RMCG

WEIDAP projects - Dak Lak/Dak Nong Provinces

Design review by AWP experts

Prepared for: WEIDAP by Rob Rendell, Rob Hughes and Ailsa Willis

7 April 2020 based on field trip 9 – 11 March

About the Authors
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Acknowledgements
This report and related program work is supported by the Australian Water Partnership (AWP), an international cooperation initiative helping developing countries in the Indo-Pacific region, and beyond, work towards the sustainable management of their water resources. The AWP is funded by the Australian Government through the Australian Department of Foreign Affairs and Trade, and managed by eWater Limited.

Citation

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1 Background

1.1 WEIDAP and Australian exchanges

Vietnam suffered a severe drought in the 2014/16 where water shortages resulted in substantial crop losses for high value horticulture crops in Central Highlands. In response Vietnam has developed a project using ADB loan funds ($120USmill) to provide a series of works that include a modernised pressurised irrigation supply system to 5 provinces involving 12 irrigation pumping schemes ranging in size from 150 to 2,000ha each. Other associated works are canal modernisations and some river weir upgrades. These are described in the Appendices with a map showing the location of the provinces.

The project is known as WEIDAP (Water Efficiency Improvement in Drought Affected Provinces).

During the feasibility stage (2017) WEIDAP/ADB staff undertook a study tour (AWP – Australia Learning Week) of Australia. Subsequently Vietnam/ADB sought Australian expertise for the project around a number of themes. AWP (Australian Water Partnership) provided Australian experts i.e. RMCG with assistance from Jacobs (Greg Holland) and Central Irrigation Trust (several personal), who provided considerable input to the feasibility phase particularly around the proposed system design. The Australian input radically changed the approach to the project system design.

In order to consolidate the Vietnam response to the Australian input there was a study tour (of those involved in the projected feasibility development, including ADB staff, designers, technical, CPO (Central Project Office within MARD – Ministry of Agriculture and Rural Development), Provincial government, Ministry of Finance and IMC (Irrigation management Companies). This study tour experienced first hand the variety of similar schemes that operated in Australia along the Murray river in SA/NSW/Vic.

As part of the feasibility phase, a Design Guideline was prepared by ADB consultants Mr Alan Clarke, Professor Hai and Mr Rob Rendell – final version released August 12, 2019. This document is particularly critical to the overall project and was to be used as the basis for TOR for the design process. Each province has developed a PPMU (Provincial Project Management Unit) overseen by a CPMU (Central Project Management Unit – within CPO) manage the schemes design, construction and commissioning.

As it is the first time that Vietnam has undertaken such schemes further assistance has been sought by Vietnam from Australian water experts in the development of the TOR for the appointment of Vietnam designers to design the works. As part of the process of issuing the TOR for consultants, there was a briefing workshop held in Hanoi 6 December 2020 for the prospective designers where each PPMU presented information as well as CPO, ADB, technical experts Mr Hai/Mr Clarke, and where Australian experts attended and participated.

Prior to the workshop Mr Rob Rendell and Mr Rob Hughes undertook field trip and local workshops in each of three provinces i.e. Ninh Thuan, Bin Thuan and Khan Hoa.

Following the workshop a detailed mission report (WEIDAP stage 1 – design tender workshops – 12 December 2019) was prepared and made available to Vietnam. This report made considerable suggestions for each of the schemes in the three provinces.

At the workshop there was considerable debate about some technical aspects of modernised pipeline design. In particular the representatives from the Dak Lak PPMU (Provincail Project Management Unit) were concerned that the Australian experts did not understand the specific requirements of Dak Lak projects and initially challenged many of the design suggestions.

It was unfortunate that both Dak Lak and Dak Nong Provinces (Bin Ma Thout region) were not included in the field trip prior to the workshop. Thus these provinces had not had the opportunity of onsite exchange of ideas. These two provinces were particularly keen for Australian experts to visit and become familiar with their situation.

In order to address the Dak Lak issues a further field trip was undertaken by AWP experts (Mr Rob Rendell – RMCG, Mr Rob Hughes ex CIT, Ms Ailsa Willis – LMW),in March 8-13. The project team was assisted by interpreter Ms Chung Vu and the regional deputy director Mr Khuat Vam Son.

Figure 1-1: The AWP experts with interpreter Ms Chung and deputy director of PPMU Mr Khuat Vam Son

1.2 Design timetable and Australian study tour

The following timetable sets out the expected program (pre Covid-19).

Table 1-1: Timetable (pre Covid-19)

Date	Binh Thuan	Ninh Thuan	Khan Hoa	Dak Lak	Dak Nong
TOR advertisement	12/2019	Q1/2020	Q1/2020	29/11/2019	Q1/2020
Tenders close	2/2020	4/2020	4/2020	3/1/2020(EOI)	4/2020
Consultants appointed	3 month 2020	8-11 month 2020	8-11 month 2020	6-9 month 2020	8-11 month 2020
Days to complete	180	270	270	270	270
Time design compete	9 month 2020	5-8 month 2021	5-8 month 2021	3-6 month 2021	5-8 month 2021

It is noted that it was mandatory that the appointed design consultants attend a technical study tour to Australia during 2020 to better understand the requirements of a modernised pr3essurised irrigation supply system.

However given Covid-19, this study tour will unable to occur. However, it is proposed that there could still be a video conferencing project which enabled a “virtual study tour” to occur. This is still to be developed by AWP in conjunction with Vietnam and WEIDAP project.

1.3 Key outcomes

The field trip to Dak Lak and Dak Nong was considered extremely successful in the exchange of ideas between the Australian experts, the local PPMU and the feasibility designers.

Dak Nong Province projects are quite different to the rest of the WEIDAP projects in that they primarily involve the construction of a number of weirs. In addition there is some proposed pipeline supply systems. AWP experts (Hughes and Willis) have provided some general comments and suggestions about the Provincial projects. However, the detail around weir construction was outside their specific expertise and have limited their comments to their expertise.

The Dak Lak discussions and field trip involved visiting four out five of the WEIDAP projects and also visited the Cu M'gar project, which is part of an earlier ADB funded project involving the same designer and PPMU staff. These discussion enabled a shared understanding of the potential concepts of a modernised pressurised irrigation supply system. It was agreed that AWP would provide some technical suggestions which had been agreed upon on site as potential options to be evaluated.

This report summarises the findings of the experts visit to both Dak Lak and Dak Nong Provinces, including some observations on the Cu M'gar project.

2 Key issues of modernised pressurised system

As background to the discussion and recommendations for the individual schemes in Dak Lak and Dak Nong Provinces the following sets out some key principles that Aus experts believe is fundamental to the successful operation of such schemes.

2.1 Traditional pumped piped supply systems

The irrigation of agricultural fields can now be thought of in Asia as dividing into three fundamental types of irrigation i.e.:

a. Rice paddy irrigation
b. Field crops like maize, alfalfa, wheat, usually irrigated by gravity flows in furrows or border check layouts, and
c. The application of water to high value field crops (vegetables, flowers and permanent plantings coffee, dragon fruit etc) by using sprinklers/drip/hand held hoses.

Each system requires a different supply system and flow rate to meet the farmers needs.

The traditional gravity canal system has been and still is still effective for to rice and traditional broad area field crops. This report does not address these traditional gravity canal systems but rather addresses the supply systems delivering water to high value agriculture.

It is the high value horticulture/vegetable crops that have seen the biggest "on farm changes" in irrigation techniques in recent times. Compared to the traditional gravity furrow applications the modernisation of on farm application (sprinklers/drip) of water for high value horticulture has led to a dramatic improvement in water efficiency at the farm level. In most cases this means that the farmers are using pumps and pipeline on farm to distribute the water. (It is acknowledged that the use of hand held "watering cans" can also provide very efficient use of water, however the labour requirement of these systems means that they are no longer economic in the modern world.)

To meet the demands of the modernised farm system there is continuing pressure to modernise the supply system from the reservoir (or river) to the farmer by the use of piped (gravity or pump) systems.

It is important to note that the modernisation of irrigation in Vietnam (like Australia) has occurred FIRST at the farm level and it is only now in Vietnam that modernisation of piped supply systems is being considered. Like Australia the first piped supply systems had a number of traditional elements including:

a. Pumping station located in a pit on the inside of the reservoir/river fed by a pipe out into the reservoir or fed by a suction line into the river
b. Constant flow pump and motor that delivers water via a mainline to a header tank controlled by a float switch in the tank
c. A header tank located on the highest point with a capacity of up to several hours of water supply
d. A Gravity line from the header tank supplying a series of small storages
e. Each storage serves about 30ha
f. A Supply system from the storage to the individual farmer via either
    - Water User Group scheme
        i. into separate farmer storages, and
        ii. each farmer having their own pump and pipe connecting to their irrigation system
    - Each farmer having their own individual pump and pipe at the group storage site connecting to their irrigation system.

Overtime Australia has modernised this system to overcome many of the inefficiencies that the traditional system includes. These inefficiencies include:

- Expensive pumping stations
- Large pumps and motors
- All water being pumped at high head
- The header tank is expensive
- The gravity fed pipeline provides low pressure
- Storages are expensive
- There is a duplication of pumps and motors as the system has at least three if not four breaks in the pipes i.e. the water is pumped into a tank, then piped to a storage, then pumped to a farm storage before being pumped again
- The operation of the system requires several different entities i.e. the main pipeline system operated by a IMC? (or equivalent). The system from the storage to the farm is operated by a water user group and then the farmer has to operate his/her own pumping system.

Australia has found that this system when compared to modernised systems is:

- Expensive to build
- Expensive to operate
- More complicated to operate
- Provides an inferior level of service to the farmer
- Less water use efficient.

2.2 Characteristics of a modernised pressurised irrigation system

Australia has evolved over 50 years to reach the current modernised systems. It has taken this long partly because of needing time to get acceptance by the IMC's of the success of the new systems, but also partly because new technology (SCADA, variable speed pumps, digital meters, computers, mobile phones etc) have only become fully available over the last ten years.

The current characteristics of a modernised system are:

a. Pumping stations often use a “floating platform” to locate pumps and motors or alternatively a vertical spindle submerged pump located in a pumping pit depending upon the change in reservoir levels
b. Submersible pumps with variable speed drives
c. Pumps controlled by digital flow meters and pressure sensors in the field
d. Pipelines utilise HDPE pipes that can be field welded
e. Direct connection between the main pump and the farmers irrigation system i.e. There is no need for storages, header tanks or farmers pumps
f. Sufficient pressure is provided to operate the farmers irrigation system
g. All flows to the farm is metered with real time monitoring using mobile phone networks
h. The farmer has “almost on demand irrigation” i.e. Can irrigate almost whenever they wish
i. The system has hydrants to which farmers connect their system to
j. The number of hydrants is carefully matched to the capacity of the pump system and the peak irrigation demand on the farms
k. The design of the pipeline uses computer programs (e.g. “epanet”) to optimally size the pipes and ensure adequate head at the hydrants
l. Pipelines utilise interconnecting “ring mains” to equalise pressure and flows to maintain a high level of service to the farmers
m. The system operates automatically with minimal labor and operating control.

2.3 Pumping stations

There are four distinct types of pumping stations. All systems need to have:

a. Adequate screening to keep debris away from the pump
b. electro magnetic flow meters in use of automation and control.

I. Floating Pond platform pumping station (e.g. Ea Kuang) – the pumps need to:

    a. Physically close or submerged (preferably) in the water to create adequate suction capability
    b. If centrifugal pumps are used care is required to maintain suction
    c. They need to have strength and flexibility to cope with the expected water level range – this strength and flexibility should not be underestimated. (The Vietnam example was considered to be inadequate in this aspect)
    d. Cabling should meet OH&S and we observed inadequacies in this regards
    e. Appropriate access and safe access.

II. Three submersible pumps in a chamber (e.g. Don Duong in Lam Dong):

    a. Suitable for low head
    b. Not suitable for a physically deep chamber (say <5- 10m)
    c. Large submersible pumps are difficult to remove for maintenance.

III. Vertical spindle submerged pump arrangement – refer sketch below:

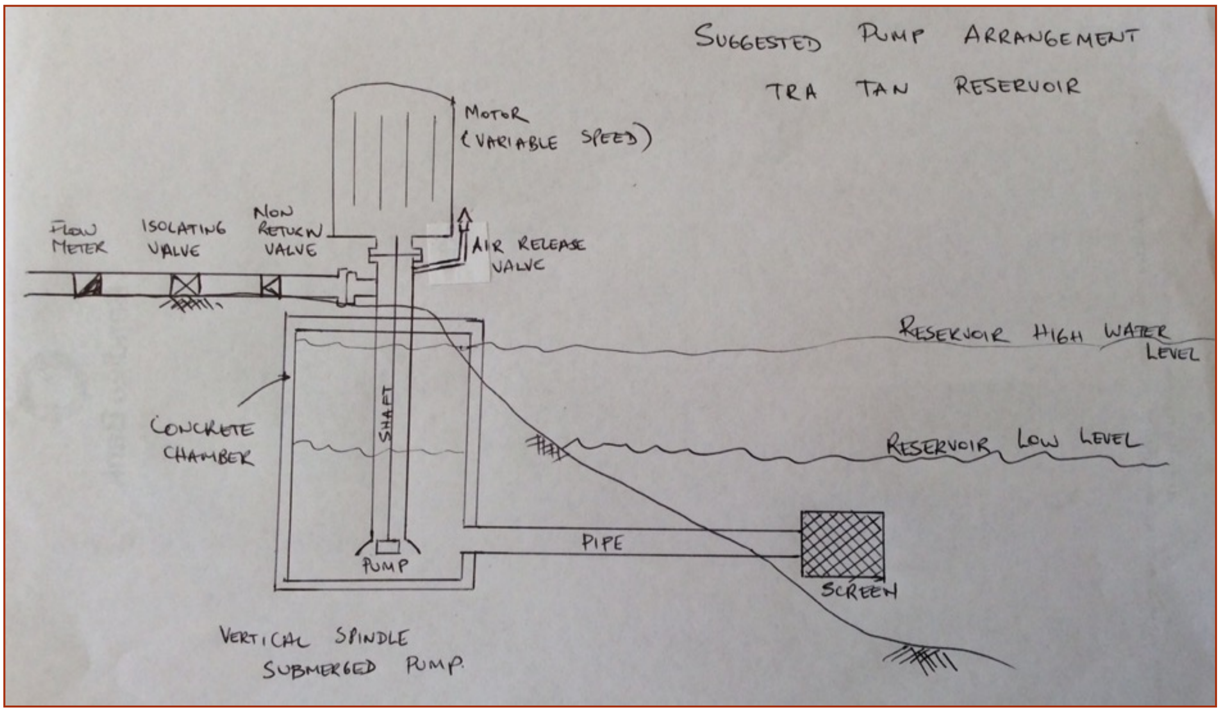


Figure 2-1: Sketch of vertical spindle submerged pump arrangement

a. The chamber can either be located at the edge of the reservoir or into the reservoir with access provided by steel platform
b. Maintenance of the motors allows easy maintenance
c. Often can have a higher cost.

IV. Low level reservoir discharge pipe (as per Cu M'Gar– pump sucks from discharge pit – this option appears simple but is not preferred because:

a. Matching the flow rate to the pump flow is very difficult
b. Requires additional pumping head – even when the storage is full cannot utilise the head
c. Maintenance of the outlet pipe and control valve is difficult.

The selection of the pumping station type will vary site by site depending upon such things as topography, changes in water level, water quality, pumping flow rate, discharge head and the geophysics of the local area.

In order to comment or recommend on pumping station at each site, the AWP experts would need to have further information.

2.4 Pipeline routes

With pressurised pipelines that use a variable speed device (VSD) to control the flow and maintain pressure, the pipeline route does not need to follow the highest land or any particular contour. Practical routes using road alignments and avoiding gullies can be used.

In some situations it is also appropriate to avoid supplying the highest point in the landscape, particularly when that is a relatively small area. It is better for the individual farmer to have their own pump which relifts the water to serve the high land. This means that the whole system does not have to incur the high pumping head thus reducing the operating costs considerably.

2.5 SCADA

As presented by AWP at the Hanoi design workshop the SCADA should be:

- Kept simple
- Considered as two systems i.e. one about the system operator and one about the customer/farmer
  - The system operations has two elements i.e.
    - pump control by pressure sensors and monitoring flows, and
    - monitor water levels, volumes, pressures displaying real time data but use alarms that reports on exception
  - Monitoring of customer water use data – infrequent small packets of data provided in real time to central computer
- Don't automate much except for pressure control and volume control
- Use it to Initiate alarm response
- Use it for data collection – optimise future capital investment/maintenance, understanding of customer use
- Farmers make their own separate decisions about when to irrigate
- Don't mix regional storage data and operations with system operations
- Don't mix regional weather data with system operations
- Don't mix farmers irrigation decisions and the systems operations decisions
- Use mobile phone network.

It would appear that there is not yet in Vietnam an understanding of how to use SCADA to control pump operations automatically within the rural irrigation departments and agencies.

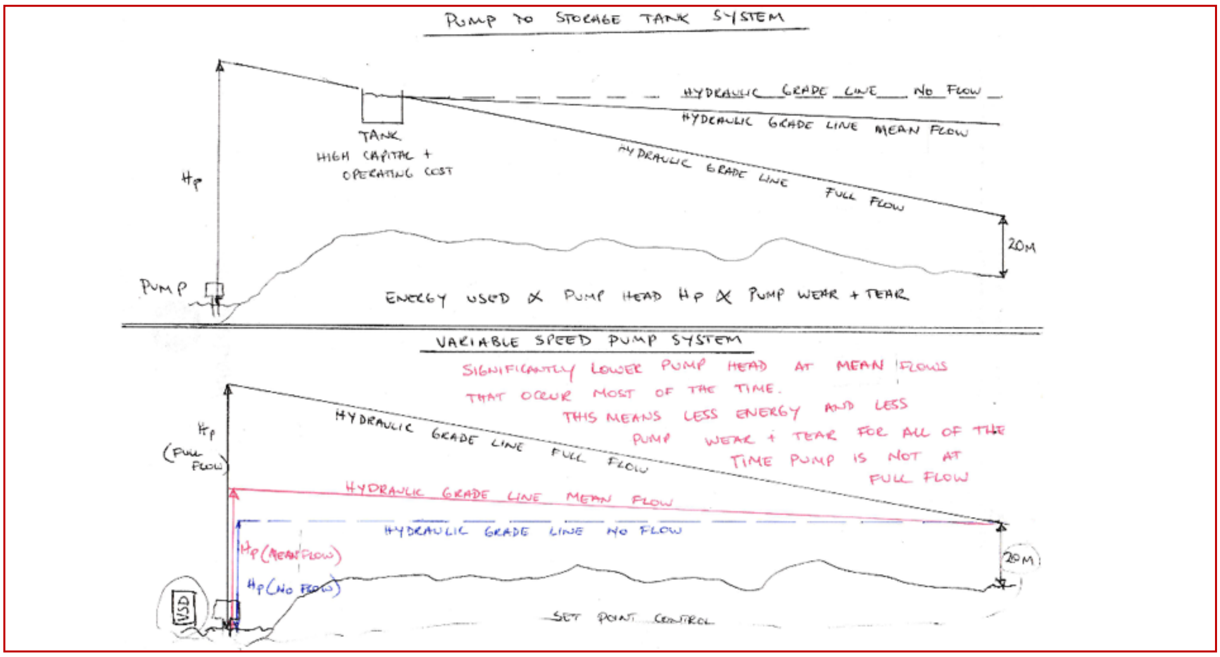
2.6 Variable speed drive pumps and direct connections

In order to provide further explanation of the operation of variable speed pumps as against using a header tank, the following diagrams show the different hydraulic grade lines for both systems.

As discussed in above (Section 2) there are numerous advantages in using a direct connection, variable speed pump with pressure control. One of which is reduced energy costs as shown in the diagram below.

The other advantages are:

I. Avoid a large capital cost of the header tank
II. The pressure delivered to the farmer is not constrained by the physical size and location of the header tank
III. Farmers will get a higher pressure and therefore the need for individual pumping is reduced significantly
IV. Farmers get a much better "Level of Service".



2.7 Locating the pressure sensor to control the VSD

A critical part of the system is deciding what points to monitor the pressure levels and which one (or several) point is selected to control the VSD (Variable Speed Drive).

This is undertaken by constructing the hydraulic grade line (HGL) and determining the highest pressure point. This is best done by the use of a computer program like “epanet”.

2.8 Resistance to modernising the piped supply systems

There are a number of reasons that funding agencies, provincial governments, designers and system operators fail to adopt a modernised system. The most obvious reason is that it is something new and unfamiliar. The modernisation of the supply system requires substantial capital and the “tried and proven” method is the “safe” option even if the alternative is cheaper and provides a better level of service.

The major stumbling blocks experienced in Australia and also in Vietnam are concepts like:

- Variable speed pumps are new and appear more expensive – even though they can be smaller in a modernised system
- Systems controlled by SCADA and pressure/volume sensors are new technology of which the traditional operators (familiar with gravity canals) are not familiar
- Header tanks appear to offer some short term storage in times of failure – even though back up capacity can be designed effectively and the actual storage is expensive and very limited
- The changed hydraulic grade line allows a lower pumping head on average yet delivers a higher and more consistent pressure to the farmers
- Allowing farmers to connect directly into the system means the operators feel like they are losing control – the operator thinks that each farmer having their own storage and pump separates the systems without considering the cost imposition.

It is worth observing that Vietnam has adopted most of the concepts of modernised pressurised pipeline supply system within it's urban water supply systems. However it appears that the concept of allowing "urban water supply" principles within the irrigation supply system is yet to be adopted. In fact there is nothing new to Vietnam in modernising the irrigation supply system – it is simply that the concepts have not made the transition from urban supply to irrigation supply systems.

2.9 Responding to the resistance of modernising

The most successful way of helping the systems to be adopted is that "seeing is believing" i.e. the Australian experience has been shared with Vietnam in an ongoing manner as follows:

a. General Study tour of Australia to provide different examples of how Australia does things
b. Australian expert came and made suggestions to the feasibility design
c. Targeted study tour of Australia where a range of officials and experts inspected a series of pressurised systems in Australia and got confidence
d. Australian experts provided technical input to the design guidelines proposed for Vietnam
e. Australian experts engaged with the specific project teams identifying what is possible
f. The designers will visit Australian and undergo technical training in the field to understand the modernised system
g. Australian experts will visit and provide ongoing mentoring as the system is constructed and commissioned.

Vietnam is fortunate that there are two projects – the Na Ghai cooperative in the Don Duong District pilot in Lam Dong Province and the Cu M'gar pipeline in the Dak Lak province – that provide examples of Vietnams first attempts at a modernised pressurised irrigation system.

To get the biggest benefit from modernisation requires a different way of thinking about the design i.e. it is not a canal design where canals have to flow downhill and follow the natural contour of the land – pipes can be less restrained by the topography.

2.10 Proposed ToR and options

The ToR for the designers suggest that*:*

> *There shall be two options for the layout of headworks: - Option 1 (FS proposed): Pumping into a header tank for subsequent gravity supply (by a pressurized pipe system). - Option 2: Direct pumping into a main pipeline of a pressurized pipe system. Selecting the optimal option for the layout of headworks shall be based on technical and economic arguments/ evaluations, and the requirements for irrigation water delivery services: Equity, Reliability and Flexibility in irrigation modernization projects.*

The following sections provides specific comments on a range of projects to assist Dak Lak and Dak Nong provinces assessing the design options, particularly with regard to option 2.

3 Cu M’Gar scheme

3.1 Description

There is another ADB funded project called “Productive Rural Infrastructure Sector Project in the Central Highlands”. It has a sub project called:

“Cu M'Gar subproject: Repairing, upgrading irrigation system for coffee in the public-private partnership in Tien Cuong village, Quang Tien commune, Cu M'Gar district – Dak Lak Province”.

Objectives of the subproject: are (i) to ensure irrigation water for 350 ha of land area of industrial plants (coffee, pepper, etc.) in Tien Cuong village, Quang Tien commune, Cu M'gar district; apply water-saving technology for 10 ha of land area; (ii) to improve livelihood and life quality of people within the area, promote socio-economic development by investing and promoting the effectiveness of rural infrastructure.

Scope of impacts: The implementation of the subproject will affect land, structures, residential structures and trees, crops of 179 households with 819 affected people; of which 23 households with 138 people are ethnic minorities.

In summary – the project involves:

- A pumping station at Buon Yong Lake/Reservoir – utilises the existing outlet structure and the pump will be located at the toe of the downstream bank of the reservoir
- Variable speed pumps – manually pressure controlled
- Mechanical flow meters for recording total flow volume
- A filter system is not proposed
- The construction of a 4,869m long pipe to carry water to the irrigation area – flow of 1,320m3/hour
- A distribution pipeline system (tree network of approx. 12.3km?) using HDPE – on site welding
- A hydrant system (70no) each serving 5ha where farmers connect direct to the pressurised system
- Remote real time meters
- An additional header tanks to supply an irrigated model with the area of 10 ha which apply water-saving technology for people to visit and study experimental area.

Figure 3-1: (Left) showing existing outlet structure from reservoir and (right) showing the downstream side

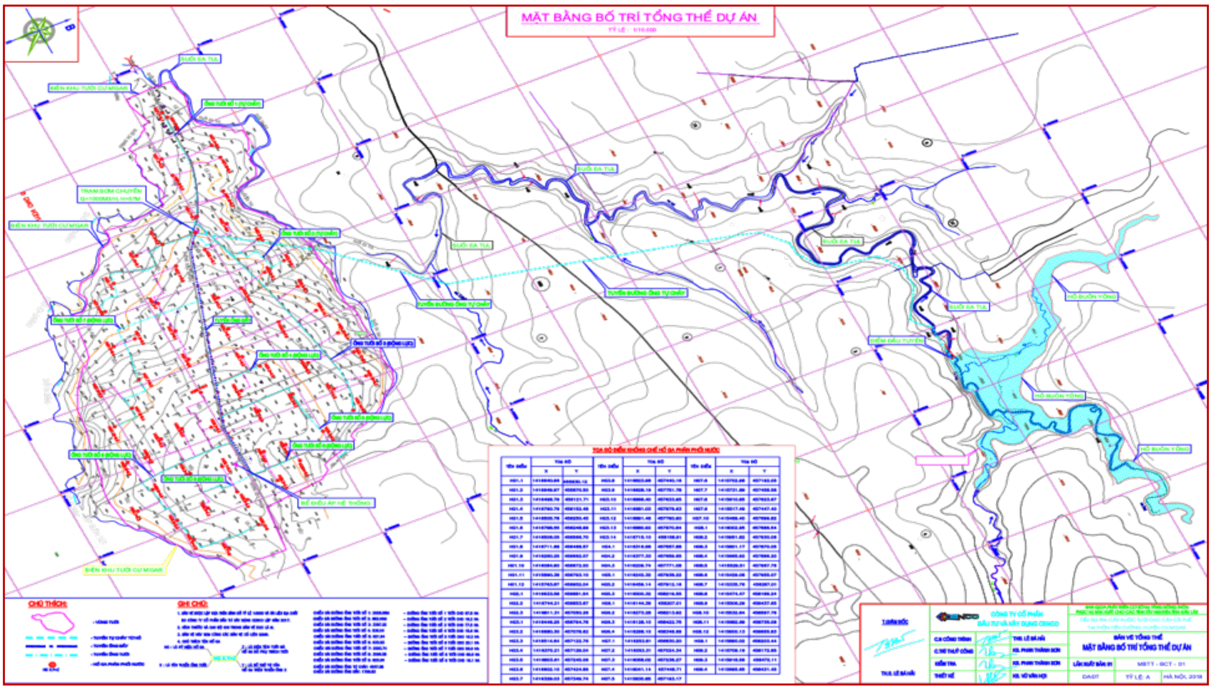


Figure 3-2: Diagram shows the project layout

3.2 Observations

3.2.1 Enormous change for Vietnam

The Cu M'Gar scheme is an example of a "modernised pressurised supply system for coffee production. It is believed to be one of two such examples in Vietnam – the other is the Thanh Nghai co-operative, Don Duong Commune in Lam Dong Province.

This system is unique for Vietnam because:

a. It utilises a variable speed pumping system
b. Farmers directly connect to the pressure pipeline without the need for further pumping
c. It does not use a header tank or any inline storage (except for the small research area)
d. It utilises HDPE piping and infield welding
e. It utilises real time meters for each farmer connection.

These changes have arisen because of the visit to Australia by Dak Lak officials (Mr Con from DARD) during the WEIDAP study tour in Oct 2017.

These two schemes potentially represent an enormous leap forward for Vietnam irrigation supply systems.

3.2.2 Concerns with the Cu M'Gar scheme

During the visit there were a number of concerns raised by AWP experts i.e.:

Figure 3-4: Pressure testing the lines – well done

Figure 3-3: Inspecting the alignment of the pipe – showing insufficient clearance on both sides of pipe

Figure 3-6: Showing the debris around the pipe

Figure 3-5: Offtake structure – the offtake pipe should have connected upstream on the larger pipe to enable better pipe flow efficiencies

I. **Pumping station proposed** – The pump is located at the base of the dam wall and will rely on the existing outlet structure to provide a water supply. (see fig 3.1)This operation will be very difficult to automate and control. It would have been much simpler and better to have a floating platform pump station located on the northern upstream edge of the reservoir dam wall. The automation of the system and also the pressure head required is much reduced

II. **Variable speed drive (VSD) control of pumps** – We were advised that the variable speed pumps were to be manually operated in accordance with pressure. Manual operation could potentially lead to system failure due to over pressurising of the pipelines above their design pressure. As described previously, the pumps should be automatically controlled by the combined use of pressures sensor (SCADA) at the furthest point in the system and by using a digital volume meter at the pump station. The pressure sensor sets the variable speed and the volume meter is used to select the pump combinations

III. **Pressure relief valves** should also be provided as suitable points in the system to ensure that the pipeline design pressures will not be exceeded in the event of a malfunction of the automatic control system or an error of judgement in the manually operated system

IV. **Ring Mains** – the system uses a "tree" layout for the pipes which limits the flexibility of flow around the system. It is suggested that the adoption of a ring mains with inter connecting pipes would have led to a more efficient and flexible system. It is much easier to design and operate and usually involves less pipe cost

V. **Construction techniques of pipe laying** – Construction techniques are critical to the success of pressurised pipe schemes. The pressure rating of the pipe used is PN6 which is suitable for heads up to 60m. We were advised that the operating head was up to 60? m and thus the pipe chosen was ONLY JUST adequate for the purpose. In this case pipe laying becomes even more critical. It was observed that:
    a. Inadequate sand bedding around the pipe
    b. Pressure testing was being correctly undertaken
    c. There should be at least one person foot width between the outside of the pipe and the trench wall on both sides – it was observed that the pipe was touching the trench wall in some cases – particularly round bends
    d. The time that trenches are left open should be limited to 1 day. It was observed that the trenches had been left open for weeks, allowing debris and stones to fall back into the trench and be left in contact with the pipe, creating a future point of failure
    e. The use of isolating valves, pressure relief valves, thrust blocks, scour valves and air release valves was not always best practice and that there were many possible improvements
    f. The construction was not being undertaken in accordance with the design plan particularly with relation to bedding sand, pipe cover and trench width.

Of most importance to the future operation of the scheme is the lack of use of SCADA and automatic control of the pumps. It is considered that this MUST be remedied in order for the scheme to operate successfully.

3.3 Lessons for WEIDAP from existing schemes

3.3.1 Lessons for WEIDAP from Cu M'Gar

In the design and construction of WEIDAP pumped schemes, particularly in Dak Lak the above concerns need to be addressed.

It is noted that AWP experts will be providing assistance to the selected designers. It was proposed that there would be an Australian study tour, unfortunately the COVID virus means that this is not possible in the near timeframe. However it is proposed to have "virtual study tour" which would help the designers understand and overcome some of the above concerns.

3.3.2 Lessons from floating platform pump station – Ea Kuang Reservoir

Whilst visiting Ea Kuang Reservoir, an existing floating platform pumping station was inspected. This was provided as an example of what future Dak Lak WEIDAP projects would utilise.

AWP experts agree that a floating platform pumping station has many advantages however there were also some concerns about the system inspected.

Figure 3-7: View of the floating platform on the reservoir from afar (left) and close (right)

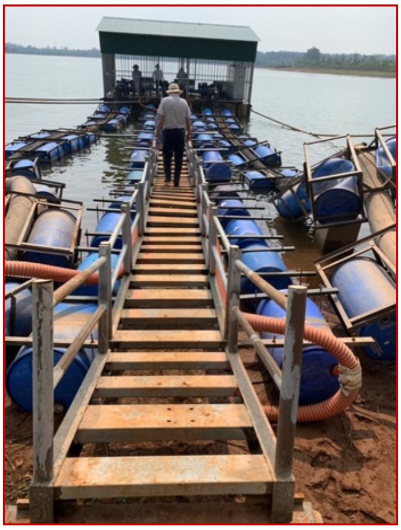


Figure 3-9: The platform structure

Figure 3-8: Internal pumping set up

Figure 3-11: Electrical cable cover was not considered safe

Figure 3-10: Showing the fittings already expanding and in danger of collapse

It was observed that there were a number of deficiencies with the system including:

a. The flexibility and strength of the supporting structure was insufficient and would likely have a very short lifespan. It also was probably insufficient to accommodate the full range of operating levels found in the reservoir
b. The flexible pipe joints were inadequate and would have a very limited lifespan
c. The safety of electricity connections was poor and could lead to accidents
d. The pumps were mounted directly onto a steel floatation pontoon, causing significant sound and noise that could be reduced by the use of more appropriate pump mounts
e. Type of pumps selected – Centrifugal pumps were used in the example floating platform at Ea Kuang reservoir, which require a system of priming. Submersible pumps would be easier to operate, be significantly quieter and eliminate the requirement for priming.
f. A higher level of instrumentation including electronic flowmeters and pressure gauges would allow the pump to be monitored using SCADA from a remote location leading to efficiencies in the operation and maintenance

3.3.3 Lessons from Thanh Nghai Cooperative scheme in Don Duong district – Lam Dong Province

Another of the sub projects within the "Productive Rural Infrastructure Sector Project in the Central Highlands" had adopted modernised irrigation supply system techniques. It is called Thanh Nghai Cooperative scheme and is in the Don Duong district of the Lam Dong Province. The scheme is part of an IDH funded pilot scheme in introducing water use efficiency by the use of a modernised water supply and water charging to service high value horticulture/vegetables.

This is a small (100ha) pumping scheme currently being constructed to replace an existing pumping station and canal distribution system. This system adopts almost all of the modernised pressurised pumping system elements described in Chapter 2 and adopted in Australia. The system, unlike Cu M'gar, does not utilise digital real time water meters to individual farmers. It too did not originally install digital flow meters to control the variable speed pumps but this has since been remedied. The system uses ring mains and submerged variable speed pumps.

A major difference with this system is that the capacity is considered greater than would be considered normal. The system has the potential to supply at least twice the area. A key lesson from this system when it starts operating (in the second half of 2020) will be to identify the peak irrigation demand and hence provide real practical data to assist in determining pipe sizes for WEIDAP.

It is also noted that there is one hydrant for each farmer and every farmer can operate their system at the one time. This is considered a very high level of service which is not proposed under WEIDAP nor Cu M'gar schemes. In WEIDAP and Cu M'Gar schemes, there will be one hydrant for every 5ha or about 5 farmers and only one (maybe 2) farmers can operate at the one time.

A separate report was prepared by AWP experts following a visit in March 2020 and provided to CPO/IDH.

Many of the learnings from this project can be applied to WEIDAP and it is critical that the WEIDAP designers become familiar with the new pumping scheme at Thanh Ngai cooperative and its operating conditions and flow rates etc.

4 Dak Lak pumped schemes

Within Dak Lak Province there are up to 8 schemes (7 pumping from reservoirs and one gravity system) based around five reservoirs that are proposed to deliver water to high value agriculture i.e. coffee and black pepper. The schemes are summarised in the table below.

AWP experts visited four of the reservoirs (did not visit Ea Drang system) and comments for each individual system are provided below. However the following general comments apply to all schemes

I. **Cu M'Gar lessons** - It is noted that the concerns raised at the Cu M'Gar system noted previously also directly apply to the proposed Dak Lak WEIDAP sites and are not repeated here

V. **Variable speed pumps without header tanks** - In every case AWP recommend that variable speed pumps without header tank and with direct connection to the farmer system be adopted. Assuming this is accepted then alternative pumping routes that are more efficient (reduced energy/pipe size and cost) would result providing a better level of service to the farmers

VI. **Surge control** - It is noted that in all of the systems there is a very high pumping head. With the high pumping head, careful analysis of the pressure surges at pump start up and stop, and in the event of a power failure would be a consideration. Variable speed control of the pump would help to reduce the start-up surges

VII. **Air release** - All of the new irrigation systems should have automatic air valves to release air on charge up and to let air back into the system when draining or in surge scenarios

VIII. **Pumping sites and pipeline routes** - The main issues addressed in the following relate to potential pumping sites and pipeline routes. Specific site by site issues are addressed in each section below. However generally:

    a. each hydrant is considered to serve 250m and thus the spacing between pipelines should be approx. 500m or more. Many of the proposed routes are unnecessarily closer than 500m and should be modified
    b. the spacing between the pipeline and the irrigation area boundary should be approx. 250m. Many of the proposed routes are not spaced appropriately or efficiently

c. the routes do not need to follow exactly a 250/500m spacing but rather can follow convenient paths i.e. along roads and avoid creek or deep valleys

IX. **High land or hills** - Some of the sites have some small areas of high land which require a very high head. It is suggested that these areas only have hydrants at the bottom of the hill and the system NOT provide sufficient head for irrigating. Rather the individual farmer should use their own pump to provide whatever extra head is necessary. If this is not undertaken the cost of pumping will be greatly increased across the whole scheme unnecessarily

X. **Filters** - There was no discussion around the use of filters at the pumping sites. This issue needs to be considered and will depend on the water quality at each site.

Table 1: Summary table of Irrigation Systems' parameters
Bảng 1: Bảng tóm tắt thông số các hệ thống thủy lợi

Reservoir Hồ chứa	Irrigation system Hệ thống thủy lợi		Area Diện tích (ha)	length Chiều dài (km)	Density (m/ha) Mật độ (m/ha)
	Supply/ *Cung cấp*	Distribution / Phân phối			
Ea Drang	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	150	2,70	18,0
Buôn Yong	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	451	8,51	18,9
Ea Kuang	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	422	15,78	18,7
	Existing open canal *Kênh mở sẵn có*	New piped *Đường ống mới*	424		
Krong Buk Ha	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	200	3,45	17,3
	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	400	6,86	17,2
	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	200	3,85	19,3
		New piped *Đường ống mới*	200	3,31	16,5
Doi 500	New pump station *Trạm bơm mới*	New piped *Đường ống mới*	203	4,07	20,0
Total = 5 Tổng số =5		8 systems 8 hệ thống	2650	48,53	AV 18,3

Figure 4-1: Summary table of Irrigation Systems' parameters

4.1 Ho Ea Kuang

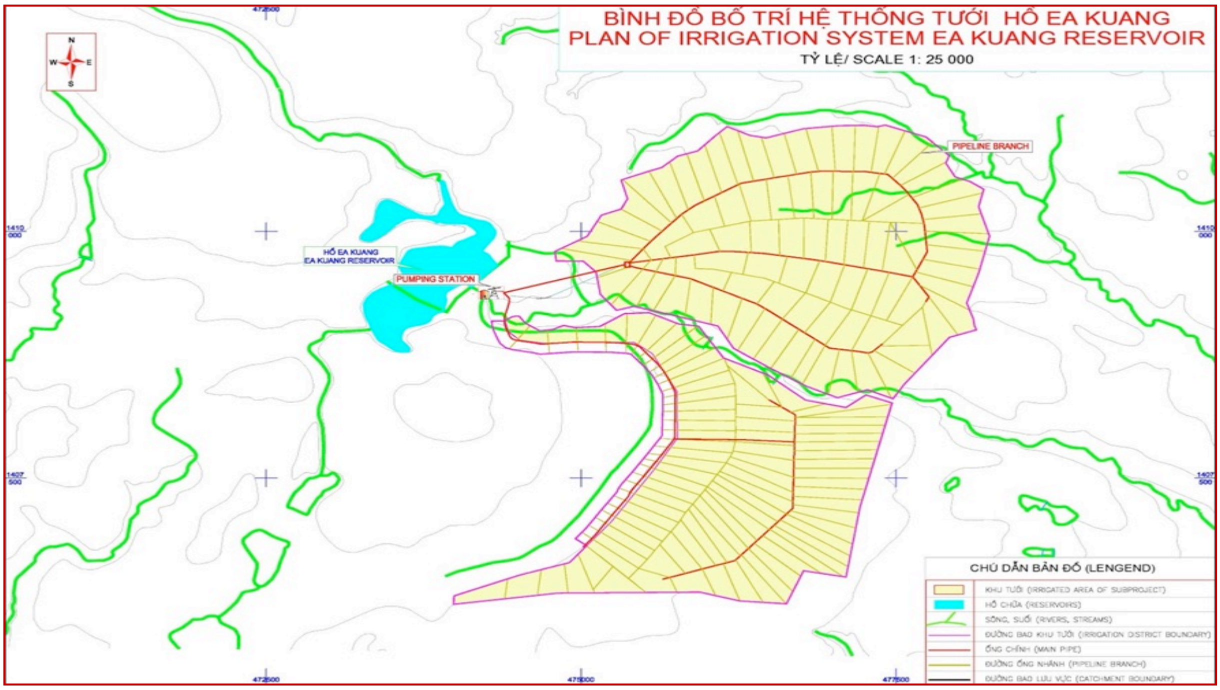


Figure 4-2: Map of Ho Ea Kuang

This system comprises two elements – a pumping scheme to high land and a gravity canal feeding a gravity pump to lower land. Each system is independent of the other and is discussed separately.

It is noted that the AWP experts have particular concerns with the proposed pumping site and the proposed canal design as the canal design are both likely to be fail unless substantially modified*. *The proposed pumping site increases the pumping head significantly unnecessarily.

4.1.1 Canal with a gravity pipeline

Description

The current system utilises a contour canal to:

a. supply farms either by direct individual farmer pumps connecting to the canal or
b. supply a gravity canal to each property.

The current canal was lined with concrete and was carefully designed so as not to overflow. The current design is shown in the sketch below.

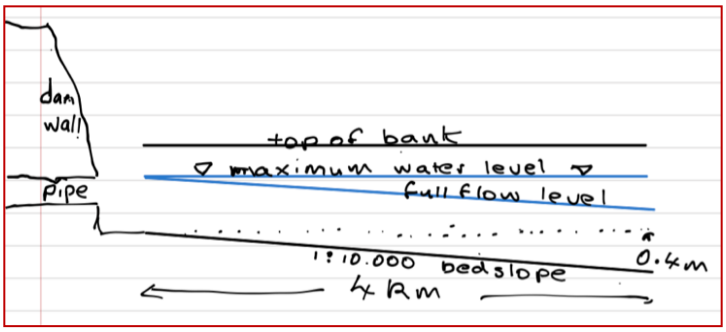


Figure 4-3: Current canal design

Figure 4-4: (left) showing the start of the canals system and (right) showing the middle part of the system

The proposed upgrade is to:

a. modernise the canal and to construct a concrete lined canal using box culverts
b. enable farmers adjacent to the canal to pump directly from the canal
c. construct a gravity pipeline with hydrants to supply the downslope properties.

The proposed hydraulic grade line of the canal is shown below and will have significant operational problems if constructed as designed.

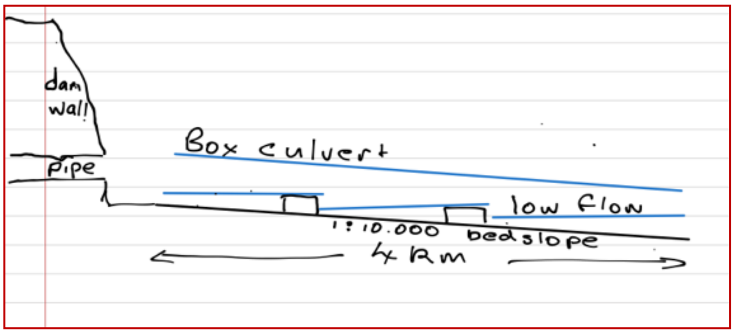


Figure 4-5: Proposed hydraulic grade line of the canal

To enable sufficient head to enable pumping off takes to work successfully at low flow in the upstream part of the canal there will need to be a series of low level weirs in the box culvert as shown above. Controlling the flow to match the pumping demand without having excess water escape at the end of the system is very difficult to achieve.

This system can only work effectively if there is a large percent of the water allowed to overflow at the end of the system.

Suggestions

Canal design - *The current proposed canal design will fail to operate successfully*. Considerable time was spent with the designer and the local PPMU officials advising them of the deficiency of the system. The canal should be designed as per the current system (see first sketch) i.e.:

a. The canal bank should be “level” for the full length of 4km
b. The canal bed should have a falling grade of 1:10,000 – 0.4m fall for the canal length
c. The farm offtake points should be a pit with:
   - A floor lower (0.5m) than the canal bed to ensure sufficient depth of water at all times and
   - Have a top point above the canal bank to prevent overflow
d. Incorporate cleaning and scouring points in the design of the canal to allow this to be regularly cleaned.

4.1.2 Pumping system

Description

This project is to rehabilitate the existing outlet from the reservoir and to build a new pumping system from the start of the canal to supply water by pumping across a steep sided water course. The pumping station would be controlled from a header tank at the high point.

Suggestions

Pumping station location - The route of the pumping main across the steep sided water course would be difficult terrain to construct a pipeline in. Consider an alternative location of the pumping station to reduce the pumping head of the system, reducing capital and operating costs. A simpler route that would mean a significantly ***lower pumping head*** and be much easier to control would be to build a new pumping station near the end abutment of the reservoir and to pump along the rising main to the high point. This new station could be a floating platform or a more traditional pumping pit with an inlet pipe. There was little information about the variation in water level in the reservoir. The design would need to consider this before a decision is made to use a floating Pumping Station solution.

Existing outlet structure - The condition of the existing outlet valve located deep within the dam wall was unknown. although the local operator indicated that it leaked and couldn’t be shut off completely. There was no evidence of any recent maintenance. Condition of the existing outlet valve be investigated as it is pivotal as to whether to use this existing outlet or to build a new Pumping station at the northern embankment of the reservoir.

Pipeline route - An alternative pipeline route is shown in the attached sketch in appendix B The key suggested changes are:

a. The middle pipeline is not necessary to provide 250m maximum access distance from the hydrant
b. The bottom and top pipelines should be connected into a ring main.

4.2 Krong Buk Ha

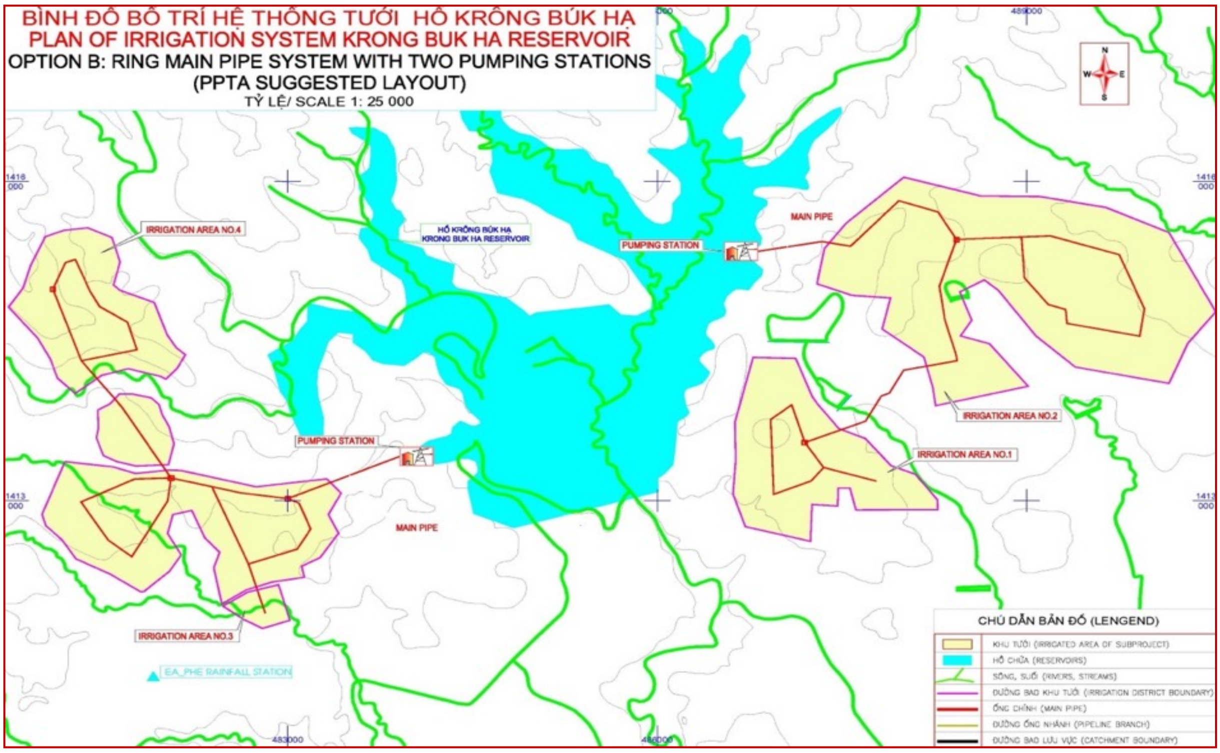


Figure 4-6: Map of Krong Buk Ha

4.2.1 Description

Two options were provided to supply four new irrigation areas. One option has 3 pumping stations and the other has two. The two pumping station option has a relift pumping station to lift water from one irrigation area into the other. In both options, tanks would be used to control the pumps. The designer suggested that in both options the pumping stations would be floating on the reservoir.

Figure 4-8: The Reservoir

Figure 4-7: Discussing the plans

4.2.2 Suggestions

Pumping in series - This is not recommended even if variable speed drive pumps were used. This is because managing two pumping stations in series requires careful controls and additional levels of protection in the control system.eg. Pressure relief valves to protect against malfunction of the control system, Dampening of VSD control responses to avoid pressure surges and controls to ensure that PS1 operates before PS2 starts.

Number of pumping stations - By using variable speed drive pumps without header tanks and directly connected to the hydrants supplying the farmers, there is only need for two pumping stations – one on each side of the reservoir. The alternatives proposed using header tanks and two pumps in series can be quite difficult to control hydraulically, potentially leading to large surges in the systems.

Pumping stations - The pumping station location appeared ok although there was little information about the variation in water level in the reservoir. The design would need to consider this before a decision is made to use a floating Pumping Station solution.

Pipeline route - The pumping head of this system is quite high because of the elevation of the properties being supplied. However, the properties supplied are at a relatively uniform level with only 5-10 m difference across the high points on each of the two systems. An alternative route connecting the properties is shown. The key aspects of the alternative routes are:

a. Ring mains always provide a better and more consistent pressure level under a wider range of conditions and are easier to operate and maintain.
b. In this case the ring mains MAY BE more expensive and alternative is provided, however if the cost difference or it provides the opportunity for a simpler route, then the ring main should be used.

Pump control - It is recommended that the pumps should be fitted with variable speed drives and be controlled by pressure at the high point and at the ends of the system. This, together with the alternative route of the rising mains would significantly reduce the pumping head requirement and the operating costs of the scheme.

4.3 Buon Yong

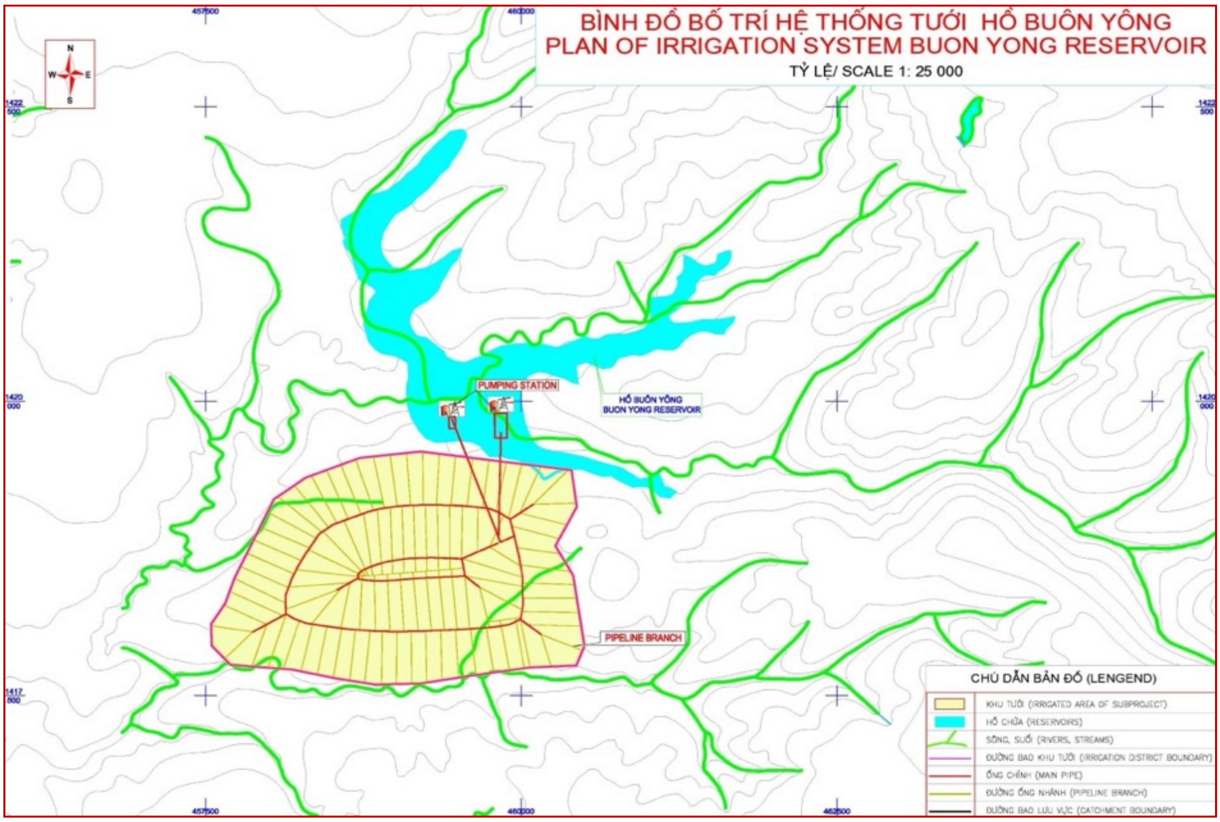


Figure 4-9: Map of Buon Yong

4.3.1 Description

This project is located at the same reservoir as the Cu M'Gar project described previously.

The proposal was to build a new floating PS in a shallow area of the reservoir near the southern abutment, or a pumping station located further along the embankment. The suction pipework would extend approximately 20 meters out into deeper water from the shoreline. The proposed floating pump station is similar to the floating pump station in existence at the Ea Kuang reservoir that was inspected by the AWP expert team.

The project is to pump to a header tank and then have a gravity supply system.

Figure 4-11: The proposed site for the floating platform pump station

Figure 4-10: Rob Hughes inspecting the highest point in the irrigation area with the feasibility designer Mr Phan Thanh Son and interpreter Ms Chung Vu

4.3.2 Suggestions

Pumping stations - The pumping station location appeared ok although there was little information about the variation in water level in the reservoir. It appeared to be a very shallow arm of the reservoir and a channel may need to be excavated to bring sufficient water at a good quality to the pump suction. The design would need to consider this before a decision is made to use a floating Pumping Station solution. The comments on the limitation of the existing Ea Kuang reservoir floating platform pumping station as outlined in Section 3.3.2 also apply to this proposal.

Pipeline route - A slightly modified pipeline route has been proposed as per Appendix B. The key changes suggested are:

a. Only one pipe is required in the centre of the area and it should follow the road
b. The alignment of the northern pipeline should avoid the gulley and be a bit higher on the ridge (subject to local conditions).

Pump control - It is recommended that the pumps should be fitted with variable speed drives and be controlled by pressure at the high point and at the ends of the system. would significantly reduce the pumping head requirement and the operating costs of the scheme.

4.4 Doi 500 Hill

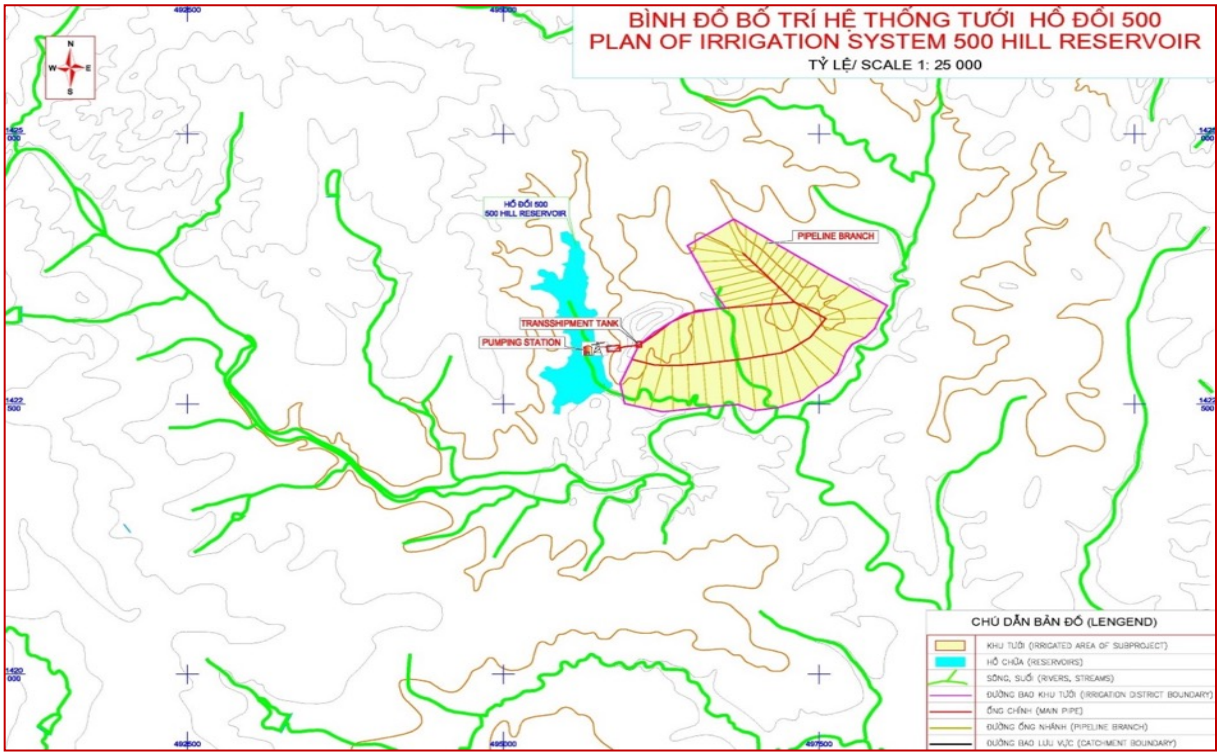


Figure 4-12: Map of Doi 500 Hill

4.4.1 Description

A new pumping station to be built in a bay of the 500 Hill Reservoir and pump water to a tank , located on a ridge between two distinct hills. The pumping lift is approximately 50 mH. The proposed tank would be 2500 cubic metres volume. The pumping station is located approx 300 metres from a power transformer. The area had what appeared to be black sandy soil suitable for pepper. Existing watering systems were manual by hand. The farmers pumped water from ponds that they had dug in the stream and there were also groundwater wells evident. We talked to a farmer who stated that they had been consulted about the new scheme and were looking forward to it. The designer suggested that the new Pump Station could be a floating PS, but would be semi automatically controlled using a level sensor in the tank. The land fell away steeply from the tank site and farming properties were much lower level than the ridge.

Figure 4-13: Proposed pumping site (left) and alternative site (right)

Figure 4-14: The area to be irrigated

4.4.2 Suggestions

Pumping stations - The pumping station location appeared ok although there was little information about the variation in water level in the reservoir. It appeared to be a very shallow arm of the reservoir and a channel may need to be excavated to bring sufficient water at a good quality to the pump suction. The design would need to consider this before a decision is made to use a floating PS solution.

Pipeline route - The pumping head of this system is quite high because of the elevation of the ridge, however, the properties supplied are at a quite low elevation running away from the other side of the hill. The suggested changes to the pipeline route is provided in Appendix B. The main suggested changes are:

a. The designer should examine an alternative route (refer Appendix B) of the rising main that would follow the contour to the south west of the two hills
b. The southern section of the pipeline could be relocated to enable the correct spacing.

Pump control - It is recommended that the pumps should be fitted with variable speed drives and be controlled by pressure at the high point and at the ends of the system. This, together with the alternative route of the rising main would significantly reduce the pumping head requirement and the operating costs of the scheme.

4.5 Ea Drang (Thi Tran)

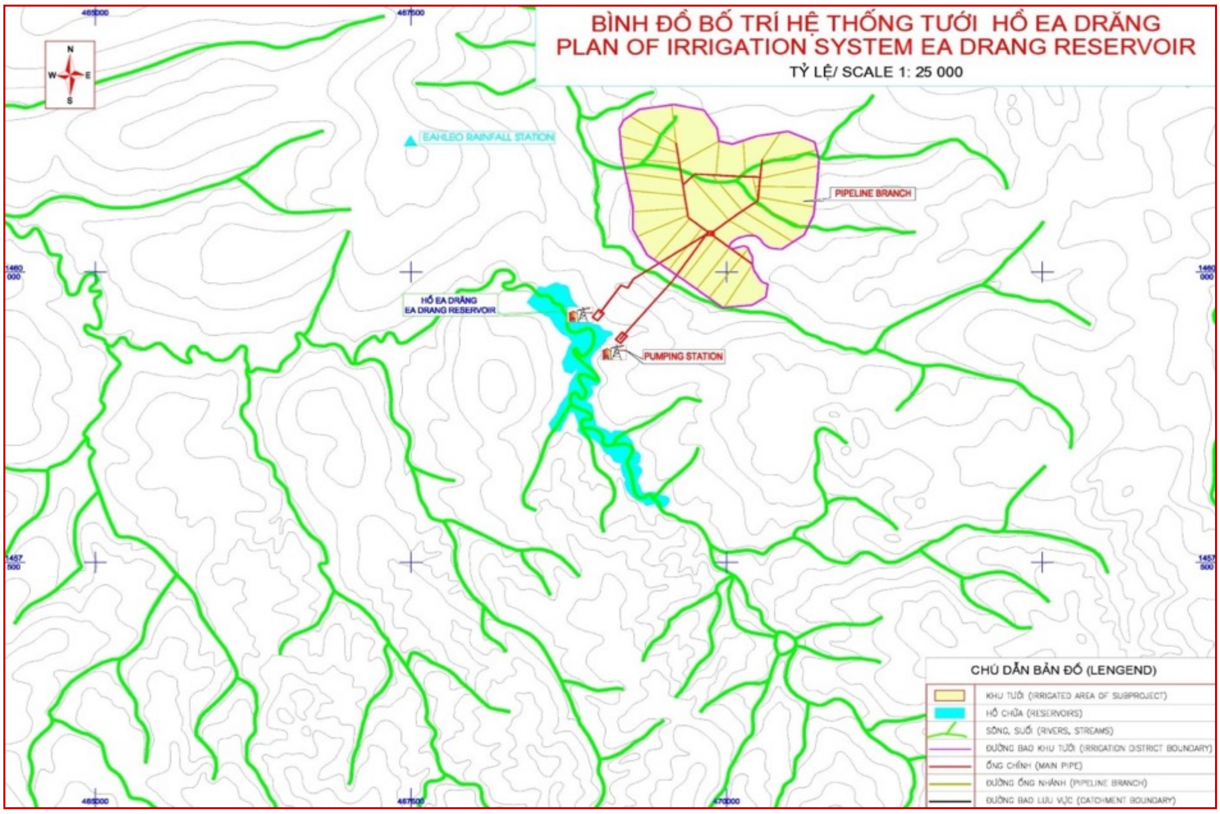


Figure 4-15: Map of Ea Drang (Thi Tran)

AWP experts did not visit this site however make the following minor suggestion for a modified pipeline route suggestions based on topography and contours. This is shown in Appendix B and involves moving the interconnector pipe further north to avoid dead ends in the lines.

5 Dak Nong schemes

During the Hanoi workshop the “Managerment Unit for Investment projects on Construction of Agriculture and Rural Development (SPPMU) outlined the following for the Dak Nong Province WEIDAP schemes of Cu Jut and Dak Mill.

Overall requirements: During the implementation process, the consultants must comply with the current recommended standard frameworks for surveys and designs as listed in the Appendix 1, and the WEIDAP Guidelines for Detailed Engineering Design, the Design Principles for Subprojects and Subproject Report: Dak Mil Subproject, Subproject Report: Cu Jut Subproject. Spencifically, designs of pressured pipe systems shall/should observe the design standard: Water supply – Distribution pipeline system and facilities (TCXDVN-33:2006).

Attending the study tour in Australia to visit the systems in the Riverland region of South Australia where the policy and institutional framework has been established, to increase water use efficiency in agriculture and developed pressure piping systems and/or water-saving irrigation technologies to be installed in the system.

5.1 Cu Jut

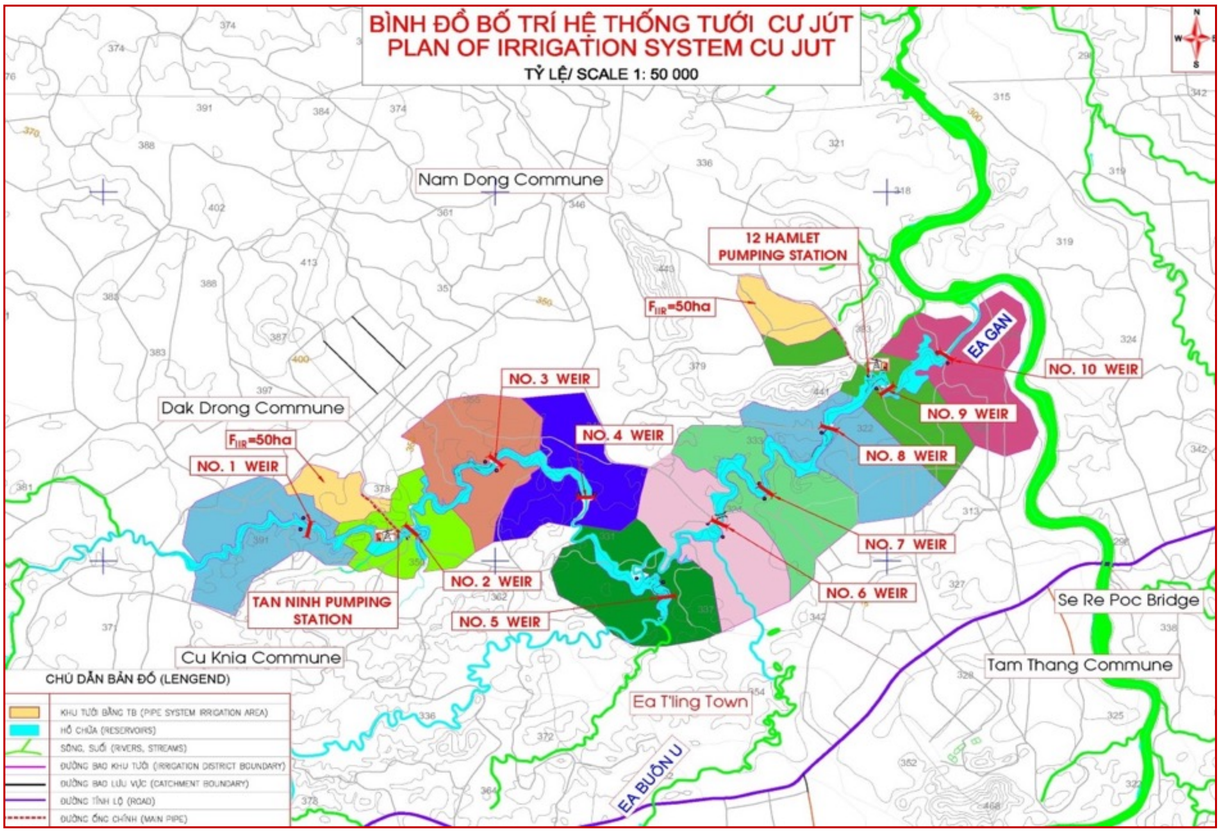


Figure 5-1: Map of Cu Jut

5.1.1 Description

The subproject comprises: (i) 10 permanent weirs to replace farmers' temporary weirs, supplied from the existing Dak Dier and Dak Drong reservoirs, (ii) two pumped-pipe demonstration irrigation systems, supplied from weirs 2 and 9, each serving about 50 ha, and (iii) upgrading of 10.95 km of access road. The layout of the 10 weirs and their service areas is attached.

AWP experts (Hughes and Willis) inspected weir sites 2 and 9 and were told the remaining weir sites were similar. The two pumped pipe demonstration irrigation systems were to be installed at these two sites. Thus the comments for this scheme are limited to these two sites.

The weir will be 3m high and 10 meters wide at Site 2. Weir 9 seemed to be much drier (much further downstream) and the crops were cashew and Coffee watered manually by hoses and pumping from the river by tractor.

The water availability at each weir will be determined by a balance of:

- Upstream reservoir release
- Storage volume in reaches
- Water use in reaches
- Environmental flows.

The monitoring of the flows will utilize SCADA although the exact details are yet to be determined.

The two proposed pumping schemes are based on the traditional concept of pumps extracting water from the weir pool and storing the water temporarily in “header tanks” at the highest point of the area proposed to be irrigated. The pumps were to be manually controlled . A gravity pipeline to each property is then proposed. It was not clear whether the farmers would have direct access to the gravity pipe or whether they would need on farm storage.

Local crops were Pepper and Coffee, both crops appeared to be suffering from inadequate watering.

Watering was predominantly hand hose although the were some higher overhead sprinklers and under tree sprinklers.

Figure 5-4: Weir 2 crossing

Figure 5-2: The Pepper vines at weir 2 site

Figure 5-3: The local farmers at site 2

5.1.2 Suggestions

Weirs

Neither of the AWP experts were detailed experts in building weirs but they do have general experience and made the following suggestions.

Design - The design of weirs is a specialist engineering field and the project must ensure the design consultants have sufficient expertise.

Flooding - Weir needs to be designed for a return year event (e.g. 1:100 or 1:1,000) year flood condition based on some water resources modeling.

Geophysical conditions - The construction of a weir should be based on a geophysical survey, there was no evidence provided that this has been done.

Scours - Scours should be incorporated into the design to flush the silt build up from the upstream side.

SCADA - The weir should include SCADA and Flow measurement (suggest V notch).

WEIR 9 - The weir at Site 9 would have to go across the mainstream and a subsidiary creek, seemed an excessive length.

5.1.3 Pumping system to farms

As discussed in chapter 2 of this report, the proposed system is expensive to build and operate and provides a poor level of service to the farmer. Rather it is recommended that the system follow those described in section 2.2 of this report i.e.:

I. Does not use a header tank but uses variable speed pumps directly connected to the pipeline that supplies the hydrants for farm connections
II. The variable speed pumps are controlled by pressures sensors (SCADA) and volume flow meter
III. Provides sufficient pressure at the hydrant to avoid the need for farmers to repump
IV. Provide hydrants on the section of pipe nearest the pump to supply adjacent landholders. Also suggested to pick up delivery to growers on the way past with the pumping system.

5.2 Dak Mill

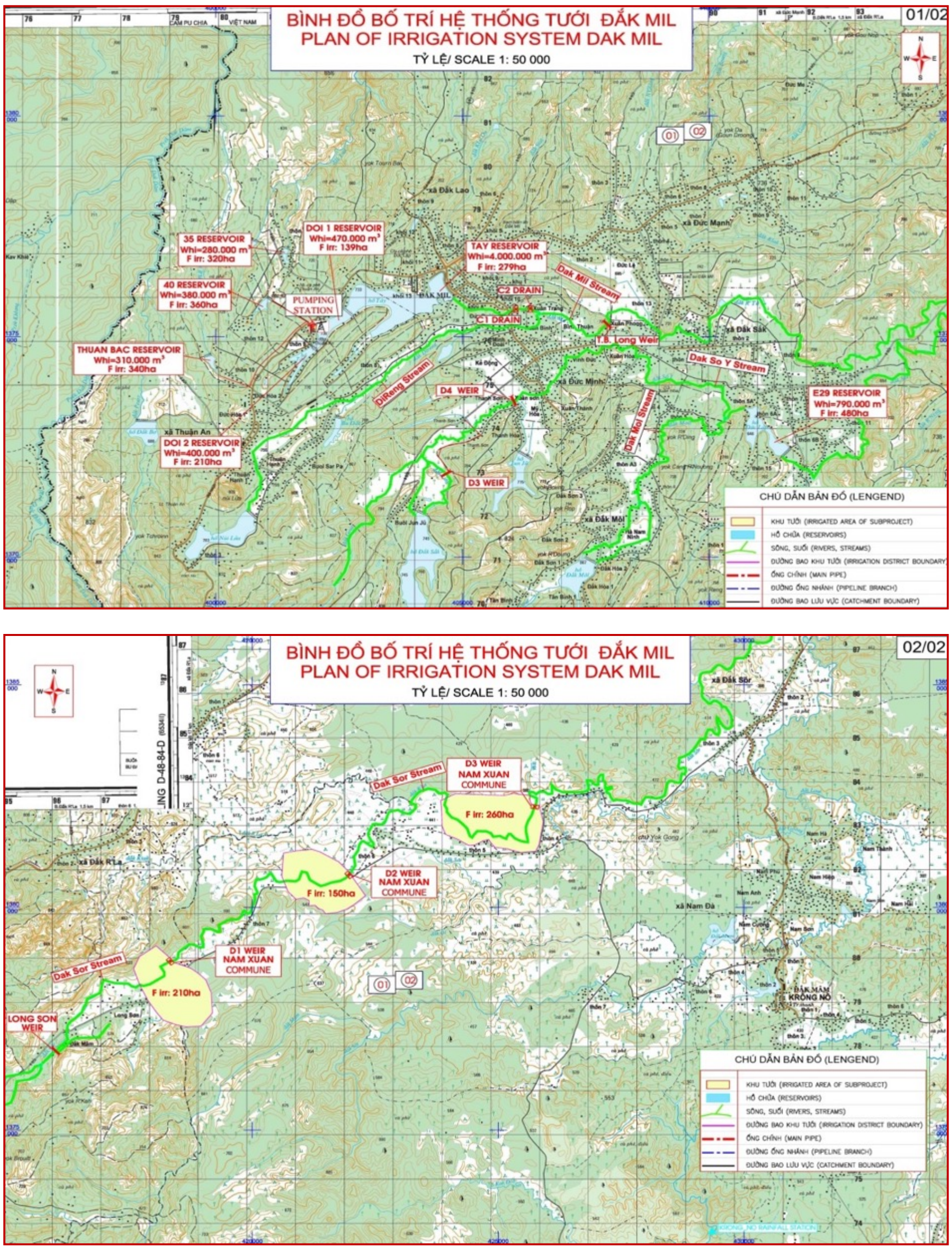


Figure 5-5: Maps of Dak Mill

5.2.1 Description

It is not completely clear to AWP experts what is involved with this project as it described slightly differently by the notes for the Hanoi Workshop and to the notes in the TOR for design consultants as follows.

The investment contents of Dak Mil subprojects include: (1) Upgrading existing reservoir; (2) Upgrading and constructing new weir to raise and store irrigation water; (3) constructing new water transfer and irrigation pumping stations; and (4) Upgrading and constructing new irrigation canals and pipelines.

The subproject includes: (i) upstream works: rehabilitation of 24 existing structures including structures on four existing storage reservoirs, five existing diversion weirs, construction of 2.75 km of reinforced concrete box culvert, construction of a new pumping station, to replace a temporary one, on Reservoir #1; (ii) downstream works: replacement of farmers' temporary weirs with three permanent un-gated weir structures, and (iii) road upgrading together with bridge/ culvert crossings.

It is noted that the AWP experts (Hughes and Willis) only visited the one site which was the proposed new transfer pumping station site. Thus the comments are limited to that site and works only.

Water is currently delivered to a storage, then re-lifted to a second. Water level was low in both storages. Farmers were using several small pumps to move water from one to the next.

A new pumping station and rising main will be built from the Dak Mil Reservoir to supply water to a splitter chamber and then using open box section to supplement supply to three smaller reservoirs.

The figures below show the reservoirs to be supplied.

Figure 5-6: The reservoirs to be supplied

Figure 5-7: Reservoir water source. Existing temporary pump and power supply

5.2.2 Suggestions for pumping system

The proposed design needs some careful consideration and the AWP experts did not have time to become completely familiar with the scheme and what is required. However the following comments are provided:

Pumping station - The pumping station location needs some consideration. Current proposal is on a very shallow arm of a large reservoir and may involve a floating platform. The difference in reservoir heights (minimum and maximum) need careful consideration when designing the pumping station.

Splitter box - The splitter box system described would need careful design hydraulically, and this was going to be used manually to balance the flows against the pump operation. It would be preferable to consider some form of automation and control structures that divided the flow to match the demand. The use of splitter boxes is a very traditional method and does not take advantage of modern systems that use SCADA and variable speed pumps that operate according to the required flow level and volumes.

Control of flows - The Control of the flows to each reservoir should use Variable speed drive pumps that have automatic control valves and to be monitored by flowmeter/pressure levels using SCADA.

Rising main - Reasonably high head, suggest look at steel or Ductile Iron for the rising main.

Air relief and surge - Design needs to incorporate air relief valves and surge attenuation.

Appendix A: WEIDAP Projects Details and Location

Province	Sub project area	Area irrigated	Main crop	Proposed works
Ninh Thuan	Thank Son – Phuoc Nhon	1,781ha	New development High-value crops	Gravity Piped supply extensions of main supply line
Ninh Thuan	Nhon Hai – Thanh Hai	1,000 ha	Vegetables, wine, pepper, etc.	Gravity Piped supply from the main pipeline
Binh Thuan	Du Du Tan Thanh	1,960 ha	Dragon Fruit	Gravity piped supply
Binh Thuan	Tra Tan	300 ha piped 790 ha canal	Rice and pepper, cashews	Pumped Piped supply & upgrade canal
Khan Hoa	Cam Ranh	2,026 ha	Mango and rice	Pumped Piped supply & upgrade canal
Khan Hoa	Suoi Dau	386 ha	Mango and rice and other vegies/fruit/flowers	Pumped pipe supply & upgrade canal
Dak Lak	Ea Drang	150 ha	Coffee and black pepper	Pumped pipe supply
Dak Lak	Buon Yong	451 ha	Coffee and black pepper	Pumped pipe supply
Dak Lak	500 Hill	203ha	Coffee and black pepper	Pumped pipe supply
Dak Lak	Krong Buk	2 pumped systems of 954ha, and 311 ha	Coffee and black pepper	Pumped pipe supply
Dak Lak	Ho Ea Kuang	536 ha pumped pipe 409 ha gravity pipe from canal	Coffee pepper, rubber cashew and fruit trees and rice	Pumped pipe and gravity pipe from canal
Dak Nong	Dak Mil	Up to 5,375 ha with more secure supply	Coffee	3 weirs and rehabilitation
Dak Nong	Cu Jut	Up to 2,163 ha with more secure supply	Coffee and black pepper	10 weirs


VIET NAM
WATER EFFICIENCY IMPROVEMENT
IN DROUGHT AFFECTED PROVINCES
National Capital
Provincial Capital
National Road
District Boundary
Provincial Boundary
International Boundary
Boundaries are not necessarily authoritative.
PROOF ONLY
Hanoi
Hai Phong
Hue
MAIN MAP
Ho Chi Minh City
Gia Lai
Ea Sup
Ea Hleo
Dak Lak
Krong Nang
Krong Buk
Buon Don
Cu Mgar
Ea Kar
M Drak
Buon Ma Thuot
Krong Pak
Cu Jut
Dak Mil
Krong Ana
Krong Bong
Lak
Krong No
Dak Nong
Tuy Duc
Gia Nghia
Dak Rlap
Dak Glong
Phu Yen
Van Ninh
Ninh Hoa
Khanh Hoa
Nha Trang
Dien Khanh
Cam Lam
Bac Ai
Cam Ranh
Ninh Thuan
Ninh Hai
Phan Rang-Thap Cham
Ninh Phuoc
Tuy Phong
Bac Binh
Binh Phuoc
Lam Dong
Dong Nai
Duc Linh
Ham Thuan Bac
Tanh Linh
Binh Thuan
Ham Thuan Nam
Phan Thiet
Ham Tan
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Ba Ria - Vung Tau
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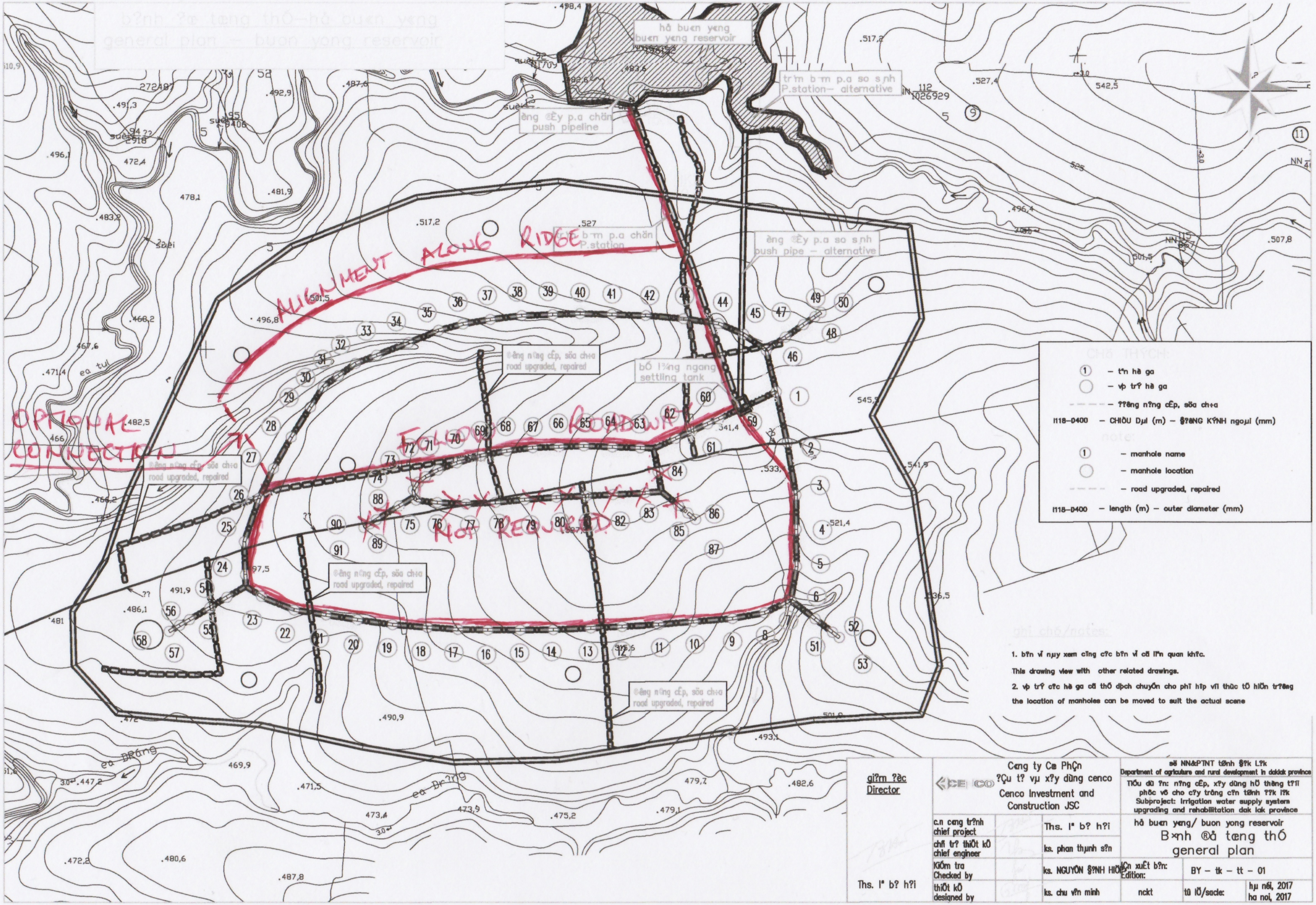
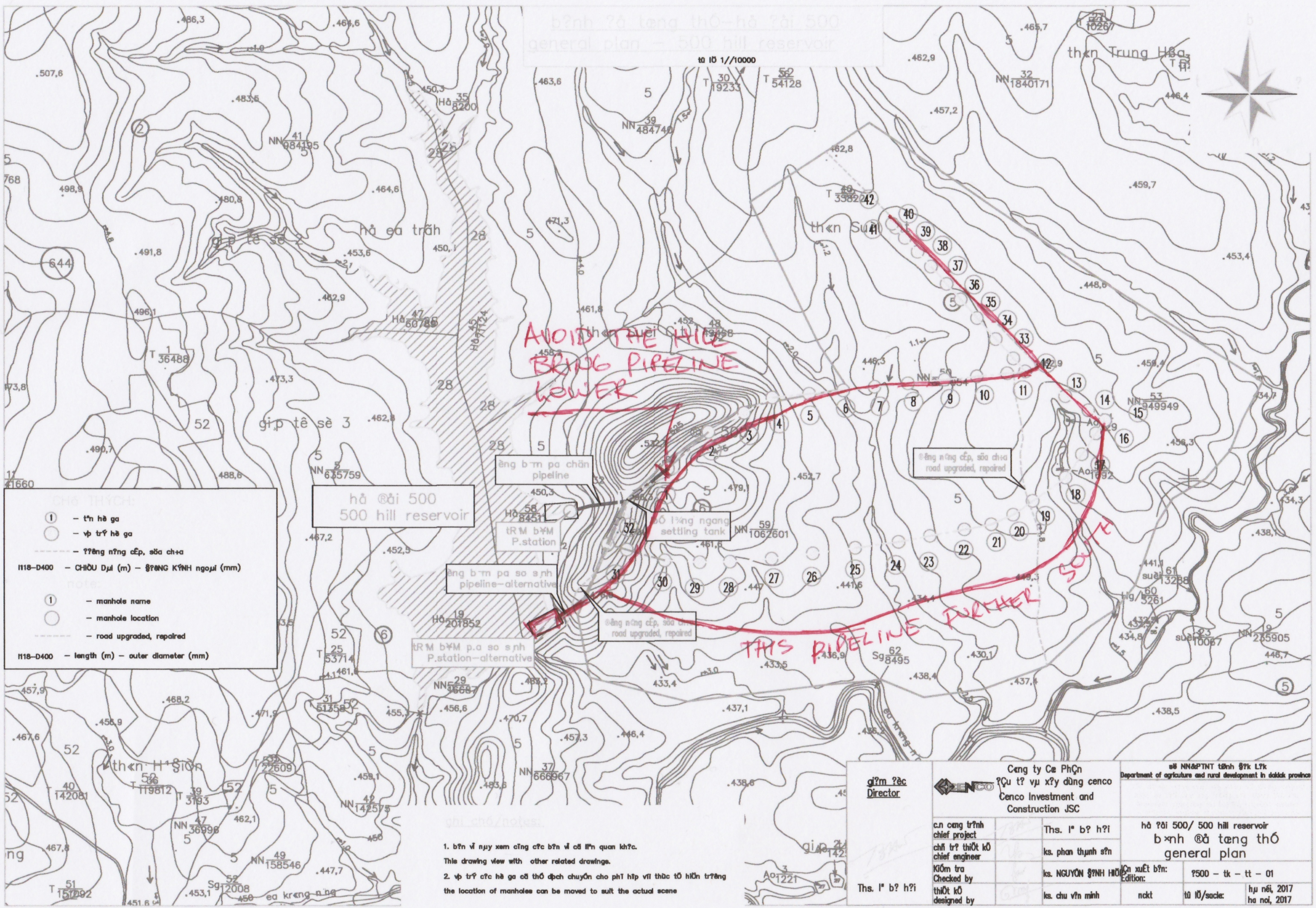
Appendix B: Sketches of alternative pipeline routes/pump locations

BUON YONG

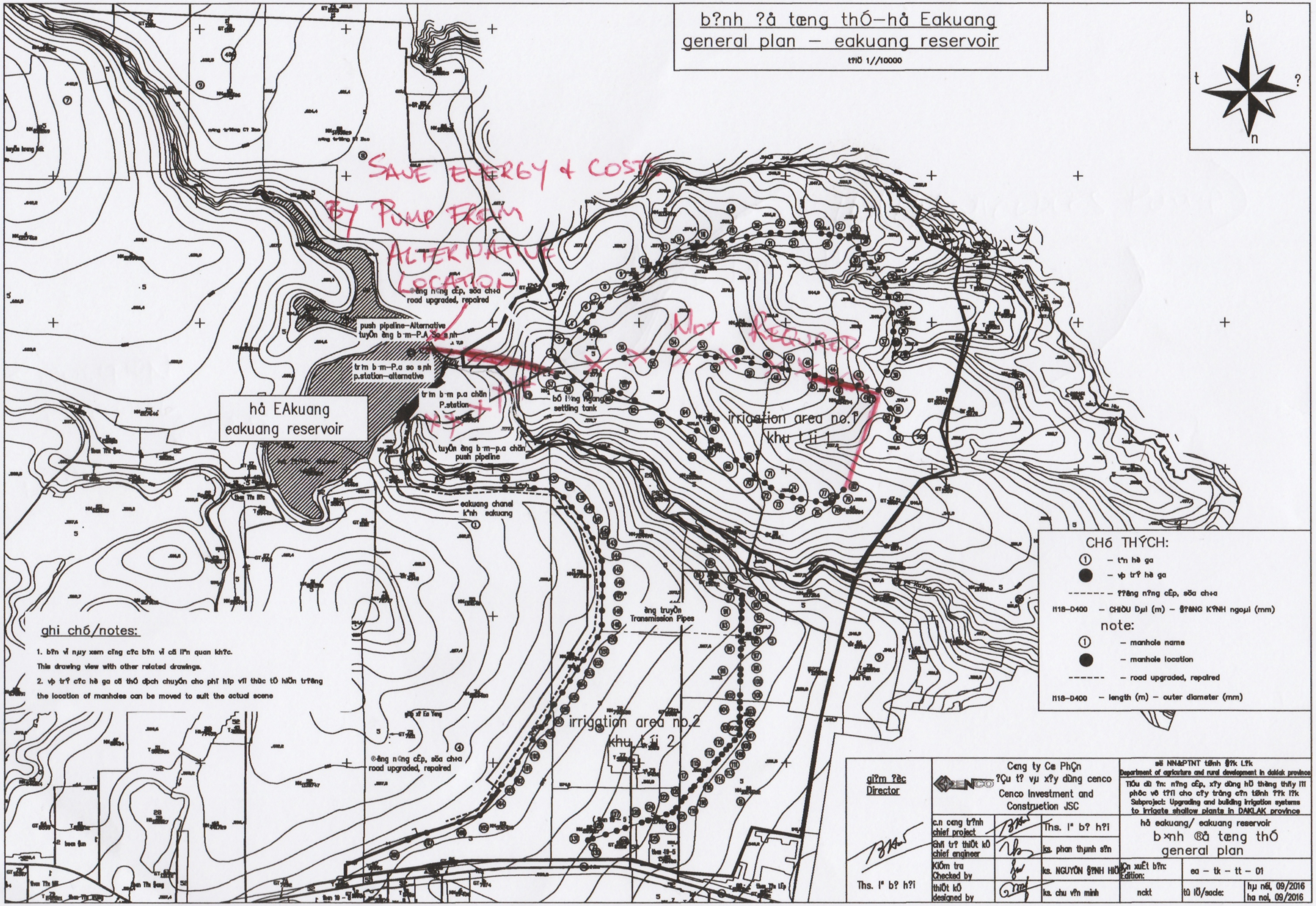


b?nh ?ӕ tӕng thӗ - hӗ buӧn yӧng
general plan - buon yong reservoir
hӗ buӧn yӧng
buon yong reservoir
tr?m bơm p.a so s?nh
P.station - alternative
ӕng ?Ẩy p.a chӑn
push pipeline
tr?m bơm p.a chӑn
P.station
ӕng ?Ẩy p.a so s?nh
push pipe - alternative
bӗ l?ng ngang
settling tank
?ӗng nӕng cẤp, sửa chữa
road upgraded, repaired
ALIGNMENT ALONG RIDGE
OPTIONAL CONNECTION
FOLLOW ROADWAY
NOT REQUIRED
ea tul
ea Brӑng
ea Dr?ng
CHÚ THÍCH:
t?n hӗ ga
v? tr? hӗ ga
?ӗng nӕng cẤp, sửa chữa
l118-D400 - CHIỀU DÀI (m) - ĐƯỜNG KÍNH ngoài (mm)
note:
manhole name
manhole location
road upgraded, repaired
l118-D400 - length (m) - outer diameter (mm)
ghi chú/notes:
1. b?n v? này xem cùng các b?n v? có li?n quan khác.
This drawing view with other related drawings.
2. v? tr? các hӗ ga có thӗ dịch chuyӗn cho phù h?p v?i thực tӗ hiӗn tr?ӗng
the location of manholes can be moved to suit the actual scene
giám ?ӕc
Director
Ths. l? b? h?i
Cӧng ty Cӧ Phần ?Ầu t? v? x?y dựng cenco
Cenco Investment and Construction JSC
CENCO
sӗ NN&PTNT tӗnh ??k L?k
Department of agriculture and rural development in daklak province
Tiểu dự ?n: nӕng cẤp, x?y dựng hӗ thӗng t??i phục vụ cho c?y trӗng c?n tӗnh ??k l?k
Subproject: Irrigation water supply system upgrading and rehabilitation dak lak province
c.n cӧng tr?nh
chief project
Ths. l? b? h?i
chủ tr? thiӗt kӗ
chief engineer
ks. phan thụnh s?n
Kiӗm tra
Checked by
ks. NGUYӖN ??NH HIӖ?
thiӗt kӗ
designed by
ks. chu v?n minh
hӗ buӧn yӧng/ buon yong reservoir
B?nh ?ӗ tӕng thӗ
general plan
lần xuất b?n:
Edition:
nckt
BY - tk - tt - 01
t? lӗ/sacle:
hà nӗi, 2017
ha noi, 2017

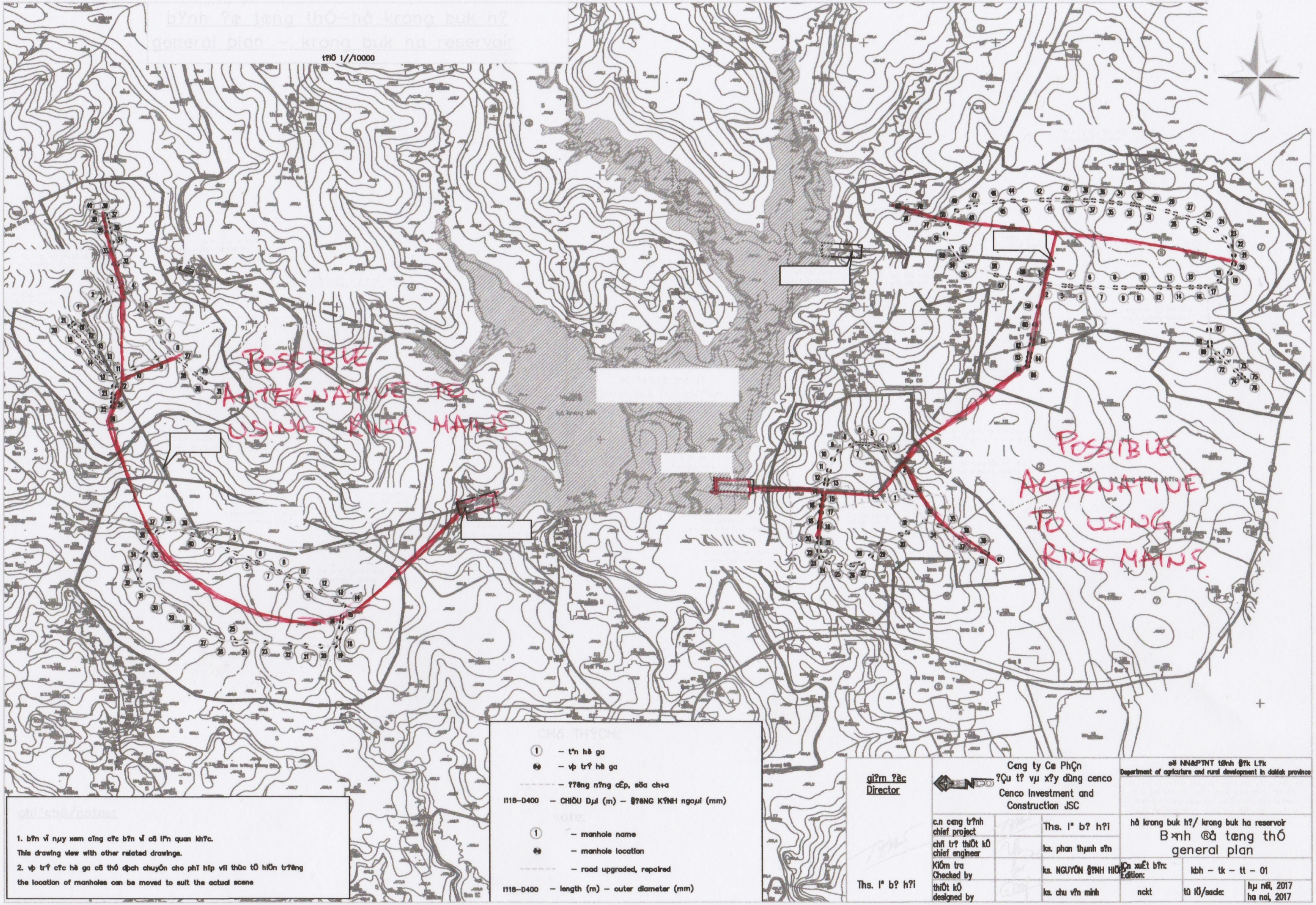
DOI 500


general plan - 500 hill reservoir
AVOID THE HILL
BRING PIPELINE LOWER
THIS PIPELINE FURTHER SOUTH
pipeline
P.station
settling tank
road upgraded, repaired
pipeline-alternative
P.station-alternative
500 hill reservoir
manhole name
manhole location
road upgraded, repaired
length (m) - outer diameter (mm)
the location of manholes can be moved to suit the actual scene
Director
Cenco Investment and Construction JSC
Department of agriculture and rural development in daklak province
500 hill reservoir
general plan
chief project
chief engineer
Checked by
designed by
Edition:
ha noi, 2017

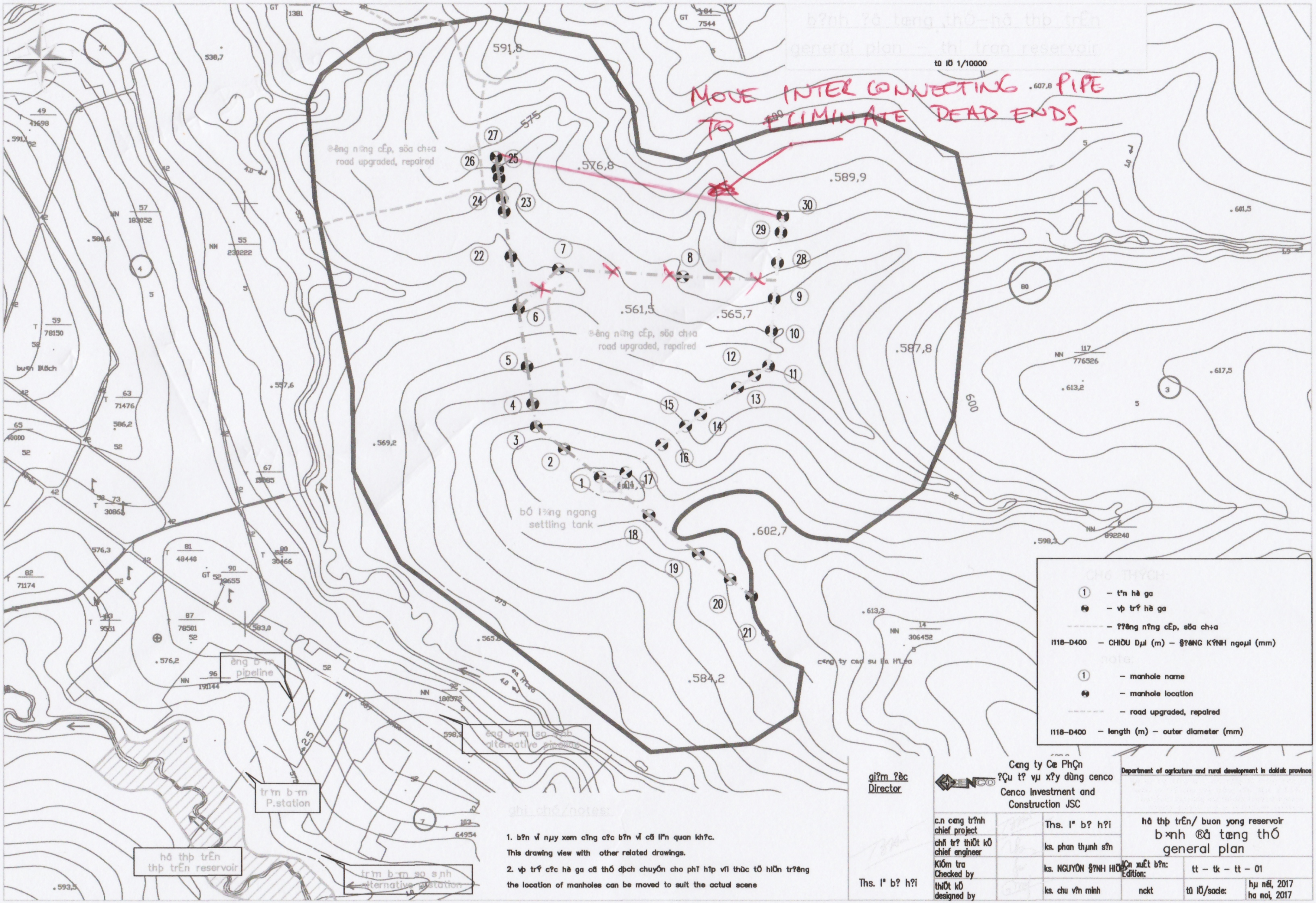
EA KUANG


b?nh ?å tæng thÓ–hå Eakuang
general plan – eakuang reservoir
t?lÖ 1//10000
SAVE ENERGY & COSTS BY PUMP FROM ALTERNATIVE LOCATION
NOT REQUIRED
push pipeline–Alternative
p.station–alternative
road upgraded, repaired
hå EAkuang
eakuang reservoir
P.station
settling tank
push pipeline
eakuang chanel
irrigation area no.1
Transmission Pipes
irrigation area no.2
ghi chó/notes:
1. This drawing view with other related drawings.
2. the location of manholes can be moved to suit the actual scene
note:
– manhole name
– manhole location
– road upgraded, repaired
– length (m) – outer diameter (mm)
Director
Cenco Investment and Construction JSC
Department of agriculture and rural development in daklak province
Subproject: Upgrading and building irrigation systems to irrigate shallow plants in DAKLAK province
chief project
chief engineer
Checked by
designed by
hå eakuang/ eakuang reservoir
general plan
ea – tk – tt – 01
ha noi, 09/2016

KONG BUK HA


b?nh ?æ tæng thÓ–hå krong buk h?
general plan — krong buk ha reservoir
t?lÖ 1//10000
POSSIBLE ALTERNATIVE TO USING RING MAINS
POSSIBLE ALTERNATIVE TO USING RING MAINS
ghi chó/notes:
1. b?n vÏ nµy xem cïng c?c b?n vÏ cã li"n quan kh?c.
This drawing view with other related drawings.
2. vÞ trÝ c?c hè ga cã thÓ dÞch chuyÓn cho phï hîp víi thùc tÕ hiÖn tr?êng
the location of manholes can be moved to suit the actual scene
chó thÝch:
– t"n hè ga
– vÞ trÝ hè ga
– ??êng n?ng cÊp, söa ch÷a
l118–D400 – CHIÒU Dµi (m) – §?êNG KÝNH ngoµi (mm)
note:
– manhole name
– manhole location
– road upgraded, repaired
l118–D400 – length (m) – outer diameter (mm)
gi?m ?èc
Director
Ths. l" b? h?i
C«ng ty Cæ PhÇn
?Çu t? vµ x?y dùng cenco
Cenco Investment and Construction JSC
së NN&PTNT tØnh §?k L?k
Department of agriculture and rural development in daklak province
c.n c«ng tr?nh
chief project
Ths. l" b? h?i
chñ tr? thiÕt kÕ
chief engineer
ks. phan thµnh s?n
KiÓm tra
Checked by
ks. NGUYÔN §?NH HIÖP
thiÕt kÕ
designed by
ks. chu v?n minh
hå krong buk h?/ krong buk ha reservoir
B×nh ®å tæng thÓ
general plan
§Çn xuÊt b?n:
Edition:
kbh – tk – tt – 01
nckt
tû lÖ/scale:
hµ néi, 2017
ha noi, 2017

THI TRAN



bản đồ tổng thể - hồ thị trấn
general plan - thi tran reservoir
tỷ lệ 1/10000
MOVE INTERCONNECTING PIPE TO ELIMINATE DEAD ENDS
road upgraded, repaired
settling tank
pipeline
alternative pipeline
P.station
thị trấn reservoir
alternative station
CHÚ THÍCH:
1 – manhole name
manhole location
road upgraded, repaired
l118-D400 – length (m) – outer diameter (mm)
ghi chú/notes:
1. bản vẽ này xem cùng các bản vẽ liên quan khác.
This drawing view with other related drawings.
2. vị trí các hố ga có thể dịch chuyển cho phù hợp với thực tế hiện trường
the location of manholes can be moved to suit the actual scene
giám đốc
Director
Ths. l* b? h?i
Cenco Investment and Construction JSC
Department of agricuture and rural development in daklak province
chief project
chief engineer
Checked by
designed by
Ths. l* b? h?i
ks. phan thịnh sơn
ks. NGUYỄN ĐÌNH HIỀN
ks. chu văn minh
nckt
hồ thị trấn/ buon yong reservoir
general plan
Edition:
tt – tk – tt – 01
tỷ lệ/scale:
hà nội, 2017
ha noi, 2017

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Document review and authorisation

Project Number: #419

Doc Version	Final/Draft	Date	Author	Project Director review	BST QA review	Release approved by	Issued to
1.0	Draft	06/05/2020	R. Rendell	-	J. Belz	-	AWP Vietnam