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## 41 EROSION AND SEDIMENT CONTROL PLANS

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## 41.1 INTRODUCTION

This chapter, based on Camp Dresser & McKee et al., 1993; describes how to prepare, implement, and monitor a stormwater Erosion and Sediment Control Plan (ESCP) for a construction project. The ESCP will become part of the Development Order to be issued by the Local Authority for most construction activities.

Preparing and implementing an ESCP need not be time-consuming and can best be accomplished using and/or slightly revising current planning, design, and construction activities employed by most projects. The best ESCPs are those that are prepared as an integral part of these typical project activities. This is because much of the information required for an ESCP is already part of the project design documentation and because the design may need to be modified to incorporate controls during construction and post-construction activities.

### 41.1.1 Statutory Context

Statutory compliance requirements with respect to erosion and sediment control in Malaysia can be found in various pieces of legislation listed below. The various statutes are administered by nominated agencies (DOE, 1996).

- The Ninth Schedule of the Malaysian Constitution (Malaysia, 1995)
- Environmental Quality Act, 1974 (Laws of Malaysia Act 127)
- Natural Resources and Environment (Amendment) Ordinance, 1993 for Sarawak
- Natural Resources and Environment (Prescribed Activities) Order, 1994 for Sarawak
- Land Conversation Act, 1960 (Laws of Malaysia Act 395)
- National Forestry Act, 1984 (Laws of Malaysia Act 313)
- National Forestry (Amendment) Act, 1993 (Act A864)
- State Mining Enactments
- The Street, Drainage and Building Act, 1974 (Laws of Malaysia Act 133) and Uniform Building By-Laws, 1984
- Town and Country Planning Act, 1976 (Laws of Malaysia Act 172); (Amendment) 1995, Act A933
- Local Government Act, 1976 (Laws of Malaysia Act 171)
- Fisheries Act 1985 (Laws of Malaysia Act 317)
- Geological Survey Act, 1974 (Laws of Malaysia Act 129)
- State Water Enactments
- Federal Territory of Kuala Lumpur, Earthworks By-Laws, 1988
- Selangor Waters Management Act, 1999

The regulatory framework for stormwater management is outlined in Chapter 5.

### 41.1.2 Erosion and Sediment Control Plans

An ESCP is a plan that details temporary measures that will be implemented during the construction phase and may include permanent measures that will remain in place once development is complete to control the environmental impacts of erosion and sedimentation.

An effective ESCP aims to prevent controllable erosion and to minimise the adverse effects of sediment transport from on-site to off-site areas. The plans may range from a simple plan for small sites (say less than 5 hectares), to detailed comprehensive plans for a complex development on large sites (say greater than 50 hectares) or for areas of high ecological value. In general, an ESCP for a development project serves to provide:

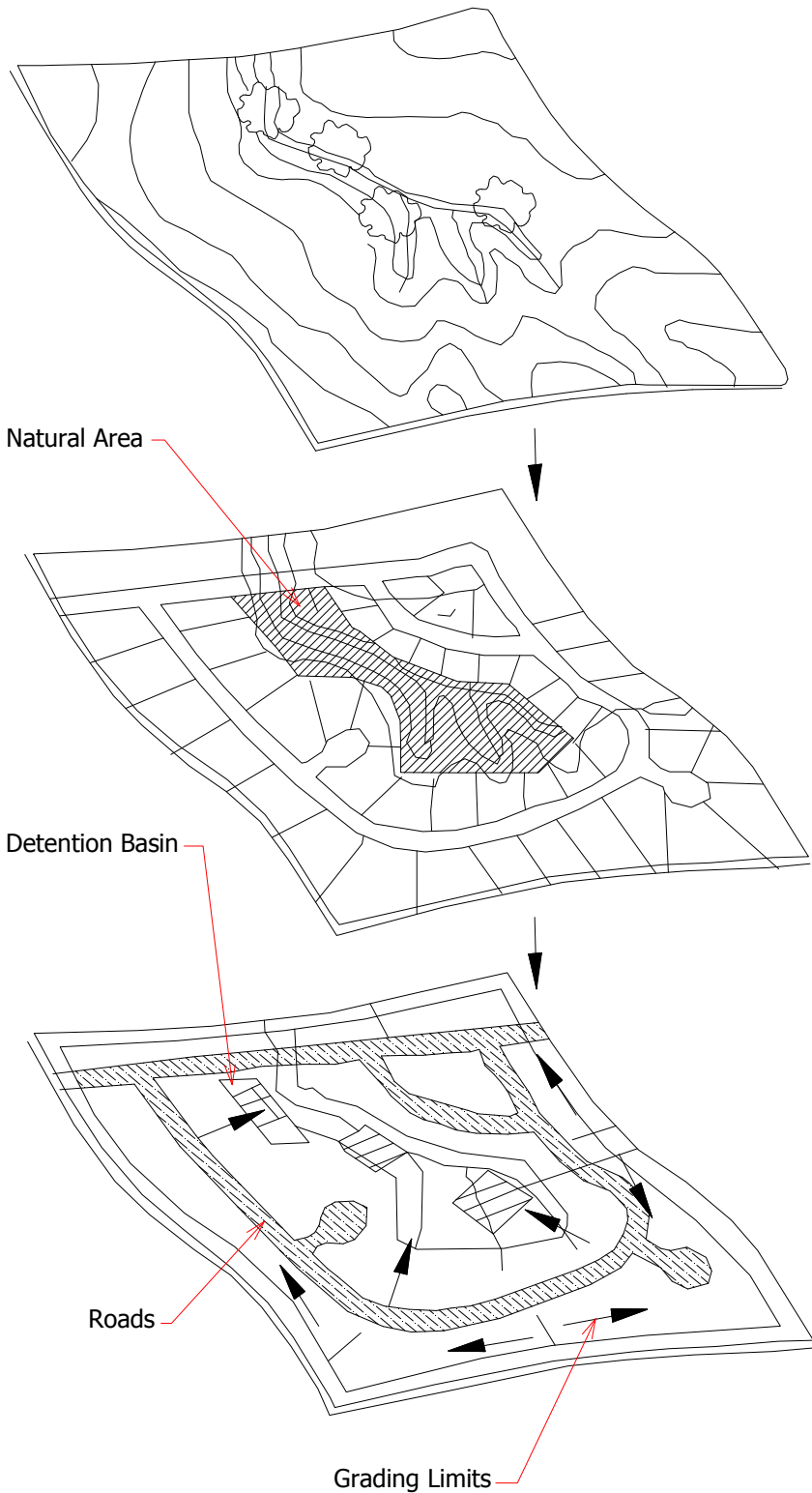
- a clear interpretation of the impact the development will have on the environment, which in turn will improve the quality of evaluation and interpretation by the government authorities responsible for commenting on, approving, and monitoring a project
- a clear interpretation of proposed erosion and sediment control measures
- a saving of time and costs because both the developer and the approving authority can agree on the implementation of the plan.
- a clear interpretation of proposed erosion and sediment control measures, thus improving the efficiency and cost effectiveness of the control techniques
- a plan that can be easily compared with measured implemented during construction to verify that the agreed measures are in place

The process that should be followed in preparing an ESCP is shown schematically in Figure 41.1.

### 41.1.3 General Principles

The first and main principle of ESCP preparation is to ensure that erosion and sediment control measures are fully integrated into the development sequence as shown in Figure 41.1. Erosion and sediment control can only be effective if construction and control practices are jointly planned during the planning and feasibility stages and implemented simultaneously throughout the construction stage.

The second principle is that an ESCP should form part of the engineering documents for a contractor and be part of the final engineering design drawings for documentation in the Schedule of Rates or Bill of Quantities.



**Planning Phase**

- Assess Site Conditions
- Develop Base Plan
- Select Permanent BMPs
- Establish Maintenance Agreements

**Design Phase**

- Prepare Project Site Plan
- Select BMP Objectives
- Define Permanent

**Construction Phase**

**Bidding and Mobilisation**

- Select BMPs
- Complete the ESCP
- Submit the Notice of Commencement

**Constructions Operations**

- Inspect and Maintain BMPs for Construction Activities
- Construct Permanent BMPs
- Revise the ESCP as Construction Evolves or Property is Sold

**Complete Constructions**

- Permanent Site Stabilisation
- Maintenance Agreement for Permanent BMPs
- Submit Notice of Termination

Figure 41.1 Integrating the Preparation of an ESCP into the Normal Site Development Process

The third principle is to ensure that all control structures are maintained at all stages of the development, such as during earthwork preparation, foundation and construction works. Well-maintained control structures may not overcome all erosional problems, but will ensure that the extent of the problems are significantly reduced.

The fourth principle is to ensure that there is a system of continuous measurement of the parameters identified in the ESCP to control erosion throughout the construction of the project.

The fifth principle is to prepare an emergency plan for immediate implementation if any of the erosion and sediment control measures fail due to unforeseen circumstances, such as severe rainstorms overtopping or breaching sediment basins.

## 41.2 PLAN CONTENTS

The ESCP should provide a simple narrative and diagram that:

- locates the construction site
- identifies potential pollutant sources on-site
- shows the location of the management practices to be used to minimise erosion and sedimentation during construction
- describes the proposed measures to eliminate pollution of stormwater runoff by any chemicals and materials used during the construction process
- shows the location of permanent control measures

This information is provided either in narrative or site plan form (see box). The level of detail will vary with the intensity, size, and type of construction. The ESCP may include copies of detail plans and specifications of the construction work.

The ESCP should be an independent document, which concisely provides the erosion, sediment, and pollution control measures to be used. The plan consists of three parts:

- a site plan
- a narrative
- an inspection and maintenance plan

The site plan is one or more of a series of maps or drawings pictorially explaining information contained in the narrative. The narrative verbally explains the problems and their solutions with all necessary documentation. The inspection and maintenance plan describes the procedures whereby the BMPs are monitored and maintained in good and effective condition.

### Contents of an ESCP

#### Project Information

- project name and location
- owners name and address
- contractors present on-site
- the Notice of Intent (NOI)

#### Site Plan(s)

- project location
- area to be disturbed
- improvements to be constructed
- on-site and downstream water bodies and watercourses
- pre-and post-construction drainage patterns
- locations where BMPs will be used:
  - BMPs for erosion and sediment control during construction
  - BMPs for other contractor activities (as appropriate)
  - permanent BMPs to be installed during construction

#### Narrative Descriptions

- known sources of on-site contamination before construction
- construction activities which may cause stormwater pollution
- pollutants expected to be present on the construction site
- BMPs for the constituents/pollutant sources
- responsible party for maintenance

#### Monitoring, Inspection, and Maintenance

- inspection and reporting procedures
- maintenance procedures

### 41.2.1 Site Plan

The ESCP site plan should be a simple illustration of the project site, showing key physical features and the location of erosion and sediment control measures and all construction operation measures such as entrance drives and construction yards. To the extent possible, locally required grading plans and/or erosion control plans should be used in preparing the ESCP.

Two scales of site plans will usually be required for all but the smallest construction sites:

*Project Location Map*: A figure showing the project site and the surrounding area (500 m beyond the project limits and with additional areas as necessary to clearly show local drainage patterns). A 1:25000 scale topographic map is typically used as a project location map.

*Detailed Site Plan*: A series of one or more drawings of the construction site at a sufficient scale (typically, no smaller than 1:5000) to clearly show on-site drainage patterns and the location of erosion and sediment controls.

Typical project construction drawings usually include a project site plan which includes most (if not all) of the required information. Simplified details and drawings may also be included or referenced where standard specifications exist.

#### 41.2.2 Narrative

The narrative is a written statement, which explains the erosion, sediment, and other pollutant control decisions made for a particular project and the justification for those decisions. The narrative should contain concise information concerning existing site conditions, construction schedules, and other pertinent items, which are not contained in a typical site plan.

The narrative is important to the construction superintendent and inspector who are responsible for implementing the plan. It provides them with a single report, which describes where and when the various BMPs for contractor activities and temporary and permanent erosion and sediment control should be installed.

#### 41.2.3 Inspection and Maintenance Plan

Every BMP installed on a construction site must be checked periodically and maintained sufficiently to ensure proper performance. An Inspection and Maintenance Plan should be prepared and implemented. The purpose of the plan is to:

- assign personnel responsible for BMP inspection and maintenance
- determine maintenance requirements of any BMP whose effectiveness is compromised (e.g. replace failed BMPs, remove trapped sediment, increase size of spill containment flushed out by rain)
- keep inspection and maintenance records on file for at least three years

Inspection requirements and methods for assessing the effectiveness of BMPs are discussed in Section 41.4.

### 41.3 PLAN PREPARATION STAGES

The ESCP must be prepared before construction begins, ideally during the project planning and design phases. It may be completed at the end of the design phase or early in the construction phase, as shown in Figure 41.1. Implementation of the ESCP begins when construction begins, typically before the initial clearing, grubbing, and grading operations since these activities usually increase erosion potential on the site. During construction, the ESCP should be referred to frequently and refined by the owner and contractors as changes occur in construction operations, which have significant effects on the potential for discharge of pollutants.

The ESCP may be very dynamic for large, complicated projects constructed in multiple stages over a long period of time. Planning, design, and construction of these projects may be occurring simultaneously. In such cases, it may be useful to prepare the ESCP in sections, with each section covering a stage or portion of the project and an overview section generally discussing the entire project.

The following sections give guidance on how to incorporate ESCP preparation into the planning, design, and construction phases of a project.

#### 41.3.1 Planning Phase

The planning phase is the source of much of the information needed for the ESCP. The basis for erosion and sediment control decisions is also made at this phase via the normal review process with the Local Authority. Four activities which occur during planning that are important to the preparation of an ESCP are:

- assessing site conditions
- developing a base plan(s)
- selecting post-construction measures
- establishing long-term maintenance agreements

##### (a) Assess Site Conditions

The planning phase of any construction project defines the characteristics of the site and how these characteristics will impact the project. Information on what will be built, how it will be constructed, drainage patterns, soils, topography, rainfall, and special site conditions (e.g. existing vegetation, unique cultural or environmental features) is usually obtained and used for initial planning of public works or land development projects. This information will be used in selecting control measures for the project and typically should be included in or referenced by the ESCP.

*(b) Develop a Base Plan(s)*

The designer will generally prepare a site analysis as either a formal document or as an information plan. The site analysis should review the physical conditions of the site and adjacent areas, the site constraints, and applicable zoning and development requirements. To avoid duplication of effort and reduce costs, the owner and the designer should prepare a site base plan to be shared by the ESCP and other site analyses (see box below).

*Base Plan(s) of Site for ESCP  
and Other Site Planning*

- use a scale large enough to distinguish existing and proposed features of the site
- location plan should extend 500 m beyond the property boundary
- site plan(s) should show:
  - topography
  - limits of construction
  - conceptual project layout
  - surface water bodies, watercourses, known wetlands, springs, and wells
  - locations where drainage leaves or will leave the property
  - existing land use
  - existing vegetation
  - steep or unstable slopes
  - areas used to store soils and wastes
  - areas of cut and fill
  - existing and planned paved areas and buildings

*(c) Select Post-Construction Control Measures*

Permanent control measures are the final improvements to and configuration of the project which are designed to control long-term stormwater pollution. Permanent measures are normally *selected* in the planning phase in conjunction with the approval of the project master plan, *designed* during the project design phase and *completed* to the satisfaction of the Local Authority and/or the ultimate owner. Occasionally, unforeseen natural or man-made factors may require revisions to or additions of permanent controls during the construction phase. Permanent controls are typically integrated with the normal project features (see box). In the planning phase (master plan), it is important to indicate the maintenance responsibility for the permanent controls.

During construction, the contractor must ensure that the permanent BMPs are installed properly and that any maintenance that may be necessary during construction is performed. After the project is complete, it will be the responsibility of the owner, private or public, to provide for long-term operation and maintenance. A discussion on selecting permanent control measures is provided in Chapter 30.

*Typical Post-Construction BMPs*

1. Stabilise the site by establishing final land grades, contours, and drainage patterns.
2. Control of the volume, flow, and/or velocity of stormwater runoff by such means as detention and/or retention basins, porous pavements, dry wells, etc.
3. Channel stabilisation, energy dissipaters, or other drainage structures.
4. Permanent landscaping, rock riprap, vegetation, or other permanent ground cover designed to stabilise the soil or slopes.

*(d) Establish Maintenance Agreements*

The Local Authority may have an established policy defining maintenance responsibilities for community infrastructure and may require a maintenance agreement as a condition of approval of a master plan. Two fundamental choices exist for post-construction operation and maintenance of stormwater infrastructure:

*Private maintenance* : After construction is complete, the property owners retain responsibility for maintenance. The responsible party may be the owner or an association of property owners and/or homeowners. It is advisable that a formal agreement (such as a deed restriction recorded on the property) be drawn up between the Local Authority and the party responsible for maintenance.

*Public Maintenance* : The Local Authority agrees to assume responsibility for maintenance for some or all of the infrastructure. Such maintenance may be incorporated into a municipality-wide program, funded from the municipality's general fund or user fee structure. Alternatively, an agency or special district may be established, to assess property owners within the district. Common examples of special funding methods would include community service areas, area drainage plans, and benefit assessment areas.

**41.3.2 Design Phase**

There are three principal activities that are typically incorporated into the ESCP during the design phase:

- preparing a project site plan
- defining objectives for control measures
- designing permanent water quality control measures

Design considerations for permanent structural water quality control measures are provided in Part G. The remainder of this section discusses how to incorporate the other two activities with little additional effort beyond normal project design activities.

<u>Studies and Reports Prepared during Project Design</u>	
<u>Type of Report</u>	<u>Information Available for an ESCP</u>
<u>Preliminary Design</u>	
Soils Report	<ul style="list-style-type: none"> <li>• areas of highly erodible soils</li> </ul>
EIR/EA	<ul style="list-style-type: none"> <li>• previous and proposed uses of toxic materials on the site</li> </ul>
Preliminary Site Layout	<ul style="list-style-type: none"> <li>• locations of buildings and paved surfaces and/or lot layouts</li> </ul>
<u>Final Design</u>	
Drainage or Hydrology Report	<ul style="list-style-type: none"> <li>• drainage patterns and catchment boundaries</li> <li>• stormwater conveyance structures</li> <li>• detention/retention facilities</li> </ul>
Grading/Drainage Plan	<ul style="list-style-type: none"> <li>• areas of cut and fill</li> <li>• slopes during and after construction</li> <li>• protection of existing vegetation</li> <li>• areas of soil disturbance</li> </ul>
Landscape Plan	<ul style="list-style-type: none"> <li>• buffer areas and set backs</li> <li>• permanent site stabilisation</li> <li>• multi-purpose uses of open space</li> </ul>

*(a) Prepare Project Site Plan*

Numerous studies, reports, and documents are typically prepared during preliminary and final design as the basis for many decisions about the project (see box).

A Hydrology Report, Drainage Study, or similar document is typically required as part of project infrastructure design. Such a study may be required by the Local Authority as a condition of approval of a project master plan for land development, or as part of improvement plans or concept plans for public projects. The Hydrology Report should address the design storm, which will be used for erosion and sediment control. Refer to Table 39.5 and 39.6 for design storm requirements for sediment basins.

A Soils Report based upon site soil sampling is normally prepared to identify soil constraints, design criteria, slope stability, etc. Both of these reports should be used by the engineer to prepare the preliminary grading and drainage plan. They also form the technical basis for selection of erosion and sedimentation control and permanent measures. Figure 41.2 shows a typical preliminary site layout based on information, which is usually readily available during the preliminary design phase of a building project. This preliminary site plan includes several items, which are required for the ESCP:

- locations of buildings and paved areas
- proposed flow paths:
  - on-site flow paths where erosion during construction may occur and erosion and sediment control BMPs should be applied
  - locations where runoff will leave the site
  - diversion of or conveyance for upstream runoff
- locations of flood control facilities and permanent structural BMPs
- approximate locations where cut and fill will occur
- access points for construction traffic
- areas where existing vegetation may be preserved
- areas to be paved
- areas most suitable for the contractor’s yard, material storage area, and vehicle maintenance area (consider locating in areas to be paved)

*(b) Define Objectives for Control Measures*

During the final project design process, the engineer, architect, or landscape architect will prepare detailed grading plans, paving and drainage plans, landscape plans, and other plans as necessary for the successful construction of the project. These plans provide the construction design requirements, specifications, and other construction documents necessary for the construction bidding, permitting, and inspection. For the ESCP to be compatible with the other engineering plans, the most



practical process may be for the engineer or architect to develop BMP objectives for the construction period based on contractor activities and the grading and drainage plan for the site (see box).

<u>BMP Objectives</u>
1. practice good housekeeping
2. contain waste
3. minimise disturbed areas
4. stabilise disturbed area
5. protect slopes and channels
6. control perimeter of site
7. control internal erosion

A narrative discussion of these objectives should be prepared for inclusion in the ESCP, as well as to guide the BMP selection process. The locations of various objectives can be shown on a site plan (Figure 41.2). Determining objectives facilitates the selection of BMPs.

This step can occur as part of the preparation of the grading and drainage plan and be included in the bid package and/or construction documents for consideration by the contractor. This allows the owner to explicitly address unique site conditions, which may impact on stormwater pollution control during construction. Alternatively, the owner could require the contractor to prepare such a plan to justify the selection of BMPs.

### 41.3.3 Construction Phase

#### (a) Bidding and Mobilisation

During bidding and mobilisation, the owner selects a contractor(s), who in turn plans and prepares to construct the project according to the construction plans and specifications. Three activities, which should be addressed during this phase, include:

- selecting BMPs
- completing the ESCP
- training of personnel

#### (i) Select BMPs

Either the owner, the owner's design consultant, or the contractor may perform these activities at the discretion of the owner and the Local Authority. The construction documentation should specify what the responsibilities of the owner and the contractor are with regard to water quality control before, during, and after construction.

#### (ii) Complete the ESCP

All of the necessary planning work has been done during the site planning and design process. The final step consists of consolidating the pertinent information and developing it into a specific ESCP for the project.

Figure 41.3 is a typical site plan showing locations of erosion and sediment control BMPs based on the BMP objectives indicated in Figure 41.2.

The ESCP should be directed at personnel involved in the construction project (e.g. supervisors, foremen, and inspectors). The ESCP should provide specific guidance on actions to be taken by these personnel, and should be presented in a format which accommodates day-to-day use (e.g. loose leaf, pullout sections, check lists, etc.).

#### (iii) Train Personnel

Training of construction personnel is imperative to the success of the BMPs plans. Adequate training is required for BMPs to be properly installed and maintained to perform their intended function.

Thus, only trained personnel should be assigned these responsibilities. An effective training program is based on four objectives:

- how to identify a stormwater pollution problem
- how to define solutions (i.e. select BMPs)
- making every employee responsible for preventing stormwater pollution and finding solutions to problems
- soliciting feedback to improve installed BMPs

#### (b) Construction Operations

During construction, the owner/contractor is responsible for implementing the BMPs according to the ESCP. Because site conditions will inevitably vary during construction, the ESCP should be revised as necessary, with any changes highlighted on the copy maintained at the construction site. There is no formal revision process; upon inspection, the ESCP must reflect the existing status and condition of the site.

#### (c) Complete Construction

Permanent water quality control BMPs (if any) should be properly installed according to the construction plans and specifications, with responsible parties designated for operation and maintenance and funds committed to long-term maintenance needs. The Local Authority may have a policy concerning the installation and maintenance of permanent BMPs and should therefore be consulted.

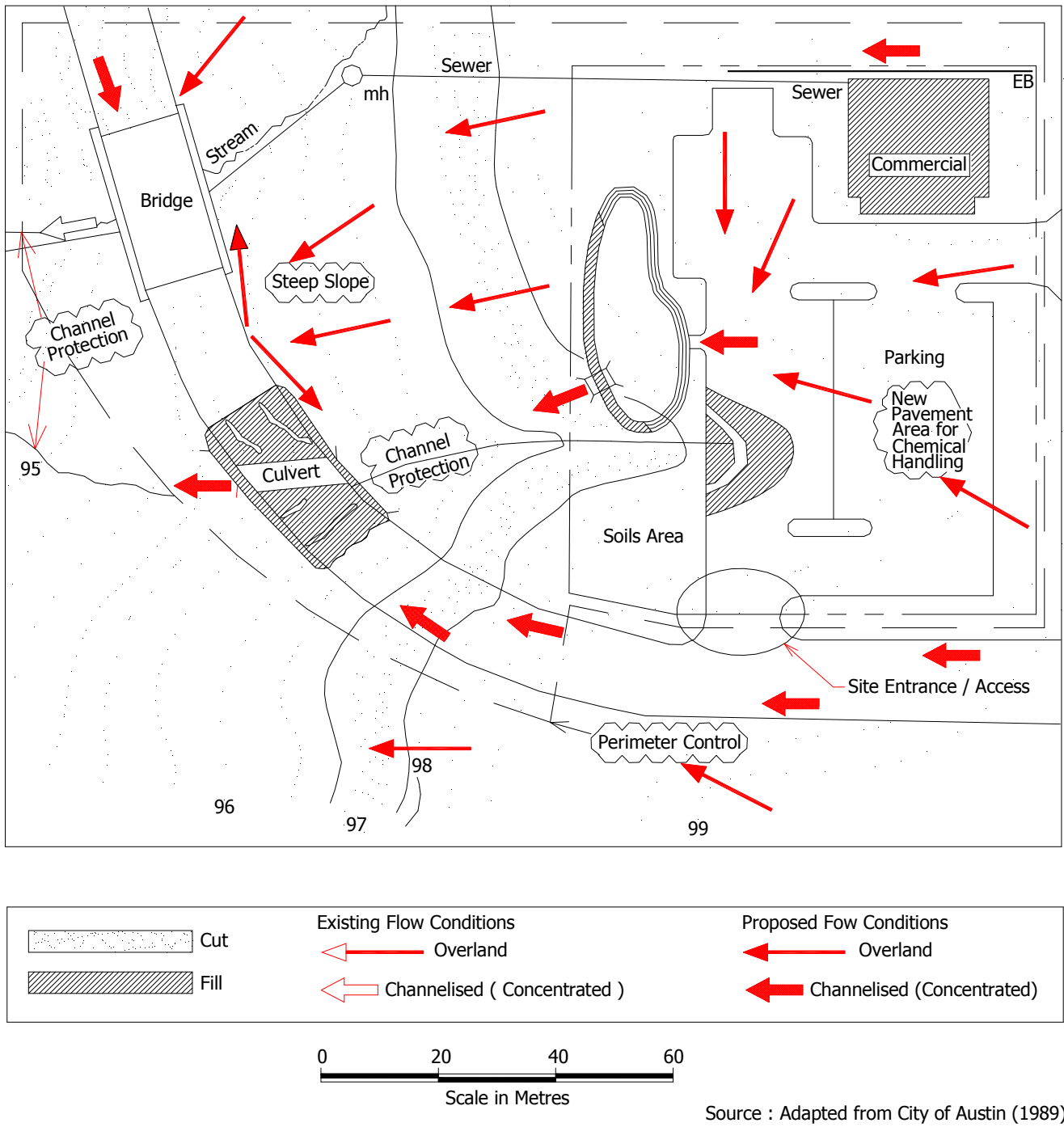
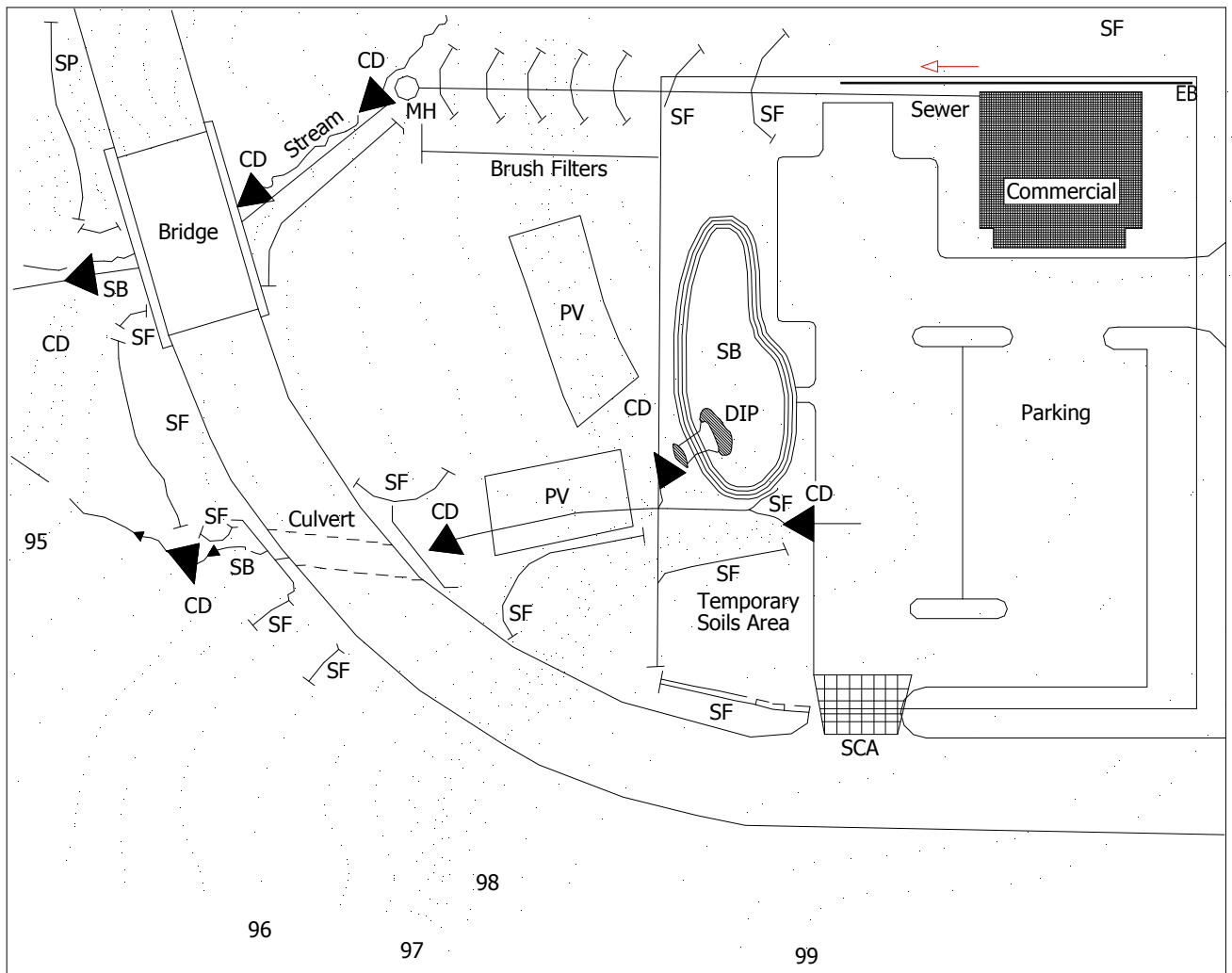


Figure 41.2 Identification of BMP Objectives on Preliminary Base Plan (City of Austin, 1989)



Source : Adapted from City of Austin ( 1989 )

Sedimentation Control BMPs

DIP	Drainage Inlet Protection
SF	Sediment Fence
BF	Brush Filter
SB	Sediment Basin ( Temporary )
SCA	Stabilized Construction Access
EB	Earth Bank

Erosion Control BMPs

CD	Check Dam
PV	Preserve Existing Vegetation

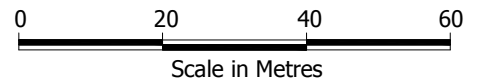


Figure 41.3 Site Plan Showing Locations of BMPs for Erosion and Sedimentation Control (City of Austin, 1989)

#### 41.4 EVALUATING PLAN PERFORMANCE

The final step in the preparation of an ESCP is to develop a program to monitor how well the BMPs work and to evaluate whether additional BMPs are required. An inspection and maintenance plan should be prepared with the following objectives:

- to inspect BMPs regularly, as well as prior to and after a storm event
- to aid in implementation of the ESCP
- to measure the effectiveness of the BMPs

To meet these objectives, the monitoring effort requires the following elements:

- site inspection
- BMP monitoring
- record keeping
- ESCP review and modification

##### 41.4.1 Site Inspections

Inspections should be carried out before and after a storm event. At the start of a construction project (e.g. clearing, grubbing, earth movement), it may be more appropriate to inspect the BMPs on a regular basis instead of just before and after a storm. This should allow sufficient time for any corrections or improvements to be made between storm events. An inspector should be identified in the ESCP. Inspection can usually be performed as part of a regular construction inspection program.

The results of the inspection and assessment must be recorded in writing. The date of the inspection, the person(s) who performed the inspection, and the observation must be included. Inspection records must be retained for three years. A sample inspection form is provided at the end of the chapter.

It is possible that activities may have changed by type or location since the last inspection. These should be noted. New BMPs and adjustments to the ESCP may be necessary to accommodate such changes.

##### 41.4.2 Monitoring

The type of BMP monitoring depends on the type of BMPs used. For contractor activity BMPs, the monitoring consists of visual inspection to ensure that the BMP has been implemented and maintained according to the ESCP. Such inspection would include:

- looking for evidence of spills and resulting clean-up procedures (e.g. supplies of spill cleanup material)
- examining the integrity of containment structures
- verifying the use of employee education programmes for the various activities

- noting the location of activity (e.g. outdoor vs. indoor, concrete vs. grass)
- verifying adequacy of trash receptacles
- verifying waste disposal practices (e.g. recycle vs. hazardous waste bins)

For sediment and erosion control BMPs, the monitoring program should consist of regular inspection to determine the following:

*(a) Are the installed BMPs effective?*

The effectiveness of the BMP would be based on the presence of silt behind or within control devices, the presence of silt downstream of the site, and sign of erosion in stabilised areas after a storm event. The system may be deemed ineffective if:

- silt is present outside of the control area
- structural controls are breached or fail under storm events of minor intensity (e.g. less than 2 year ARI)
- rills and gullies are present in stabilised slopes
- evidence of silt buildup in downstream stormwater drains and waterways is apparent
- controls are not maintained in accordance with design guidelines

*(b) Have drainage patterns changed?*

If the site has undergone significant grading operations, which change the drainage patterns, adjustments to the BMP controls will likely be required to address this change. The inspector shall determine the extent of the drainage pattern changes, if the changes are addressed in the ESCP, and if modifications to the erosion and sediment control BMPs are required to address this change.

*(c) Are sediment and erosion control BMPs installed properly?*

The ESCP BMPs should include details or references to allow for the proper construction of structural or vegetative erosion and sediment control devices. The inspector should ensure that these systems are installed according to the ESCP in the proper locations.

*(d) Are areas stabilised as quickly as possible after completion of construction activities in an area?*

Active construction areas (inactive construction areas may be defined as areas in which no construction activity will occur for a period of 30 days or longer) which have been disturbed should be stabilised through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area. If construction, climatological, or other site conditions do not allow stabilisation within 7 days, the

ESCP should define alternative approaches (e.g. watering or chemicals for dust control).

*(e) Are the BMPs properly maintained?*

Maintenance of the erosion and sediment control devices is the most critical as well as potentially the most expensive item in the ESCP. The inspector should inspect the site on a regular basis and after any rainfall of 15 mm or greater to determine maintenance requirements and the general condition of the installed system. The Local Authority may also inspect the site on a typical bi-weekly basis to assess the maintenance performed on the systems. The following maintenance tasks should be performed on a regular basis and all maintenance related to a storm event should be completed within 48 hours of the storm event.

1. Removal of silt from barriers and sediment traps and basins.
2. Replacement or repair of worn or damaged geotextile fabric.
3. Repair or replacement of damaged structural controls.
4. Seeding or mulching of damaged stabilised areas.
5. BMPs for any chemicals or fuels not addressed in the ESCP must be developed.
6. Any other control maintenance that is specified in the approved ESCP.

#### 41.4.3 Record Keeping

Records of all inspections, compliance certifications, and non-compliance reporting are to be retained for at least 3 years by the owner/developer.

It is suggested that records of incidents such as spills or other episodic releases be kept. Analysing a history of this information can provide insight into modifying the BMPs. The history may suggest a predominance of spills in particular locations, from particular activities, and/or of particular materials. Efforts can be focused accordingly. Photographs may be useful. A record should be kept of maintenance activities or any other BMPs that are of an "action" nature. It is easy to demonstrate that a BMP involving a physical change, such as berming or covering, has been accomplished, but actions that relate to good housekeeping can only be demonstrated by record keeping. Keeping a record of sediment trap cleaning, for example, also provides insight into how soon it takes for the trap to refill.

#### 41.4.4 Plan Review And Modifications

During the course of construction, unanticipated changes may occur which affect the ESCP, such as schedule changes, phasing changes, staging area modifications, off-site drainage impacts, and repeated failures of designed controls. These changes must be made known and the ESCP revised accordingly. During the preparation and review of the modified ESCP, construction may continue

with temporary modifications to the erosion and sediment control BMPs.

Revisions to the ESCP are also required when the properly installed systems are ineffective in preventing silt transport off the site. This may be due to unforeseen site conditions or construction techniques, which adversely affect the system as designed. Revisions to the ESCP are also required if there is a new, deleted, or moved activity that could result in the discharge of significant amounts of pollutants.

#### 41.4.5 Specific Activities

The key to controlling erosion and sediment is the implementation and maintenance of ESCPs. This is best achieved by undertaking a regular site inspection program to ensure that the ESCP is always operating in accordance with its design intent. It requires records to be kept of rainfall, maintenance works, and other matters that contribute to the standard of performance of site work practices. These records might be required for review by DOE or Local Authority Officers, especially if any damage or pollution of the environment occurs during construction. It is recommended that the following activities be undertaken (after NSW EPA, 1996).

*(a) When and What to Inspect*

Inspections should be undertaken:

- during any storm event that threatens to exceed the available capacity in sediment basins and permanent water quality control structures
- after any storm that has caused runoff
- daily, during hot or dry weather when grass cover is less than 100% on vegetated areas
- weekly (on Mondays) as a matter of site routine for all site work practices
- before site closure or any other time when it might be otherwise unattended for more than twelve hours
- from the site access in a clockwise direction around the site, which will allow others (replacement worker, DOE or consent authority officers) to follow the recorded inspection route

*(b) Installation*

A logbook should always be kept on site for inspection by DOE or Local Authority Officers with entries made at least weekly on:

- dates of installation and removal of site work practices
- repair of any damage to site work practices
- rainfall depths, durations, and times
- storage capacity available in pollution control structures

- condition of site work practice structures and stabilised surfaces
- time, date, volume, and type of any additions of flocculants
- estimates of water volumes discharged
- estimate of pollutant volumes removed

*(c) Typical Program*

Begin the following program each Monday or as otherwise required.

1. Inspect catch drains, earth banks, table drains, and slope drains and clean as required.
2. Remove any stockpiled material or sediment that has encroached within 2 m of surface drain.
3. Restore any low spots in earth banks and diversion drains to their original height and compact.
4. Where necessary, construct extra earth drains and/or diversion drains that help separate on-site dirty waters from other waters.
5. Install any new erosion and sediment control measures that have become necessary since previous inspections because of severe storms or progress in the site's development.
6. Check to ensure that all earth banks, diversion drains, and waterways are operating within the safe limits for their surface conditions by noting any evidence of scour.
7. Ensure that any construction work at the site since the previous inspection has not diverted sediment and water away from any site work practice.

*(d) Removing Sediment and Other Pollutants from Structures*

Regularly inspect pollution control site work practices, especially after each runoff event and arrange to remove pollutants as necessary. This might include:

- monitoring dust daily or any time when vehicle movements increase and apply water, soil binder, or a permanent surface sealing agent as necessary
- removal of sediment from sediment basins and traps and disposal in compliance with local regulations
- clearing trash racks of all bulky and floatable material after each heavy storm or as otherwise required to avert flooding of their surroundings

*(e) Maintenance of Vegetated Surfaces*

Observe revegetated surfaces and ascertain if they are progressing as planned. Where they are not:

- seek professional agricultural advice as appropriate
- consider the following:
  - additional irrigation (watering)
  - application of fertilisers
  - reseeding
  - mulching
  - weed control
  - other forms of maintenance

*(f) Repairing Damaged and Breached Structures*

Make inspections of all structures for damage, especially after any significant rainfall, and:

- repair, re-pin, or replace torn, detached, or otherwise damaged liners, biodegradable blankets, geofabric, etc
- fill and compact any low spots and breaches in earth banks and diversion drains where vehicles or other factors have reduced the design height or stability
- repair any breached sediment traps or basins, with the benefit of appropriately qualified advice and soil data
- repair (restabilise) any areas of soil erosion to reduce further erosion

*(g) Recording, Measuring, Observing, and Sampling Site Work Practice Performances*

The Supervising Engineer should:

1. Collect any samples of sediment, water, chemical additive, or other pollutants required by the DOE or Local Authority.
2. Keep accurate records with respect to the time, place, and nature of the sample.
3. Make any necessary declarations with respect to the samples.

**APPENDIX 41A ESCP SITE INSPECTION CHECKLIST**

***SAMPLE***

- Regular Inspection
- Rainfall Event Inspection (Before)
- Rainfall Event Inspection (After) Rainfall ..... mm

Inspected By : ..... Date : .....

Project : .....

YES	NO	DOES NOT APPLY	
			Are the BMPs called for on the ESCP installed in the proper location and according to the specifications for the ESCP?
			Are all operational stormwater drain inlets protected from sediment inflow?
			Do any structural practices require repair or clean out to maintain adequate function? If yes, indicate which ones:
			Are on-site construction traffic routes, parking, and storage of equipment and supplies restricted to areas specifically designated for those uses?
			Are locations of temporary stockpiles in approved areas?
			Do any seeded or landscaped areas require maintenance, irrigation, fertilisation, seeding, or mulching?
			Is there any evidence that sediment is leaving the site?
			Is there any evidence of erosion of cut or fill slopes?
			Is there any evidence of sediment, debris, or mud on public roads at intersections with site access roads?
			Does the ESCP require revisions? If yes, explain:

**APPENDIX 41B MODEL ESCPs**

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## **41B.1 MODEL ESCP – SINGLE RESIDENTIAL DEVELOPMENT**

### *41B.1.1 Introductory Notes*

Model plan ESCP 1 shows erosion and sediment control BMPs that may be implemented for the construction of a bungalow house. The BMPs indicated would be suitable for other types of small scale building development such as semi-detached housing and shop lots.

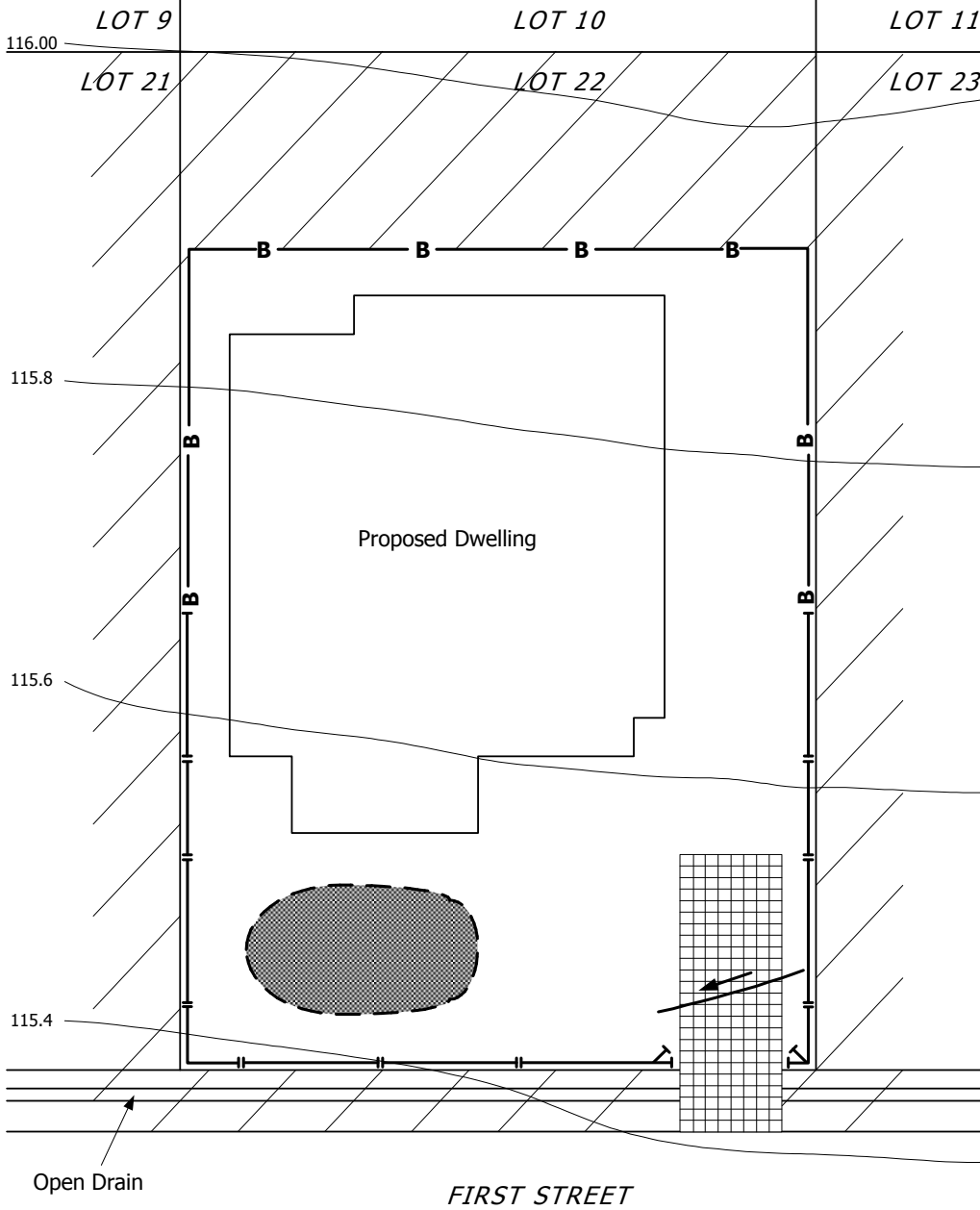
The following model information is an example of the narrative that would be submitted by the owner/builder/developer together with an accompanying plan (ESCP 1) and BMP standard drawings to the Local Authority.

### *41B.1.2 Erosion Control Conditions*

1. Site works will not start until the erosion and sediment control works outlined in clauses 2 to 5 below are installed and functional.
2. Entry and exit to the site will be confined to one stabilised location. Fencing will be used to restrict all vehicular movements to the stabilised site access. Stabilisation will be achieved by either:
  - constructing a concrete driveway to the street
  - constructing a stabilised site access in accordance with Standard Drawing SD I-4 or according to another suitable technique approved by the consenting authority
3. Sediment fences (SD I-11) and barrier fences will be installed as shown on ESCP 1 with a low flow earth bank (SD I-5).
4. Topsoil will be stripped and stockpiled for later use in landscaping the site.
5. All stockpiles will be placed in the location shown on ESCP 1 and at least 2 m clear of all areas of concentrated runoff and the driveway protected by site works (SD I-8).
6. Land to the rear and side of the lot and on the street verge will not be disturbed during the works except where essential, e.g. drainage works across the verge. Where works are necessary, they will be undertaken in such a way as to leave the lands in a condition of high erosion hazard for as short a period of time as practicable. They will be rehabilitated as soon as possible. Stockpiles will not be placed on these lands and they will not be used as vehicle parking areas.
7. Approved waste disposal bins for concrete and mortar slurries, paints, acid washings, and litter will be provided and arrangements made for collection and disposal.
8. Roof guttering will be connected to the stormwater system as soon as practicable.
9. Topsoil will be re-spread and all disturbed areas will be rehabilitated within 20 working days of the completion of the works.
10. All sediment and erosion controls will be checked at least weekly and after rain to ensure they are maintained in good working order.

Photocopies of the following Standard Drawings (given in Chapter 39) should be appended to these notes:

- SD I-4 Construction Access Stabilisation
- SD I-5 Earth Bank
- SD I-8 Stockpiles
- SD I-11 Sediment Fence



**LEGEND**

- Vegetated buffer area
- Stabilised construction access
- Earth bank
- Sediment fence
- Barrier fence
- Stockpile area

PROPOSED RESIDENTIAL DWELLING	Designed: SMB
New Housing Developments Sdn Bhd	Drawn: LDZ
	Date: 12/12/99
	Scale: 1:200
<b>EROSION &amp; SEDIMENT CONTROL PLAN</b>	<b>ESCP 1</b>

## 41B.2 MODEL ESCP - SUBDIVISION DEVELOPMENT

### 41B.2.1 Introductory Notes

The model plan ESCP 2 is based on an actual development in the state of Selangor. The development entailed the subdivision of building lots (community facilities; detached, semi-detached, and apartment style housing), the construction of roads, and the installation of utility services. It has been given the fictitious name of Selangor Estate. The site covers an area of 8.5 hectares of gently sloping land traversed by an existing small stream. The entire site was cleared and disturbed during construction.

The following is the narrative component to accompany the plan (ESCP 2) prepared for the above subdivision. It illustrates the type of information that should be included in an ESCP for submittal to a Local Authority.

### 41B.2.2 General Construction Conditions

1. The ESCP will be read with the engineering plans and any other plans or written instructions that may be issued in relation to development at the subject site.
2. Contractors will ensure that all erosion and sediment control works are undertaken as instructed in this specification and constructed in accordance with the Urban Stormwater Management Manual for Malaysia, 1999.
3. All contractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution of downslope areas.

### 41B.2.3 Land Disturbance

4. Where practicable, the soil and erosion hazard of the site will be kept as low as possible by limiting land disturbance as follows:

Land Use	Limitation	Comments
Construction areas	Limited to 5 m (preferably 2 m) from the edge of any essential construction activity as shown on the engineering plans.	All site workers will clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope), or similar materials.
Access areas	Limited to a maximum width of 5 m.	The Supervising Engineer will determine and mark the location of these zones on-site. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries.
Remaining lands	Entry prohibited except for essential management works.	Thinning of growth might be necessary, for example, for fire reduction.

### 41B.2.4 Erosion and Sediment Control Measures

5. The following erosion and sediment control measures (BMPs) will be constructed prior to commencement of clearing and grubbing operations and infilling of the stream through the site:
  - (a) Temporary diversion channels 1A and 1B and temporary waterway crossing of site access road.
  - (b) Stabilised site access and sediment fence along lower perimeter of site.
  - (c) Vehicle and equipment area 1, and materials storage area 1.
  - (d) Temporary access to the sediment basin on the alignment of the permanent roadways.

- (e) Sediment basin and earth bank 1, and barrier fencing to protect area surrounding the basin.
6. The following erosion and sediment control measures (BMPs) will be constructed when required according to the location and timing of works:
- (a) Earth banks 2, 3, and 4.
  - (b) Topsoil stockpile areas 1 and 2 including sediment fencing on downslope side.
  - (c) Vegetated buffer areas.
  - (d) Vehicle and equipment area 2, and materials storage area 2.
  - (e) Barrier fencing

*41B.2.5 Erosion Control Conditions*

- 7. Clearly visible barrier fencing will be installed as shown on the plan and elsewhere at the discretion of the Supervising Engineer to ensure traffic control and prohibit unnecessary site disturbance. Vehicular access to the site will be limited to only that essential for construction work and all vehicles shall enter the site only through the established site access point.
- 8. Soil materials will be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the surface at the completion of the works.
- 9. Where practicable, the construction programme will be scheduled so that the time from starting land disturbance activities to stabilisation is less than six months, weather permitting.
- 10. Notwithstanding this, works will be scheduled so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 20 working days.
- 11. Lands recently stabilised with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Further application of seed might be necessary later in areas of inadequate vegetation establishment.
- 12. Where practical, foot and vehicular traffic will be kept away from all recently stabilised areas.
- 13. Earth batters will be constructed with as low a gradient as practical, but not steeper than:

Slope Length (m)	Batter Slope
< 7	2(H):1(V)
7 to 10	2.5(H):1(V)
10 to 12	3(H):1(V)
12 to 18	4(H):1(V)
18 to 27	5(H):1(V)
> 27	6(H):1(V)

Slope length may be shortened by using low flow earth banks as catch drains.

- 14. Topsoil stockpiles will be located as shown on plan ESCP 2.
- 15. All earthworks, including waterways, drains, and spillways and their outlets, will be constructed to be stable in at least the design storm event.
- 16. During windy weather, large, unprotected areas will be kept moist (not wet) by sprinkling with water to keep dust under control. In the event water is not available in sufficient quantities, soil binders and/or dust retardants will be used or the surface will be left in a cloddy state that resists removal by wind.

#### *41B.2.6 Pollution Control Conditions*

17. Notwithstanding condition 14, stockpiles will not be located within 5 m of hazard areas, including the likely areas of high velocity flows such as waterways, paved areas, and driveways.
18. Sediment fences will:
  - (a) be installed where shown on plan ESCP 2, and elsewhere at the discretion of the Supervising Engineer to contain the coarser sediment fraction (including aggregate fines) as near as possible to their source
  - (b) have a catchment area not exceeding 0.4 hectares, a length not exceeding 30 m, or a total outflow not exceeding 50 l/s for a 1 year ARI
  - (c) provide a return of 1.5 m upslope at intervals along the fence to satisfy the criteria in (b) above
  - (d) a storage depth (including both settling and settled zones) of at least 0.6 m, and internal dimensions that provide maximum surface area for settling
19. The sediment basin will:
  - (a) be constructed where shown on plan ESCP 2. It will have been designed in accordance with the procedures given in the Urban Stormwater Management Manual for Malaysia, 1999, based on a design event of 3 months ARI.
  - (b) be flocculated before discharge occurs (unless the design event is exceeded)
  - (c) have one or more pegs placed on the floor to clearly indicate the level at which design capacity occurs and when sediment will need to be removed
20. The stored contents of the sediment basin will be treated with gypsum or other flocculating agents where they contain more than 50 mg/l of suspended solids. Treatment will be as follows:
  - lower suspended solids to less than 50 mg/l within 24 hours of filling
  - the basin will then be allowed to stand 36 to 48 hours for flocculated particles to settle
  - the basin will then be drained so that full storage capacity is regained without discharging sediment from the site
21. Sediment removed from any trapping device will be disposed of in locations where further erosion and consequent pollution to downslope lands and waterways will not occur.
22. Water will be prevented from directly entering the permanent drainage system unless it is relatively sediment free (i.e. the catchment area has been permanently landscaped and/or any likely sediment has been treated in an approved device). Nevertheless, stormwater inlets will be protected.
23. Temporary erosion and sediment control structures will be removed only after the lands they are protecting are stabilised.

#### *41B.2.7 Waste Management Condition*

24. Acceptable waste storage bins will be provided for any concrete and mortar slurries, paints, acid washings, lightweight waste materials, and litter. Clearance services will be provided at least weekly.

#### *41B.2.8 Site Inspection and Maintenance*

25. A self-auditing programme will be established based on an Inspection Checklist. A site inspection using the checklist will be made by the Supervising Engineer:
  - at least weekly (on Mondays)
  - immediately before site closure
  - immediately following any rainfall event that has caused runoff.
26. The self audit will include records of:
  - the condition of every BMP used
  - maintenance requirements (if any) for each BMP
  - rainfall depths, durations, and times

- time, date, volume, and type of flocculants added to the sediment basin
  - the volume of sediment removed from the sediment basin
  - recording the site where sediment is disposed
  - forwarding a signed duplicate of the completed Inspection Checklist to the project manager/developer for their information
27. In addition, a suitably qualified person will be required to oversee the installation and maintenance of all erosion and sediment control measures on the site. The person will be required to spend a minimum of two hours on-site each fortnight and to provide a short monthly written report. The responsible person will ensure that:
- the ESCP is being implemented properly
  - repairs are undertaken as required
  - essential modifications are made to the ESCP if and when necessary
- The report shall include certification that the works have been carried out in accordance with the approved plans.
28. Waste storage bins will be emptied as necessary. Disposal of waste will be in a manner approved by the Supervising Engineer and in accordance with local regulations.
29. Proper drainage of the site will be maintained. To this end, drains (including inlet and outlet works) will be checked to ensure that they are operating as intended, especially that:
- no low points exist which can overtop in a large storm event
  - areas of erosion are repaired (e.g. lined with a suitable material) and/or velocity of flow is reduced appropriately through the construction of small check dams or installing earth banks and/or diversion drains upslope
  - blockages are cleared (these might occur because of sediment pollution, sand/soil/spoil being deposited in or too close to them, or breaching by vehicle wheels, etc)
30. Sand/soil/spoil materials placed closer than 2 m from hazard areas will be removed. Such hazard areas include any areas of high velocity water flows (e.g. open drains and gutters), paved areas, and driveways.
31. Recently stabilised lands will be checked to ensure that the erosion hazard has been effectively reduced. Any repairs will be initiated as appropriate.
32. Excessive vegetation growth will be controlled through slashing or mowing.
33. All erosion and sediment control measures will be kept in good working condition until all earthwork activities are completed and the site stabilised. In particular, attention will be given to:
- recent works, to ensure that they have not resulted in diversion of sediment-laden water away from them
  - degradable products, to ensure they are replaced as required
  - sediment removal, to ensure the design capacity or less remains in the settling zone
34. Any pollutants removed from the sediment basin will be disposed of in areas where further pollution to downslope lands and waterways should not occur.
35. Additional erosion and sediment control works will be constructed as might become necessary to ensure the desired protection is given to downslope lands and waterways, i.e. alterations to the ESCP will be made where it proves inadequate in practice or is subjected to changes in conditions at the work site or elsewhere in the catchment.