Appendix G

HOOSIER NATIONAL FOREST ROAD DESIGN GUIDELINES

DESIGN GUIDANCE

The following guidelines should be used, when appropriate, when setting design standards in road contracts or road special use permits on NFS lands in Indiana. The guidelines (Table G.1) are in compliance with Forest Service manuals and handbooks, recommended guidance from Hoosier staff, and the Indiana field guide for best management practices (IDNR 1998).

Table G.1

HOOSIER NATIONAL FOREST ROAD GUIDELINES

Type Of Use	Road Width (Feet)	Clearing Widths (Minimum Feet)	Driving Surface	Road Grades (Maximum Percent)	Traffic Svc Level	Maintenance Level	Cut Slope Ratios	Fill Slope Ratios
FS Access Roads non-gated, long term)	12	22	Aggregate	8	B	3-4	1:1-2:1	1½:1
FS Access Roads (gated, long term)	12	22	Native or Aggregate	12	D	1-3	1:1-2:1	1½:1
Driveways:								
1-5 Homes	12	22	Aggregate	8	B	3-4	1:1-2:1	1½:1
>5 Homes	14	24	Aggregate	8	B	3-4	1:1-2:1	1½:1
Recreation Roads:								
Access road (2 lane)	20	30	Asphalt or	8	A	4-5	1:1-2:1	1½:1
Campground loop	12	22	Aggregate	4	B	4-5	1:1-2:1	1½:1
Temporary Roads	10	10	Native or Aggregate	12	D	Obliterate after use	Verticle-2:1	1½:1

Note: All roads above are single lane except the 2-lane Recreation Access road.

ROAD WIDTH

The widths shown above are the recommended road widths; the actual width should be based on the design vehicle for that particular road.

On single lane roads, turnouts should be constructed for safety purposes. The location of turnouts should reflect the proper blend of road user, safety, visuals, and economics. Normally, turnouts should be located on the outside of cuts; outside of curves; low side of fills or at the run out point between through cuts and fills. Turnout widths should be a minimum of 10 feet wide and 50 feet long with 25-foot tapers. Turnout spacing is showing in Table G.2 below (USDA 1994a).

TURNOUT SPACING

Table G.2
TURNOUT SPACING AND OPERATIONAL CONSTRAINTS BY TRAFFIC SERVICE LEVEL

Traffic Service Level	Turnout Spacing	Operational Constraints
A	Make turnouts intervisible unless excessive costs or environmental constraints preclude construction. Closer spacing may contribute to efficiency and convenience. Maximum spacing is 1,000 feet.	Traffic: mixed Capacity: up to 25 vehicles per hour Design Speed: up to 40 mph Delays: 20 seconds/mile or less
B	Intervisible turnouts are highly desirable but may be precluded by excessive costs or environmental constraints. Maximum spacing is 1,000 feet.	Traffic: mixed Capacity: up to 25 vehicles per hour Design Speed: up to 25 mph Delays: should be 30 seconds/mile or less Use signs to warn non-commercial users of the traffic to be expected. Road segments without intervisible turnouts should be signed.
C	Maximum spacing is 1,000 feet. When the environmental impact is low and the investment is economically justifiable, additional turnouts may be constructed.	Traffic: small amount of mixed Capacity: up to 20 vehicles per hour Design Speed: up to 20 mph Delays: up to 60 seconds/mile Road should be managed to minimize conflicts between commercial and noncommercial users.
D	Generally, only naturally occurring turnouts, such as additional widths on ridges or other available areas on flat terrain are used.	Traffic: not intended for mixed Capacity: generally 10 vehicles/hour or less Design Speed: 15 mph or less Delays: up to 60 seconds/mile expected Road should be managed to restrict concurrent use by commercial and noncommercial users.

Note: On roads identified as being subject to the Highway Safety Act, intervisible turnouts or appropriate signing should be provided.

CLEARING WIDTHS

Clearing limits shall be kept to a minimum on all roads. The minimum clearing limits on all roads, not to be obliterated, are 5 feet from the shoulders of the road. On driveways and non-gated roads clearing limits shall be no greater than 5 feet beyond the top of cut and to the toe of fill. On gated access roads, the clearing shall be to the top of cut and toe of fill. On temporary roads clearing shall be enough to allow equipment to use the road without damage to the vehicle.

SLASH DISPOSAL

To meet the visual quality objectives of the *Forest Plan,* slash generated from construction activities should be disposed of in such a manner that large concentrations are not showing. However, not all of the slash needs to be removed from a site in order to meet the ecosystem objectives of the *Forest Plan*. There several ways to handle slash, but recommendations will be based on site-specific analysis. Slash is the tops, limbs, and unmerchantable logs generated by building a road. Possible slash handling recommendations are:

- Lop and scatter:
    - Scatter the slash so that it is generally between 2 feet and 3 feet high. The lowest heights would be recommended on Traffic Service Levels A and B roads, with taller heights allowed on Traffic Service Levels C and D roads.
    - A variation of lop and scatter is to place some of the slash in such a way as to trap sediment and mitigate effects on soil and water, if needed.
- Chip: The slash could be chipped. The chips could be scattered on the site or could be partially scattered and partially removed.
- Burn: If the volume of slash is heavy, some of it could be burned to reduce the fuel loading.
- Bury: Some of the slash and stumps could be buried in the disturbed area.
- Remove: Tree stumps could be removed from the site. Other slash could be partially removed, as listed above.

SURFACING

A minimum of 4 inches of aggregate should be placed on roads to be used year round. This will allow for adequate maintenance of the road surface. On gated roads, native surfacing is acceptable if the road is not to be used during wet times of the year. On temporary roads that are to be used during dry seasons, native surfacing is acceptable. If the road is to be used during wet seasons, the road shall be rocked to accommodate the design vehicle. Temporary roads shall be obliterated after use is terminated.

ROAD GRADES

The desired grade on roads is 8 percent or less. Safety, State laws, and economic and environmental constraints and concerns govern the selection of the maximum grade, or at least require mitigating measures to lessen the impacts of steep grades. The maximum grade varies with the ability of each material type to resist erosion. Steeper grades normally require additional costs for drainage, surface stabilization, maintenance, and use.

ROADWAY CRITERIA

The following recommendations should also be used as guidelines on new road construction.

Type

The travel way should be constructed to the following type for the grades given:

0-2 percent	Crowned
2-4 percent	Insloped or outsloped
4-8 percent	Insloped or outsloped with drain dips
>8 percent	Insloped with ditch

Insloped, outsloped, and crowned travel ways shall have a three percent cross slope (Garland 1983). Shoulders are usually not needed. On side slopes greater than 35 percent, full bench excavation for the roadway shall be used. Slopes less than 35 percent cut and fill excavation for the roadway can be used.

Sight distance

Roads should be evaluated for adequate sight distance on vertical and horizontal curves, intersections, and in passing areas. The ability to see ahead is important in the safe and efficient operation of a vehicle on a road.

Sight distance is the length of roadway ahead visible to the driver. The minimum sight distance available on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. At road intersections, this is of great importance to allow vehicles time to see and react to a vehicle turning into the path of another vehicle or slowing to make a turn.

Stopping sight distance should be calculated to arrive at a minimum sight distance needed for a vehicle to see an obstruction and slow enough to avoid a collision. To arrive at the minimum required sight distance refer to one of the following: FSH 7709.56 Road Preconstruction Handbook (USDA 1994a); A Policy on Geometric Design of Highways and Streets (American Association of State Highway and Transportation Officials 1994); or the Indiana Department of Transportation Design Manual, Part V, Volume I, Road Design (INDOT 1994).

Drainage structures

Use drain dips on road grades four to eight percent. Use culverts on grades of eight percent and greater. Install water bars on temporary roads when not in use (Barnickol 1988, IDNR 1998, USDA 1991, and West Virginia Department of Natural Resources Division of Forestry et al. 1980).

Culverts and drain dips should be skewed 30 degrees for ditch relief. Culverts shall consist of corrugated aluminum, galvanized or aluminized steel, or polypropylene. For culverts to be self-cleaning they should have a grade two percent greater than the ditch grade, minimum grade should be three percent (Beschta 1984b). If culverts are used on temporary roads, they shall be removed immediately upon termination of use on the road.

The Forest compared several sources for spacing formulas (Beschta 1984b, Fisher and Taber 1975, Kochenderfer 1970, Pence unknown, Trimble and Sartz 1957, Haussman and Pruett 1973, and USDA Forest Service Manuals and Handbooks). Spacing recommendations for culverts and drain dips are usually based on the Kochenderfer formula in the Eastern U.S. It is the formula that results in the spacing table on page 11 of the Indiana BMP field guide (IDNR 1998). The Kochenderfer formula is: spacing in feet = (400/slope percent) + 100 (Kochenderfer 1970). The formula results in the following spacing for culverts and drain dips by road grade.

Table G.3

RECOMMENDED MAXIMUM SPACING FOR CULVERTS AND DRAIN DIPS

Road Grade (Percent)	Spacing (feet)
1	500
2	300
3	233
4	200
5	180
6	167
7	157
8	150
9	144
10	140
11	136
12	133
13	131
14	129
15	127

Drainage structures should be properly sized. The structure size is dependant on local conditions, but an acceptable starting point is to have the area of the culvert-opening equal the area of the drainage channel at the high-water level. Although a minimum size of 12 inches diameter is recommended in many sources, the Hoosier NF recommends that the minimum culvert diameter be 18 inches due to the leaf litter in southern Indiana (Beschta 1984a, Douglass 1974, Fisher and Taber 1975, and Kochenderfer 1970). Smaller diameter pipes have a greater tendency to become plugged with leaves in the fall and winter. Additional information

about installing culverts is found on pages 27 and 28 of the Indiana BMP field guide (IDNR 1998).

There are several methods commonly used to determine the runoff and size for the proper drainage structure. The selection of the method depends on the conditions, availability of reliable information, and judgment of the designer. Several of the procedures and formulas that can be used are:

- Drainage end area calculations
- The Manning Formula *
- The Talbot Formula*
- McMath and Burkli-Ziegler Formulas*
- The Rational Method*
- Computer Programs

*These formulas can be found in most drainage structure books such as the Handbook of Steel Drainage and Highway Construction Products (American Iron and Steel Institute 1971), FSH 7709.56 Drainage Structures Handbook (USDA 1994a and 1994b), and Flood Frequencies and Bridge and Culvert Sizes for Forested Mountains of North Carolina (Douglass 1974), as well as hydraulic manuals.