



Urban Water Quality Management

Case Study from Sri Lanka

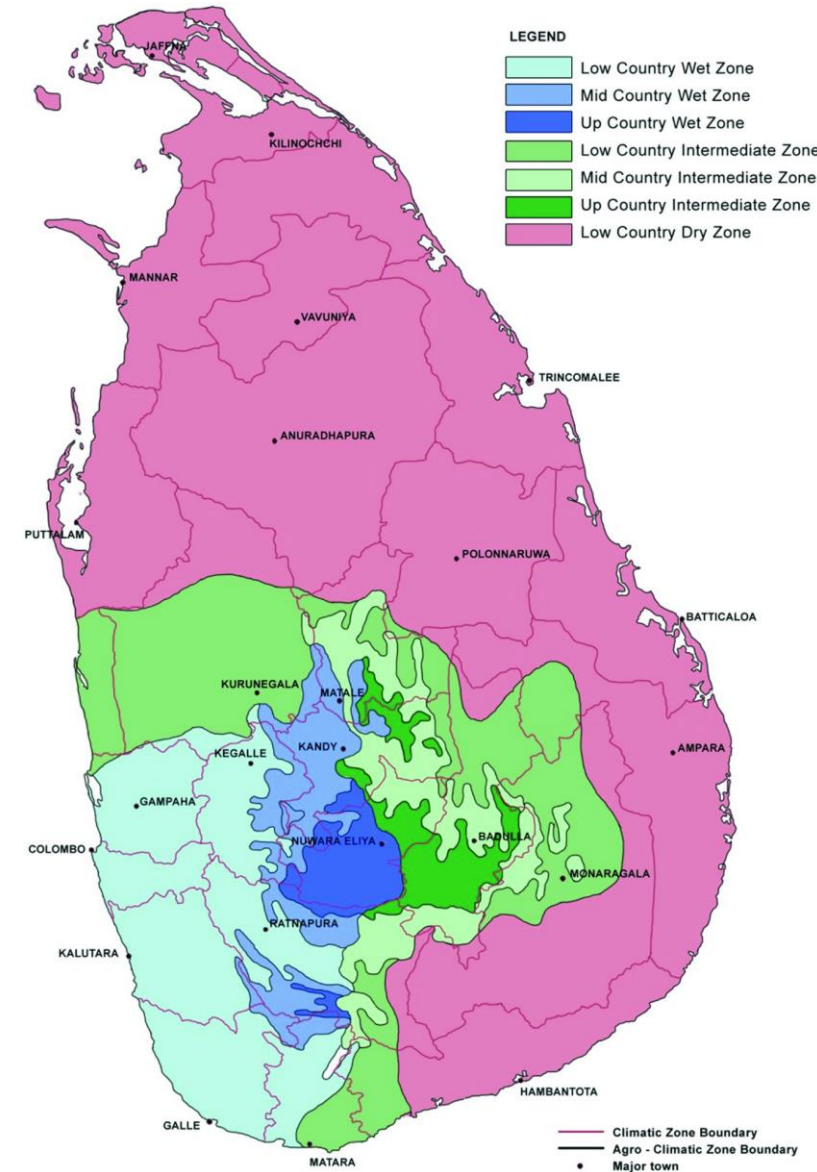
Shameen Jinadasa, PhD

PIFI Fellow, RCEES, Chinese Academy of Sciences, China
Professor in Civil Engineering, University of Peradeniya

Sri Lanka – Pearl of the Indian Ocean



- Tropical climate
- Temperature
 - 15 °C (Nuwaraeliya)
 - 28⁰- 30⁰ C (Average)
- Precipitation
 - 1200 mm/yr (Dry zone)
 - >2500mm/yr (Wet zone)
- Water resources
 - 220 river basin
 - No natural lakes
 - >10,000 Ancient reservoirs
- Mountains
 - Center of the country
 - Peak is 2, 524 m above MSL



History - Heritage



Kandy Perahera



Sigiriya – Heritage site

Rice & Curry



Wildlife



University of Peradeniya (Garden University)



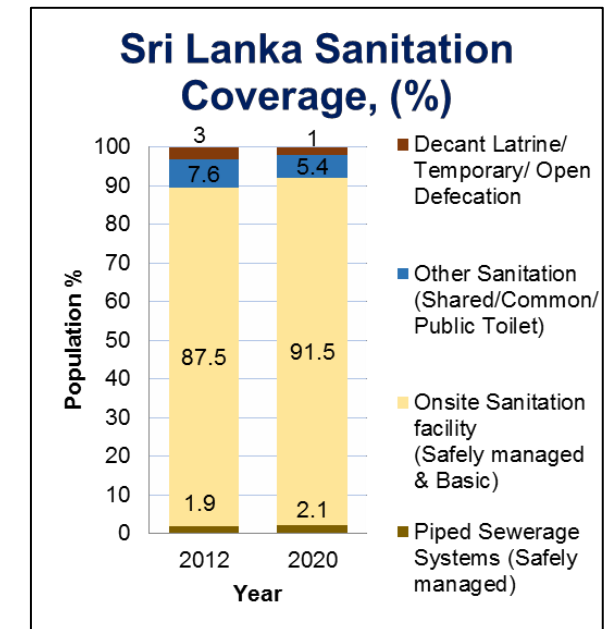
- Top 500 (THE ranking)
- Top 10 World most beautiful universities
- Multi-disciplinary faculty



Wastewater Management in Sri Lanka



- According to the UN [Joint Monitoring Program](#), less than three percent of the rural and about 12 percent of Sri Lanka's urban population is discharging its wastewater from toilets ('black water') into sewers.
- In the capital city of Colombo, where [90 percent of the below-ground infrastructure is 100 years old](#), more than 100,000 cubic meters of untreated sewage are discharged into the ocean through two pipes that extend about [1.5 kilometers into the sea](#).
- Wastewater doesn't end up in sewage treatment plants (STP).
- However, high costs and the lack of suitable land have stalled the expansion of sewer networks and treatment systems remains limited in the country.





News

Hundreds of fish die in Kandy Lake

Over population, low oxygen levels and multiplication of parasites

By Shane Seneviratne and Nadia Fazlulhaq, Pix by Shane Seneviratne

A senior lecturer of the University of Peradeniya said recent reports of fish deaths in Kandy Lake was due to the over population of fish, low oxygen levels and multiplication of parasites in the water introduced into the lake.

Dr. A. Arulkanthan, Senior lecturer and Co-ordinator to the Centre for Aquaculture, Diagnosis and Research Faculty of Veterinary Medicine and Animal Science, University of Peradeniya said the deaths in hundreds are reported daily and there is high mortality.



"If it was a cancer, we would see only human deaths. Research shows that the over population of fish is the main reason for the deaths.

He said as the fish become overpopulated, they breed in large numbers, which breeds a place to swim.

Home / Latest News / Sri Lanka: Kelani River ...




INASIA
INSIGHTS AND ANALYSIS

Addressing Industrial Pollution Along the Kelani River

April 26, 2017

By Johann Rebert and Dhiya Sathananthan

Home News Entertainment Sports Living & Travel Features Press

President visits and inspects the Kandy City and the Lake

Like Be the first of your friends to like this. Tweet 0

Details Published on Thursday, 29 December 2011 11:35 Hits: 1202



President Mahinda Rajapaksa visited Kandy yesterday and inspected Kandy city. During this visit the President enlightened the Mahanayakes' of the Asgiriya Chapters on the Kandy city development plan.

The President told the Mahanayakes' that he has instructed Minister Nimal de Silva to clean and renovate the Kandy Lake and a team led by the Minister will inspect the lake on Thursday. He said that when he visited the areas around the lake he found that waste materials have been thrown there thereby polluting it. The Mahanayakes focused the attention of the President on the vehicle congestion prevailing in the city.

19 Sep 2015
Hafsa Sabry, Sunday
Leader [Sri Lanka]

Article

Sri Lanka: Kelani River Contaminated With Cancer Causing Chemical?



Coca-Cola



Waste disposal

Water Quality Issues



No space for Wastewater Treatment



Limited WWTP



Agro chemical use

No safe water
~15% total population



Water Pollution (Community)



Septage/FSM

Rapid growth of Kandy City & Increased Pollution



Infrastructure challenges:

- Mixed development
- Space constraints
- Densely-populated
- Unregulated settlements



Mid-Canal then and now:

“... as a child, I used to play in the mid-canal”
-Mr MG Gunarathna, Mid-canal resident, 81

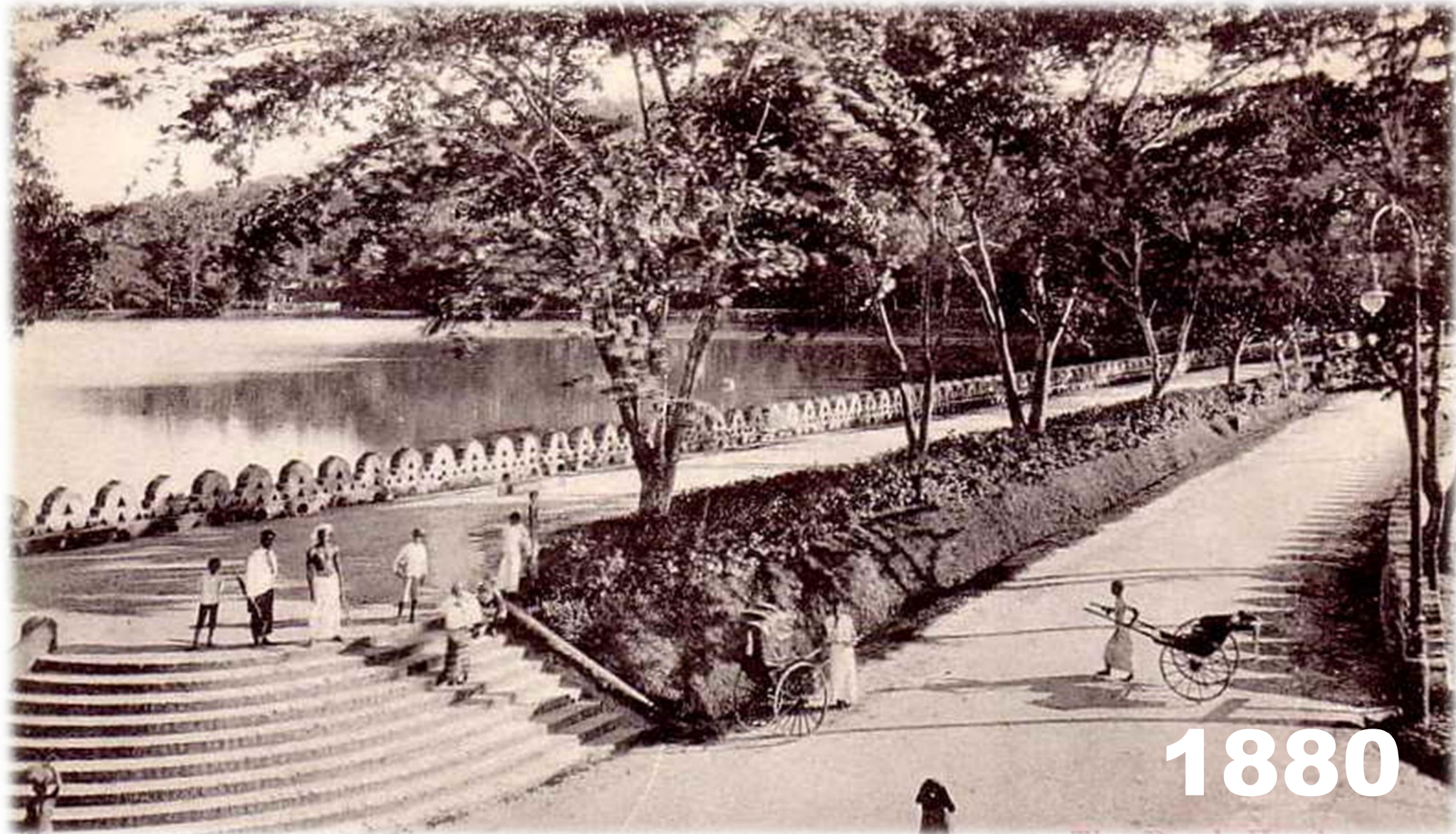


“In 2001, there was a drought and algal bloom, the smell was so bad.” - Dr CS Kalpage, Senior Lecturer, U of Peradeniya

Is there space for wastewater treatment facility?



Overpopulation of tilapia in Kandy Lake & social practice of feeding the fish, and case of mass fish death in 2009



1880



1980





1990



2000





2022



2022





Underground stormwater and sewer network

165 YR Old Yatinuwara Brick Tunnel

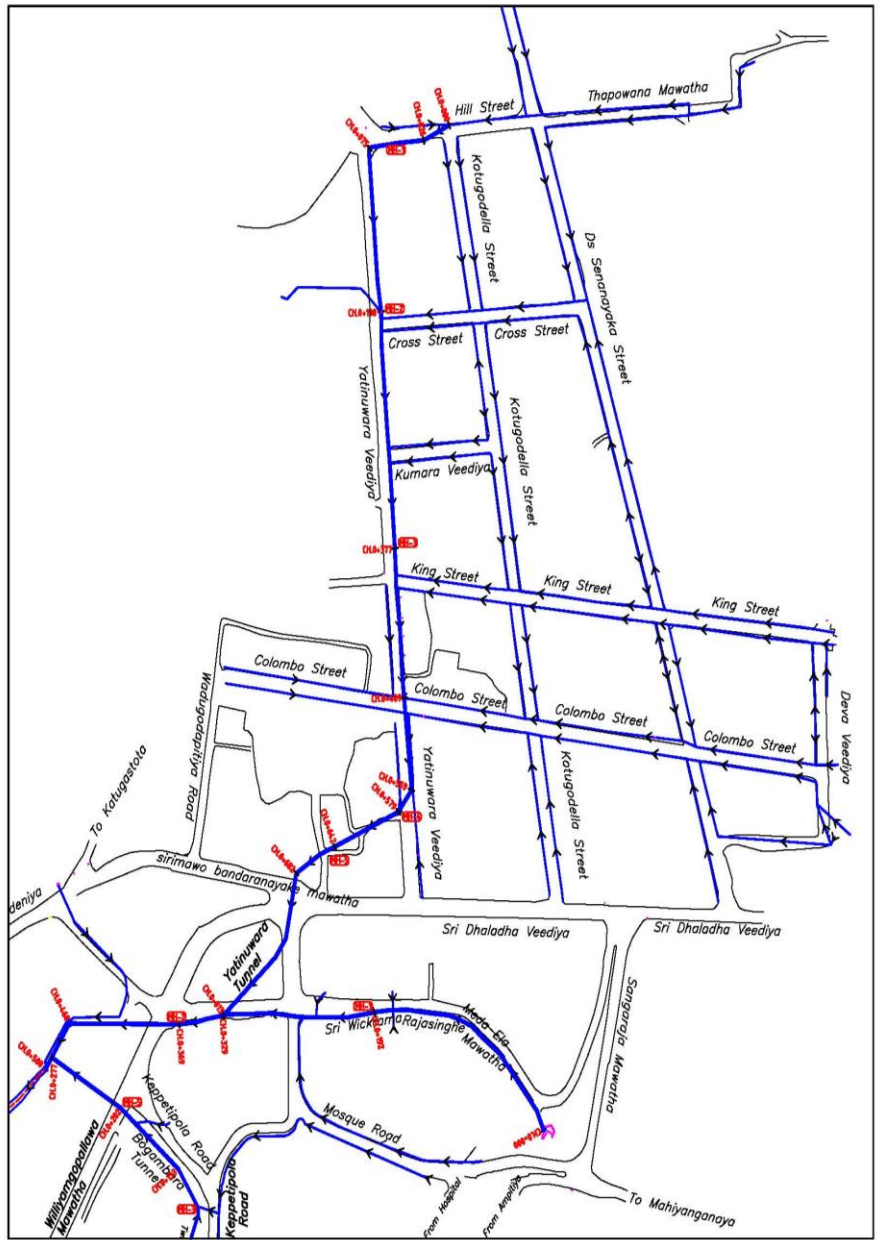
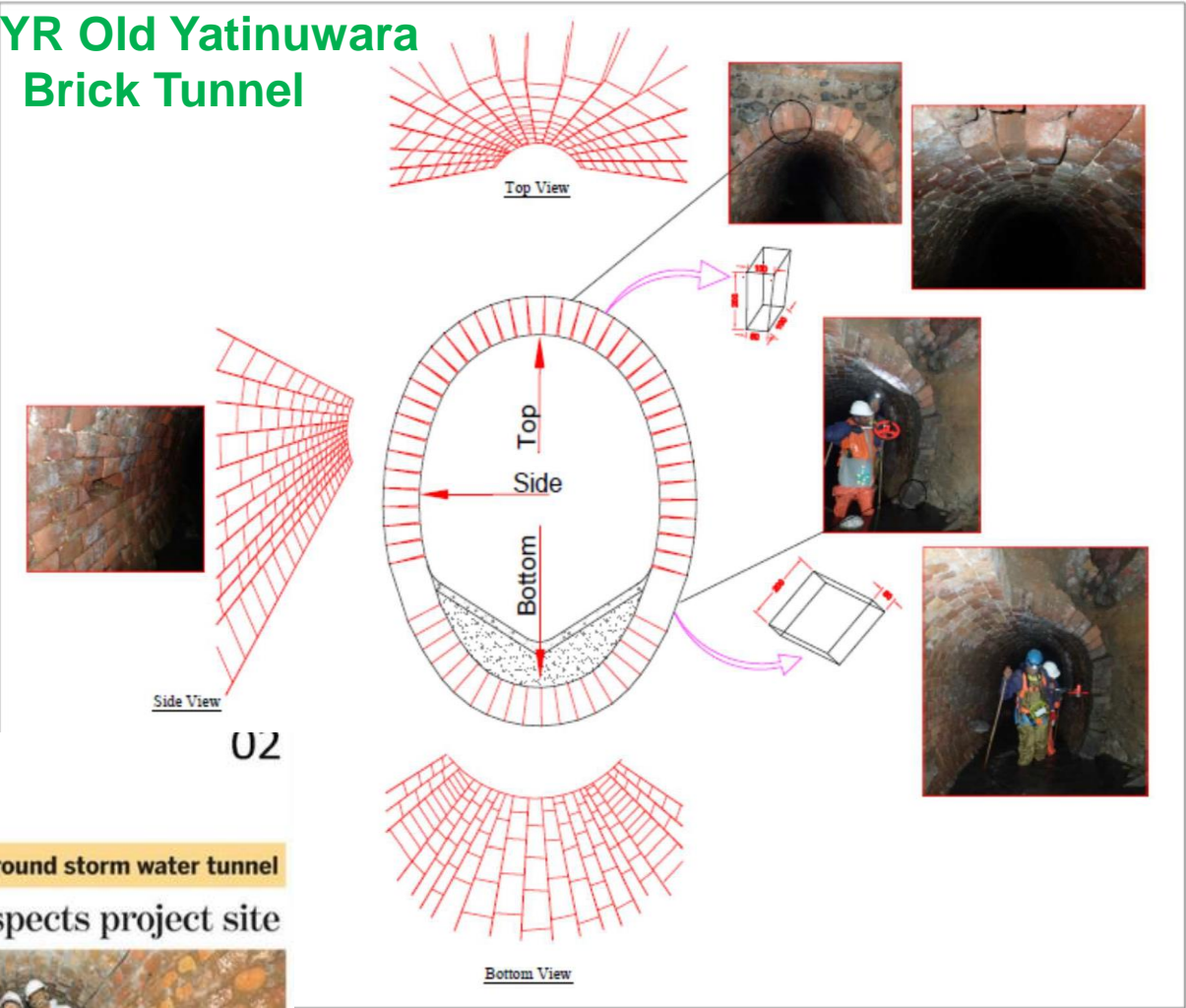


Fig 04 Underground Drainage Network in Grid City Area of Kandy

Daily News
July 16, 2019

Rehabilitation of Kandy underground storm water tunnel

Minister Ranawaka inspects project site

Megapolis and Western Development Minister Patali Champika Ranawaka recently visited the Kandy underground storm water tunnel which is being rehabilitated under the Strategic Town-Planning Project.

The project, which was launched by the minister, is expected to be completed by 2020. The cost of the project is estimated to be Rs.1.016 billion.

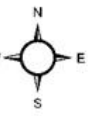
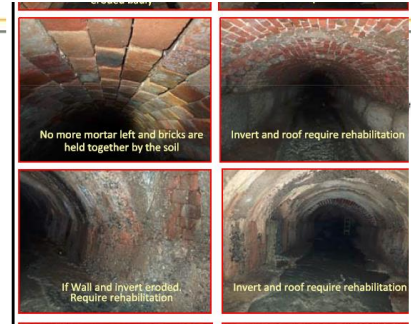
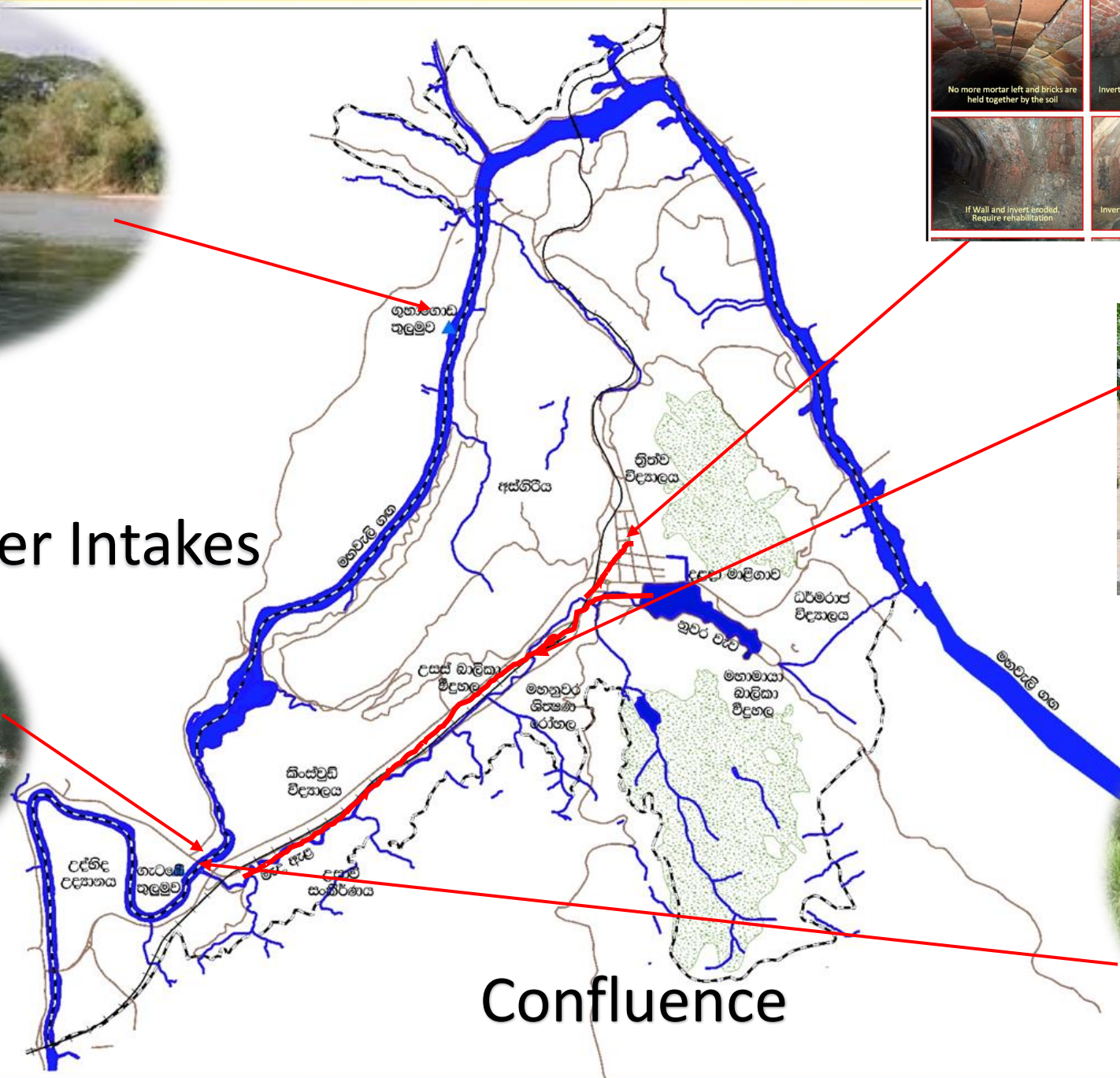
The underground storm water tunnel had been built during the time of Sinhala kings as a flood control measure.



Minister Ranawaka inspecting the storm water tunnel.



Two Water Intakes



Mid Canal



Confluence



Community Engagement – Kandy Lake



Kandy Lake:

- UNESCO Heritage site
- Landmark at Kandy City centre
- Tourist attraction
- Next to Sri Dalada Maligawa- Buddhist pilgrimage destination & national treasure



Pu et al.(2012) - IAHR



Problem Identification

First SCIENCE – why is this happening?

Deployment

And then DEPLOYMENT – where & how (¥) can this be used?

Research Translation
to Community

Proposed R & D Strategy

Next ENGINEERING – how to make this happen and to scale?

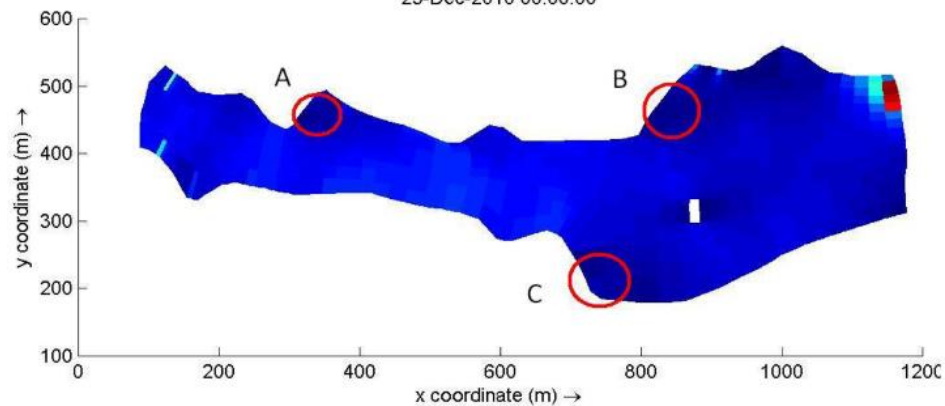
Sustainability

OWNERSHIP/BUSINESS MODEL – who will take care after implement?

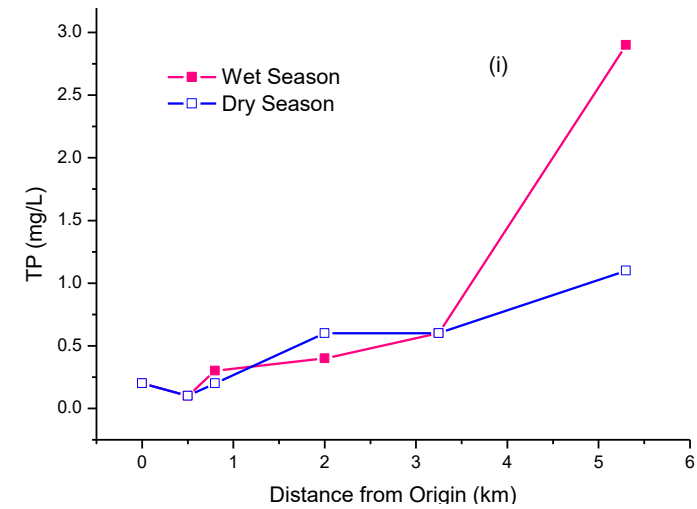
Preliminary Studies



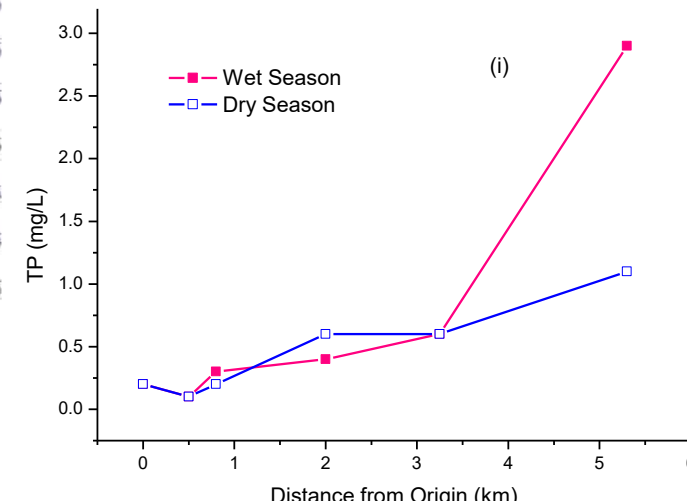
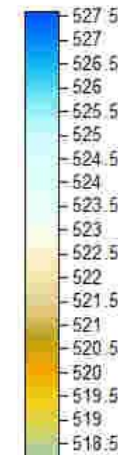
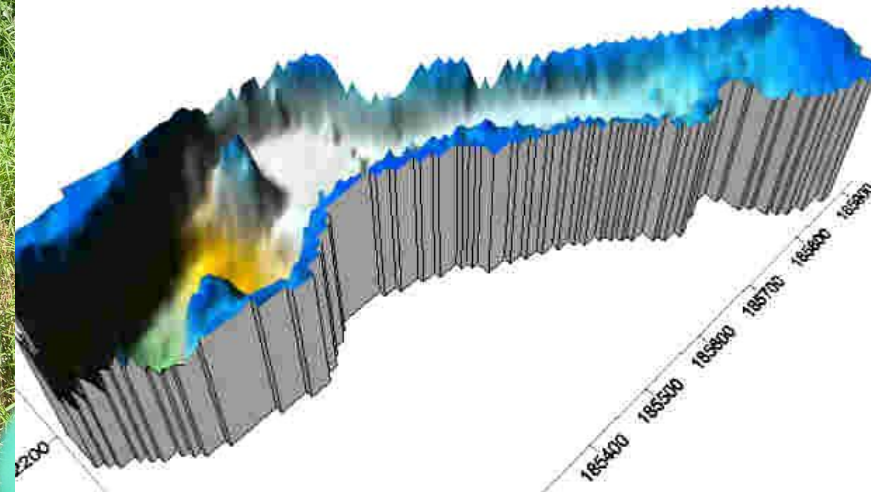
depth averaged velocity, magnitude (m/s)
25-Dec-2010 00:00:00



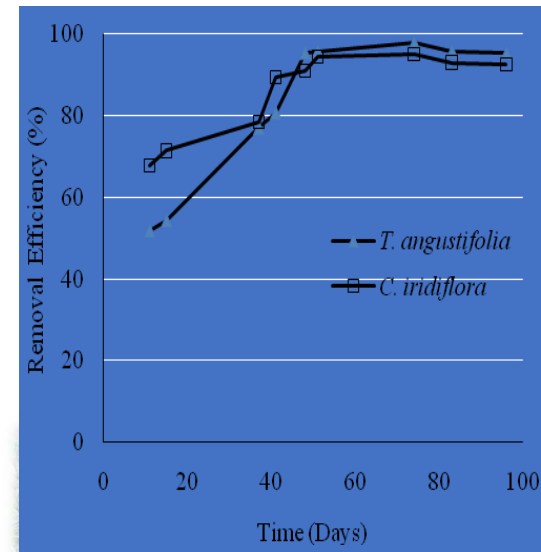
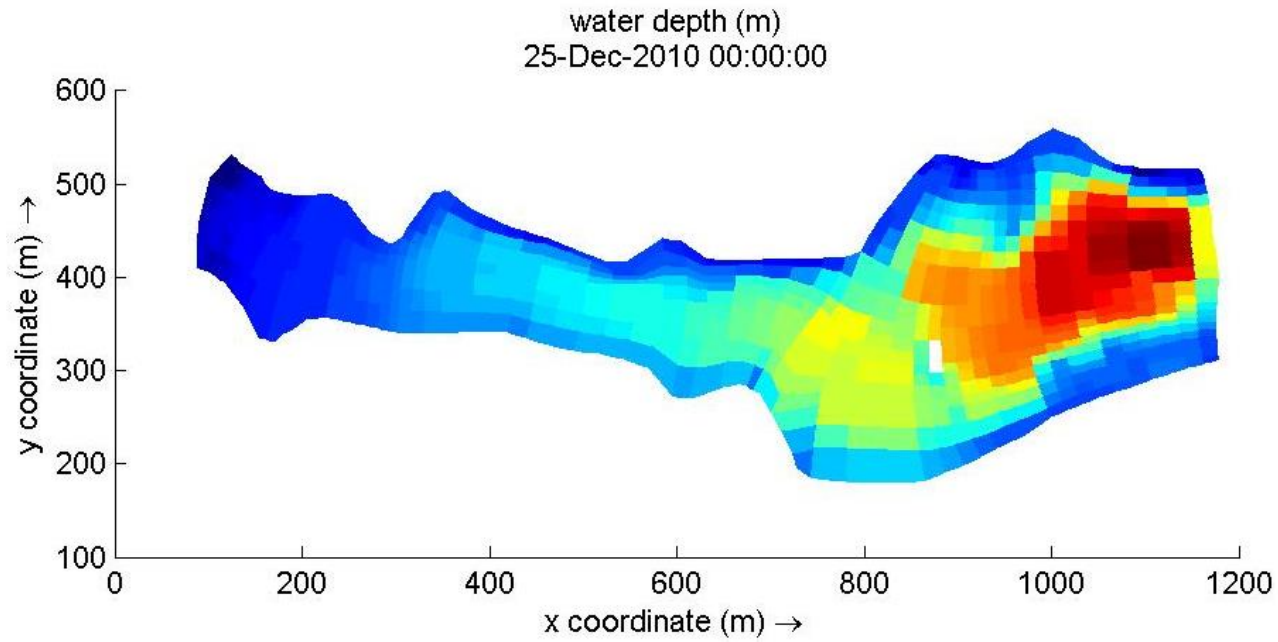
Jinadasa et al.(2018) – IJWRM



Understanding of the Problem



Development



Treatment Options and Implementation

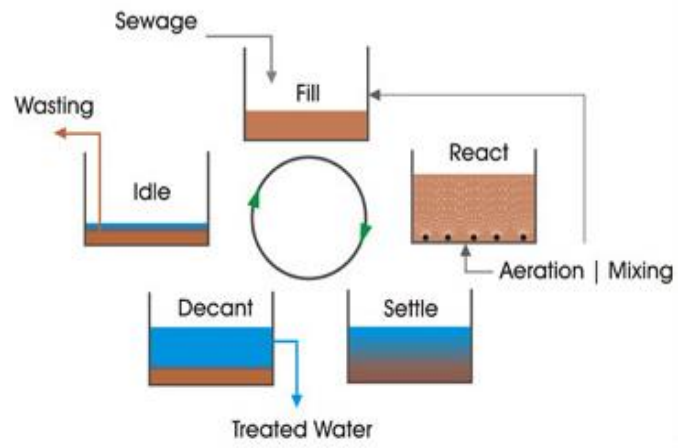
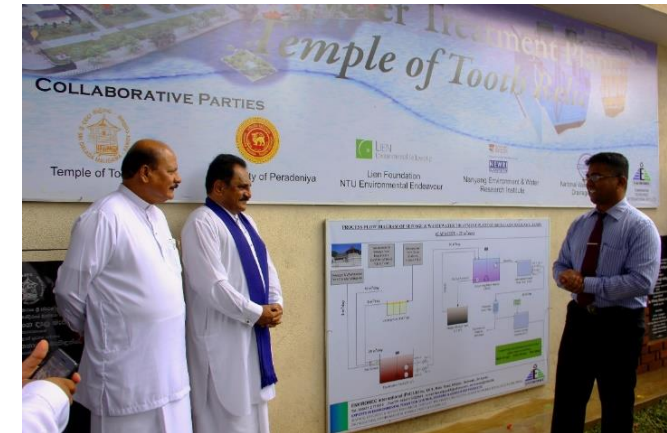


Fabrication and Installation

Full scale Floating Wetlands



Treatment Plant at Temple

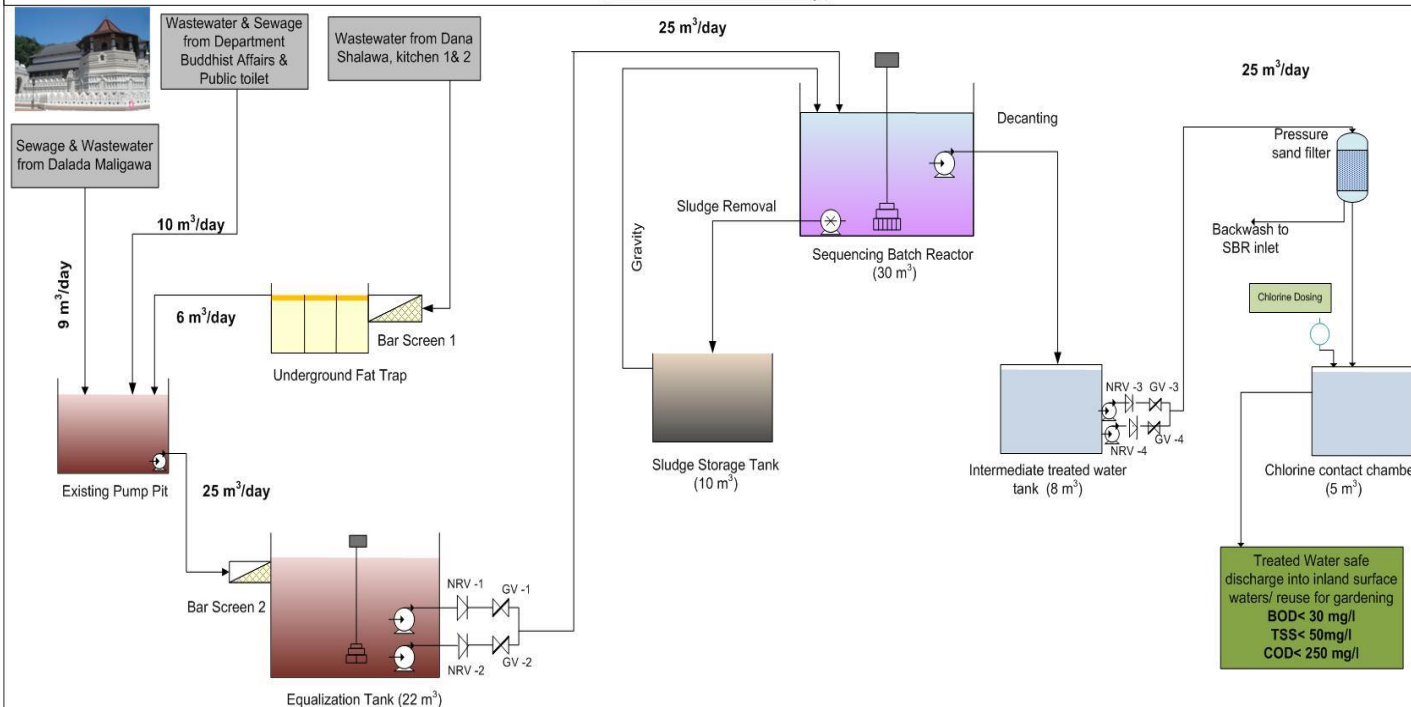




Treatment Options and Implementation



PROPOSED P&I DIAGRAM FOR SEWAGE & WASTEWATER TREATMENT PLANT FOR SRI DALADA MALIGAWA, KANDY
(CAPACITY – 25 m³/day)



Sequencing Batch Reactor (SBR) system:

- Compact;
- Large load bandwidth.

SBR system has not been previously applied in Kandy.

Capacity: 200 – 1,200 users.

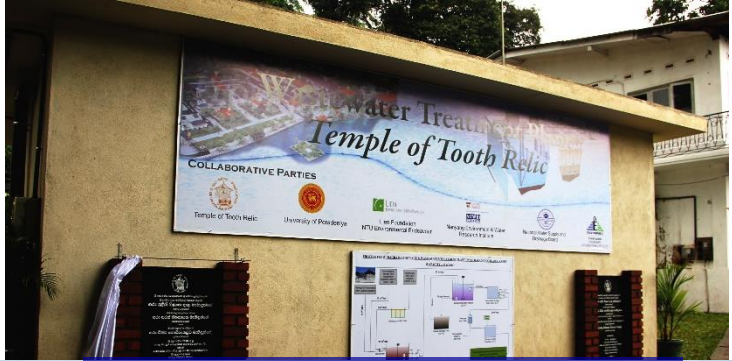
Severe construction constraints



Community-Driven Clean-up and Conservation of Kandy Lake



Floating Wetlands at Kandy Lake



Sewage Treatment at Sri Dalada Maligawa



Awareness - Formal discussion Officials





Impact Across the Development

STP at Dalada Maligawa is used as a model for new treatment facilities in Kandy (e.g. Grand Kandyan hotel and Devon Hotel).

Close to 200 million USD have been invested by JICA and the Government of Sri Lanka for sanitation infrastructure.



Rehabilitation of Mid-Canal, pictures taken in January and May 2017



HOME PROJECT MANAGEMENT STRUCTURE ACTIVITIES GALLERY PUBLICATIONS BLOG FAQ CON

PROJECT UPDATES: on, Suduhumpola East GN Division, Mulgampola GN division | Micro tunneling Constructions at : Kandy City Market A

Project Financing

This Project is Funded by Japanese International Cooperation Agency (JICA) and Government of Sri Lanka (GOSL).

PROJECT COST

Package	Description	TOTAL (million Rs.)
Package 1	Construction of WWTP, Main Pump Station with pumping main (ICB)	5,316
Package 2	Construction collection system, Trunk, Branch & Service sewers, Manhole Pump Stations (ICB)	8,319
Package 3	Construction of House (Property) connections (NCB)	2,767
Package 4	Sanitation facilities for Low-Income area (NCB)	102
	Private Sanitation Facility Improvement for Low Income areas (Private latrine programme)	20
	Consultancy Services	1,126
	LOAN PORTION	17,922
	GOSL PORTION	
	Land Acquisition, VAT & NBT, Import tax and Duties, Administration Cost	4,060
	Grand Total	21,982

Funding Agency : Japan International Corporation Agency (JICA)
Consultancy Services for Preliminary Detailed Design, Tendering Assistance and Construction Supervision

NEWS & EVENTS

Construction Progress

Project Progress Noti



Map of KCWMP Service

Government & capacity building:

- Kandy Municipality won “best municipality award” in 2016;
- Kandy City secured funding from JICA and World Bank for Kandy Lake and Mid-canal rehabilitation, sewerage network, and centralized wastewater treatment facility.

KANDY CITY WASTEWATER MANAGEMENT SYSTEM

General Layout Plan

LEGEND

- Manhole Pumping Stations
- Main Pump Station
- Common Toilet
- Mobile Toilet Location
- Stream
- Trunk Sewer
- Branch Sewer
- Service Sewer
- Pumping Main
- Trenchless Pipe
- Property Connections
- Sewerage Service Area (733.2 h)



Sledge Drying Beds - Gohagoda



MPS 08-2 (Hospital WTP)



WWTP
Oxidation ditch with capacity of 14,000m³/day



Effluent Discharge approx. 1km Out Fall



MPS 15-1 (Peradeniya Campus)



MPS 13-1 (Bowala)



MPS 16-1 (Getambe)



Main Pump Station (Package 01) At Heeressagala Junction



Common Toilet - PKG 4 (Mahaiyawa Area)

1. Mahaiyawa - Common Toilet	Re Construction
2. Mahaiyawa - Common Toilet	Re Construction
3. Mahaiyawa - Common Toilet	Re Construction
4. Mahaiyawa - Common Toilet	Re Construction
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29. Mahaiyawa - Common Toilet	Re Construction
30. Mahaiyawa - Common Toilet	Re Construction

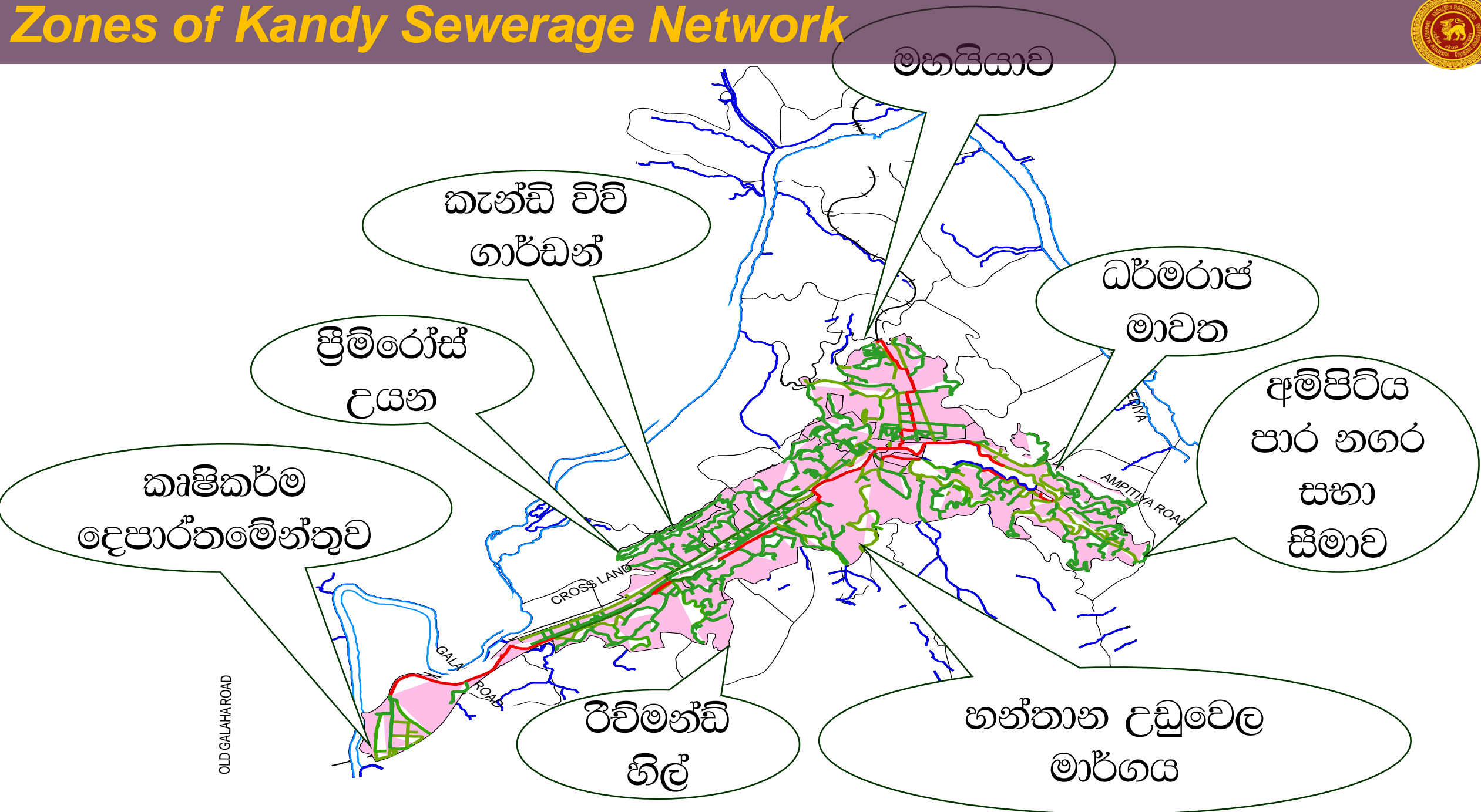
Common Toilet - PKG 4 (Deiyannewela Area)

1. 12/31 Deiyannewela - Common Toilets	Re Construction
2. 10/46 Deiyannewela - Common Toilets	Re Construction
3. 62/13 Kamatha - Common Toilets	Re Construction
4. Edward Silva - Bathing Place	Rehabilitation

Catchment	Pumping	Total	Trunk		Branch		Service	Total Length (m)	Service Pit	IC Total	No of MH	
			Trenchless	Open Cut	Trenchless	Open Cut						
T01	304	1080	595	485	13096.4	643.4	12453	23811	38381.4	773	2272	432
T02	497	372	0	372	5470.4	461.4	5009	6386	12725.4	141	222	175
T03	0	747	337	410	0	0	0	326	1073	9	37	14
T04	0	62	0	62	7827.6	34.6	7793	1827	21716.6	389	640	387
T05	676	1215	666	549	5438.1	483.1	4955	10510	17839.1	293	355	226
T06	0	89	0	89	654.9	33.9	621	1500	2243.9	43	73	21
T07	0	0	0	0	4014.1	886.1	3616	5311	9325.1	218	289	132
T08	76	1238	706	532	11195	1258	9937	26383	38902	940	2034	471
T09	16	1379	135	1244	6178.2	316.2	5862	21888	29461.2	747	1311	234
T10	0	731	23	708	2134	0	2134	3254	8099	196	225	84
T11	0	299	143	156	4054.7	166.7	4492	4305	5052.7	108	187	158
T12	0	542	19	523	3897	22	2875	5823	9261	157	350	109
T13	559	199	199	0	10123	1417	8686	17389	26270	366	1040	339
T15	433	1093.3	0	1093.3	3031.5	468.5	2563	3562	8119.8	91	141	102
T16	548	59.3	53.9	5.4	128	0	128	170	905.3	2	9	7
Total	3199	9105.6	2876.9	6228.7	76826.9	5722.9	71104	146244	235375.5	4471	9205	2791



Zones of Kandy Sewerage Network



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මාර්ගය

OLD GALAHARA ROAD

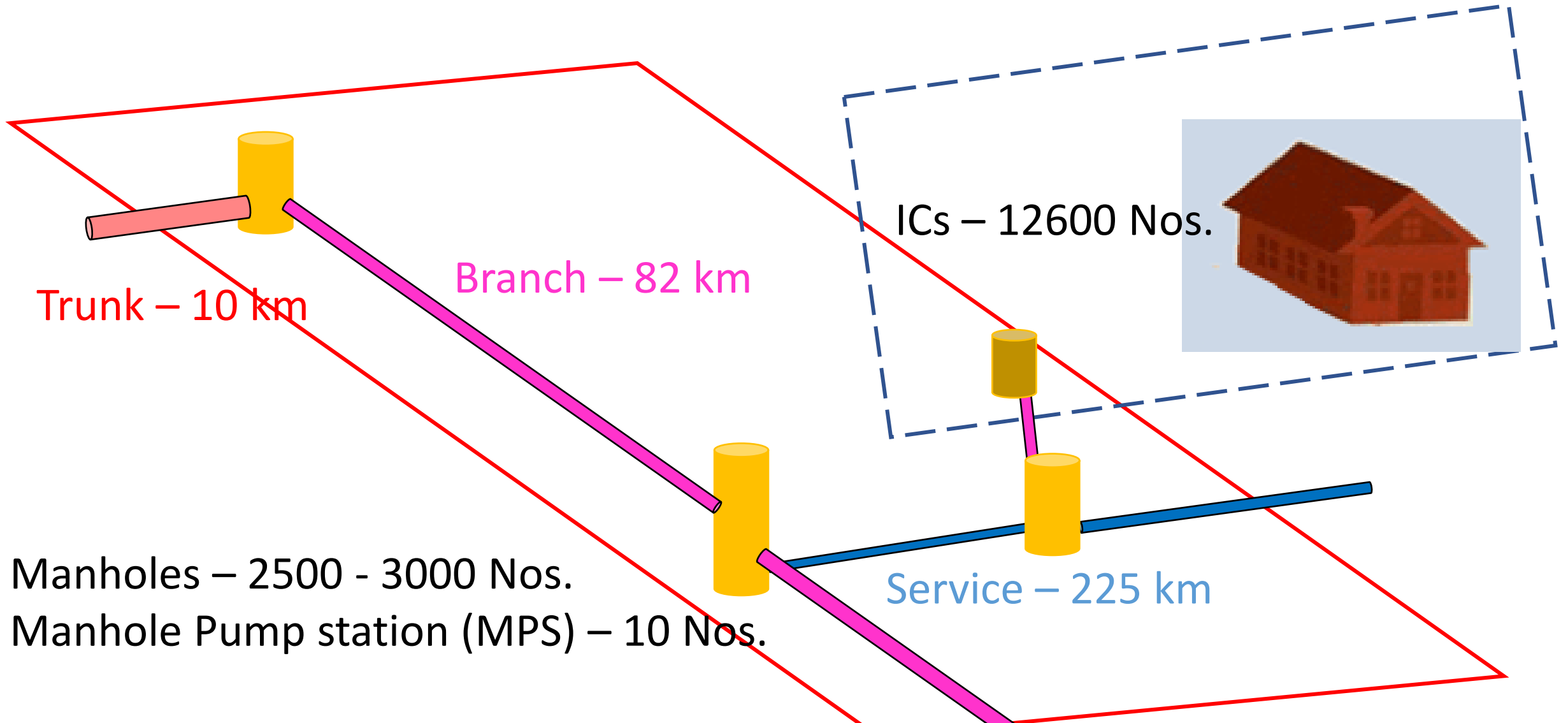
GALAHARA ROAD

CROSS LANE

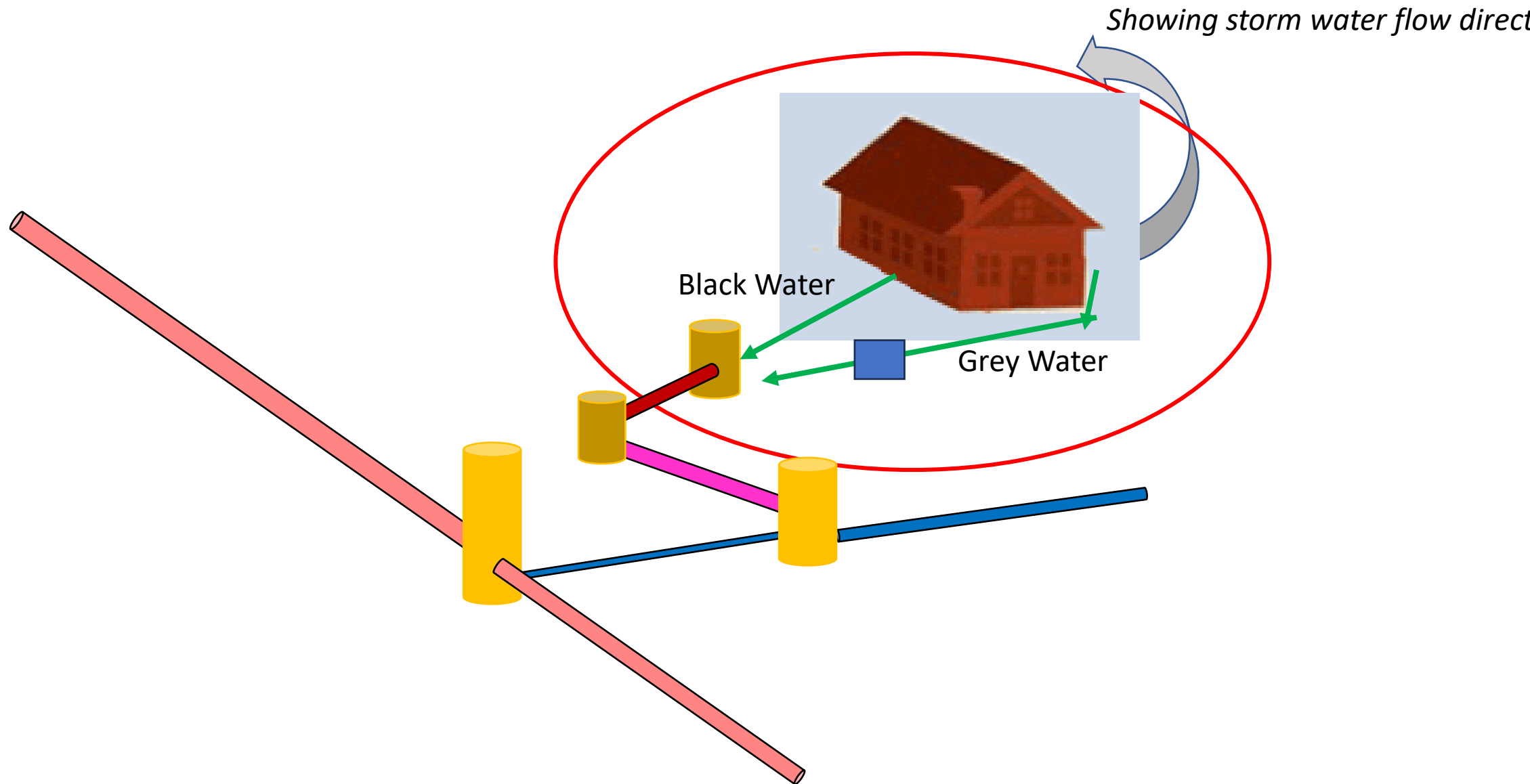
ETVA

AMPITIYA ROAD

Household connections – sewerage system



House connection to main sewer line



Construction Difficulties







After Treatment





Poor construction of sewernetwork

Hospital sewer outflow

Energy consumption

Hospital overflow – raining condition – cross contamination



Overflow – pumping station



Manhole overflow – during the rain



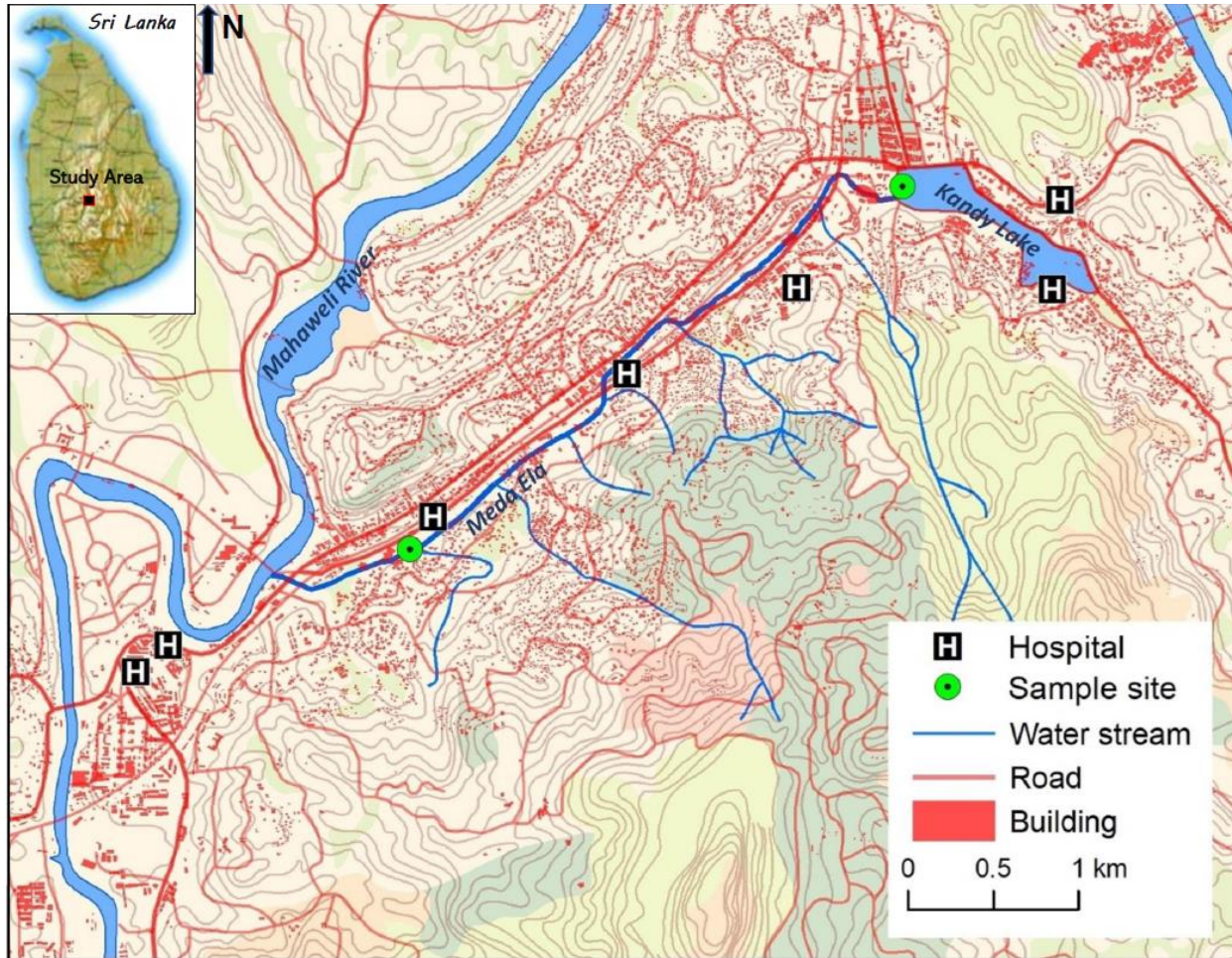
Stormwater infiltration into sewer network



Map of Centre Area of Kandy City



Water quality issues in hospital wastewaters and adjacent surface waters in Sri Lanka



Showing storm water flow direction

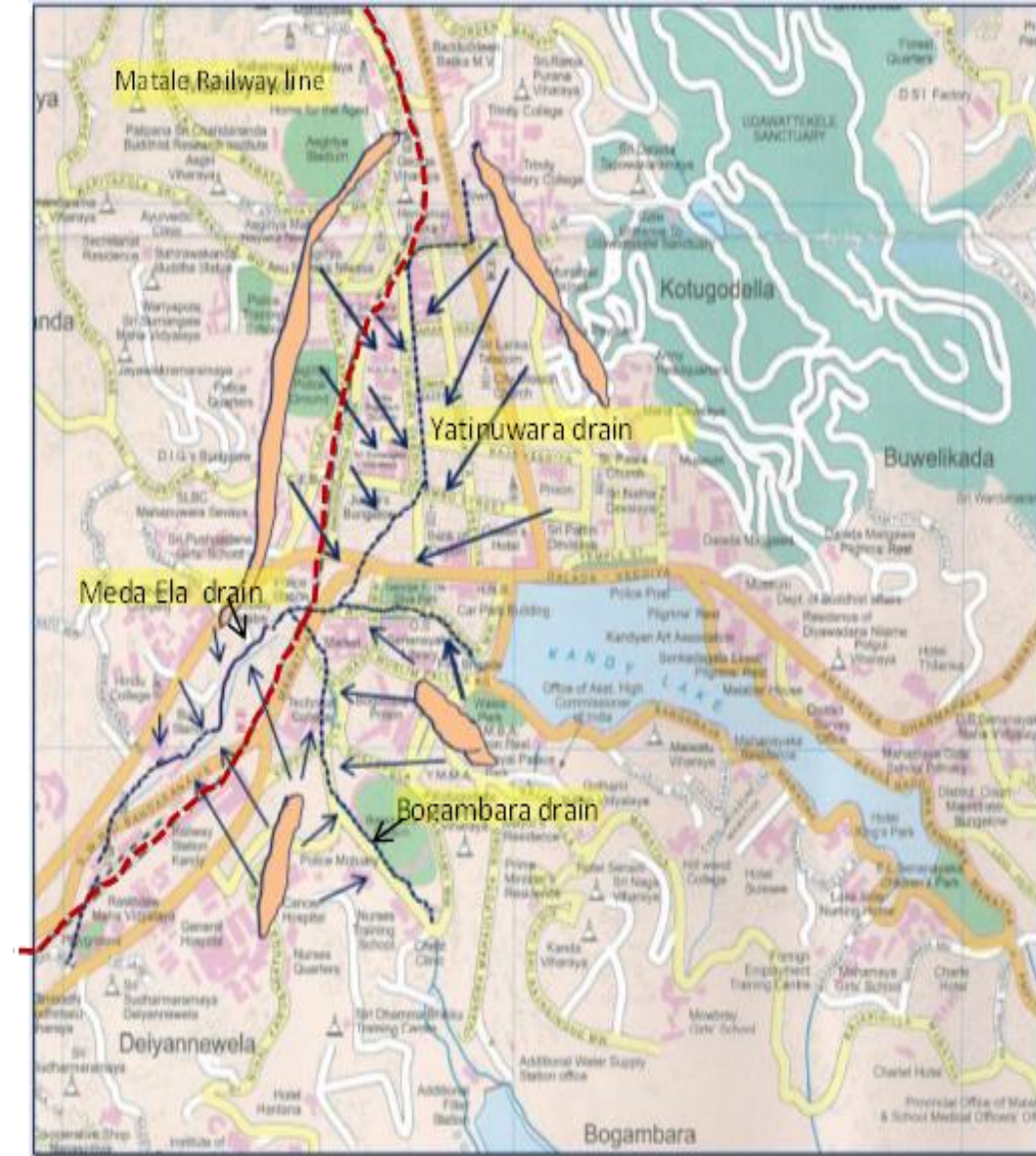
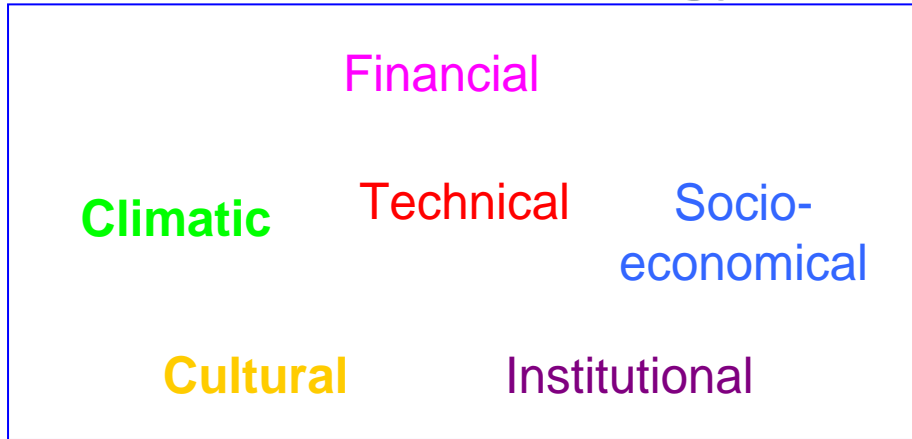


Fig. 03 Kandy Drainage Pattern



Appropriate technology



- *Master Plan Development*
- *Coordination among agencies*
- *Financial feasibility of sanitation projects*





Research Center for
Eco-Environmental Sciences
Chinese Academy of Sciences

Thank You



Gift of Water - Flow of Hope