

Plan 4000 Canal

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John Lyrenmann | Project Manager



**Don
Jaguar Design**

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John Butler

Kristen Hedrich

John Lyrenmann

- International Senior Design
- Santa Cruz, Bolivia



Bolivia

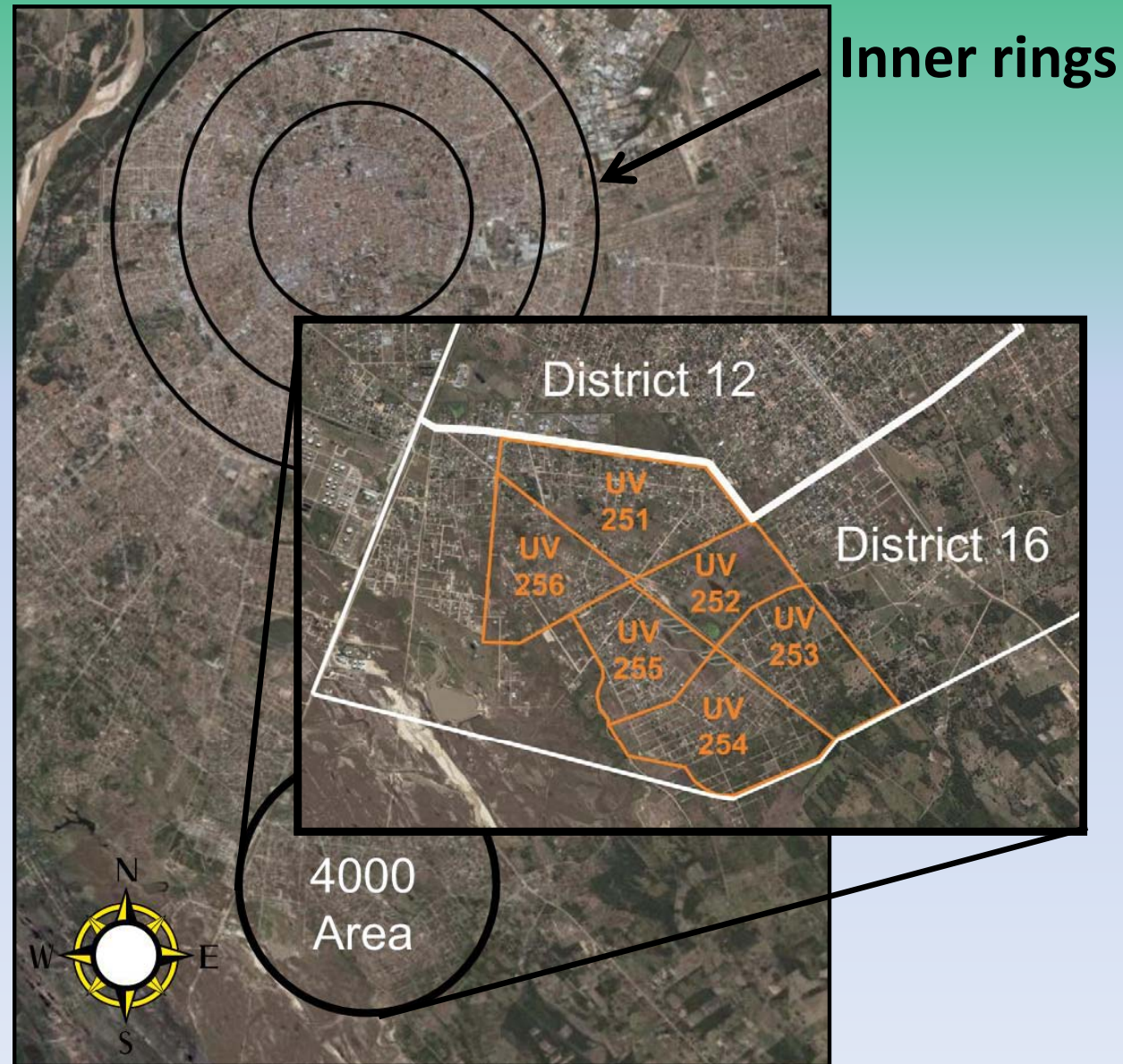


ISD involvement with Walter Henry since 2000



Santa Cruz Layout

- Inner city rings
- 16 Districts
- Districts into UVs
- Plan 4000 area



Funding

- Central Government in La Paz
- Funding to Santa Cruz



Santa Cruz: Flooding



Stormwater Drainage

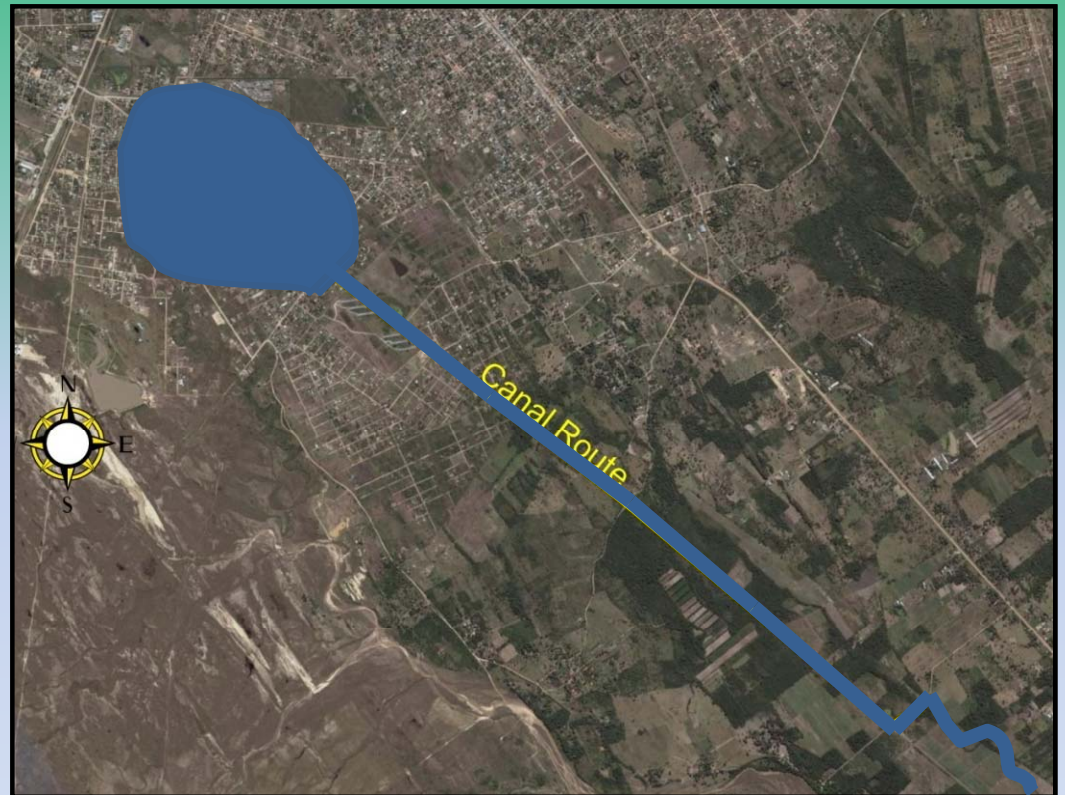
“In the slums and shanty towns of the Third World, many residents feel that they need drainage more urgently than water supply or latrines ... Many neighborhoods are flooded several times a year, and people have to cope with water or other people’s sewage inside their dwellings.”

-Cairncross and Feachem

From Environmental Health Engineering in the Tropics, 2007

Plan 4000: Flooding

- Residential and septic flooding
- Transportation
- Diseases



Survey

- DJD worked with city of Santa Cruz surveyors



Survey

- City crew established a total of 27 benchmarks



Survey

- DJD conducted topographic survey of 5.5 km canal route



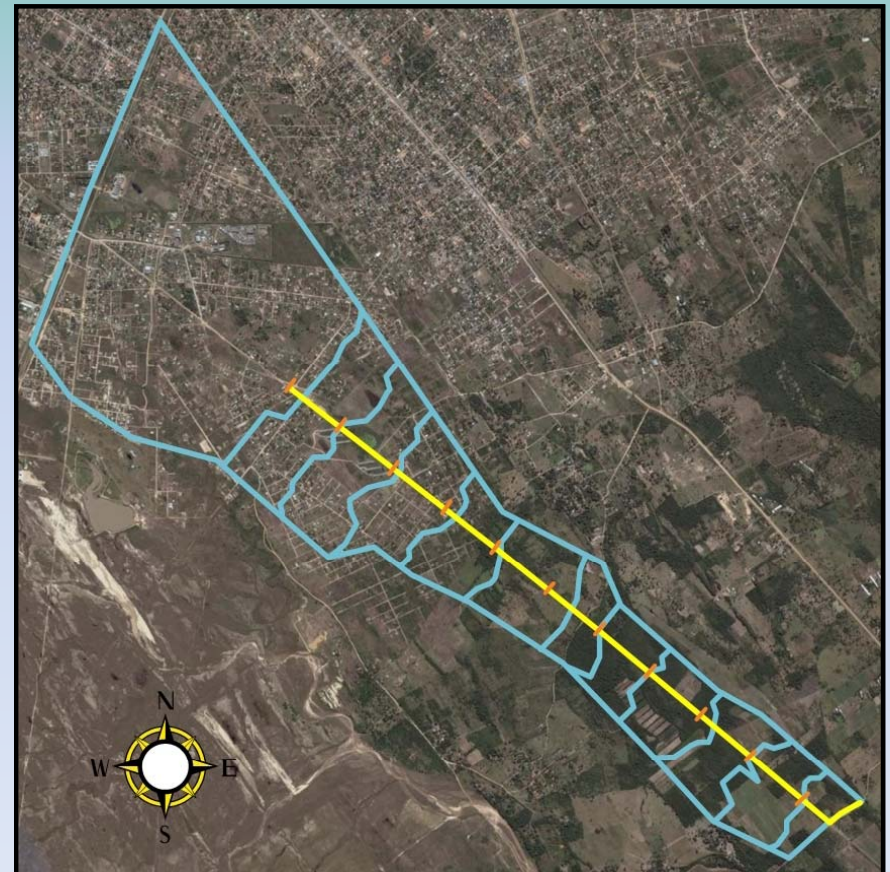
Soil Samples

- Soil samples were performed at 3 locations
- In country tests = sand-silt with clay underneath



Design Methods

- Watershed Delineation
- 500m sections



Design Methods

- Time of concentration based on watershed
- Rainfall intensity for Santa Cruz

- Rational Method

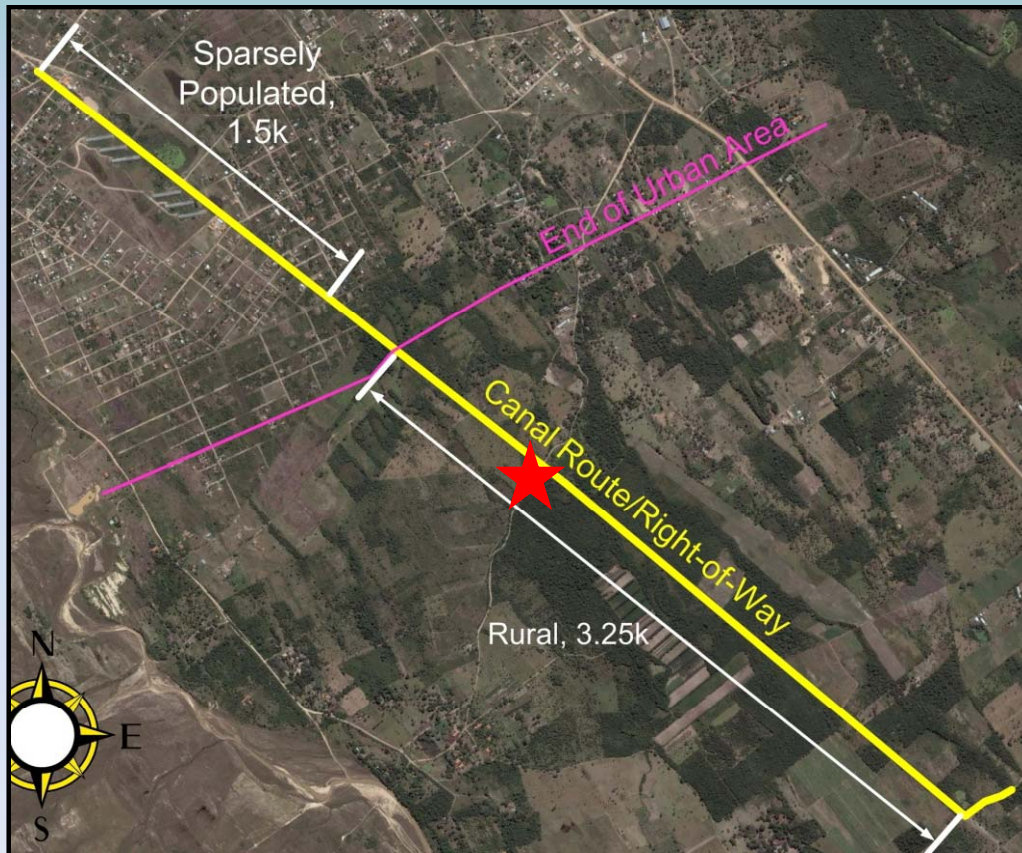
$$Q = C * I * A$$

- Manning Equation

$$V = \left(\frac{k}{n} \right) * R_h^{2/3} * S^{1/2}$$

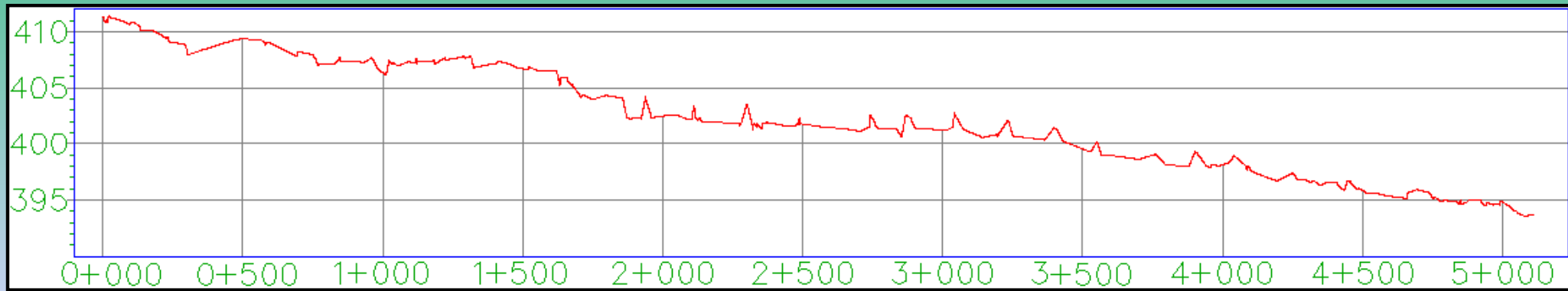
Existing Conditions

- Plan 4000 area is in District 16
- Population of Plan 4000 = 30,000

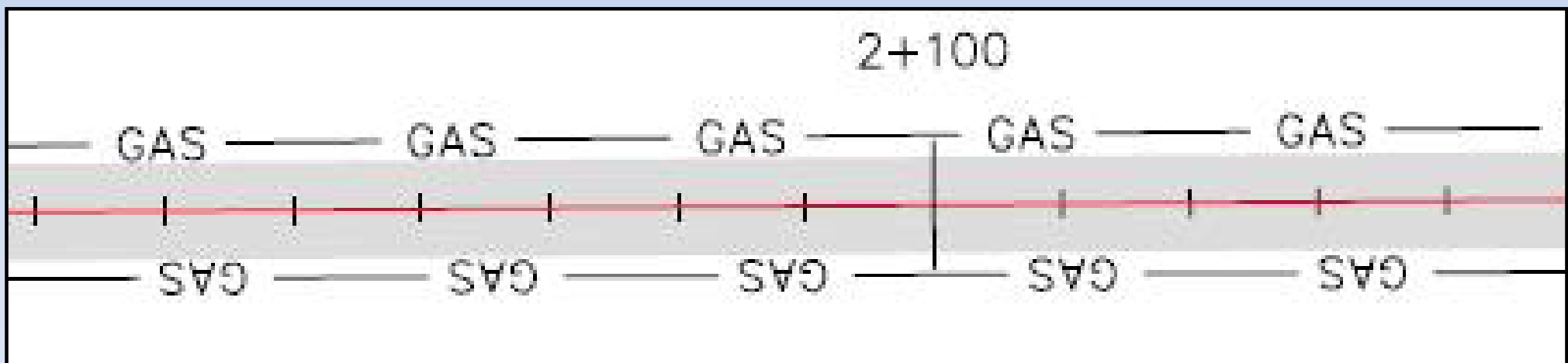


Existing Conditions

- Elevation change over 5.5 km route is 20m



- Canal route follows existing gas lines



Design Options

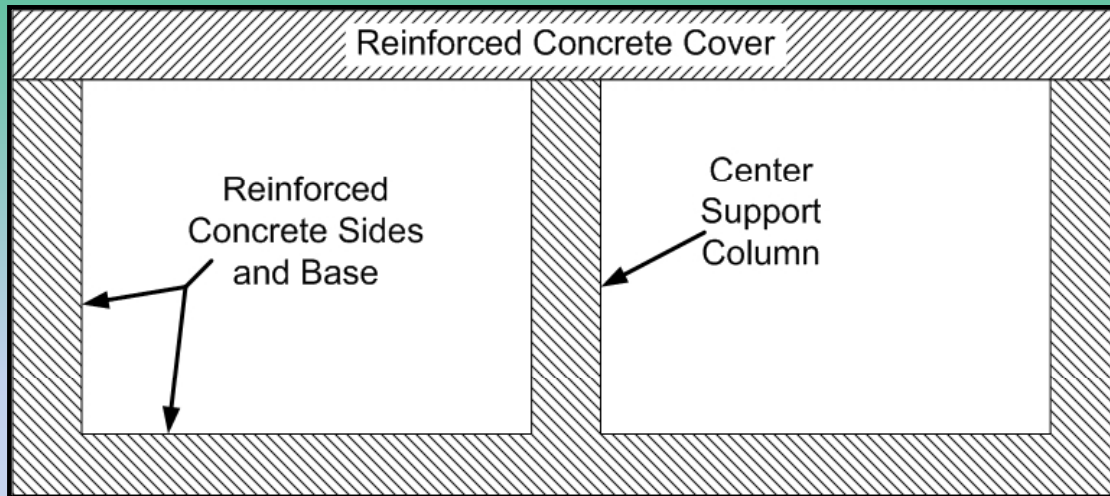
- **Underground Pipe**



- Required diameter
- Pipe diameters < 1.2 m (Bolivian Standards)

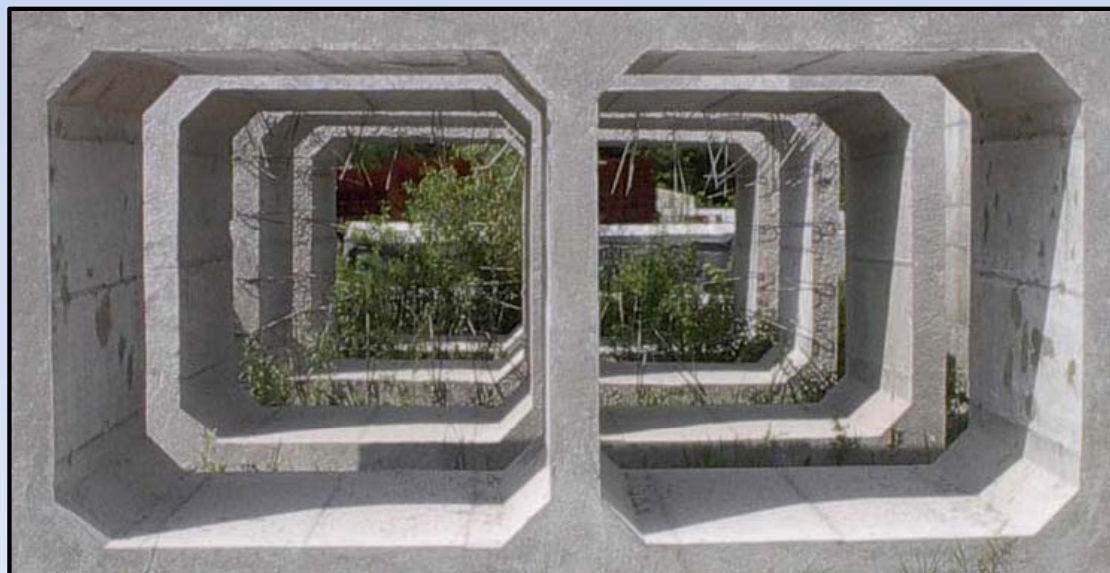
Design Options

- **Covered Rectangular Concrete Canal**



- Removal of cover

- Inlets necessary

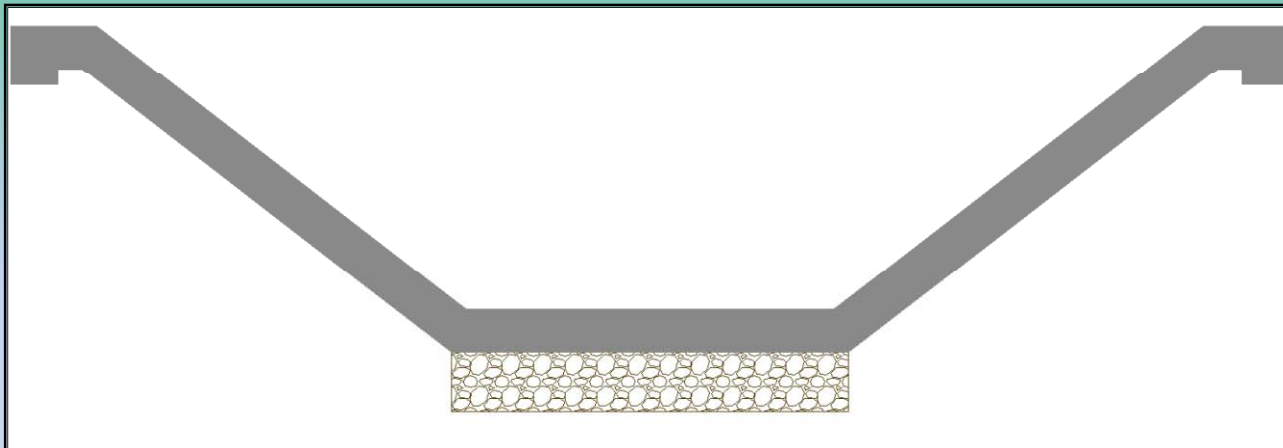


- Excavation Depth

Design Options

- **Open Trapezoidal Canal**

Concrete



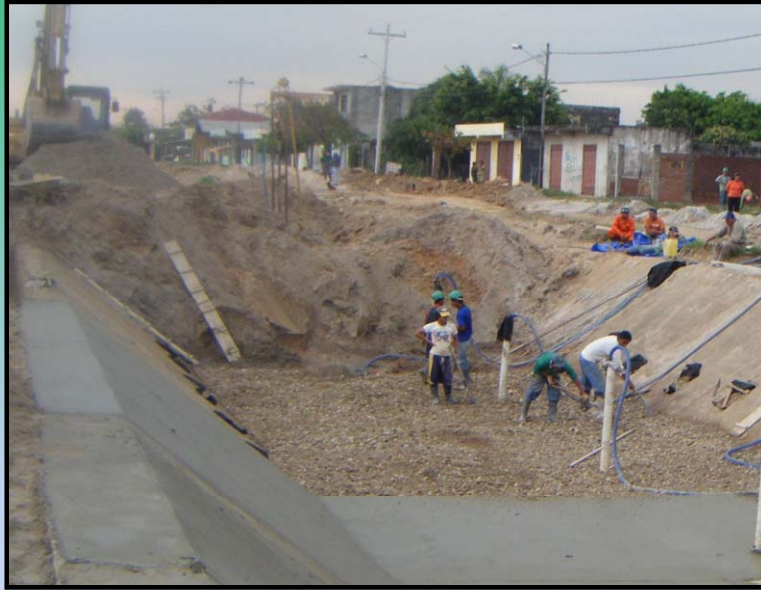
- Easy maintenance
- Hydraulically efficient

Earthen



- Minimal Excavation
- Construction methods

Canal Construction



Estimated Earthret Cost:
\$10,200,000 or \$710,500,000 US Dollars



Concrete Trapezoidal

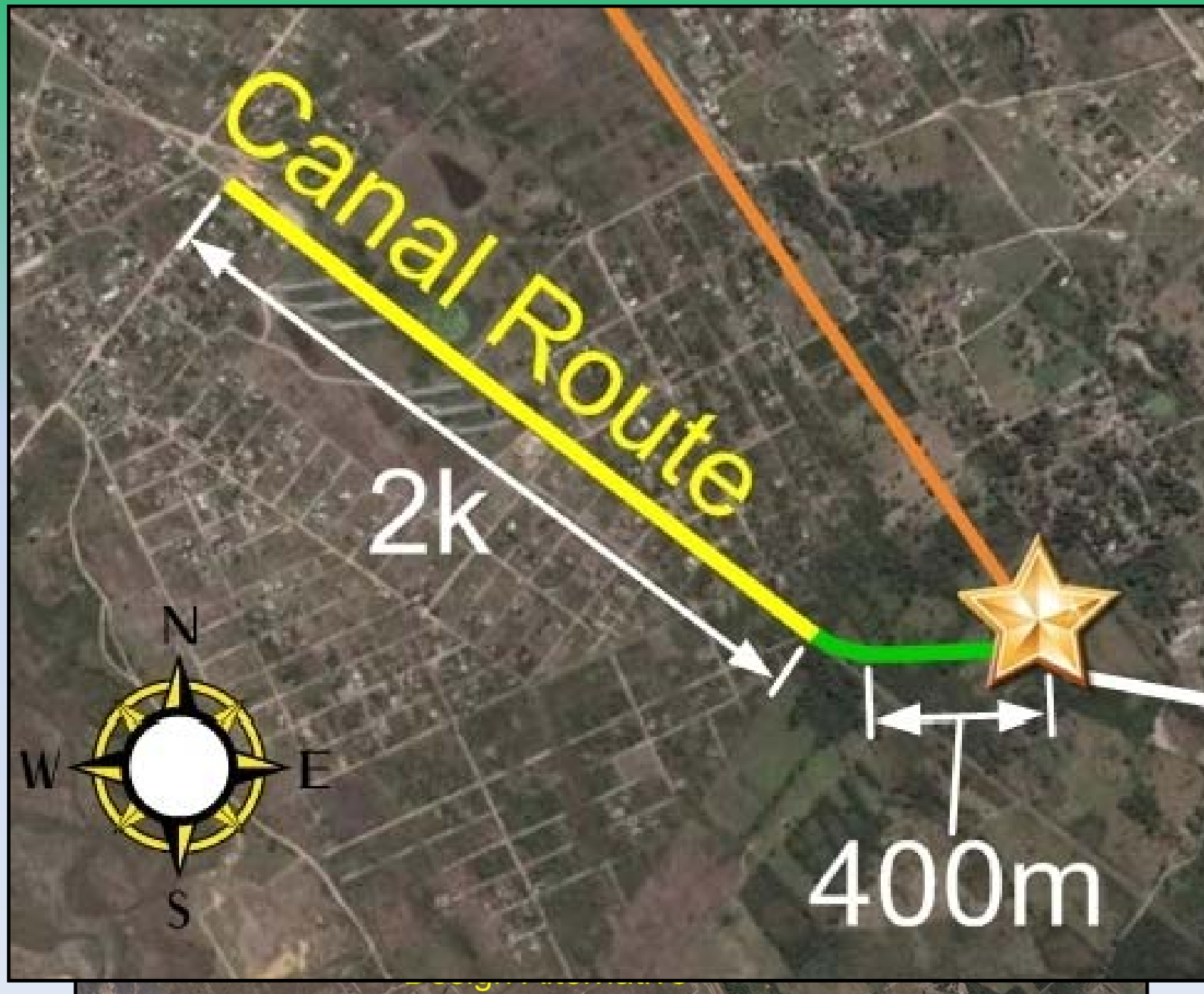
- 50 year design life
- Easy Maintenance
- Concrete Required



Design Alternative



Design Alternative



DJD Recommendation

- Further investigation for alternate route
- Open concrete lined trapezoidal canal



Cost vs. Benefit

- Transportation access
- Domestic life
- Improve Health





Questions?

