Appendix A

ROAD DESIGN STANDARDS – SYNOPSIS OF MAIN FACTORS

Goal: Establish a quantifiable character definition and standard for the park road that will:

- Improve safety as a primary component of road character.
- Maintain road character and the visitor experience as defined in the 1997 *Entrance Area and Road Corridor Development Concept Plan and Environmental Impact Statement (DCP/EIS).*
- Provide a road that safely supports the authorized design vehicle and links it to road character with the intent of keeping increasing bus size from causing changes to road character and the visitor experience.
- Establish a design guide for repairs and maintenance of the park road.

ITEM	Denali National Park Standards	Comments and Discussion
Road Character Definition Baseline	DCPEIS Appendix C	Intent is to provide a safe road while preserving the road character described in 1997 DCPEIS.
Rules of the Road	Final regulations for Denali NP & P "Rules of the Road" Published in 2000, included as Appendix C.	This element is crucial to preservation of road character. Continued progress toward enhancing safe travel and passing of vehicles on the park road is expected.
Design Speed	Maximum of 35 MPH, existing section standard.	
Design Vehicle	Current newest Tour Bus: Length: 40' 3" Width: 96" Maximum Height: 11' Maximum Wheelbase: 288" Maximum GVWR: 36,200 pounds Turning Radius: 40' 5" **All visitor transport vehicles exceeding this specification must travel during oversize hours.**	This represents the current largest bus on the park road. The new tour buses introduced in 2004 meet this spec as do current various business buses traveling to Kantishna on a daily basis. The intent of these standards is not only to quantify character but to also link bus size to that character. The intent of the design vehicle specification is to limit buses that transport visitors to a size that the road can safely support and is designed by these standards to safely carry. It is also to keep increasing bus size from forcing changes to the park road. Buses exceeding these specifications exceed the design and safety parameters of the road and will be subject to oversize travel restrictions.
Road Surface Type	Gravel west of Savage River, pavement east of Savage River.	Intent is to adhere to existing road character.

General Template Shape	Variable width and grade, either crowned (3 to 6%, with 3% typical) or gently outsloped (3% to 6%).	Intent is to stay with variable width and grade west of Teklanika Bridge in keeping with DCP/EIS, and to provide drainage for the road surface to reduce potholing, vehicle damage and road wear.
Maximum General Road Surface Width	Parks Highway to Savage: 24' to 28' Savage to Teklanika: 24' to 28' Teklanika to Tattler Creek: 24' Tattler Creek to East Fork: 24' East Fork to Toklat: 24' Toklat to EVC: 24' EVC to Kantishna: 22'	The intent is to establish maximum road width per segment based on existing widths and to preserve those widths as maximums.
Minimum Allowable Road Surface Width	This is a safety element in the standard that would authorize work to alter road width in specific locations when this standard is not met. Parks Highway to Savage: 24' to 28' Savage to Teklanika: 24' to 28' Teklanika to Tattler Creek: 20' Tattler Creek to East Fork: 18'* East Fork to Toklat: 16'* Toklat to EVC: 18'* EVC to Kantishna: 16'* *Except short anomalies where adequate intervisible pullouts exist, fill slope depths make achieving minimum segment width impracticable or impossible *and* sufficient travelway stability exists. In these areas the park will work to achieve a minimum width of at least 14 feet.	The intent is to keep variable width as existing within each segment and establish minimum widths based on safe travelway widths. It also establishes absolute minimums to improve safety.
Width Limitation and Control	1. Existing roadway widths and extent of road structure footprint will be retained except when the standards for minimum or maximum designated segment width, road edge variation, ditch widths, and intervisible pullouts cannot be met. 2. In areas between intervisible pullouts (see Section 3.8 Intervisible Passing Pullouts), where outer road edge variation standards (see Section 3.9 Road Edge Variation) cannot be met, widening to the minimum extent necessary to achieve the road edge variation standards can occur. Exceptions will be in very low speed areas (example: Polychrome Pass) where it is impossible or impractical to achieve this standard due to the extreme fill depths required. 3. A road section between intervisible pullouts can be	The intent is to provide adequate opportunities for vehicle passing while retaining reasonable and safe variations in width road by generally restricting repair work to the current area of the road area of disturbance unless specific standards for minimum road width, road edge variation, ditch width, or intervisible pullouts are not met. Site specific corrections would be used first rather than employing extensive sections of widening to a uniform two lane width. This use of intervisible pullouts and other site specific corrections rather than systematic widening is the approach that was endorsed by the 1997 DCP/EIS and preceding road repair planning for improving vehicle passing and general road safety. See intervisible pullouts for more information.

Width Limitation and Control, continued	widened to the maximum designated segment width in those limited areas where intervisible pullouts must be spaced so closely that they become impractical for maintenance activities or safe traffic management. Site specific corrections would be used first rather than employing extensive sections of widening to a uniform two lane width. This use of intervisible pullouts and other site specific corrections rather than systematic widening is the approach that was endorsed by the 1997 DCP/EIS and preceding road repair planning for improving vehicle passing and general road safety.	
Widening Work Parameters	**1.** The road could be widened up to a segment's maximum width by correcting ditch dimensions that are currently deeper and wider than the drainage standard (see Section 3.7 Drainage and Ditches) requires. Widening would not go past the outer disturbance limits of the existing ditch. In fill slope sections the road would be widened to the inboard ditch. In flatter road sections, with ditches on both sides, both ditches would be filled if necessary to meet the standards in Section 3.2.4. **2.** Oversteepened road edges that do not meet fill slope angle standards (see Section 4.6 Fill Slopes) would be laid back or reconstructed until standards are achieved. The objective would be to first accomplish the work within the existing structural footprint if possible, or then within the existing disturbance limits by concurrently filling any ditches that do not meet standards to regain the width that may have been lost during the edge repairs. **3.** Any fill slope road edge width variation that is still beyond standard limits after the preceding edge and ditch repairs have been completed would be corrected by widening the indented area outward to the minimum extent necessary until it tapers into surrounding road widths in a manner that meets the road edge variation standard and roadway structural standards (see Section 3.9 Road Edge Variation and Section 4.4 Load Bearing). **4.** In those remaining locations that are below minimum designated segment widths, widening would be accomplished by the method that causes the least disturbance while still achieving important safety standards for roadway width structural standards and road edge variation. Exceptions are in very low speed areas (example: Polychrome Pass) where it is impossible or impractical to achieve this standard due to the extreme fill depths required.	The goal and intent is to improve safety within design elements such as outer edge fill slope angle, outer edge variation, and minimum segment width while causing the least amount of additional expansion of the existing road area of disturbance. For example, repair of both road edge variation and oversteep edges could be achieved in many locations by laying back oversteepened edges and at the same time filling overly wide and deep ditches to gain back any lost roadway width. The result could be minimal changes in the amount of new disturbance while still making significant improvements in the road edge contribution to load carrying capacity, consistency, and safety.

Predominant Widths in Designed Repairs	Roadway width ratios of the completed project will generally simulate the ratios of pre-existing road width within the proposed repair section. Widths of the section to be repaired will be inventoried and assigned into 2' increment width classes so that the linear distance and percentage of occurrence of each width class within the section can be established for the section proposed for repair. Center points of the width classes will be 16', 18', 20', 22', and 24'. A designed repair using these center points will place each width class present in the pre-repair inventory in their preexisting proportions and in locations where they would best fit first within the road structure footprint if possible or then within the existing area of disturbance. Whenever it can be done first within the road structure footprint, or then within the existing area of disturbance, roadway widths between intervisible pullouts or other prominent terrain features such as large fill slope or corners will be designed to stay within one width class to simplify subsequent road maintenance and monitoring efforts. Existing pullouts would be excluded from the width inventory formula. They will be established and sized based on the pullout standard.	The goal and intent is to generally reflect the same percentage and pattern of widths in the finished repair that was present in the road prior to repair while still improving safety regarding road edge variation, bearing strength, and minimum width standards. Designers would place these widths where they best fit in the road area of disturbance to achieve these safety goals while creating the least amount of additional disturbance from the repair effort. The width standards established during a designed repair for any section will then become the road character design specifications for that section. In other words, the final design becomes the "quantifiable standard" for that road section in terms of long term monitoring for compliance with road character or for guiding maintenance crews during their routine activities.
Vertical and Horizontal Alignment	To comply with road character definitions, both horizontal and vertical alignments will be maintained as presently existing. Abrupt changes in vertical alignment resulting from periodic and/or continuing sub-grade deformation will be repaired following a parabolic arc which retains a smooth grade transition throughout the replaced section. Where slope failures necessitate horizontal realignment in order to retain the road (for example, realignment is the only effective alternative) such realignment will conform to the site topography and maintain the sinuous character of the road.	The intent is that both horizontal and vertical alignments will be maintained as presently existing. The exception will be with alignments such as the corner at Mile 68 where safety for oversized transport vehicles commonly used on the park road to haul fuel, supplies or equipment needs to be improved. This type of project will require separate environmental compliance review and management approval.
Grade – Longitudinal and in Cross-section	The longitudinal grades of the road will be maintained as existing, Maintain existing grades (see Table 3), including grades resulting from repairs as discussed in Section 3.2. The horizontal grades of the road will be as described in Section 3.1, Road Cross-Section Geometry. Road surface will be either crowned (3 to 6%, 3% typical) or gently outsloped or insloped (3% to 6%) as required for surface drainage on a particular section.	The intent is that longitudinal grades remain as existing and that grades in cross-section (perpendicular) provide appropriate drainage for the road surface and structure to reduce potholing, vehicle damage and road wear.

Road Edge Variations (General road edge and Pullouts)	This is safety element in the standard that would authorize work to alter road width in specific locations when this standard is not met. Any change in general roadway width will not be shorter than a ratio of 1' in 10'. Transition tapers to and from pullouts will not be shorter than a ratio of 1' in width to 10' in length. This proposed taper standard may or may not provide enough smooth transition for the general road, especially if the transition narrows the road. Field monitoring will be conducted and the standard may be changed in the future if necessary.	The intent of this element is to minimize vehicle "traps" in which an abrupt road width/edge transition traps a vehicle in a narrow spot when meeting another vehicle and to minimize abrupt road edge transitions.
Drainage	Ditch design will follow the general rule of width equals at least 2.5 times the depth, and ditch banks will be 1V to 1.5H or flatter. Existing ditches may be filled in to meet this standard in designed repairs as long as the resulting roadway width gain does not exceed the segments allowed maximum and additional disturbance is not created beyond the road structure footprint.	The intent of this element is that over-wide ditches may be filled in to gain road width up to a segment's authorized maximum as long as existing road prism cross section and disturbance is not increased. Drainage systems will be installed and maintained in a manner that matches surrounding road width on either side of the structure while also achieving the established standard for road edge taper.
Drainage Materials Preference	Galvanized steel, aluminum, concrete, HDPE or other composite material.	The intent is that the best and most appropriate culvert material will be available and chosen for a specific location or application to enhance longevity, efficiency, fish passage, etc…
Intervisible Pullout Spacing	This is a safety element in the standard that would authorize work which could alter road width in specific locations when the standard is not met. To be clearly visible and easily reachable from one pullout to the next they would be placed approximately 300' to 700' apart in areas where the roadway width is less than 24'. Areas of road with a roadway width of 24' do not need intervisible passing pullouts.	Intervisible passing pullouts help improve the safety of meeting and passing of vehicles on sections of the park road which are less than two lanes. The intent is that passing pullouts will be more intervisible and spaced close enough so that drivers can judge distance and comfortably reach them to facilitate a smoother and safer pass. In some locations they may need to be placed closer than 300', and 700' may be too far in some areas. This element will be field tested, and any changes to the standard will meet the intent.
Intervisible Pullout Dimensions	This is a safety element in the standard that would authorize work which could alter road width in specific locations when the standard is not met. Location of new passing pullouts will take advantage of terrain and minimize disturbance as long as sight distance can be achieved. Passing pullouts will provide a total roadway width of not less than 24 feet and will be a minimum of 75 feet long, including tapers. Existing passing pullouts may remain as currently configured unless they are inadequate for safe passing.	The intent is to provide the design vehicle adequate dimensions to safely pull over, stop, and yield to an oncoming vehicle and then safely pull back onto the driving surface.

Load Bearing Capability	This is a safety element in the standard that would authorize work to the road structure if the standard is not met when the road is at the desired service condition. Fully support the design vehicle within the roadway width when the design vehicle is stopped.	The intent of this element is to improve the safety of the road within the roadway width for supporting the design vehicle when the road is at the desired service level
Road Monitoring	An Inventory of the park road would be conducted every 3 years using the best available technology.	The intent is that the road, its width and features be monitored to ensure that it stays within the road character definition. The best method is expected to be the cycle road inventory performed by the FHWA every three years. This inventory will provide a photographic record of the road and its features and it is hoped that it will be able to provide roadway width measurements with future software versions.