Sediment and Erosion Design Guide
Watershed Processes

Goals of this Session

• Overview of Design Guide
• Review watershed process issues
• Watershed sediment yield
Purpose of the Guide

• Provide guidance for analysis of sediment areas and arroyos in the SSCAFCA area to assess:
  – Lateral and vertical stability of arroyos
  – Potential effect of proposed structures
  – Establish the Lateral Erosion Envelope (LEE) Line
  – Scour countermeasures
The LEE Line

• Boundary along an arroyo or drainageway that would have a low possibility of being disturbed by erosion, scour, or lateral migration by storms up to and including the 100-year storm
History and Background

- 1994 AMAFCA Design Guide
- SSCAFCA Draft Design Guide
  - Joint effort involving MEI and DPM Technical Committee
  - Provides analysis procedures for typical arroyo stability problems in SSCAFCA area
  - **NOT** intended to be “cookbook” for those not well-founded in storm drainage issues
  - Provides SSCAFA staff and consultants with commonality of procedures
General Philosophy

• Channel stability and LEE Line analysis require understanding of:
  – Physical setting
  – Physical processes that control channel behavior
    • Hydrology
    • Hydraulic conditions
    • Sediment transport processes
Level 1: Qualitative Analyses

LEVEL 2 ANALYSIS

Yes

MORE DETAILED ANALYSIS NECESSARY?

No

ESTABLISH LEE LINE AND/OR DESIGN COUNTERMEASURES

STEP 1: CHANNEL CHARACTERISTICS
STEP 2: WATERSHED CONDITIONS
STEP 3: OVERALL STABILITY
STEP 4: LATERAL STABILITY
STEP 5: VERTICAL STABILITY
STEP 6: CHANNEL RESPONSE
Level 2: Basic Engineering Analyses

Level 3 Analysis

Step 1: Flow Regime and Flood Discharges
Step 2: Hydraulic Conditions
Step 3: Bed and Bank Material
Step 4: Watershed Sediment
Step 5: Armoring Potential
Step 6: Aggradation/Depgradation
Step 7: Bank Stability
Step 8: Local Scour

More Detailed Analysis Necessary?

Establish Lee Line and/or Design Countermeasures

Yes

No
Maintaining Natural Conditions in Urban Arroyos:

Is it Possible?

Mussetter and Harvey
ASCE 2004
General Philosophy

• Analysis sequence
  – Big-picture ➔ Local details
  – Qualitative understanding ➔ Detailed quantification
ALBUQUERQUE

4% Slope
Sand-bed arroyos
URBANIZATION AND HYDROLOGY

• Reduced infiltration and detention storage
• Increased runoff volumes (3-8 times depending on location)
• Increased flood peaks (up to 10 times)
• Increased magnitude of higher frequency floods and reduced lag times
• Size of mean annual flood increases (up to a factor of 4)
Urbanization Effects on Runoff

- 2-year Event, Pre-development Conditions
- 2-year Event, Development Conditions
- 10-year Event, Pre-development Conditions
- 10-year Event, Development Conditions
- 100-year Event, Pre-development Conditions
- 100-year Event, Development Conditions

Discharge (cfs) vs. Time (hours)

- 10-year 2036
- 10-year Existing
- 2-year 2036
- 2-year Existing

2-year Existing
URBANIZATION AND SEDIMENTATION

• During construction yields can increase by a factor of about 200, and can lead to channel aggradation.
• Following construction sediment yields tend to be much lower than under pre-development conditions and can lead to channel degradation.
2006 Storm
## Precipitation Frequency

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### Rainfall Intensity (RI)

**6 hr** | **12 hr** | **24 hr**
---|---|---
25 | 1.85 | 2.00 | 2.23
50 | 2.10 | 2.25 | 2.50
100 | 2.36 | 2.51 | 2.78
Modes of Sediment-load Transport

**WASH LOAD**
Composed of particles finer than those found in appreciable quantities in the bed. Washload moves in suspension and is provided by available bank and watershed supply.

**BED LOAD**
Composed of particle sizes typically found in the bed that move by surface creep, sliding, saltation or rolling within the bed layer.

**SUSPENDED BED MATERIAL LOAD**
Composed of particle typically found in the bed that remain in suspension during transport.

**NOTE:**
The term "suspended load" is used when referring to the sum of the "wash load" and "suspended bed material load" components. Therefore, an alternate definition of total sediment load is the sum of the suspended load and bed load.
Estimating Wash Load

• Watershed sediment yield

• Available techniques
  – Pacific Southwest Interagency Committee (PSICA)
  – Modified Universal Soil Loss Equation (MUSLE)
Estimating Wash Load

- Pacific Southwest Interagency Committee (PSICA)
  - Appendix A.1
  - Based on watershed ratings (Table A.1.1)
- Rating Factors
  - Surface Geology
  - Soils
  - Climate
  - Runoff
  - Topography
  - Ground Cover
  - Land Use
  - Upland Erosion
  - Channel Erosion and Sediment Transport

Table A.1. Summary of PSIAC classifications.

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<th>Classification</th>
<th>Rating</th>
<th>Sediment Yield (annual)</th>
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<td>(ac-ft/sq mi)</td>
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<td>&gt;100</td>
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Silt Haul from NDC System (yds³) vs Year

Unit Sediment Yield (tons/acre) vs Year

Thousands

MEI
Estimating Wash Load

• Modified Universal Soil Loss Equation (MUSLE)
  – Appendix A.2
  – \( Y_s = \alpha(Vq_p)^{\beta} K L S CP \)
  • \( \alpha = 285 \) for Rio Rancho/Albuquerque Area
  • \( \beta = 0.56 \)
GIS Technology

\[ LS = \left( \frac{FAC \times \text{Cell Size}}{22.13} \right)^{0.4} \left( \frac{\sin(\text{Slope})}{0.09} \right)^{1.3} \]

FAC= upslope contributing area per unit contour width

Mitaseva et al. (1996)
Slope Distribution