PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2014

Trail Conservation at Celery Bog Nature Area

Agricultural & Biological ENGINEERING

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Problem Statement

The trails around the Lilly Nature Center in the Celery Bog Nature Area provide a scenic environment for local students, athletes, and the general public to exercise and learn about local wildlife and the history of the surrounding area. In addition to accommodating runners and walkers of all ages, these trails also provide critical access for maintenance and emergency vehicles.

Figure 1: Severe trail erosion at vehicular access point.

During short duration, high intensity rainfall events, the trails experience high amounts of erosion, as illustrated in Figure 1.

The goal of this project is to evaluate the current drainage of the site and develop a range of improvements to present to the West Lafayette Parks and Recreation Board.

Figure 2: Desirable trail appearance.

Criteria and Constraints

- Trail quality and appearance should be improved
- Need for continued maintenance should decrease
- The aesthetics of the area should be maintained
- Trail modifications should not limit vehicular access
- Existing trees should be minimally disturbed

Design Process

In order to define the scope of the project, the team met Dan Dunten, the project's sponsor, at the Lilly Nature Center. His insight, along with the team's observations of water flow during and after significant runoff events, made possible the identification of several key points of focus. The focus areas and their proposed solutions are detailed in Figure 3 and in the Final Recommendations section of this poster.

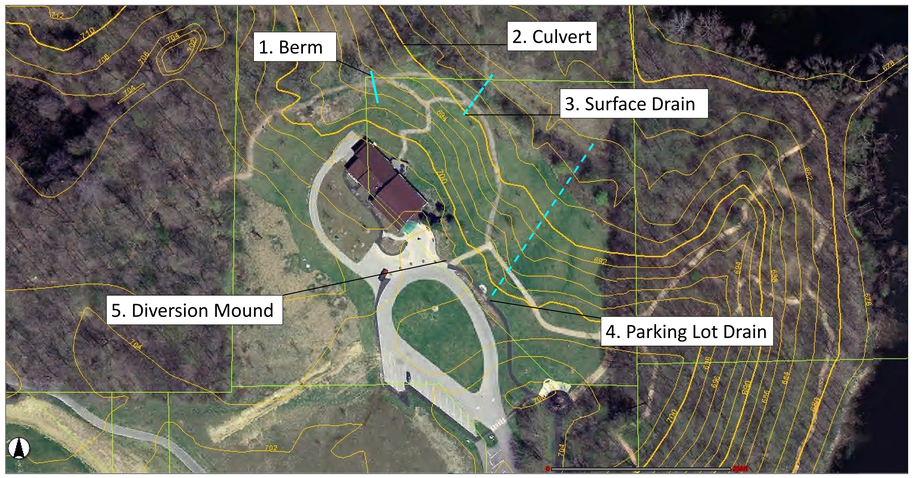

Figure 3: Locations of suggested drainage improvements.

Once the problem areas had been identified and potential solutions had been selected, the team used a total station to explore the topography of the area and collected rainfall and soils data from national databases. A summary of the methods and data used is presented in Table 1.

Table 1: Calculation methods and resources utilized.

Quantity Calculated	Method Used	Required Inputs	References
Peak Flow	Rational Method	Drainage area, rainfall intensity, soils, land use	IndianaMap, NCDC, USGS Soil Survey
Drainage System Capacity	Tile Drainage Nomograph	Slope, peak flow	Indiana Drainage Guide, Tippecanoe Co. GIS
Required Berm Height	Manning's Equation	Peak flow, slope, berm geometry	Agricultural Engineers' Handbook
Culvert Capacity	Pipe Flow and Weir Flow Equations	Peak flow, pipe roughness, hydraulic head, culvert diameter	Soil and Water Conservation Engineering, 5th Ed.

Final Recommendations

Recommendations are based on runoff from a 10-year return period storm.

1. Earthen Berm
   - 8" tall, 50' long, 4:1 side slopes
2. Culvert
   - 15" diameter, 20' long, corrugated steel
3. Surface Drain
   - Beehive drain, 50' of 6" plastic tile
4. Parking Lot Drain
   - Flat drain, 200' of 10" plastic tile
5. Diversion Mound
   - 1:12 slope to direct water to parking lot drain

Cost Analysis

Table 2: Prices of current practices and design improvements.

Component	Estimated Cost
Earthen Berm	**$500**
Culvert	**$300**
Surface Drain	**$150**
Parking Lot Drain	**$900**
Total	**$1850**
Current Annual Maintenance Cost	**$100**

Alternative Solutions

- Extend the existing 4" tile from the parking lot to the bridge underground to the woods.
- Convert the lawn area in front of the Nature Center to prairie vegetation similar to what exists along either side of the driveway. This would potentially increase infiltration, reduce runoff rates, and lessen the inputs necessary to maintain the area.
- Use permeable pavement on the trail segments that wash out most frequently and that are necessary for emergency vehicle access.

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Technical Advisor: Dr. Vincent Bralts, Professor, Agricultural and Biological Engineering
Course Instructors: Dr. Bernie Engel, Department Head, Agricultural and Biological Engineering
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