THE HOW AND WHY OF EROSION AND SEDIMENT CONTROL

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ABOUT THE AUTHOR

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ABSTRACT

Development and construction activity can result in high rates of soil erosion in a relatively short time period, through the removal of protective vegetation, and subsequent land shaping. Sediment removed by erosion damages lower land, blocks stormwater drains, and is eventually deposited in the receiving waters. The result is turbidity in natural water bodies, a reduction of recreational value, and damage to aquatic life.

The need to minimise erosion and off-site sedimentation from disturbed areas is now seen as a basic requirement for ensuring that the status of water quality will meet statutory requirements.

The increasing requirement for erosion and sediment control policies and plans, examples of some of the more common and effective control measures, and the need for industry wide training are discussed to illustrate why and how erosion and sediment control should be integrated into existing work practices, and the role that CaLM can play in this important area.

INTRODUCTION

It is difficult to question the need for urban development. It is obviously essential. The community is, however, questioning the way in which that development is carried out, and the adverse environment impact that it can have.

So WHY erosion and sediment control?

1. The Soil Erosion Problem

The need to minimise erosion and off site sedimentation on disturbed areas is now seen as a basic requirement for ensuring that the status of water quality will meet statutory requirements.

A majority of soil erosion occurs in a relatively short period of time as a result of the removal of site vegetation, and subsequent land shaping. Sediment removed by erosion damages lower land, blocks stormwater drains, and is eventually deposited in the receiving waters. The result is turbidity in natural water bodies, a reduction of recreational value, and damage to aquatic life.

2. Erosion and Sediment Control Policies

The first guideline on urban erosion and sediment control in this state was produced in 1978 (Soil Conservation Service of NSW, 1978). The Service has recently updated that guideline (Department of Conservation and Land Management, 1992). For many years, therefore, a range of appropriate erosion and sediment control measures has been available to tackle the emerging urban erosion and land degradation problem associated with the rapid expansion in urban development within this state.

The way and extent to which these control measures have been implemented has varied greatly over time, and from one local government and geographical area to another, but in general the results on the ground have been less than ideal.

One of the main reasons for this poor track record in implementation has I feel, been the lack of guidelines for consent and development authorities and developers/consultants, on how to embrace the concept of urban erosion and sediment control in a co-ordinated and a standardised way.

The Soil Conservation Service of NSW strongly supports the concept of adoption by Councils and Government Authorities of standardised erosion and sediment control policies and/or codes of practice as the most appropriate means of improving the implementation of control measures in the field.

Some councils and Catchment Management Committees have already produced policies/codes of practice, an initiative for which they should be congratulated. It has become apparent from the policies produced to date, however, that the content and structure of an erosion and sediment control policy document are critical to its effective implementation.

2.1. Requirements of the Policy

An effective erosion and sediment control policy (Hunt, 1994) must have specific clauses related to:

* which development/activities require an Erosion and Sediment Control Plan (ESCP)

* the requirements for an ESCP

* when the ESCP is to be submitted

* how the ESCP will be assessed and approved

* how the ESCP relates to other plans for the site

* reference to relevant technical documents which establish technical standards for control measures

* appropriate standard conditions which may be attached to building approvals or development consents relating to the control of erosion and sedimentation

* procedures for Part V determination under the Environmental Planning and Assessment Act (1979) Regulations.

* nomination of the person responsible for sites to which this policy applies

* the level of knowledge, experience or training required by personnel implementing this policy, particularly those preparing, assessing or implementing ESCPs.

* the need for community education and awareness initiatives to ensure the policy is understood by all policy users

* acknowledgment that the policy applies to all! - from the owner/builder to Council's and Government Authority's own activities

2.2. Policy Implementation

The success of any policy can only be measured by the rate of effective implementation. Principle factors contributing to effective policy implementation are:

* Policy enforcement - Policy users must be made clearly aware that failure to implement the controls required by the policy will result in definite action being taken by the consent or appropriate authority.

* Staff training - The training of Council and authority staff and the development industry generally is an essential component of policy implementation because:

* *Education of policy users* - Full implementation of any policy will only occur when there is a change of attitude in the whole community to urban land degradation and its impacts on our lands and waterways.

2.3. Catchment Approach

The positive benefits to be gained by the adoption and effective implementation of erosion and sediment control policies can be maximised if the principles of Total Catchment Management (TCM) are applied to this process.

By standardising and co-ordinating the adoption and implementing of policies by the various consent and development authorities operating within a particular catchment, all the players in the development and construction industries are operating under known and consistent requirements. This can markedly improve the rate and standard of adoption of any policy principles, through improved industry performance and compliance.

Further, the public education and awareness and staff training aspects of the policy adoption can be co-ordinated more efficiently and effectively.

Because of these added benefits the Soil Conservation Service sees this as the way of the future in respect of improved implementation. In fact there are several Catchment Management Committees and Trusts currently going down the path of initial policy adoption; most notedly:

* Hawkesbury/Nepean Catchment Management Trust
* Lake Macquarie Catchment Management Committee
* Georges River Catchment Management Committee
* Hunter Catchment Management Trust

Having considered WHY we need erosion and sediment control, now let us consider HOW to implement it.

3. Control Measures

Some erosion and sediment generation during the construction stage of urban development is inevitable. Sound planning can reduce the potential for erosion, but the use of control measures will always be necessary to minimise the impact of any development, both on-site and off-site.
These control measures can comprise a variety of construction practices, structural or vegetative measures, or soil stabilisation techniques, which should complement each other in an integrated development program.

3.1 Erosion Control Measures

Sediment can only be generated when soil erosion occurs. The prevention or minimising of soil erosion must therefore be the first priority of any erosion and sediment control strategy.

It is environmentally sound, easier, and more cost-effective to prevent erosion than to concentrate on trapping sediment from eroding areas. This applies particularly to areas where the soils have a high proportion of fine silts and clays, or are dispersible. Indirectly therefore, erosion control measures also control sediment.

These measures generally function by reducing the duration of soil exposure to erosive forces, either by holding the soil in place, or by shielding it. Measures to be used are aimed at managing runoff at a non-erosive velocity, and protecting disturbed soil surfaces.

The following measures and practices (CaLM, 1992) can be integral components of an effective erosion control program:

* Vegetation - the most effective form of erosion control because it both absorbs and uses water, and protects the soil surface.

  To make the best use of vegetation:

  - identify critical areas of existing vegetation.
  - allow minimal disturbance - expose the smallest possible area for the shortest possible time.
  - save and reuse topsoil.
  - progressively revegetate or stabilise areas as they are developed.

* Site management - reduce erosion hazard by control of plant and vehicle movements, careful location of soil and building material stockpiles, protection of critical vegetation, and having a flexible sequence of works that allows for changing site conditions.

* Land shaping - reduce erosion hazard by minimising slope lengths and by leaving the surface in a roughened condition.

* Batter stabilisation - all cut and fill slopes should be graded to a stable gradient, protected and progressively stabilised.

* Banks, channels and level spreaders - used to convey, divert, or control runoff onto, through, or from a site.

  Banks and channels convert sheet flow to concentrated flow, and increase the time of concentration of runoff. They can be used to:-

  - intercept and direct sediment laden runoff from disturbed areas to an appropriate sediment trapping structure.
  - intercept and direct clean runoff from above disturbed areas to a stabilised outlet at a non-erosive velocity.
  - reduce the flow path length and velocity of runoff flowing down a slope or along a graded right of way.

A *level spreader* (often called a level sill) is an excavated outlet from a bank or channel constructed at zero grade. It converts an erosive, concentrated flow of sediment free runoff into sheet flow, and discharges it at a non-erosive velocity onto an undisturbed area stabilised by vegetation.

* Check dams - small, temporary dams built across a swale, drainage channel or waterway, to reduce the velocity of flow in the channel and thus reduce erosion of the channel bed. The entrapment of sediment behind these structures is a secondary function.

  Check dams can be used:

  - to protect a grass lined channel during initial establishment of vegetation.
  - as a substitute for channel lining in a temporary channel.

* Bank and channel linings - measures to protect the bed and banks of drainage channels against erosive flows. Stability is achieved either by reducing flow velocity or by providing a lining that will withstand high flow velocities.

* Grade stabilising structures - measures to convey stormwater flow from a higher to a lower elevation without causing erosion, and so protecting the downstream channel. They usually comprise either a flume or a drop structure.

* Construction Exit - This comprises a pad of coarse gravel, occasionally with a concrete steel or timber shaker ramp, located at entry/exit points at construction sites. It is designed primarily to prevent erosion and stabilise the entry/exit to construction sites, while also minimising the transport of sediment onto public roads via the wheels and sides of vehicles.

* Outlet protection structures - energy dissipating structures at outfalls from stormwater pipes or channels that reduce the velocity of water leaving the pipe or channel to a level consistent with the maintenance of stability in the downstream channel.

* Stormwater detention measures - measures to delay the flow, and therefore the concentration, of stormwater runoff leading to reduction in downstream channel capacities and flow velocities.

All these measures can reduce the amount of soil materials mobilised within a development site, and thereby reduce the potential sediment load.

3.2 Sediment Control Measures

We have established that some erosion will be inevitable. Sediment control measures are therefore required to trap and retain sediment once soil has been eroded. Sediment control measures, therefore, only control sediment, they do not control erosion. Their function is to trap eroded soil before it leaves the site and pollutes adjacent property or water bodies.

These measures usually function by slowing the velocity of runoff and allowing suspended soil particles to settle by gravity or filtration.

Sediment control measures require regular maintenance and cleaning. If too much sediment is allowed to accumulate in them, they will cease to function. Little or no settling will occur, and trapped sediment will be re-suspended and washed away.

There are three main types of sediment control measures:

3.2.1 Sediment Basins

A sediment basin is a barrier or dam designed to intercept sediment laden runoff and retain the sediment. It is usually located on a drainage line below a construction site, or at some other stormwater collection point. It is fitted with a dewatering system and usually remains empty between rainfall events.

These basins trap sediment from developing areas where the drainage area is usually larger than 1 ha and concentrated flows exist. They may be either temporary or permanent structures.

A typical sediment basin will have:-

* compacted earth, rock, or gabion embankments.
* upstream storage, provided by excavation.
* one or more inflow points carrying sediment laden runoff.
* a primary outlet.
* an emergency outlet or spillway.
* a basin dewatering device.
* outlet protection to reduce erosion downstream.
* all-weather access for sediment removal.

Sediment basins are installed prior to development or construction activity on a site, and should remain in place until such activity has been completed and the land stabilised.

They do not replace on-site control measures such as perimeter banks, temporary revegetation or sediment traps at stormwater inlets. These measures retain a portion of the sediment carried in runoff, and the sediment basin is a final check to trap a significant part of the remaining sediment, before runoff discharges into stormwater mains or enters streams.

The sediment basin is a specifically sited and purpose designed structure, and formal hydrologic and hydraulic design procedures must be applied.

Aspects of sediment basin design and construction that are critical for maximum basin efficiency are:

* storage surface area is a critical design feature, and should be maximised within the site constraints.

* the Length:Width ratio should not be less than 3:1.

* the distance between the basin inlet and outlet should also be the maximum practical.

* access for sediment removal and provision for sediment disposal is essential.

3.2.2 Sediment Traps

Sediment traps function by intercepting sediment laden runoff, particularly where runoff is channelised, and retaining the sediment. They are small temporary structures and are usually located at stormwater inlets which receive runoff from only a small catchment.

Sediment traps can be constructed from a wide range of materials. No formal design is required provided the recommended design criteria (CaLM, 1992) are adhered to.

The most commonly used sediment traps are as follows:

Excavated Sediment Traps

An excavated sediment trap is in effect a small temporary sediment basin, designed to function in a drainage area of 2 ha or less.

Stormwater Inlet Sediment Traps

Inlet protection should be provided to reduce the sediment load entering stormwater drainage systems. Materials commonly used for this purpose include straw bales, geotextile filter fabric, gravel and sand bags. Several types of inlet filters are described in CaLM (1992). The choice of filter structure depends upon site conditions and the type of inlet being protected.

These structures are designed to keep sediment out of stormwater drain inlets where the drainage area is 0.4 ha or less, but do not have provision for sediment storage.

Some common types of inlet sediment traps are:

Geotextile Filter Fabric Drop Inlet Sediment Trap

A geotextile filter fabric drop inlet sediment trap can be used where the inlet drains a relatively flat disturbed area (slopes no greater than 5 per cent) on which minor concentrated flows occur. Traps of this type should not be placed around inlets receiving major concentrated flows.

Gravel Kerb Inlet Sediment Trap

A semi-portable variation of this structure, which is particularly suitable for overnight or short term use, is a cylinder of wire mesh and geotextile filter fabric filled with 50 to 75 mm sized gravel and placed against the kerb inlet. This structure is simple to make and place on site and is easily cleaned, moved and reused.

Culvert Entry Sediment Trap

An existing road embankment and culvert can be converted for use as a temporary sediment trap. It can be used where heavy flows are expected, and incorporates an overflow mechanism to prevent excessive ponding.

3.2.3 Sediment Filters

Sediment filters are temporary structures which function by intercepting and filtering small volumes of runoff which mainly occur as sheet flow.

Sediment filters are relatively inexpensive and easy to install. However, they can only function to their design limits if particular care is taken with their location, installation and maintenance.

Should a sediment filter fail, sheet flow is changed into concentrated flow and serious damage can result, damage which may exceed that if no sediment filter had been installed.

There are three common types of sediment filters.

Straw Bale Sediment Filters

These are temporary structures made of straw bales laid end to end across the direction of flow.

Straw bale sediment filters may be used where:-

* The area draining to the filter is 0.4 ha or less.
* The maximum slope length behind the filter is 40m.

Sediment Fences

A sediment fence (often called a silt fence) is a temporary barrier of geotextile filter fabric, usually supported on wire or mesh fencing.

A sediment fence may be used where:

* The area draining to the fence is 0.6 ha or less.
* The maximum slope length behind the fence is 60 m.

A sediment fence can last up to 6 months or longer, at least twice as long as a straw bale sediment filter. A properly installed sediment fence is generally more effective than a straw bale sediment filter and usually cheaper to construct.

Vegetative filter strip

Vegetation is the most effective erosion control measure of all. These filter strips may be natural swales to intercept channel flows, or buffer zones around stormwater inlets or behind the kerb. The flatter and wider the strips, the more sediment they will retain.

4. Erosion and Sediment Control Publications

To assist with the selection, design and implementation of appropriate control measures, the following CaLM publications are available:

* Urban Erosion and Sediment Control Handbook (1992)
* Urban Erosion and Sediment Control Field Guide (1992)
* Erosion and Sediment Control Drawings (Autocad drawings on disk) (1994)

5. Training

The adoption of Erosion and Sediment Control Policies by local government authorities has placed increased emphasis on the need for industry wide training in erosion and sediment control. Effective implementation of control measures will only be achieved when the regulators and the development industry have received similar training, and erosion and sediment control becomes one of the many standard work practices on a construction/development site.

CaLM has recently established a Training Unit in the Sydney-Hunter Region which is available to offer practical training for staff, including training needs analysis, on a fee for service basis.

6. Summary

Everyone involved in the urban development process must give serious consideration to implementing appropriate controls on land development to improve the quality of runoff at source, rather than at the point of entry into the local stream, lake or water body.

The community and the local environment demand more stringent erosion and sediment control, and by:

* adopting and using erosion and sediment control policies,

* utilising the guidelines provided in the latest CaLM Urban Erosion and Sediment Control publications,

* and ensuring industry wide training of staff in the use of erosion and sediment control measures is undertaken

    - the technology is available to provide the necessary strategies and measures.

7. References

1. Department of Conservation and Land Management (1992) - 'Urban Erosion and Sediment Control' Handbook (Hunt, J.S. - Editor).

2. Hunt, J.S. (1994)
Erosion and Sediment Control Policies. Proceedings "Soil and Water Management for Urban Development" Conference, Sydney, September, 1994