SOIL & WATER VALUES WITH PARTICULAR REFERENCE TO LOGGING & ROADING

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LOGGING AND SOIL AND WATER VALUES

Regardless of the primary objective of growing wood production forest lands have undoubted secondary objectives in water production and in watershed protection. The importance of these secondary products is of course dependant on many factors including geological stability, soil type, topography and location. The forest operations that fall under the umbrella of logging inevitably result in soil disturbance to a greater or lesser degree which may effect soil and water values implicit in these secondary products.

The degree to which logging effects soil and water values is dependant upon the physical characteristics of the site along with the type and standard of operation undertaken. The effects of logging operations on soil and water values can be expressed in terms of suspended sediment load down stream of the site of operation. Megahan (1971) notes that this effect differs markedly, varying from no detectable change in suspended sediment load in some cases to extremely large increases in others. One particular study reported by the U.S. Department of the Interior in it's Industiral Waste Guide (1976) recorded suspended sediment levels 7,000 times greater than those occuring upstream of the operation.

Roading and Tracking

Road and track formation involves soil distrubance but it is when soil and other associated debris move off site that soil and water values are threatened. Numerous studies including those of Megahan (1971), Slaney, Chamberlin and Halsey (1973), Haupt (1959), Fredricksen (1965) and Packer (1967) identify roading and tracking operations as being the chief contributor of sediment. While these studies originate in North America the results are undoubtedly pertinent to the New Zealand situation as confirmed in Pearce and O'Loughlin (1978).

Mechanisms operating in suspended sediment contribution from roading and tracking include:-

1. movement of soil and debris directly into watercourses during construction and maintenance;
2. movement of soil and debris placed near watercourses, or in ephemeral watercourses, during periods of peak flow or overland flow;
3. surface erosion of carriageway and watertables;
4. surface erosion of fill and sidecast materials;
5. mass movement of sidecast material from the failure of oversteepend sideslopes;
6. mass movement of upslope materials from reactivation of old erosion features;
7. failure due to slope toe removal.

The studies referred to above have also noted that the suspended sediment load associated with roading is greatest in the first year or two after construction while earthworks settle and revegetate. Fredricksen (1965) found that the runoff from the first rainstorm following the completion of the road under study carried 250 times the concentration of sediment measured from an adjacent undistrubed catchment. Two months after construction the observed sediment concentrations had diminished to levels slighly above those from the undisturbed catchment. Megahan (1971) found that 93% of the total sediment production during a six year study period occured by the end of the second year after construction.

Slash Deposition

The deposition of logging slash and associated organic debris in watercourses or in a position such that it may enter the watercourse, and damage to the banks and beds of watercourses are the other major effect that logging operations can have on soil and water values.

LOGGING AND WATER QUALITY

Water quality is adversly effected by the addition of suspended sediment and organic materials.

Suspended Sediment

The adverse effect of high suspended sediment loads includes:

1. increased costs of treatment for water supply purposes;
2. excessive wear on turbine blades, pumps, irrigation gear etc;
3. reduction of channel storage by deposition which may lead to increased flood risk;
4. inhibited recreational use, both aesthetic and physical;
5. damage to the aquatic ecosystem by:
   i) acting directly on fish living in the water and either killing them or reducing their growth rate and resistance to disease;
   ii) reducing the abundance of fish food where settleable materials blanket the bottom of water bodies damaging invertebrate populations and disrupting plant life. Sediment concentrations of 80 mg/l have been shown to reduce invertebrate populations by up to 60%;
   iii) silting of spawning grounds and smothering of fish eggs.

Nutrient Enrichment

Logging slash and organic debris in contact with water go through the process of decomposition resulting in an increase of dissolved plant nurtients, particularly the wood sugar products released by leaching. Evidence of this decline in water quality is seen in the growth of bacterial slimes and algae bloomswhich thrive in these conditions.

Dissolved Oxygen

The decomposition of this material is carried out by microorganisms which utilise dissolved oxygen in the process. As dissolved oxygen is a vital part of the aquatic environment any depletion by way of the decomposition of organix materials is detrimental to water quality. Where there is insufficent dissolved oxygen in the water column anaerobic processes function producing materials such as hydrogen sulphide and methane which are generally regarded to be undesirable.

Light Penetration and Temperature Changes

The combined effects of suspended sediments and algal growth reduce the penetration of light into the water body so reducing the photic zone and limiting primary production in the food chain. A further effect is the heating of the surface water due to the greater heat absorbancy of this particulate matter. This heating stabilises the water column and prevents vertical mixing which in turn decreases the dispersion of dissolved oxygen to the lower levels so promoting anaerobic processes.

Where previously shaded streams are exposed to full sunlight after logging has removed cover from the banks water tempreature rises with an accompanying decrease in dissolved oxygen content (the saturation level of dissolved oxygen is temperature dependant). The decrease of dissolved oxygen levels can be sufficient to limit aquatic life.

FOREST OPERATIONS GUIDELINES

The realisation that forest operations can have significant impacts on soil and water values for considerable distances downstream, coupled with the fact that many forests are located in upper catchments above areas of more intensive land use and occupation with associated demands on the water resource, saw the introduction of the Forest Operations Guideline (1978).

This guideline was prepared by a Technical Committee established by the National Water and Soil Conservation Organisation with representatives from the New Zealand Forest Owners Association, the New Zealand Loggers Association, the New Zealand Forest Service, Catchment Authorities and NWASCO. It has the objective of assisting forest managers in the development of practices that will safeguard the country's soil and water resources.

The Guideline is designed to give individuals involved in forest operations an indication of the requirements or considerations necessary to protect soil and water values when undertaking individual phases of forest management. It was intended that the Guideline should form a broad basis upon which local interpretation would build specific requirements for specific sites. It would be neither practical nor desirable to attempt to formulate a rigid National Guideline that was site specific due to the immense variations in soil type, topography, vegetation cover, climate and operational objectives. Forestry concerns may wish to produce their own Guidelines specific to their situation in consultation with the Catchment Authorities e.g. the NZ Forest Service Kaingaroa Forest Guideline.

LOGGING AND THE FOREST OPERATION GUIDELINE

The introduction of the Guideline saw some concern within the forest industry that it would, or could, be used by the Catchment Authorities in a heavy handed manner that would unduly restrict normal operations or add to costs unreasonably. There was also some concern that the conservation and environment lobby could attempt to use the Guideline for purposes outside its intent.

Experience to date has shown that the Guideline has been largely successful and has been used as intended by both the Catchment Authorities and the Forest Industry. Overall there has been a definite improvement in operations, in terms of soil and water values, with some exceptions. The most notable exceptions is in the area of the smaller private contractor, particularly the two or three man indigenous logging contactor, where soil and water values are either not recognised or are not considered as being important or are consciously ignored.

Roading: Planning

The adverse effects of roading and tracking described earlier can be eliminated or brought to within acceptable limits with sound and careful planning and the application of existing knowledge. The roading section of the Forest Operations Guideline outlines measures that should be viewed as good roading practice regardless of the Guideline. High standards of roading planning should not be regarded as a concession to the water and soil movement or to the environmental movement but should be regarded as an integral part of responsible land management.

By specifying high standards of design it is not inferred that all forest roads and tracks should be designed as four lane highways, it is implying that all roads should be designed with regard to the level of use intended, to the terrain to be covered and to sensitive water and soil matters encountered on route. For example the criteria used to determine the satisfactory location, design and construction or a roadline through terrain of moderate slope may fail to cope with steepland conditions and lead to intolerable levels of disturbance. On the other hand identical criteria should not be applied to two different roadlines that traverse similar sloped terrain with widely varying geological stability.

Hence future road planning must continue to strive for road lines that:

1. are planned and implemented well ahead of logging and with regard to catchment topography and general drainage conditions;
2. minimise the risk of debris and spoil entering watercourse;
3. avoid the unnecessary crossing of watercourses and erosion prone areas;
4. stabilise cut and fill slopes be appropriate measures such as seeding, compacting, benching etc;
5. avoid earthworks on unstable slopes when climatic or soil moisture conditions would aggravate soil erosion and sediment transport;
6. have adequate culverting and cutoffs to provide for the safe disposal of runoff water and prevent concentrations of flow and the scour of water tables and fills;
7. have stream crossings designed with due regard to flow characteristics;
8. minimises interference with natural drainage.

Roading: Construction and Supervision

It is considered that the planning phase of roading in logging generally causes few problems to soil and water values. There is however some concern that supervision of road construction and ongoing maintenance are not always up to the required standards.

No matter how good the technical knowledge and capability of the planning staff it is performance in the field that is critical during the construction phase. Many machine operators cause irrepairable damage by failing to follow instructions or being unaware of the consequences of their actions. A high level of competent supervision is not a luxury but a necessity. In a similar vein all the good work put into building a road of good standard is negated by the failure to ensure that ongoing maintenance is carried out:- a blocked culvert is useless when it comes to safely disposing of runoff water.

Temporary Tracking

The location and construction of temporary tracking utilised in logging must be treated in a similar manner to the planning and construction of permanent roads as discussed previously, but obviously to design standards suited to their temporary nature.

While it is considered that few threats to soil and water values exist in permanent roading today, the area of temporary tracking is viewed with some concern. There would appear at times to be a lack of proper planning with machine operators taking the easiest line, sometimes with a total disregard to soil and water values, resulting in spectacular and damaging results.

With the completion of use temporary tracks should be left in a state providing for adequate drainage and soil stability without the need for ongoing maintenance. All too often these tracks are abandoned with little or no provision for drainage and stability which results in scour of their surfaces by way of uncontrolled runoff. It would appear that there is often the thought that perhaps the track may be needed just once more, with the result that the necessary work is overlooked. The logging supervisor should be held responsible for ensuring that all necessary drainage and runoff control works are completed before his machinery leaves the area.

Similarly temporary crossings must be removed when no longer required.

Riparian Strips

The Guideline provision for riparian strips, or protection areas, along watercourses was initially viewed with concern by the Forest Industry. It was felt that the over zealous use of this section of the Guideline would unreasonably restrict forest planning and operations with considerable cost effects. In practice the provision of riparian strips where local conditions or the significance of the watercourse warrant has proved to be a useful measure in protecting the watercourse and it's water quality by:

1. ensuring that machinery is kept out of the watercourse;
2. ensuring that logging slash and debris is not deposited in the watercourse;
3. acting as a filter for suspended sediments being carried in runoff waters entering the watercourse;
4. maintaining water temperature by keeping the bank cover vegetation intact.

Involvement of Catchment Authorities

Regular inspection of field operations by Catchment Authority staff is a useful means of ensuring that soil and water values are protected. The presence of Catchment Authority staff in the field has the psycological effect of keeping field supervisors and machine operators aware of these values as well as allowing problems that do arise to be remedied quickly.

The level of contact between the Forest Industry and the Catchment Authorities varies from Authority to Authority, ranging from frequent contacts with good understanding to few contacts with possibly a corresponding poorer level of understanding.

CONCLUSION

The protection of soil and water values during forestry operations, particularly those operations falling under the logging umbrella, is an essential and integral phase of forest management. Consequently the costs of keeping soil resources on site and protecting water quality for downstream users must be regarded as a legitimate cost of responsible land management.

Following the introduction of the Forest Operations Guideline the standard of operations, particularly in the area of roading, have shown a general improvement to the extent that in general few soil and water problems are expected from this area provided that routine maintenance is carried out.

Temporary tracking and the exclusion of logging slash and debris from watercourses are seen as being areas that require a further improvement in standards. All too often the principles of good roading practice employed in the primary roading system are not carried into temporary tracking operations with the result that soil and water values are threatened.

Many problems occuring through machine operator error or ignorance will be avoided with adequate supervision and more importantly proper training and education. The education of equipment operators and lower echelon supervisors is an important factor in determining the field performance of operations. Contact with Catchment Authority staff is seen as a valuable tool in this process.

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