Section 1
Introduction to Low-Volume Roads Best Practices

Introduction

Why do we care about low-volume or rural roads?

- 60 to 70 % of roads in most countries worldwide are low-volume, unpaved roads;
- Half of the miles of roads in the United States are unpaved;
- Cumulatively low-volume roads are a major expense for states, counties, municipalities, and agencies. A simple unsurfaced road can cost $5,000 to $20,000 per kilometer. A gravel road can cost over $50,000 per kilometer. High standard collector highways often cost over $500,000 per kilometer.
- Rural roads often have significant negative cumulative environmental impacts;
- Poor drainage and barren ground along roads often lead to significant erosion and sedimentation problems;
- Safety is a big concern on rural roads. Many single car fatalities occur on local rural roads;
- There is no one central source of information on rural roads. The information is dispersed in a variety of locations;

What is a low-volume road?

Definitions vary, but most rural, local roads have a relatively low volume of traffic. AASHTO (2001) defines a **low volume road** as a road that has an Average Daily Traffic (ADT) of 400 or less vehicles per day. Most National Forest System roads and many other rural roads are considered **"very" low- volume roads** because they have very little traffic, perhaps less than 50 ADT. Most of these roads are unsurfaced, while the more heavily used roads will likely have an aggregate or seal coat surfacing.

Basic uses of low-volume roads

Low-volume roads are a basic need of society to provide for a flow of goods and services throughout rural areas. Important uses include the following:

- They allow for the development of rural areas, for livelihoods, and for improvement in quality of life;
- They provide a necessary link from rural areas to the cities;
- They help rural communities and areas with resource production and protection, such as agriculture, logging, mining, or grazing;
- With access provided by a rural road, a community can obtain electrical services, improve potable water and sanitation systems, attract teachers for local schools, gain access to markets for agricultural and other products; and
- They help receive technical support from local governmental agencies and lending institutions.

Common impacts of low-volume roads

We need roads in most areas, but they have a cost and impacts! Roads have both direct and indirect environmental impacts that can be either positive or negative. Social and economic benefits are typically positive. Some of the common negative impacts of roads include:

- Production of sediment and degradation of water quality.
- Wildlife mortality and habitat fragmentation;
- Barriers to fish and aquatic organisms;
- Ingress of invasive species and noxious weeds;
- Illegal logging and hunting due to improved road access; and
- Changes in land use and social conditions, especially along the road corridor.

Many of these negative impacts can be eliminated or minimized through environmental analysis, good planning and design, appropriate design standards, application of mitigation measures, and good road maintenance. Figure 1.1 shows the minimum impacts of a rural, low-standard road compared to a highway. **Appropriate design standards should balance road user needs, costs, safety, and environmental impacts.**

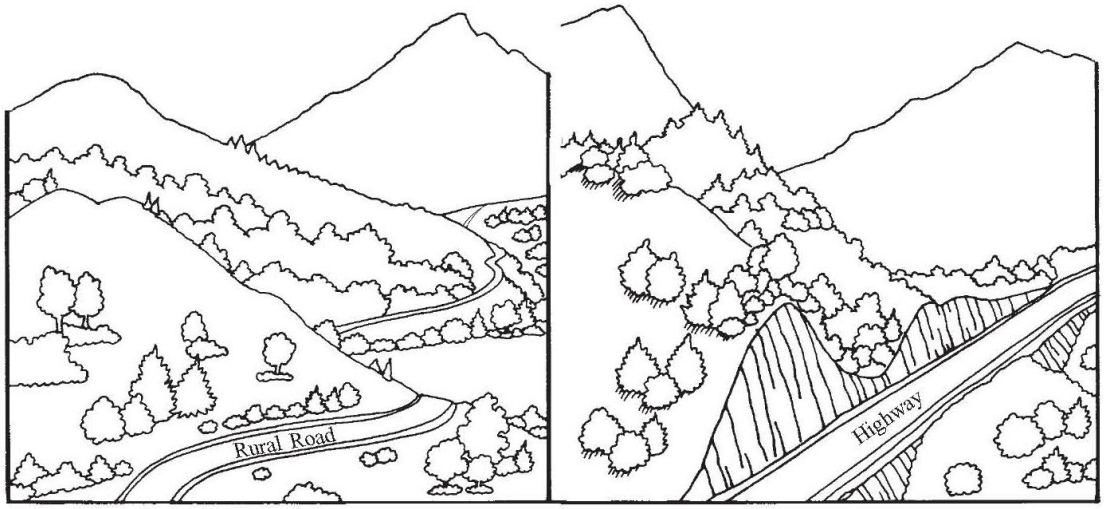

Figure 1.1 The impacts of varying design standards on construction and terrain modification.

Environmental Analysis, using an **interdisciplinary** team approach with resource specialists, should be used for road planning and design to identify impacts and appropriate mitigation measures.

Development in and around parks, reserves or forest areas may produce negative impacts, particularly to local residents or indigenous groups. In some sensitive areas roads should not be built, since the impacts and induced changes are often irreversible.

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How do we achieve a good low-volume road?

Good "Road Engineering" involves a blend of three basic components:

1. **Application of Sound, Basic Engineering and Design Concepts**, including Good Transportation Planning and Location, Drainage Analysis, Stable Slopes, Proper Selection of Roadway Materials, and Maintenance of all the Improvements;

2. **Environmental Awareness and Application of Practical Environmental Mitigation Measures**, such as Environmental Analysis, Consideration of Social Issues, Erosion and Sediment Control, Fish Passage and Wildlife Crossings, Invasive Species Control; and

3. **Use of Appropriate, Innovative Technologies** to facilitate work and make it more cost-effective, including GIS Mapping, use of Geosynthetics, Trenchless Technology, Mechanically Stabilized Earth Structures, and simple In-Situ Site Characterization tools.

Road engineering is a process. A stable, safe, cost-effective, and minimum impact road requires a combination of basic planning, road location, design, construction and quality control, and maintenance. Some of the best environmental mitigations for a road are good planning and good design:

- Environmental Analysis should be the beginning and an integral part of the planning process. Communication between all interested parties is critical!;
- Road location is needed to optimize the use of the road and avoid costly, problematic, and high impact areas;
- Road design involves most aspects of the road template and drainage, and is where many mitigation measures are incorporated;
- Good construction techniques are needed to implement the design. Construction requires some degree of quality control and often some sampling and testing. Remember, "**You get what you Inspect, Not what you Expect**"!; and
- Every road, no matter how well built, needs ongoing and long-term maintenance. Good planning, design and construction just reduce the amount of needed maintenance; and
- Seasonally close rutting roads and eliminate unwanted roads where possible.

Road design and incorporating environmental protection measures involves a number of key design issues, as outlined below:

- Natural drainage crossings must be carefully selected and properly sized, designed, a protected. Structures used include bridges, fords, or culverts;

- Adequate surface drainage is important to avoid fast, concentrated flows on the road, in road ditches, and at cross-drain outlets;

- Roads need stable cut and fill slopes, and apply slope stabilization measures such as drainage, vegetation, or retaining structures where appropriate;

- Roads should ideally be surfaced with quality materials for structural support, erosion control, and rider comfort. Marginal materials may be used with varying results. Development of materials sources can significantly reduce road costs, but sources should then be reclaimed;
- Finally, erosion control measures should be an integral part of every project. Gully stabilization should be undertaken where needed. Usually gullies only grow larger with time.

Each of the above mentioned items are important elements for a good road! Design details vary with specific geographic and climatic regions. Thus local experience and knowledge are very important in rural roads.

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Best Management Practices

Best Management Practices or "BMPs" are those principals and engineering design practices that can protect water quality and improve function of the road when properly applied. BMPs also represent good road design and construction practices that can reduce long-term road costs by preventing failures, eliminating repair needs, and reducing road maintenance.

The key objectives of Best Management Practices are:

- To produce a safe, cost-effective, environmentally friendly, and practical road design that is supported by and meets the needs of the users;
- To protect water quality and reduce sediment into water bodies (see Figure 1.2);
- To avoid conflicts with land use;
- To protect sensitive areas and reduce ecosystem impacts;
- To maintain natural channels, natural stream flows, and maintain passage for aquatic organisms;
- To minimize ground and drainage channel disturbance (see Figure 1.3);
- To minimize wildlife impacts, mortality and habitat fragmentation; and
- To stormproof or extend the useful life of roads.

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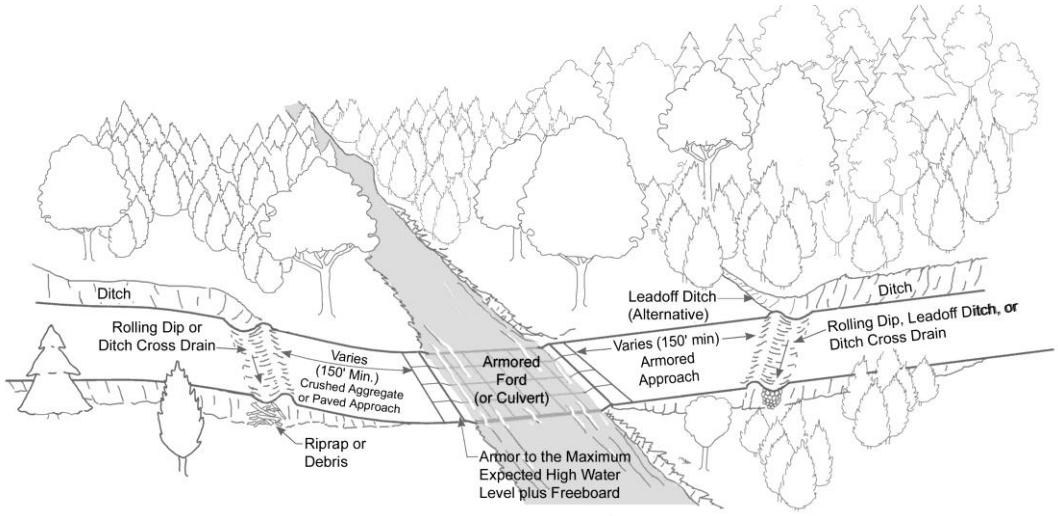

Figure 1.2 Sediment protection measures at stream crossings.

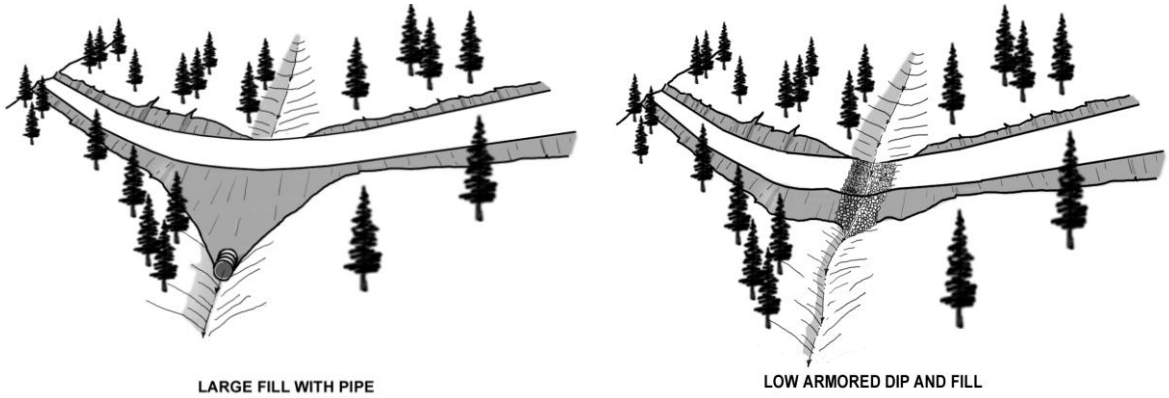

Figure 1.3 A large fill versus small fill and armored dip on a low-volume road, thus minimizing ground disturbance.

Key Best Practices to maximize the utility of and minimize the impacts of roads include the following:

- Involve the road users and population affected by the road;
- Minimize road width and area of disturbance, but provide for road safety;
- Avoid problematic areas such as wet areas, steep slopes, or unstable terrain;
- Design drainage crossing with adequate flow capacity and protection measures;
- Avoid alteration of natural drainage patterns;
- Control drainage and water flow on the road surface and in ditches;
- Minimize the "connectivity" between roads and streams, and prevent "diversion potential" of streams;
- Incorporate animal crossings and aquatic organism passage into projects;
- Prevent spread of noxious, exotic or invasive weeds;
- Use stable cut and fill slope angles to minimize slope failures;
- Install needed slope stabilization measures to reduce mass wasting and use structures and drainage as needed;
- Stabilize the roadbed driving surface and have a structurally sound roadway;

- Develop quarries and borrow pits for roadway materials, but rehabilitate them;
- Apply erosion control measures to protect exposed soil areas (see Figure 1.4) and use gully stabilization measures;
- Plan and budget for thorough, routine and periodic road maintenance;
- Control road use or close unneeded roads where possible;
- Use innovative, appropriate technologies where cost-effective; and
- Have knowledgeable, trained personnel to build, manage, and maintain your road system.

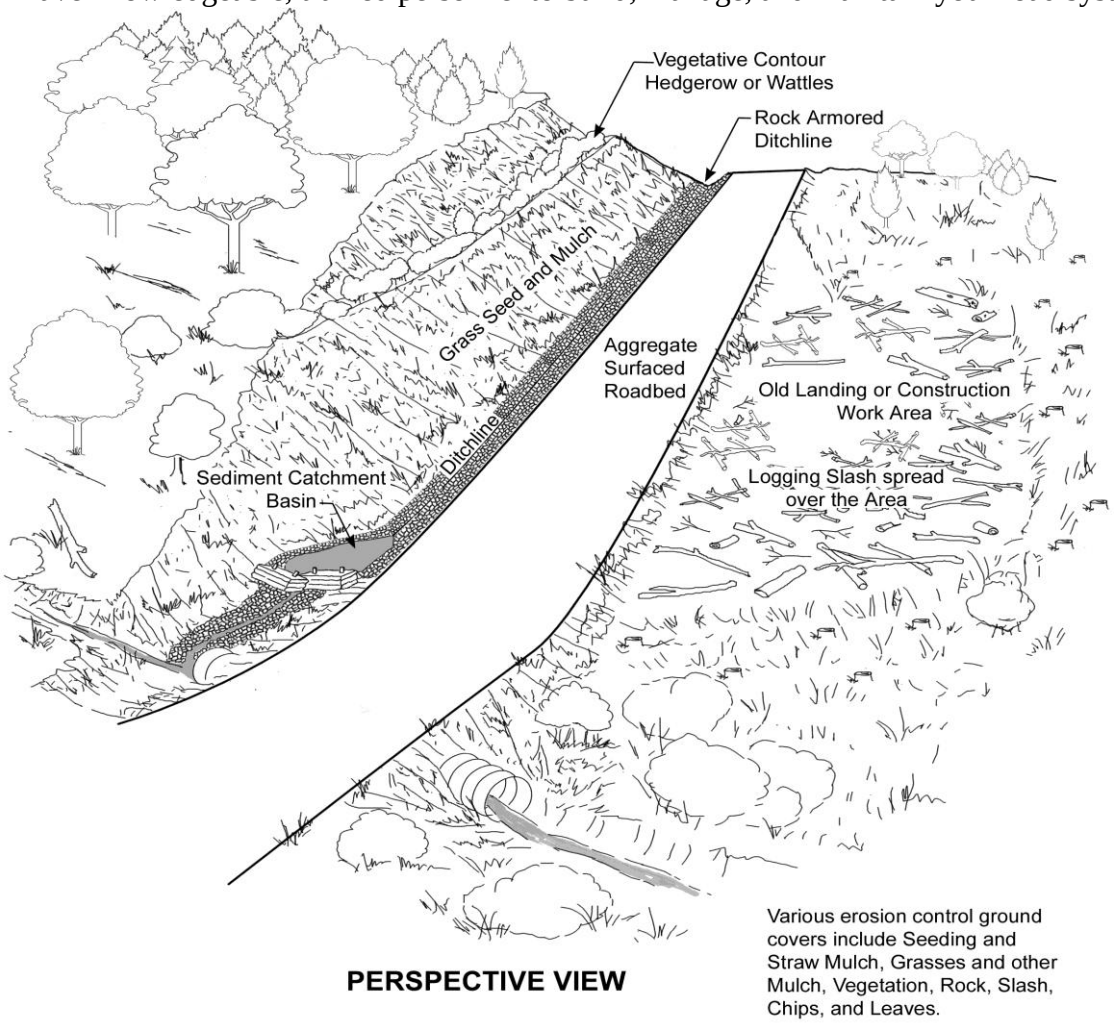

Figure 1.4 Erosion control measures along a road and in disturbed areas.

Key to the development and maintenance of a good low-volume road system is hiring and retaining good, well-trained, and experienced engineers! They can evaluate problems, consider local conditions and resources, develop sound designs, and implement or adapt Best Practices as appropriate**. "Ideas are a dime a dozen. People who put them into action are priceless"** *(A. Einstein).*

Selected Key References

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