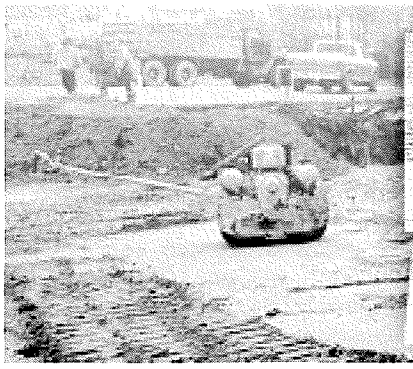
City of Nanaimo



EROSION AND SEDIMENT CONTROL

A relatively flat, 1 hectare (2 acre) construction site can erode 2.5 to 5 dump trucks of sediment in one construction season (10-100 tons/acre/year). On gentle slopes, losing 6mm to sheet and rill erosion in a season is common. On steep slopes, one heavy rainfall can remove 50-75 mm of sediment.

This brochure provides information about erosion and how to deal with it during construction.

The following pages introduce three strategies for minimizing erosion and controlling sediment:

Source Erosion Control - stopping erosion before it starts, by keeping soil from being displaced.

Runoff Control - reducing the erosive energy of runoff and/or conveying it using non-erodible surfaces.

Sediment Control - trapping runoff and reducing its velocity allowing sediment to settle.

The back page illustrates how some of the methods presented under these three strategies can be applied to construction on a single family lot.

Plan for Success

To avoid erosion and associated impacts, erosion control professionals produce an **Erosion Control Plan**.

These plans can reduce erosion by customizing the erosion control strategies in this brochure to the conditions on your site.

Erosion risk can be calculated using the Modified Universal Soil Loss Equation. The equation allows the prediction of the amount of erosion in different scenarios considering disturbed area, local rainfall, soil erodibility, slope length and gradient, and erosion control measures taken.

An Erosion Control Plan allows cost control, identifies successful strategies, eliminates surprises and speeds approval processes.

The City encourages Erosion Control Plans as part of all development applications.

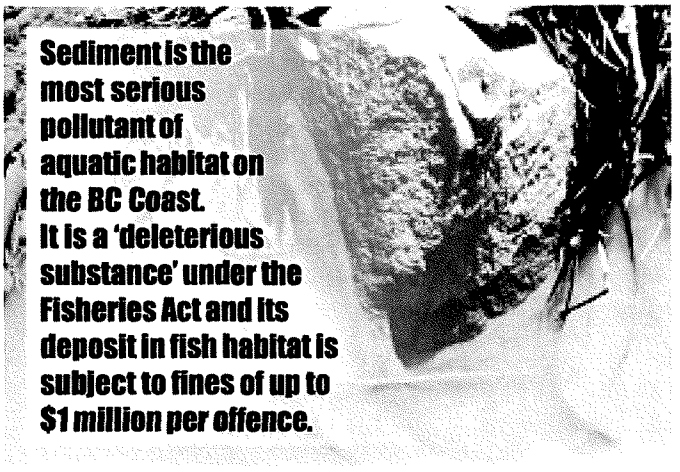
This brochure has been produced for the City of Nanaimo
by Lanarc Consultants Ltd
Landscape Architecture
Land Planning
Environmental Planning

The Dirt on Erosion

Erosion is a natural process - but when land is disturbed by construction activities, erosion increases by 2 - 40,000 times the preconstruction rate. Erosion creates sediment, which is transported by flowing water, wind or gravity (slumping).

Impacts of relocated sediment include:

- Silting of fish-spawning beds, which suffocates salmon eggs and entombs emerging juvenile fish.
- Cloudy water in streams which reduces the production of insects and aquatic vegetation, important food sources for fish. Sediment in streams also clogs the gills of fish.
- Heavy metals and other pollutants which are attached to sediment and carried with it into waterways.
- Sediment being deposited on someone else's property, which can lead to litigation and cleanup costs.
- Sediment entering the storm drainage system, leading to increased municipal costs for catch basin maintenance, plugged storm drainage systems, filled-in ditches and detention ponds, and increased flooding risks.
- Eroded sediment is lost topsoil - a replacement value of $20/cu.m.



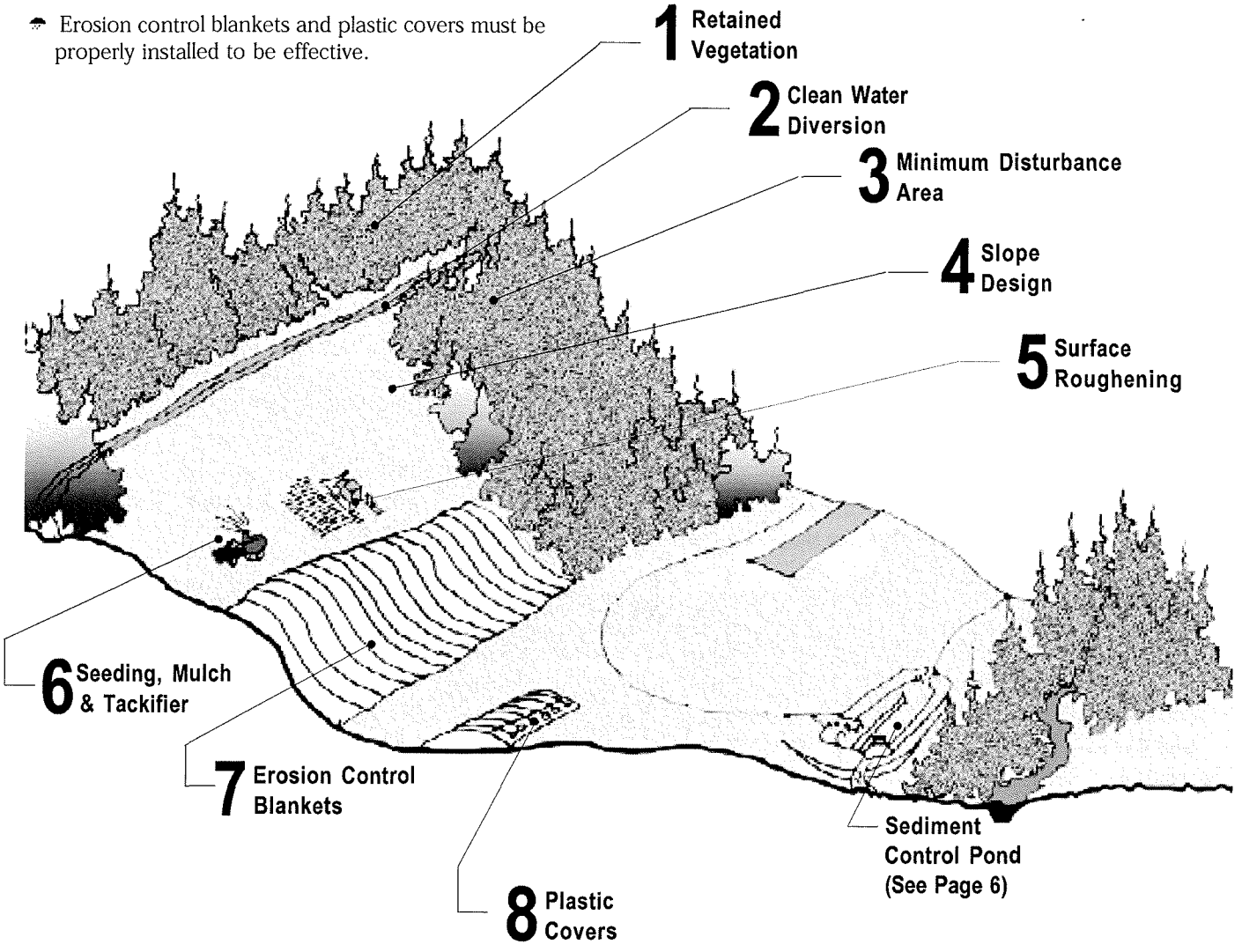
SOURCE EROSION CONTROL

Source Erosion Control stops erosion before it starts, by keeping soil from being displaced at the outset. Source Erosion Control is less expensive than other controls. A key to success is minimizing the exposure of uncovered soil to rainfall, running water or wind.

- Complete mass grading work in the dry season.
- Phase the work to minimize the area exposed at one time, retaining as much existing vegetation as possible.
- Design slopes to be stable, with steepness and slope length appropriate for the soil type and groundwater condition.
- Apply temporary cover - (seeding or erosion control blanket) - to bare areas that will be dormant as construction proceeds.
- Vegetated covers must be allowed to establish in the growing season (Easter to Thanksgiving) prior to heavy rains.
- Erosion control blankets and plastic covers must be properly installed to be effective.

First Line of Defence:

- **The most effective and economical way to keep soil on construction sites is to minimize clearing and grading, and to keep exposed soil surfaces covered.**
- **Vegetation cover is the most effective source control - reducing erosion by more than 90% by protecting the soil from raindrop impact.**



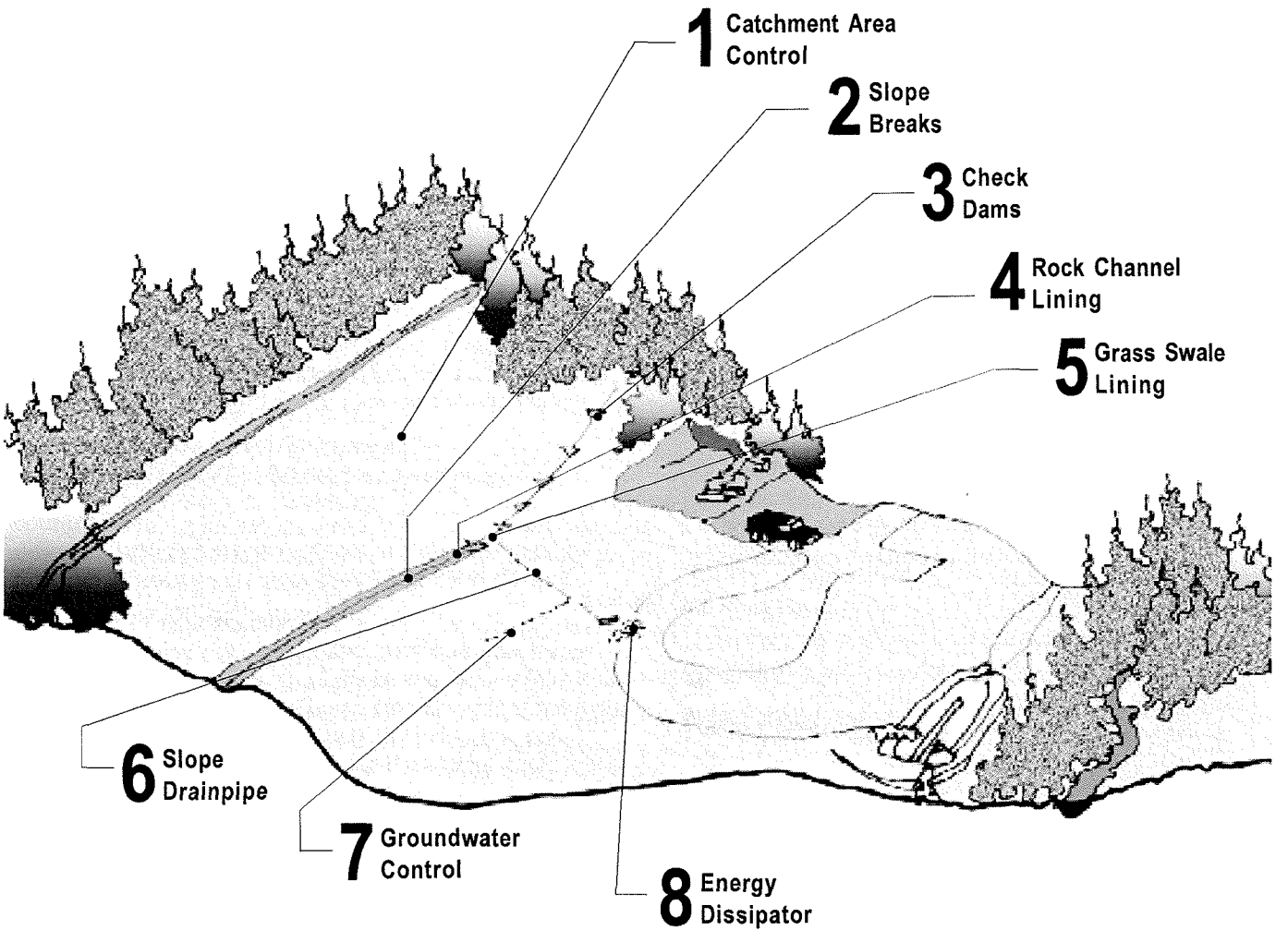
RUNOFF CONTROL

Runoff Control reduces the erosive energy of runoff and/or conveys it using non-erodible surfaces.

- Divide the project area into small catchment areas.
- Determine how the total runoff from each catchment area will be collected and conveyed; e.g. by slope break and diversion swale; by a temporary slope drainpipe; or by a permanent storm drain.
- Calculate the flows in each water conveyance, and determine its size and required level of erosion protection. The need for armouring of swales or for pipe solutions will be greater in erodible soils, and will increase with greater slopes and higher velocity of runoff.
- Inspect sites frequently and correct problems or failure promptly.

The 4 D's of Runoff Control:

- **Decrease** - decrease the amount of runoff.
- **Detain** - detain water to decrease the downstream velocity. Decreasing the velocity of running water by 1/2 reduces its erosive energy by 4 times.
- **Divert** - divert the runoff to less erodible areas.
- **Dissipate** - spread the runoff out, to encourage 'sheet' runoff.



SEDIMENT CONTROL

Sediment Control traps runoff by creating ponds to reduce water velocity, allowing sediment to settle out of suspension.

There are several methods of creating sediment interception ponds - including sediment barriers (silt fence) and constructed ponds (sediment traps and basins). All of these work by ponding runoff to reduce velocities and allow sediment to settle. They do **not** filter sediment - they slow down water movement to allow settling.

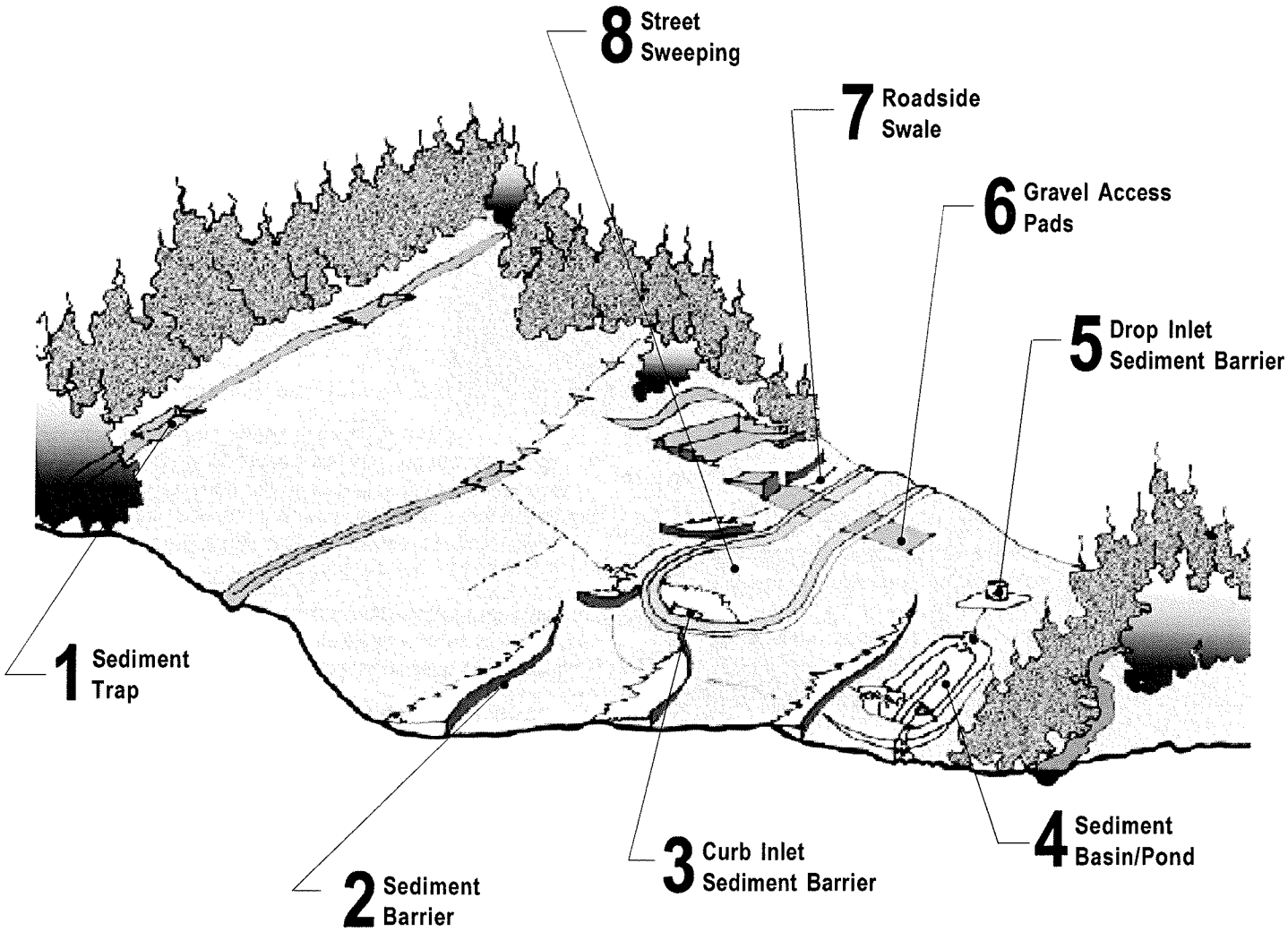
Install sediment basins before general site clearing, and maintain them as a last defence for at least one year after construction.

Install smaller sediment traps and sediment barriers in phases as the construction is completed.

All sediment interception ponds must be inspected after each storm event, and must have sediment removed regularly to maintain capacity.

Last Line of Defence:

- **Sediment interception is an expensive last resort - it is never a replacement for source erosion control.**
- **In practice, sediment interception is only about 50% effective, whereas revegetation is over 90% effective at a lower installation and maintenance cost.**
- **Runoff must be ponded for several hours to allow sands to settle out, several days for silts, and even weeks for finer particles.**



Source Erosion Control Methods

With Nanaimo's summer drought, the least expensive and most effective erosion control measure is to limit site disturbance to dry periods of the year, and to ensure that sites are revegetated prior to the winter wet season.

1 Retained Vegetation

- Retain existing trees, shrubs and grasses or other vegetation wherever possible - they are the best and lowest cost defence against erosion.
- If clearing must be performed, hold back grubbing of tree roots until grading is to proceed - the root masses and groundcover provide substantial erosion control.

2 Clean Water Diversion

- Install a diversion swale above graded areas to direct clean water from undisturbed areas away from the grading activity.
- Ensure gentle swale grades (1%) if in erodible material, or install erosion control lining to the swale.
- Place a rock apron to disperse swale runoff into vegetated areas of the property, or use a slope drainpipe, if necessary, to transport clean water to below the construction site.

3 Minimum Disturbance Area

- Clear only those areas of the site that must be graded in the current phase of development.
- Leave vegetated areas in place as long as possible; to enhance wildlife and property values, at the same time as reducing erosion.
- On larger sites, complete grading and erosion control in one area before opening another.

4 Slope Design

- Recognize soil, runoff and groundwater conditions when designing slopes. Saturated sand and silt soils are highly erodible.
- Avoid erodible soil slopes over 2:1.
- Avoid slope lengths over 30 metres between slope breaks.
- Encourage 'sheet' drainage, avoiding concentrated water flow down unarmoured slopes.

5 Surface Roughening

- Roughen the surface of graded areas across the slope, especially before seeding. This slows runoff, and encourages infiltration which promotes germination and plant survival.
- Roughening can be created by machine tracking, contour ripping or ploughing.
- A roughened surface layer of strippings - topsoil and coarse organics - can reduce the erodibility of high-risk soils, like sands and silts.
- For mass stability, ensure deep compaction of fills prior to surface roughening.

6 Seeding, Mulch & Tackifier

- Seed disturbed areas whenever they will be dormant for 45 days or more. Consult local seed suppliers for appropriate seed mixes.
- Seed with respect for the germination season. No grasses will germinate in winter. Permanent grasses are best planted April 15-May 30 or Aug. 15-Sept. 30. Annual ryegrass may germinate March 1-Oct. 15 and will form a temporary tall grass cover, but it requires a summer mowing for good appearance.
- Apply mulch & tackifier to large sites or slopes to stabilize soils until germination. Hand placed straw mulch on flat or small sites will provide some cover and enhance germination.

7 Erosion Control Blankets

- For steep slopes, highly erodible soils or late seeding conditions, supplement seeding with erosion control blankets (specially designed sheets of fiber, sometimes reinforced with plastic netting).
- Choose the right blanket for the application, and ensure proper installation according to the manufacturer's specifications. Ensure the blanket top is trenched in, ensure soil contact (no slope roughening under the blanket) and follow staple patterns and overlap specifications.
- Bonded Fibre Matrix is an alternative which can be hydraulically applied to dry ground.

8 Plastic Covers

- Short term cover of small areas, when other methods are not feasible, can be provided by plastic tarps held down by ropes between tires.
- Always use plastic covers over stockpiles which will not be used for the next 2-3 days, or when rain is expected.
- Plastic covers can protect against windblown dust in the summer as well as winter rainfall.

Seed is the most economical form of erosion control.

To be effective, the seed must be applied in time to allow it to germinate and establish before the growing season ends.

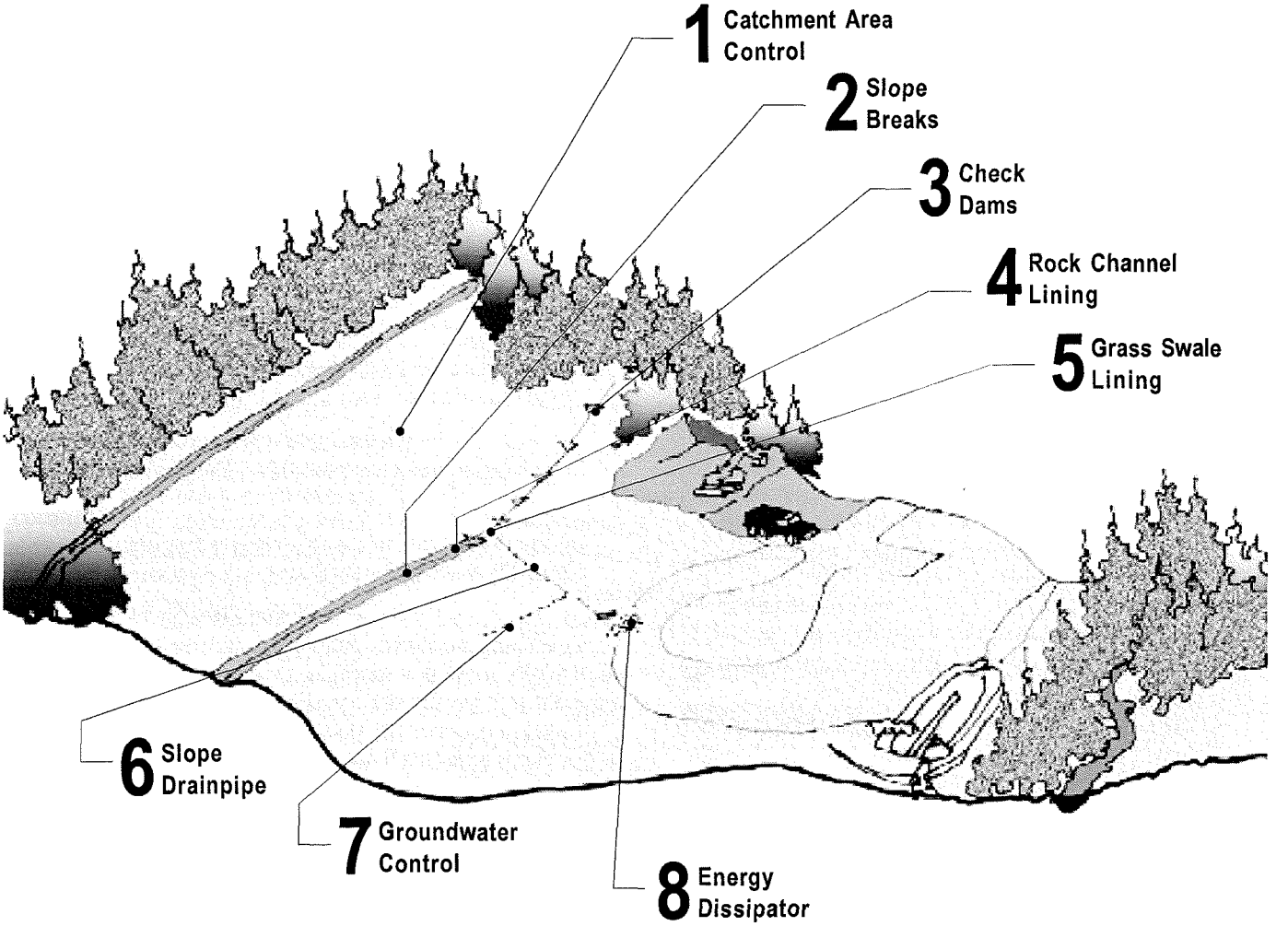
RUNOFF CONTROL

Runoff Control reduces the erosive energy of runoff and/or conveys it using non-erodible surfaces.

- Divide the project area into small catchment areas.
- Determine how the total runoff from each catchment area will be collected and conveyed; e.g. by slope break and diversion swale; by a temporary slope drainpipe; or by a permanent storm drain.
- Calculate the flows in each water conveyance, and determine its size and required level of erosion protection. The need for armouring of swales or for pipe solutions will be greater in erodible soils, and will increase with greater slopes and higher velocity of runoff.
- Inspect sites frequently and correct problems or failure promptly.

The 4 D's of Runoff Control:

- **Decrease** - decrease the amount of runoff.
- **Detain** - detain water to decrease the downstream velocity. Decreasing the velocity of running water by 1/2 reduces its erosive energy by 4 times.
- **Divert** - divert the runoff to less erodible areas.
- **Dissipate** - spread the runoff out, to encourage 'sheet' runoff.



Sediment Control Methods

1 Sediment Trap

- Sediment traps are small settling ponds used for drainage areas <2 Ha.
- Construct sediment traps by excavating in stable soils, and/or with compacted dykes. Armour the pond outfall with rip rap and/or geotextile.
- Use engineering calculations to size the traps e.g. to handle 12.7 mm of runoff over a 24 hour period, sediment trap volume would be 130 cu.m./Ha. minimum.

2 Sediment Barriers

- Silt fence is the most common sediment barrier, but alternatives include straw bales, or continuous berms of gravel or earth.
- Install sediment barriers to create ponded water - on flatter ground below exposed slopes, along the contour with ends curved uphill to contain water.
- Slopes draining to sediment barriers should not be more than 30 metres long. Ensure barriers are trenched in at the base, and staked to support the weight of water. Clean out collected sediment often.
- Do **not** use sediment barriers in concentrated flow (channels).

3 Curb Inlet Sediment Barrier

- Curb inlet sediment barriers pond runoff to allow sediment to settle out rather than entering the stormdrain. They can play a minor role on gently sloping paved streets.
- Create a dam around the curb inlet, using gravel filled sandbags or supported structures of filter cloth and drain rock.
- Include an overflow to allow for high flow conditions. Improper allowance for overflow can result in runoff overtopping the basin around the inlet, causing downstream erosion.

4 Sediment Basin/Pond

- Sediment basins are settling ponds with a pipe outlet. They should be professionally designed to provide adequate size for water and sediment storage (about 150 cu.m./Ha) and stable sideslopes.
- Locate at the stormwater outlet from the site. Do not locate in streams or riparian corridors.
- Provide a perforated pipe designed for controlled outflow, a pipe overflow and emergency spillway.
- Design - or use baffles - to create a min. 3:1 length:width ratio (9:1 preferred) to allow sediment to settle.

5 Drop Inlet Sediment Barrier

- Place a temporary gravel berm around drop inlets, to pond sediment laden runoff - this can play a minor role on flat areas.
- Ensure that terrain is shaped to create a pond, and to avoid the pond overspilling the basin around the drop inlet. The contributing area should be small, with low flows.
- Remove collected sediment after each storm event.

6 Gravel Access Pads

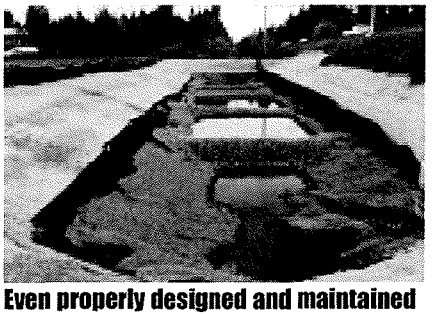
- Gravel Access Pads - a 200 mm thick layer of gravel at the site access - reduce the tracking of mud off the site onto adjacent roadways, where it would wash into the stormwater system.
- Install gravel access pads prior to use of heavy equipment or site grading operations, and maintain them throughout construction operations. When trucks and other heavy equipment are moving on and off the site frequently, install gravel runways within the site and restrict those vehicles to them.
- Maintenance or reinstallation of gravel access pads may be necessary on large or wet construction sites.

7 Roadside Swale

- Manage erosion from building sites by controlling silt-laden runoff before it gets to the road or catch basin.Where grade allows, install a temporary roadside swale uphill of paved roadways to pond building site runoff and allow sediment to settle.On sloping sites, use silt fence sediment barriers or continuous roadside berm to pond building site runoff.
- In subdivisions with boulevard between sidewalk and street, leaving the topsoil out of the boulevard can provide a settling pond until after construction on the lot is complete.

8 Street Sweeping

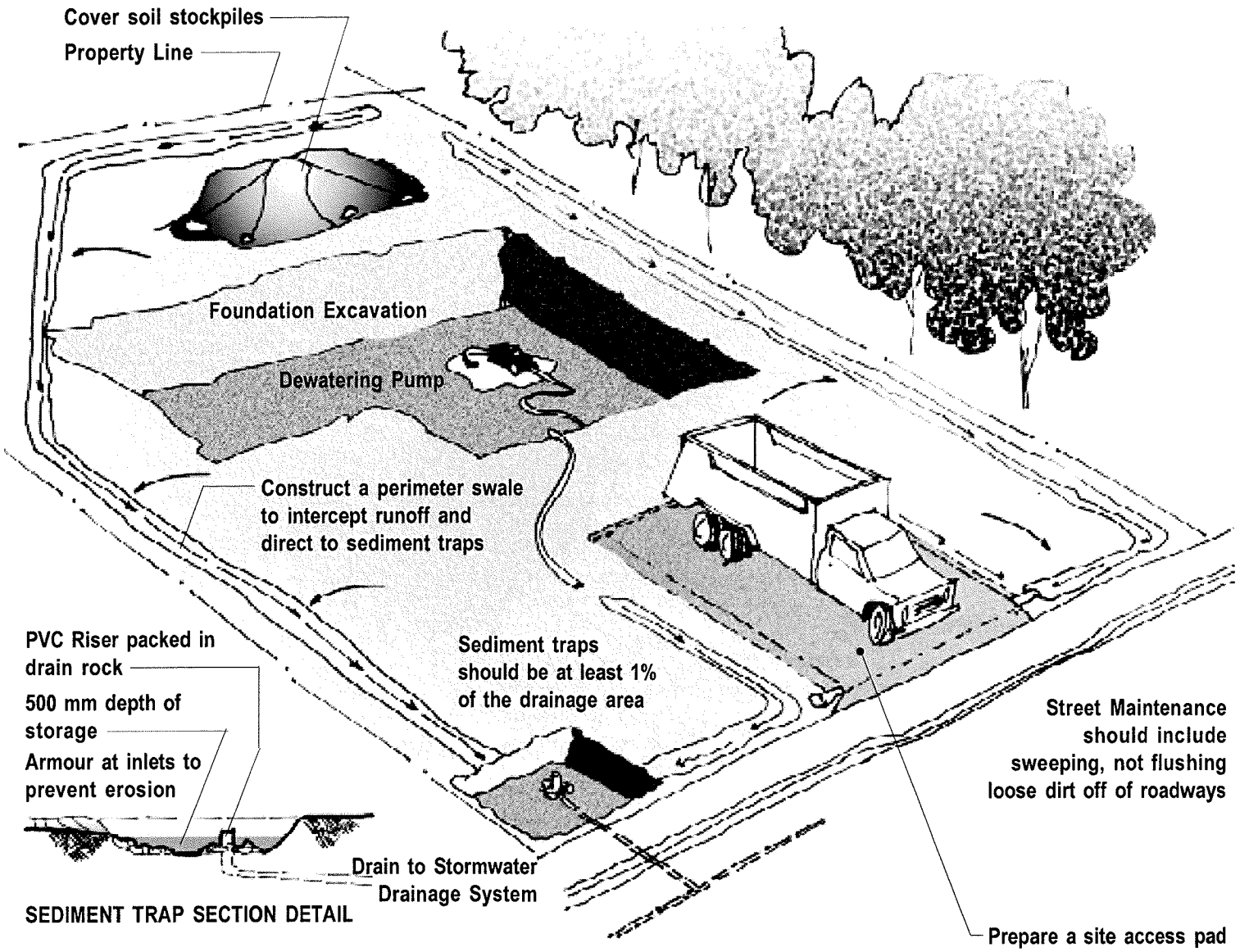
- Regular street sweeping during construction will remove sediment collected by curb inlet sediment barriers or from construction traffic.
- Use street sweeping - avoid street washing which carries sediment into the storm drainage system.
- Summer street sweeping also reduces problems of windblown dust.



Even properly designed and maintained Sediment basins let about 50% of sediment - the fine silts/clays - pass through.

You can increase success by using source erosion control, runoff control and sediment interception ponds together.

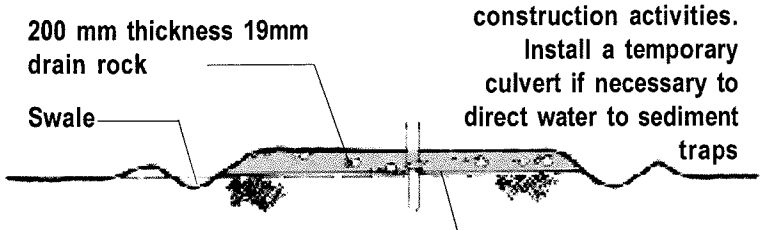
This illustrates erosion control practices on a single family lot during construction.
Apply these ideas to your property as needed to ensure that sediment is not tracked offsite.
For larger and more complicated sites, seek professional advice and prepare an erosion control plan.



SEDIMENT TRAP SECTION DETAIL

1. Erosion and sediment control measures should be installed prior to any other on site activities.
2. No sediment laden water is to leave the site.
3. Soil stockpiles are to be covered with poly or surrounded with silt fencing.
4. Construct site access pads 4.5 m wide at all accesses to site.
5. Swales to be installed as needed, based on lot grading.
6. These are guidelines for single family lot development. For larger or more complex sites an erosion control plan prepared by a qualified professional may be required.

Prepare a site access pad to prevent carrying dirt on to the street. This pad should be 4.5 M wide and long enough to allow for construction activities. Install a temporary culvert if necessary to direct water to sediment traps



SECTION THROUGH ACCESS PAD