CEDAR MESA RANCHES - ROADWAY NETWORK ASSESSMENT REPORT
SPRING, 2017

EXECUTIVE SUMMARY

The Cedar Mesa Ranches (CMR) subdivision road inventory and assessment was undertaken in spring, 2017 to understand the needs and priorities for the road network maintenance which is funded and performed through the budget of the CMR Home Owners Association (HOA). A road committee, which performed the inventory and assessment, serves under the direction of the HOA Board of Directors (BOD), with all members being current CMR landowners. Inventory data for the assessment was acquired on numerous days by and through use of Global Positioning Systems equipment and manual measurements and observations and entered into a Geographic Information System (GIS) database. The GIS database was envisioned, developed, compiled and maintained to be used as a tool for the specific analysis of the CMR road network needs and priorities, as a visual presentation aide, and for use by the road committee and HOA BOD as a road maintenance decision-making tool. The assessment was also performed to strengthen the understanding and follow-on discussion of the current road maintenance practices and how to improve upon them. Alternatives to address short and long-term CMR roadway network maintenance needs and issues have been developed and are presented in this report.

INTRODUCTION

Cedar Mesa Ranches is a 139-lot rural residential subdivision located in central Montezuma County, Colorado. CMR has a 9.63 mile (GIS miles) roadway network which was originally designed, constructed and maintained with the intention of providing access to those lots and serving as a vehicular traffic collection system. The roadway network is comprised of 1039 feet of paved road while the remainder (49,827 feet) is gravel surfaced (GIS feet). Even though the signed and legally recorded plat document for CMR states that the roads within the CMR subdivision are to be considered public roads, the maintenance of the CMR road network is the responsibility of the CMR HOA. Thus all of the roads in CMR are considered to be privately maintained and have red colored road name signs. The road network was built as a part of the subdivision development and infrastructure construction in the early 1990s at which time Montezuma County did not have road design, construction and maintenance standards. In the period since CMR roadway network completion, Montezuma County has adopted road construction standards. The CMR network does not meet the current county standard. Entrance upon the CMR roadway network is gained via a paved public frontage road along US Highway 160 at the Mesa Verde National Park entrance bridge and ramps. Although the privately owned CMR subdivision lands are surrounded by public lands, all subdivision roads come to a termination in cul-de-sacs which means that there is no external traffic allowed to travel through the subdivision to another point upon the external public road system. The road network is shown in Figure 1. The CMR HOA BOD has struggled to identify the best use of limited budgeted funds for road maintenance. This report summarizes the road assessment findings and seeks to make recommendations to the BOD and CMR residents regarding roadway network maintenance priorities.

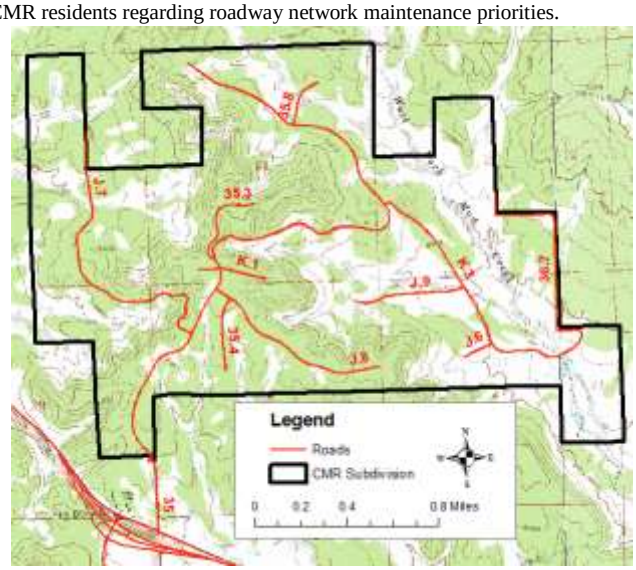

Figure 1 - Cedar Mesa Ranches General Map

SEASONAL IMPACTS

CMR roads are impacted by winter seasons which can bring a wide range of snowfall accumulation, spring precipitation in the form of rain showers and by late summer monsoon thunderstorm rainfall which can be voluminous with dry periods in between these precipitation and runoff events. Temperatures on a winter day can fall to well below zero and rise to above freezing. This means that, given wet weather before a cold weather event onset, all subdivision roads are

subject to freeze-thaw action upon the surface and the sub-roadbed. Results of freeze-thaw cycles are seen by the appearance of potholes both in the gravel and the paved segments of the roadway network. Several roadway network segments experience standing water puddles and mud during and after large precipitation and runoff events. Snow plowing and clearing is the typical maintenance activity in the winter and has been achieved by a local contractor with a motor grader and a skidsteer. The typical maintenance activity in the warmer months is smoothing washboard segments and some minor ditch cleaning and the addition of roadbase.

Road surface impacts are seen during dry periods, especially in the summer, and exaggerated by frequent windy conditions. When the gravel road surface is dry, vehicles driving create washboard and grind the surface materials into a dust. The dust, upon becoming fugitive cloud behind a moving vehicle, becomes a nuisance to nearby residential homes and a potential driving safety hazard for oncoming vehicles and those travelling behind in the dust cloud. This dust also represents a significant loss of roadbase material over time.

TOPOGRAPHIC, BIOTOC COMMUNITY AND SOIL TAXONOMIC IMPACTS

The CMR subdivision roadway network is located within an area of steep hillsides and native soils that are prone to erosion from large precipitation and runoff events. There is a deer herd located in the subdivision area which can cross roadways without warning and also pose a driving safety hazard.

ROAD NETWORK FEATURES

The as-built road network has gravel and asphalt pavement segments. There are 69 culverts which cross CMR roads to provide cross drainage. There are 12.06 GIS miles of ditches that also provide drainage once the water is laterally drained off the road surface. Due to topography and the original roadway segments' horizontal alignment, not all roadway segments have a drainage ditch on both sides. There are eight three-way junctions and one four-way intersection. For the report reader's reference, the ideal road section and terminology is shown in Figure 2.

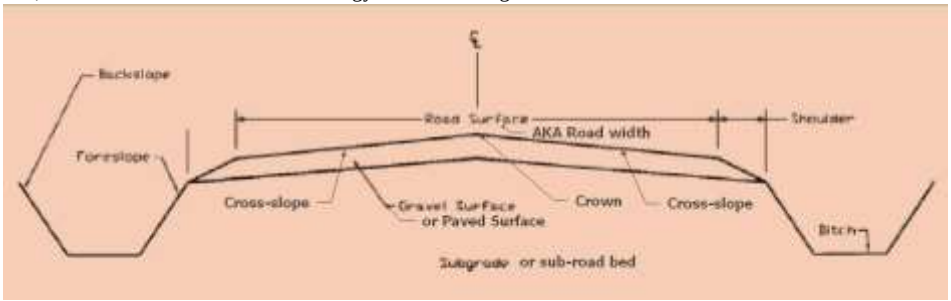

Figure 2- Roadway section features

Materials important in road maintenance in the road section are located in the surface and the subgrade. Surface materials are frequently called road base and the ideal selected material consists of aggregates less than 1" in size with fine materials of a sand and clay mixture to act as a "binding" agent or a "glue" to keep the aggregates in place. The subgrade ideally consists of larger aggregates below up to 3" in size, also with a binder.

INVENTORY DATA ACQUISITION

The CMR road network was driven by the GIS coordinator with a GPS to acquire horizontal and vertical alignment characteristics and attributes. The GPS acquired road network linear data was then broken into roughly 100 foot segments and GPS data was manipulated to acquire the vertical grade for any given road segment. This data was converted into linear GIS vector data and compiled in the GIS database. The length used for determining the above discussed totals is the GPS acquired 3-dimensional length. This is the item named Lg_3d_ft in the roads data GIS shapefile. The road length may be different from that shown on plat maps and design drawings because road terminations at cul-de-sacs were not driven during GPS data acquisition to the point on the cul-de-sac where a line extending from the end road segment would end on the cul-de-sac radius. The road inventory team then drove the road network and acquired and entered into the GIS database other data as follows: road section width, road section cross-slope, cross-drain culvert diameter, roadway surface deficiencies, lateral drainage ditch length and deficiencies and existing culvert specifications and deficiencies.

The road inventory team had time and resources to sample 253 of the 495 roadway network inventory segments which average 102 GIS feet in length. This is a CMR overall roadway network statistical sampling rate of 51%. In the interest of keeping this report statistically simple, this type of calculation will be used to assist in extrapolation of further statistical analysis. Through GPS data manipulation and GIS inspection of the map of the roadway network, all 495 segments' vertical gradient were calculated and a segment alignment specification (tangent, curve or cul-de-sac) was assigned. Once the data was entered and

compiled into the GIS database, the results were queried to provide the statistical analysis in the following report sections. All numeric data discussed in this report is derived from the GIS tabulated data.

VEHICLE TRAFFIC IMPACTS

Traffic count data were estimated by the number of existing homes upstream from any given roadway segment and the estimates were entered into the GIS database. Traffic impacts must consider not only current and future traffic generated by residential homes but also guests travelling to visit residents, and contractors and service and delivery vehicles. Traffic counts vary from the maximum average daily vehicle count on Road 35 at the subdivision entrance (currently 86 homes upstream) to a very low count along Road 36.7 (1 home upstream of the termination cul-de-sac).

INVENTORY FINDINGS AND SUMMARY

All roads need additional roadbase (gravel surfacing), with most having little to no roadbase over the sub-base The road committee believes that average vehicle speed is a large factor in the loss of surface gravel and the rapid formation of washboard. The rate of loss of surface gravel is also a function of the average vehicular traffic count a given roadway segment experiences. Road 35, along its alignment from the subdivision entrance to Road K.3 is a good example of this. This roadway segment is the busiest in the subdivision. The surface materials are displaced by vehicle wheel loads over time and this can readily be observed during dry periods and within a few weeks after grading operations in the form of tire channels. The tire channels appear as a hardpan of the fine materials which remain after the larger aggregates have been displaced to the road shoulder or in between the tire wear areas of the path of vehicles in the roadway. Surface materials can also be displaced by improper grading practices. This hardpan becomes muddy in wet periods. Some segments have lost the surfacing materials, either through vehicular travel upon the surface or by improper grading, to the point where the underlying sub-roadbed materials are exposed. This is particularly the case along Road 35 from the hill crest to Road K.3.

Roadway horizontal alignment statistical summary and needs: There are 50,866 feet (9.63 miles) of roadway in the CMR road network of which 49,827 feet (9.43 miles) are gravel surfaced and 1039 feet (0.2) miles are paved. The roadway width throughout the network varies from 30 feet on Road 35 to 12 feet on Road 36.7. There are multiple segments of roadways that ideally should be relocated laterally further from a hillside cut so as to provide more room for the lateral drainage ditch on that side of the road. Current maintenance of the ditch along the hillside cut along these roadway segments is difficult because the cut slope continually fills in the ditch after precipitation and/or runoff events.

Roadway vertical alignment statistical summary and needs: The vertical gradient within the CMR roadway network ranges from a steep 13% at the hill on Road 35 to numerous segments which are flat at 0% grade. Maintenance considerations of the 13% grade segments are made more complex in that many of these segments are also curved in horizontal alignment. Severe washboarding appears during dry periods at locations of large gradient changes.

Roadway tangent segments and needs: Washboarding can appear at locations on tangent segment where there are vertical gradient changes. There are 110 tangent roadway sections in the CMR road network for a total length of 11,364 feet (2.16 miles). 1439 feet (0.27 miles) of the 49 sampled tangent segments (5051 total feet) meet the standard 2-4% drainage cross-slope (calculation–> 1439/5051 = 28% of the sampled tangent segments have cross-slope which meets the standard. 0.28 x 11364 = 3181 feet) This extrapolates to 3181 feet (0.60 miles) which meet the cross-slope standard and 8182 feet (1.55 miles) do not meet this standard with either slopes of more or less than the standard cross-slope specification on tangent segments.

Roadway curved segments and needs: There are 38,784 feet (7.34 miles) and 372 segments of curved roadway sections in the CMR road network of which 192 segments were sampled. From the sampled segments, six segments of negative 2-4% cross-slope right and +2-4% cross-slope left and there were four segments of negative 2-4% cross-slope left and +2-4% cross-slope right. This is a total 10 sampled curve segments of the total of 192 curved segments (calculation–> 10/192 = 5% of the sampled tangent segments have cross-slope which meets the curved segment super-elevation crosslope standard. 0.05 x 38784 = 1939 feet). 1939 feet (0.37 miles) meet the super-elevation standard and 36,844 feet (6.98) miles do not. Washboarding can and does frequently appear on curved segments and especially when there is a gradient in combination with the curve.

Roadway junctions, cul-de-sacs and needs: There are 13 cul-de-sacs including the gang mailbox at the subdivision entrance and one on Road K.3 before the Mud Creek crossing adjacent to Lot 82. There are additional factors that bear on junctions and cul-de-sacs in the form of higher stresses on the roadway surface and sub-roadbed due to vehicle turning movements. The wheel loadings become intensified at these locations. Washboarding can and does frequently

appear at junction segments due to additional wheel load stresses from vehicles slowing and accelerating. Maintenance of the full width of the cul-de-sacs are critical in accommodating large vehicles such as fire-fighting and emergency response equipment and other transport vehicles.

Ditch statistical summary and needs: There is 63,661 feet (12.06 miles) of ditches alongside the roads. Ditches which drain steep road segments are extremely prone to erosion and filling of eroded sediment at the base of steep runs. A particular example of this is on the Road 35 hill where the left (north) side ditch is incised to the point where in places it is 3 feet deeper than the roadway surface. This is a safety hazard for vehicles whose tires catch on the shoulder and the vehicle cannot pull back onto the roadway. 35,284 feet of ditches need cleaning/reshaping to recover road base that has been lost thru motor grader operations and 2000 feet of ditches need armoring.

Culvert and cross drainage features summary and needs: There are 70 existing cross-draining culverts. A number of culverts need to be reinstalled with attention taken to ensure a proper drainage gradient along the culvert. This is primarily due to the nature of the native soil suspended in water flows and runoff thru the culvert and the need to ensure a thorough "sluicing" action thru the culvert so that the sediment does not settle into the culvert. A number of culverts need armoring at the inlet, outlet or both ends to guard against erosion which takes place at transition areas from drainages and ditches into the culverts. In addition, there are numerous culverts which need to be cleaned of the accumulated sediment within them. There are three locations on the roadway network where culverts need to be installed and four locations where the need for culverts needs further determination.

Guardrail needs: There is 300 feet of guardrail. The guardrails' conditions are satisfactory at this time but none of the terminals meet current safety standards.

Road Profile needs: Much of the road network is lacking in proper crown, which greatly increases the incidence of pothole and rut formation. Re-crowning of the road profile before application of additional roadbase is needed to provide a more solid and robust roadway.

Dust abatement: Abatement materials are expensive to apply from a cost/length perspective but may offer some advantages in assisting to hold road base in place once applied. Another advantage of abatement application is the control of fugitive dust.

ROAD MAINTENANCE BEST PRACTICES

Dale Murphy is the current CMR road maintenance contractor and has had the contract for many years. Motor grader operations, during winter snow plowing or summer grading, have caused an additional loss of surface gravel into the ditches. Some, but likely not all gravel in the lateral drainage ditches can be reclaimed. Close coordination between the HOA BOD, CMR road committee and the road maintenance contractor machinery operations staff is imperative. Periodic review of maintenance machinery operations, practices and contractor staff qualifications as appropriate to CMR roads and their conditions is highly recommended.

Weeds – Although the efforts of the CMR volunteer weed management team is to be commended, extra noxious weed management vigilance will be required after any road network feature has been reconstructed and/or maintained. These activities can disturb soils surrounding the roadway section and the noxious weed seed bank activity can be reinvigorated.

KEY NEEDS FOR CMR ROADS

1. Close coordination between the HOA BOD, CMR road committee and the road maintenance contractor machinery operations staff is imperative.
2. Periodic review of maintenance machinery operations, practices and contractor staff qualifications as appropriate to CMR roads and their conditions is highly recommended.
3. Listed roadway network drainage problems should be addressed.
4. If a special district with authority to gather large amounts of capital cannot be formed to accomplish roadway network improvements quickly, a systematic approach for improvements which are financially feasible in the current annual HOA budget is the only maintenance program possibility

ALTERNATIVES AND RECOMMENDED ACTIONS

No Action Alternative - The no action alternative will be asked for by a certain contingent of landowners and they will want to know why this alternative is not further considered. This, of course, is the least expensive alternative because no action is taken. Roadway surfaces will deteriorate drastically if a

minimum of maintenance is not accomplished on an annual or periodic basis. It is likely that after just a few years without maintenance, much of our road system would be simply impassable, even with high clearance and 4wd.

Proposed Alternative – This alternative would resurface one mile of Road 35 from the entrance into the subdivision first in year one. The second year the second mile of Road 35 would be resurfaced. And so on until all roads would be satisfactorily resurfaced or cycle back to begin resurfacing Road 35 again in years after year two. This alternative may not financially provide for addressing the other roadway network maintenance needs such as those described in the above sections for culvert and ditch maintenance issues.

Alternative A – Form a road maintenance special district which meets state regulations and has the authority to levy assessments upon lots in the district. This would be a way of gathering an amount of capital large enough to pay for needed improvements up front instead of the pay-as-you-go approach of the other action alternatives listed here. There would be an additional amount payable by each lot owner to retire the debt incurred for the special district formation.

Alternative B - Address the worst segments and roadway features first such as culverts and ditches. This could be done on a systematic basis and stay within the current annual HOA roadway maintenance budget line item.

Alternative C - Building the road sections to meet the original design speed (25 mph). Reduce roadway widths to minimum County standards based on maximum build-out including one travel lane width with turnouts at curves and other long stretches on CMR lower traffic count roads (35.3, 35.4, 35.6, K.1, J.6, J.9, J.7). This could possibly offer cost savings for the relatively smaller inconvenience of cars waiting for oncoming cars to pass.

Alternative D - Building the road section to meet the speed capacity currently being experienced on CMR roads (possibly 35 mph). This would be quite a bit more expensive than the other action alternatives listed here. This would also require additional curve signing as many of the curves are too sharp for vehicles to safely maintain 35 mph.

Alternative E – A CMR landowner has suggested the fabrication of a pull behind sliding grader composed of old tires to be used to regrade the CMR roads. This owner has volunteered to provide this service if this alternative were approved. This would be a cost savings over the current contractor using costly grading equipment. This alternative would need to be undertaken with other actions including the badly needed improvement of drainage features and would not include the rebuild of the roadway section crown and cross-slope.

Alternative F – A CMR landowner has suggested the CMR HOA purchase a small motor grader and then take bids from operations contractors to operate the equipment for maintenance. As in Alternative E, this alternative would need to be undertaken with other actions including the badly needed improvement of drainage features and would not include the rebuild of the roadway section crown and cross-slope.

Alternative G – Leave the washboarding in place to control vehicular speed but implement drainage improvements to ditches and culverts.

The life-cycle costs for alternatives have not been estimated nor amortized for each alternative's lifetime, but this should be performed as a next step given the HOA BOD consideration of this report. The HOA BOD can accept and implement any alternative, can combine features of multiple alternatives, create a new alternative or implement none of the alternatives.

RECOMMENDATIONS AND PRIORITIES

1. Vehicle speed - The assessment team believes this item is of the highest priority and the HOA BOD must take more aggressive steps to reduce the average vehicular speed currently observed on the CMR road network in order to lengthen the lifespan of the roadway gravel surface. Washboarding and tire channeling is another result of average vehicle speeds that are too high.
2. Periodic review of maintenance machinery operations, practices and contractor staff qualifications as appropriate to CMR roads and their conditions should be undertaken and performed by qualified members of the CMR road committee.
3. Listed roadway network drainage problems should be addressed. This includes reinstallation and cleaning of noted culverts, and armoring of noted culvert inlets and outlets. This also includes cleaning, reshaping and some armoring of noted roadway segment ditches.
4. Segments with underlying sub-roadbed problems should be repaired.

5. Proper roadway section crowning with proper cross-slope should be made a long-term goal
6. Gravel surfacing materials should be applied through a systematic approach.

COORDINATION NEEDS

1. Coordination with private owner (Lot 67 - Eschalier) in the Road J.9 cul-de-sac for redirection of their driveway drainage currently impacting the cul-de-sac.
2. We also need discussions with Montezuma Water Company for possible relocation of a valve box along Road 35 which is in the lateral drainage ditch within the HOA right-of-way. Grading and maintenance of the ditch is not possible with the valve location.
3. As was noted earlier, our roads provide the sole access to a substantial amount of BLM land. Discussions are in order with them to participate in our road maintenance.

A cooperative agreement with the above parties is recommended as the best approach to long-term solutions of the above problems. A copy of the written documentation of such agreements should be kept in HOA files for safekeeping and future reference.

SUMMARY

Rural roadway maintenance is a complex and expensive undertaking. Specific maintenance problems for the CMR road network have been inventoried and a brief recommendation and priorities list has been developed for the consideration of the CMR HOA BOD in this report. The GIS database has been compiled and is available for further queries which would support more detailed and accurate cost estimates and future decision-making.

REFERENCES

FHWA Gravel Road Maintenance Manual

ACKNOWLEDGEMENTS

The road committee sponsored a team comprised of Terry Wheeler, road committee chairman; Don Murrell, CMR HOA BOD/ road committee member; and Stan Mattingly, database coordinator and custodian.