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# Stormwater Management

## Muri & Aroko Catchment

3<sup>rd</sup> September 2020 - Consultation

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# Agenda

Welcome & introductions

Background

Feasibility Study Outcomes

Stormwater Design

Project Works

Closing

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## Project Goal

Provide appropriate storm water management solutions, to improve storm water quality (sediment, nutrients) and quantity impacts (flooding) in the Muri Catchment

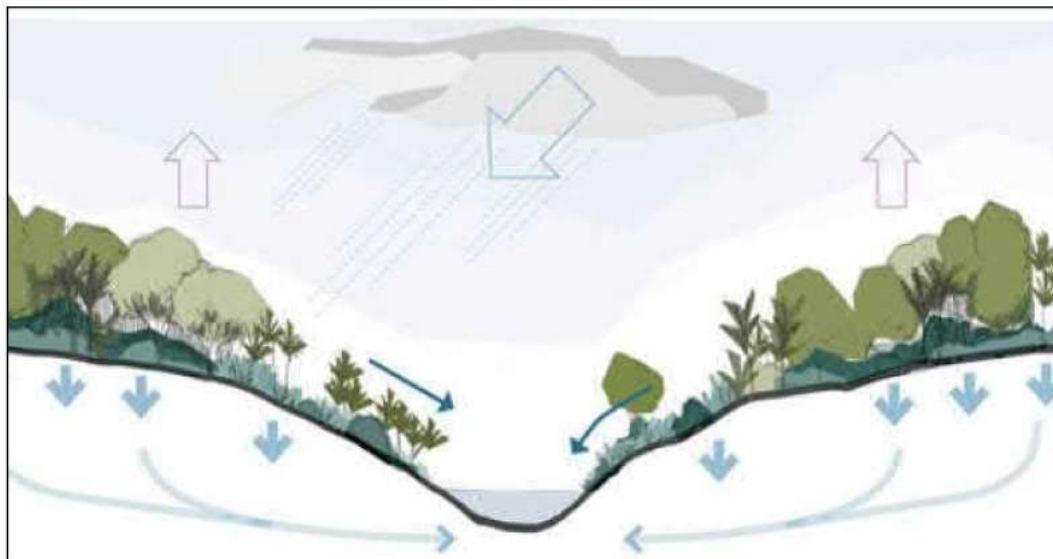




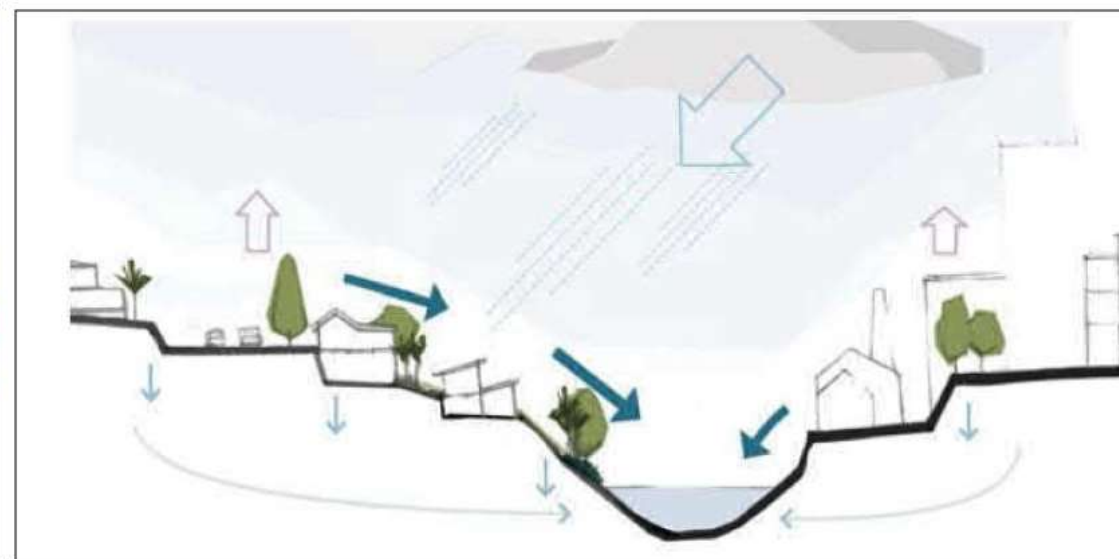
# Storm water 101: The water cycle

*Cycle of water circulating between the oceans, atmosphere, and land, involving rain (precipitation), drainage in streams and rivers, soakage into ground, and returning to the atmosphere (evapotranspiration)*

HISTORICALLY



...over time WITH DEVELOPMENT

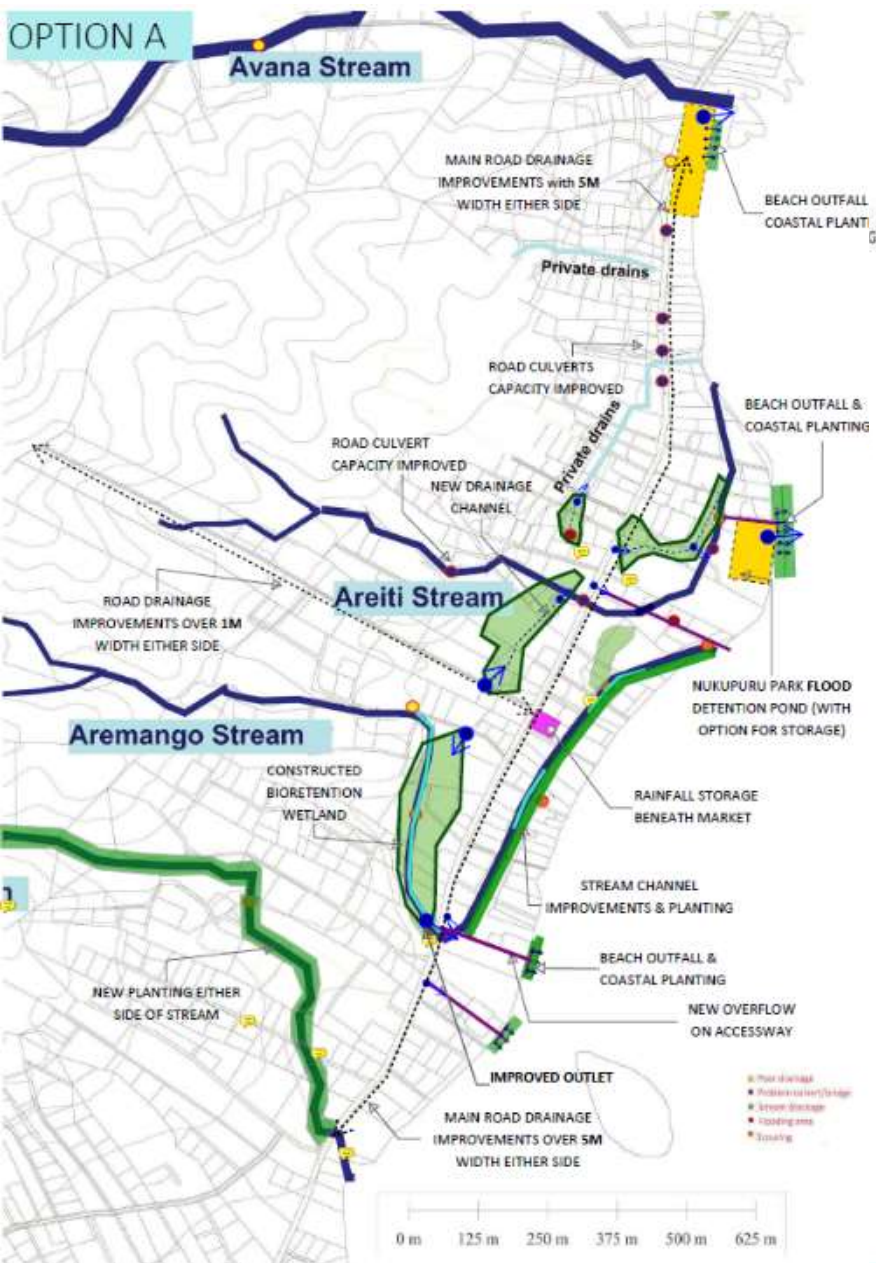


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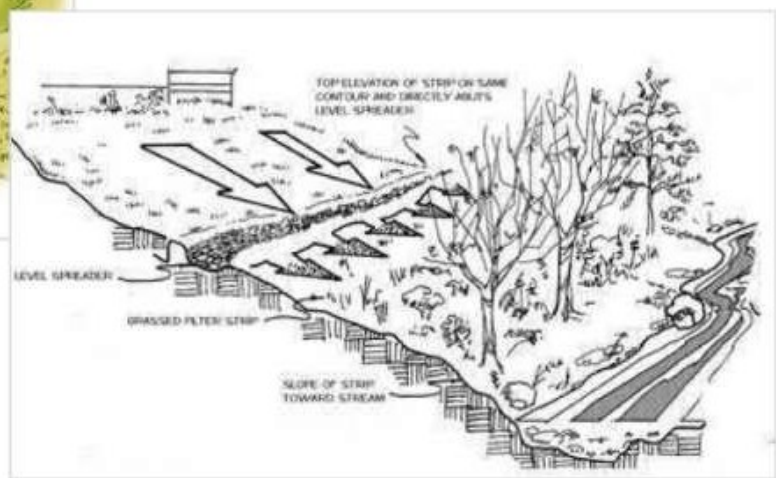
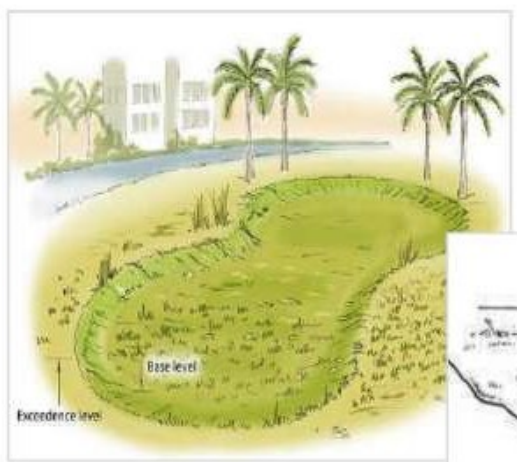
↓ precipitation   ↑ evapotranspiration   ↓ shallow infiltration   ↪ deep infiltration   ↪ surface runoff



**OPTION A**



**T+T Tonkin+Taylor**





**ACTIONS NEEDED TO KEEP A STREAM HEALTHY AND SAFE**

1. Wash water flowing onto lawn
2. Garden chemicals applied far from stream
3. Silt fence in place around construction
4. Covered stock pile
5. Building not in floodplain
6. Natural floodplain left alone
7. Fences in floodplain let water through
8. Use fences to keep kids safe
9. Bridge rather than culvert allows a more natural flow
10. No barriers to fish – culverts gently sloping and not perched
11. Use soft engineering and natural materials

**SIGNS OF A HEALTHY STREAM**

12. Deeper water and pools
13. Natural features such as meanders and stony / rocky sections
14. Native plants
15. Stream shaded by trees and shrubs
16. Logs, sticks and leaves along stream bed
17. Cool, clear, flowing and odourless water
18. Stones and plants not covered in silt
19. Algae and water plant growth similar between winter and summer
20. Natural habitat for birds and other life
21. Many different fish, water insects and other aquatic animals
22. Litter free and attractive environment



# Feasibility Study Outcomes

Option A was the preferred option from the workshop & MCA

Option A assumes treatment and slowing down of water are the primary functions. Key opportunities explored by this option are:

- The enhancement of multiple existing areas to provide flood attenuation and sediment treatment; and
- Provision of buffers for enhanced biofiltration and infiltration;

Staged implementation was recommended given uncertainty about land access/availability.



Figure 6.1: Group scoring process at options workshop.





# Stormwater Design

Based on option A the design was progressed based on utilising a Constructed wetland (with attenuation) within the existing identified swamp areas.

Stage 1: The Muri streams Aremango & Areiti will be upgraded for capacity and will continue to operate under normal flow conditions. Flows in excess of stream capacity will be bypassed to a secondary overflow to manage flooding.

Stage 2: Provide attenuation utilising the swamp to manage flooding and improve stormwater treatment capability and quality of the stormwater being discharged.



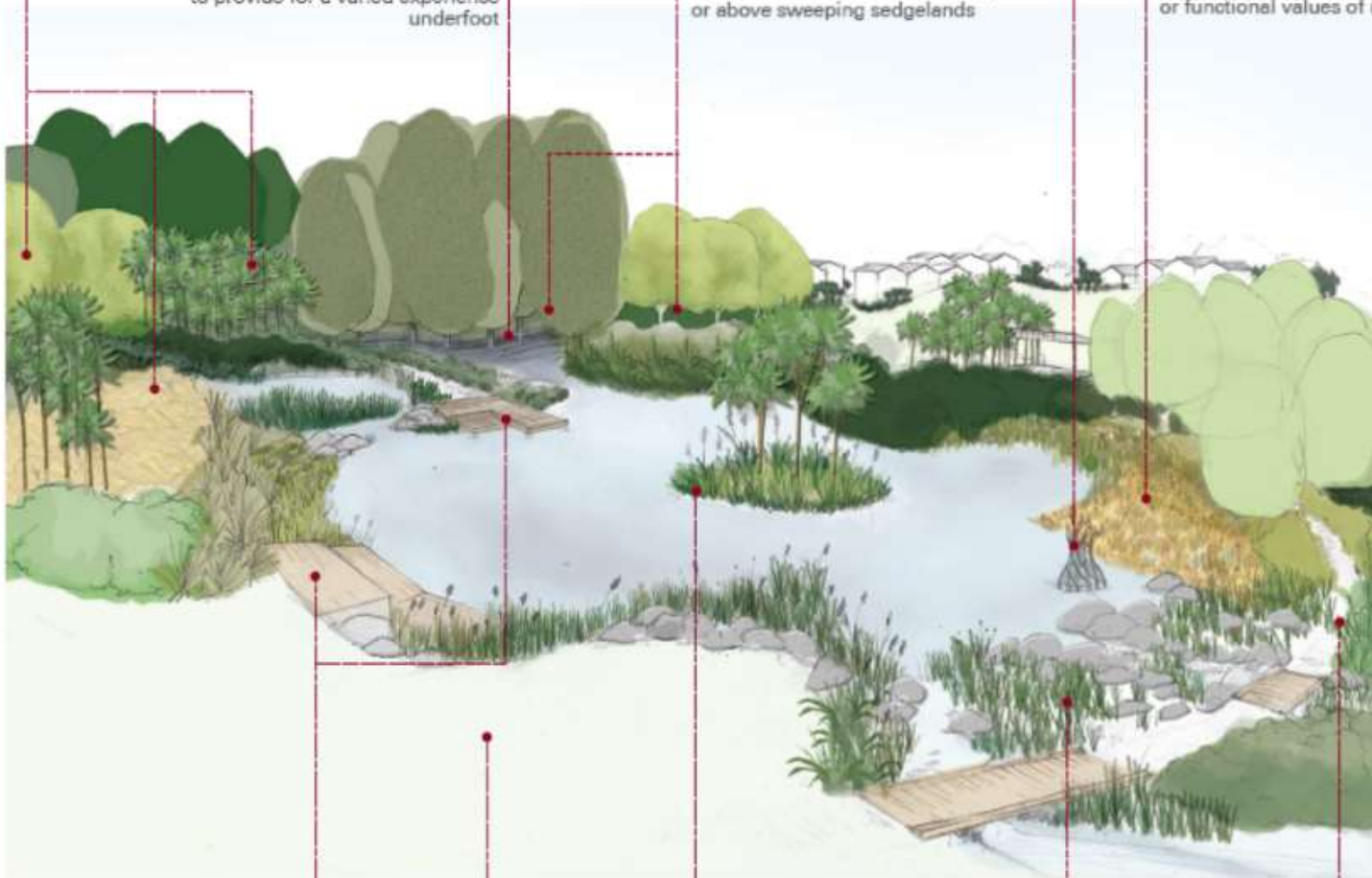
Harmonising colour combinations

Boardwalk through swamp forest to provide for a varied experience underfoot

Variation of spatial experiences within the wetland - underneath the canopy of swamp forest, enclosed within dense reedlands, or above sweeping sedgeland

Use/celebration of infrastructure as sculptural elements

Mass planting to emphasize qualities and/or functional values of individual species



Options of pathways and vantage points - revealed and concealed from one another

Gathering areas for education or socialising opportunities

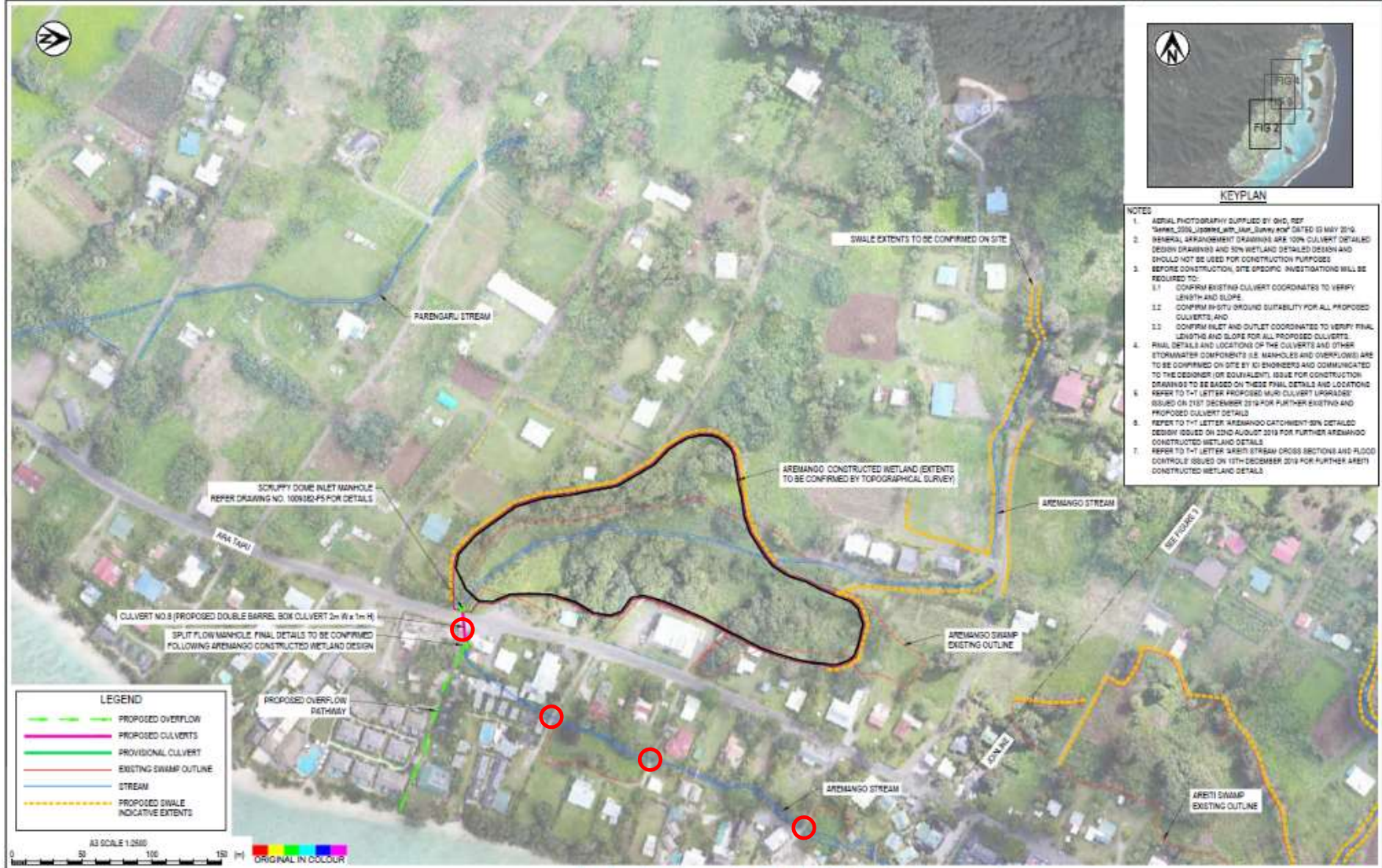
Islands break up sight lines and the mass of the pond, providing the illusion of a continuous landscape

Wetland shelves provide a safety margin to deep water areas

Pathways can be placed on top of weir structures as a means to reduce infrastructure and provide a level spreader for overflows



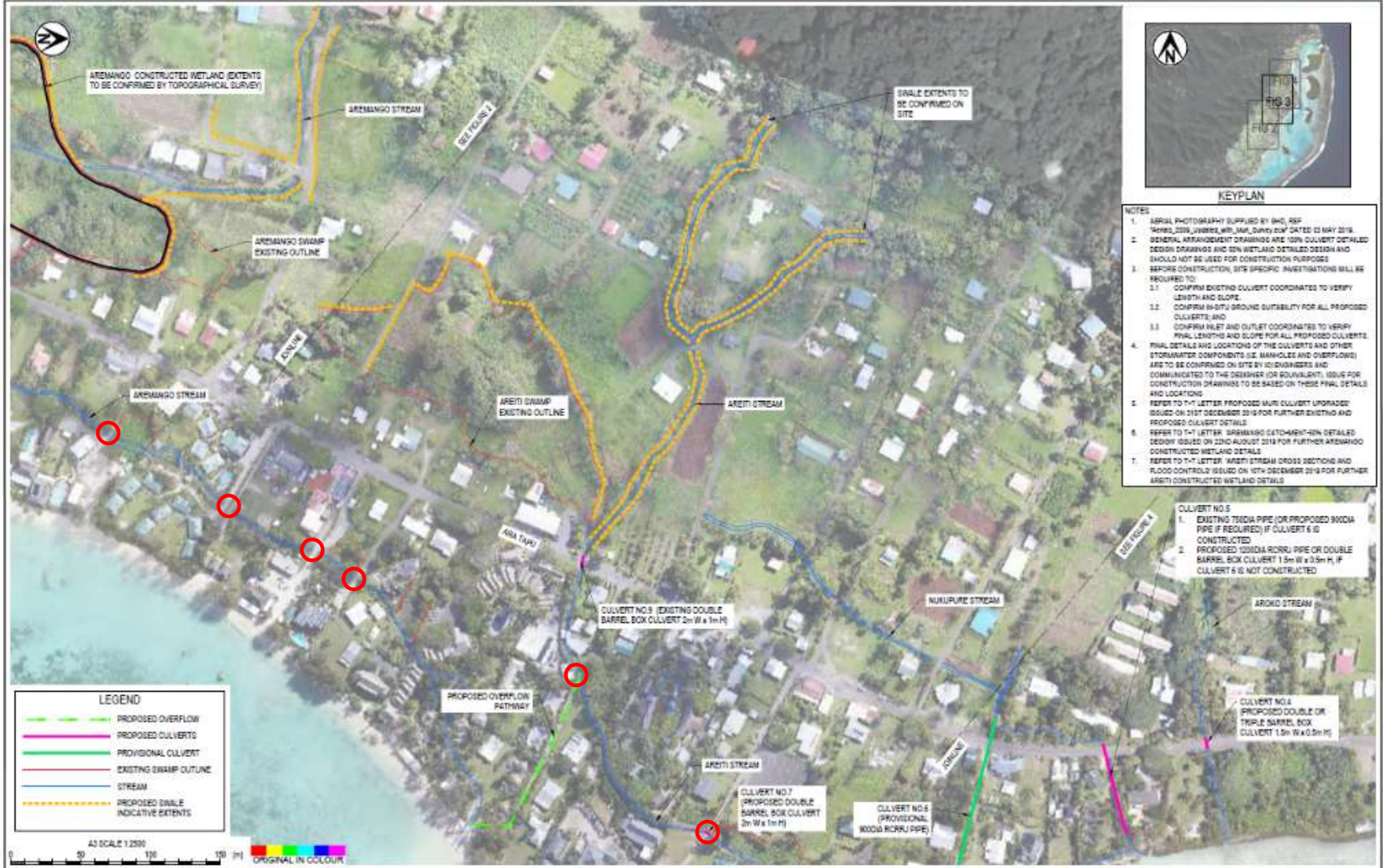




- NOTES**
1. AERIAL PHOTOGRAPHY SUPPLIED BY OIG, REF 'AERIAL\_PHOTOGRAPHY\_MURI\_SURVEY\_05' DATED 03 MAY 2016
  2. GENERAL ARRANGEMENT DRAWINGS ARE 100% CULVERT DETAILED DESIGN DRAWINGS AND SOIL WETLAND DETAILED DESIGN AND SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES BEFORE CONSTRUCTION. SITE SPECIFIC INVESTIGATION WILL BE REQUIRED TO:
    - i.1. CONFIRM EXISTING CULVERT COORDINATES TO VERIFY LENGTH AND SLOPE
    - i.2. CONFIRM IN-SITU GROUND SUITABILITY FOR ALL PROPOSED CULVERTS AND
    - i.3. CONFIRM INLET AND OUTLET COORDINATES TO VERIFY FINAL LENGTH AND SLOPE FOR ALL PROPOSED CULVERTS.  3. FINAL DETAILS AND LOCATIONS OF THE CULVERTS AND OTHER STORMWATER COMPONENTS (I.E. MANHOLES AND OVERFLOWS) ARE TO BE CONFIRMED ON SITE BY A/S ENGINEERS AND COMMUNICATED TO THE DESIGNER (OR EQUIVALENT) ISSUE FOR CONSTRUCTION DRAWINGS TO BE BASED ON THESE FINAL DETAILS AND LOCATIONS
  4. REFER TO T-1 LETTER PROPOSED MURI CULVERT UPGRADES ISSUED ON 21ST DECEMBER 2019 FOR FURTHER EXISTING AND PROPOSED CULVERT DETAIL
  5. REFER TO T-1 LETTER AREMANGO CATCHMENT SOIL DETAILED DESIGN ISSUED ON 20/04/2019 FOR FURTHER AREMANGO CONSTRUCTED WETLAND DETAILS
  6. REFER TO T-1 LETTER ARETI STREAM CROSS SECTIONS AND FLOOD CONTROL ISSUED ON 10TH DECEMBER 2019 FOR FURTHER ARETI CONSTRUCTED WETLAND DETAILS

DESIGNED AHOU Feb.20	DRAWN JC Feb.20	DRAWING STATUS DETAILED DESIGN	CLIENT <b>INFRASTRUCTURE COOK ISLANDS</b>			
			PROJECT <b>MURI RIDGE TO REEF</b>			
DESIGN CHECKED GPP Feb.20	DRAWING CHECKED TRJ Feb.20		TITLE STORMWATER DETAIL DESIGN GENERAL ARRANGEMENT MURI CATCHMENT			
NOT FOR CONSTRUCTION		THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNLESS SIGNED AND APPROVED	SCALE (AS) 1:2500 DWG No. 1009382.0000-FIG2 REV 2			
REV	DESCRIPTION	CAO	CHK	DATE	APPROVED	DATE
1	PRELIMINARY DESIGN	JC	AHOU	OCT.19		
2	100% CULVERT DETAILED DESIGN	JC	AHOU	FEB.20		



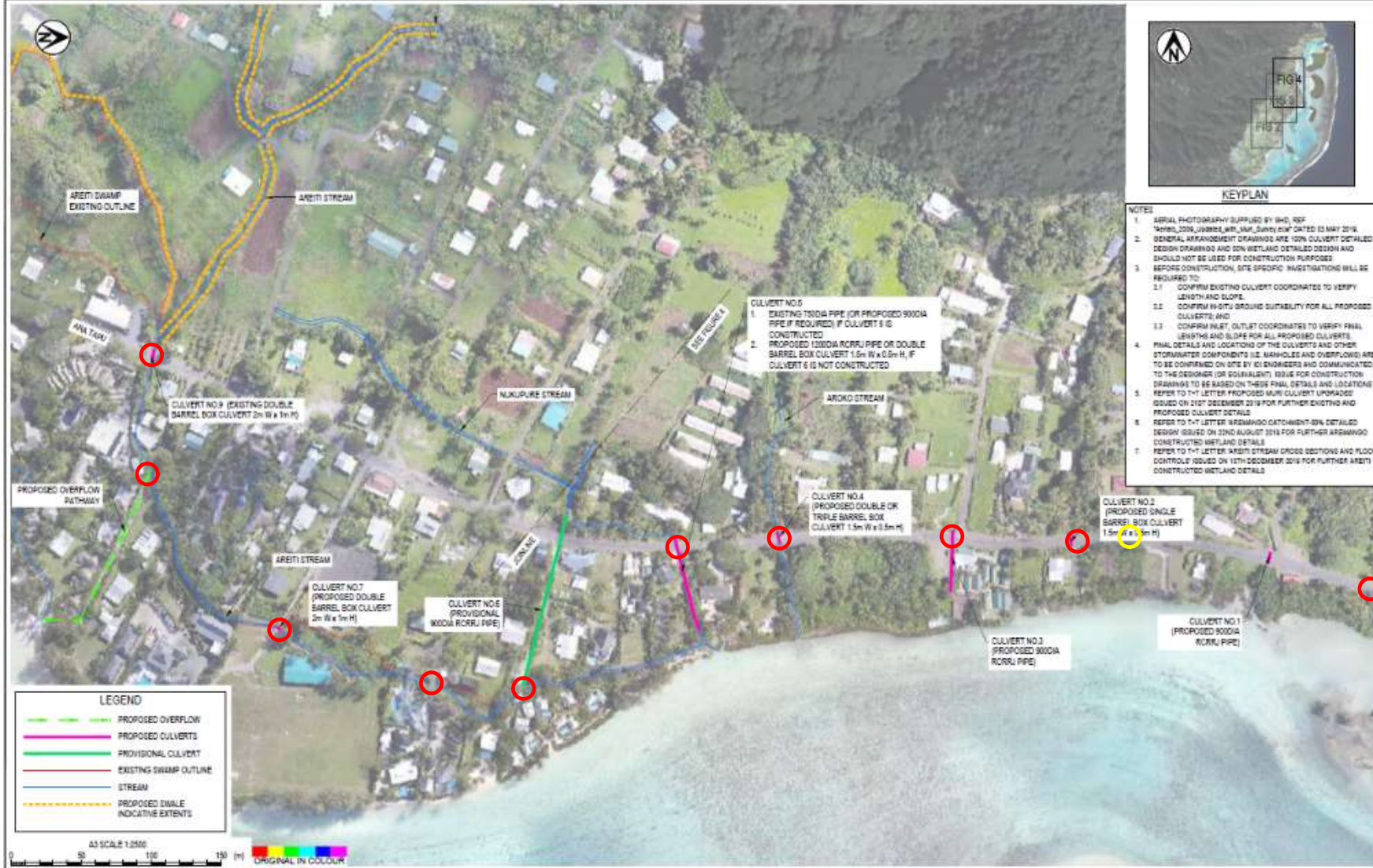


- NOTES**
1. AERIAL PHOTOGRAPHY (SUPPLIED BY GNS) REF: 'MURI\_2016\_SURVEY\_MRI\_MRI\_SURVEY\_2016' DATED 23 MAY 2016.
  2. GENERAL ARRANGEMENT DRAWINGS ARE 100% CULVERT DETAILED DESIGN DRAWINGS AND 10% WETLAND DETAILED DESIGN AND SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.
  3. BEFORE CONSTRUCTION, SITE SPECIFIC INVESTIGATIONS WILL BE REQUIRED TO:
    - 3.1. CONFIRM EXISTING CULVERT COORDINATES TO VERIFY LENGTH AND SLOPE.
    - 3.2. CONFIRM IN-SITU GROUND SUITABILITY FOR ALL PROPOSED CULVERTS; AND
    - 3.3. CONFIRM INLET AND OUTLET COORDINATES TO VERIFY FINAL LENGTHS AND SLOPE FOR ALL PROPOSED CULVERTS.
  4. FINAL DETAILS AND LOCATIONS OF THE CULVERTS AND OTHER STORMWATER COMPONENTS (I.E. MANHOLES AND OVERFLOWS) ARE TO BE CONFIRMED ON SITE BY IO ENGINEERS AND COMMUNICATED TO THE DESIGNER (OR EQUIVALENT). ISSUES FOR CONSTRUCTION DRAWINGS TO BE BASED ON THESE FINAL DETAILS AND LOCATIONS.
  5. REFER TO THE LETTER 'PROPOSED MURI CULVERT UPGRADES' ISSUED ON 21ST DECEMBER 2019 FOR FURTHER EXISTING AND PROPOSED CULVERT DETAILS.
  6. REFER TO THE LETTER 'AREMANIGO CATCHMENT-2019 DETAILED DESIGN' ISSUED ON 22ND AUGUST 2019 FOR FURTHER AREMANIGO CONSTRUCTED WETLAND DETAILS.
  7. REFER TO THE LETTER 'AREITI STREAM CROSS SECTION AND FLOOD CONTROL' ISSUED ON 16TH DECEMBER 2019 FOR FURTHER AREITI CONSTRUCTED WETLAND DETAILS.

- CULVERT NO. 5**
1. EXISTING T800IA PIPE (OR PROPOSED 900x4 PIPE IF REQUIRED) IF CULVERT 6 IS CONSTRUCTED.
  2. PROPOSED 1000x4 RORU PIPE OR DOUBLE BARREL BOX CULVERT 1.5m W x 0.5m H, IF CULVERT 6 IS NOT CONSTRUCTED.

- CULVERT NO. 6**
1. PROPOSED DOUBLE OR TRIPLE BARREL BOX CULVERT 1.5m W x 0.5m H.

1	PRELIMINARY DESIGN	JC	AHOU	OCT.19	DESIGNED	AHOU	Feb.20	DRAWING STATUS	CLIENT	INFRASTRUCTURE COOK ISLANDS	
	2				100% CULVERT DETAILED DESIGN	SPP	Feb.20				DETAILED DESIGN
NOT FOR CONSTRUCTION		CAD		CHK	DATE	APPROVED	DATE	TITLE			
REV		DESCRIPTION		APPROVED		DATE		SCALE (A3)			1:2500
								DMG No.			1009382.0000-FIG3
								REV			2



- NOTES**
- SERIAL PHOTOGRAPHY SUPPLIED BY IBE, REF 'AIBES\_2006\_000000\_WRI\_MRI\_SURVEY\_CIN' DATED 03 MAY 2016.
  - GENERAL ARRANGEMENT DRAWINGS ARE 100% CULVERT DETAILED DESIGN DRAWINGS AND NOT WETLAND DETAILED DESIGN AND SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.
  - BEFORE CONSTRUCTION, SITE SPECIFIC INVESTIGATIONS WILL BE REQUIRED TO:
    - CONFIRM EXISTING CULVERT COORDINATES TO VERIFY LENGTH AND SLOPE.
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  - FINAL DETAILS AND LOCATIONS OF THE CULVERTS AND OTHER STORMWATER COMPONENTS (I.E. MANHOLES AND OVERFLOWS) ARE TO BE CONFIRMED ON SITE BY KL ENGINEERS AND COMMUNICATED TO THE DESIGNER (OR SOLICITOR) IN WRITING FOR CONSTRUCTION DRAWINGS TO BE BASED ON THESE FINAL DETAILS AND LOCATIONS. REFER TO T-1 LETTER 'PROPOSED MURI CULVERT UPGRADES' ISSUED ON 21ST DECEMBER 2018 FOR FURTHER EXISTING AND PROPOSED CULVERT DETAILS.
  - REFER TO T-1 LETTER 'BIRIMANGO CATCHMENT 50% DETAILED DESIGN' ISSUED ON 30ND AUGUST 2018 FOR FURTHER ARRANGING CONSTRUCTED WETLAND DETAILS.
  - REFER TO T-1 LETTER 'AREMI STREAM CROSS SECTIONS AND FLOOD CONTROL' ISSUED ON 16TH DECEMBER 2018 FOR FURTHER AREMI CONSTRUCTED WETLAND DETAILS.



DESIGNED AHOU Feb.20	DRAWN JC Feb.20	DRAWING CHECKED TRU Feb.20	DRAWING STATUS DETAILED DESIGN	CLIENT <b>INFRASTRUCTURE COOK ISLANDS</b>		
				PROJECT <b>MURI RIDGE TO REEF</b>		
TITLE <b>STORMWATER DETAIL DESIGN GENERAL ARRANGEMENT MURI CATCHMENT</b>				SCALE (A3) 1:2500		
1 PRELIMINARY DESIGN 2 100% CULVERT DETAILED DESIGN NOT FOR CONSTRUCTION				DWS No. 1009382.0000-FIG4 REV 2		
REV	DESCRIPTION	CAO	CHK	DATE	APPROVED	DATE



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# Project Works

## Stage 1: In progress

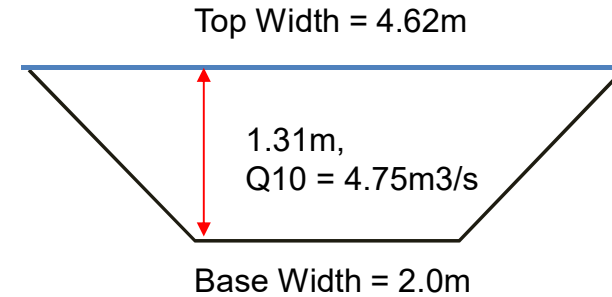
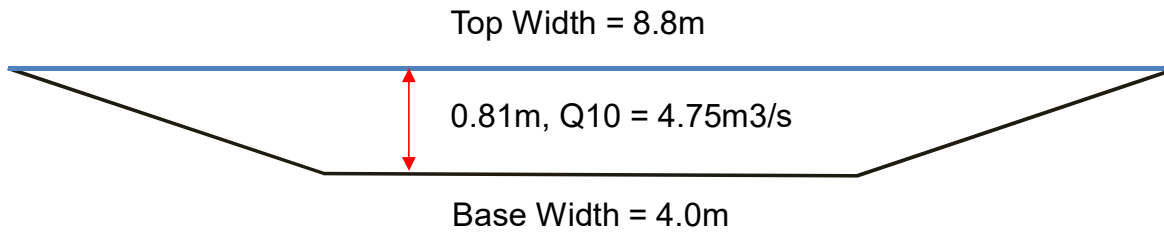
- Improve stream capacity, inverts and widening as per design. Physical works to commence.
- Stream culvert upgrades and main road culverts in Aroko. Physical works to commence following Material supply.
- Provision of emergency stormwater bypass. Land discussions
- Wetlands to provide flow/flood management and later treatment functions. Land discussions.

## Stage 2: Planned

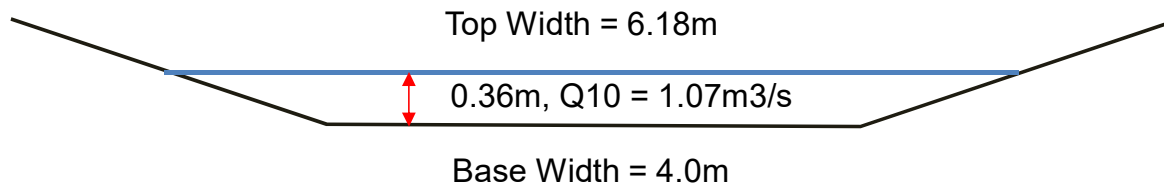
- Physical works wetland stormwater treatment improvements
  - Riparian planting
-

# Stream Profile (Aremango)

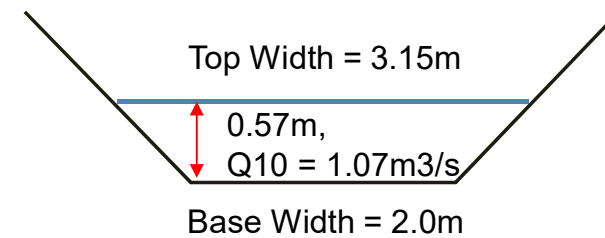
## Design Stream Profile (without Attenuation from Swamp)



## Design Stream Profile (Attenuation from Swamp & overflow controls)



Shallow/Flat Profile



Steep/deep Profile







### Aqua Café Access

Replace existing culvert with 10 m long twin 900mm dia pipe culvert with inlet and outlet wing walls.



Aqua Café Access existing culvert

### Sailing Club

Replace existing culvert with 7.5m long twin 900mm dia pipe culvert with inlet and outlet wing walls.



Sailing Club existing culvert



### Access north of Pacific Resort

Replace existing culvert with 5m long twin 900mm dia pipe culvert with inlet and outlet wingwalls.



Access north of Pacific Resort existing culvert

### Flame Tree Villas

Remove existing culvert at boundary with rugby field. Construct rock lined open channel and reinstate timber fencing on boundary.



Existing culvert at boundary with rugby field

Replace existing Flame Tree Villas access road culvert with 5m long twin 900mm dia pipe culvert with inlet and outlet wing walls.



Flame Tree Villas access road existing culvert



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# Thank you

Comments or further queries can be directed to:

Paul Moate [paul.maoate@cookislands.gov.ck](mailto:paul.maoate@cookislands.gov.ck) or  
Gareth Clayton [gareth.clayton@cookislands.gov.ck](mailto:gareth.clayton@cookislands.gov.ck)

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### Te Vakarua

Replace existing culvert with 7.5m long twin 900mm dia pipe culvert with inlet and outlet wing walls.  
Reinstate existing timber Walkway Bridge and low walls including lighting etc. as per existing preexisting condition.



Te Vakarua existing culvert

### Sailing Club

Replace existing culvert with 7.5m long twin 900mm dia pipe culvert with inlet and outlet wing walls.



Sailing Club existing culvert



### Muri Beachcomber/Night Market

Replace existing culvert with 10m long twin 900mm dia pipe culvert with inlet and outlet wing walls. Reinstate existing timber fence and gardens etc. as per existing pre-existing condition.



Muri Beachcomber/Night Market existing culvert

### Koka Lagoon

Replace existing culvert with 5m long twin 900mm dia pipe culvert with inlet and outlet wing walls.



Koka Lagoon existing culvert



### Access opposite Te Ara Museum

Replace existing culvert with 5m long twin 900mm dia pipe culvert with inlet and outlet wing walls



Access Opposite Te Ara Museum existing culvert

### Aqua Café Access

Replace existing culvert with 10 m long twin 900mm dia pipe culvert with inlet and outlet wing walls



Aqua Café Access existing culvert



### Access north of Pacific Resort

Replace existing culvert with 5m long twin 900mm dia pipe culvert with inlet and outlet wingwalls.



Access north of Pacific Resort existing culvert

### Flame Tree Villas

Remove existing culvert at boundary with rugby field. Construct rock lined open channel and reinstate timber fencing on boundary.



Existing culvert at boundary with rugby field

Replace existing Flame Tree Villas access road culvert with 5m long twin 900mm dia pipe culvert with inlet and outlet wing walls.



Flame Tree Villas access road existing culvert





### Sokahala Bridge

Remove existing bridge and replace with 5m long twin 900mm dia pipe culvert with inlet and outlet wingwalls.



Existing Sokahala Bridge

### Aroko Bungalo's

Removal of existing culvert and construction of 45m of 900mm dia pipe culvert including outlet wing wall and scruffy dome inlet chamber.

### Krua Kabanas

Removal of existing culvert and construction of 70m of 1200mm dia pipe culvert including inlet and outlet wing walls.

### Ara Tapu cross culvert adjacent to Tamariki Drive

Removal of existing culvert and construction of 57m of 900mm dia pipe culvert including inlet and outlet wing walls.

### Ara Tapu cross culvert south of Avana Bridge

Removal of existing culvert and construction of 14m of 1200mm dia pipe culvert including inlet and outlet wing walls.



Existing Ara Tapu cross culvert south of Avana Bridge



Ara Tapu cross culvert adjacent to Vodafone building

Construct new 12m of 600mm dia pipe culvert including outlet wing wall and Scruffy dome inlet chamber.



Proposed location of Ara Tapu cross culvert adjacent to Vodafone building

