HEALTHY WATERWAYS

Soil Erosion & Sediment Control
Basic Principles and Practices

Acknowledgements

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Disclaimer:

Water by Design is a program of Healthy Waterways Ltd. For further information about Healthy Waterways, please email hwwinfo@healthywaterways.org or telephone (07) 3177 9100.

The following is a summary only and is not a technical manual. The erosion and sediment controls discussed in this document were chosen because they were common controls seen during the recent ESC Compliance Course (2014). It is not an exhaustive list as there are other controls available.
For specific ESC designs, technical specifications and drawings see ***IECA Best Practice Erosion Sediment Control Manual*** - http://www.austieca.com.au
For more examples and photographs of ESC: ***Catchments and Creeks – Erosion & Sediment Control Field Guide*** http://www.catchmentsandcreeks.com.au/docs/Erosion-and-Sediment-Control-A-Field-Guide-for-Construction-Site-Managers-screen.pdf

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Impact of Sediment and Benefits of Erosion & Sediment Control

What are we trying to achieve?
To prevent or minimise environmental harm caused by sediment pollution

How can we achieve this?
By controlling soil erosion and minimising the transport of sediment during land-disturbing activities

Impacts of Sediment

- Road safety problems (traffic & pedestrians)
- Siltation of drains and waterways can cause localised flooding
- Requires more frequent de-silting of stormwater system, reservoirs, navigable channels
- Reduced life span of stormwater infrastructure and increased maintenance costs passed on to rate payers/community
- Increased water treatment costs
- Increased bank erosion
- Smothering & destruction of streams, wetlands and freshwater habitats
- Increased weed growth in waterways
- Decline of recreational and commercial fishing resources
- Impacts on marine environments – seagrass, coral reefs, Great Barrier Reef
- Reduced recreation and aesthetic 'values' such as spoiling of swimming holes and sandy beaches

Benefits of on-site erosion & sediment control

- Healthier waterways and environment
- Reduced risk of fines and poor public image
- Reduced downtime and clean-up costs
- Earlier project completion
- Reduce soil and stockpile losses

Benefits of ESC Compliance Program:

- Consistency and fairness across the industry
- Assurance for development industry
- Reduced cost shifting from developer to community
- Economic/social/environmental benefits of reduced sediment in waterways

Soil Erosion and Sediment Control Principles & Practices

There are two basic types of sediment - coarse & fine, and different management practices are required to control each.

Coarse sediment (eg sand) falls out of suspension quickly, so often deposits close to the source, for example on the bottom of drains, culverts and waterways. It directly smothers aquatic plants (fresh and marine). Coarse sediment can be controlled relatively effectively through sediment controls such as sediment basins, sediment fences and stormwater inlet protection.

Fine sediment (eg clay) stays in suspension longer and can travel further. This suspended sediment is what causes water to look turbid or murky. It is these fine particles that cause the greatest environmental harm as they can kill aquatic organisms, for example by clogging fish gills, and by sticking on to and smothering plants and coral reducing their ability to photosynthesis. They also travel the furthest and reach wetlands and marine environments, impacting on seagrass beds and coral reefs. Fine sediments are much more difficult to control than coarse, because sediment controls on their own do not remove fine particles. The most effective controls are:

- Minimising soil disturbance – this will reduce erosion so sediment is retained on site. This method also reduces reliance on end-point controls such as sediment basins.
- Protecting the soils surface (erosion control) through stabilisation such as revegetation, mulching, geofabric, concrete, etc.
- Drainage controls also assist, for example by slowing down flow velocities, diverting dirty water to a sediment basin for treatment, and by diverting clean water away from exposed soil.

A good site will have the following elements:

1. Minimised extent and duration of soil disturbance
2. Erosion controls - to protect soil surface
3. Drainage controls - to manage run-off
4. Sediment controls - to capture sediment
5. Progressive stabilisation & revegetation
6. Monitoring & maintenance

1. Minimise soil disturbance

Purpose: To reduce the area of exposed soil thereby reducing erosion, reducing sediment run-off and reducing reliance on sediment controls. Overall this will make sediment controls on the site easier to manage and maintain.

Good Practice:

- Earthworks are kept to a minimum.
- Earthworks are staged – manageable areas are cleared, worked in, then stabilised, before progressing to the next stage. Future stages remain uncleared until the preceding stages are stabilised.
- Maintain as much grass, mulch and other soil coverage as practicable

Poor Practice

- Large areas (eg several stages) are cleared at once
- Areas not being worked in are left exposed for prolonged periods of time

2. Erosion Controls

Purpose: To minimise soil erosion by protecting the soil against splash erosion and surface run-off (scouring)

Common Uses:

- Protect allotment areas
- Stabilise earth batters and other steep areas
- Control erosion caused by surface run-off
- Control erosion of stockpiles

Good Practice:

- Exposed soil is protected against erosion as soon as practicable (eg if an area or stockpile is not going to be used or worked in for longer than **2-8 weeks** - period may depend on forecasted weather conditions, rain, wind etc).
- Selecting the correct erosion control technique for the situation.
- Site is progressively stabilised –stabilisation takes place progressively during all stages of the development, and once earthworks have been completed in an area, no matter how small the area is (eg small scale earth batter, road verges, open drains, house pads etc).
- Achieving greater than **>70-80%** coverage per square metre (see *Catchments and Creeks – Erosion and Sediment Control Field Guide*, pg30 on how to estimate coverage http://www.catchmentsandcreeks.com.au/docs/Erosion-and-Sediment-Control-A-Field-Guide-for-Construction-Site-Managers-screen.pdf)

Poor Practice:

- Leaving erodible soils unprotected against erosion.
- Using the incorrect erosion control technique for the situation eg. grass seeding an open stormwater channel where seed could wash away; or seeding an infertile soil without using fertiliser/mulch.

Erosion Control Method Examples:

- **Mulch** – works best on flat sites, may be washed away on steep slopes or concentrated flow paths (eg drains, waterways)
- **Hydromulch** - Hydro-mulching combines seed, fertiliser, water, mulch and a tackifier (glue) and is sprayed over the soil to provide erosion control. It can be particularly effective during drought periods and on batters where erosive forces are higher
- **Grass seeding** – soil should be tested first for fertility, permeability etc. If the soil is not adequate for successful plant growth, it should be treated, for example with gypsum for sodic/dispersive soils, fertilised and mulched/hydromulched to provide a suitable medium for plant growth.
- **Turfing** – particularly useful in some concentrated flow paths where other methods such as mulch, hydromulch and grass seeds could be washed away (note: only use turf within allowable velocity limits – refer to IECA for further guidance). Also useful for stabilising some slopes and batters (see IECA for appropriate gradients).
- **Turf strips** – usually used to provide erosion protection adjacent to pathways and kerbs.
- **Erosion Control Blankets** - typically made from synthetic geotextile fabrics or natural products such as Jute fibre. The type of fabric used usually depends on whether the product is being used for short term (building and construction phase) erosion control or long-term revegetation or rehabilitation of batters involving replanting. Synthetic erosion control blankets are typically used for short term erosion control and natural biodegradable blankets are preferred for long-term rehabilitation.
- **Rock Lining** - is usually used where high water velocities are expected, for example at stormwater outlets to reduce scouring.

3. Drainage controls

Purpose: To control the flow of stormwater run-off to minimise erosion

Common Uses:

- Divert "clean" up-slope water run-off around and away from soil disturbances
- Divert "dirty" water run-off within the site to a suitable sediment control device
- To control water flow velocity and minimise soil erosion

Common issues:

- Using the wrong device in the wrong location. For example do not use sediment fences in concentrate flow paths, as they cannot withstand high velocities. They may be used however to slow down sheet flow when placed along the contours of a hillside.
- Installing devices incorrectly. For example rock check dams should not be mounded in the middle of a channel as this can cause scouring around the edges. Rock check dams should be higher at the sides and lower in the middle to direct flows away from the banks.

Drainage Control Examples:

- **Catch Drains or Diversion Berms** - used to concentrate and direct flow to a certain point in the landscape. For example – dirty water is directed to sediment basins for treatment prior to release, and clean water is

directed away from disturbed soils. Catch drains and berms should be adequately stabilised against erosion – otherwise they will erode and will contribute sediment to the water they are conveying.

- **Check Dams** – placed in catch drains/drainage channels as a *temporary* measure to slow down water flow, which in turn reduces scouring and erosion of the drain. In most cases though channel lining will be more effective at reducing erosion of the drain. If check dams are used, the gradient of the drain should be less than 1 in 10. When installed the rocks or sand bags should be higher at the sides and lower in the middle to direct flow towards the middle of the drain and avoid scouring of the banks.

- **Temporary Downpipes** – for use when constructing a building to divert clean water from the building to the stormwater system. When installing connection should be undertaken in the following order: connect underground drainage to roadside gutter or stormwater system prior to roofing being laid; then connect temporary downpipes to permanent house drainage system as soon as roof and guttering is installed. Temporary downpipes should be firmly adhered in place and fully operational.

4. Sediment Controls

Purpose: To capture on-site sediment run-off from exposed areas. Note that these controls are the last line of defence, and they largely only capture coarse sediment and not fine suspended sediment. Release of fine sediment can only be prevented through protection of the soil surface, or by collecting stormwater in an enclosed sediment basin.

Common Uses:

- Minimise sediment run-off from allotments
- Minimise tracking of sediment onto roads
- Control stockpiles of erodible material
- Protect stormwater inlets and waterways

Common Types of Sediment Controls:

- Sediment basins
- Sediment fences
- Stabilised entry/exit point
- Stormwater inlet protection
- *NB straw bales and grass filter strips are not regarded as adequate or effective sediment controls*

Good Practice:

- Site has an adequate stabilised entry/exit point to manage vehicular movement.
- Dirty water is diverted to a sediment basin/s
- Sediment fence located downslope of soil disturbance.
- Stockpiles contained by sediment fences (and preferably erosion protection when not in use)
- Stockpiles located away from overland flow paths, concentrated flow paths, drains, waterways, roadways
- Stormwater inlet is adequately protected.

Poor Practice:

- Over reliance on "sediment controls" and minimal use or absence of erosion controls.
- Sediment controls are not installed correctly

- Sediment controls are full, blocked, not maintained.
- Site access not managed to prevent sediment tracking onto road.
- No sediment basin, or inadequately constructed / inadequately sized basin/s
- Sediment runoff not adequately controlled at the downslope site boundary.
- Stormwater inlet is totally blocked resulting in localised flooding

Sediment Control Examples:

- **Sediment Basin** – Site drainage should direct all dirty water to a sediment basin for settling or flocking prior to release. If flocked (eg with gypsum or other flocking agents) sediment basins can capture both coarse and fine sediments. To be effective basins need to be adequately designed to suit site size and conditions (see **IECA – Appendix B** for details on sediment basin design, operation, and design rainfall events). Water should only be released when water quality meets set objectives (eg **50mg/L TSS**). NB some flocking agents can increase pH and/or lower oxygen levels. pH must therefore be tested and meet the water quality guidelines (**pH 6.5-8.5**) prior to release.

- **Sediment Fence** – Only captures coarse particles (ie sand particles >0.14mm) and does not adequately filter out fine particles (ie clay). They are suitable for capturing sediment from sheet flow and not concentrated flow. General rules for installation: posts at **2m i**ntervals down slope of the fabric, bottom of fence is buried **200mm deep**, and the return faces upslope. Specific sediment fence fabrics such as tightly woven geotextile fabric or composite sediment fence fabric should be used (shade cloth is inadequate as it is not tightly woven and allows sediment to pass through). Sediment fences should be placed across the slope, along the contour, to capture sheet flow, not vertically down the slope as this is ineffective and can result in scouring. The maximum recommended spacing between rows of sediment fencing down a relatively flat slope (up to 2% gradient) is 60m. As slope gradient steepens the spacing between the row should be reduced – refer to *IECA Book 4 Design Factsheets Sediment Fences* for more details.

- **Stabilised entry/exits** – Designed to shake vehicles to remove sediment from tyres and prevent sediment tracking onto roads. Exit pads might include one or a combination of the following:

    - **Rock pads** – Rock size 50-75mm or 100-150mm, pad 200mm thick, Minimum length 10m for building sites, 15m for construction sites, minimum width 3m (single lane) or 2.5m per lane. Geofabric placed underneath rocks can prevent compaction thereby increasing the working life of the gravel pad at minimal cost. Gravel pads need regular maintenance to prevent clogging. Drainage should be installed to direct sediment from the rock pad into a sediment trap. If falling towards the road a diversion bud should be installed across the pad to direct flows away from road and back onto the site.

    - **Vibration grids** – To be placed at the start of the rock pad as vehicles are exiting the site, to shake off larger sediment/sand particles. This will increase the working life of the gravel pad.

    - **Wash bays** – When clay soils are present, particularly cohesive (sticky) clays, wash bays can assist greatly with removing sediment from tyres.

- **Stormwater Kerb Inlet and Field Drop Inlet Protection** – These controls should be setup to capture sediment, but not prevent water from entering the inlet during rain events. These devices can quickly become clogged so it's important to keep them well maintained. It's important to note that while they capture some coarse sediment they don't capture fines and are a lower grade of control so they should not be relied upon as the only control on site. While a site is still being worked in, even during building/civil work stages, overland flow and underground stormwater drainage should be directed to a sediment basin for treatment prior to discharge.

- **Grass filter strips** – Grass or turf strips provide good erosion controls but do not adequately remove suspended sediment from overland flow and should not be relied upon as a sediment control.

- **Straw bales** - Straw bales are rarely used appropriately or maintained properly. Rock or sand bag check dams are generally more effective in minor off-road flow-paths. Filter socks or sand bags are more effective in the roadside gutter.

5. Progressive Stabilisation

Purpose: To minimise soil exposure duration (closely linked to erosion control)

Common Uses:

- Batter Stabilisation
- Allotment stabilisation
- Road verges
- Open drains
- Stockpiles

Good Practice:

- Progressively stabilise site – Areas not worked for longer than 2 -8 weeks are actively stabilised, then revegetated as soon as work completed.
- Achieving and maintaining greater than >70-80% coverage in any square metre across all disturbed ground (refer *IECA – Book 1 pg 4.16, Table 4.4.7*).

Poor Practice:

- Leaving all stabilisation to the very last stage
- Providing little to no stabilisation across the site once works have finished
- Not checking and/or rectifying failed stabilisation attempts

Methods:

- Success requires the correct soil properties to grow agricultural grass species.
- Contractor must assess soil properties and ameliorate – pH and fertiliser
- Hydromulch – creates an instant cover but birds sometimes eat the seed, so less long term cover
- Direct seeding – provides a higher rate of survival but no instant cover
- Combination of soil amelioration, followed by hydromulch and direct seeding has the most success and provides instant and long term cover

6. Monitoring & Maintenance

Purpose: To ensure control measures are performing their task and remain fully operational. ESC devices must be regularly monitored and maintained for them to work properly, and effectively minimise sediment pollution.

Methods:

- Regularly inspect devices, especially directly after rainfall events
- Remove sediment deposits directly after rainfall events
- Repair/replace damaged devices
- Flock sediment basins to settle-out suspended sediment.
- Test water (Total suspended solids, turbidity, pH, dissolved oxygen etc) and ensure water quality meets requirements prior to off-site discharge

Principles Summary:

Summary:

1. Minimised extent and duration of soil disturbance
2. Control water movement through the site
3. Promptly and progressively stabilise to minimise erosion
4. Sediment retention maximised
5. ESC measures maintained
6. Site and Water Quality monitored and ESC practices adjusted to maintain required performance standard

A Compliant Site Checklist:

- Disturbs only those areas necessary for the current and near-future works (2 - 8 weeks depending on erosion risk)
- ESC Plans are consistent with current phase of works, best practice (currently IECA International Erosion Control Association Best Practice Erosion Sediment Control Manual **http://www.austieca.com.au/**), and statutory requirements.
- ESC measures implemented & maintained. Additional ESC installed if necessary to achieve water quality outcomes
- 'Clean water' is diverted. 'Dirty water' drains to sediment basin(s). Discharge from sediment basins <50mg/L TSS
- Areas not worked for longer than 2-8 weeks are actively stabilised, then revegetated as soon as work completed to at least 70-80% coverage in any square metre

More Information:

- **IECA** Best Practice ESC Manual and other ESC information :
  - http://www.austieca.com.au/ ;
  - http://www.ieca.org/
- **Catchments and Creeks** – has great free resources with plenty of pictures:
  - Website- http://www.catchmentsandcreeks.com.au/
  - Field guidehttp://www.catchmentsandcreeks.com.au/esc_field_guide.html
- **Healthy Waterways** - Water by Design - http://waterbydesign.com.au/
- **Auckland Council** – has good ESC guidelines (see TP90)
  - https://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Pages/technicalpublications51-100.aspx#81-90
- **Legislation** –
  - http://www.austlii.edu.au/
  - https://www.legislation.qld.gov.au/OQPChome.htm