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Small Structures of an Irrigated Area. Case study: Intake Structures in the Setting out Of the Inland Valley of Bingou

Internship report as a partial fulfillment in earning the Higher National Diploma (HND) in Supply of Potable Water and Hydro-Agricultural Facilities

From December 07, 2015 to January 15, 2016

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Year

2015-2016

Dedications

To my late father KAMENI TCHETCHOUM Roger, *my mother* MBIADA JACQUELINE,

my brothers and my sisters.

May this work to testify the depth of my gratitude.

Acknowledgements

I thank the Lord God Almighty for all the blessings and grace that He gives me every day of my life.

I thank Mr. Paul TCHAPMI for the trust he placed in me by agreeing to oversee this work and also accepting me as a trainee in his enterprise. His knowledge and ability to analyze problems and vision that he has, makes him an example for young novices.

My gratitude goes to Mr. NYABEU NKOUNDJA Emeran and Mr. MOUGBARAM Yves Alain for their availability at all times to ensure my training and monitoring of this work, for their modesty and sense of understanding to face my problems, for the rigor they knew how to impose.

I thank the teachers of REDSTS Kumba who guided me in research through education and support. I spare a kind thought for Mr. TAKANG AKO Francis to whom I am very grateful for his availability in making this work be a good one.

To all my friends, I thank you, my brothers and sisters for your love and invaluable support.

To all whose names have not been mentioned here, but who have contributed in one way or the other to the success of this work, receive my sincere gratitude.

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List of Abbreviations

EIC Sarl U: Environnement-Ingénierie-Conseils Sarl U

IOW: Intake Over Water

AON: All Or Nothing

PVC: Polyvinyl Chloride

Dn: Nominal Diameter

th.: Thickness

PFE: Prise au Fil de l'Eau

REDSTS: Rural Equipment Development and Specialization Training School

Abstract

An internship being an obligatory phase in every learning process, I did an internship at EIC Sarl Douala from December 7, 2015 to January 15, 2016 in the setting out of the inland valley of Bingou in the Western region of Cameroon. Thus the theme "Small Structures of an Irrigated Area. Case study: Intake Structures in the Setting out of the Inland Valley of Bingou». This report is focused on the conception, design and graphical representation of intake structures present on the Bingou inland valley without leaving behind the description of these structures.

First of all, I started by presenting the company EIC Sarl U and taken note of the work to be done, established hypothesis following the technical prescriptions and the considerations of the milieu. The conception and design of the intake structures followed calculations taking into considerations the hydraulic features of the intake structures. Then I produced a calculation note of the IOW followed by a graphical representation of these intake structures. After having done the graphical representation using AutoCAD 2014, the calculation note was established following a bill of quantities and specifications. The result obtained is such that the intake structures can satisfy the water needs of the plants which in our particular case is rice. At the end of this work, we proposed some recommendations both to the enterprise and the school.

Keywords:

Design

Intake structure

Intake Over Water (IOW)

Résumé

Le stage étant une phase obligatoire et nécessaire dans tous les processus d'apprentissage, j'ai effectué un stage au sein de l'entreprise EIC Sarl de la période allant du 7 décembre 2015 au 15 janvier 2016 dans le cadre de l'aménagement du bas fond de Bingou dans l'arrondissement de Tonga région de l'Ouest Cameroun d'où le thème de ce travail « Les Petits Ouvrages d'un Périmètre Irrigué. Etude de cas : Les Prises d'eau dans l'aménagement du bas fond de Bingou ». Ce rapport est essentiellement axé sur la conception, dimensionnement et représentation graphique des ouvrages de prises dans le périmètre irrigué de Bingou passant par la description de ces ouvrages.

Tout d'abord j'ai commencé par présenter l'entreprise EIC Sarl et ainsi fait une prise de connaissance du travail à faire, posé des hypothèses suivant les prescriptions techniques et les considérations du milieu d'étude. La conception et dimensionnement des ouvrages de prise suivaient des calculs tenant compte des paramètres hydrauliques des ouvrages de PFE. Ensuite produit une note de calcul des ouvrages de prises PFE proprement dite, puis produit une représentation graphique de ces PFE. Après avoir fait la représentation graphique sur AutoCAD 2014, la note de calcul est établie suivant les tableaux des métrés, devis et sous détail des prix. Le résultat est en sorte qu'ils puissent satisfaire les besoins en eau des plantes, dans notre cas d'espèce le riz. Au terme de l'étude, nous avons suggérés quelques recommandations à l'entreprise.

Mots clés :

Dimensionnement

Ouvrage de prise

Prise au Fil de l'Eau (PFE)

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INTRODUCTION

Context

After more than a year during which we were taught the theory on the various fields of water management and rural infrastructure such as irrigation, water supply and sanitation, Rural Equipment Development and Specialization Training School (REDSTS) Kumba sends its students on internship in different enterprises and companies which deal in the same fields of studies which the school offer to students. One of these enterprise is EIC Sarl which welcomes trainees in its headquarters to pass out their technical knowhow.

This internship was done for a period of 45 days from the 7th of December 2015 to the 15th of January 2016 in two parts. A part was held at the office where I learned how to mount executions projects, understand the environment and operation of the enterprise and then run the project on the field as the second part of the internship.

Objectives

i. Primary objective

The objectives of this course is to help students know about the realities of the training and put into practice the theory they see in class and then be exposed to the realities of field work. This report is a partial fulfillment in earning the Higher National Diploma (HND) in Supply of Potable Water and Hydro-Agricultural Facilities.

ii. Specific objectives

- Familiarize with the enterprise, know the running of the enterprise and its area of expertise;

- Establish a structure file on the works of the irrigated perimeter of Bingou;

- Understand the functioning of an intake structure

- Be able to mount an execution file of an intake structure (design, implantation plans, reporting methodology of execution, bill of quantities and specifications, monitoring and evaluation procedure file);

- Be able to make the necessary calculations for the proper functioning of an intake.

Chapter 1: PRESENTATION OF THE ENTERPRISE

The company EIC Sarl is located in Akwa - Bonamikengué in the district of Douala 1 more precisely in front of COMECI S.A. near Avenue Ahmadou Ahidjo. The company's address is P.O Box: 15117 Douala. Tel: +237 233 42 75 55; GSM: +237 677 74 19 32; e-mail: eicsarlu_2014@yahoo.fr

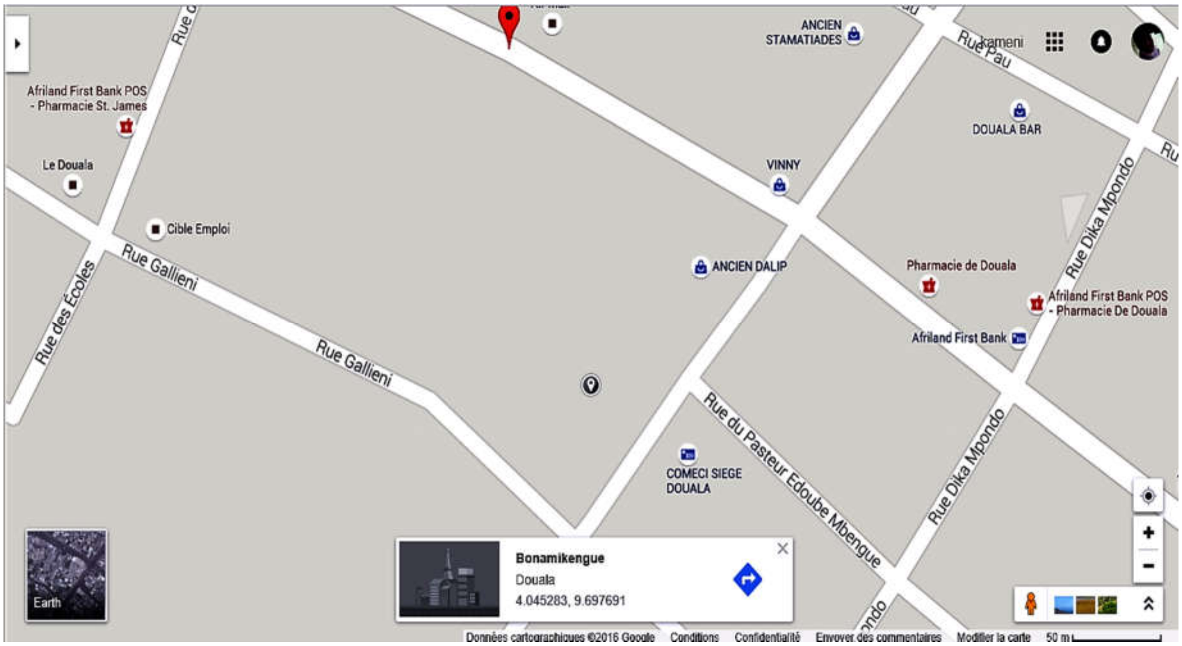


Figure 1: Location plan of the enterprise EIC Sarl U

1.1. Area of expertise

The company's areas of expertise are:

- Environmental impacts studies
- Rural engineering
- Environmental audit
- Buildings construction
- Consultancy
- Water Supply

1.2. Company's organization chart:

The manager of the company Mr. Paul TCHAPMI a Rural Engineer out of scale. The company is organized as follows:

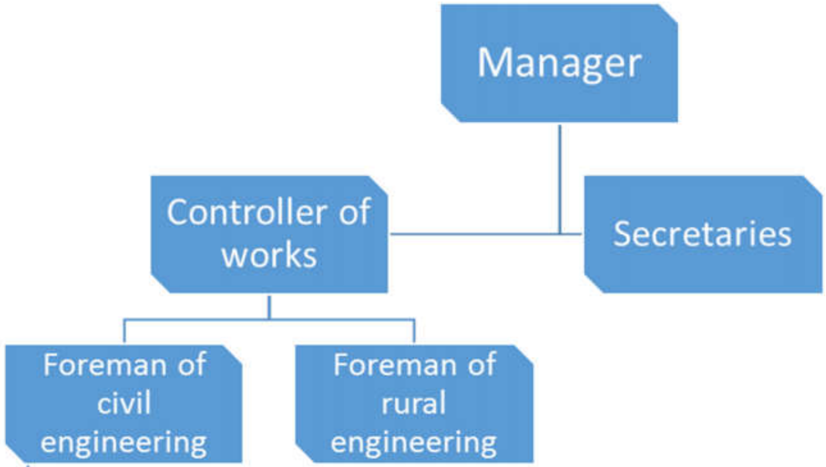


Figure 2: Organization chart of EIC Sarl U

EIC Sarl is a newly created enterprise. The manager is at the head of the enterprise and controls the company. The controller of works supervises the works of both the civil engineering and rural engineering foremen. The secretary responds to both the manager and the controller of works.

1.3. Presentation of the site

The locality of Bandounga where the inland valley of Bingou is, is a very large rural town located 21 km from the center of Tonga on the main road that connects Tonga and Bazou. The total area of the inland valley is 40.2 ha but only 23.6 ha will be laid out as specified by the project but future expansion is possible on the perimeter. The natural slope of the land is 0.2% which is ideal for a gravity irrigation by flooding for rice cultivation

1.3.1. Vegetation

The inland valley in its studied portion, is partially used for rice cultivation. The presence of tall grasses is noted in some areas over the valley.

1.3.2. Landscape

Given the current partial operations inside the inland valley, it is relatively flat, but some areas are steep.

1.3.3. Hydrology

The actual water intakes in the inland valley are from three (03) major sources:

- From rainfall,
- From numerous springs which take their sources on steep sided mountains,
- The rivers Ndé, Nsè, Maheuchou, Bingou, Djakata.

Since the water inside the inland valley is supplied by many sources of water, and also due to the different testimonies given by the local population, it is sufficient to perform at least two (2) rice production cycles if not three (3) cycles per year.

In the absence of flow measurement methods for the flow rate of the river, the estimates are made from formulas involving precipitation and physical characteristics of the inland valley, including slopes and permeability. The flow rate of the decennial flood is 4.06 m^3/s and the tidal wave of the project has a flow rate of 0.5 m^3/s. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***

Chapter 2: LITTERATURE REVIEW

An irrigated area is the actual cultivated zone, efficiently irrigated by an irrigation network. This irrigation network is in fact all equipment that enable the transportation and distribution of irrigation water in an irrigated area.

In an irrigated area we find several structures that are used to bring water to the plots. Among these structures, we distinguish two types in particular; linear structures and spot structures.

2.1. Linear structures

Linear structures consist essentially of canals. There are several types of canals in an irrigated area

i) “Dead canal”: This is the channel used to carry water from the mobilization structure to the head of the command area.
ii) Primary canal: This channel dominates the perimeter and comes after the "dead canal". The area dominated by this canal is called "zone".
iii) Secondary canal: The primary canal feeds the secondary canals with water and the area dominated by this canal is called "sector".
iv) Tertiary canal: It is powered by the secondary canals and the surface dominated by this type of canal is called "quarters".
v) Quaternary canals or sprinklers: A tertiary canal supplies several sprinklers. Each sprinkler is used to carry water to a plot in the quarter.
vi) Drains: They are usually made of earth and are present throughout the irrigated area. Drains are mostly hydraulic structures that can artificially favor the discharge of the free water present in the soil’s macro porosity after precipitation. We have a total of 15 drains inside our irrigation area.
    - Main drain: The river that runs throughout the inland valley is the main drain of the site with a length of approximately 1500 m.
    - Secondary drains: The secondary drains are designed to evacuate outside the perimeter, the maximum daily rainfall of annual frequency for a maximum time equal to the acceptable duration of submersion of rice. They are nine (09) for a total length of 1350 m. These drains are made out

of earth and are of trapezoidal shape with a depth of 30 cm. They are fully excavated and drain each a maximum area of 3 ha.

- Plot drains: Plot drains will be made in the various rice traps and to drain its excess water. These plot drains will be connected to the secondary drains of hydraulic quarters with the following characteristics: bed = 15cm, slope = 1, depth = 30cm.

2.1.1. Longitudinal profile

The longitudinal profile of the canals is chosen so that the velocity of water remains within well-defined limits. Speed is a function of the slope of the canal's geometry and the nature of the walls. It should not be too low to avoid the deposition of suspended solids and not too great for degradation of the walls. The minimum suitable speed is given by the empirical formula of Kennedy below. ***(Source: MINH TRAN Duc " Conception et Ouvrages d'un Réseau d'Irrigation Gravitaire")***

$$\mathbf{V_S = 0.55*Cy^{0.64}}$$

Where:

V_S=Velocity of flow to ensure stability of the canal in order not to have neither sedimentation of particles nor scour (m/s);

y = height of water inside the canal (m);

C = Coefficient which depends on the nature of the land covered.

Table i: Table giving the different values of C

Extremely fine soils	0.56
Fine soils, light sandy	0.84
More coarse, light, sandy	0.92
Clay loam, sandy	1.01
Coarse silt or debris endured soil	1.09

2.1.2. Cross sections

There are 4 types of cross sections; trapezoidal, rectangular, semicircular and circular

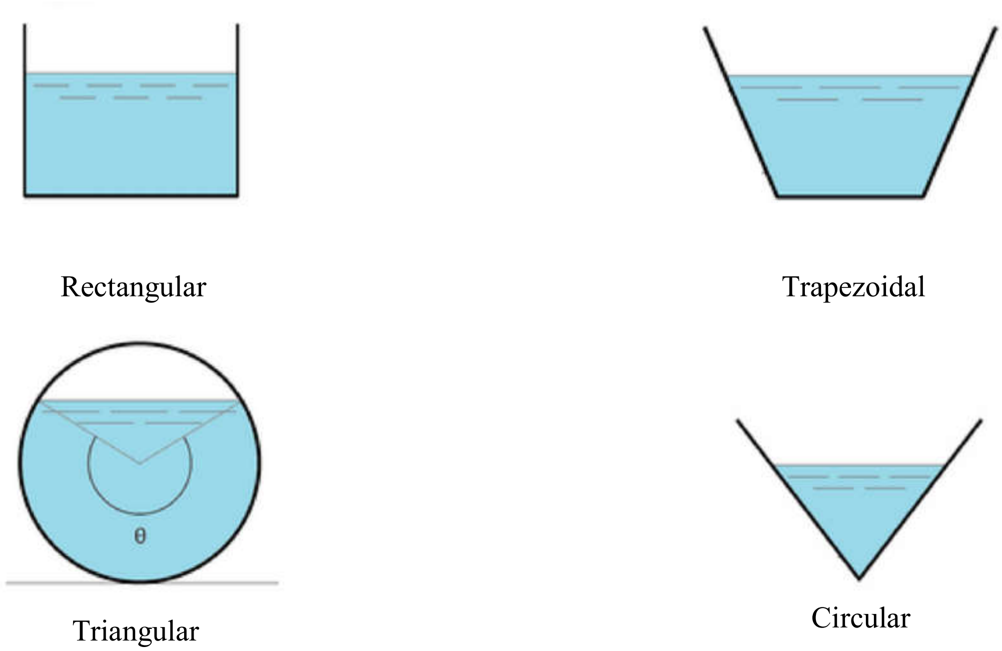


Figure 3: Different types of cross sections

Note that earth canals and those carrying high flow rates are generally trapezoidal. These limit erosion of walls and the deposition of sediments at the bottom of the canal. For the trapezoidal profile, depending on the layout of the land, we will have a channel excavation, embankment or mixed profile.

2.2. Spot structures

In an irrigation system, spot structures are all structures other than canals and have the function other than the transmission of water. The spot structures that we find in our irrigated area are;

2.2.1. The sills

A sill is a structure, mobile or fixed built in the riverbed of a stream which blocks partially or completely the river and is less than 5m high and not deeper than 5m. In our irrigated perimeter we find 4 fixed type of sills with bays equipped with removable flow gates. Note that in the intake structure, planks made out of hard wood will be used as sills.

Figure 4: V-shaped type of sill

2.2.2. Culvert

These are crossings to cross a runway or road and natural barriers by a canal or river. They have a rectangular section and inside is open channel flow. Culverts are made of a slab and piers made of reinforced concrete or masonry covered by a thin slab made in reinforced concrete.

In general, for small-sized culverts (height less than 50 cm, so cannot be visited), the thin slabs are recommended since it can facilitate the maintenance of the structure. In our irrigated area we will execute only crossing culverts and are three in number (3).

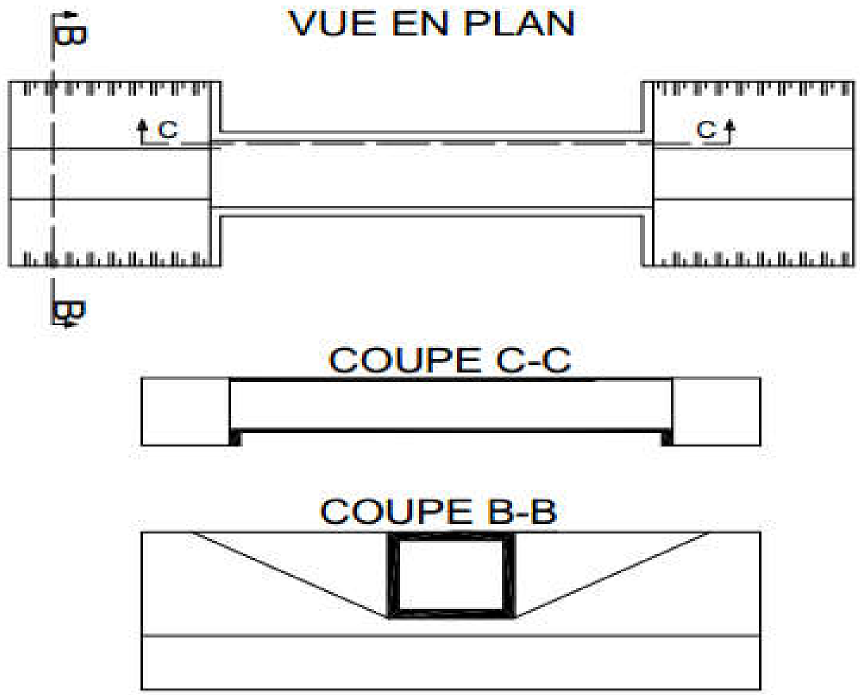


Figure 5: A crossing culvert with plan and section views

2.2.3. Intake structure

An intake structure is a hydraulic structure whose function is to distribute all or part of a canal’s flow rate to derivative canals. We mainly have two types of intake structures;

* Intake of the type surface weir:

Here we create a simple opening in the canal bank. This intake is provided with a valve which blocks the passage of water when it is fully lowered. This type of intake can still be called open air intake.

* Intake by pipe or intake of the type "all or nothing" (AON):

A PVC pipe is usually under the wall of the supply canal and is preceded by a metal valve to regulate the flow of water as shown in the diagram below. They are nineteen (19) in the perimeter and will be built in the primary canals.

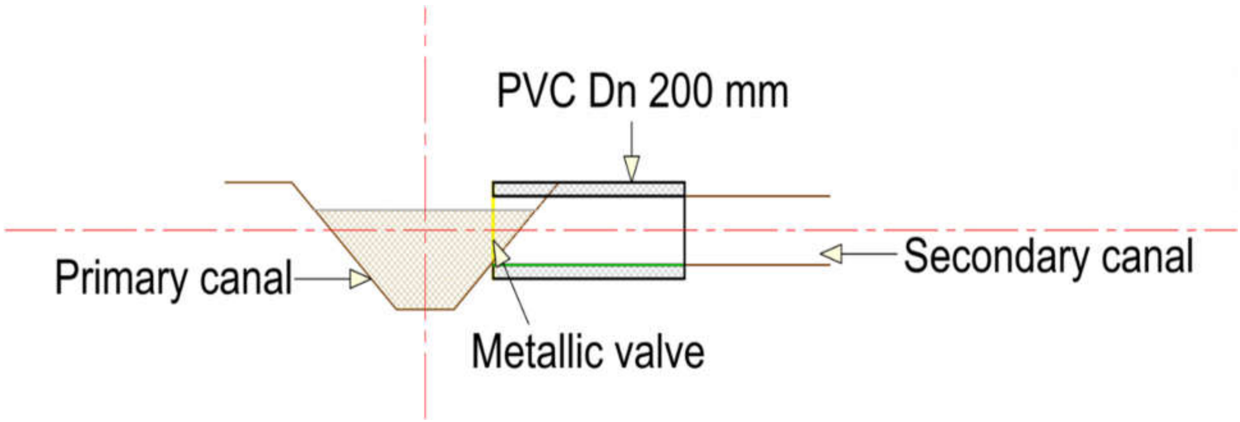


Figure 6: Section view of an AON intake

* Intake Over Water (IOW):

An IOW is a structure used for passing all or only part of the water of a river into an irrigation canal. The intake structure should take part of the river's flow rate without disturbing its flow. To achieve this, the height of the water during low water levels must be sufficient to properly feed the intake. On our perimeter we have three (03) IOWs and are concrete rectangular structures.

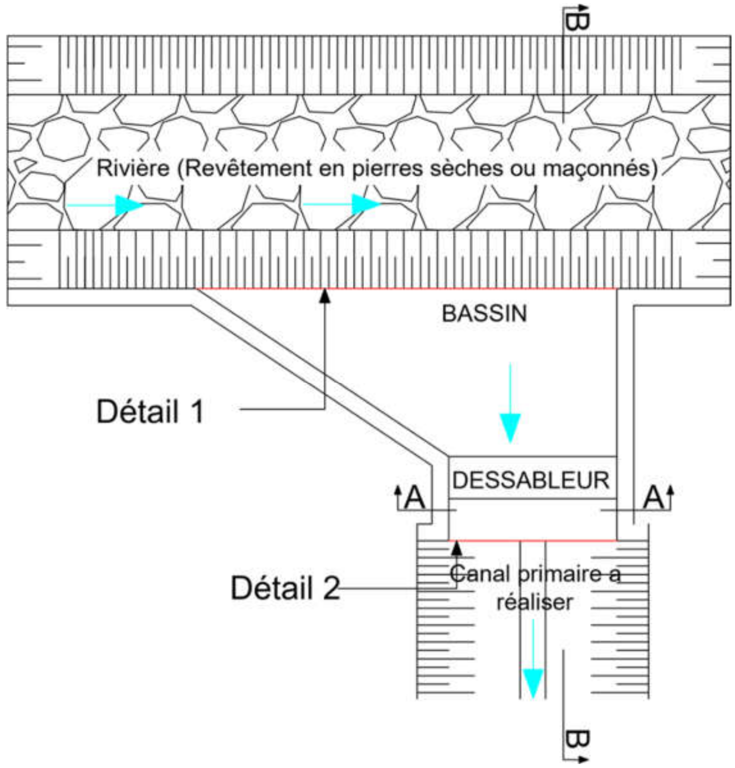


Figure 7: Plan view of an IOW

2.2.4. Bottom sluice:

This structure is constituted by a water level control device located in the supply canal situated after the intake, a short calibrated opening (sluice) and a sump (reception basin).

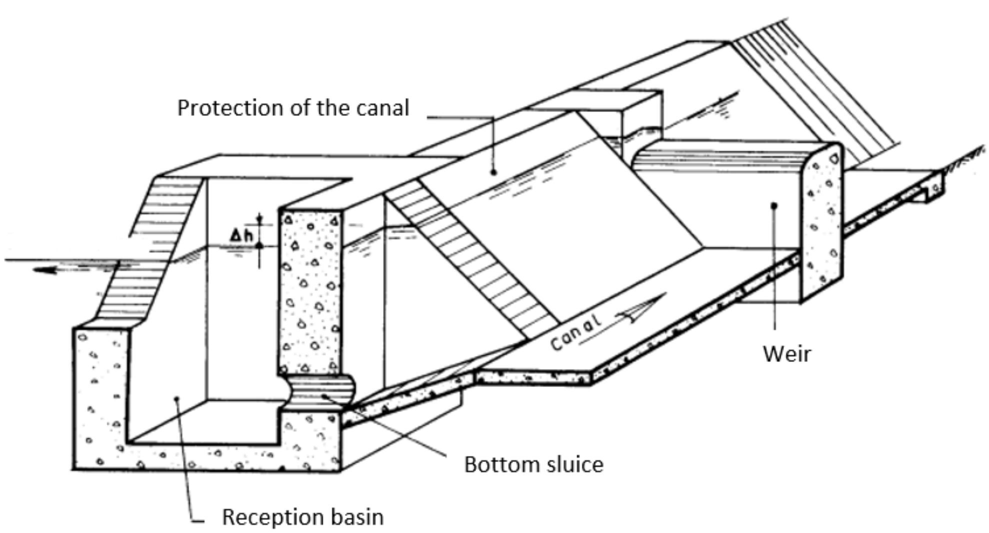


Figure 8: Bottom sluice

2.2.5. Baffle distributor:

This type of structure has a relatively low sensitivity to variations in water levels. When water remains below the bottom of the baffle, we have a surface flow on the sill and the device functions as a weir. When the water exceeds the bottom of the baffle, the flow is in charge and contraction appears that amplifies with the increased upstream water level. The device works in this state as an orifice type.

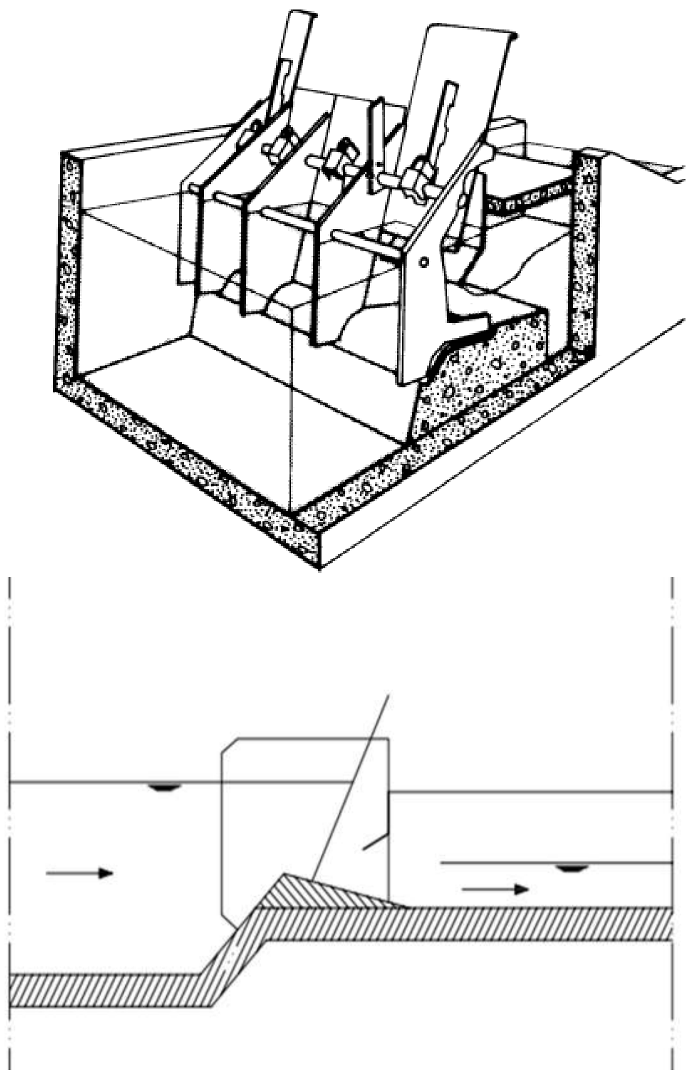


Figure 9: Baffle distributors of the type XX_1 90 with section view

2.2.6. Divisors

Divisors are structures designed to automatically allocate a constant ratio of the flow rate of a supply canal to one or more bypass canals whatever the speed of water in the supply canal. This distribution is provided by a vertical component installed directly in the main canal. To achieve this, it is necessary that the water velocities at the control section are the same in every aspect, and that the flow rate is critical to the structure (so the flow regime in one of the bypass canals can influence the split). This critical speed can be obtained by:

- The establishment of a thick sill
- The narrowing of the section
- Lowering of the raft

The in-stream flow sharing can stay in constant ratio if the vertical component is fixed, it is called fixed divisor. Whereas, if the vertical component is adjustable in order to change the ratio of shares in case of need, we are dealing with a proportional divisor. We are going to realize two (2) divisors in our perimeter. There are several types of divisors, among others:

i. Fixed weir divisor

The flow over a weir is, the contraction phenomena closely proportional to the length of the sill. This can be achieved by splitting the flow rate of the divisor to the right of the sill of a weir. However to avoid sharing to changes in water levels in the downstream canal, the spillway has to be dewatered, which implies the creation of a drop which is not necessarily compatible with the slope of the perimeter.

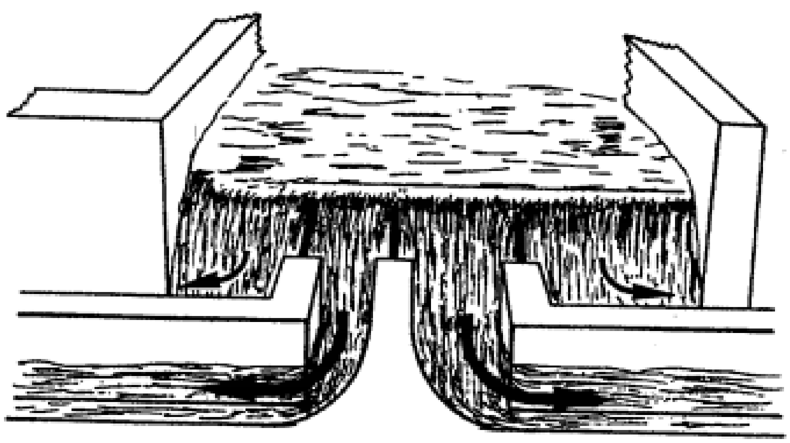


Figure 10: Fixed weir divisor

ii. Fixed divisor with sill :

A torrential flow is created by a thick raft foundation placed on the sill of the rectangular canal. The critical height of the sill is calculated using the classic formula: ***(MINH TRAN Duc "Conception et Ouvrages d'un Réseau d'Irrigation Gravitaire")***

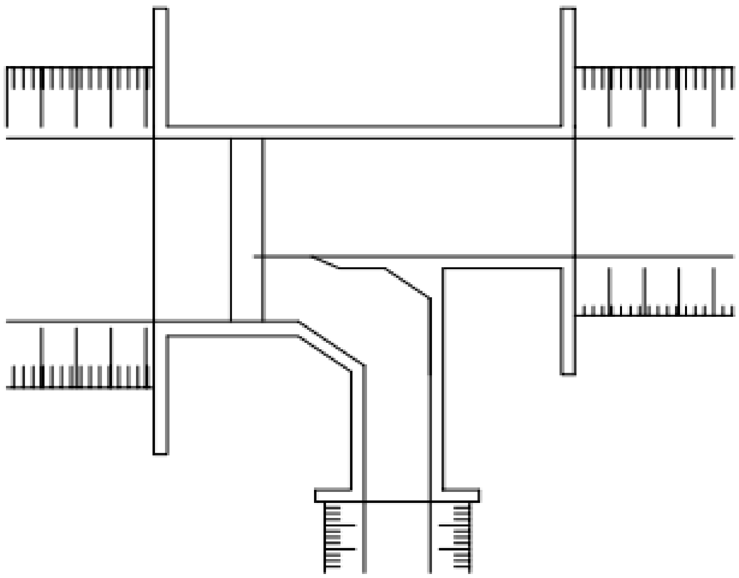
$$h_c=(Q^2/L^2g)^{1/3}$$

Q: Flow rate of the supply canal (m^3/s)

L: length of the sill (m)

g: acceleration due to gravity (m/s)

h_c: critical height (m)



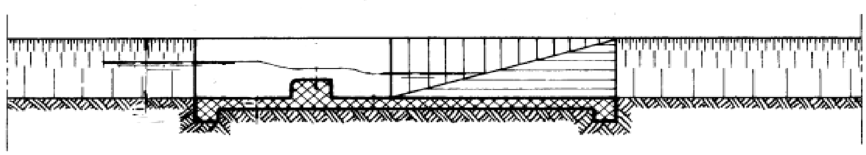


Figure 11: Plan and section view of a divisor

iii. Mobile divisors :

It allows to distribute the flow rate of the supplying canal in adjustable proportions. This division of flow rates is achieved by a flap which pivots about a vertical axis. The design of this structure is based on the formula; ***(Source: MINH TRAN Duc " Conception et Ouvrages d'un Réseau d'Irrigation Gravitaire")***

$$Q=1.235Rh^{1.5}$$

Q: Flow rate of the supply canal (m^3/s)

R: radius of the flap (m)

h: Head on the sill (m)

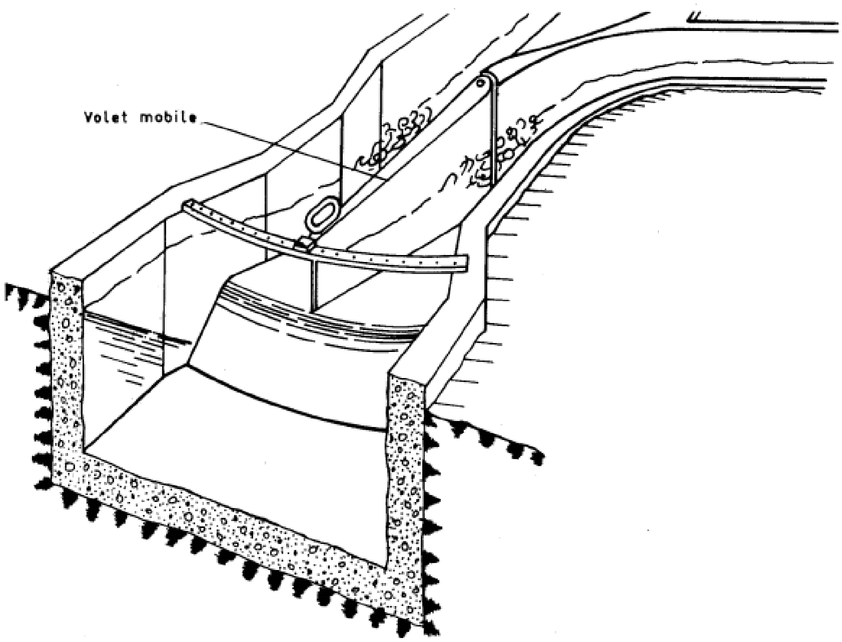


Figure 12: Mobile divisor

2.2.7. Drop

These structures are usually installed to avoid the deterioration of canals. This is done by reducing the slope which bring the speed to acceptable values. The canal therefore becomes a succession of fore bay to moderate slopes as below. It is important to note that drop structures are usually less than 1m. Our perimeter will have 10 and are installed in primary canals.

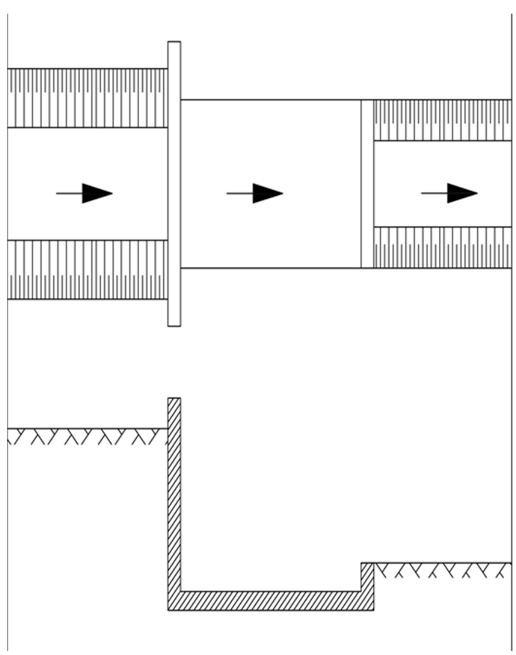


Figure 13: A drop (plan and section views)

2.2.8. End of canals structures:

End of canal structures are structures in which the water height is held up at a certain altitude so that when water exceeds this height, the excess water is discharged using a canal. In our perimeter, end of canal structures will have metallic flow gates and PVC pipes of Dn=200mm with a length of 1.3m

Chapter 3: MATERIALS AND METHODS

3.1. Materials and equipment

The work carried out during this internship was the execution of an IOW and AON intakes present on the irrigated perimeter. To do this, we need the following equipment:

- Hydraulic Excavator (with tires or with chains): principally used for excavations.

- Manual Compactor: used for compacting all types of soils.

- Dump Truck: generally used for transport of gravels, soil and sand.

- Grader: an engine which is used to give a uniform ground level over a given surface area.

- Vibrating compactor type Bomag BW90: has as goal, to compact the earth in order to bring the porosity index of the turned earth to a closer index as that of non-excavated earth.

We also had other materials such as

- Concrete batch plant: Used to produce concrete following the prescribed formulation.

- Cement mixer: Used to mix the different components of concrete

- Flatbed truck with lifting arms: Used for the transport of loads and be able to lift and move them with ease

- Autonomous shaker: Permits to reduce the proportion of gaps and remove air bubbles inside concrete.

- Formwork: Gives the form of the elements to be made out of concrete and reinforced concrete

-Shoring: Sustains the elements inside the formworks

- Water tank: Stores water

- Motor pumps: Pumps water

3.2. Execution Methods

3.2.1. Excavations and foundations

The excavation will be carried with a hydraulic excavator under the supervision of the topographical and geotechnical teams. It consists in the diversion of the river side of the flooded area, implant the trench to execute and perform the excavation works according to the outline below:

- ✓ Execution of trenches.
- ✓ Taking out water.
- ✓ Stripping, removal and replacement of poor land held by draining gravels for the foundation stones of varying thickness.
- ✓ Evacuation out of the road the excess or unsuitable materials.
- ✓ Compacting the bottom of the trench.
- ✓ A rock fill of at least one meter will be carried out downstream of the structure.

3.2.2. Concrete

Concrete consists of

- ✓ The works for valves and flow gates, wing walls at 35 grades of 0.20 m in thick reinforced concrete.
- ✓ The execution of pre-raft and back raft in reinforced concrete.
- ✓ The steels will be left pending for the construction of the raft-post from upstream head structure.

Note that all the structures will be cast on site

3.2.3. Backfilling

These concern:

- ✓ The backfilling of trenches in lateritic gravel, backfilling earth is compacted by layers of 0.20 m.
- ✓ The summary setting up of river beds over a maximum distance of 20 m upstream and downstream.
- ✓ The cleaning of the riverbed about 50 m upstream and 50 m downstream.

3.2.4. Structural plans

Given that on our small irrigated area we had many structures to be executed, and due to the limited time for this internship, this work is limited to the intake structures. On the site we have two types; IOW and AON intakes. Intakes on primary canals are of the type "all or nothing (AON)." The design of all these structures are done with a computer. AutoCAD 2014 helps us to model our design. It starts with a study of the field planimetry made by a topographer containing the locations of all the structures to be executed on the site. Then it comes to us to identify the subject of this work is the intake structures.

Chapter 4: ANALYSIS, RESULTS AND RECOMMENDATIONS

In this chapter we will discuss in particular the hydraulic design of IOW and its structural plans to be executed.

4.1. Analysis

4.1.1. Description of the structures

The main water intake in the river for irrigation of rice on the inland valley of Bingou is composed of three (03) IOW. These structures help to deflect some of the flow rate of the river into the network for the irrigation of rice. The river intake is a structure used for passing all or only part of the water of a river into an irrigation canal also called a bypass canal. IOWs are concrete rectangular canals. According to the bed width which varies from 0.70 to 3 m, the length of planks to manually manipulate varies from 0.70 to 1.5 m. The depth of the IOW also varies from 0.70 to 1 m.

Intakes on primary canals for supplying secondary canals are intakes by pipe or intakes of the type AON. The pipes are rigid PVC of 200 mm in diameter with the entrance of the intake controlled by metallic flow gates. A sill of variable height (5 to 7cm) with a length which also varies from 51 to 67 cm, ensures a constant water level in the intake.

Intake structures on secondary canals for feeding the plots are mostly AON. These pipes are rigid PVC diameter 125 mm. To ensure a minimum head for the functioning of the pipes, removable sills will be constructed and used in the secondary canals.

4.1.2. Hydraulic design

The design principles of an IOW are based on:

- The hydraulic calculation: the facility to deliver the designed flow rate of the primary canals they feed.

- The hydrological calculation: capacity of the considered structure to evacuate the flood.

- Calculation of stability: the ability of the structure to resist sliding, perforation and reversal.

IOW present on the site will have the following basic features: Case of the 301a structure, IOW: b = 2.0 m; Hmax = 1.2 m, L = 3.0 m and th. = 20 cm with 3 spans of metal valves (55 x 80 cm; th. = 4 mm with 2 departures including canals: 2 metal flowgates 42 x 60 cm; th. = 4 mm), reinforced concrete pathway with protection by rocks masonry). This is the basis of the calculations that follow later in this work. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***

These calculations are made to determine the hydraulic parameters of each structure. As parameters to be determined, we have;

- The flow rate (Q): In principle, the decennial flood flow rate (Q_{10}) is used to design the main drain and IOW structures built in rivers beds. The results of calculations give high flood flow rates. So to design the IOW, we considered the flood flow rate generated by the ten-year maximum daily rainfall for which the evacuation outside the perimeter is done in 72 hours. This gives us a flow rate of 0.13 m^3/s depending on the estimation by ORSTOM method but we will design the IOW with a flow rate of 0.5 m^3/s. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***
- The longitudinal slope (I): The landscape of the site is relatively flat and its slope is natural and follows the hydrological area calculation. We have an inclination of land to 0.2% (2m/km) according to survey data collected on the site. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***
- Roughness coefficient (k): Given that the IOW are to be built entirely out of reinforced concrete, the roughness coefficient for that material is k = 50. ***(Source: EIER irrigation gravitaire)***
- The depth (y): is given by the formula below. This design is for a hydraulically favorable section of maximizing the wet surface and minimize the wetted perimeter. ***(Source: Lecture notes on Hydraulics-REDSTS)***

$$y = \frac{b}{2\left(\sqrt{1+m^2} \quad m\right)}$$

Where: b=bed width (m), m=side slope

We have b=2m, m=0 given that we have a rectangular section.

N.A (Numerical application): $y = \frac{2}{2\left(\sqrt{1+0^2}-0\right)}$

$$y = 1\ m$$

- Wetted surface (S) : It is given by the formula, ***(Course notes on Hydraulics-REDSTS)***

$$S = l \quad y$$

Where; *l*=top width (m), *y*=depth of water (m)

l=2m, y=1m

N.A: $S = 2 \quad 1$

$\boldsymbol{S = 2\ m^2}$

- Wetted perimeter (P): It is given by the following formula. ***(Course notes on Hydraulics-REDSTS)***

$$\boldsymbol{P = l + 2y}$$

N.A: $P = 2 + 2(1)$

$\boldsymbol{P = 4\ m}$

- Hydraulic radius (R_H) : It is determined by the formula: ***(Course notes on Hydraulics-REDSTS)***

$$\mathbf{R} = \boldsymbol{S/P}$$

N.A: $R = 2/4$

$\boldsymbol{R = 0,5\ m}$

- Average speed in the IOW (V): It is determined using the formula below. It must be a minimum value so that no sediment is being deposited in the bottom of the canal and that there is no scouring. ***(MINH TRAN Duc "Conception et Ouvrages d'un Réseau d'Irrigation Gravitaire")***

$$\boldsymbol{V = k \quad R^{\frac{2}{3}} \quad \sqrt{I}}$$

N.A: $V = 50 \quad 0.5^{\frac{2}{3}} \quad \sqrt{0.002}$

$$\boldsymbol{V = 1,41\ m/s}$$

- The associated area: The area associated with these IOW are given in the table that follows
- The flow rate in the primary canals: The flow rate of the primary canals are given in the table that follows

Table ii: Hydraulic features of the structures of the irrigated perimeter

HYDRAULIC FEATURES OF THE PROJECT STRUCTURES OF THE SITE OF BINGOU												
Intake structure	**Necessary flowrate at the intake in l/s**	**Majorated flowrate of the intake by**	**Canals supplied by the intake**	**Length of primary canals in m**	**Length of secondary canals in m**	**Needs in l/s/ha**	**Specific needs on the line in l/s**	**Flowrate per line in l/s**	**Flowrate per line majorated by 50% in l/s**	**Zones supplied by line**	**Specific surface by line in ha**	**Surface of supplied zones per line in ha**
N°1	22.41	33.62	TB01	257.00	257.00	9.00	9.18	9.18	13.77	**SB02**	1.02	1.02
			TB02	185.00	185.00	9.00	6.30	13.23	19.85	**SB01 +** SB03	0.70	1.47
			TB03	78.00	78.00	9.00	6.93	6.93	10.40	**SB03**	0.77	0.77
N°2	50.94	76.41	TB04	239.00	239.00	9.00	4.32	16.74	25.11	**SB04 +** SB06	0.48	1.86
			TB05	141.00	141.00	9.00	12.42	12.42	18.63	**SB06**	1.38	1.38
			TB06	179.00	179.00	9.00	24.93	34.20	51.30	**SB05, SB07 +** (SB08)	2.77	3.80
			TB07	144.00	144.00	9.00	9.27	9.27	13.91	**SB08**	1.03	1.03
N°3	120.15	180.23	TB08	304.00	304.00	9.00	24.57	68.58	102.87	**SB14 +** (SB11, SB12 and SB13)	2.73	7.62
			TB09	177.00	177.00	9.00	10.26	44.01	66.02	**SB11 +** (SB12 and SB13	1.14	4.89
			TB10	100.00	100.00	9.00	14.13	33.75	50.63	**SB12 +** (SB11)	1.57	3.75
			TB11	145.00	145.00	9.00	19.62	19.62	29.43	**SB13**	2.18	2.18
			TB12	654.00	654.00	9.00	25.65	51.57	77.36	**SB10 +** (SB09)	2.85	5.73
			TB13	113.00	113.00	9.00	25.92	28.80	43.20	**SB09**	2.88	3.20
TOTAL				2716	2716							

4.1.2.1. Hydraulic scheme

Hydraulic scheme is closely linked to the irrigation flow rate mobilized by the IOW. The designed flow rate is equal to the product of the module (20 l/s) by the number of hydraulic quarters dominated by the IOW considered. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***

The IOW that feed the primary canals consist of canals with a rectangular section made out of reinforced concrete. The starting height of the main canals at the IOW is 50 cm above the raft of the IOW. This practical arrangement prevents flooding of the intakes and canals dominate many plots to irrigate.

4.1.2.2. Hydrologic conception

The flood flow rate is used for the design of main drains. At the passage of these floods, the planks forming the sills are supposed to be completely removed. The height of the sill that allows to derive the irrigation flow varies from 0.73m to 0.85 m. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***

4.1.2.3. Stability of the IOW

The sustainability of IOW is mainly linked to their stability. The stability study extents to determining the thickness of walls and slabs to implement and necessary anchor tin order to avoid piping. ***(Source: Avant-projet détaillé de l'aménagement du bas fond de bingou)***

The results of the calculations gave

- Upstream anchoring the slab = 64 cm

- Downstream anchoring the slab 40 cm

- Wall thickness = 20 cm and slab

4.1.2.4. Graphic design

Due to the presence of numerous structures in our irrigated perimeter and given the limited time for internship, this work is limited only to intake structures. On the site, we have two types; intakes on rivers (IOW) and intakes on primary canals. Intakes on primary canals are type taken "all or nothing (AON)".

The design of these structures is done using a computer which is essential to us. It starts with a study of the global plan made by a topographer containing the locations of the works which will be executed on the site.

4.2. Results

In this section, we present bill of quantities, prices detailing and structural plans of the intakes.

4.2.1. Description and functioning of the IOW

The designed IOW of rectangular section is divided into three compartments:

- The basin; width at the entry (L ') = 5 m; width (L) = 2 m; length (l) = 2 m; depth (p) = 1.2 m

- The sand trap; width = 2 m; length = 0.5 m; depth = 1.2 m

- The connection with the primary canal; width = 2 m; length = 0.5 m; depth = 1.2 m

This gives us a total length of 3m and a structure height to 1.2m. The thickness of the walls is 20cm. The IOW is covered by a reinforced concrete slab concentrated at 350 kg/m^3 to serve as crossing to the opposite bank of the river. At the entrance of the basin is a wooden gate and hardwood beams used sills.

Part of the stream is sent to the intake that is built in the river with a specific flow rate. Planks present in the intake height h = 0.83m will serve as removable sills to regulate the flow rate sent to the primary canals. The valves with 3 spans of 55 x 80cm and 4mm thickness will also serve to regulate flow.

The dimensioning and previous features have led us to design an IOW which is shown as below

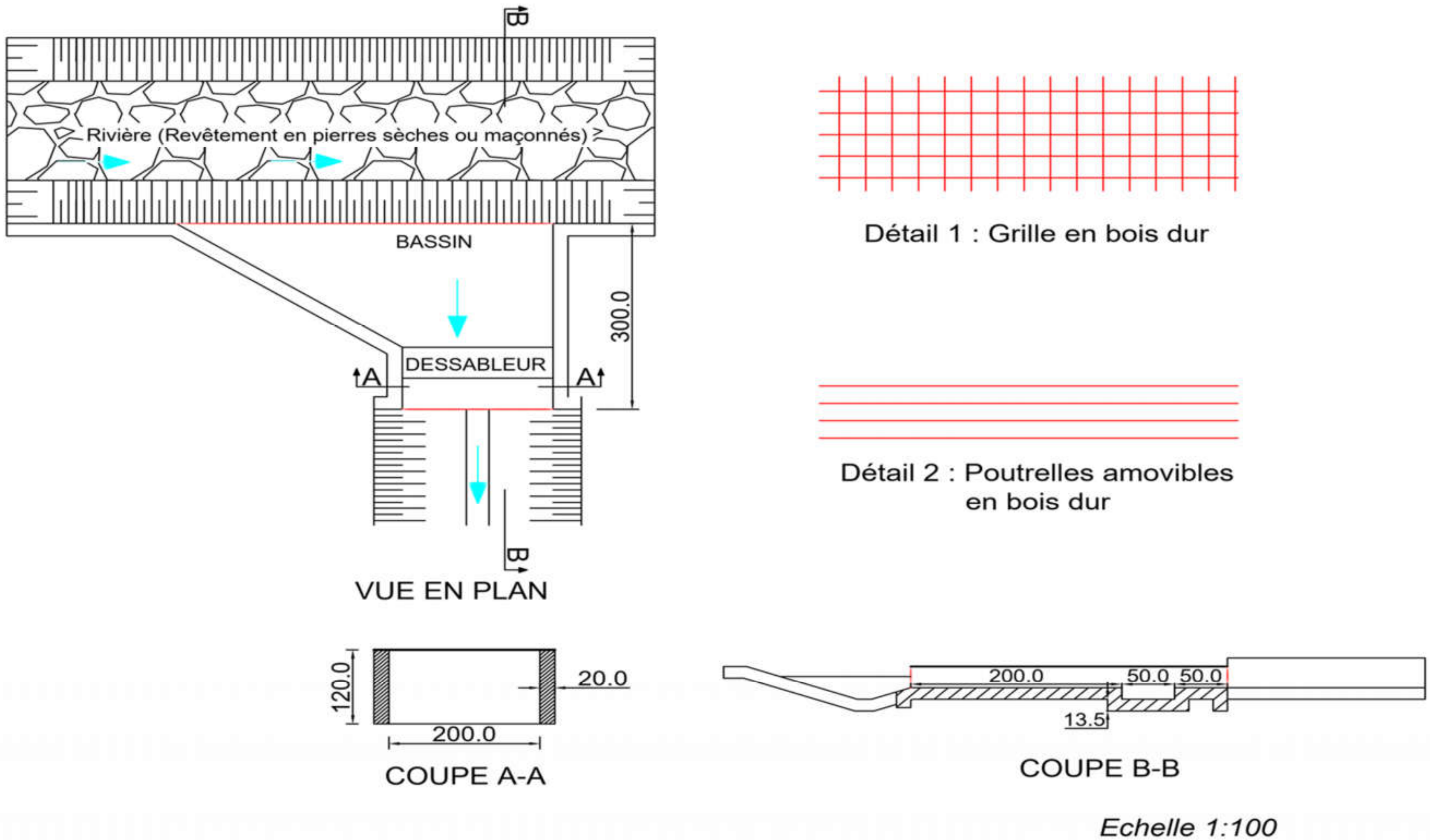


Figure 14: IOW with plan view, section views and details

The second type of intake is the intake on the primary canal. These intakes are of the type AON made with PVC pipe of Dn 200mm. They feed the secondary canals

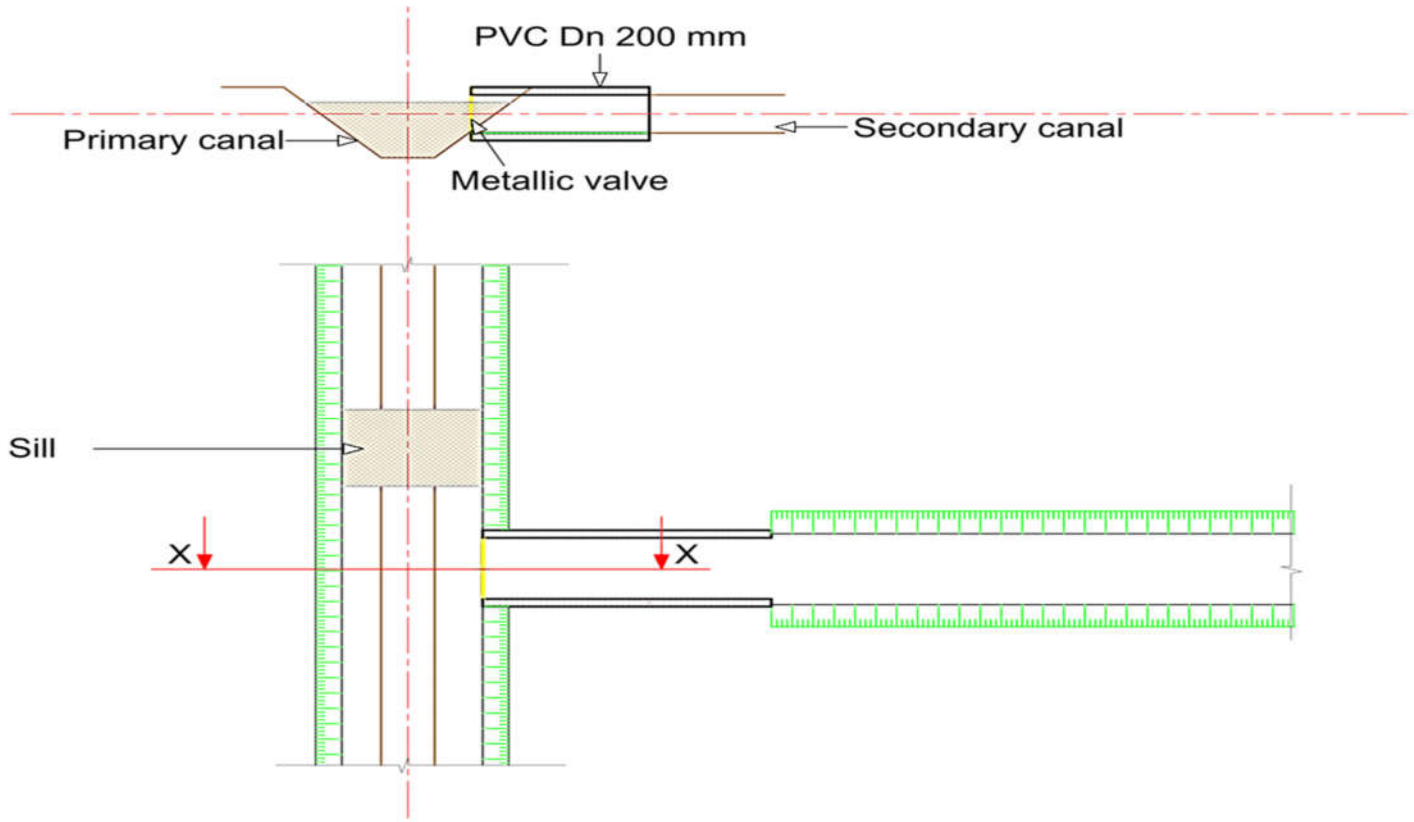


Figure 15: AON intake with plan and section view

4.2.2. Bill of quantities, estimates and price specifications:

These concerns only the IOW. The gross price for the execution of an IOW is 2,651,124 FCFA including the prices of labor, materials and equipment. Tables iii, iv and v at the annexes give the actual description of these.

4.3. Benefits from the internship and recommendations

4.3.1. Benefits

Having come to an end of this internship held for a period of 45 days where I tried to link theory to practice, we can say that all the specific objectives have been achieved. The benefits gotten throughout this internship are,

- Respect of hierarchy
- Assiduity in work
- Understanding the functioning of hydraulic structures
- Capability of drawing, reading and understanding hydraulic plans
- Ability to establish execution projects (bill of quantities, designing, calculations)

4.3.2. Recommendations

To the company EIC Sarl, a recommendation could be that the company should at least send their interns on the field for a better and rapid acquisition of technical knowhow. Also, the company should look forward in its expansion and increase of its personnel for an effective division of labor.

To the school authorities, we usually face a difficulty when looking for internships. The main cause is the internship periods. This being a suggestion, it would be judicious to review the school calendar concerning internships and allocate a longer period of internship.

CONCLUSION

An academic internship is an exercise that allows students to apply the theoretical knowledge acquired during their training, to make remarks and proposals to improve the identified shortcomings which is the main objective of every internship. I spent 45 (forty five) days within the company EIC Sarl in Douala for an internship as part of my training. I became familiar with the company and its environment to know its operation. This internship allowed me to take advantage of new practical knowledge of certain theoretical courses received at school such as irrigation basis, irrigation structures and design of irrigation networks, improve my technical vocabulary, to gain experience in the field especially in graphic design

We focused our study on the conception and the design of structures of a small irrigated area from where the theme of our report. I recall that the problem was the design of structures of an irrigated perimeter mainly over the intake structures (IOW) to supply a gravity irrigation network over 23ha approximately for rice cultivation. So I presented the EIC structure as a whole, then talked about the different structures present in an irrigated area. Followed the description of the materials and methods used for this work. Then I proceeded with the hydrological and hydraulic design of our case study which was the intake structures and showed how to calculate the different parameters of an intake structure in order to have a good sustainability at the end, showed the the different execution plans of an IOW and presented to you the bill of quantity, estimates and specifications.

Having reached this stage of my work, it would be pretentious to say that I made the perfect study, but nevertheless we can say that our main objectives have been achieved by the view of the results obtained.

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ANNEXES

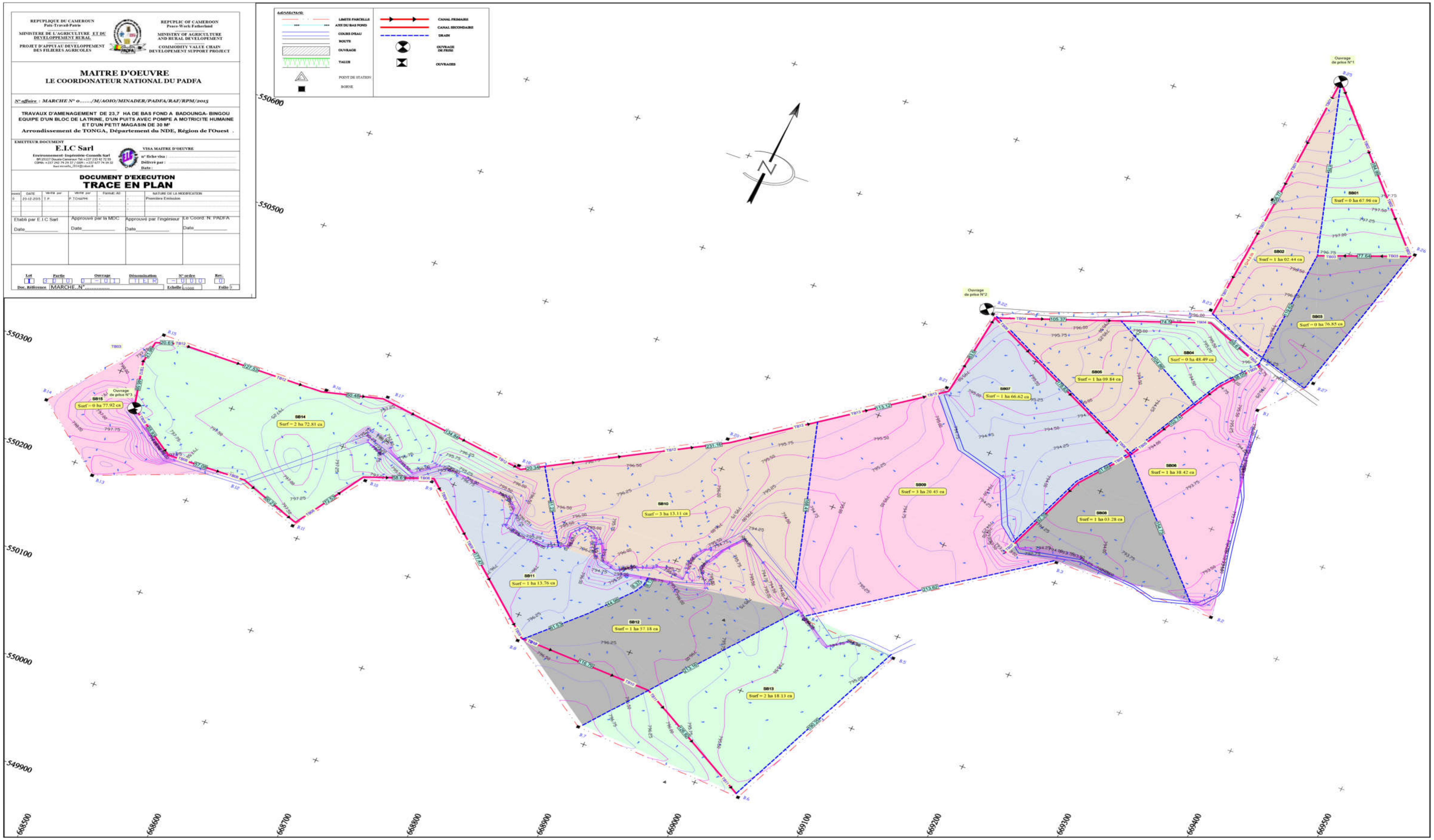

Figure 16: Global plan of the irrigated perimeter of Bingou showing the IOWs and the different plots

Table iii: Bill of quantities for the IOW

Ouvrage de Prise au fil de l'eau (PFE)										
N°	Designation	NPS	Quantités	Dimensions(m)			Surface (m²)		Volume(m3)	
				l/a	L/b	h/e	Partielle	Total	Partielle	Total
1	Parois au béton armé dosé à 350kg/m3	2	1	3	0.2	1.2			0.72	1.44
2	Rainures	2	1	0.55	0.8	0.05			0.022	0.044
3	Béton de propreté dosé à 350 kg/m3	1	1	3	2	0.05			0.3	0.3
4	Passerelle en béton armé dosé à 350 kg/m3	1	1	3	2	0.5			3	3
Total BA dosé à 350kg/m3										**4.784**
4	Madriers	3	1	0.4	2	0.05			0.04	0.12
Total madriers										**0.12**
5	Vannes	3	1	0.55	0.8	0.004			0.00176	0.00528
Total vannes										**0.00528**
6	Vannettes	2	1	0.42	0.6	0.004			0.001008	0.002016
Total vannettes										**0.002016**
7	Béton de propreté d	1	1	1.53	2	0.05			0.153	0.153
Total BP dosé à 150 kg/m3										**0.153**

Table iv: Quantity estimates for the IOWs

DEVIS ESTIMATIF DE DES PFE 301					
Devis pour les matériaux de construction					
N°	**Designation**	**Unités**	**Quantité**	**PU**	**PT**
1	Béton armé dosé à 350 kg/m	Unités	1	107,000	107,000
2	HA 08	Kg	50	850	42,500
3	RL 06	Kg	20	250	5,000
4	Bois de coffrage	m^3	2	150,000	300,000
5	Gabions	m^3	1.75	60,000	105,000
6	Madriers	m^3	0.5	200,000	100,000
7	Peinture anticorrosive	kg	2	7,500	15,000
8	Plaques métalliques	m^2	0.44	2,000	880
9	Divers (10%)				72,188
	TOTAL A				**747,568**
Devis pour la main d'œuvre					
N°	**Catégorie**	**Nombre**	**Salaires Journaliers**	**Jours facturés**	**Montant**
9	Conducteur des travaux	1	10,000	5	50,000
10	Chef de chantier	1	7,500	10	75,000
11	Chef d'équipe	2	5,000	10	100,000
14	Manœuvres	8	3,000	15	360,000
15	Ouvriers spécialisés	8	4,000	7	224,000
16	Topographe	1	4,000	5	20,000
17	Laborantin	1	4,000	5	20,000
	TOTAL B				**849,000**
Devis pour matériels et engins					
N°	**Catégorie**	**Nombre**	**Salaires Journaliers**	**Jours facturés**	**Montant**
18	Pelle hydraulique	1	350,000	2	700,000
19	Niveleuse	1	350,000	1.5	525,000
20	Compacteur vibrant	1	250,000	2	500,000
21	Citerne d'eau	1	10,000	15	150,000
22	Vibreur autonome	1	150,000	2	300,000
23	Bétonnière	1	25,000	3	75,000
24	Camion avec bras de levage	1	120,000	1	120,000
25	Centrale à béton	1	250,000	1	250,000
26	Camion bennes	1	140,000	1	140,000
27	Compacteur manuel	1	60,000	5	300,000
28	Pick up	1	45,000	15	675,000
29	Motopompe	1	20,000	15	300,000
30	EPI	10	2,000	15	300,000
	TOTAL C				**4,335,000**
	Coût Total A+B+C				**5,931,568**

Table v: Price specification for the IOWs

	SOUS DETAIL DE PRIX			**PRIX N°**	**301.a**
	PRISE AU FIL D'EAU				
	Rendement journalier	Quantité totale		Unité	Durée (jour)
	0.20	3.00		Unité	15.0
A - MAIN D'ŒUVRE	**Catégorie**	**Nombre**	**Salaire journalier**	**Jours facturés**	**Montant**
	Conducteur des travaux	1	10,000	5.00	50,000
	Chef de chantier	1	7,500	10.00	75,000
	Chef d'équipe	2	5,000	10.00	100,000
	Manœuvres	8	3,000	15.00	360,000
	Ouvriers spécialisés	8	4,000	7.00	224,000
	Topographe	1	4,000	5.00	20,000
	Laborantin	1	4,000	5.00	20,000
				TOTAL A	**849,000**
B - MATERIEL & ENGINS	**Type**	**Nombre**	**Taux journalier**	**Jours facturés**	**Montant**
	Pelle hydraulique	1	350,000	2	700,000
	Niveleuse	1	350,000	1.5	525,000
	Compacteur vibrant	1	250,000	2	500,000
	Citerne d'eau	1	10,000	15	150,000
	Vibreur autonome	1	150,000	2	300,000
	Bétonnière	1	25,000	3	75,000
	Camion avec bras de levage	1	120,000	1	120,000
	Centrale à béton	1	250,000	1	250,000
	Camion bennes	1	140,000	1	140,000
	Compacteur manuel	1	60,000	5	300,000
	Pick up	1	45,000	15	675,000
	Motopompe	1	20,000	15	300,000
	EPI	10	2,000	15	300,000
				TOTAL B	**4,335,000**
MATERIAUX ET DIVERS	**Type**	**Unités**	**Prix unitaire**	**Consommation**	**Montant**
	Plaques métalliques	m^2	2,000	0.44	880
	Graviers	m^3	12,000	4.5	54,000
	Sable	m^3	10,000	4	40,000
	Ciment	Sac	8,500	7	59,500
	Coffrage	m^3	150,000	2	300,000
	Gabions	m^3	60,000	1.75	105,000
	HA 08	kg	850	50	42,500
	RL 06	kg	250	20	5,000
	Madriers	m^3	200,000	0.5	100,000
	Peinture anticorrosive	kg	7,500	2	15,000
	Divers (10%)				72,188
				TOTAL C	**794,068**
D	**TOTAL COÛT DIRECT (A+B+C)**				**5,978,068**
E	Fraix généraux de chantier			**5.00%**	298,903
F	Fraix généraux de siège			**4.50%**	269,013
G	**COÛT DE REVIENT (D+E+F)**				**6,545,984**
H	Risques + Bénéfice			21.50%	1,407,387
P	**PRIX DE REVIENT TOTAL HTVA (G+H)**				**7,953,371**
V	**PRIX DE VENTE UNITAIRE HTVA**				**2,651,124**