



**FOREST SERVICE HANDBOOK
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FSH 7709.55 – TRAVEL PLANNING HANDBOOK

CHAPTER 30 – ENGINEERING ANALYSIS

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New Document	7709.55_30	14 Pages
Superseded Document(s) by Issuance Number and Effective Date	30 thru 34.1 (FSH 3/88)	28 Pages

Digest:

30 – Removes direction on planning for projects in its entirety and replaces it with direction on engineering analysis consistent with FSM 7715.

30.3 – Adds policy that travel management decisions involving motorized mixed use must be informed by engineering analysis conducted by a qualified engineer. Distinguishes the role of the responsible official from the role of the qualified engineer. Establishes the range of analysis that may be required, from documented engineering judgment to a comprehensive engineering report. Provides guidance on the qualifications of a qualified engineer.

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Digest--Continued:

31 – Describes the process for documenting engineering judgment when an engineering report is not required.

32 – Describes the process for preparing and documenting an engineering report.

32.1 – Describes the factors to be considered in an engineering report.

32.11 – Describes the factors to consider when determining the probability of a crash.

32.12 – Adds direction on assessing crash probability.

32.13 – Adds direction on assessing crash severity.

32.2 – Establishes criteria for determining if crash probability or crash severity or both need to be mitigated.

32.21 – Describes methods for mitigating crash probability and crash severity.

32.3 – Describes the contents of an engineering report.

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This chapter supplements direction on motorized mixed use in FSM 7715.77.

30.3 – Policy

1. Where the responsible official proposes to depart from state traffic law or change current travel management direction by authorizing motorized mixed use on a National Forest System (NFS) road where it would otherwise be prohibited, that decision must be informed by engineering analysis conducted by a qualified engineer. Engineering analysis should include a technical evaluation of road conditions and traffic and an analysis of potential mitigation measures regarding motorized mixed use. Depending on the complexity of the situation, the analysis may range from documenting engineering judgment to a comprehensive engineering report that addresses many factors related to motorized mixed use, including mitigation. The analysis should be presented to the responsible official for a decision.
2. Decisions regarding motorized mixed use must be reflected in designations on a motor vehicle use map and documented in road management objectives (RMOs).
3. The starting point for engineering analysis is current travel management direction. In most cases, this direction will reflect current state traffic law regarding motorized mixed use.
4. Designations under 36 CFR Part 212, Subpart B, include class of vehicle and, if appropriate, time of year. Requirements for operator qualifications and personal protective equipment are established by state law.
5. When all of the following conditions exist, a qualified engineer may document engineering judgment that an engineering report is not needed to designate a road for motorized mixed use:
 - a. The proposed designation is consistent with state and local law.
 - b. The road being considered for designation currently has motorized mixed use.
 - c. There is no documented crash history involving motorized mixed use on the road or similar roads in the vicinity.
6. Even when paragraphs 5a through 5c apply, documentation of engineering judgment without a full engineering report is subject to the discretion of the qualified engineer.
7. The responsible official makes decisions on motorized mixed use. The qualified engineer advises the responsible official on designation of NFS roads for motorized mixed use. When the appropriate level of analysis is complete, the qualified engineer documents the engineering judgment or prepares an engineering report.

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8. For purposes of conducting engineering analysis for motorized mixed use, a qualified engineer should generally have the following knowledge, experience, and training:
- a. Knowledge and understanding of FSH 7709.55, chapter 30.
 - b. Knowledge and understanding of Forest Service regulations concerning use of motor vehicles on NFS roads, including 36 CFR Part 212.
 - c. Knowledge and understanding of applicable federal, state, and local laws and regulations concerning use of motor vehicles on public roads.
 - d. Experience in transportation management, including planning, road design, operation, and maintenance.
 - e. Knowledge of operational characteristics of the motor vehicles being considered. Some off-highway vehicles (OHVs) respond differently on paved surfaces from motor vehicles designed for highway driving.
 - f. Specialized training in transportation management, traffic engineering, or road safety, such as training on the Manual on Uniform Traffic Control Devices (MUTCD), accident investigation training, road safety audit training, or other training related to motorized mixed use.

31 – DOCUMENTATION OF ENGINEERING JUDGMENT

When an engineering report is not required, one page is generally sufficient to document engineering judgment. A simple format may be used to record:

1. The date.
2. The road identifier and name.
3. The termini of affected road segments.
4. Objective and operational maintenance levels for the road.
5. Who is responsible for maintenance?
6. Jurisdiction over the road.
7. Applicable road use agreements, maintenance agreements, and encumbrances.
8. Consistency of motorized mixed use with state law.
9. Other factors considered.

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10. Recommended mitigation measures.
11. Conclusions.
12. The signature of the qualified engineer.

Where multiple roads or road segments are included in the documentation of engineering judgment, the above items may be addressed by road or road segment.

32 – ENGINEERING REPORT

The qualified engineer may determine that an engineering report is required. The engineering report may include the entire road or may identify specific segments of a road that require more detailed analysis.

32.1 – Factors to Consider

Engineering reports should consider the probability and severity of crashes involving highway-legal vehicles and non-highway-legal vehicles and should include appropriate mitigation to reduce the risks involved. The qualified engineer should determine the specific factors to include in the report.

32.11 – Crash Probability

Determining crash probability involves assessing the likelihood of a crash on a road resulting from factors affecting traffic safety. Review any established RMOs for types of traffic, design criteria, and operation and maintenance criteria. Additional information that may need to be developed includes:

1. Non-Highway-Legal Operator Considerations. Each state has specific licensing or permitting requirements for operation of highway-legal vehicles. Some states also have requirements for operation of non-highway-legal vehicles. It is important to understand applicable state licensing or permitting requirements, as well as other factors affecting drivers of non-highway-legal vehicles.
 - a. State Requirements. Applicable state requirements include:
 - (1) Driver's license or certification.
 - (2) Driver training.
 - (3) Supervision of unlicensed or underage drivers.
 - (4) State requirements for personal protective equipment.

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- b. Age-Related Factors. Age-related factors include:
- (1) The state's minimum driving age for a class of vehicle.
 - (2) State requirements for the size or class of vehicle based on the age of the driver.
 - (3) Driver understanding of the rules of the road, including basic traffic rules such as passing on the left and driving on the right-hand side of the road.
 - (4) Driver understanding of traffic control devices, such as signs and striping.
 - (5) Driver experience in assessing and reacting to dangerous situations.
- c. Training-Related Factors. Training-related factors include:
- (1) Scope and content of required training.
 - (2) Rules of the road.
 - (3) Vehicle handling characteristics.
- d. Season of Use, Type of Use, and Time of Day. Considerations regarding season of use, type of use, and time of day include:
- (1) Seasonal issues that may affect the driver's focus, such as fall foliage, hunting in the area, or winter weather.
 - (2) Recreational driving where the driver may be focused on the recreational activity rather than the road.
 - (3) Scenic viewing.
 - (4) Nighttime operation.
2. Highway-Legal Vehicle Driver Considerations.
- a. Type of Use. Drivers of highway-legal vehicles need to be aware of:
- (1) Local drivers.
 - (2) Commercial vehicles.
 - (3) Hunting.
 - (4) Sightseeing.

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- (5) Commuter traffic.
- (6) Other uses.
 - b. Experience With NFS Roads. Drivers familiar with the road are more likely to be aware of hazardous situations.
3. Crash History. Determine if there has been a history of near misses or crashes and how that history relates to motorized mixed use. Review available records. Field evidence of skid marks, chrome strips, glass, fenders, damaged road appurtenances, or marks on existing features may indicate crashes have occurred.
4. Traffic Volume and Type. Consider total traffic volume, peak traffic volume, and traffic composition. The presence of trucks and other large commercial vehicles may increase the probability of crashes. Consider whether use is intermittent or seasonal. If possible, determine the history of use of non-highway-legal vehicles on the road. Determine the types of traffic using the road after dark. Vehicles operated at night that do not have highway-legal or similar lighting systems may increase the probability of crashes.
5. Speed. Consider the speed at which motor vehicles are likely to travel. Consider the difference in speed of the various types of traffic. The probability of crashes increases significantly if users consistently exceed the safe speed for a road segment or there is a large difference in speed between types of vehicles.
6. Road Surface.
 - a. Pavement or pavement-like surfaces tend to encourage drivers to increase their speed. Some non-highway-legal vehicles are not designed for operation on paved surfaces and handle poorly on pavement. Manufacturers of some OHVs recommend that their vehicles not be driven on pavement.
 - b. Non-highway-legal vehicles are generally designed for operation on gravel and native surfacing. Traction may be reduced and stopping distance increased for all vehicles on these surface types.
7. Intersecting Roads and Trails. Identify intersecting roads and trails, and determine if intersection controls are necessary.
8. Other Roadway Factors. Consider the following and other factors when they are inconsistent with driver expectations for the road:
 - a. Visibility and sight distance.

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- b. Roadway alignment.
- c. Climatic conditions.
- d. Single lane with turnouts.
- e. Shoulders that are not continuous through open culvert sections.
- f. Drop inlets in roadside ditches.
- g. Drainage dips that occur on curves.
- h. Likelihood of debris (such as limbs and pine needles) in the roadway.

32.12 – Assessing Crash Probability

1. A lower probability of crashes exists where there are such factors as:
 - a. No known crashes.
 - b. Low traffic volume.
 - c. Low speeds (25 MPH or less).
 - d. A consistent roadway where drivers do not encounter unexpected conditions.
 - e. Only vehicles with highway-legal lighting systems are operated at night.
 - f. Good visibility with sight distances exceeding the stopping distance.
 - g. Licensed or certified operators.
2. A higher probability of crashes exists where there are such factors as:
 - a. A history of crashes.
 - b. High traffic volume.
 - c. High speeds (more than 40 MPH).
 - d. An inconsistent roadway where drivers encounter unexpected conditions.
 - e. Vehicles with non-highway-legal lighting systems are operated at night.

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- f. Poor visibility with sight distances that are less than the stopping distance.
- g. Unlicensed and uncertified drivers.

32.13 – Crash Severity

Determining crash severity involves assessing the probable degree of property damage and personal injury or death resulting from a crash on the road. Factors that may affect crash severity include:

1. Roadside Conditions.
 - a. The slope and the height of constructed embankments and natural ground slopes below the roadway increase the probability of major property damage, serious injury, or death as a result of a crash where the vehicle runs off the road.
 - b. Large, unyielding features adjacent to the road, such as trees, bridge abutments, and boulders (in contrast to those that are set back from the road or are more yielding) increase the potential crash severity. The crash severity may be increased where features have been constructed that do not conform to the contour of the natural setting.
2. Speed. Speed is generally the single most important factor to be considered. While it may be modified by other factors, in general, the higher the speed, the greater the crash severity.
3. Traffic Type. In general, the greater the disparity in the size of the vehicles involved in a crash, the greater the crash severity.
4. Severity factors. Severity factors are low where a crash most likely will result in minor personal injury and property damage and high where a crash most likely will result in major personal injury and property damage.

32.2 – Evaluation and Mitigation of Crash Risk

1. The qualified engineer may determine that the road is uniform and conduct one analysis for the entire road. On the other hand, the qualified engineer may determine that one or more segments of the road have significantly higher or lower crash risk and may consider those segments separately.
2. The need for and magnitude of mitigation to designate an NFS road for motorized mixed use vary depending on the probability and severity of crashes.

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3. Generally, no mitigation is necessary for road segments with low probability and low severity of crashes.
4. Generally, mitigation is necessary for road segments with high probability and high severity of crashes and road segments with low probability and high severity of crashes.
5. Mitigation may be necessary for road segments with high probability and low severity of crashes.
6. After completion of the analysis for probability and severity of crashes, determine alternatives and costs for managing the risk. The investment required to reduce the risk needs to be balanced against the benefit of risk reduction.

32.21 – Mitigation Methods

1. Separation of Use. Separation of use is often the best way to reduce the probability and severity of crashes. However, the cost to provide adequate separation can be very high. Methods utilized to separate use include:
 - a. As appropriate, allow use on the shoulder of a road.
 - b. Provide barriers between a road and an OHV trail.
 - c. Develop grade separation between a road and an OHV trail.
 - d. Provide a separate route for non-highway-legal vehicles.
 - e. Separate vehicle classes by the day of the week or time of day.
2. Signing. Examples of signing to mitigate crash risk include:
 - a. “Share the Road” signs (EM 7100-15, FW 8-7 and W 16-1).
 - b. Pavement markings in accordance with the MUTCD.
 - c. Standard state or local signs, if approved for NFS roads, where users are accustomed to state or local signs that do not conform to Forest Service standards (see EM 7100-15 for Forest Service requirements).
 - d. Route marking to insure that non-highway-legal vehicle routes and motorized mixed use routes are clearly identified.
 - e. “Highway-Legal Vehicles Only” signs to identify the termini of road segments designated for motorized mixed use.

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- f. A “Motorized Trail Crossing” sign may be used where motorized trails cross the road.
- g. Other appropriate regulatory and warning signs contained in EM 7100-15 that are consistent with the MUTCD and Forest Service standards.

Signage installed on roads should be designed to meet all requirements in the MUTCD. Additional or modified signage may be needed when there will be a change in use. For instance, signs that indicate trucks will be present at certain times may be needed when a borrow pit or timber sale is opened.

- 3. Information. Use handouts, verbal messages, or other methods for conveying information on motorized mixed use at:
 - a. Entry stations.
 - b. Routes from OHV trails to campgrounds.
 - c. Trailheads.
- 4. Communication. A communication plan may be required to make drivers aware of changes in use, such as when motorized mixed use is implemented on an NFS road.
 - a. Timber sale contracts or road use permits authorizing commercial hauling may require that truck drivers receive information on motorized mixed use when commercial activities commence.
 - b. A communication plan may include information for OHV user groups.
 - c. A communication plan may be appropriate where special activities or events are anticipated, such as OHV rallies or OHV programs at organizational camps.
- 5. Training. State-required training for drivers of non-highway-legal vehicles may mitigate risk. Coordinate with state agencies to consider including rules of the road in required or recommended training for unlicensed, underage drivers.
- 6. Road Maintenance and Reconstruction.
 - a. Sight distance.
 - (1) Clearing can improve sight distance, but requires adequate maintenance.
 - (2) Corner-rounding or flattening of roadside cut slopes can improve sight distance.

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- (3) Realignment of road segments can eliminate blind spots and otherwise improve sight distance.
- b. Speed reduction. Roughened surfaces can reduce speeds. Such surfaces usually reduce the speed of passenger cars and trucks more effectively than the speed of non-highway-legal vehicles.
- c. Realignment. Realignment of the road bed may reduce use conflicts, improve roadway consistency, reduce speeds, or otherwise reduce the probability or severity of crashes.
- d. Widening. Road widening may reduce use conflicts, improve sight distance, and accommodate additional traffic.
- (1) A shoulder may be added for use by non-highway-legal vehicles.
- (2) A lane may be added for non-highway-legal vehicles or to accommodate two-way traffic if significant volume is added.
- (3) The roadside ditch may be modified to accommodate non-highway-legal vehicles. Consider the risk of propagating invasive plant species before selecting this mitigation measure.
- (4) Curves with limited sight distance may be widened to provide two lanes.
7. Restrictions.
- a. Speed limits. Speed limits may be established in an order issued under 36 CFR 261.54. A speed study is required for these orders. See EM 7100-15, section 3A.3.
- b. Vehicle class. Vehicle class should be included in motorized mixed use designations and reflected on a motor vehicle use map.
- c. Enforcement.
- (1) Restrictions alone are not adequate mitigation measures unless there is enforcement to ensure compliance. Ensure Law Enforcement and Investigations Staff and state and local law enforcement agencies are included in analysis of motorized mixed use. Adequacy of enforcement depends on the availability of law enforcement personnel.
- (2) Federal laws and regulations are enforced by Forest Service law enforcement personnel. Certain Forest Service regulations and orders incorporate state laws, making them enforceable federally.

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- (3) State and local law enforcement officers enforce state and local law, including state traffic law. Forest Service law enforcement officers may enforce state law when they have been deputized as state peace officers or otherwise designated to enforce state law under 16 U.S.C. 559d(5) or 559g. Forest Service law enforcement officers also may enforce state laws that have been assimilated into federal law under the Assimilative Crimes Act (18 U.S.C. 13).
- (4) Coordinate with state and local law enforcement agencies and ensure that they are notified of Forest Service designations that conflict with state traffic law.
8. Changes. Changes in road restrictions and other operational criteria that are made to accommodate motorized mixed use may require a transition plan. A transition plan should address:
- a. Duration of the transition.
 - b. Timing of implementation.
 - c. User groups and other interested parties.
 - d. Media involvement.
 - e. Availability of agency staff.
 - f. Volunteers.
 - g. Communication with state and local authorities.

32.3 – Documentation

When the qualified engineer determines that an engineering report is needed, the following information should be included in addition to the information listed in section 31:

1. Existing and proposed uses.
2. Summary of analysis.
3. Summary of risk (crash probability and severity).
4. Recommended mitigation.
5. Alternatives (with associated changes in risks).
6. The name of the person who prepared the report (if it was drafted under the supervision of the qualified engineer, rather than by the qualified engineer).