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Karachi, Pakistan WTF Potential

Discussion and Comments on the bio-methane of Karachi

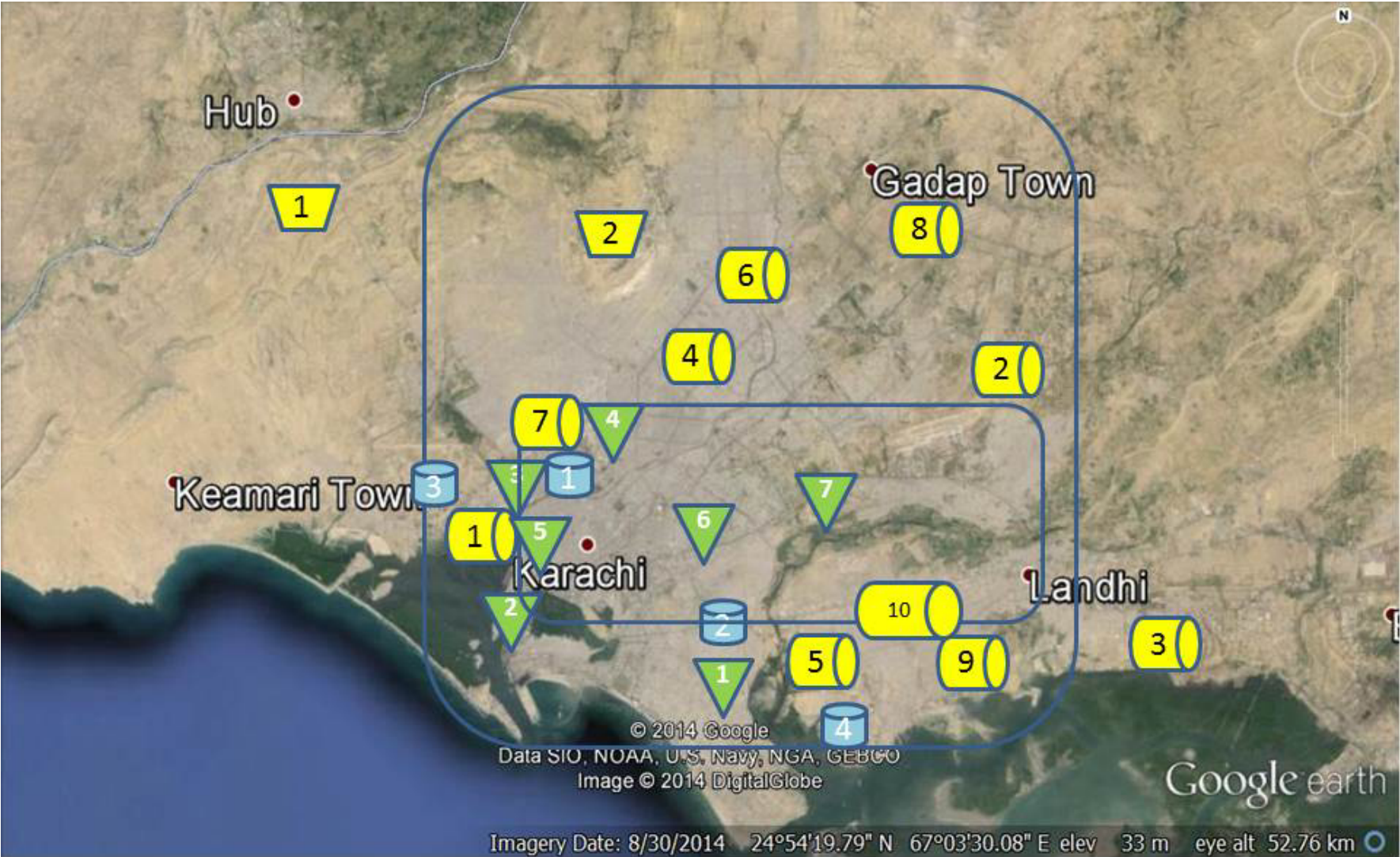
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Where is the Best Green Transport Route?

- **Feedstock Locations** – Where are the facilities producing the biogas and bioCNG (see next slide)?
- **Role of the Canals and Sewers** –How much solid biomass is caught in the open drains? How much goes to the sea?
- **Illegal Dumping** – How much diverted to and from Landfills?
- **Refueling Plan** – Can these Routes be linked up to existing distribution centres for CNG?
- **Growth Plan** – Do these routes support the implementation for CNG infrastructure – spill over effect?
- **Efficiency** - Can these routes be served by smaller local facilities removing waste management truck trips?
- **Competing Uses for biosolid** – Compost, Feed, biogas power?



Bio-methane Sources



Legend

Solid Waste Sorting



Aqua/Agri Processing



NG Gas Main Pipeline (assumed)



Waste Water Plant



Landfill



Bus & Metro Service Area



Neighbourhood Sorting



Plastics Recycling



Canal Beside Recycler



Downstream at Canal



Canal Discharges to Bay



Bay Producing Gas

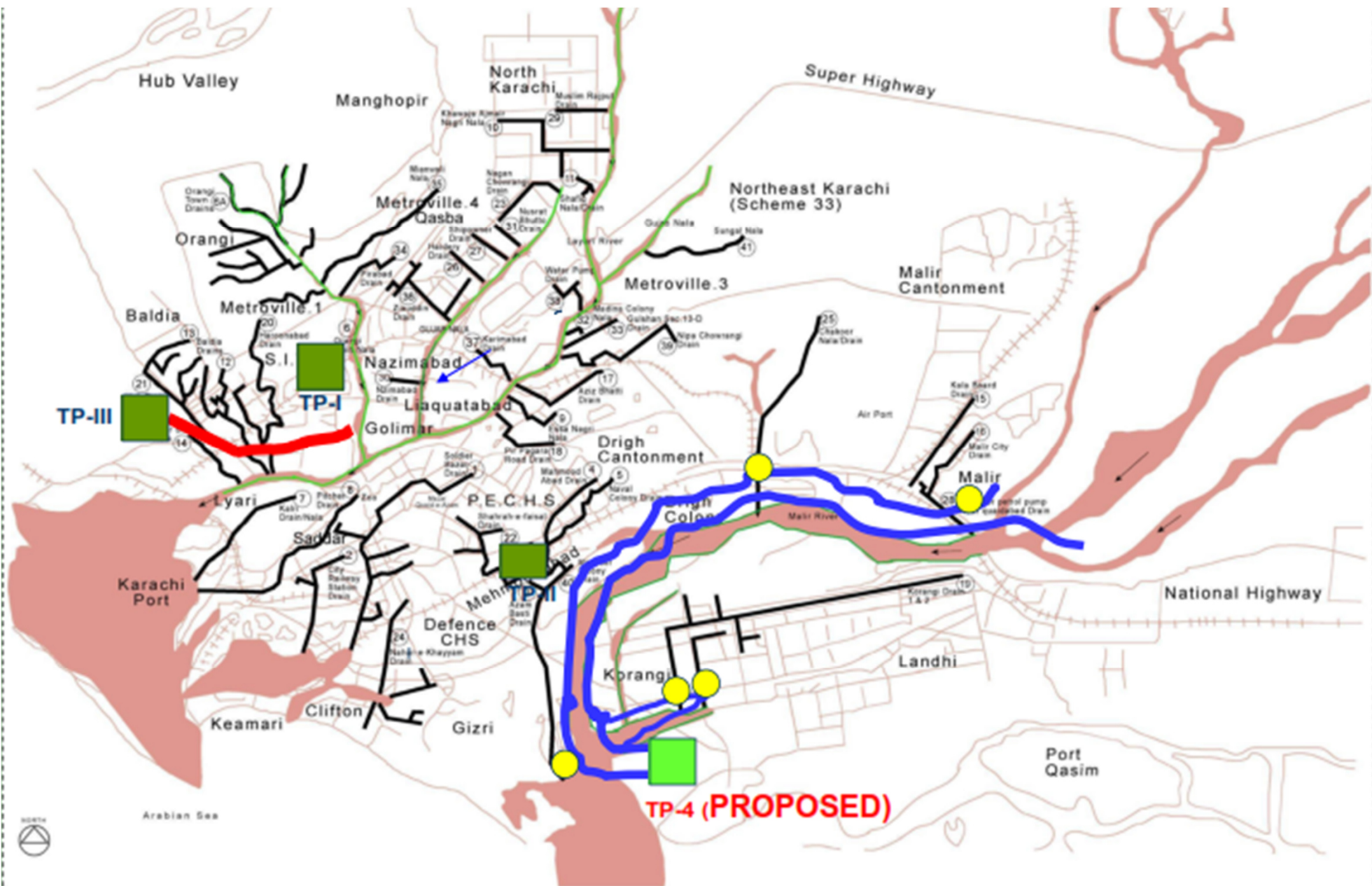




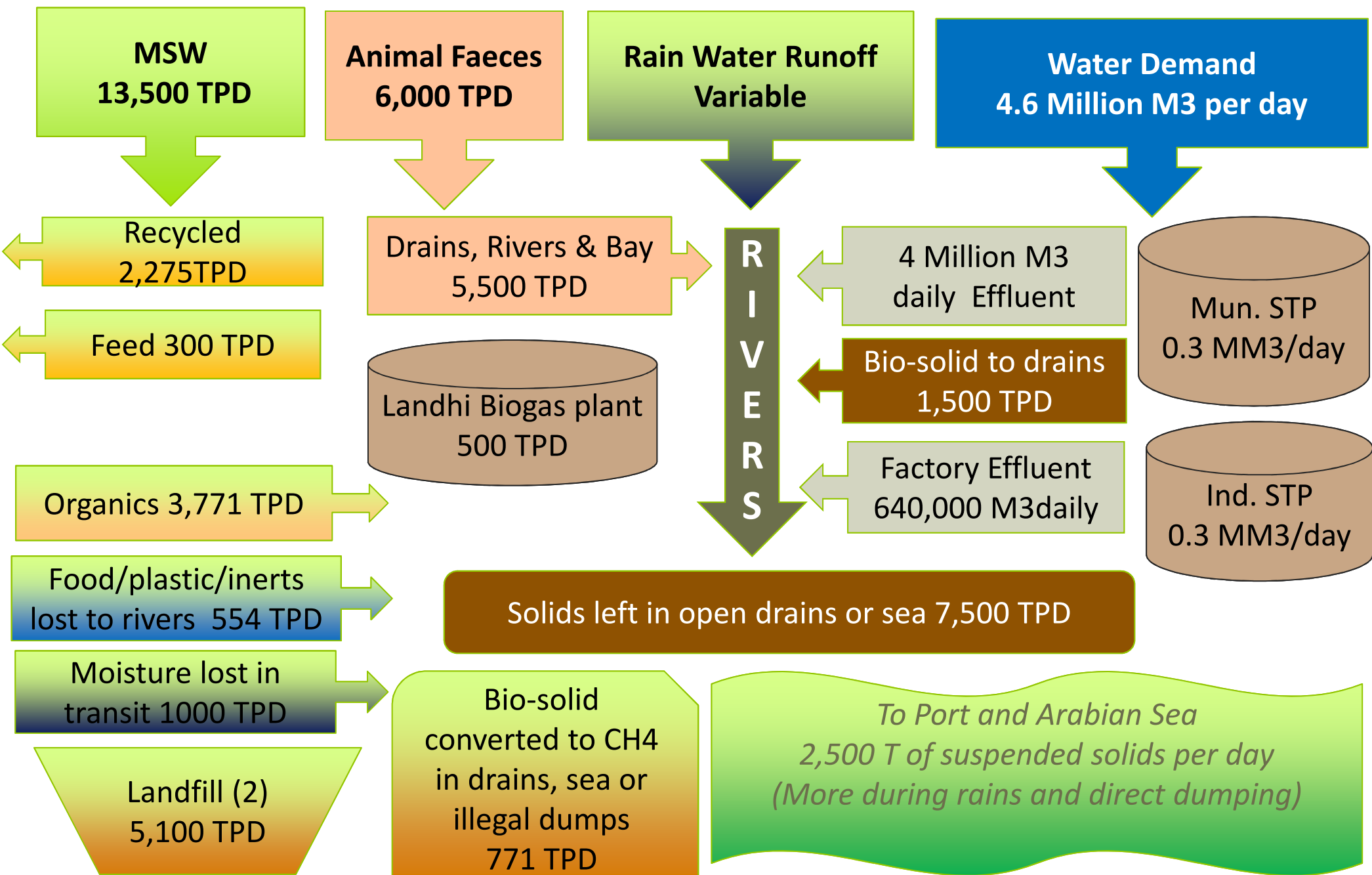
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Sewer and Open Drain Network



Where is the Daily Waste going Now?

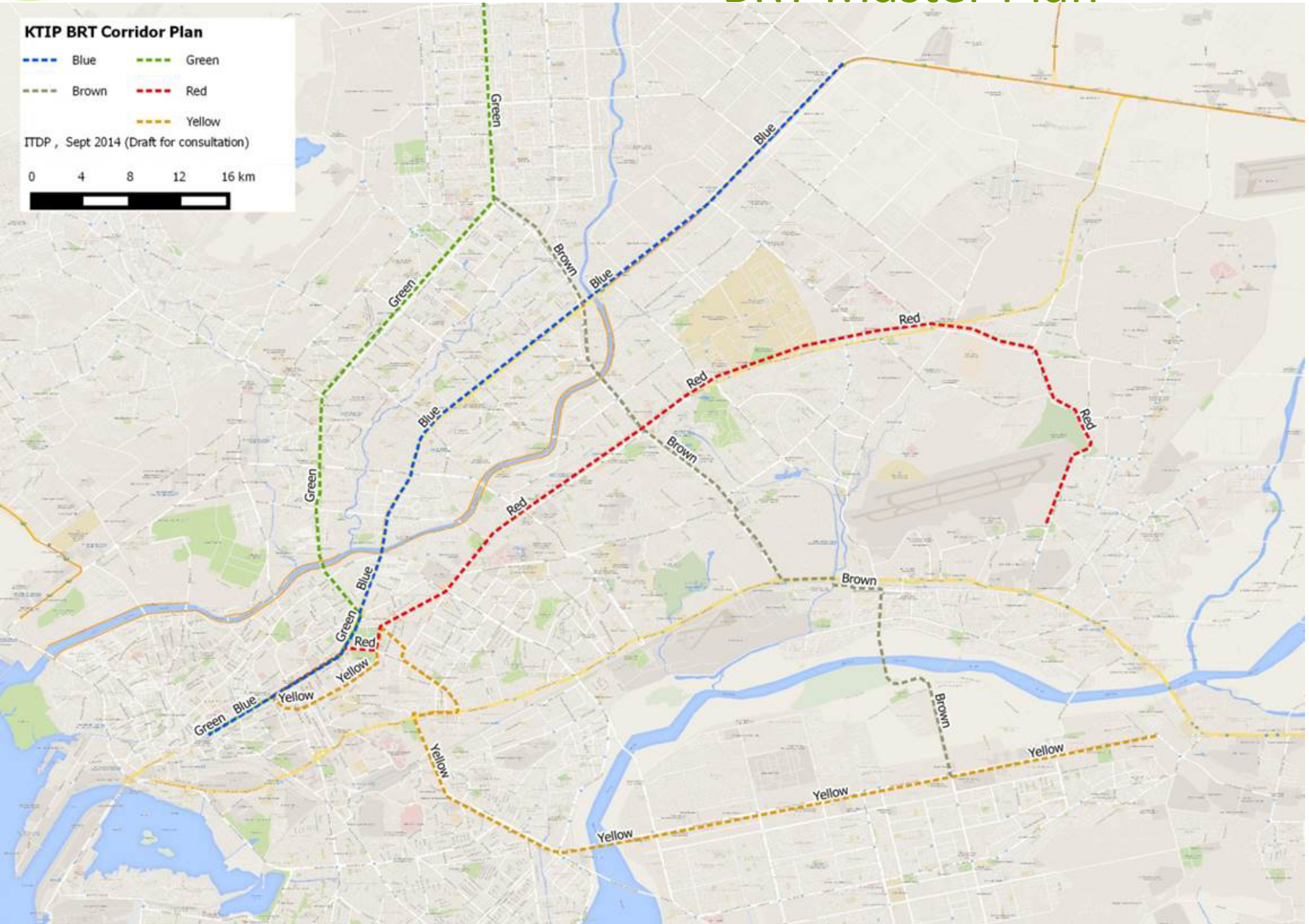




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BRT Master Plan





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CNG and Bio-solid Maximum Potential (Daily)

Location	Waste type	NG NM3	Bio solid	Capital Cost Biogas	Capital Cost Purification	Biogas \$ / NM3	NG \$/ NM3	NGe as Diesel
Deh Gond Pass LF	Landfill	10,526	0	\$ 3,500,000	\$ 1,875,000	\$ 0.13	\$ 0.30	\$ 0.35
Deh Jam Chakro LF	Landfill	10,526	0	\$ 3,500,000	\$ 1,875,000	\$ 0.13	\$ 0.30	\$ 0.35
Central Resource Recovery Facility	Food & Organics	126,561	50	\$ 29,000,000	\$ 16,395,435	\$ 0.13	\$ 0.27	\$ 0.31
East Resource Recovery Facility	Food & Organics	126,561	50	\$ 29,000,000	\$ 16,395,435	\$ 0.13	\$ 0.27	\$ 0.31
South Resource Recovery Facility	Food & Organics	126,561	50	\$ 29,000,000	\$ 16,395,435	\$ 0.13	\$ 0.27	\$ 0.31
East Resource Recovery Facility	Food & Organics	126,561	50	\$ 29,000,000	\$ 16,395,435	\$ 0.13	\$ 0.26	\$ 0.31



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CNG and Bio-solid Maximum Potential (Daily)

Location	Waste type	NG NM3	Bio solid	Capital Cost Biogas	Capital Cost Purification	Biogas \$ / NM3	NG \$/ NM3	NGe as Diesel
Plant SEI	Waste water	32,622	14	\$ 47,000,000	\$ 4,648,585	\$ 0.37	\$ 0.67	\$ 0.79
Plant SE II	Waste water	32,745	14	\$ 46,000,000	\$ 4,666,193	\$ 0.36	\$ 0.66	\$ 0.77
Plant SE III	Waste water	152,811	66	\$ 138,000,000	\$ 21,775,568	\$ 0.27	\$ 0.50	\$ 0.59
Plant SE IV	Waste water	152,811	66	\$ 138,000,000	\$ 21,775,568	\$ 0.27	\$ 0.50	\$ 0.59



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CNG and Bio-solid Maximum Potential (Daily)

Location	Waste type	NG NM3	Bio solid	Capital Cost Biogas	Capital Cost Purification	Biogas \$ / NM3	NG \$/ NM3	NGe as Diesel
Diary Sites Multiple Colonies	Industrial WW	1,327,832	480	\$ 95,000,000	\$157,680,000	\$ 0.10	\$0.21	\$ 0.24
Northern Karachi Industrial Zones	Industrial WW	86,447	31	\$ 28,000,000	\$ 10,265,625	\$ 0.15	\$ 0.30	\$ 0.36
Food processing Bin Qassim & East	Industrial WW	172,895	63	\$ 43,000,000	\$ 20,531,250	\$ 0.14	\$ 0.27	\$ 0.32
Other Processing Zones	Industrial WW	172,895	63	\$ 43,000,000	\$ 20,531,250	\$0.14	\$ 0.27	\$ 0.32
Totals Daily		1,474,372	568.8	\$641,000,000	\$ 190,607,779			

Solution to a number of Issues

Issue	Impact of Buses using Bio-methane Mix
Diesel/Petrol fumes at peak hour – not a walking city	By switching to new CNG buses, the impact of high sulfur diesel will be reduced. By using bio methane the GHG impact of the bus service will be reduced and add to the prestige of the service. People can walk at peak hour.
Congestion at bus stations	By simplifying routes and building new bus stations with amenities for consumers, Buses will increase ridership and reduce the impact on traffic by road side pickups
Congestion at intersections due to taxis and cars	By creating nodes where commuters will congregate, taxis will be forced to look for passengers at these locations
Delays in bus traffic due to congestion	By reducing the number of bus routes and the number of buses on the same roads will be reduced. This will reduce congestion due to numerous pollutive vehicles on the road

Solution to a number of Issues

Issue	Impact of Buses using Bio-methane Mix
Cattle faeces being dumped in the bay	Methane Economy will mean that there will be an incentive to turn this to biogas and then fuel.
Organics solid waste being dumped in drainage canals	Currently canals are choked with solid residue which cleaned out prior to Monsoon. This is a gold mine for biogas and fertiliser.
Truck trips to Landfills	Currently the trucking of MSW to landfills is rorted. The cost to the city and the amenity to residents are not linked. A methane economy will reduce these trips three times with better primary sorting and separation, aided by methane revenues.
Disease risk to city	Crimea Congo Disease is endemic to nearby Baluchistan and in 2014, 4 deaths were recorded. It is spread by tick bite and is incurable. Goats at dumpsites and suburban dumps are a prime vector. These will be reduced with better practices.

Case for Bio-methane Buses

Bus Costs - US\$ 458,000 Diesel, US\$ 550,000 CNG, US\$ 580,000 Bio-methane (with Trailer support).

Fuel Costs per litre equivalent of Diesel – Diesel US\$ 1.15/le , CNG US\$ 0.49/le , Bio-methane US\$ 0.35/le

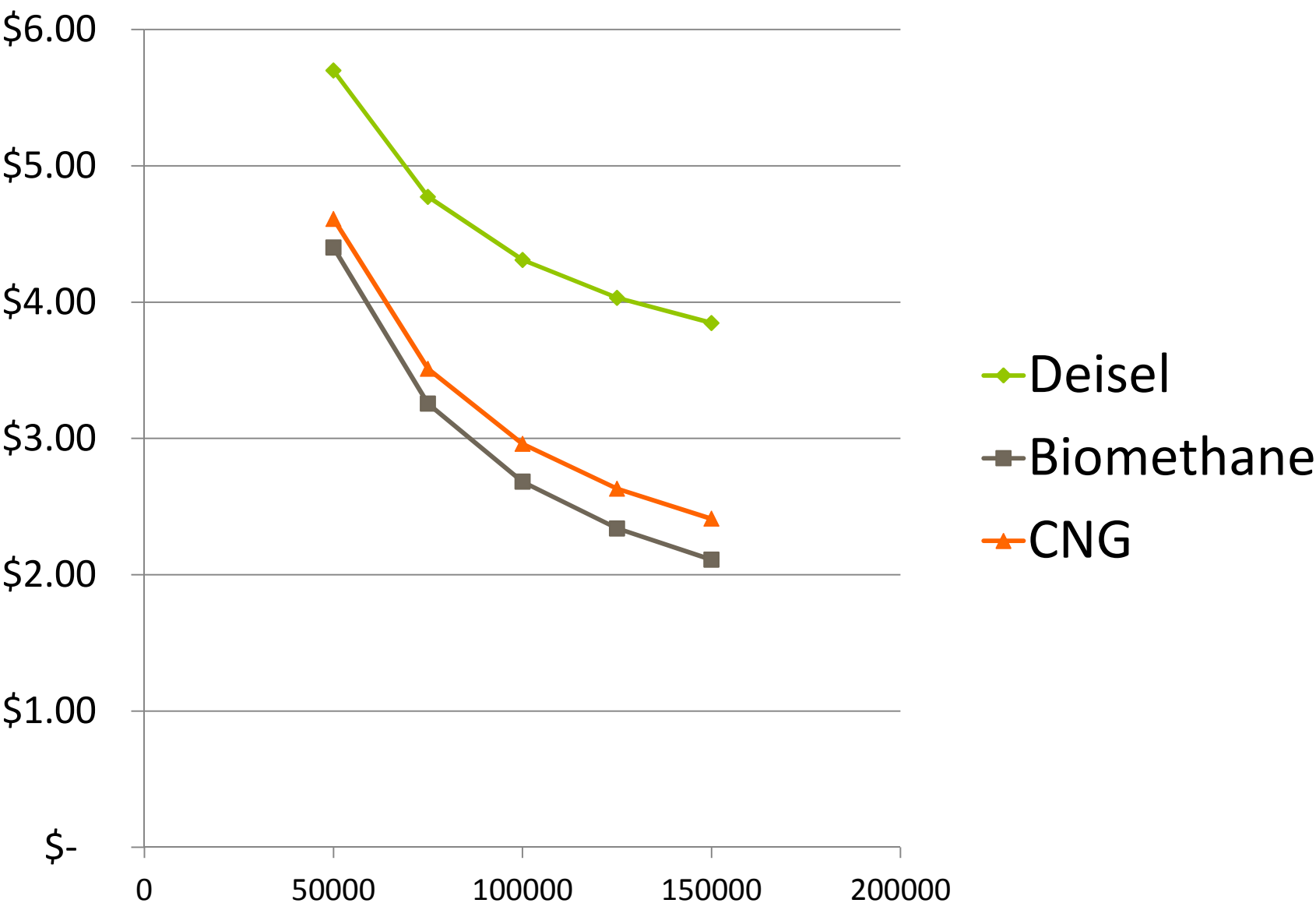
Environmental benefits based in Dutch experience – NOX US5c/km, PM10 US0.3c/km, CO2e US7.5c/km

Maintenance Costs – 6% higher per 25,000km for CNG and Bio-methane.

Additional Benefits - US5c/km for sale of bio-solid (impact of use of bio-solid for environmental restoration is not included in analysis but will be significant).



Case for Bio-methane Buses



Case for Biomethane Buses

Based Purely on financial Analysis

Km travelled per year	Diesel		Bio-methane		CNG	
50000	\$	5.70	\$	4.40	\$	4.61
75000	\$	4.77	\$	3.26	\$	3.51
100000	\$	4.31	\$	2.68	\$	2.96
125000	\$	4.03	\$	2.34	\$	2.63
150000	\$	3.85	\$	2.11	\$	2.41

Case for Biomethane Buses

Based on Financial Analysis with Environmental and Social Costs Included based in Dutch Experience

Km travelled per year	Diesel	Bio-methane	CNG
50000	\$ 5.78	\$ 4.35	\$ 4.61
75000	\$ 4.86	\$ 3.21	\$ 3.51
100000	\$ 4.39	\$ 2.63	\$ 2.96
125000	\$ 4.11	\$ 2.29	\$ 2.63
150000	\$ 3.93	\$ 2.06	\$ 2.41

Important Thinking

- The major available source is the dairy sites despite issues with ownership of waste.
- Waste water is difficult to secure. It will be easier to mine the canals in the short term.
- The landfills have potential but will require reform on site practices.
- The processing sites near dairy can provide feedstock to biogas plants nearby. This provides scale to make Bio CNG easier.
- Need to find the most likely solution which is “Do-able”

Low hanging Fruit for Bio CNG Buses

Based on buses travelling 75,000 per year and using sites most easily developed.

Location	Waste type	BIO NG NM3	Buses	Probable
Deh Gond Pass LF	Landfill	10,526	17	17
Deh Jam Chakro LF	Landfill	10,526	17	17
Diary Sites Multiple Colonies	Industrial WW	1,327,832	2104	200
Northern Karachi Industrial Zones	Industrial WW	86,447	137	70
Food processing Bin Qassim & East	Industrial WW	172,895	274	100
Other Processing Zones	Industrial WW	172,895	274	100
Totals Daily		1,781,121	2823	503