Guyana Conservancy Adaptation Project: Pre-Investment Studies

Overview of Modelling Approach

Martha Taylor: Deputy Team Leader & Engineer

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Overview of Modelling Approach Introduction

1. **Scope of Modelling Work**
2. **Pre-modelling Data Collection**
3. **EDWC Model Construction**
4. **EDWC Model Calibration**
5. **ECD Model Construction**
6. **Questions?**

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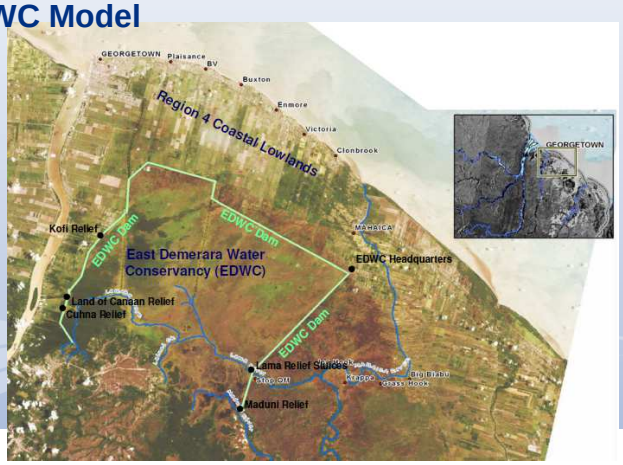
1. Scope of Modelling Work

1. EDWC Model



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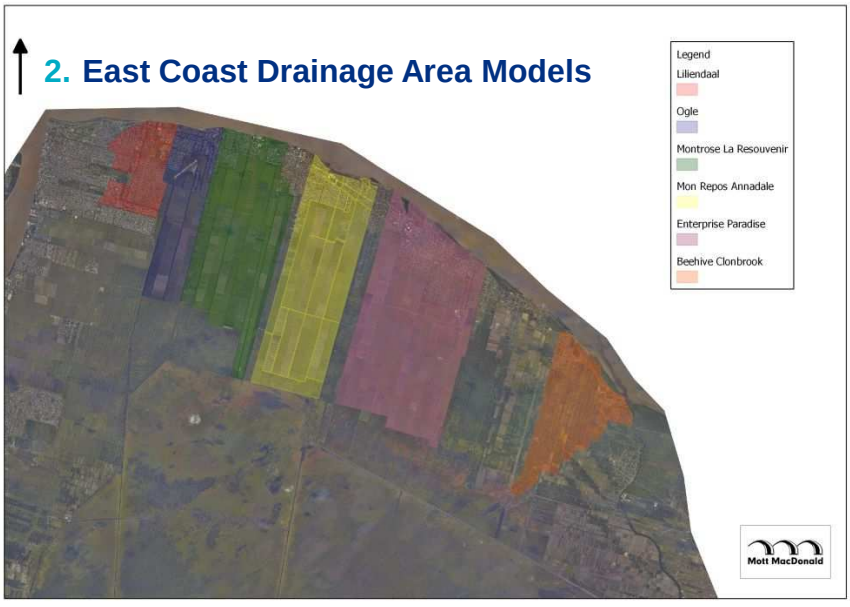
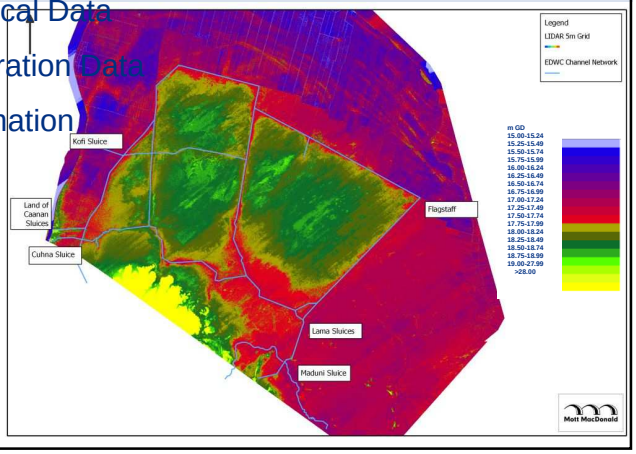
1. Scope of Modelling Work

2. East Coast Drainage Area Models



2. Pre-modelling Data Collection

1. **Topographic Data**
2. Bathymetric Data
3. Hydro-meteorological Data
4. Infrastructure Operation Data
5. Stakeholder Information



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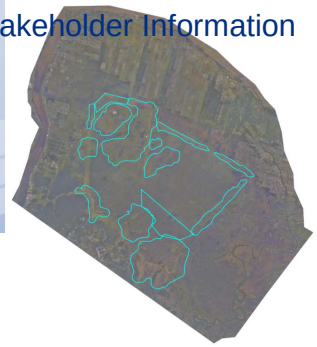

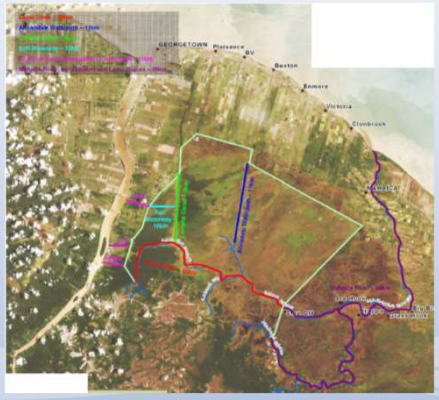

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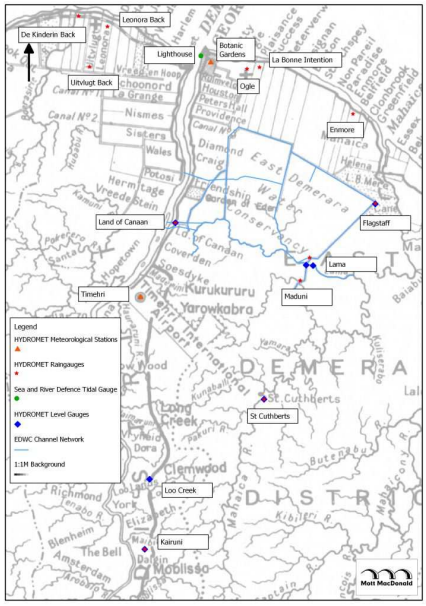

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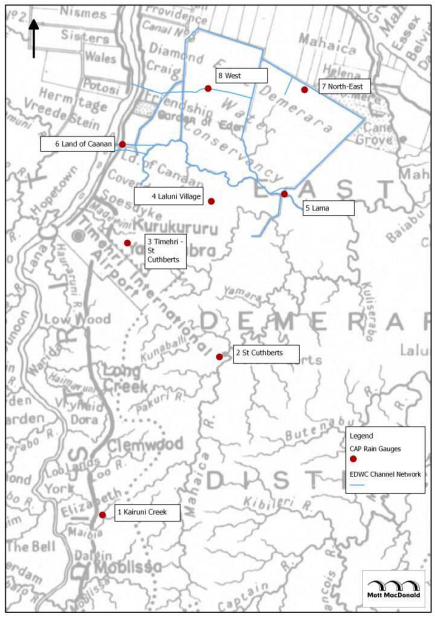

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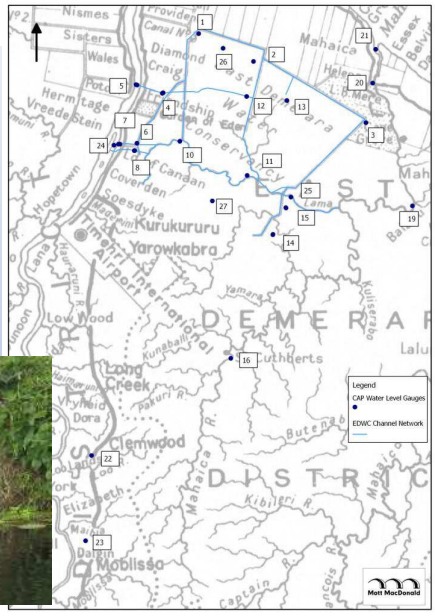

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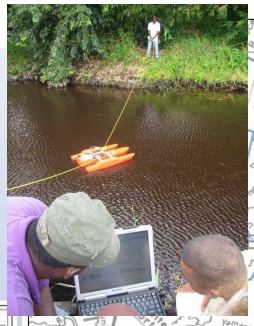

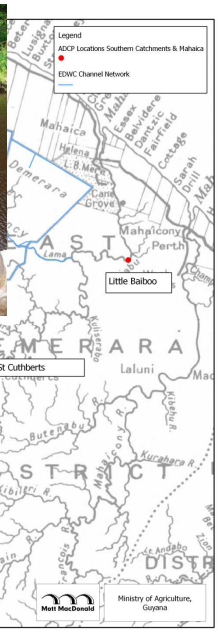

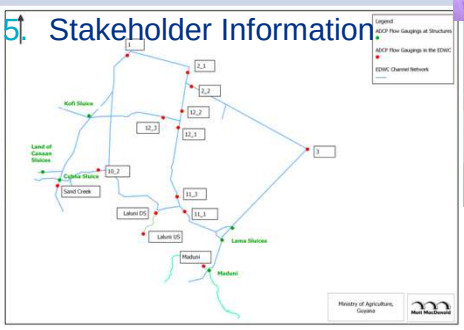

2. Pre-modelling Data Collection

1. Topographic Data
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4. **Infrastructure Operation Data**
5. Stakeholder Information

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2. Pre-modelling Data Collection

1. Topographic Data
2. Bathymetric Data
3. Hydro-meteorological Data
4. Infrastructure Operation Data
5. **Stakeholder Information**

NDIA EDWC NDCs WUAs GUYSUCO CDC Mangroves Sea Defences HYDROMET

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3. EDWC Model Construction

Task 2 Objectives:

- *To ascertain effectiveness of recent modifications to drainage conditions*
- *Determine current effectiveness of drainage relief system*
- *Identify interventions to improve relief capacity*
- *Develop water management recommendations*

To keep water level below safe operating level during rainy season, while safe-guarding supply during dry season

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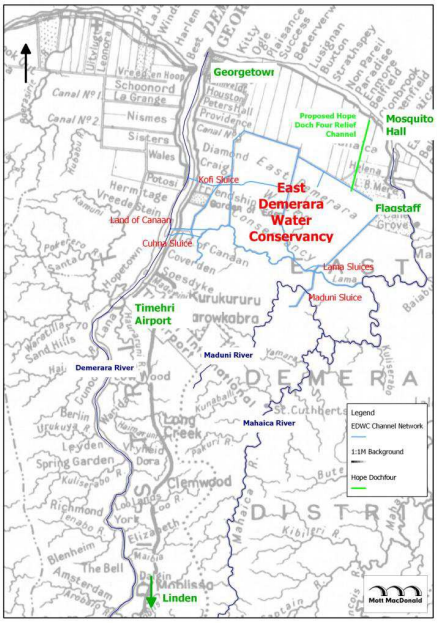
3. EDWC Model Construction



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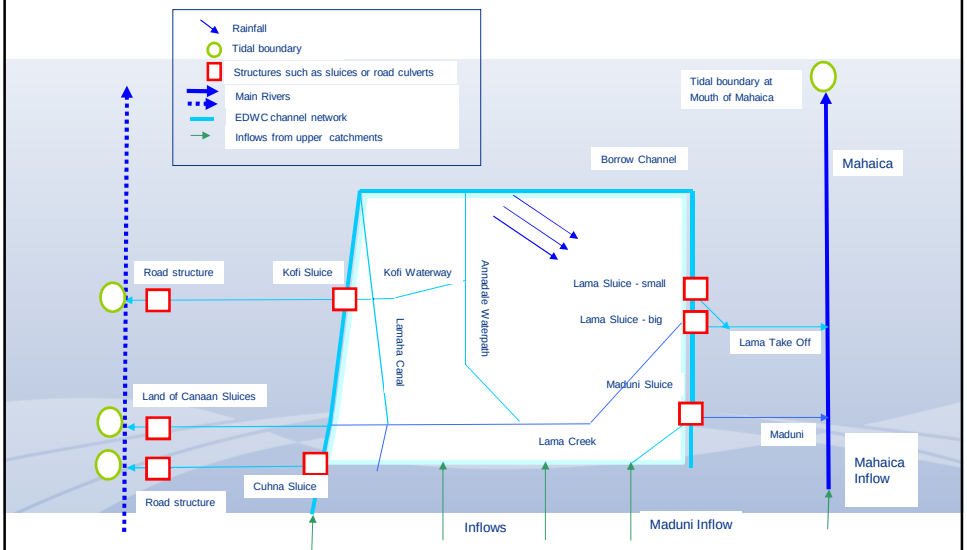
3. EDWC Model Construction



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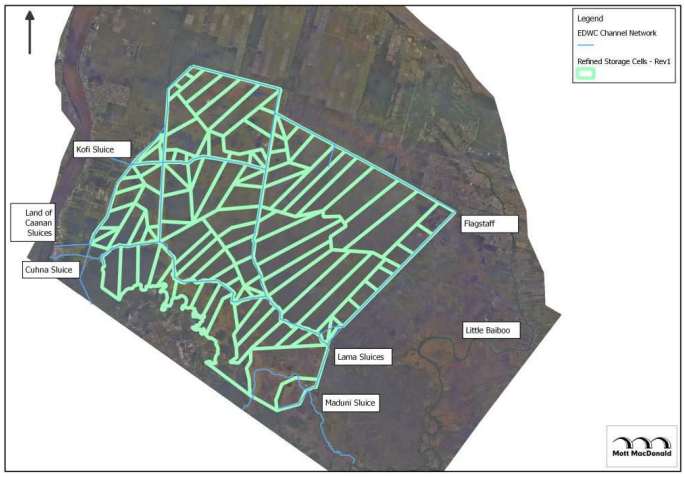

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3. EDWC Model Construction

Reach = length of channel or structures connected by nodes

Nodes = define the connection between reaches
Also acts as
-inflow points
-boundaries
-junctions

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4. EDWC Model Calibration

Calibration Events

- 1 January to 31 March 2005 (2005 Event)
- 19 January to 31 March 2012 (2012-1 Event)
- 1 May to 30 June 2012 (2012-2 Event)

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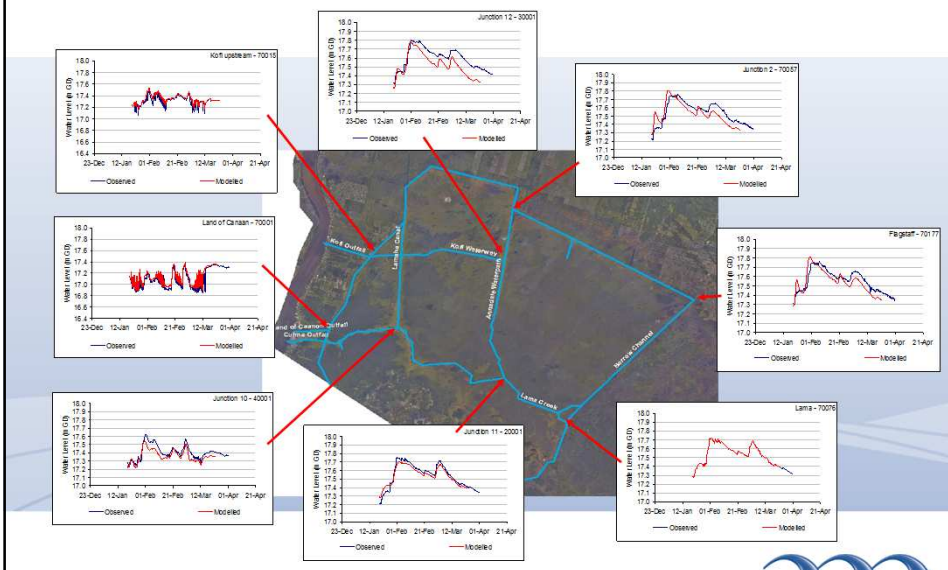
4. EDWC Model Calibration



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5. ECD Model Construction

Task 4 Scope of Works:

- *To provide a comprehensive model and framework for the evaluation of flood waters*
- *Define the existing drainage system*
- *Identify critical duration event*
- *Recommend interventions designed to mitigate future flooding*

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5. ECD Model Construction

Identify drainage areas to be modelled

↓

Decide on approach/level of modelling

↓

Collate appropriate level of data

↓

Develop model

↓

Decide level of service to be provided

↓

Identify critical duration

↓

Test impact of interventions

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5. ECD Model Construction

Matrix used to score drainage areas along the coastal lowland region against:

- Frequency of Flooding
- Rate of Dissipation
- Population
- Affected Agricultural Area
- Key Areas of Infrastructure and Agricultural Significance

...final assessment led to 11 drainage regimes within 6 drainage areas

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5. ECD Model Construction

6 drainage areas assessed (as individual models) are:

- Liliendaal: Liliendaal regime
- Ogle: Ogle regime
- Montrose: Montrose and Sparendaam regimes
- Mon Repos: Mon Repos and Annadale regimes
- Enterprise: Strathspey, Enterprise and Paradise regimes
- Beehive: Beehive and Clonbrook regimes

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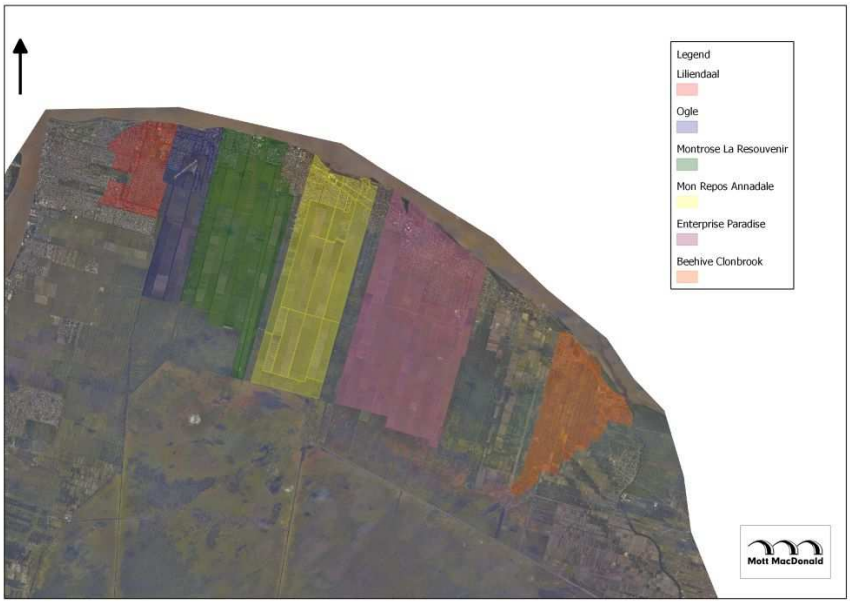
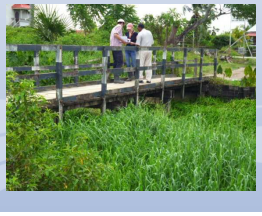
5. ECD Model Construction



5. ECD Model Construction

- More Data Collection
  - Walkover surveys
  - Additional channel sections
  - Structure Surveys



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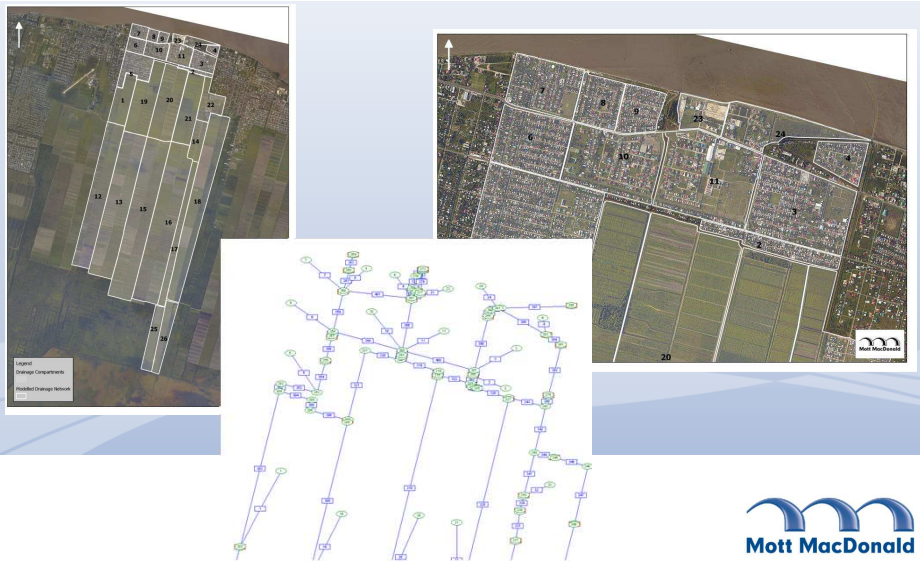
5. ECD Model Construction



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5. Questions?

Any questions?

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Guyana Conservancy Adaptation Project:
Pre-Investment Studies

EDWC Modelling Results and Drainage Interventions
Martha Taylor: Deputy Team Leader & Engineer

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EDWC Modelling Results and Drainage Interventions

1. Analysis of Recent and Proposed Interventions
2. Options Tested
3. Results
4. Preferred Option
5. Questions?

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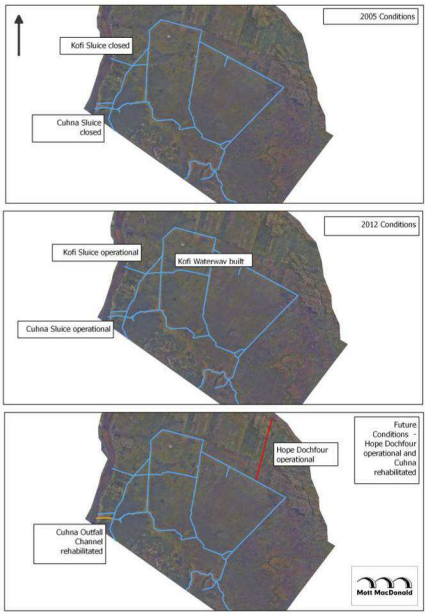
1. Analysis of Recent and Proposed Interventions



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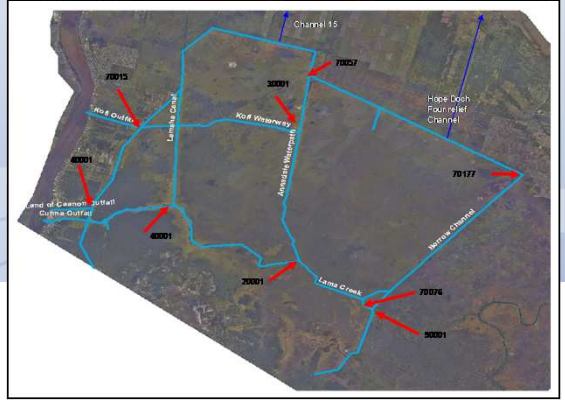
1. Analysis of Recent and Proposed Interventions

		Kofi and Cuhna sluices non-operational; Kofi Waterway not in place	As now	Hope Dochfour operational	Cuhna outfall channel rehabilitated
Location		2005	Baseline	Option 1	Option 2
Model Node	Description	Peak Water Level (m GD)			
Node 20001	Junction 11	17.95	17.90	17.84	17.84
Node 30001	Junction 12	18.12	18.04	17.92	17.92
Node 40001	Junction 10	17.87	17.78	17.75	17.75
Node 70001	Land of Cannan	17.56	17.36	17.33	17.33
Node 70015	Kofi upstream	17.86	17.64	17.59	17.59
Node 70057	Junction 2	18.07	18.01	17.79	17.79
Node 70076	Lama U S	17.89	17.84	17.76	17.76
Node 70177	Flagstaff	18.05	18.00	17.75	17.75



50 YEAR EVENT

Safe Operating Level = 17.83mGD

Overtopping Level = 18.29mGD

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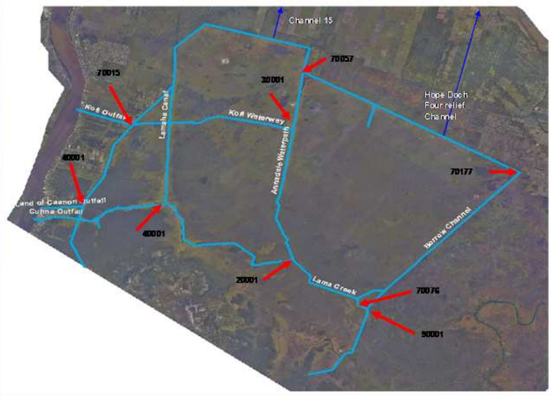
1. Analysis of Recent and Proposed Interventions

		Kofi and Cuhne sluices non-operational, Kofi Waterway not in place	As now	Hope Doch for operational	Op1 + rehabilitated Cuhne outfall channel
Location		2005	Baseline	Option 1	Option 2
Model Node	Description	Peak Water Level (mGD)			
Node 20001	Junction 11	18.00	17.96	17.89	17.89
Node 30001	Junction 12	18.17	18.09	17.98	17.98
Node 40001	Junction 10	17.92	17.83	17.79	17.79
Node 70001	Land of Canaan	17.60	17.39	17.37	17.35
Node 70015	Kofi upstream	17.91	17.71	17.64	17.64
Node 70057	Junction 2	18.12	18.06	17.84	17.84
Node 70076	Lama US	17.93	17.89	17.80	17.80
Node 70177	Flagstaff	18.10	18.05	17.79	17.79



100 YEAR EVENT

Safe Operating Level = 17.83mGD

Overtopping Level = 18.29mGD

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1. Analysis of Recent and Proposed Interventions

100 YEAR EVENT

Safe Operating Level = 17.83mGD

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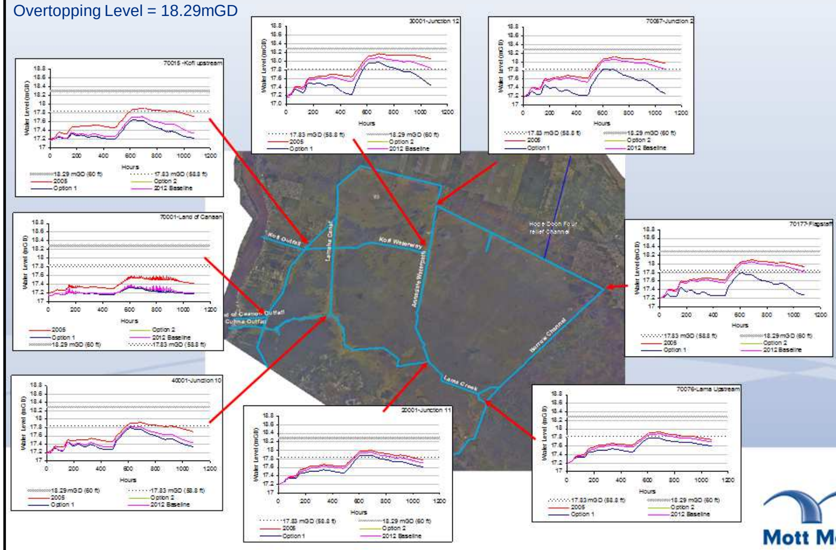

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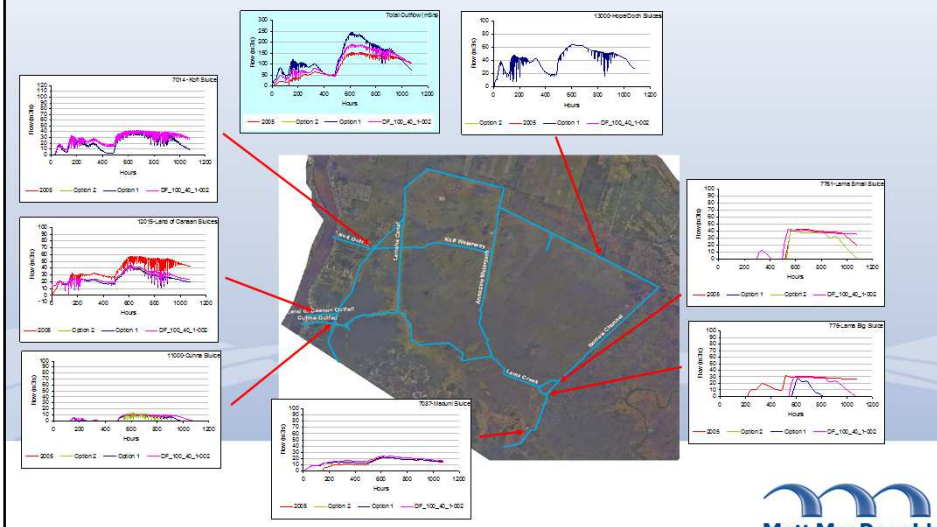
1. Analysis of Recent and Proposed Interventions

100 YEAR EVENT



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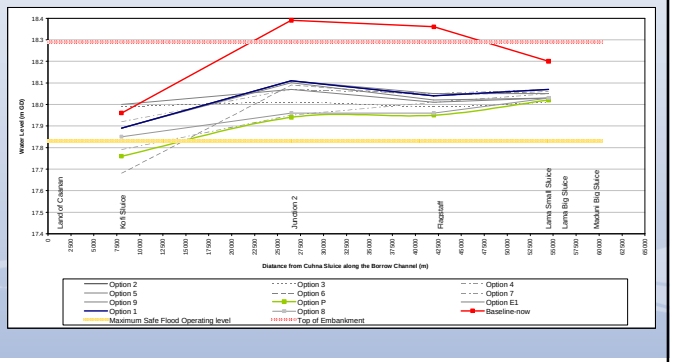
1. Analysis of Recent and Proposed Interventions

10,000 year event

		As now	Hope Dach Four = Baseline
Location		Baseline	Option 1
Model Node	Description		
Node 20001	Junction 11	18.28	18.20
Node 30001	Junction 12	18.41	18.28
Node 40001	Junction 10	18.10	18.06
Node 70001	Land of Canaan	17.59	17.56
Node 70015	Kofi upstream	17.96	17.89
Node 70057	Junction 2	18.39	18.11
Node 70076	Lama US	18.20	18.07
Node 70177	Flagstaff	18.36	18.04
Node 90001	Lama DS	17.55	17.43
Mahaica			
Node 60075	Little Baiboo	17.37	17.26
Node 60109	Belmont	17.35	17.34



10,000yr event

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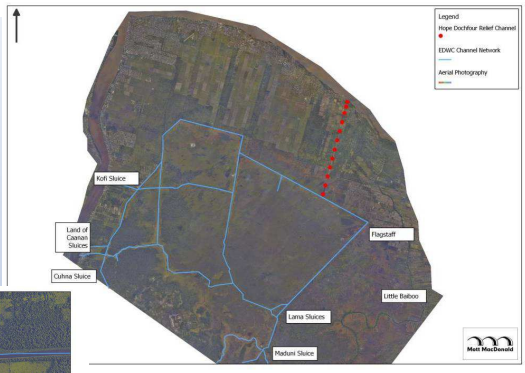
2. Options Tested

Option 1

As now plus Hope Dochfour Operational

Option 2

Option 1 plus Cuhna Sluice Rehabilitated



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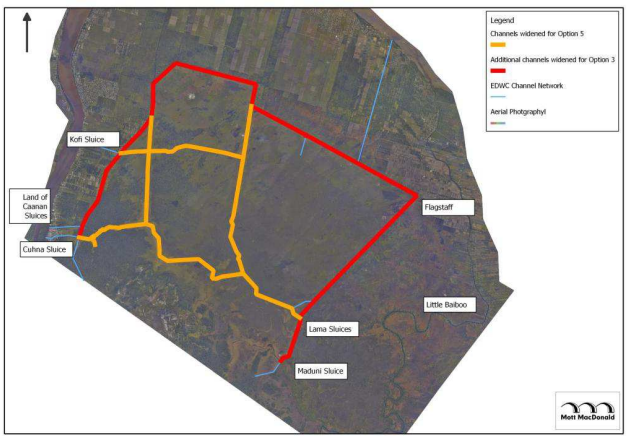
2. Options Tested

Option 3 and Option 5

As now plus Hope Dochfour plus increased conveyance by excavating existing channels



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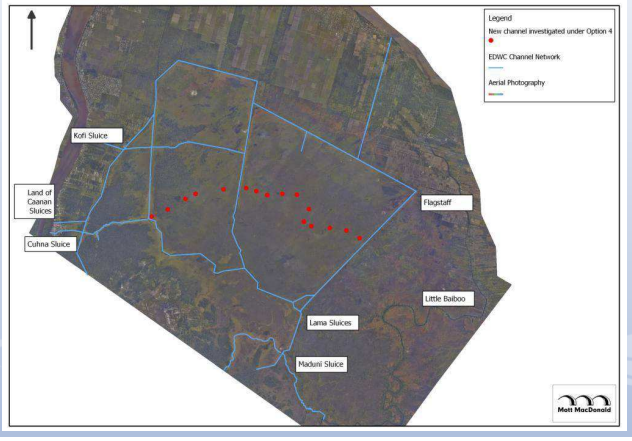
2. Options Tested

Option 4

As now plus Hope Dochfour plus increased conveyance by excavating new channel



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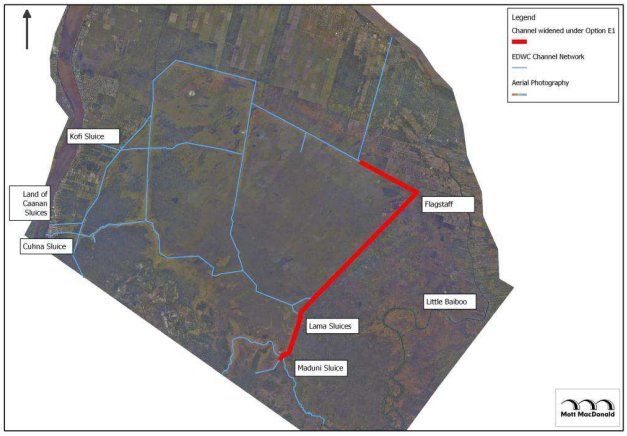
2. Options Tested

Option E1

As now plus Hope Dochfour plus increased conveyance in East



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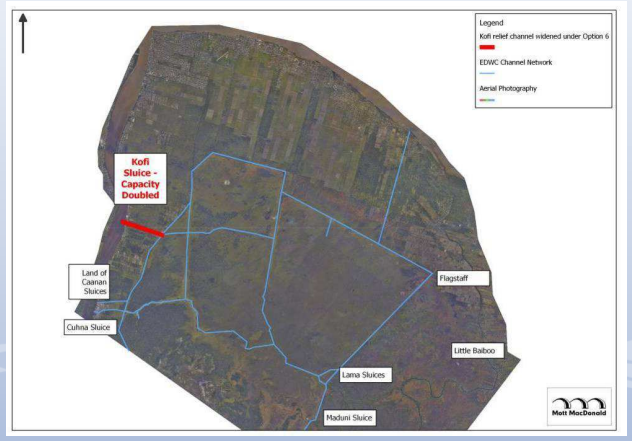
2. Options Tested

Option 6

As now plus Hope Dochfour plus Kofi Sluice doubled



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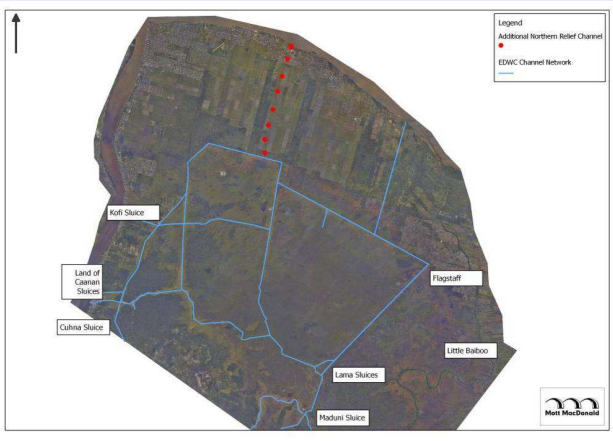
2. Options Tested

Option 7

As now plus Hope Dochfour plus new northern relief channel



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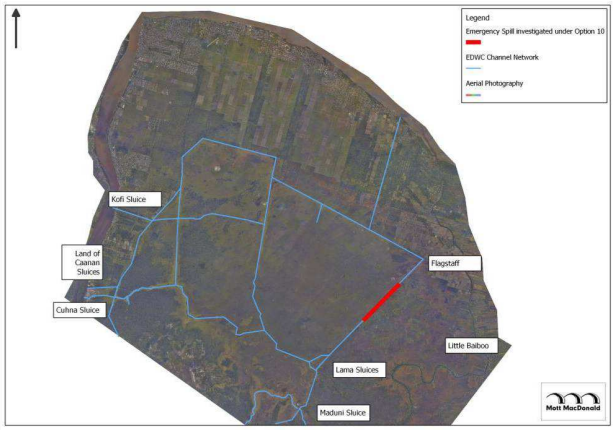
2. Options Tested

Option 9 & 10

As now plus Hope Dochfour plus emergency spills to East



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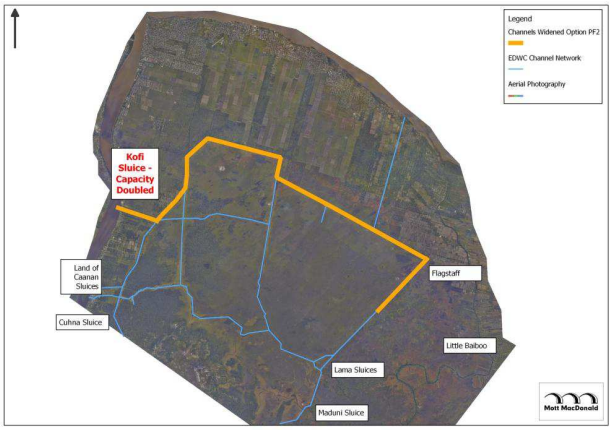
2. Options Tested

Preferred Option

As now plus Hope Dochfour plus additional capacity at Kofi plus widened channels to Kofi



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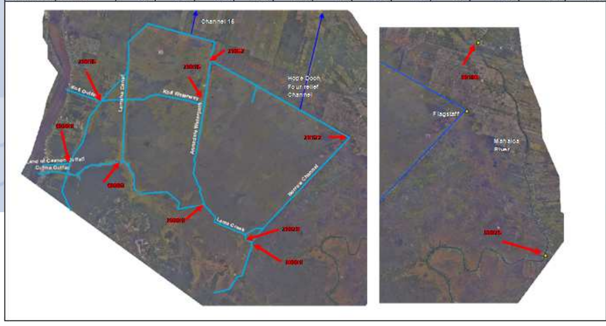
10,000 year event

3. Results

				Internal Drainage				Outlet conditions			Outlet and Conveyance	Emergency Spill	
		As now	Hope Dooh Four = Baseline	Op1+60m widening of Lama C, Annadale, KoftNW, Lamaha C	Op1+60m widening of Lama C, Annadale, KoftNW, Lamaha C plus Borrow Channel	Op1+ New channel from NW to LaC	Op1+ Borrow channel between Lama and Hope widened by 60m	Op1+rehabilitated Cuhna outfall channel	Op1+ Kofi capacity doubled	Op1+additional northern relief channel	Op1+ Option 8 + Borrow Channel, Annadale and Kofi NW widened by 60m	Op1+ Emergency spill to the east	Op8+ only Borrow Channel widened by 60m
Location		Baseline	Option 1	Option 5	Option 3	Option 4	Option E1	Option 2	Option 6	Option 7	Option 8	Option 9	P
Model Node	Description	Peak Water Level (m GD)											
Node 20001	Junction 11	18.28	18.20	18.07	18.04	18.16	18.17	18.20	18.20	18.19	18.18	18.19	18.18
Node 30001	Junction 12	18.41	18.28	18.07	18.03	18.09	18.29	18.28	18.26	18.22	17.97	18.28	18.21
Node 40001	Junction 10	18.10	18.06	18.01	18.00	17.99	18.05	18.06	18.03	18.04	18.05	18.06	18.03
Node 70001	Land of Canaan	17.59	17.58	17.90	17.96	17.86	17.58	17.55	17.40	17.54	17.58	17.58	17.55
Node 70015	Kofi upstream	17.96	17.89	18.00	17.99	17.92	17.89	17.89	17.68	17.79	17.85	17.89	17.76
Node 70057	Junction 2	18.39	18.11	18.07	18.01	18.07	18.11	18.11	18.09	17.95	17.96	18.10	17.94
Node 70076	Lama US	18.20	18.07	18.03	18.01	18.07	18.05	18.07	18.06	18.05	18.03	18.03	18.02
Node 70177	Flagstaff	18.36	18.04	18.01	17.99	18.05	18.05	18.04	18.04	18.01	17.96	18.02	17.95
Node 90001	Lama DS	17.55	17.43	17.39	17.38	17.41	17.41	17.43	17.43	17.41	17.40	17.42	17.40
Mahaica													
Node 80075	Little Baiboo	17.37	17.28	17.19	17.18	17.23	17.23	17.28	17.28	17.24	17.23	17.25	17.23
Node 80109	Belmont	17.35	17.34	17.33	17.33	17.33	17.33	17.34	17.34	17.33	17.33	17.33	17.33



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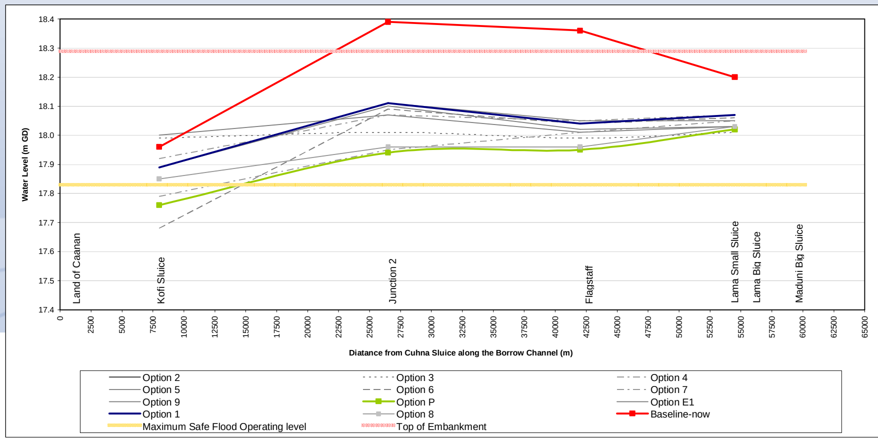
3. Results

10,000 year event

Chainage (m)	Distance (m)	Location	Node	Baseline	Option 1	Option 5	Option 3	Option 4	Option E1	Option 2	Option 6	Option 7	Option 8	Option 9	Option P
0	0	Cuhna													
1000	1000	Land of Canaan													
8000	7000	Kofi Sluice	Node 70015	17.96	17.89	18	17.99	17.92	17.89	17.89	17.68	17.79	17.85	17.89	17.76
26500	18500	Junction 2	Node 70057	18.39	18.11	18.07	18.01	18.07	18.11	18.11	18.09	17.95	17.96	18.1	17.94
42000	15500	Flagstaff	Node 70177	18.36	18.04	18.01	17.99	18.05	18.05	18.04	18.04	18.01	17.96	18.02	17.95
54500	12500	Lama Small Sluice	Node 70076	18.2	18.07	18.03	18.01	18.07	18.05	18.07	18.06	18.05	18.03	18.03	18.02
56000	1500	Lama Big Sluice													
60200	4200	Maduni Sluice													
Cumulative reduction in water level from Option 1						0.00	0.11	0.00	0.01	0.00	0.24	0.31	0.31	0.07	0.44



1,000 year event

3. Results

				Internal Drainage				Outlet conditions			Outlet and Conveyance	Emergency Spill	
		As now	Hope Dooh Four = Baseline	Op1 + 60m widening of Lama C, Annadale, KofiWW, Lamaha C	Op1 + 60m widening of Lama C, Annadale, KofiWW, Lamaha C plus Borrow Channel	Op1 + New channel from NB to LaC	Op1 + Borrow channel between Lama and Hope widened by 60m	Op1 + rehabilitated Cuhna outfall channel	Op1 + Kofi capacity doubled	Op1 + additional northern relief channel	Op1 + Option 6 + Borrow Channel, Annadale and Kofi WW widened by 60m	Op1 + Emergency spill to the east	Op6 + only Borrow Channel widened by 60m
Location		Baseline	Option 1	Option 5	Option 3	Option 4	Option E1	Option 2	Option 6	Option 7	Option 8	Option 9	Option P
Model Node	Description	Peak Water Level (m GD)											
Node 20001	Junction 11	18.12	18.05	17.93	17.91	18.01	18.00	18.05	18.05	18.04	18.03		18.03
Node 30001	Junction 12	18.25	18.12	17.93	17.90	17.97	18.13	18.12	18.11	18.07	17.86		18.07
Node 40001	Junction 10	17.96	17.93	17.87	17.86	17.86	17.91	17.93	17.91	17.92	17.92		17.91
Node 70001	Land of Canaan	17.49	17.48	17.78	17.82	17.73	17.48	17.45	17.32	17.44	17.48		17.45
Node 70015	Kofi upstream	17.82	17.78	17.86	17.85	17.79	17.78	17.78	17.58	17.88	17.73		17.65
Node 70057	Junction 2	18.22	17.97	17.93	17.88	17.95	17.96	17.97	17.96	17.83	17.84		17.82
Node 70076	Lama US	18.04	17.93	17.89	17.87	17.92	17.90	17.93	17.92	17.91	17.89		17.89
Node 70177	Flagstaff	18.20	17.92	17.88	17.86	17.92	17.90	17.92	17.92	17.89	17.85		17.83
Node 90001	Lama DS	17.42	17.35	17.34	17.33	17.35	17.34	17.35	17.35	17.35	17.34		17.34
Mahaica													
Node 80075	Little Baiboo	17.19	17.08	16.99	16.97	17.05	17.04	17.08	17.08	17.08	17.05		17.05
Node 80109	Belmont	17.33	17.33	17.33	17.33	17.33	17.33	17.33	17.33	17.33	17.33		17.33

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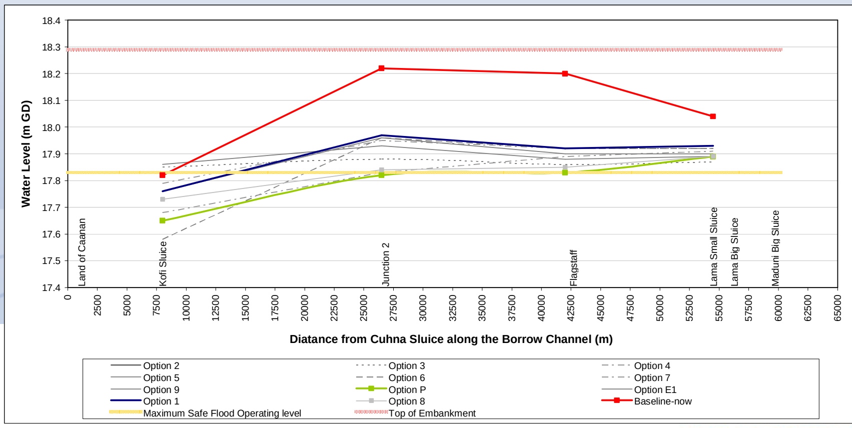
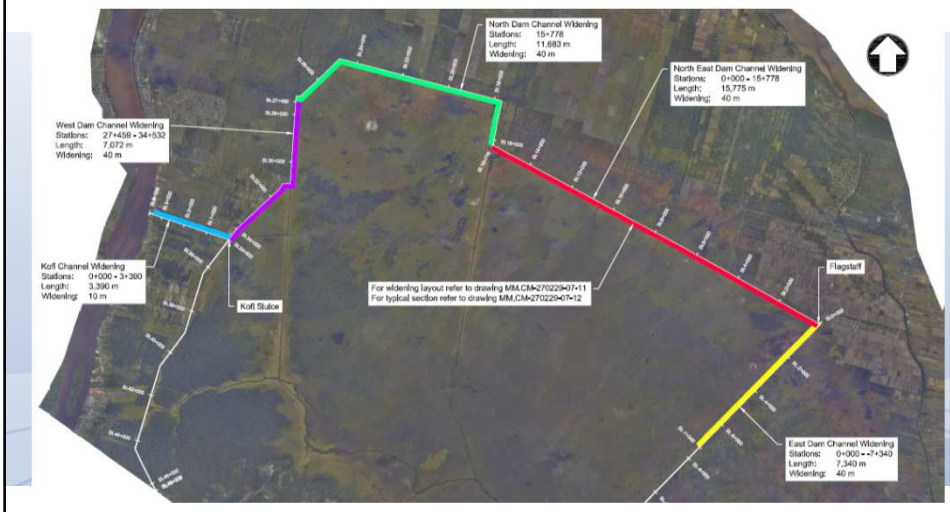
1,000 year event

3. Results

Chainage (m)	Distance (m)	Location	Node	Baseline	Option 1	Option 5	Option 3	Option 4	Option E1	Option 2	Option 6	Option 7	Option 8	Option 9	Option P
0	0	Cuhna													
1000	1000	Land of Canaan													
8000	7000	Kofi Sluice	Node 70015	17.82	17.76	17.86	17.85	17.79	17.76	17.76	17.58	17.68	17.73	0	17.65
26500	18500	Junction 2	Node 70057	18.22	17.97	17.93	17.88	17.95	17.96	17.97	17.96	17.83	17.84	0	17.82
42000	15500	Flagstaff	Node 70177	18.2	17.92	17.88	17.86	17.92	17.9	17.92	17.92	17.89	17.85	0	17.83
54500	12500	Lama Small Sluice	Node 70076	18.04	17.93	17.89	17.87	17.92	17.9	17.93	17.92	17.91	17.89	0	17.89
56000	1500	Lama Big Sluice													
60200	4200	Maduni Sluice													
Cumulative reduction in water level from Option 1						**0.02**	**0.12**	**0.00**	**0.06**	**0.00**	**0.20**	**0.27**	**0.27**	**71.58**	**0.39**



4. Preferred Option



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4. Preferred Option

BILL	DESCRIPTION	AMOUNT (GYD)	AMOUNT (USD)*
1	Preliminaries	$6,000,000	30,000
2	Earthworks and Clearance**	$5,804,299,500	29,021,498
EXT	Kofi Relief Structures and Channel Widening	$923,466,533	4,617,333
	Subtotal	**$6,733,766,033**	**33,668,830**
	Civil Contingencies of 10%	$673,376,603	3,366,883
	Grand Total (GYD)	**$7,407,142,636**	**37,035,703**

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5. Questions

Any questions?

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Guyana Conservancy Adaptation Project: Pre-Investment Studies

EDWC Dam Interventions

Martha Taylor: Deputy Team Leader & Engineer

Mott MacDonald

EDWC Dam Interventions

1. Approach
2. Design Options Considered
3. Analysis of Options
4. Preferred Intervention
5. Questions

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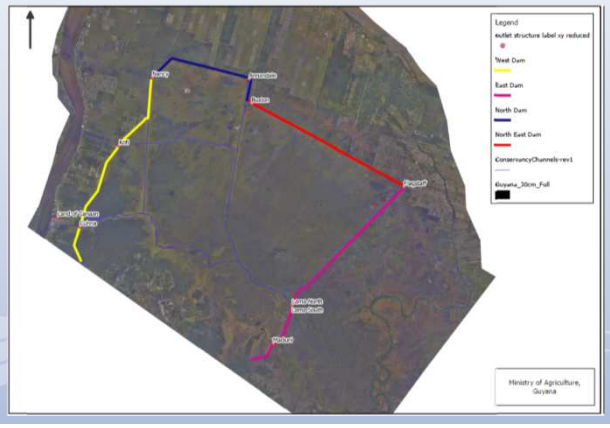
1. Approach



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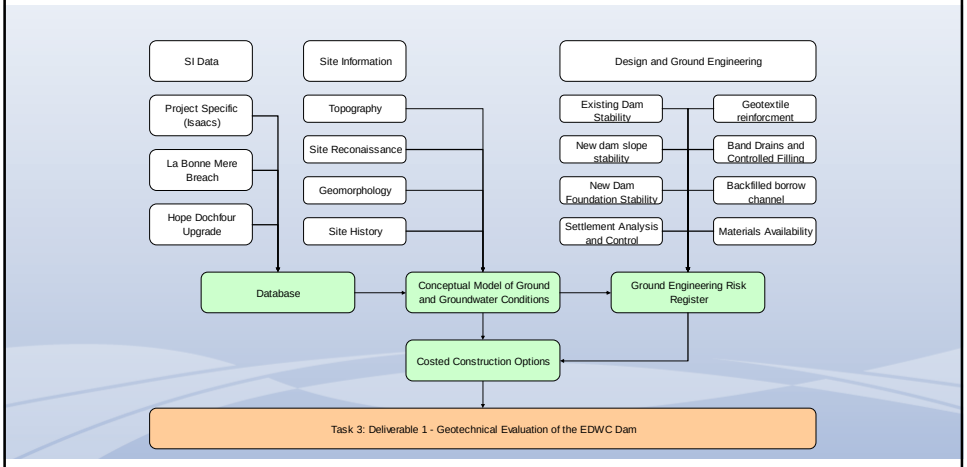
1. Approach



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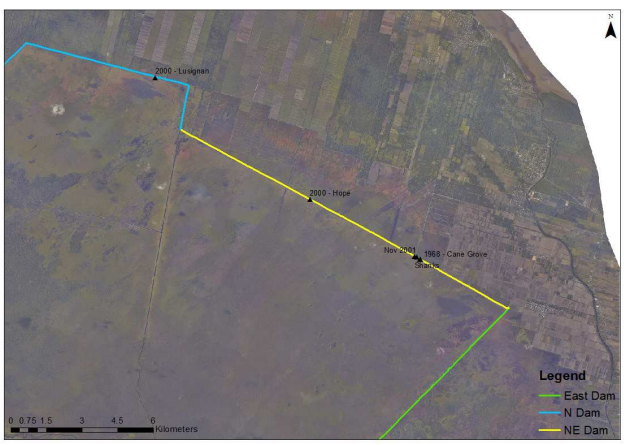
1. Approach



Old breach locations

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1. Approach

Slip at Old Shanks

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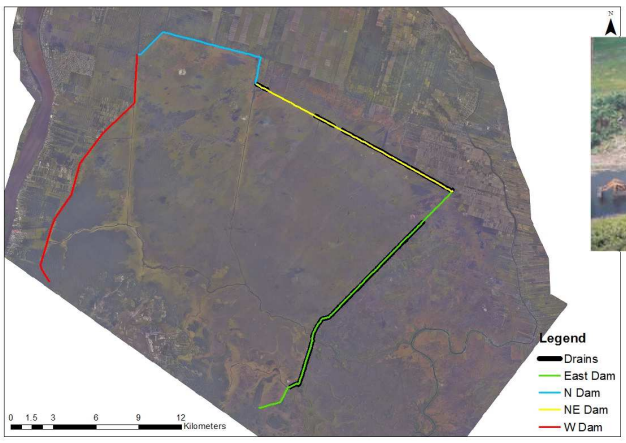
1. Approach



Areas with seepage drain

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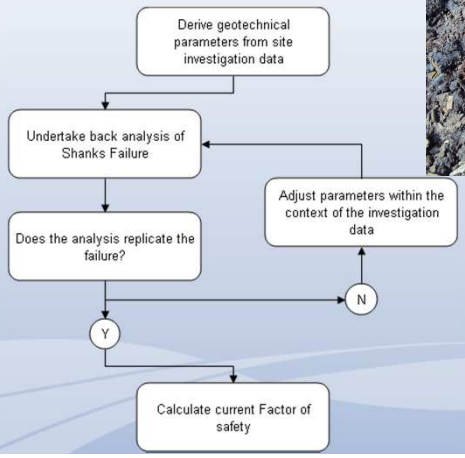
1. Approach



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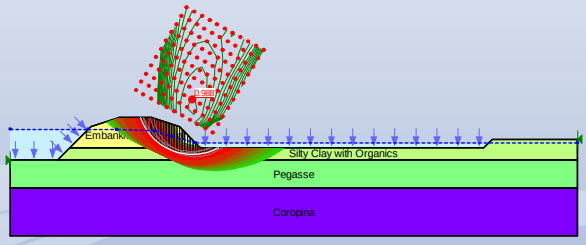
1. Approach

Back Analysis at Shanks



Name: Embankment Material
Model: Mohr-Coulomb
Unit Weight: 15 kN/m³
Cohesion: 3 kPa
Phi: 21 °
Piezometric Line: 1

Name: Silty Clay with Organics
Model: Mohr-Coulomb
Unit Weight: 15 kN/m³
Cohesion: 2 kPa
Phi: 19 °
Piezometric Line: 1

Name: Pegasse
Model: Mohr-Coulomb
Unit Weight: 15 kN/m³
Cohesion: 2 kPa
Phi: 19 °
Piezometric Line: 1

Name: Coropina
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 10 kPa
Phi: 20 °
Piezometric Line: 1

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1. Approach

Dam	Geometry Parameters	Typical Credible	Typical Worst	Worst Credible	Worst Worst
West	Drained Cohesion (c') in kPa	1.48	1.34	1.27	1.16
East		1.60	1.5	1.48	1.38
North		1.48	1.4	1.08	1.01
North East		1.49	1.4	1.25	1.14

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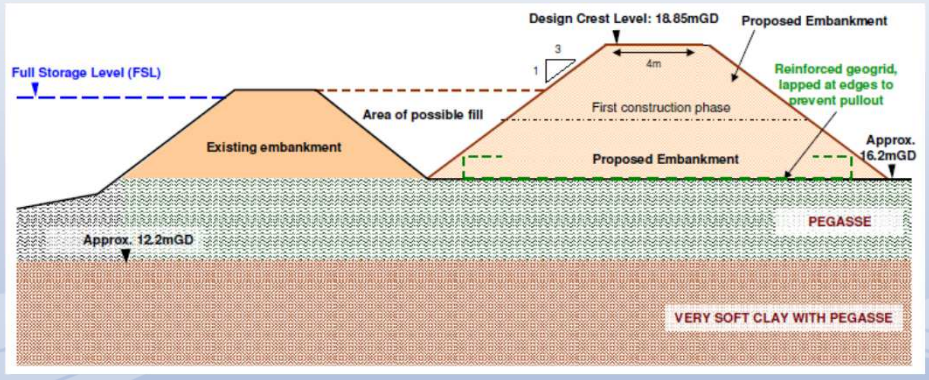
2. Design Options Considered

Offline dam, staged construction, reinforced geogrid at base



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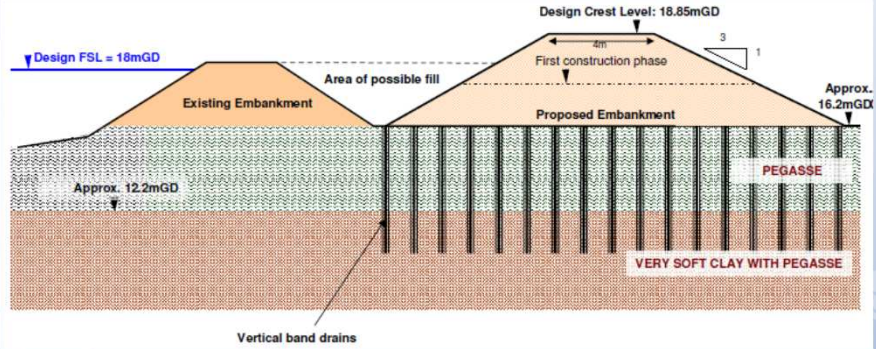
2. Design Options Considered

Offline dam, staged construction, vertical band drains to stabilise foundations



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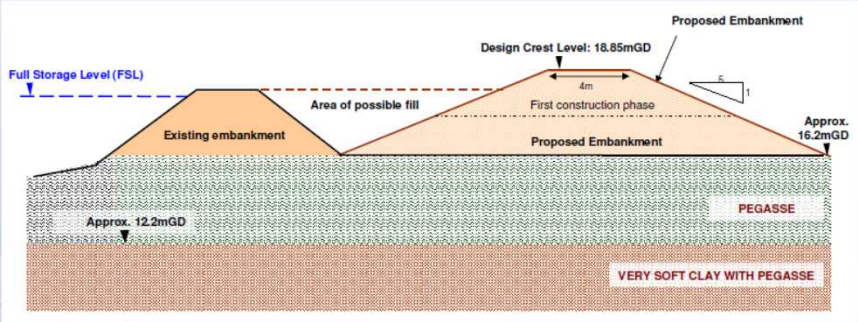
2. Design Options Considered

Offline dam, staged construction, shallow slopes



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2. Analysis of Options

Indicative costs

Indicative costs for North East Dam	US$ Million
Earth dam with 1:3 side slopes and basal geofabric	7.5
Earth dam with 1:3 side slopes and wick drains (inc sand blanket)	9.5
Earth dam with 1:5 side slopes	5.5
Earth dam with 1:6 side slopes	6

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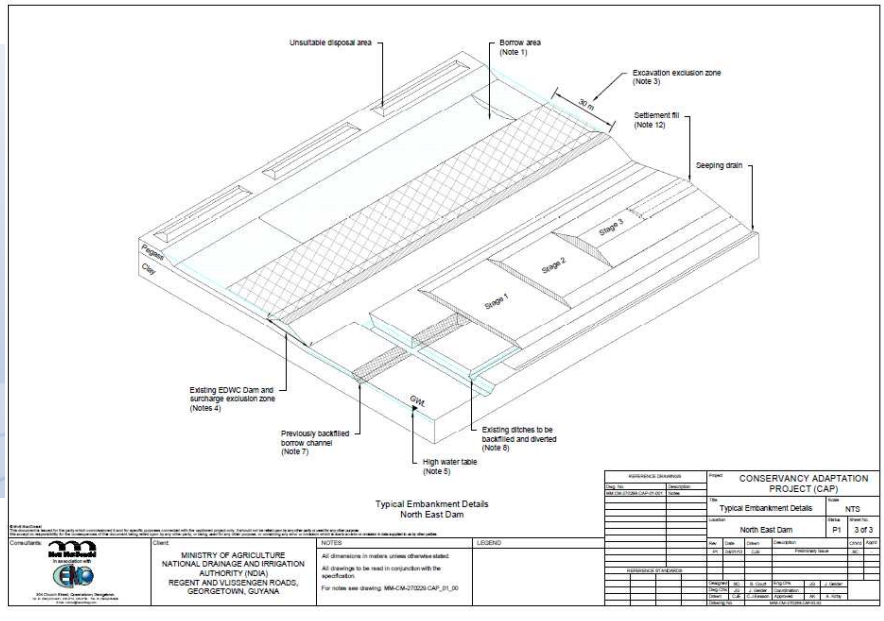
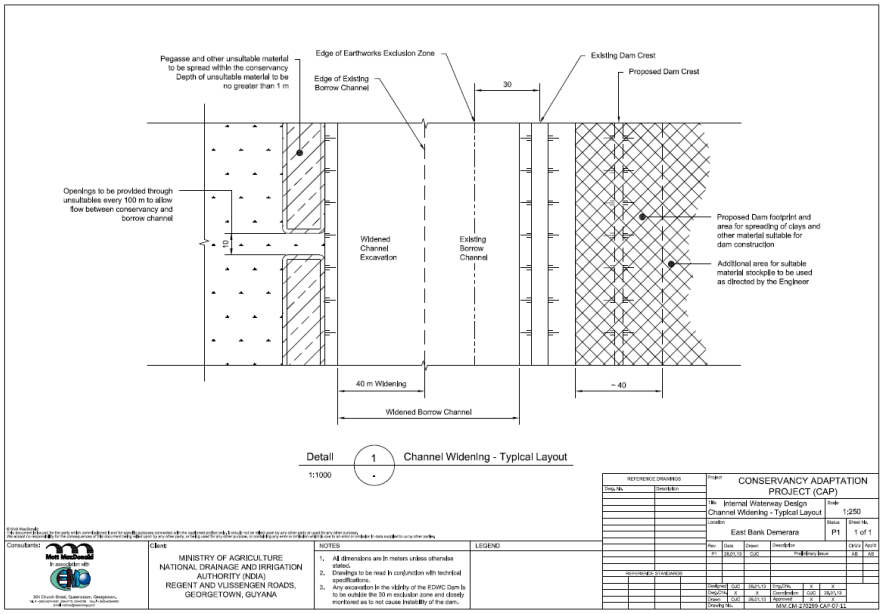
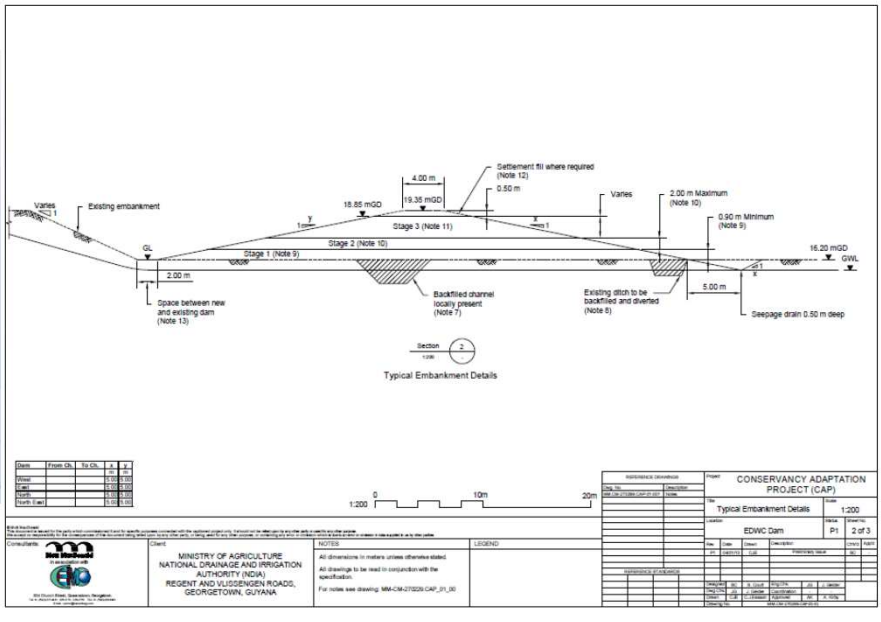
3. Preferred Intervention



3. Preferred Intervention



3. Preferred Intervention



4. Questions

Any questions?

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Guyana Conservancy Adaptation Project: Pre-Investment Studies

ECD Interventions

Martha Taylor: Deputy Team Leader & Engineer

Mott MacDonald

ECD Interventions

1. Ogle
2. Montrose
3. Mon Repos
4. Enterprise
5. Beehive
6. Liliendaal
7. Summary

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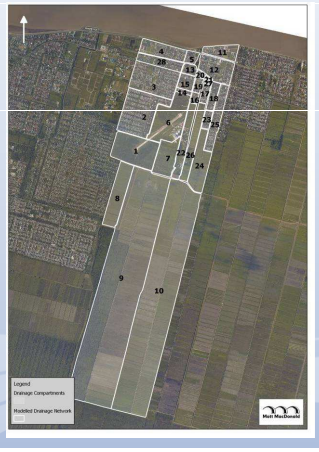
1.Ogle



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1. Ogle

Option 1: increase in pump capacity by 6 m3/s

Option 2: increase in pump capacity by 10 m3/s

Option 3: increase in pump capacity by 6m3/s and doubling of culverts at nodes 1058, 1077 and 1085 where significant head losses had been noted

Option 4: increase pump capacity by 10m3/s and doubling of culverts at nodes 1058, 1077 and 1085 where significant head losses had been noted

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1. Ogle

1. Ogle

Land Use	Land Use Area (ha)	Baseline Flooded Area (ha)	Area Benefited (ha)			
			Option 1	Option 2	Option 3	Option 4
Heavily Urbanised	124.9	44.4	39.0	40.2	39.0	41.3
Part Urbanised	211.7	80.6	72.4	77.5	72.4	77.9
Total Urbanised Land Benefited (ha)*			75.2	78.95	75.2	80.25
Cost of Option (GD)			290,129,434	387,699,434	311,958,809	417,648,809
Cost/ha Benefited (million GD)			3.86	4.91	4.15	5.20

Option 1 gives the best value per hectare benefited and has therefore been taken forward as the preferred option. Option 3, in which three culverts are rehabilitated in addition to the Option 1 additional pumping intervention, is only marginally more expensive, and while it does not result in any noticeable increase in area benefited, it may be worth considering in the future if local effects upstream of the culverts are noted.

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2. Montrose La Resouvenir

Option 1: Additional 14m3/s of pumping capacity

Option 2: Additional 14m3/s of pumping capacity plus additional storage

Option 3: Separation of urban and agricultural drainage

Option 4: Additional 14m3/s of pumping capacity plus separation of urban and agricultural drainage

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2. Montrose La Resouvenir

Mott MacDonald

2. Montrose La Resouvenir

Land Use	Land Use Area (ha)	Baseline Flooded Area (ha)	Area Benefited (ha)			
			Option 1	Option 2	Option 3	Option 4
Heavily Urbanised	221.53	116.12	71.86	74.47	76.06	90.03
Part Urbanised	219.53	126.36	57.34	58.14	62.45	82.34
Total Land Benefited (ha)*			100.53	103.54	107.285	131.2
Cost of Option (GD)			369,915,000	602,014,440	296,656,260	666,571,260
Cost/ha Benefited (million GD)			3.68	5.81	2.77	5.08

, Option 3 gives the best value per hectare benefited and has therefore been taken forward as the preferred option. This is also the option which avoids the introduction of additional pumping capacity.

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3. Mon Repos Annandale

Option 1: Additional 12m3/s pumping capacity plus excavation of channels

Option 2: Additional 7.5m3/s pumping capacity plus separation of urban and agricultural drainage

Option 3: Additional 12m3/s pumping capacity plus excavation of channels plus introduction of additional storage through widening of the façade channel

Option 4: Additional 10m3/s pumping capacity plus excavation of channels plus introduction of additional storage through widening of the façade channel

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3. Mon Repos Annandale

Mott MacDonald

3. Mon Repos Annandale

Land Use	Land Use Area (ha)	Baseline Flooded Area (ha)	Area Benefited (ha)			
			Option 1	Option 2	Option 3	Option 4
Heavily Urbanised	400.7	196.8	165.6	185.5	169.7	165.0
Part Urbanised	698.1	22.3	12.6	18.6	13.4	11.7
Total Land Benefited (ha)*			171.9	194.8	176.4	170.85
Cost of Option (GD)			546,155,860	433,764,590	606,831,100	553,986,100
Cost/ha Benefited (million GD)			3.18	2.23	3.44	3.24

Option 2 gives the best value per hectare benefited and has therefore been taken forward as the preferred option. It is also worth noting that it is the option which introduces the least additional pumping capacity, and benefits the greatest land area

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4. Enterprise Paradise

Option 1: 2No new pumping stations plus additional pumping at Hope pumping station (see below) plus widened channels plus rehabilitated culverts

Option 2: 2No new pumping stations plus additional pumping at Hope pumping station (see below) plus widened channels plus rehabilitated culverts plus additional storage

Option 3: 2No new kokers plus widened channels plus rehabilitated culverts

Option 4: 2No new pumping stations plus additional pumping at Hope pumping station (see below) plus widened channels plus rehabilitated culverts plus separation of urban and agricultural drainage

	Additional Pumping Capacity (m3/s)		
	Location 1	Location 2	Hope PS
Option 1	12.0	18.0	8.0
Option 2a	12.0	18.0	8.0
Option 2b	8.0	12.0	4.0
Option 2c	8.0	15.0	6.0
Option 3	0	0	0
Option 4	1.5	9.0	2.5

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4. Enterprise Paradise

4. Enterprise Paradise

Land Use	Land Use Area (ha)	Baseline Flooded Area (ha)	Area Benefited (ha)				
			Option 1	Option 2	Option 2b	Option 2c	Option 4
Heavily Urbanised	295.54	183.39	167.51	173.18	167.10	173.29	175.76
Part Urbanised	993.05	766.76	602.52	659.82	519.29	643.11	665.93
Total Land Benefited (ha)*			468.77	503.09	426.745	494.845	508.725
Cost of Option (GD)			3,337,176,166	3,972,786,246	3,602,871,246	3,734,983,746	2,999,541,026
Cost/ha Benefited (million GD)			7.12	7.90	8.44	7.55	5.90

Option 4 gives the best value per hectare benefited and has therefore been taken forward as the preferred option. It is also worth noting that it is the option which introduces the least additional pumping capacity, and benefits the greatest land area

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5. Beehive Clonbrook

Option 1: Additional 150cusec pump at Greenfield pumping station

Option 2: Additional 2No 150cusec pumps at Greenfield pumping station plus channel widening

Option 3: Channel widening plus separation of urban and agricultural drainage

Option 4: Additional 150cusec pump at Greenfield Pumping station plus channel widening plus separation of urban and agricultural drainage

Option 5: Additional 3No 150cusec pumps at Greenfield plus channel widening plus additional storage

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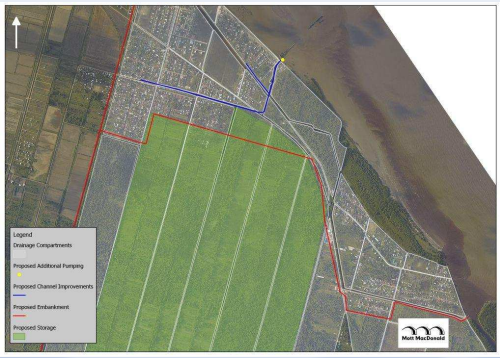
5. Beehive Clonbrook



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5. Beehive Clonbrook

Land Use	Land Use Area (ha)	Baseline Flooded Area (ha)	Area Benefited (ha) Option 1	Option 2	Option 3	Option 4	Option 5
Heavily Urbanised	127.1	71.6	11.3	36.7	55.2	68.8	54.38
Part Urbanised	88.5	28.9	8.1	18.0	20.3	22.0	21.8
Total Land Benefited (ha)*			15.35	45.7	65.35	79.8	65.28
Cost of Option (GD)			112,295,625	276,021,050	138,394,160	250,689,785	75,115,316,675
Cost/ha Benefited (million GD)			7.32	6.04	2.12	3.14	1150.66

Option 3 gives the best value per hectare benefited and has therefore been taken forward as the preferred option. It is also worth noting that it is the option avoids the introduction of additional pumping capacity, and benefits the greatest land area.

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6. Liliendaal

This area is heavily urbanised and intrinsically linked to other drainage regimes within Georgetown. It is considered that the modelling carried out under the terms of this project was not sufficient to provide the basis for sound investment decisions. There is a significant secondary and tertiary network that could not be included in the level of modelling carried out, but that could have a notable effect on model results. There are also interconnections between Liliendaal and adjacent areas within Georgetown which could not be properly represented in our model. It is considered that a master-planning exercise for the whole of Georgetown is required to identify interventions that will tackle the severe flooding issues within the capital. The recommendation for this area is to carry out a further urban drainage master-planning study.

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7. Summary

Drainage Areas	Options				
	Option 1	Option 2	Option 3	Option 4	Option 5
Ogle	Additional Pumping (6m3/s)	Additional Pumping (10m3/s)	Additional Pumping (6m3/s) Culvert Improvements	Additional Pumping (10m3/s) Culvert Improvements	
Montrose La Resouvenir	Additional Pumping (14m3/s)	Additional Pumping (14m3/s) Offline Storage	No Additional Pumping Restriction of Agricultural Drainage	Additional Pumping (14m3/s) Restriction of Agricultural Drainage	
Mon Repos Annandale	Additional Pumping (12m3/s) Small Channel Modifications	Additional Pumping (7.5m3/s) Restriction of Agricultural Drainage	Additional Pumping (12m3/s) Small Channel Modifications Widening façade drain to increase storage	Additional Pumping (10m3/s) Small Channel Modifications Widening façade drain to increase storage	
Enterprise Paradise	Additional Pumping (38m3/s) Channel Modifications	Additional Pumping (38m3/s) Channel Modifications Offline Storage	(Option 2b in Report) Additional Pumping (24m3/s) Channel Modifications Offline Storage	(Option 2c in Report) Additional Pumping (29m3/s) Channel Modifications Offline Storage	(Option 4 in Report) Additional Pumping (13m3/s) Channel Modifications Restriction of Agricultural Drainage
Beehive Clonbrook	Additional Pumping (4.25m3/s)	Additional Pumping (8.5m3/s) Channel Modfications	No Additional Pumping Channel Modifications Restriction of Agricultural Drainage	Additional Pumping (4.25m3/s) Channel Modifications Restriction of Agricultural Drainage	Additional Pumping (12.75m3/s) Channel Modifications Offline Storage

8. Questions

Any questions?

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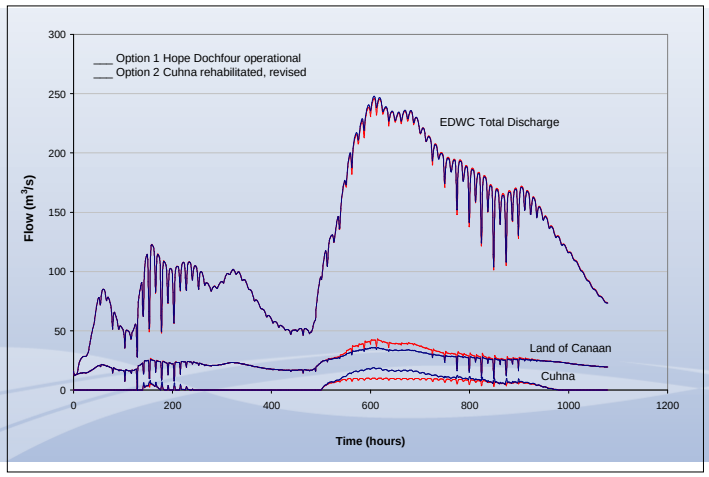
Comparison of 100-Year Flow with and without the Rehabilitated and Revised Cuhna Relief Channel



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