Carmelo Watts Canal Rehabilitation

International Senior Design
Santa Cruz, Bolivia

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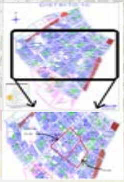
Background

In August 2006, a group of International Senior Design (ISD) students from Michigan Technological University traveled to Santa Cruz, Bolivia to volunteer engineering services for Santa Cruz's 10th District. The city of Santa Cruz is divided up into 16 districts with the 10th District situated in the southwest part of the city. UV 125 and UV 126 neighborhoods within District 10 experience flooding during the 4 month rainy season due to storm-water overflow from a "curichi", or swamp, and subsequent flooding from that swamp's lone earthen drainage canal, Carmelo Watts Canal. Carmelo Watts Canal is an important link in the storm-water drainage system of Santa Cruz since it collects water from the curichi and the surrounding neighborhoods and deposits it into the 6th Ring canal, which then continues on to deposit the water the Pirai River and out of the city. Watts Engineering was appointed by District 10 officials to provide engineering solutions to these flooding problems.



Existing Conditions

•Impermeable surfaces such as steel roofs and roads create high storm-water runoff flow

•Cross sectional area of current canal is not large enough to adequately drain storm-water runoff and curichi overflow from a significant storm causing flooding conditions for homes and roads adjacent to canal

•Garbage and sediment deposition in canal impede flow

•Sediment in the canal is classified as poorly graded sand with silt, implying poor drainage properties

Fieldwork

•Topographic Surveying
• Soil sampling and analysis
•Visual site inspection

Surveying was performed to determine the topographic characteristics of the land over the course of the 6000 ft long Carmelo Watts Canal.

Soil samples were taken from the invert of the Carmelo Watts Canal and a "Soil Classifying Geotechnical Gauge" was used to visually classify the collected soils.

Design Parameters

•Close proximity of security walls and buildings, roads, walking paths, street lamp posts and soccer fields
•Location of these structures does not permit the alignment of Carmelo Watts Canal to be moved
•Elevation constraints present at additional canal feeding into Watts Canal and at 6th Ring Canal

Hydrologic Analysis

•Rational Method used to model flow
•Watershed area determined from published data
•Design storm consisted of a 10 year, 4 hour storm event
•Resulting peak runoff flow used for canal design

Designs Considered

1. Earthen canal
2. Concrete Canal

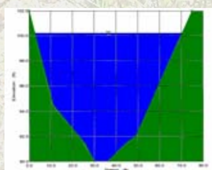
Earthen Canal

An earthen canal excavated to adequate capacity was first considered

Advantages
•Relatively low initial cost of construction

Disadvantages
•Greater life cycle costs than lined canals due to high maintenance costs of regularly clearing sediment and debris.

Typical required cross section of an earthen canal



Watts Engineering dismissed this design alternative because the required land area is not available to construct an earthen canal large enough to accommodate peak storm-water flows.

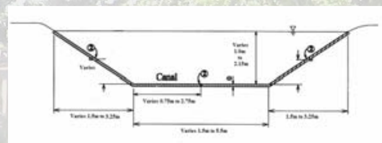
Concrete Canal

W.E. Observed concrete lined canals throughout the city of Santa Cruz, therefore a concrete lined canal was considered as a second design option. The design was completed based on an assumption that the design presented in a 2005 ISD report by EMT Engineering for a 6th Ring Canal renovation will be completed.

Advantages
- Can be designed large enough to accommodate peak storm-water flows, therefore preventing flooding
- Will allow for more efficient maintenance practices compared to an earthen canal
- Will provide a sustainable link in the storm-water drainage system in District 10 for future projects

Disadvantages
- Relatively high construction cost
- Design is dependant on the completion of 6th Ring design (or equivalent)

Typical required cross section of a concrete canal



Watts Engineering chose to recommend a design for a concrete canal.

Maintenance Plan

Watts Engineering recommends these steps be implemented in order to maintain proper function of the newly constructed canal.

•Clear gabions, steel grates or grilles, and sediment control devices of collected sediment at least once per year
•Clear the interior of the canal of deposited sediment including weep holes at least one time per year
•Clear curb-side inlets three times per year
•Inspect the canal slab and overall structure at least once every 5 years and complete necessary structural maintenance
•Grade roadways adjacent to canal at least two times per year
•Take measures to strongly discourage littering into canal

Conclusion

Watts Engineering recommends that the client construct design option #2 calling for a concrete lined canal over the entire length of Carmelo Watts Canal. The concrete lined canal design will most effectively address the concerns given by the client during the on-site field investigation in August 2006. Watts Engineering also feels that this design option is in the best interest of the client in terms of safety and sustainability.
The approximate cost to construct a concrete canal is $864,000. The scheduled duration of construction is 416 total working days and occurring over three seasons (April 1st through October 30th). The city must implement an effective maintenance plan in order to prevent sedimentation and littering within the canal detrimental to its function.
Construction of the designed concrete lined canal will benefit local residents and government because the direct and indirect impacts of current flooding will significantly decrease or disappear. This will improve conditions in the area for residents and reduce the possibility of disease from stagnant flood waters.