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TECHNICAL ASSESSMENT OF THE RECONNECTION AND REHABILITATION OF THE BUOTA – TANAEA WATER SUPPLY, TARAWA

For

GOVERNMENT OF KIRIBATI – KIRIBATI ADAPTATION PROJECT IMPLEMENTATION PHASE (KAP II)

MAY 2010

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TECHNICAL ASSESSMENT OF THE RECONNECTION AND REHABILITATION OF THE BUOTA – TANAEA WATER SUPPLY, TARAWA

1. INTRODUCTION

GWP Consultants (GWP) has been requested by the Project Management Unit of the Kiribati Adaptation Project Implementation Phase (KAP II) to undertake a technical assessment and prepare a report regarding the reconnection of the Buota – Tanaea water supply pipeline and the associated refurbishment of the pump galleries within the Buota water reserve.

The assessment was undertaken by Jeremy Baldock of GWP from the 4th to 13th May 2010. Assistance was provided for this work by Marella Rebgetz, and staff from Public Utilities Board (PUB) and Ministry of Public Works and Utilities (MPWU).

1.1 Background

Some 30 years ago 6No. freshwater galleries were constructed within the Buota Water Reserve to provide fresh water to the water treatment plant on Bonriki. Drawing No. 1 shows that the original pipeline between Buota and Tanaea was placed on the floor of the tidal channel from the southern shore of Buota, to the north-western shore of Tanaea. Following the construction of the road bridge between Buota and Tanaea the pipeline was re-routed across the bridge in a 100mm diameter cement lined ductile iron pipe.

In June 2008 the Buota – Tanaea bridge collapsed severing the pipeline. In September 2009 the United States Navy reconnected Buota to Tanaea by installing a 60m long Mabey Compact 200 Bailey Bridge, however the water pipeline was not reconnected.

The water extraction galleries have not operated since the pipeline was severed in June 2008 and have fallen into disrepair through lack of use, lack of maintenance and damaged by acts of vandalism. This assessment was undertaken to determine the condition of the galleries and the work required to refurbish the galleries, where necessary, and examine the options for reconnecting the pipeline between Buota and Tanaea.

Photographs from the assessment are attached in Appendix I.

2. BUOTA WATER RESERVE

2.1 Assessment of Galleries Condition

2.1.1 Pump Housing Concrete Surround

Each headwork is contained within a *c.* 3 x 1.5m rectangular precast concrete box comprising *c.* 100mm thick concrete panels bolted together at the corners, located on a moulded concrete base which has a slight up stand to retain the wall panels. These chambers were installed in association with a previous AusAid project. Each panel is bolted together using *c.* M14 bolts. Many of the bolts have been removed or have corroded. None of the concrete panels or bases have been breached, although Table No. 1 shows that chamber 2 has been slightly damaged.

Each concrete panel has a number of holes, possibly ventilation holes, formed using PVC pipe and have an additional horizontal slot at the base. The end panels contain 4 x 160mm holes which are used to locate the bolts from the adjacent side panel and a 0.55m x 0.1m horizontal slot at the base. The side panels contain 8No. 100mm holes and a

2.06m x 0.1m horizontal slot at the base. These holes/vents enable people to damage the internal components with sticks, bars and provide access for hands and tools to undo the bolts of the hasp that retains the pump chamber galvanised steel covers. Once the covers are released, all of the internal components are stolen.

It is recommended that 16No. 5mm galvanised flat u-shaped steel plates are fabricated and bolted to the inside of each chamber to prevent hand/stick access into the chamber whilst retaining ventilation. The plates could be fixed using short M10 bolts grouted into inner chamber wall, secured with a split washer and nut to suit. Similar plates should be fabricated and fitted to restrict access to the inside of the pump chamber through the slot at the base of the concrete side panels.

Once the missing or rusty fixing bolts have been replaced the bolts should be cut flush with the concrete and grouted in place to prevent future tampering or corrosion. Once the bolts have been fixed the holes within the end panels should be filled with concrete to prevent future access to the bolts and to the components within the pump chamber. Ventilation will be maintained through the horizontal slots along the base of each panel and through the holes within the side panels.

2.1.2 Pump Chamber Covers

The top of each concrete pump chamber is secured with 2No. 1200mm x 1200mm x 5mm thick galvanised steel plates, located under the lips at each end of the chamber and padlocked in place using a hasp and brass padlock. The hasp is bolted onto one of the side panels of the chamber.

The galvanised steel covers show no signs of corrosion and have not been broken. On the basis that the ventilation holes of the chamber side panels are protected to prevent unauthorised access (see Section 2.1.1, paragraph 2) the current method of securing the pump chambers using galvanised steel covers is acceptable. Thus the 2No. chambers (4 and 5) where the galvanised steel covers are missing, require replacement.

2.1.3 Pumps

All pumps are 32mm diameter non-submersible Mono Merlin pumps. The pump is located below a Teco 3-phase motor which is fixed on a fabricated stool directly above the pump. The pumps have been unused since the Buota – Tanaea bridge collapsed over two years ago, thus it is recommended that the 4No. pumps remaining are replaced in addition to the 2No. pumps that have been stolen.

Throughout the 9 days site assessment the main pump mechanic could not be located by anyone, who would have been able to provide further information regarding the operational requirements of the pumps and motors. However, according to Mr Terauno Luka, foreman at PUB Bekinabu, PUB has the capacity to service, maintain and repair the Mono Merlin pump. The spare parts are readily available and reasonably priced. PUB also have stainless steel submersible sewage pumps which they dislike as the parts can takes months or years to obtain and the mechanics do not have the skill to repair them. Therefore it is recommended that the pumps are replaced with identical pumps sourced from Mono Pumps Ltd.

It is recommended that an additional pump is purchased and kept in the PUB stores to provide an immediate pump replacement if/when a pump requires repair. In such circumstances the pump requiring repair can be instantly replaced whilst replacement parts are sourced and fitted. Once repaired the repaired pump can be replaced or remain in the stores ready for future deployment.

2.1.4 Pump Chamber Electrics

Each pump chamber contains a 415v electrical control panel contained within a stainless steel wall mounted cabinet. Where still present the control panels have been used for replacement components over the last 2 years by PUB electricians to maintain the gallery system on Bonriki as the parts are interchangeable. In four pump chambers the control panels remain in situ however the internal electrics will require replacement. In 2No. chambers the whole control box and internal components have been removed by others and require replacement.

PUB have not yet located copies of the wiring diagrams for the pump chamber electrical systems.

The pump chamber control panel drives the 3 phase induction motor. The existing Teco motors have corroded very badly and the assistant pump mechanic stated that this corrosion has been an on-going problem. It is recommended that the replacement motors are more corrosion resistant that the existing motors.

2.1.5 Well Covers

The well access covers comprise 500mm x 500mm x 4mm galvanised steel plates with a simple flat staple handle welded onto the top. These covers are sufficient for the purpose and 2No. of these covers have been removed by others and require replacement.

2.1.6 Well Access Chambers

The well access chambers comprise *c.* 1m diameter precast concrete chamber rings. These are all in good order although Table 1 shows that the 2No. pump chambers that have been stripped of all components will require coconuts and other vegetation to be removed from the well access chamber.

The assessment was not able to assess the condition of the gallery pipework, however it was noted that rodding points are available at each end of every gallery pipeline to enable the pipeline to be cleared if necessary. In addition the 1m diameter access chambers are sufficient to provide rodding access from within, if necessary.

2.1.7 Pump Chamber Pipework

Appendix II contains a list (in order from well to outlet) of the pipework and fittings used within a complete headwork. The pump chamber pipe work contains in addition to the pump and electric motor, a flow meter, a non-return valve and a gate valve, all 50mm diameter. It is recommended that all the metalwork components are replaced in every pump chamber. It is recommended that existing pipework where in place can be re-used, however the missing pipework within pump chambers No. 4 and 5 will require replacement.

Table No. 1 summarises the works required to refurbish the pump chambers within the Buota water reserve.

2.2 Assessment of Electrical System Condition

The electrical system comprises within the Buota water reserve comprises a 11Kv to 415v transformer, a switch box and a main control unit all located close to Pump 3. An additional sub-control panel is located close to Pump 4. The transformer and the switch box are the property and responsibility of the Electric Department of PUB. Once the supply

has passed through a meter into the main control unit the responsibility is passed to PUB Water Dept.

In addition each pump chamber has an individual control board, described in Section 2.1.4. The electrical drawings for the pump chamber control boards are still to be located by PUB.

All electrical cabinets are mounted on a concrete platform, which remains in good condition. Originally a fence enclosed the electrical system, however the chain link fencing has been removed and only the posts remain. It is noted that many of the fence posts surrounding the electrical control boxes in the nearby Bonriki Water Reserve have been removed using an angle grinder to cut the posts off. It is likely that if the fencing is replaced it will be stolen again.

2.2.1 Transformer and Switch Box

The main 11Kv transformer is housed within a stainless steel 4 door cabinet, whilst the switchbox is located directly onto the concrete and not housed in a cabinet. One of the doors to the 11Kv transformer has been removed, leaving the live transformer connections exposed to the public. The PUB Electricity Department has been informed that one of the cabinet doors is missing and it has been recommend that the panel is replaced urgently.

If the power to the transformer is switched off, rather than the missing panel replaced it is suspected that the whole transformer will be stolen.

The switch box alongside the transformer has be set alight at the base and requires it's integrity checked by PUB Electrical Department.

A 415v supply is provided to each pump housing and enters an individual stainless steel wall mounted control box to supply each pump with a 415v supply.

2.2.2 Main Control Unit

Located close to pump chamber 3, the main control box is contained within a 2 door stainless steel cabinet. One door has been removed providing unlimited access to the meter (vandalised) and the 3 phase master switch, whilst the lock for the other door has been broken and many of the electrical components have been removed. The 2-3mm stainless steel cabinets have proved to be very resistant to the natural elements, having been installed 10 years ago but have no been so successful at resisting the human element.

PUB have provided GWP with the drawings for the electrical system in the Main Control Unit.

2.2.3 Sub-Main Control Unit

Located close to pump chamber 4, the sub-main control box is contained within a 2 door stainless steel cabinet. Both doors are in place but the locks and handles have been vandalised and many of the electrical components have been removed.

PUB have provided GWP with the drawings for the electrical system in the Main Control Unit.

2.3 Buota Galleries Summary

4No. of the pump chambers require refurbishment, i.e. rewiring, new pump, motor, flow meter, non-return valve and gate valve, whilst all components within 2No. pump chambers have been stolen and require complete replacement. It is recommended that an additional pump is purchased and retained in PUB stores to provide and instant replacement when a pump breaks down. The broken pump will then be repaired/refurbished and then retained in stores for future deployment.

It is recommended that the ventilation holes in the concrete pump chamber panels are sealed in such a way to prevent access for vandalism or theft, whilst maintaining ventilation.

It is recommended that the main control box and sub-main control boxes are rewired and the cabinet doors are replaced however additional security devices should be used to secure the doors to prevent unauthorised access in the future. Additional security devices may comprise the fitting of McGard's Intimidator locking bolts (or similar) at the corner of each door.

3. BUOTA – TANAEA CROSSING ASSESSMENT

To arrive at a recommendation for the routing of the pipeline from Buota to Tanaea a number of options were considered. In principle there are two options, 1) lay the pipeline under the tidal channel, 2) run the pipeline across the Buota bridge. Each option has advantages and disadvantages.

Laying the pipeline across or under the channel presents construction difficulties, i.e. working in a tidal channel which does not completely dry, however this route would not result in the pipeline being directly limited by the life expectancy of the bridge. Laying the pipeline on the channel floor would expose the pipe to UV degradation and damage from spear fishermen or others.

Running the pipeline across the bridge simplifies installation, is a shorter route but the pipeline is at an increased risk from UV degradation and vandalism.

It is understood that the 4No. 100m long rolls of 110mm diameter PE80B polythene pipe along with a number of straight couplings and fittings which are currently in stock at PUB Betio were purchased for this project. It is proposed to use the 110mm diameter Black PE80B SDR11 Polyethylene Pipe and fittings for the reconnection between Buota and Tanaea.

3.1 Channel Options

3.1.1 Causeway Route

Following the collapse of the previous Buota bridge in 2007 a temporary causeway was constructed across the tidal channel between Buota and Tanaea. The causeway comprises concrete filled sandbag sides in filled with rough concrete. The channel floor either side of the causeway was assessed as possible lines for the burial of the water pipeline.

The lagoon side (western side) of the causeway is, in parts, deeply scoured up to 3m from the causeway to a maximum depth of 2 – 2.5m below the adjacent channel floor. The deep scouring does not make this route a suitable site for the installation of the pipeline.

The ocean side of the causeway is not scoured and the channel floor is *c*. 300mm below the crest of the causeway almost constantly along the length. The approximate length of the ocean side of the causeway (measured by pacing) is *c*. 170m. The northern end of the causeway terminates *c*. 20 – 25m from the location of the existing pipeline, however the southern end terminates *c*. 100m from the existing pipeline. Thus the total pipe length required for this option would be *c*. 300m.

The causeway was designed as a temporary structure with a limited life and is rapidly eroding. Either as a result of natural erosion or human intervention, it is unlikely that the causeway will be in place much longer. Once removed it is likely that the channel floor will alter along the line of the causeway, which probably result in the pipeline being disturbed.

3.1.2 Channel Crossing close to Buota Bridge

A possible line for the pipeline would be to run *c.* 3-5m to the east of the bridge access ramps, *c*. 10m East of the Buota Bridge. In order to assess the practicalities of the route across the channel, data to form a channel profile was gathered. This data was collected by wading and swimming across the channel and recording the depth of the channel relative to the sea level at that time. The survey was carried out at 08:15 – 08:30 on Saturday 8th May 2010.

Drawing No. 1 shows the profile of the channel *c*. 10m east of the Buota bridge. The profile shows that there is a deep channel below the southern half of the bridge. Anecdotal evidence from locals suggests that this channel never dries out completely and there is always a minimum of *c*. 1.0m of water retained in the channel.

To make a connection to the existing pipeline at the northern end of the ramp leading to the bridge, the pipe could be installed 3-5m out from the base of the ramp/abutment and would require *c*. 40m of pipe to reach the bridge. A similar length of pipe would be required at the southern end of the bridge to join to the existing pipeline. Thus, in addition to the 60m length of bridge span, the total length of pipe to be installed to cross the channel of *c*. 140m.

The greatest difficulty with this option is the construction method as the pipeline would be required to be buried at a sufficient depth (2-3m below the channel floor) to avoid scouring and to prevent floatation. Discussions with Taani Lasike of Criag Construction established that Craig Construction have a 12 tonne excavator in country however this would not be capable of undertaking the work. With the Ministry excavator committed to sea defence work there is not an excavator available in Kiribati which is capable of excavating a deep trench in the tidal channel.

3.2 Bridge Options

Marella Rebgetz has sourced the construction drawings from Mabey for the new installed Buota bridge. The Mabey Compact 200 Bridge comprises side rails and a roadway supported by a series of 400mm deep I-beams at 3m spacing and smaller cross braces connected to the I-beams. According to Iplex Design Guide if suspended this specification of pipe requires support at 1.91m intervals.

The bridge is located at each end on cast in situ concrete plinths, flanked by cement/sand filled PVC woven sandbags. Each corner of the bridge is guarded by a cast *in situ* concrete block. These blocks on the northern side of the bridge have 2No. holes formed using 150mm diameter PVC pipes. The guard block at the north eastern corner of the bridge contains the remnants of the old water pipe in the upper duct whilst the lower duct hole

contains a redundant electric cable (both pipe and cable are disconnected). Neither of the blocks at the southern end of the bridge have such ducts cast in.

To use the upper duct through the guard block on the northern end of the bridge as previously, the water pipe must be located at ground surface level immediately before entering the guard block, exposing the pipe to UV and damage. It would be greatly beneficial if the pipe were to use the lower duct thus enabling the pipeline to remain *c.* 500mm below ground level.

The transition on the southern side can be accomplished by either core cutting a 150mm diameter hole through the concrete guard block (*c.* 530mm thick) through which to feed the 110mm PE80B pipe before joining the *in situ* 100mm diameter PVC pipe. Alternatively if core cutting a hole through the end block is not economic then the pipe could be routed around the block. To ensure that the pipe is buried wherever possible this will require the removal and reinstatement of a number of the concrete sandbags forming the bridge ramp.

The 2No. options considered for routing the pipeline across the bridge are described overleaf.

3.2.1 Central Route

Locate the pipeline under the centre of the bridge connecting to the I-beams at 3m intervals and the cross braces at 1.5m between each I-beam. There is sufficient clearance (*c.* 400mm) between the abutments and the base of the I-beams and the 110mm diameter PE80B pipe would not require ducting as the pipe would remain protected from the UV degradation.

The main advantage of this option is reduced exposure to UV light and reduced risk of the pipe being damaged by children or vandals, however access for installation could be difficult thus costly.

3.2.2 Side Route

Locate the pipeline along the continuous side beam of the bridge. The advantage of this route is that the pipe could be supported at intervals closer than 1.5m and would be easier to fit. However the pipe would be exposed to direct sunlight and to local children playing on and jumping from the bridge. To protect the pipeline the PE80B pipe would require ducting in another pipe or wrapping the pipe in "Densyl"[1] type bitumen tape to protect the pipeline from UV degradation and would help to deter interference by others.

If the pipe is to be ducted then galvanised steel ducting, is advised. The galvanised steel bridge has an expected life expectancy of 20 years, thus using stainless steel ducting or support brackets incur unnecessary expense for no gain as the lifetime of the pipeline is determined by the life expectancy of the bridge. Furthermore it is not advisable to place galvanised steel and stainless steel in contact as it is possible for the 2 metals to react together resulting in a reduced life expectancy for both metals.

3.3 Buota – Tanaea Crossing Assessment Summary

It is recommended that the pipeline is routed across bridge suspended beneath the lower side beam of the bridge, using galvanised steel hanging brackets. The option of threading

[1] Densyl tape is a cold applied impregnated non-hardening and non-cracking cloth tape used to protect pipelines from corrosion. It is formulated particularly for use at tropical temperatures.

the PE80B pipe through a galvanised steel duct or wrapped in "Densyl" type tape is a matter of cost. The advantages of selecting this route are:

- the most direct line requiring *c.* 70m of pipe,
- easy of access for installation, (installation can be undertaken using harness and safety line rather than scaffolding),
- sufficiently close support points though pre-drilled holes on bridge beam.

4. EXISTING PIPELINES

The pipework either side of the bridge is 100mm diameter PVC solvent weld pressure pipe work which terminates just below the surface. On the southern side the pipe has not been capped off and PUB have been requested to ensure that this pipeline is capped off before further soil or rubbish enters the pipeline. The pipeline on the northern side of the bridge is 100mm diameter PVC solvent weld pressure pipe, however a ductile iron gate valve and a double orifice air relief valve have been inserted in the pipeline prior to the pipeline reaching the bridge. The DI pipe work has corroded and requires replacement.

In lieu of a double orifice air value which can be unreliable (when installed below ground unless properly maintained) it is recommended that a simple ball valve is fitted to a T-junction to enable any air to be released manually from the highest point of the pipeline.

PUB records indicate that the route of the Buota Water Reserve to Buota bridge pipeline leaves the water reserve heading southwest towards the road on the lagoon side of Buota. The pipeline is then supposed to follow the road southeast and then northeast to bridge.

The pipeline is not marked on the ground and no-one could located or determine the exact route. Within the village, alongside the road, a number of rubbish pits have been excavated *c.* 1m deep. If any of these pits have intercepted or disturbed the pipeline, the integrity of the pipeline may have been compromised.

During the assessment it would have been desirable to test the integrity of the pipelines which run between 1) Buota Water Reserve and the northern end of Buota bridge and, 2) the southern end of Buota bridge and the Water Treatment Plant. After consultation with Mr Evire (PUB) and Mr Luka (PUB) it was determined that PUB lacked both the equipment and experience to undertake such tests. Therefore it must be recognised that there is a risk of the works to refurbish the galleries and reconnect the pipeline across the bridge are undertaken, only to find that one or both of the connecting pipelines (Buota Water Reserve to Buota bridge, or Buota bridge to the Water Treatment Plant) have been damaged and need inspection and repair.

If this risk is considered unacceptable by PMU or PUB, the pipeline will need to be inspected (CCTV) or tested (water or air test) to prove the pipeline's integrity. Currently PUB has neither the expertise nor equipment to undertake these tests. If this proving the integrity of the pipeline is a pre-requisite to the works, the experience and equipment will have to be imported.

If the risk is considered acceptable, it is recommended that once the galleries have been refurbished, the pipeline is flushed in stages, 1) galleries to the bridge and 2) once the inlet to the water treatment plant is disconnected (to prevent contaminated/dirty water entering the treatment plant) the pipeline can be flushed to the water treatment plant.

It may possible during the procurement process for PUB attempt to repair 1No. of the pump chambers using spare parts from stores and other galleries and to attempt to flush the pipeline as far as the bridge.

5. DAMAGE PREVENTION

A major component to the longevity of the works is to protect the system from intentional damage by the public.

During the assessment 2 reasons for damage to Buota Water Reserve equipment were identified:

i) Intentional theft of equipment for commercial gain. People come equipped with disc cutters, pick axes etc. with the intension of removing equipment for use at home or to sell for scrap. These people cut down the galvanised steel fence posts, remove fencing, electrical cabinet doors, pump chamber covers and the internal components of the pump chambers.

   This can be counteracted by securing the works using not profitable materials i.e. composite rather than stainless/galvanised steel and/or using properly secured locks on the electrical cabinets rather than relying solely on proprietary locks. Such locks could be security bolts which can only be removed using a security socket. These bolts can be fitted to the existing stainless steel cabinets and used to secure new stainless doors or GRP panels to the cabinets before refitting the electrical components inside.

ii) Petty vandalism from drunks. Mainly opening cabinets and turning off power for "fun". This is not considered a major threat to the system as most don't go equipped with angle grinder and/or pick axe. Improved security locks on the main electrical cabinets and covering the side holes to the pump chambers should negate this problem.

   Combat casual vandalism using simple measures such as blocking or protecting the holes in the pump chamber housing.

6. CAPABILITY AND CAPACITY FOR WORKS

During the assessment it was found that although PUB do have the skills to undertake this work, given their program of scheduled maintenance, it is unlikely that PUB would have the capacity to undertake the rehabilitation and reconnection program to a specific deadline.

If the option to reconnect the pipeline across the bridge is selected, then there should be sufficient skills within the contractors already operating within Tarawa to undertake the work. Therefore the work could be issued to PUB and PUB can contract the work out *via*. competitive tender.

The successful contractor should be responsible for procurement, importation, storage and installation of all materials not already in stock at PUB Betio for this project to complete the works. The work should be overseen by a PUB engineer(s) in association with GWP Consultants.

7. CONCLUSIONS

The assessment found that:

- 4No. pump chambers in Buota Water Reserve require refurbishment (replacing pump, motor, valves and flow meter) and the rewiring of the electric control panel;
- 2No. pump chambers in Buota Water Reserve require totally rebuilding as these chambers have been stripped of all components, including the removal of vegetation from the well;
- the replacement motors should be more durable as the existing motors are extremely corroded;
- all other metalwork, i.e. pump, valves, flow meters should be replaced like for like for easy of maintenance and servicing;
- anti-vandalism measures should be taken to protect the pump chambers and electrical control units. Guard plates should be fitted to the pump chamber ventilation holes to prevent unauthorised access and damage, and security bolts fitted to the control panel cabinets in addition to the single proprietary lock;
- the recommended option is for the pipeline to be reconnected from Buota to Tanaea using the side rail option across the new bridge using the 110mm diameter PE80B polythene pipe already held in stock at PUB Betio.
- the pipe should be suspended using galvanised steel pipe brackets and either ducted in galvanised steel pipe or wrapped in "Densyl" type tape, depending on cost;
- the connection between the bridge and the existing pipeline on Tanaea is possible in a number of ways, however the actual route to make the connection will be determined by cost and availability of core cutting equipment.

However with the limited experience and lack of testing equipment in Kiribati it was not possible to confirm the integrity of the pipeline connecting the Buota Water Reserve to the bridge and the southern side of the bridge to the water treatment plant. Therefore it must be recognised that unless the integrity of these existing pipelines is proven beforehand, there is a risk that the refurbishment of the galleries and the reconnection of the pipeline over the bridge will be fruitless if either of the existing pipelines are damaged.

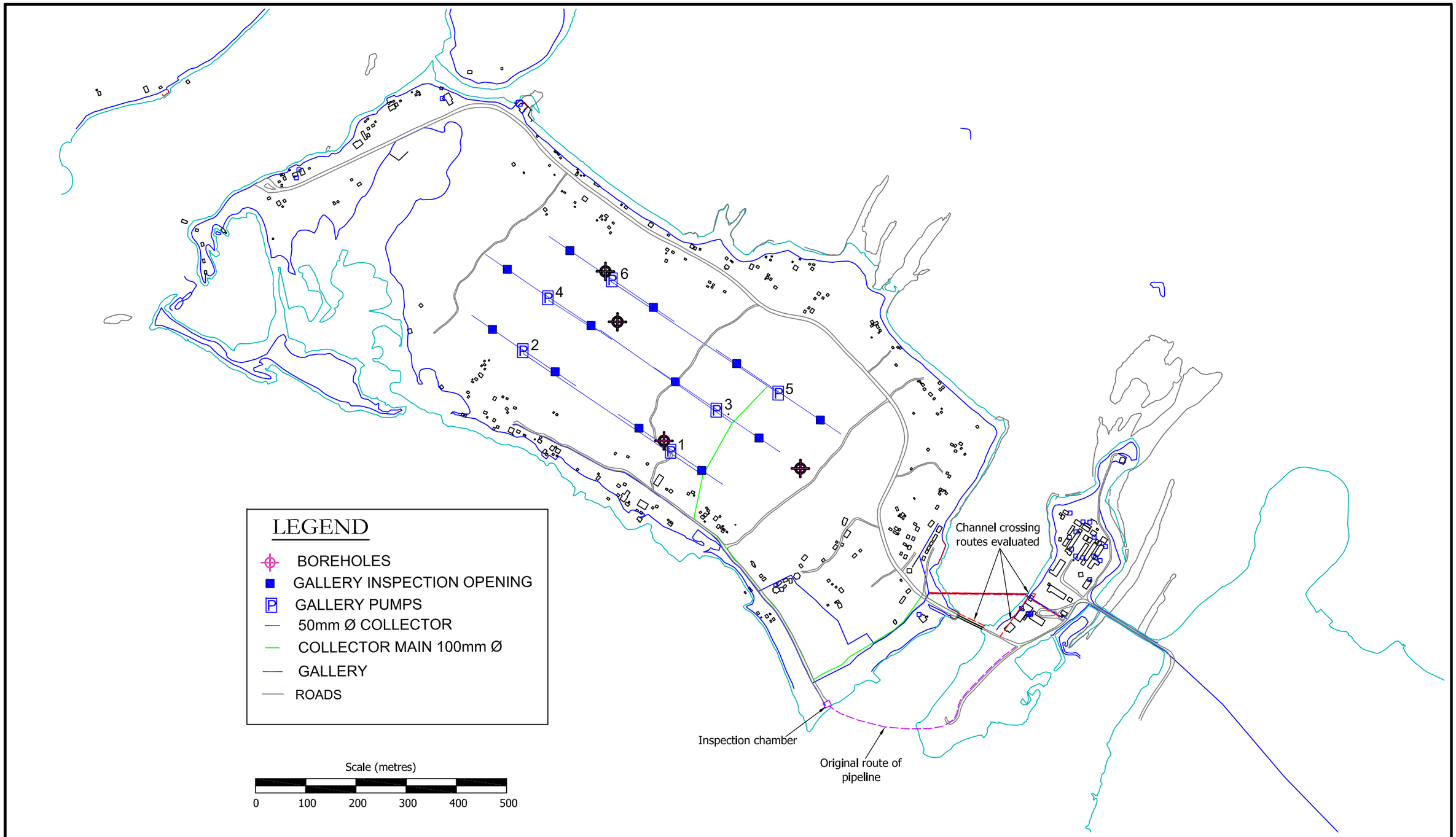
Finally although PUB may have the capability and skill to undertake the work, they probably do not have the capacity to undertake the work in conjunction with their everyday workload, therefore it is recommended that PUB contract the work to a contractor already working in Tarawa *via* competitive tender.

GWP CONSULTANTS
September 2010

Table 1 – Observations of Buota Water Reserve pump chambers condition

Pump Chamber	Condition	Parts to be replaced	Depth of water within gallery chamber	Depth from surface to base of sump
1	Padlock jammed – Internal components are present but could not be inspected.	Padlock, pump, electric motor, flow meter, non-return valve, gate valve, sampling gate valve. Refurbishment of electric contol panel required.	N/A	N/A
2	Concrete surround needs relocating onto guides (may have been hit by vehicle). Repair to concrete on NW corner required & replace bolt. No sediment in sump. The internal components are *in situ*.	Pump, electric motor, flow meter, non-return valve, gate valve, sampling gate valve. Refurbishment of electric contol panel required.	1.6m	3m
3	1 good bolt on concrete panels, 3 rusty and 4 missing. The internal components are *in situ*.	Pump, electric motor, flow meter, non-return valve, gate valve, sampling gate valve. Refurbishment of electric contol panel required.	2.02m	3.2m
4	Only concrete chamber panels remain. Gallery well contains coconut and leaf debris. No sediment in sump	Galvanised covers, hasp and padlock, all internal components.	1.9m	3.04m
5	Only concrete chamber panels remain. Gallery well contains coconut and leaf debris. Soft debris in sump, probably vegetation.	Galvanised covers, hasp and padlock, all internal components.	1.65m	2.9m
6	Galvanised cover is in place and the contents of the pump chamber remains *in situ*.	Pump, electric motor, flow meter, non-return valve, gate valve, sampling gate valve. Refurbishment of electric contol panel required.	1.6m	3.4m

N.B. Concrete side panel retaining bolts should be replaced where rusty or missing.



LEGEND

Original route of pipeline

Channel crossing routes evaluated

Version	Revision and compilation notes	Date
A	Draft	20.05.2010

Client: Government of Kiribati - KAPII office

Project: Buota Pipeline Reconnection

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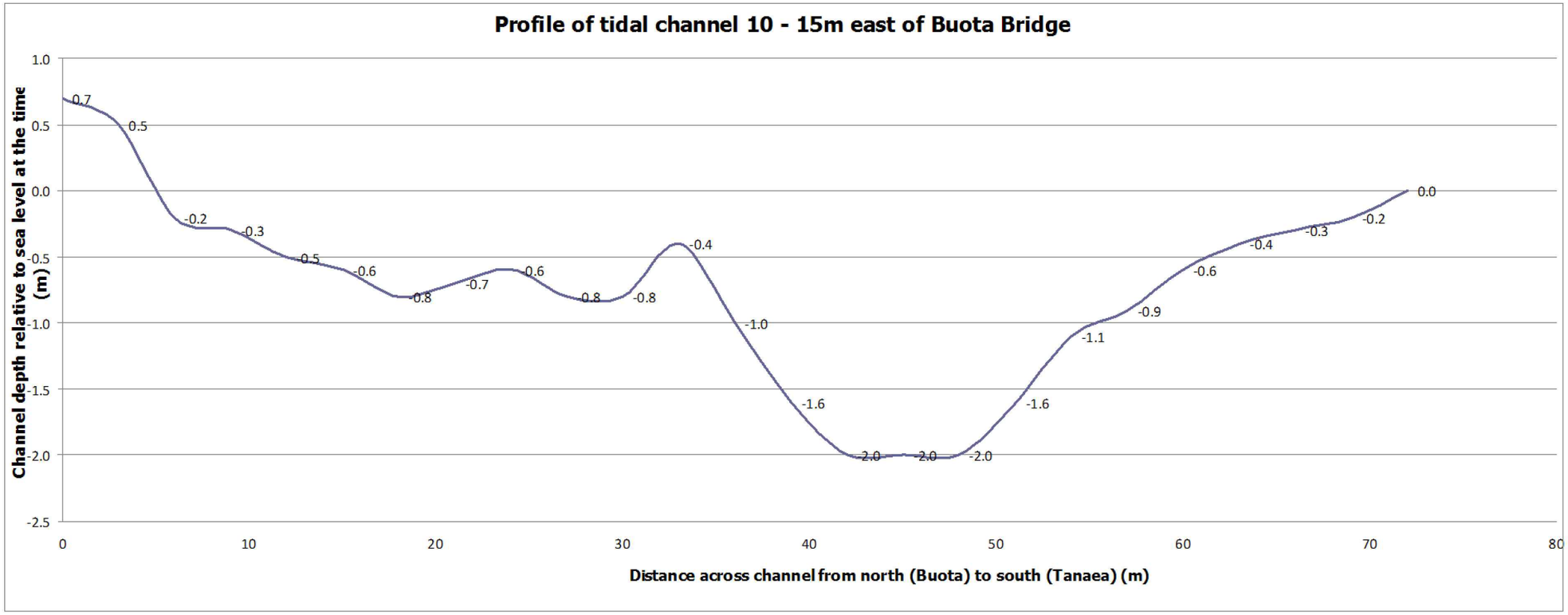
Plan of Buota - Tanaea pipeline routes

Date	Drawn	Checked	Scale
20.05.2010	JCB/EMB	JCB	1:7500 at A3

Drawing Ref	Drawing No	Version
KIRI1005C	1	A



Distance across Bridge (m)	Depth of Water (m) - Surveyed at 08:15 on 8th May 2010
0	0.7
3	0.5
6	-0.2
9	-0.3
12	-0.5
15	-0.6
18	-0.8
21	-0.7
24	-0.6
27	-0.8
30	-0.8
33	-0.4
36	-1.0
39	-1.6
42	-2.0
45	-2.0
48	-2.0
51	-1.6
54	-1.1
57	-0.9
60	-0.6
63	-0.4
66	-0.3
69	-0.2
72	0.0

NOTES

- All measurments were made from north to south.
- The bridge spans from 0-60m. 60 - 72m was the profile aloingside the southern bridge abbutment.
- The depths of 2m are approximate as I was not even close to being able to touch the bottom. At this point the locals were interested in the white bloke swimming and making notes at the same time! Waterproof notes books are a wonderful develoment.

Version	Revision and compilation notes	Date
A	Draft	20.05.2010

Client: Government of Kiribati - KAPII office

Project: Buota Pipeline Reconnection

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Profile of tidal channel 10 - 15m east of Buota Bridge

Date	Drawn	Checked	Scale
20.05.2010	JCB/LS	JCB	NTS

Drawing Ref	Drawing No	Version
KIRI1005C	2	A

APPENDIX I

Relevant photographs from the assessment

Appendix I - Site Assessment Photographs

Photo No. 1 - Pump chamber No. 3 showing the large ventilation holes on the end panel.

Photo No. 2 - Inside pump chamber No. 3 with complete pipework and fittings but requires refurbishment.

Photo No. 3 - Pump chamber No. 5 with all components stolen and vegetation has fallen into the well.

Photo No. 4 - Pump chamber No. 4 with all components stolen.

Photo No. 5 - Photo showing ease of access through chamber ventilation holes enabling the hasp bolts to be released.

Photo No. 6 - Missing panel enabling easy access to live 11,000 volt connections.

Photo No. 7 - Photo showing missing and broken door on main control unit.

Photo No. 8 - Photo showing the vandalised electric panel due to a broken door lock on the main control unit.

Appendix I - Site Assessment Photographs

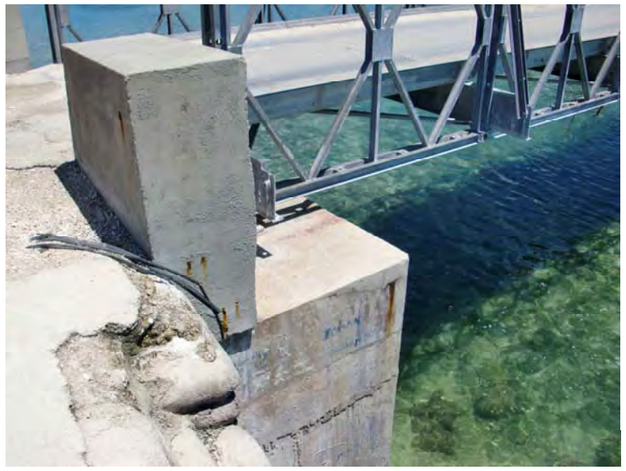

Photo No. 9 - Southern guard block which needs to be cored through or the pipe routes around. If routed around the concrete sand bags will require reinstating.

Photo No. 10 - The lower side rail is the recommended route from which the pipeline could be suspended.

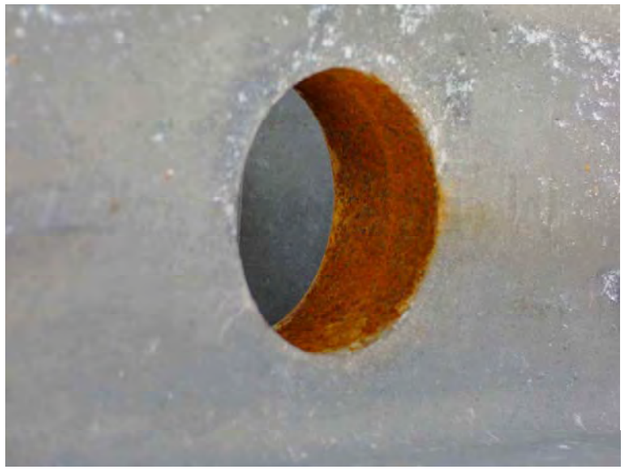

Photo No. 11 - Rust discolouration already showing in most of the holes in the upper and lower cross rails of the Mabey bridge.

Photo No. 12 - The lower side rail is the recommended route from which the pipeline could be suspended.

Photo No. 13 - The 200mm clearance between the lower rail and the bridge abuttment.

Photo No. 14 - The 25mm diameter pre-dilled hole in the lower side rail. Note the rust discolouration forming after just 6 - 9 months.

Photo No. 15 - The northern guard block showing the old water pipe in the upper duct and the electric cable in the lower.

APPENDIX II

Detailed list of pipe work fittings contained within each pump chamber

Detailed list of pipe work fittings contained within each pump chamber

Abbreviations: SW = solvent weld

FI = Female Iron

MI= Male Iron

32mm dia PVC SW pipe rising from well (cut to suit) – presumably a filter is attached to the end.

32mm dia PVC SW 90 elbow

32mm dia PVC SW pipe x 100mm long (cut to suit)

32mm dia PVC SW 90 elbow

32mm dia PVC Union (unions are screw joints to enable access to significant sections without having to break the solvent welds)

32mm dia PVC SW 90 elbow

32mm dia PVC SW pipe x 200mm (cut to suit)

32mm dia PVC SW - flange adaptor

32mm dia gasket set to seal pump inlet

32mm dia Mono pump

32mm dia outlet with gasket set to seal pump outlet

32mm dia SW - flange adaptor

32mm/50mm PVC SW enlarger

50mm dia PVC union

50mm dia PVC SW 90 elbow

50mm dia PVC SW pipe x *c.* 1m (cut to suit)

50mm dia PVC SW to 15mm dia FI Tee – leading to MI to MI adaptor and a 15mm FI stop tap with wheel

50mm dia PVC SW pipe x 100mm (cut to suit)

50mm dia PVC SW 90 elbow

50mm dia PVC SW pipe x 200mm (cut to suit)

50mm dia PVC union

50mm dia PVC SW 90 elbow – Galv strap over pipework bolted to floor

50mm dia PVC SW - flange adaptor and associated gasket set

50mm dia double flanged "Kent" flow meter

50mm dia PVC SW - flange adaptor and associated gasket set

50mm dia PVC union

50mm dia PVC SW 90 elbow

50mm dia PVC union

50mm dia PVC SW to MI adaptor

50mm dia ductile iron non-return valve

50mm dia PVC SW to MI adaptor – Galv strap over pipework bolted to floor

50mm dia PVC union

50mm dia PVC SW to MI adaptor

50mm dia ductile iron gate valve with hand wheel top

50mm dia PVC SW to MI adaptor

50mm dia PVC SW pipe x 150mm (cut to suit)

50mm dia PVC union

50mm dia PVC SW pipe x 200mm (cut to suit)

50mm dia PVC SW 90 elbow

50mm dia PVC SW pipe (vertical) to connect up to 100mm distribution pipe c. 1 – 1.5m below.

APPENDIX III

Work or information required from PUB

Work or information required from PUB

- The 4No. 100m long rolls of 110mm PE80B pipe which is exposed to the sun at PUB Betio stores should be covered from the sunlight using a thick tarpaulin or similar. This will prevent UV degradation and bleaching which will lead to the pipe becoming brittle and weak.

- The 100mm PVC solvent weld pipe which is exposed at ground level on the southern side of the bridge on Tanaea must be sealed to prevent additional soil and rubbish entering the pipe. A solvent weld end cap correctly adhered on the end of the pipe will be sufficient.

- Kevin of PUB (Betio) to investigate if electrical drawings are available for the pump chamber control panels.

- A piece of information is required from the pump mechanic for the galleries, who was not available during the 9 days site assessment:

    - the motor type, model, size (kW) & pulley sizes of the pump motor used in the Buota pump chambers.

- If parts and time is available it may be possible to repair 1No. of the pump galleries in the Buota Water Reserve sufficiently to test the pipeline between the galleries and the bridge, to prove the pipeline is complete.