About the Institute for Transportation
The mission of the Institute for Transportation (InTrans) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

Iowa State University Nondiscrimination Statement
Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a US veteran. Inquiries regarding nondiscrimination policies may be directed to the Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, telephone: 515-294-7612, hotline: 515-294-1222, email: eooffice@iastate.edu.

Disclaimer Notice
The contents of this document reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the sponsors. The sponsors assume no liability for the contents or use of the information contained in this document. This document does not constitute a standard, specification, or regulation. The sponsors do not endorse products or manufacturers. Trademarks or manufacturers’ names appear in this document only because they are considered essential to the objective of the document.

Iowa DOT Statements
Federal and state laws prohibit employment and/or public accommodation discrimination on the basis of age, color, creed, disability, gender identity, national origin, pregnancy, race, religion, sex, sexual orientation or veteran’s status. If you believe you have been discriminated against, please contact the Iowa Civil Rights Commission at 800-457-4416 or the Iowa Department of Transportation affirmative action officer. If you need accommodations because of a disability to access the Iowa Department of Transportation’s services, contact the agency’s affirmative action officer at 800-262-0003.

The preparation of this document was financed in part through funds provided by the Iowa Department of Transportation through its “Second Revised Agreement for the Management of Research Conducted by Iowa State University for the Iowa Department of Transportation” and its amendments.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Iowa Department of Transportation.
**Abstract**

This user manual accompanies the Microsoft Excel-based Granular Roads Asset Management System (GRAMS) tool prepared for the Iowa County Engineers Association (ICEA). The tool and manual were developed under Iowa Highway Research Board Project TR-729, Development of Granular Roads Asset Management System.

You are free to use, alter, and distribute this product with authorization from the sponsor.

The GRAMS tool is designed to assist local agencies in making more reliable gravel loss estimates and consequently determining annual aggregate (rock) requirements for proper budgeting purposes. To gather information to develop the tool, a series of online and in-person meetings and interviews were conducted along with electronic mailing surveys.

When the user enters several input values, GRAMS generates a range of estimates for varying budget conditions and different levels of service. The tool is expected to help local agencies obtain consistency in terms of estimating gravel loss and determining aggregate (rock) requirements. As a result, agencies can better justify their granular road maintenance budget requests and management practices.

**Key Words**

- beta regression
- deterioration modeling
- granular roads
- GRAMS
- maintenance
- survival analysis

**Security Classification (of this report)**

Unclassified.

**Security Classification (of this page)**

Unclassified.
ANNUAL ROCK REQUIREMENT ESTIMATE:
GRANULAR ROADS ASSET MANAGEMENT
SYSTEM (GRAMS) USER MANUAL

User Manual
December 2019

Principal Investigator
Bora Cetin, Assistant Professor
Civil and Environmental Engineering, Michigan State University

Co-Principal Investigators
H. David Jeong, Professor
Construction Science, Texas A&M University

Jeramy C. Ashlock, Richard L. Handy Professor
Civil, Construction, and Environmental Engineering, Iowa State University

Research Assistants
Shafkat Alam-Khan and Meng Wai Yaw

Authors
Bora Cetin, Jeramy C. Ashlock, H. David Jeong, Shafkat Alam-Khan, and Meng Wai Yaw

Sponsored by
Iowa Highway Research Board and
Iowa Department of Transportation
(IHRB Project TR-729)

Preparation of this document was financed in part
through funds provided by the Iowa Department of Transportation
through its Research Management Agreement with the
Institute for Transportation
(InTrans Project 17-615)

A document from
Institute for Transportation
Iowa State University
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
Phone: 515-294-8103 / Fax: 515-294-0467
www.intrans.iastate.edu
# TABLE OF CONTENTS

ACKNOWLEDGMENTS .................................................................................................................. vii

1. INTRODUCTION .................................................................................................................... 1

2. INITIAL SETUP ....................................................................................................................... 1
   2.1 Security Warning .............................................................................................................. 1
   2.2 Launching the GRAMS Tool .......................................................................................... 1

3. REQUIRED INPUT ................................................................................................................. 2
   3.1 Editing Guidelines ........................................................................................................... 2
   3.2 Input Parameters ............................................................................................................. 3

4. ROCK REQUIREMENT ESTIMATES ...................................................................................... 4

5. FINAL REPORT ....................................................................................................................... 6
LIST OF FIGURES

Figure 1. Security warning notification .........................................................1
Figure 2. Introduction sheet .................................................................2
Figure 3. Editing guidelines .................................................................3
Figure 4. Input screen sheet .................................................................4
Figure 5. Inventory condition ...............................................................5
Figure 6. Rock requirement estimates ....................................................5
Figure 7. Total cost and risk curves for 100% network maintenance ............6
Figure 8. Material cost and risk curves for 100% network maintenance ......7
Figure 9. Summary of cost and risk for 100% network maintenance .........7
Figure 10. User-defined maintenance range ...............................................8
Figure 11. Total cost and risk curves for user-defined network maintenance level .... 8
Figure 12. Material cost and risk curves for user-defined network maintenance level .... 9
Figure 13. Roadway network life cycle ...................................................9
ACKNOWLEDGMENTS

The authors gratefully acknowledge sponsorship for this project from the Iowa Department of Transportation (DOT) and the Iowa Highway Research Board (IHRB).

The project technical advisory committee (TAC) members, Danny Waid (Iowa County Engineers Association, ICEA), Brian Moore (ICEA), Vanessa Goetz (Iowa DOT), Eric Cowles (Iowa DOT), Zachary A. Gunsolley (Union County), Adam W. Clemons, (Wright County), Brad Skinner (Montgomery County), Jacob Thorius (Washington County), Catherine Nicholas (Black Hawk County), David Paulson (Carroll County), John Riherd (Butler County), Mark Nahra (Woodbury County) and Todd Kinney (Clinton County) are gratefully acknowledged for their guidance, support, and direction throughout the research.

The authors would also like to sincerely thank graduate research assistant Sajjad Satvati for his timely assistance with the field visits.

You are free to use, alter, and distribute this product with authorization from the sponsor.
1. INTRODUCTION

The Iowa County Engineers Association (ICEA) Granular Roads Asset Management System (GRAMS) is a useful tool to estimate the annual rock requirements for efficient granular roadway network maintenance. It provides a quick estimation of annual rock and budget requirements using key parameters such as agency location, existing roadway inventory condition, rock quality, annual traffic, and engineering estimates. The GRAMS tool also approximates the risk level of the roadway system for various budget situations.

This manual provides step-by-step guidance for generating annual rock requirements using the GRAMS tool.

2. INITIAL SETUP

2.1 Security Warning

GRAMS is a Microsoft Excel-based tool that requires Excel macros to be enabled. Depending on the version of the operating system on which the tool is being used, various security warning messages may appear when the tool is first opened, as shown in Figure 1.

![Security Warning Notification](image)

**Figure 1. Security warning notification**

Click either the Enable Content, Enable Macros, or Enable Editing button. Note that the user may not see any security warning if the computer is set up to enable macros automatically.

2.2 Launching the GRAMS Tool

An introduction sheet appears when the tool is first opened, as shown in Figure 2.
Welcome to Iowa County Engineers Association (ICEA) Granular Roads Asset Management System (GRAMS)

This tool is developed to help Iowa local agencies to approximate annual rock requirement to effectively maintain the granular roadway network. Local agencies can choose roadway treatment policy based on unique budget scenario and required level of service to determine amount of rock needed in terms of ton per mile (TPM).

GRAMS tool consists of two major section. User needs to provide agency specific local information in the input screen regarding the granular roadway inventory condition and cost information. Based on input data, the tool will generate annual rock requirement report.

**Figure 2. Introduction sheet**

This sheet provides basic information on each sheet of the GRAMS tool. Click the **Launch Tool** button to see the specific parameters needed for estimation.

3. **REQUIRED INPUT**

3.1 **Editing Guidelines**

Light yellow colored cells indicate that user input is allowed, and light green colored cells indicate inputs calculated from historical data. The inputs based on historical data will automatically be generated after the user provides a county name.

**Please note:** All light green colored cells are accompanied by corresponding light yellow colored cells. The user has the option to gain administrative access when the user does not agree with the inputs calculated from the historical data. To override these inputs, the user is required to edit only the light yellow colored cells, as shown in Figure 3.
Figure 3. Editing guidelines

3.2 **Input Parameters**

The following input parameters are required to estimate rock requirements in the GRAMS tool:

- **County Information**
  - County Name
  - Granular Roadway Network Size
  - Average Width of Granular Roadway
  - Percentage of Roadway with Very Poor Drainage

- **Rock Quality Information**
  - Los Angeles (LA) Abrasion (%)
  - Fines Content (%)

- **Cost Information**
  - Material Cost
  - Crushing Cost
  - Hauling Cost
  - Transportation Cost
  - Placing, Grading, and Miscellaneous Cost

- **Level of Service Information**
  - Thickness for 50% Level of Service

After clicking the **Launch Tool** button, the user sees the **Input Screen** sheet shown in Figure 4.
Within this sheet, the user can provide county, rock quality, cost, and level of service information. After inputting this information, click the **Go to Analysis** button to access the **Rock Requirement Estimates** sheet. The user can click the **Reset Input** button to clear all of the values entered.

### 4. ROCK REQUIREMENT ESTIMATES

In the **Rock Requirement Estimates** sheet, the roadway inventory condition must be entered manually to estimate the rock requirements, as shown in Figure 5. The user can also provide an annual gravel loss estimation if needed.
Clicking the **Estimate Rock Requirements** button will generate the rock requirements, as shown in Figure 6.

Here, the Minimum Resurfacing Requirements cell approximates the length of the roadway network, for which a thickness of less than 2 inches is assumed. In the range of options, the annual budget in terms of the total cost and material cost is shown, along with the risk level.
After reviewing this information, click the **Proceed to Final Report** button. The user can click the **Reset Values** button to clear all of the values entered and click the **Go Back to Input Screen** button to change the input values.

5. **FINAL REPORT**

In the final report, Graphs A and B simulate what-if scenarios for the budget and the percentage of the system at risk when 100% of the granular roadway network is maintained annually, as shown in Figures 7 and 8 for the total and material costs, respectively.

![Figure A: System at Risk and Total Cost Curve for different TPM level - Rock Application 100% of Network](image)

**Figure 7. Total cost and risk curves for 100% network maintenance**
Figure 8. Material cost and risk curves for 100% network maintenance

A summary of Graphs A and B is also tabulated for convenience, as shown in Figure 9.

![Figure B: System at Risk and Material Cost Curve for different TPM level - Rock Application 100% of Network](image)

**Figure B: System at Risk and Material Cost Curve for different TPM level - Rock Application 100% of Network**

The user can define how much of the roadway network will be maintained in a given year in the light yellow colored cell shown in Figure 10.

![Figure 9: Summary of cost and risk for 100% network maintenance](image)

**Figure 9. Summary of cost and risk for 100% network maintenance**

The user can define how much of the roadway network will be maintained in a given year in the light yellow colored cell shown in Figure 10.
Graphs C and D provide the percentage of the system at risk, the budget, and the rock requirement estimations for the user-defined roadway maintenance level, as shown in Figures 11 and 12 for the total and material costs, respectively.

Figure 10. User-defined maintenance range

Figure 11. Total cost and risk curves for user-defined network maintenance level
Graph E, shown in Figure 13, simulates a time series curve to predict when the roadway system will collapse under the scenario in which no maintenance activity is performed.
THE INSTITUTE FOR TRANSPORTATION IS THE FOCAL POINT FOR TRANSPORTATION AT IOWA STATE UNIVERSITY.

**InTrans** centers and programs perform transportation research and provide technology transfer services for government agencies and private companies;

**InTrans** contributes to Iowa State University and the College of Engineering’s educational programs for transportation students and provides K–12 outreach; and

**InTrans** conducts local, regional, and national transportation services and continuing education programs.

Visit [InTrans.iastate.edu](https://InTrans.iastate.edu) for color pdfs of this and other research reports.