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Monitoring Surface Displacement of the Colby Green Retaining Pond Dams

John Goss
Colby College

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John Goss, Department of Geology, Colby College, Waterville, Me, 04901; jmgoss@colby.edu

Abstract

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Goss, John M., Department of Geology, Colby College
6456 Mayflower Hill, Waterville, ME, 04901;
jmgoss@colby.edu

The Colby Green is a campus expansion project which began in October of 2003. The construction would result in three new buildings, additional parking, and an elliptical 75,000-square-foot green southeast of Mayflower Hill Drive. There were also plans for the construction of three run-off management and sediment ponds below the green, to manage flooding of the green. Three drains in the green transport water to the three retaining ponds which slowly disperse water into the surrounding environment,

The ponds were created by constructing earthen dams around the drain outlets. The dams are composed of soil, cobbles, and boulders procured from the surrounding excavation site. Unfortunately, earthen dams are susceptible to many types of erosion which result in their failure. In this case the potential for clay and silt from the underlying Presumpscot Formation to mix with the soil in the earthen dams raised concerns with regards to frost action.

In order to monitor the surface displacement of the dams I drove 92 poles into the ground in 8 straight lines across the faces of the dams in the fall of 2005. I returned to the sites during and after the spring thaw of 2006, to check for any signs of movement resulting from frost-heave, surface creep, or any other form of mass wasting. Fortunately, there was no recordable sign of movement in the stakes across any of the retaining ponds. The dams appear to be functioning as designed.

Figure 1: Setting stakes along eastern side of 1st pond.

I hammered 5'0" long hollow-metal stakes 2'0" into the ground along the multiple faces of the earthen dams around each pond. Because the dams were composed of cobblestones and small boulders, as well as soil, distances between certain stakes were occasionally varied in order to maintain a straight line.

Figure 2: Line of sight image of stake line across eastern side dam of 3rd pond, after spring thaw.

The stake line along the eastern dam of 3rd pond. This image was taken after spring thaw and is an example of how there was little to no surface displacement that took place over the winter. It is important to note that there are 13 stakes on this line; many are hidden behind others.

Background Information

- **Soil Types**
  - **Paxton Charlton fine sandy loam (PdB)**
    - **3-8° slope, well drained, and contains coarse material and gravel.**
  - **Hollis fine sandy loam (HrB)**
    - **3-8° slope, exceptionally well drained, and contains coarse material and gravel.**
- **Dam Composition**
  - **1st Pond = PdB soil mixed with cobbles and boulders. Maximum slope is 25° ; site was well vegetated with grass and small shrubs.**
  - **2nd Pond = PdB and HrB soil mixed with cobbles and boulders. Maximum slope is 10°; site was well vegetated with grass and small shrubs.**
  - **3rd Pond = HrB soil mixed with cobbles and boulders. Maximum slope is 30°; site was well vegetated with grass and small shrubs.**
- **Influx of water was from three drains in the Colby Green**
- **Potential Causes of Surface Displacement to the Earthen Dams**
  - **Flow Erosion = inadequately sized spillways can result in overtopping of the dam, which can speed up erosion.**
  - **Embankment Leakage/Seepage = Water leaks through the embankment due to high pressure and high drainage of the soil and lack of gravel to fill in gaps.**
  - **Outlet Conduit Leakage = paths develop in the earthen dam walls through which water flows at high pressure. This greatly increases erosion.**
  - **Frost Action = expansion and contraction of the earthen dam due to water-saturated soil freezing and expanding, followed by contraction as the dam thaws. This is most common in earthen dams composed of soils containing clay and silt, and can result in mass-wasting which destroys the dam walls.**

Results

There was no discernable stake movement at either the 1st, 2nd, or 3rd pond (see Figure 6, at right, for pond locations). Therefore, there was no frost heave that affected the dams during the spring thaw. Also, there were no signs of embankment leakage/seeping or outlet conduit leakage.

There was, however, flow erosion of the splash pond of 2nd pond and the overflow pond of 3rd pond, as seen in figures 4 and 5. Fortunately this is an intentional result of the dams' design, because it releases the water into the surrounding environment with a low flow and volume.

Figure 3: Image of the flooded Colby Green before drainage was installed, on August 13, 2004.

Figure 4: (above) Flow erosion of 2nd Pond splash pond

Figure 5: (right) Flow erosion of 3rd pond overflow pond

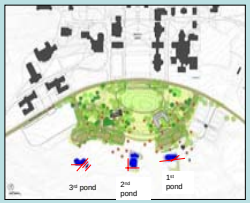

Figure 6: Study transects (red lines) on each of the three pond complexes in the Colby Green drainage system.

Figure 7: Kennebec River discharge data south of the Waterville/Sidney town line, showing results of high-precipitation fall season.

Conclusions

The dams performed their functions very well without displaying any signs of unwanted surface displacement. The conditions under which the dams were tested were exceptionally stressful as well because of the high precipitation and resulting stream flows (see Figure 7 for high stream flow data of the surrounding area). Due to the exceptional stability of the 1st 2nd and 3rd dam walls under high stress conditions, we can reasonably expect the Colby Green retaining ponds to safely manage the run-off of the Colby Green for years to come.

1st Pond

Figure 8: Image of the 1st pond and myself from the southwestern slope. Stake lines were set along the eastern and northern face of the pond dams.

2nd Pond

Figure 9: Image of the 2nd pond from the western slope. Stake lines were set along the eastern and southern faces of the pond dams

3rd Pond

Figure 10: Image of the 3rd pond from the southern slope of the dam looking over the flood wall. Stake lines were set along the eastern and nothern faces of the pond dams

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