and 0.71m for the 1000 cumec flood. These water level reductions would lead to net cost saving of KES 16 Million for the 500 cumec flood flow, rising to KES 160 Million for the 1000 cumec flood flow.

The saving of KES 160M represents around a 3% saving on the overall construction costs for the 1000 cumec flood flow. However as noted above, it is emphasised that the cost and human impact of relocation of communities and infrastructure has not been quantified.

Summary

The results of the assessment above may be summarised as follows:

- Realignment of dykes to remove constrictions can provide water level reductions of up to 0.38m for the 1000 cumec design flow, with greater benefits when combined with improved conveyance through the floodplain at Sigiri (larger culverts or removal of road embankment)
- However, the benefit provided by realignments is generally unlikely to be sufficient to offset 3rd party and infrastructure costs where these are affected. A realignment of the southern dyke at Rugunga has lesser impact on settlements (farmland only) and therefore worth taking forward into the preferred arrangement
- Culvert improvement does not provide sufficient benefit to offset cost, but given that the existing culverts need to be replaced it is worth looking at what cost effective improvements can be made
- Removal of the embankment at Sigiri provides good benefits in terms of reduction in water levels and is effectively cost neutral as embankment material can be reused. However, the impact on communities is not considered acceptable as this would limit accessibility to the river crossing to / from Port Victoria.
- The maximum benefit derived from the options modelled provides a saving of approximately 3% on overall construction costs (comparing to the baseline case B1/ B2). However, this does not take into account the potential impacts on communities.

6.3 Appraisal of Other Shortlisted Interventions

6.3.1 Benefits and Costs

Table 7 (Section 5.4) identifies the interventions which were shortlisted for option appraisal.

This section summarises the evaluation of other interventions which do not directly contribute to flood risk reduction in the levee section (and therefore were not subject to further hydraulic modelling as part of the option appraisal stage), but provide other benefits which contribute to the overall effectiveness of the flood management plan for the Lower Nzoia. The appraisal of benefits associated with these options is described qualitatively, as reported in full in the Feasibility Assessment section of this report (Section 5 and Appendix C).

Costs estimates have been prepared and are reported in Table 13, below.

Table 13 Appraisal of Other Shortlisted Interventions

		Summary of Benefits	Costs (KES M)
Secondary Interventions			
B10	Extend flood embankments to prevent backflow around ends (north side alignment - from end north dyke tying to higher ground, others not shortlisted)	Prevents backflow flooding to agricultural land west of Narera. Modelling has confirmed no adverse impact on water levels upstream.	**123**
D3	Improve drainage in floodplain areas so that floods become less deep and drain away faster	Faster recovery after floods.	Not costed Recommend drainage solution to be led by NIB
D15	Provide new drainage outlets for northern floodplain area	Faster recovery after floods.	**48**
Tertiary Interventions			
B4	Provide special crossing points with hard surfaces to stop erosion of crest.	Maintains integrity of flood defence.	**40** (assumes 1km spacing)
B5	Protect embankment from erosion during flood/overtopping using bioengineering measures.	Maintains integrity of flood defence.	Included in B1/B2 Baseline Cost
B6	Provide roads along embankment tops (surfacing only, not a public road)	Maintains integrity of flood defence.	**58**
B7	Keep embankments free of trees to avoid long-term problems and protect against excess grazing by livestock	Maintains integrity of flood defence	Maintenance cost

6.3.2 Summary and Recommendation

Implementation of B10 will primarily benefit agricultural land (approximately 100ha) and the value of this economically to the community should be considered, alongside the high level objectives for growth in food production and food security in this area. Our understanding is that the proposed irrigation scheme for the Lower Nzoia does not extend to this downstream area and that there is potential for the area to be Gazetted along with the rest of the marshy delta area on environmental grounds. Given the low economic value of the farming currently taking place in this area it is recommended that B10 is not implemented at the current time. In the event that the area is not Gazetted and a more formal arrangement for farming the land to the west of Narera is put in place, this should consider construction of an embankment to protect against backflow from the river during periods of high flow.

The proposed Lower Nzoia Irrigation Development Project will benefit from, and have a significant impact on, the drainage of the floodplain on both sides of the River Nzoia. It is understood that significant new drainage infrastructure will be provided as part of the project. It is therefore recommended that interventions associated with improvements to the drainage of the floodplain (D3) are led by NIB who are best placed to coordinate the requirements of the irrigation scheme and drainage. The design of outfalls structure through the embankment near Sigiri can form part of the flood defence works, although coordination with NIB is required for design criteria.

The other (tertiary) interventions listed in Table 13 are best practice measures for maintaining the integrity of the flood defences and should be taken forward as part of any combined option. The implementation costs for B4 can be reduced through use of locally won materials (in lieu of a concrete surface) and by targeting the spacing of crossings at strategic points. Currently crossings are assumed to be positioned every 1km along the dykes and the possibility to reduce this spacing will be investigated during detailed design.

6.4 Option Appraisal Summary and Recommendations

6.4.1 Embankment Improvements B1 & B2 (Option 1)

Option 1, a combination of intervention B1 (New higher and stronger embankments) and B2 (Raise and Strengthen Existing Embankments) provides the most cost effective way of making significant improvements to the reliability of the flood defences by raising the crest level, improving stability and providing a seepage berm or cut off to reduce the hydraulic gradient during flood conditions. Where a berm is used it may be necessary to resettle population living near to the landward face of the existing dyke.

Option 1 has the potential to provide savings of approximately 38% (for the 500 cumec flow) when compared to a B1-only option. The potential saving for the 1000 cumec flood flow are reduced to around 21% as the amount of material available for reuse becomes a smaller proportion of that needed for the higher embankments.

Currently it is envisaged that for the majority (90%) of the northern dyke, the existing structure will be retained and improved (B2) and localised areas at Sibanze and Sigiri will be replaced with a new (B1) embankment.

For the southern dyke, it is envisaged that around 80% of the existing structure would be retained and improved (B2) and the remainder replaced with a new embankment. The exact locations for improvements and/or replacements will be confirmed at the start of the construction phase following further geotechnical investigations .

Several of the proposed locations for B1 works provide opportunity to set back the alignment to provide greater protection from erosion.

The basis of design for both B1 and B2 will aim to provide an equivalent standard of construction and level of protection for both new and improvement works.

It is recommended that all of the tertiary embankment improvements shortlisted in Table 13 are taken forward as part of the preferred arrangement.

6.4.2 River Channel Improvements C4 & C5 (Options 2 to 8)

The modelling showed worthwhile benefits of dyke realignment in terms of reductions in water levels, leading to good savings in imported fill materials and hence costs. However, with settlements established in close proximity to the dykes in most potential realignment locations, the implementation of this intervention is likely to be very difficult.

Based on the results of the assessment presented above, it is recommended that realignment at Ruguna is taken forward as the impact of these works on settlements should be minor and, as this section of dyke has been identified as requiring replacement the additional cost of realignment is relatively small. These works should be combined with new enlarged culverts at Sigiri, although it is recognised the outline design should be optimised (for example using precast culverts) to make this economically viable.

A complete removal of the crossing at Sigiri provides good benefits, but following community consultation on the draft FMP (workshop on 18 October 12) there was strong opposition to removal of the road embankment and new enlarged culverts were preferred.

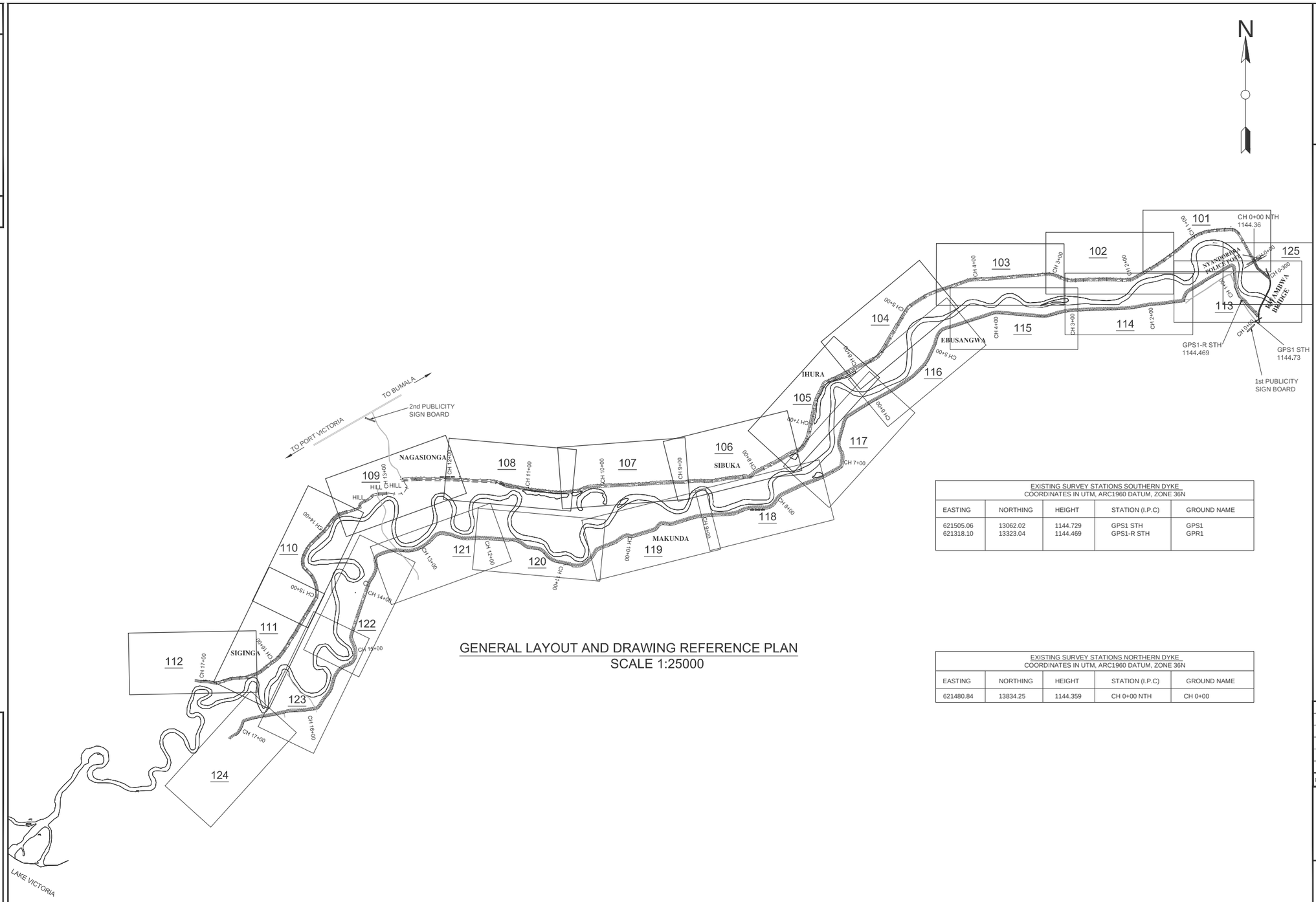
6.4.3 Other interventions

Drainage solutions on the northern floodplain will need to be addressed by NIB as part of the implementation of the proposed Lower Nzoia Irrigation Development Project planned for 2014/2015. The cost of these has not been included in the estimate presented in this report. A

means of conveying water from the floodplain across the line of the north dyke should be provided and the cost of a drainage outlet has been included in the preferred arrangement (see Table 14).

Given the low economic value of the farming currently taking place in this area to the west of Narera it is recommended that intervention B10 is not implemented at the current time. In the event that a more formal arrangement for farming this land is put in place, this should consider construction of an embankment to protect against backflow from the river during periods of high flow.

Appendix D: Drawings for the Proposed Nzoia Flood Protection Works



GENERAL LAYOUT AND DRAWING REFERENCE PLAN
SCALE 1:25000

EXISTING SURVEY STATIONS SOUTHERN DYKE
COORDINATES IN UTM, ARC1960 DATUM, ZONE 36N

EASTING	NORTHING	HEIGHT	STATION (I.P.C)	GROUND NAME
621505.06	13062.02	1144.729	GPS1 STH	GPS1
621318.10	13323.04	1144.469	GPS1-R STH	GPR1

EXISTING SURVEY STATIONS NORTHERN DYKE
COORDINATES IN UTM, ARC1960 DATUM, ZONE 36N

EASTING	NORTHING	HEIGHT	STATION (I.P.C)	GROUND NAME
621480.84	13834.25	1144.359	CH 0+00 NTH	CH 0+00

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NOTES

1. ALL LEVELS AND CHAINAGES IN METRES
2. CONTRACTOR TO UNDERTAKE LEVEL CONTROL SURVEY PRIOR TO COMMENCING WORKS
3. ORIGINAL TOPOGRAPHICAL SURVEY (COORDINATES IN UTM, ARC1960 DATUM, ZONE 36N)TAKEN IN 2009 BY MAP SURVEYS. RE-SURVEYED AND UPDATED IN 2012. LEVELS SHOWN HERE HAVE BEEN REDUCED BY 921mm TO LiDAR DATUM ADOPTED FOR THIS DESIGN.

SURVEY INFORMATION ISSUED TO THE CONTRACTOR IS FOR INFORMATION ONLY. THE CONTRACTOR SHALL NOTE THAT LEVELS PROVIDED AS PART OF THE TOPOGRAPHIC SURVEY INFORMATION ARE TO A DATUM 921mm HIGHER THAN THE SITE DATUM USED FOR THE CONSTRUCTION DRAWIMGS.

Rev	Description	By	Date	Chk'd	Auth
B	ISSUED FOR APPROVAL	FO	02/07/13	HG	JC
A	ISSUED FOR APPROVAL	FO	20/06/13	HG	JC
0	ISSUED FOR COMMENTS	PM	28/03/13	HG	JC

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Title

OVERALL SITE KEY PLAN
AND SURVEY CONTROL STATIONS

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	AS SHOWN	SPO / PM	HG	JC
		Date 22/11/12	Date 28/03/13	Date 28/03/13

Status	Drawing Number	Rev
D	5076826/WA/100	B

Rev B
Status D
Drawing Number 5076826/WA/100
DO NOT SCALE
A1
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File: 5076826-WA-100-A-D4.dwg
Date: Jul 10, 2013 - 4:23pm Plotted by: Fokoth

Rev B | Status D | Drawing Number 5076826/WA/300

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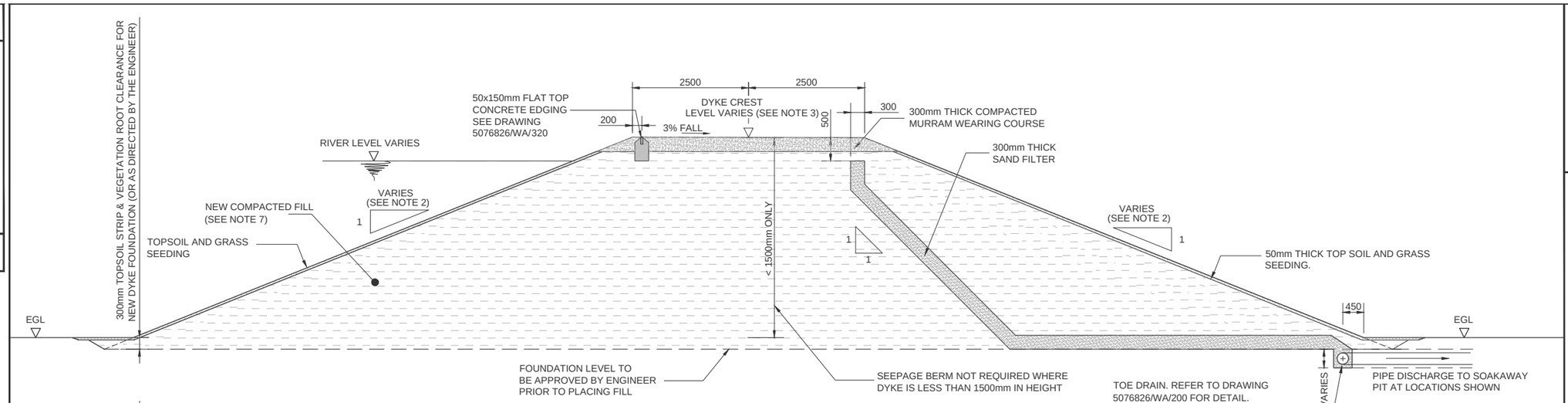
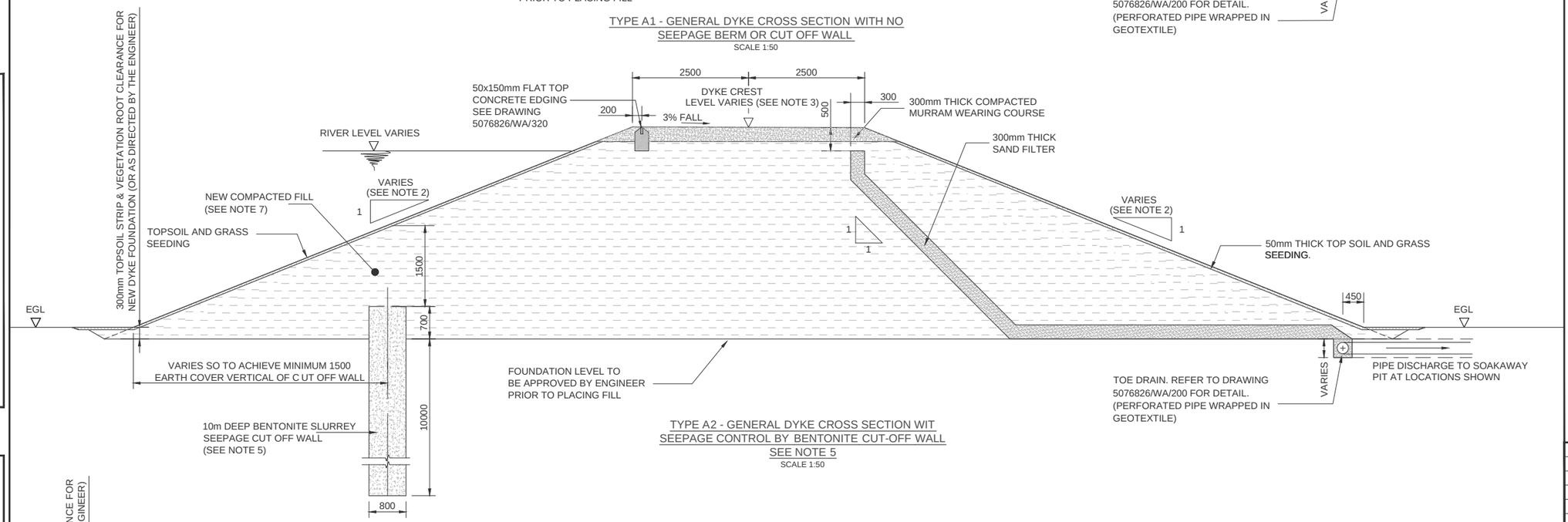
A1



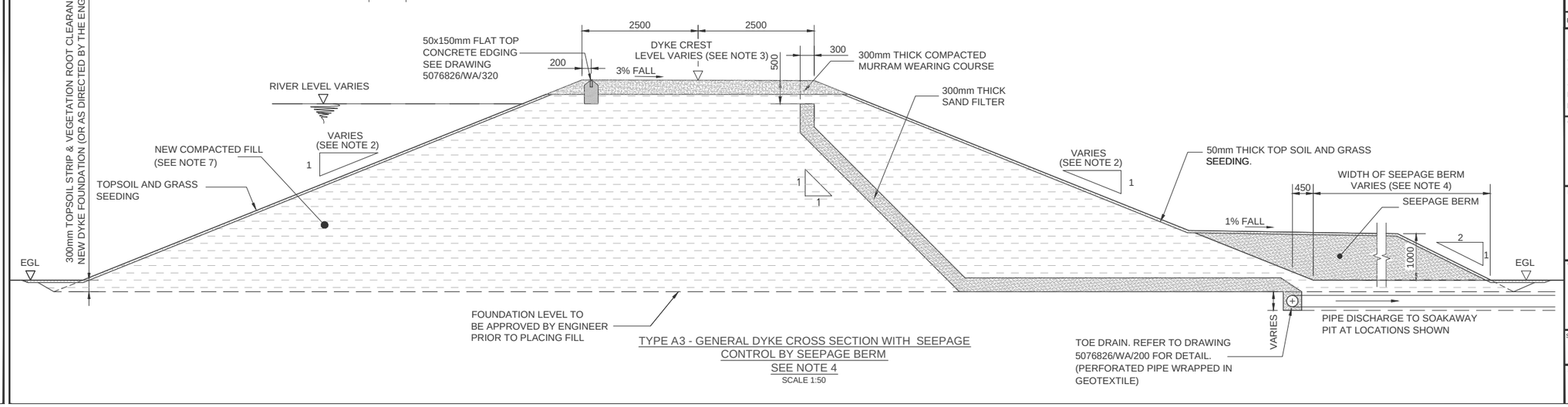
TYPE A1 - GENERAL DYKE CROSS SECTION WITH NO SEEPAGE BERM OR CUT OFF WALL

SCALE 1:50



TYPE A2 - GENERAL DYKE CROSS SECTION WIT SEEPAGE CONTROL BY BENTONITE CUT-OFF WALL SEE NOTE 5

SCALE 1:50



TYPE A3 - GENERAL DYKE CROSS SECTION WITH SEEPAGE CONTROL BY SEEPAGE BERM SEE NOTE 4

SCALE 1:50

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Date: Jul 10, 2013 - 4:24pm Plotted by: Fokoth

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NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE.
2. REFER TO LONG REFERENCE 'D' ON DRAWINGS 5076826/WA/101 TO 125 FOR SLOPE REQUIREMENTS.
3. REFER TO LONG SECTION REFERENCE 'A' ON DRAWINGS 5076826/WA/101 TO 125 FOR NEW DYKE CREST LEVEL. LEVEL GIVEN REFERS TO THE CENTERLINE OF THE DYKE.
4. REFER TO LONG SECTION REFERENCE 'E' ON DRAWINGS 5076826/WA/101 TO 125 FOR LOCATION & MINIMUM WIDTH OF SEEPAGE BERM.
5. REFER TO LONG SECTION REFERENCE 'F' ON DRAWINGS 5076826/WA/101 TO 125 FOR LOCATION OF CUT OFF WALLS.
6. TOE DRAINAGE TO DISCHARGE TO SOAKAWAYS AND, EXISTING NATURAL DRAINAGE CHANNELS/SEASONAL STREAMS AT LOCATIONS TO BE DETERMINED ON SITE.
7. REFER TO SPECIFICATION FOR DYKE FILL MATERIAL

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION:

CONSTRUCTION
1. PUBLIC SAFETY, VILLAGES IN CLOSE PROXIMITY TO THE DYKES AND DYKES USED FOR ACCESS.
2. DEEP EXCAVATIONS, RISK OF COLLAPSE AND FALLING IN.
3. FLOODING, RIVER LEVELS CAN RISE QUICKLY OUT OF BANK. IN EXTREME EVENTS THE DYKES CAN BE BREACHED OR OVER TOPPED.

OPPERATION AND MAINTENANCE
1. PUBLIC SAFETY
2. NEW DYKES WILL NOT GIVE TOTAL PROTECTION FROM FLOODING.

DEMOLITION
1. PUBLIC SAFETY
2. FLOODING

DESIGNERS RISK ASSESSMENT REFERENCE: 5076552/72/DG/22

Rev	Description	By	Date	Ch'k'd	Auth
B	ISSUED FOR APPROVAL	FOO	02/07/13	HG	JC
A	ISSUED FOR APPROVAL	FOO	21/06/13	HG	JC
0	ISSUED FOR COMMENTS	PM	28/03/13	HG	JC

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Title

TYPE A GENERAL
DYKE CROSS SECTION

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
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Status	Drawing Number	Rev
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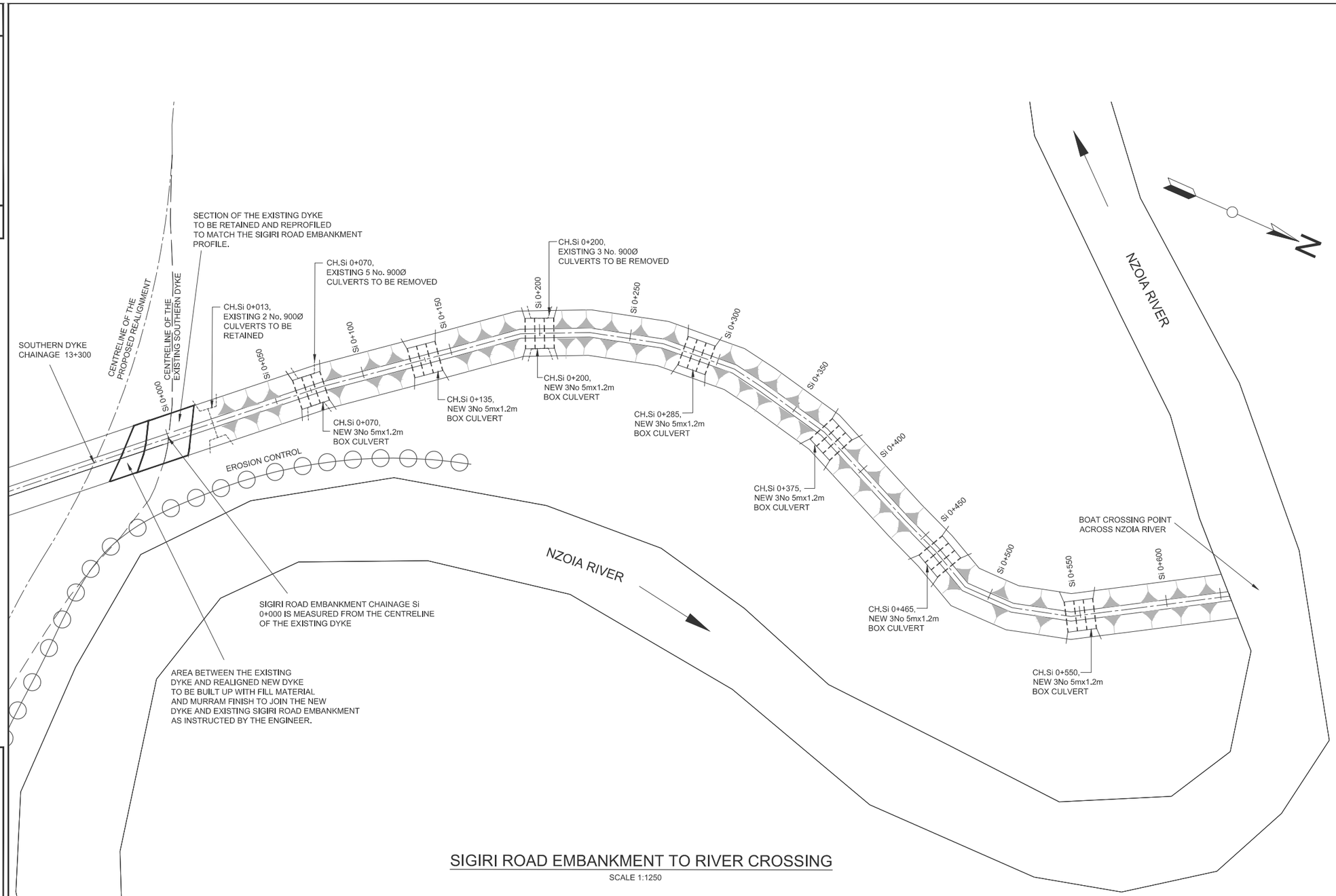

SIGIRI ROAD EMBANKMENT TO RIVER CROSSING

SCALE 1:1250

DO NOT SCALE

A1

0 10 100

Status	Drawing Number	Rev
D	5076826/WA/400	A

File: 5076826-WA-400-D-A.dwg
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NOTES:

1. CHAINAGE IN KILOMETRES
2. REFER TO DRAWING Nos.5076826/WA/401 TO 5076826/WA/403 FOR CULVERT CONSTRUCTION DETAILS
3. CHAINAGE PROVIDED FOR SETTING OUT REFERS TO THE CENTRELINE OF THE NEW CULVERTS
4. ROAD EMBANKMENT CREST LEVELS TO REMAIN THE SAME. CONTRACTOR TO BACKFILL WITH COMPACTED EXCAVATED MATERIAL TO ORIGINAL GROUND LEVEL.
5. SCOUR PROTECTION OMITTED FOR CLARITY, REFER TO DRAWING 5076826/WA/402 FOR DETAILS.

LEGEND

NEW BOX CULVERT, 3No 5mx1.2m CLEAR OPENING

EROSION CONTROL

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION:

CONSTRUCTION
1. PUBLIC SAFETY, VILLAGES IN CLOSE PROXIMITY TO THE DYKES AND CROSSING IS USED FOR ACCESS.
2. FLOODING, RIVER LEVELS CAN RISE QUICKLY OUT OF BANK. IN EXTREME EVENTS THE DYKES CAN BE BREACHED OR OVER TOPPED.

OPPERATION AND MAINTENANCE
1. PUBLIC SAFETY
2. STRUCTURES LOCATED BETWEEN NEW DYKES AND WILL BE LIKELY TO FLOOD.
3. ACCESS TO ENTER STRUCTURES EXPOSED TO FLOOD RISK.

DEMOLITION
1. PUBLIC SAFETY
2. FLOODING

DESIGNERS RISK ASSESSMENT REFERENCE: 5076552/72/DG/22

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A	ISSUED FOR APPROVAL	FOO	21/06/13	HG	JC
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Title
SIGIRI ROAD EMBANKMENT CULVERT SETTING OUT PLAN

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	AS SHOWN	SPO/ PM	HG	JC
		Date 22/11/12	Date 28/03/13	Date 28/03/13