

PLAN 4000 CANAL



Project Scope

Don Jaguar Design (D.J.D.) was formed as part of the International Senior Design Program at Michigan Technological University in April of 2008. In August D.J.D. traveled to Santa Cruz, Bolivia for two weeks, where they were asked to design a 5.5km drainage canal for the Plan 4000 area of District 16 (formerly part of District 12). Sub-Mayor Ing. Victor Escobar Diaz of District 12 presented the project after he had received numerous requests from area residents to relieve the flooding that occurs in their neighborhoods.

John Butler – Surveyor/Design Technician
 Kristen Hedrich – CAD Technician
 John Lyrenmann – Project Manager

Santa Cruz, Bolivia

Bolivia is located in the central portion of South America. The country has 9 departments. D.J.D. traveled to the department of Santa Cruz, which contains the city of Santa Cruz. Santa Cruz is the largest city by population in the country.



Methods and Procedures

While in Santa Cruz, Bolivia in August, 2008 D.J.D. met with city officials and other parties of interest to discuss the project, performed a survey of the proposed route, collected and analyzed soil samples, and acquired other pertinent data and drawings.

•Worked with city workers as they established 27 new benchmarks along the site.



•Completed a topographical survey of the site with the help of other ISD members, mentors, and Bolivian surveyors.



•Collected soil borings at three locations along the route.

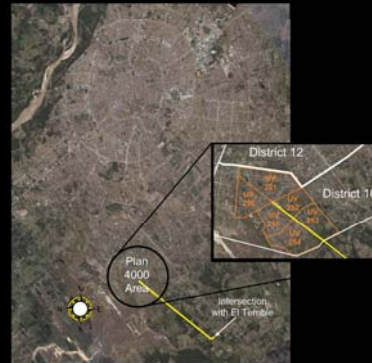


•Met with city and district officials to discuss the project.



Existing Conditions

The Plan 4000 area is in District 16, the newest district in the city. Plan 4000 canal route would border 6 UVs.



•School at the beginning of canal route.



•A portion of the canal is located outside of the city limits.



•Profile view of the canal route. A 20m change in elevation occurs over the 5.5 km.



•The canal will drain into an existing stream known as "El Terrible".



Design Options

•Underground Pipe



Commercially available pipe diameters differ from what is available in the US.

Bolivian standards require drainage systems with Pipe diameters > 1.2 m be redesigned for a canal.

•Covered Rectangular Concrete Canal

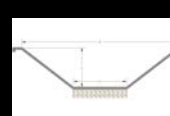


Cover would need to be removed for cleaning.

Design would require inlet design.

Rectangular shape requires more excavation.

•Open Trapezoidal Canal



Canal can be earthen or concrete lined.

Open canal allows for easy cleaning.

Bolivian maintenance equipment is for open canals.

Trapezoidal design is most hydraulically efficient.



Depth of excavation is minimized.

Construction techniques are well practiced.

•Construction of an open concrete lined trapezoidal canal in Santa Cruz.



Estimated Design Costs

- Earthen Trapezoidal Canal = \$700,000 US Dollars
- Concrete Trapezoidal Canal = \$1,450,000 US Dollars

Alternative Route

D.J.D. noticed that the Plan 4000 canal was in close proximity to a canal being designed by another ISD team, Canal Magisterio. An alternative design of connecting the two canals was noted, however, more data was required to complete a design and it was recommended that this option be further explored.



Recommended Design and Conclusion

D.J.D. recommends an open trapezoidal concrete canal to alleviate the flooding problems in the Plan 4000 area.

- Earthen canal would be susceptible to erosion and require annual re-excavation.
- Concrete lined canal will have an estimated 50 year design life.
- Maintenance cost savings will be observed for the concrete design.
- Allows for transportation through the Plan 4000 area.
- Improves resident living conditions by keeping floodwater in out of homes.
- Benefits the health conditions of thousands by removing standing water which fosters the breeding of mosquitoes that spread diseases.

