

Renewable Gravel Sources for Road Maintenance in Denali NP&P

By Kenneth F. Karle

A 90 mile gravel road forms the main transportation corridor into Denali National Park and Preserve (DNA). Decisions by previous park managers not to pave this road were based on a desire to maintain a 'wilderness' quality to the road system. Also, it was felt that asphalt pavement might act as a hindrance to migrating wildlife within the park. As such, the gravel roadbed requires long-term material sources for annual maintenance and resurfacing. NPS requirements for in-park material sites impose special constraints upon managers considering source development. Perhaps the most important of these is that the site and method of excavation operations should lend themselves to as close a return to a natural condition as possible.

In response to the constraints of these criteria, the NPS has determined that alluvial floodplain sites will help meet the needs of replenishable gravel production in Denali NP&P. Because of its size, central location, and acceptable material quality, the Toklat River floodplain has been chosen by park engineers as a primary alluvial gravel removal site. However, numerous questions remain as to the quantities of gravel that may be mined without causing floodplain degradation, as well as to which removal methods will best promote a natural floodplain rehabilitation.

A research program was initiated in 1988 to provide a detailed and comprehensive analysis of the fluvial processes that occur near and in an alluvial floodplain gravel removal site. The determination of a safe yield for gravel removal and the proper placement of removal sites on the Toklat River floodplain required a two-fold approach.

Computer modeling was employed to note the effect of annual floods on various excavation configurations. A predictive computer sediment transport code was used for the modeling effort. With such a code, floodplain gravel removal sites may be modeled by altering river bed geometry, and noting replenishment in the form of surface elevation changes after the passage of a flood. In this manner, scrapes or pits for gravel removal may be designed for optimum size and location in order to assure a maximum replenishment rate.

The second approach method used in the study was analysis of experimental gravel pits excavated on the Toklat floodplain during the 1988 and 1989 summers. Three gravel removal sites, each significantly different in design, were analyzed for both qualitative and quantitative information regarding replenishment and site rehabilitation. The first two scrapes involved excavations placed longitudinally and laterally (respectively) to the direction of flow on the floodplain. Both scrapes eventually incurred natural replenishment and rehabilitation over a two year period. However, the third design tested offered much quicker rehabilitation results, and merits further investigation by park managers. A brief explanation of this scrape design follows.

Floodplain Gravel Excavations

The Toklat River is a 100 mi² watershed located on the northern side of the Alaska Range. The basin is extremely mountainous, with several peaks over 7000 feet high. In addition to snowmelt and rainfall, the Toklat is fed by glaciers, which cover two percent of the basin

area. The river is extremely braided in nature, and is usually milky in color, due to the large amount of glacial silt in the water.

The third Toklat River test scrape, designed with the assistance of William Jackson, NPS Water Resources Division, was excavated on June 6 and 7, 1989. The idea behind this design was to try to mimic the braiding processes that occur on the gravel bed drainage course. To accomplish this, a main channel with substantial water flow was identified and surveyed. The excavated scrape was placed so that it mirrored a significant meander in the main channel. The scrape, in the form of a channel, matched in length, width, depth, and slope the channel it mirrored. Approximate dimensions of the excavated channel included an average width of 25 feet, depths of 2-3 feet, and a length of 430 feet, which resulted from the excavation of 1000 cubic yards of gravel. This excavated channel was connected both downstream and upstream to the existing channel, which allowed immediate inundation to occur. The design was implemented to provide an equal flow split between the existing and excavated channels. Upon completion, the designed channel pattern was essentially indistinguishable from natural channel patterns. To monitor this scrape, six cross-sections were located along the test area, and level surveys were used to keep track of elevation changes in the original and excavated channels. These cross-sections were surveyed June 5 and 6 (time of excavation), July 15, and Sept. 12, 1989.

Aesthetic healing of the excavated scrape was observed to begin almost immediately following streamflow inundation. Even at relatively low flow conditions, scour and deposition of streambed materials was significant enough to erase most signs of heavy

equipment operations in and near the excavated channel within a two-week period. By the end of the first four weeks, casual observers unfamiliar with the project could not identify the test channel as a human-engineered excavation.

Though significant aesthetic healing processes occurred soon after excavation, substantial gravel deposition and replenishment did not occur until much later in the summer. This may be attributed to significantly larger streamflows on the west side of the Toklat drainage course, which took place from the beginning of August through the middle of September.

By Sept. 12, topography changes in the drainage course were so substantial that the excavated channel was completely obliterated. From the surveys, it is roughly estimated that at least 77 percent of the removed gravel in the excavation was replenished.

Conclusions

Based on the study results, it would appear that extraction design based on mimicking natural channels on a braided drainage course will encourage rapid healing and gravel replenishment. It should be noted that terms such as 'healing' and even 'replenishment' are difficult to quantify, and that estimates of replenished gravel (such as 77%) should be used with caution, and perhaps only in terms of general trends.

Additional hydrologic studies of the Toklat basin are continuing. A complete analysis, based on both empirical observations and mathematical modeling, should allow NPS planners to formulate a practical, yet conservative, gravel extraction management plan to meet park needs while vigorously protecting park resources and promoting rapid site rehabilitation.

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The Toklat River study site, looking upstream (South).