

LONG-TERM BED DEGRADATION IN MARYLAND STREAMS (PHASE III, PART 2): URBAN STREAMS IN THE PIEDMONT PLATEAU PROVINCE

Problem

Estimation of potential long-term down-cutting of the stream bed is necessary for evaluation and design of bridges for scour and culverts for fish passage. Existing guidelines for assessing this potential long-term bed degradation (LTBD) in Maryland streams require expertise that may not be available and/or field studies that, depending on the project budgets, may be cost prohibitive, especially for replacement of county structures. The morphological techniques recommended by these guidelines also lack verification data and may lead to overly conservative estimates, unnecessarily large foundation depths, and consequently, significantly higher costs.

Objectives

The purpose of this study was to improve predictions of LTBD in Maryland streams through the measurement and analysis of stream bed and waterway structure survey data and bridge plans. A primary objective was the development of equations for estimating potential LTBD in urban streams in the Piedmont Plateau Province.

Description

Phases I and II examined LTBD of streams in non-urbanized watersheds of the Allegany Plateau, Blue Ridge, and the Western Piedmont physiographic provinces. Phase III Part 1 was limited to urban watersheds (those with impervious ground cover greater than 10%) of the Piedmont Plateau province in Montgomery, Baltimore, and Howard counties and Baltimore City. Preliminary analysis of the data collected in Phase III Part 1 indicated significant data gaps. Phase III Part 2 was completed in an effort to fill those gaps, including the following activities:

1. Continue development of a database of field measurements of LTBD in Maryland streams.
2. Collect data to fill gaps in the Phase III Part 1 study in urban streams.
3. Using the data collected in Phase III Parts 1 and 2, define the range of degradation depths to be expected in urban streams of the Piedmont Plateau province in Montgomery, Baltimore, Harford, and Howard counties and Baltimore City.
4. Evaluate the possibility of developing a relation between watershed percent impervious area and LTBD.
5. Develop quantitative relations between the risk factors identified in Phases 1 and 2 and measured LTBD.
6. Evaluate the possibility of developing a regional relation for LTBD by physiographic province.

Results

Equations for estimating this potential long-term bed degradation (LTBD) were developed from field data collected in urban Maryland streams in the Piedmont Plateau region. The conservative upper limit curve that describes LTBD as a function of valley slope (S_v) was:

$$\text{LTBD (ft)} = 3 \text{ ft for } S_v < 0.0043 \text{ ft/ft}$$

$$\text{LTBD (ft)} = 48 S_v^{0.51} \text{ for } 0.0043 \text{ ft/ft} \leq S_v < 0.03 \text{ ft/ft}$$

These equations can be used as a general guide for the prediction of long-term bed degradation in streams that have all of the following characteristics:

1. Valley slope of less than 0.03 ft/ft.
2. Drainage area from 0.2–60 mi².
3. A majority of the watershed drainage area in the Piedmont Plateau physiographic province of Frederick, Carroll, Montgomery, Baltimore, and Howard counties, Baltimore City, and Washington, DC.
4. Impervious area of less than 58% of the contributing watershed's surface area.

Until further study has been completed, the research team recommends that use of these equations be limited to sites not located in deep deposits of sediment created by backwater from dams or other structures or in streams with evidence of active channel degradation. For stream channel networks already experiencing significant degradation or at structures located in thick dam deposits, the value of LTBD may be substantially greater than those given in this study.

Report Information

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Link to Final Report: http://www.roads.maryland.gov/OPR_Research/MD-17-SP409B4H_LTBD_PhaseIII-Part2_Report.pdf

Links to Reports of the Previous Three Phases:

http://www.roads.maryland.gov/OPR_Research/MD-14-SP309B4S_Long-Term-Bed-Degradation_Phase-III-1_Report.pdf

http://www.roads.maryland.gov/OPR_Research/MD-12-SP109B4K_Long-Term-Bed-Degradation_Phase%20II_Report.pdf

http://www.roads.maryland.gov/OPR_Research/MD-11-SP909B4G_Long-Term-Bed-Degradation_Phase-I_Report.pdf