Santa Anna Drainage

Santa Cruz, Bolivia
International Senior Design
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KEC Engineering

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Background

Michigan Technological University (MTU) offers a course titled International Senior Design. For the past six years this course has allowed groups of students to travel to Santa Cruz, Bolivia in South America. The class provides a chance for graduating students to utilize their engineering skills, by solving civil/environmental type problems in the developing world. Students within the class form teams to undertake specific engineering projects.

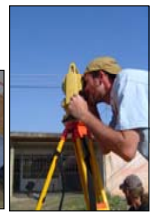
Objective

To study storm water drainage problems in a Santa Cruz neighborhood.

Santa Anna Flooding

Methods and Procedures

- Topographic Survey
- Soil Samples
- Water Samples
- Client/Neighborhood meetings



Results

- Minimal elevation relief provides no natural floodwater drainage
- Underlying impervious clay layer inhibits water infiltration
- Floodwaters contain E. Coli Bacteria
- Neighborhood services are restricted during flooding
- Property is damaged resulting from flooding

Possible Drainage Routes

Four routes - # 2 & #4 Closest to flooding

Infrastructure Options

Earth Canal

Advantages
- Very constructible
- Low in cost
- Familiar to local residents
- Minimal environmental impact

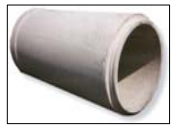
Disadvantages
- Short life expectancy
- Substantial maintenance to remove sediments
- Often require repairs due to erosion
- Greater frictional coefficients reducing flow

Concrete Canal

Advantages
- Increased life expectancy
- Reduced maintenance costs
- Increased flow rate
- Familiar to local residents

Disadvantages
- Higher initial costs
- Susceptible to sedimentation
- Required maintenance to remove sediments

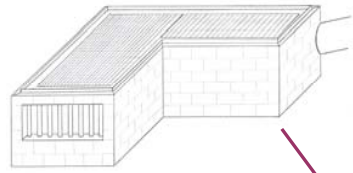
Subsurface Concrete Pipe



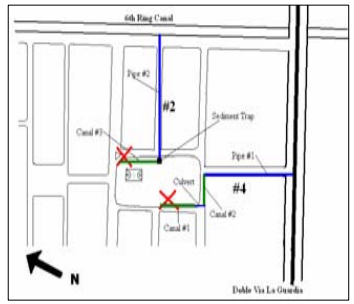
Advantages
- Less intrusive to community
- Greater life expectancy
- Available in pre-cast
- Self cleaning when flow is at scour velocity

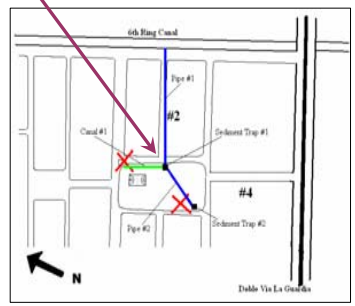
Disadvantages
- Higher initial costs
- Unfamiliar construction
- Difficult to repair

Sediment Trap



Sedimentation poses a serious problem to the majority of drainage systems. As a solution, sediment traps can be used in conjunction with subsurface pipes to help alleviate this problem. Sediment traps allow time for sand particles to settle out before entering the outflow pipe. There is some maintenance required to maintain proper working conditions. This design has been equipped with a built in ladder and a hinged lid to allow a person to enter into the trap and shovel out the settled sediment.





Design One

- Uses both drainage routes #2 and #4.
- Uses a system of two subsurface pipes, three earth canals, and one sediment trap.
- Diverts the water from northeast side of basketball court to a sediment trap via an earth canal.
- Water enters the sediment trap allowing sediment particles to settle, that floodwater then enters subsurface pipe #2 where it is conveyed to the 6th Ring canal.
- Removes the floodwater from southwest corner of the basketball court via two earth canals and a culvert. Here it enters an invert to subsurface pipe #1, where it is conveyed to the Doble Via Canal.

Cost= $48,000
Construction Time= 40 days

Design Two

- Drains floodwater down route #2.
- Uses a system of two subsurface pipes, two sediment traps, and one earth canal.
- Floodwater would flow into sediment trap #2 on west side of soccer field. Here, sand particles would settle out before entering subsurface pipe #2.
- This pipe would convey the water to sediment trap #1, where it would join the floodwaters from earth canal #1. Here, more sand particles would be removed before entering pipe #1.
- Pipe #1 conveys storm water to the 6th Ring canal.

Cost= $29,000
Construction Time= 22 days

FINAL RECOMMENDATION

The *advantages* that design #2 has over design #1 are:

- Less initial cost
- Less time to complete construction
- Superior sediment removal
- Fewer earth canals
- Less maintenance
- Lower social impact

For these reasons, KEC recommends design #2 be implemented to remediate the flooding problems in Santa Anna neighborhood. This design will be effective at removing the majority of floodwater. This design is sufficient to handle flooding from a storm event of 50 years. It will still be able to remove the floodwaters resulting from storm events of greater magnitude and less occurrence, but not at a rapid rate. It can be done at a reasonable price and has a good life expectancy. The width of drainage route #2, 3rd Street, is quite small and the social impacts from placing a canal along it become apparent.

CONCLUSION

KEC prepared engineering solutions for a storm water drainage problem in the 10th District of Santa Cruz. KEC studied this problem by conducting a topographic survey, taking soil and water samples, and meeting with local officials and residents. KEC evaluated many options to alleviate the storm water flooding problem that plagues Santa Anna neighborhood each rainy season. Several different types of infrastructure and different drainage routes were studied. In the end, KEC found to remove the neighborhoods floodwater, a combination of drainage routes and infrastructure styles would work better than one drainage route and infrastructure type. KEC recommends the design option that utilizes one drainage route with a system of two subsurface pipes, two sediment traps, and one earth canal. This design will effectively remove the neighborhoods floodwater to the 6th Ring canal. However, the design does require monthly maintenance, and will not function if not properly maintained.