

5.8.6 PRINCIPLES

D. Development Standards

3. Engineering Standards and Guidelines for Roads and Drainage—The following Standards and Guidelines are designed to promote affordable and timely completion of projects in keeping with the mission of the Rural Land Use Process, while at the same time taking into account the specific requirements of the site and providing for public health, safety, and welfare. To that end, it will be the responsibility of the Owner’s Engineer, who must be a qualified professional engineer licensed in the state of Colorado, to design a project in keeping with the following Standards and Guidelines, to provide a signed and stamped certification that a project is designed according to the Standards, and to provide a signed and stamped certification that the project was built in substantial conformance with the design. For the purposes of this document, the words “shall” or “must” will designate Standards, which are requirements. Guidelines, which are recommendations and suggestions, will be *italicized* and designated by the word “*Guideline(s)*”.
 - a) All existing roads providing access to the project must be safe and in an acceptable all-weather driving condition.
 - b) Site Drainage—Drainage paths and basins for historic flows must be identified and preserved. Effective drainage paths for new developed flow must be provided. At a minimum, a basic review of the topography of the project site must be performed to identify historic drainage patterns and flow paths. If there are historic drainage paths, there must be an analysis of the approximate limits of the contributing areas. The method used to predict the design peak discharge must take into account the size of the drainage basin(s). A simple rational method calculation should be sufficient in most instances to yield historic peak discharge in the drainage path.
 - 1) All building envelopes must be sited so that they do not interfere with the existing drainage patterns. Drainage easements shall be used as needed.
 - 2) All proposed site grading must convey drainage into an existing drainage way. If cross drainage from one parcel to another is required, adequate drainage improvements must be designed and installed to prevent harming adjoining parcels.
 - 3) Drainage design must demonstrate how the developed flows will be conveyed through and from the residential cluster to an historic drainage path.
 - 4) If a residential cluster causes drainage flows to concentrate at a single point of discharge, the concentrated flow must be discharged without adversely impacting the adjacent property.
 - 5) Residential lots must be laid out to provide positive drainage away from all building sites, and the overlot grading must be designed and maintained consistent with the general storm drainage pattern for the area.

- c) Road and Driveway Drainage—Plans for adequate site and roadway drainage are required for all road and driveway construction. Road and driveway design should provide for positive storm water drainage at all locations. Adequate design must insure the natural drainage system will be maintained and erosion is minimized.
- 1) Driveways—Where driveways cross natural drainages, adequate cross culverts or structures must be provided to maintain natural drainage patterns and conduct storm water away from the driveway. These culverts must, at a minimum, be sized to pass the flow generated by a 10-year storm. They must be at least 12 inches in diameter and have a minimum cross-sectional area of at least 0.78 square feet. Structures must appear on the driveway grading plan.
 - 2) Roads—Roads must provide cross culverts, as needed, to maintain natural drainage patterns and distribute storm water away from the roadway. Such structures must, at a minimum, be sized to pass the flow generated by a 10-year storm. Culverts must be at least 18 inches in diameter and have cross-sectional area of at least 1.77 square feet. The Owner’s Engineer will determine the need for flared end sections or headwalls for the culverts.
 - 3) Culvert specification—Culverts must be either double-wall corrugated plastic or single wall corrugated metal pipes. The culvert must be of sufficient strength and proper installation to assure a minimum of 10 tons bearing capacity. *Guideline: Single-wall pipe may be acceptable if it can be demonstrated that it meets the minimum requirements of this section. A minimum of 12 inches of cover of material compacted to manufacturer’s specifications is recommended unless manufacturer’s specifications indicate a lesser amount is sufficient to achieve the required bearing capacity.*
 - 4) Bridge specification—Bridges must be designed and constructed to comply with the specifications of Section 7.1 of the Larimer County Road Standards.
- d) Road and Driveway Design—All roads (either public or private) must be located within either a dedicated public right-of-way or a private access easement. An additional utility easement may be required to accommodate needs of utility providers. At a minimum, the publicly dedicated right-of-way or private access easement must be 50 feet in width, located twenty-five feet (25’) from either side of the road centerline.
- 1) Planning and construction of roads and driveways must take into consideration encroachment upon critical wildlife habitat; wetlands conservation; protection of water quality in local streams, ponds and lakes; and esthetics. The Owner’s Engineer may consider and prescribe site specific design alternatives to mitigate environmental concerns as long as roadway safety is maintained.
 - 2) Driveway Design:
 - a) Width—*Guideline: A minimum useable all weather driveway surface width of 12 feet is recommended to assure safe ingress and*

egress of emergency response vehicles. To minimize cut volumes, or if topography makes this width impractical, a narrower width for short distances may be prescribed by the Owner's Engineer if the driveway design is demonstrated to be otherwise safe and maintainable. The minimum acceptable driveway width in these cases is 10 feet.

3) Internal Road Design:

- a) Road Width—Roads must be designed for a minimum useable all weather road surface width of 20 feet for an adequate two-way road to assure safe ingress and egress of emergency response vehicles. *Guideline: The Owner's Engineer may prescribe a narrower width for short distances to minimize cut volumes or address other environmental or agricultural concerns if adequate turnouts are incorporated into the design and the road design is demonstrated to be otherwise safe and maintainable. The minimum acceptable width in these cases is 12 feet and must incorporate appropriate turnouts.*
- b) Paved Road Width—Paving width must be a minimum of 20' with a 4' structural shoulder on each side of paved roadway. Pavement structural design must be performed by the Owner's Engineer. Design shall be stamped and signed by the Owner's Engineer in accordance with Certification Requirements contained in Section 5.8.6.D.3.f.
- c) Road Grade— Road designs exceeding 8% (10% in mountainous terrain) must ensure that other safety and site disturbance standards are not compromised. *Guideline: Where topography requires, the Owner's Engineer may prescribe steeper grades. However, the average grade for 200 feet should not exceed 12%.*
- d) Clearance Height—Roads through forested areas must maintain proper clearance heights above the traveled way sufficient to allow passage of emergency vehicles. Tree branches must be trimmed to obtain a minimum overhead clearance of 13 feet 6 inches.
- e) Horizontal Road Curve—Radii of curvature on centerlines must be a minimum of 100 feet (60 feet in steep terrain), so long as adequate sight distance exists to allow a safe stopping distance. Steep mountainous terrain may require other engineering solutions as prescribed by the Owner's Engineer.
- f) Vertical Road Curve—For safety reasons, design of crest vertical curves (top of hill crests) must be based on the design speed of the road. The design speed must take into account sight distance limitations, which result from extreme crest vertical curves. Correspondingly, sag vertical curves (bottom of hill) must also be designed based on the design speed, such that headlight visibility will not be compromised in nighttime or dim light conditions. Recommended design speed for most local access roads is 15 mph in steep, mountainous areas and 25 mph in rolling to flat areas.

- g) Road Intersections—Driveway and road intersections must be within ten degrees of perpendicular for at least 50 feet from intersection centerlines with adequate sight distance both directions. *Guideline: If topography allows, grades should flatten to 3% or less for at least 50 feet approaching intersections.*
- h) Dead End Roads—Dead end roads exceeding 600 feet in length must be constructed with a vehicular turnaround area at the end or within the last 600 feet of roadway. For roads narrower than 20 feet, turnouts must be provided at approximately every 600 feet of road between the beginning at the road intersection and its terminus. Greater distances are allowable if good sight distance is maintained between adjacent turnouts. *Guideline: Though not a requirement in the design for 20 ft. wide roads, turnouts should be considered if the road is the single access and egress point to the parcels served.*
- i) Cuts—Roadways must follow existing contours to the extent possible. Roadway cuts and embankments must be considered only to the extent they are necessary to maintain safe geometric conditions for the design speed. Construction of cuts and fills must be constructed to the following requirements to maximize the safety and integrity of such work.
 - 1) General—Unless otherwise prescribed in the soil engineering or engineering geology report prepared and stamped by the Owner's Engineer, cuts must conform to the provisions of this section.
 - 2) Slope—The slope of cut surfaces must be no steeper than is safe for the intended use and must be no steeper than 1 unit vertical in 1.5 units horizontal (66.7% slope) in common soil. Cut slopes in competent rock may be vertical when less than 3 feet high. Various soil types may require flatter slopes (up to 4 to 1) based on the written determination of the Owner's Engineer as to the stability and erosiveness of the soil type. Cut slopes in competent rock greater than 3 feet high and less than 8 feet high must be no greater than 1 unit vertical to 1 unit horizontal. Where cut slopes are greater than 8 feet high, or where unstable or compromising geology occurs, the Owner's Engineer shall prepare a written soils engineering report or an engineering geology report, or both, prescribing a design solution based on his/her investigation. The report(s) must prescribe a slope configuration to stabilize the constructed cut and construction must conform to the findings of the report(s). Cut slopes must be seeded and mulched to reestablish appropriate vegetative cover to maximize slope stability and minimize erosion. Seeding and mulching is not required if, in the written determination of the Owner's Engineer, the steepness of the slope or the slope material is not conducive to plant growth. In these cases it may be necessary to use other physical or mechanical means to

stabilize the slope material. *Guideline: Whenever possible, existing topsoil on the site should be saved and stockpiled for dressing the slope prior to seeding.*

- j) Fills—Fill slopes must not be constructed on natural slopes steeper than 1 unit vertical in 2 units horizontal (50% slope). The ground surface must be prepared to receive fill by removing woody vegetation such as shrubs, topsoil and other unsuitable materials and scarifying to provide a bond with the new fill. Where slopes are steeper than 1 unit vertical in 5 units horizontal (20% slope) and the height is greater than 5 feet, stability must be achieved by benching at the toe into sound bedrock or other competent material.
 - 1) Fill Material. Composition of fill material must follow these requirements:
 - a) Detrimental amounts of organic material will not be permitted in fills.
 - b) Rock sizes greater than 12 inches in maximum dimension must be placed 2 feet or more below grade, measured vertically.
 - c) Rocks must be placed so as to assure filling of all voids with well-graded soil.
 - d) The upper 2 feet of fill must be compacted for stability in preparation for placement of surfacing material.
 - 2) Slope—Fill slopes must be no steeper than 1 unit vertical in 2 units horizontal (50% slope) unless the fill is engineered and constructed in such a way as to establish stability at a steeper slope. Various soil types may require flatter slopes (up to 4 to 1) based on the written determination of the Owner's Engineer as to the stability and erosiveness of the soil type. Fill slopes must be seeded and mulched to reestablish appropriate vegetative cover to maximize slope stability and minimize erosion. *Guideline: Whenever possible, existing topsoil on the site should be saved and stockpiled for dressing the slope prior to seeding and mulching.*
- k) Cut and Fill Setbacks from Property Lines—*Guidelines: These setback recommendations are included for general consideration to avoid conflicts and potential problems with other landowners. They should be followed when planning a road or other excavations.*
 - 1) *General—Cut and fill slopes should be set back from site boundaries in accordance with this section. Setback dimensions are horizontal distances measured perpendicular to the site boundary.*
 - 2) *Top of Cut Slope—The top of cut slopes should not be made nearer to a site boundary line than one fifth of the vertical height of cut with a minimum of 2 feet and a maximum of 10 feet.*

3) *Toe of Fill Slope*—The toe of fill slope should not be made nearer to the site boundary line than one half the height of the slope with a minimum of 2 feet and a maximum of 20 feet. Where a fill slope is to be located near the site boundary and the adjacent off-site property is developed, special precautions should be incorporated in the work, as necessary, to protect the adjoining property from damage as a result of such grading. These precautions may include but are not limited to:

- a) *Provision for retaining or slough walls.*
- b) *Mechanical or chemical treatment of the fill slope surface to minimize erosion.*
- c) *Provisions for the control of surface waters.*

1) **Buffer Zones for Streams, Intermittent Streams, and Wetlands**—Construction of roadways within perennial or intermittent stream corridors or drainage ways shall not be permitted except for purposes of crossings. Proper revegetation of cut and fill slopes or other means of erosion and storm water control must be affected to protect water quality of the stream. Proper design to allow adequate flow of storm water, as indicated by the normal high-water line, must be incorporated in the plan. A minimum of 50-foot buffer zone must be maintained for wetlands unless further encroachment has been approved by the U.S. Army Corps of Engineers. Delineation of the wetland may be required by a qualified person to properly identify the extent of the wetland boundaries. *Guidelines: For roads which follow perennial stream corridors, a minimum 50-foot buffer zone of undisturbed vegetation should be maintained between the roadways or from any fill material generated by the construction of the road and the normal high-water line of the stream. For roads which follow intermittent stream corridors, a buffer of at least 20 feet of undisturbed ground and vegetative cover from the normal high-water line should be maintained for roadways paralleling these features.*

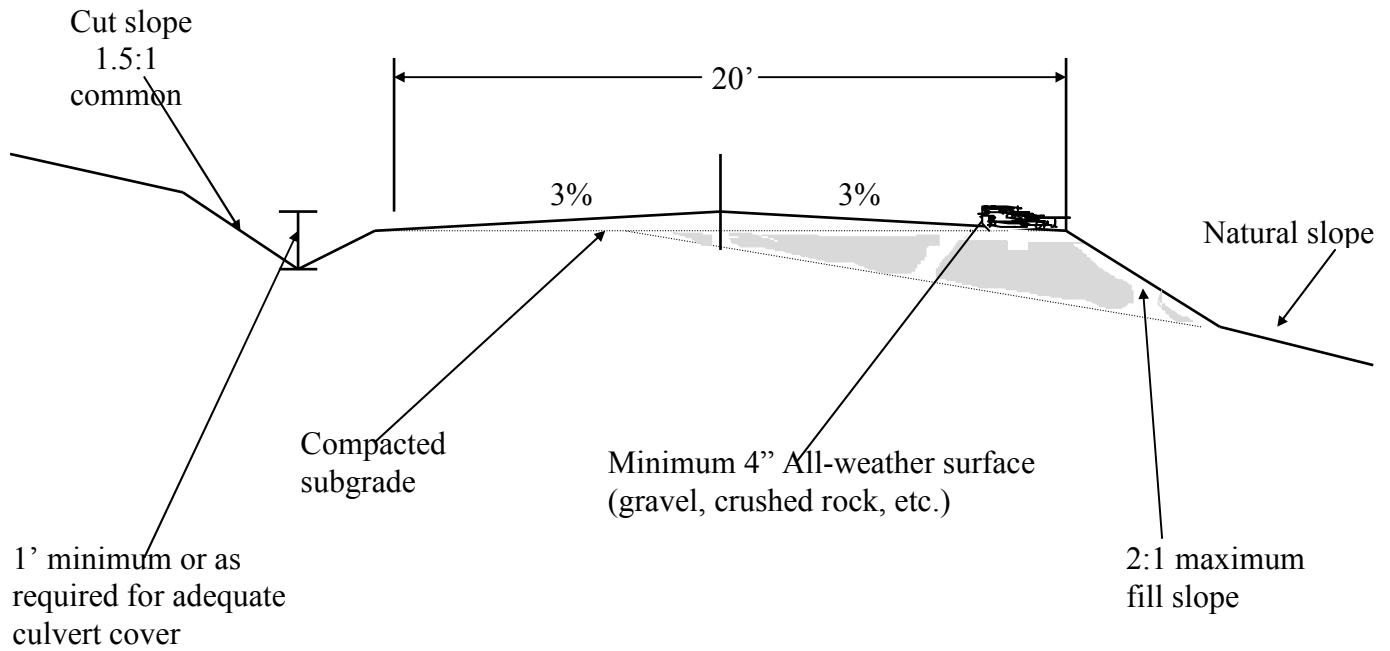
e) **Other Requirements**—

1) **Disturbance of Land**—All construction activities are required to obtain a State stormwater management permit if they disturb one or more acres of land. The Colorado Department of Health and Environment, Water Quality Control Division administers the permits. The main pollutant of concern for construction activities is sediment. The permits require holders to control or eliminate the sources of pollutants in stormwater through the implementation of a Stormwater Management Plan, developed as part of the application process. These Stormwater Management Plans must include best management practices (BMPs) that include treatment of stormwater discharges along with source reductions. Inclusions of the BMPs allow most permits to avoid numeric effluent limits. The permit

application and guidance documents can be obtained by contacting the Water Quality Control Division.

- 2) Fugitive Dust during Construction—Colorado’s air quality laws contain requirements for controlling fugitive dust during construction activities. The steps necessary to comply with those laws depend on the amount of land disturbed, and the duration of the disturbance. The requirements are outlined below.
 - a) Development that involves clearing more than five acres of land must incorporate all available and practical methods which are technologically feasible and economically reasonable in order to minimize dust emissions.
 - b) If land development creates more than a 25-acre contiguous disturbance or exceeds 6 months in duration, the responsible party is required to prepare a Fugitive Dust Control Plan, submit an Air Pollution Emissions Notice (APEN), and obtain an emissions permit from the Colorado Department of Public Health and Environment. The APEN and specialty permit application form for land development can be obtained by contacting the Air Pollution Control Division directly.
 - c) Regardless of the size or duration of development, all land disturbances should be conducted so that nuisance conditions are not created. If dust emissions do create a nuisance, a Fugitive Dust Control Plan will be required.
- 3) Erosion Control and Site Reclamation—Erosion control and site reclamation improvements are necessary as part of every road construction and excavation project. A plan to control storm water along the roadway to lessen the degree of concentration of storm waters must be incorporated in the erosion control plan. The plan must incorporate erosion control and site restoration measures to assure effective stabilization of soil materials so that displacement and transport of soil materials is minimized and to affect restoration of natural vegetative ground cover to disturbed areas.
Guideline: In many cases the most effective means of controlling erosion is reestablishment of vegetation on disturbed areas. It is recommended that natural vegetation be left intact to the greatest extent possible.
- 4) Road Name Signs And Traffic Control Devices—All road name signs and traffic control devices must conform to the standards in Chapter 4.10 and standard drawings 8, 9, and 10 of the Rural Area Road Standards.
- f) Certifications—A template for the following Certifications will be provided by the Rural Land Use Center and must be signed and stamped by the Owner’s Engineer. The following certifications will be required:
 - 1) Stamped certification that roads and drainage for the Rural Land Plan were designed to the Standards listed in Section 5.8 of the Larimer County Land Use Code.
 - 2) Stamped certification that roads and drainage installations for the Rural Land Plan were built to the Standards listed in Section 5.8 of the Larimer

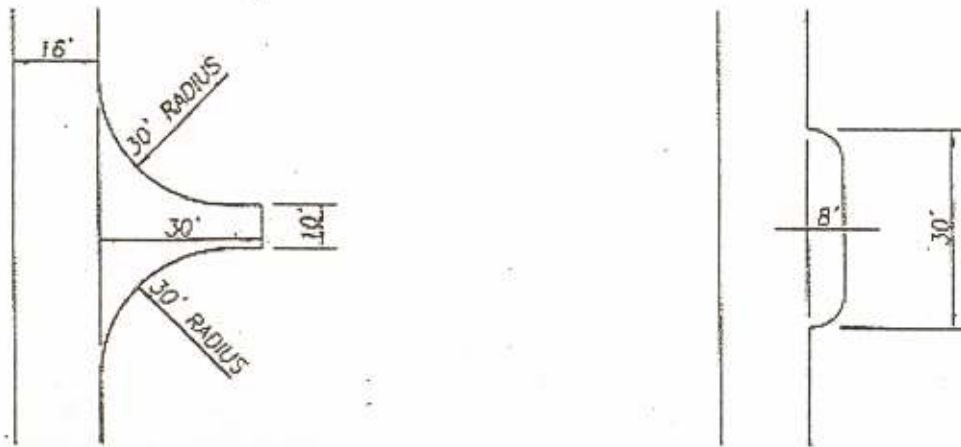
County Land Use Code. A brief stamped written explanation by the Owner's Engineer shall be submitted in situations where, due to site constraints, deviations from the original design have been made.



1. Total road width may be reduced to 12' (10' in unusual cases) with constant 4% cross slope for single residence access. Turnouts at maximum intervals of 600' should be at least 30' long.

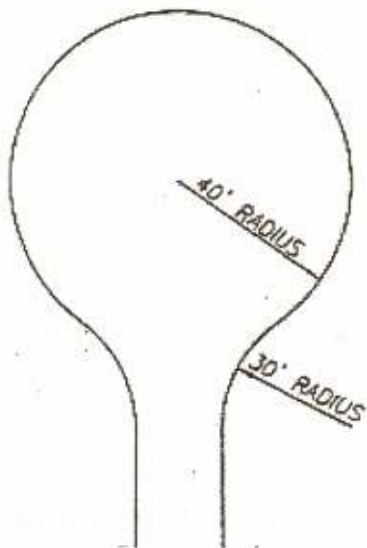
Figure 1. - Typical Road Cross Section

TYPICAL TURNOUTS



TYPICAL TURNAROUNDS

BUBBLE



"T" TYPE

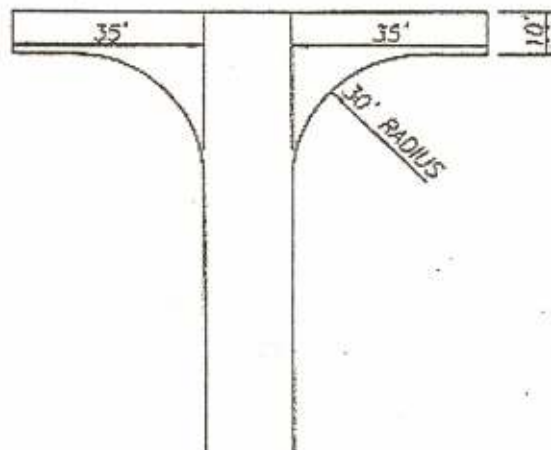


Figure 2. Minimum Geometric Requirements for Turnouts and Turnarounds

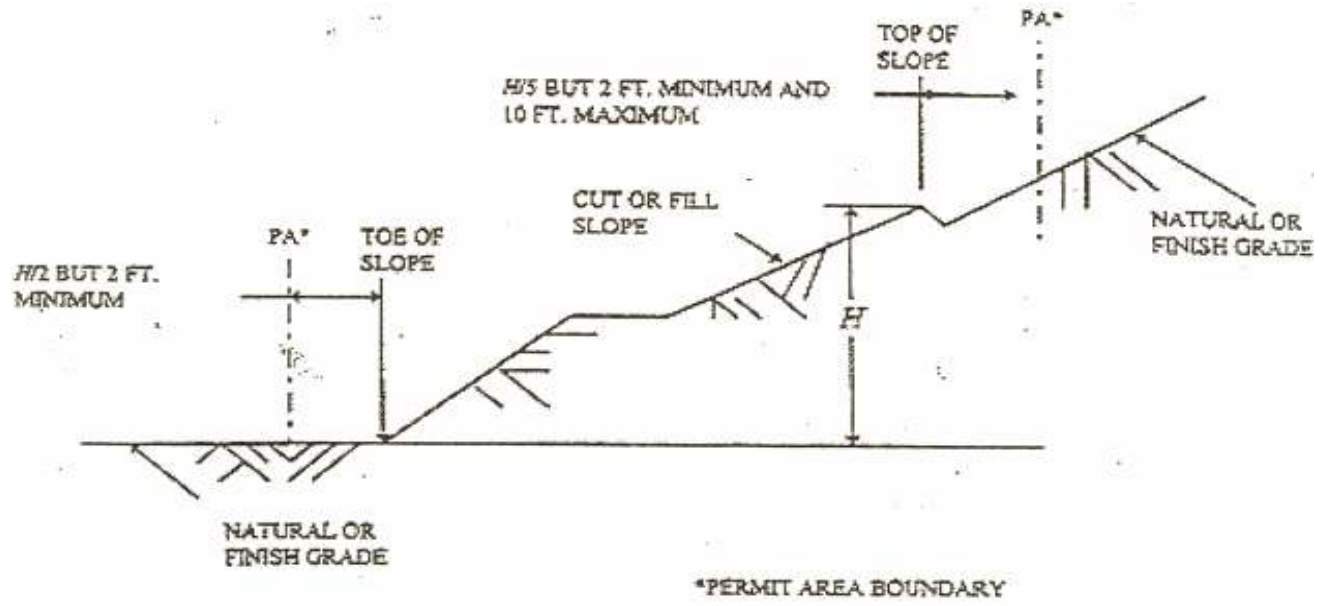


Figure 3. Setback Requirements