LATIHAN 1NRE : PENYIASATAN KAWALAN HAKISAN DAN KELODAKAN UNTUK PEGAWAI JAS DI BAWAH PERWAKILAN KUASA PENYIASATAN KAWALAN HAKISAN DAN KELODAKAN 2012

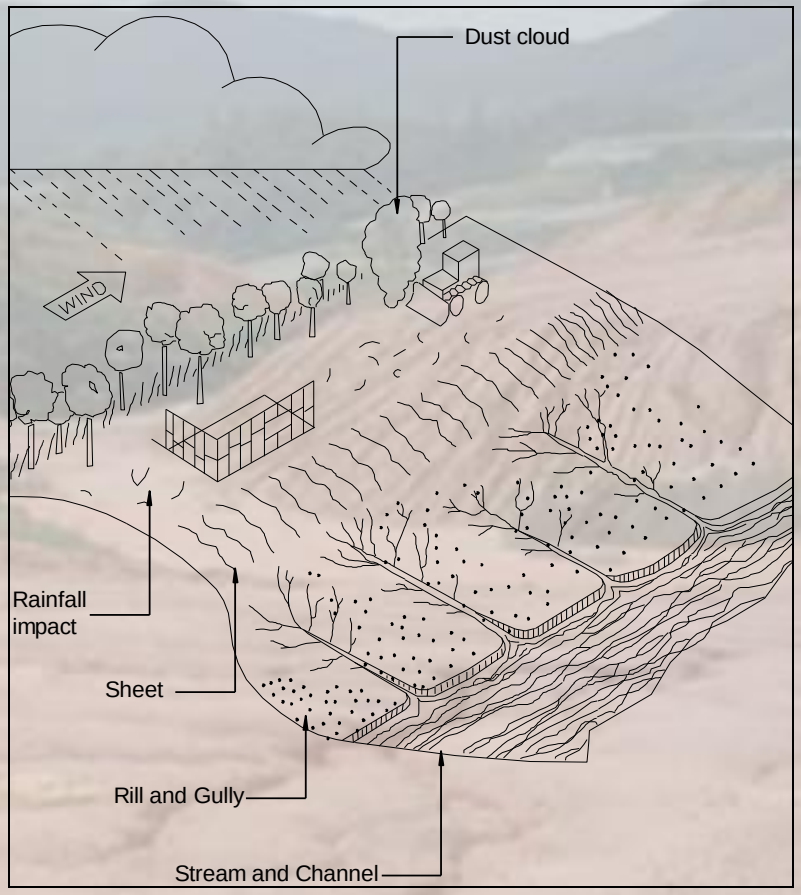
Modul 1 : Pengenalan ESCP dan BMPs

Content of Presentation

- Introduction – Erosion and Sediment
- The Erosion & Sediment Control Plan
- Erosion & Sediment Control Structure

SOIL EROSION & SEDIMENTATION

Types of Erosion



INTRODUCTION

Problem Statement

- Areas undergoing construction usually experience sediment yields 2 to 3 orders of magnitude greater than those under natural land cover conditions.
- Sediment chokes urban waterways, exacerbating flooding, and often necessitating expensive river desilting and training works.
- An **ESCP** must be **submitted to Local Authority** for development which involves an area of **more than 1 ha** (DID, 2008). The plan must comply, wherever possible with all requirements in the Checklist for Erosion and Sediment Control Plans Submission (Annex C).

SOIL EROSION & SEDIMENTATION

Understanding The Process

- **Soil erosion** is the detachment, entrainment, and transport of soil particles from their place of origin by the agents of erosion.
- **Sedimentation** is the build-up (aggradation) of sediment on the land surface or the bed of a watercourse.
- **Soil Loss** is the amount of soil being eroded from a specific piece of land.
- **Sediment Yield** is the final amount of sediment delivered to the target point by the agents of erosion , after erosion and sedimentation processes.

Erosion

Erosion is the process in which, by the actions of wind or water, soil particles are detached and transported.

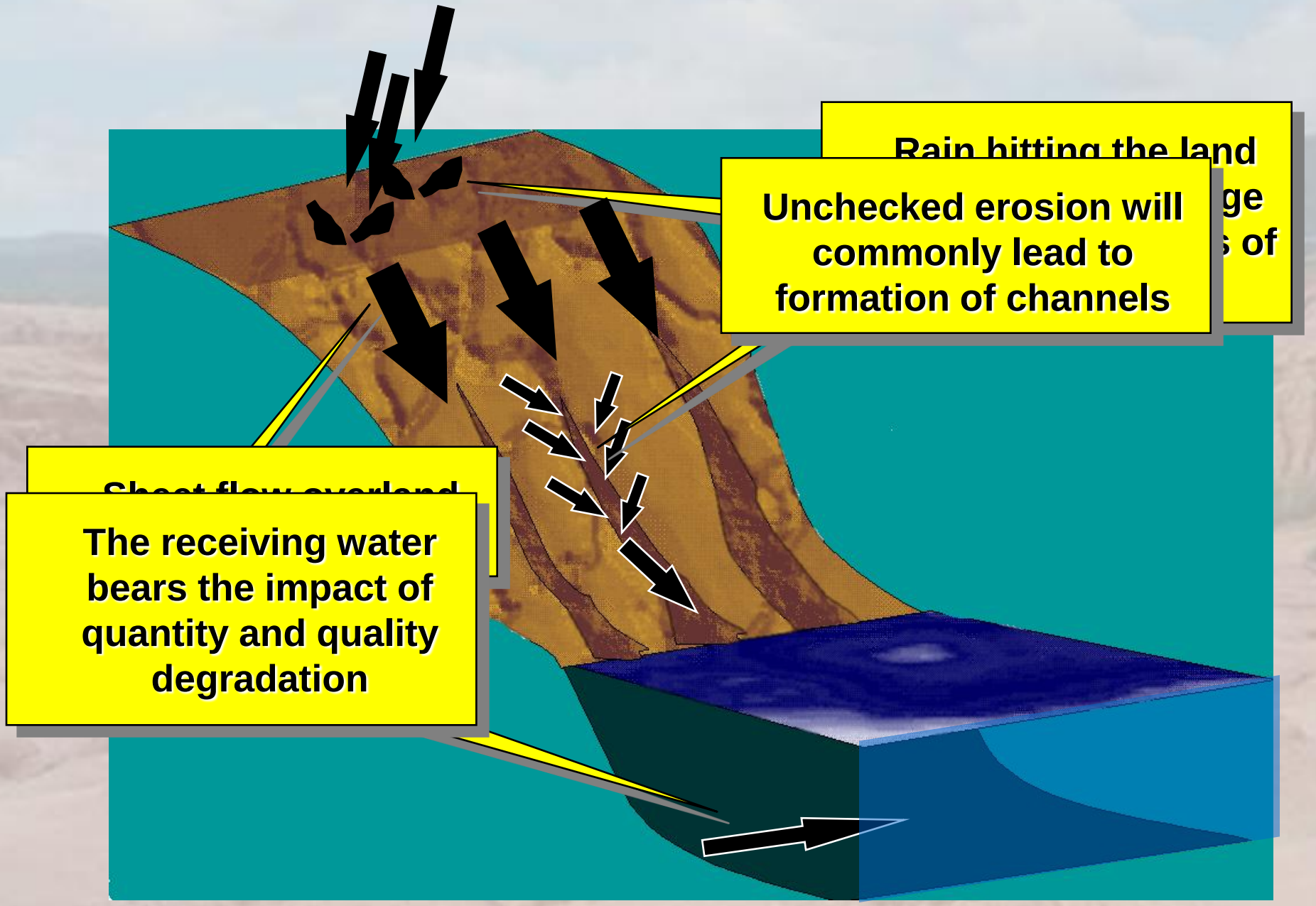
Sediment

Sediment is eroded material suspended in wind or water.

Sedimentation

Sedimentation is the deposition of eroded material.

The Erosion Process



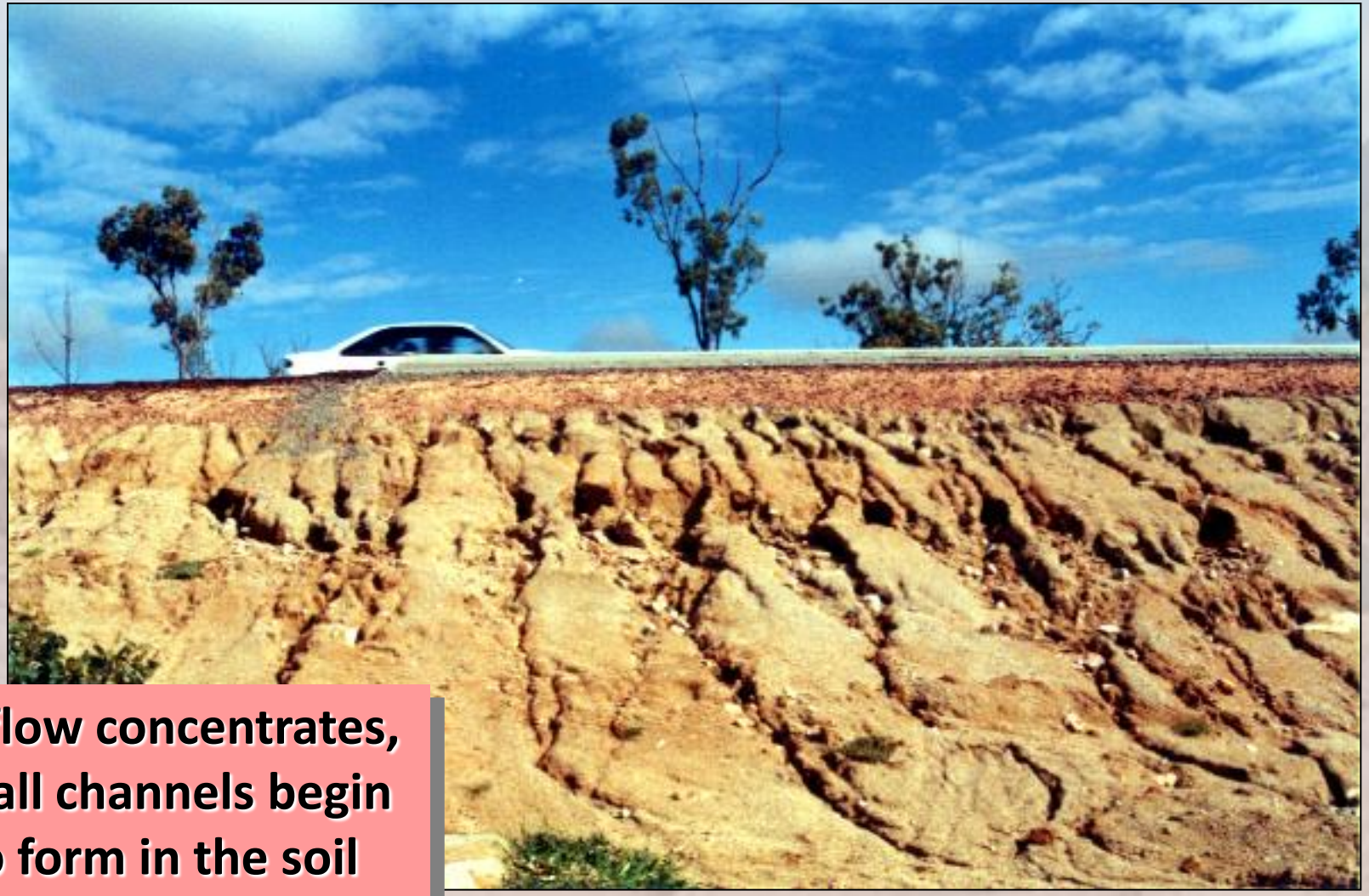
Splash Erosion

Raindrop impact energy is enough to dislodge surface sediments.

Sheet Erosion

Sheet erosion is caused by rain splash detaching soil particles lifting them up and removing them by shallow "sheets" of water flowing down the sloped soil surface .

Rill Erosion



As flow concentrates, small channels begin to form in the soil surface.

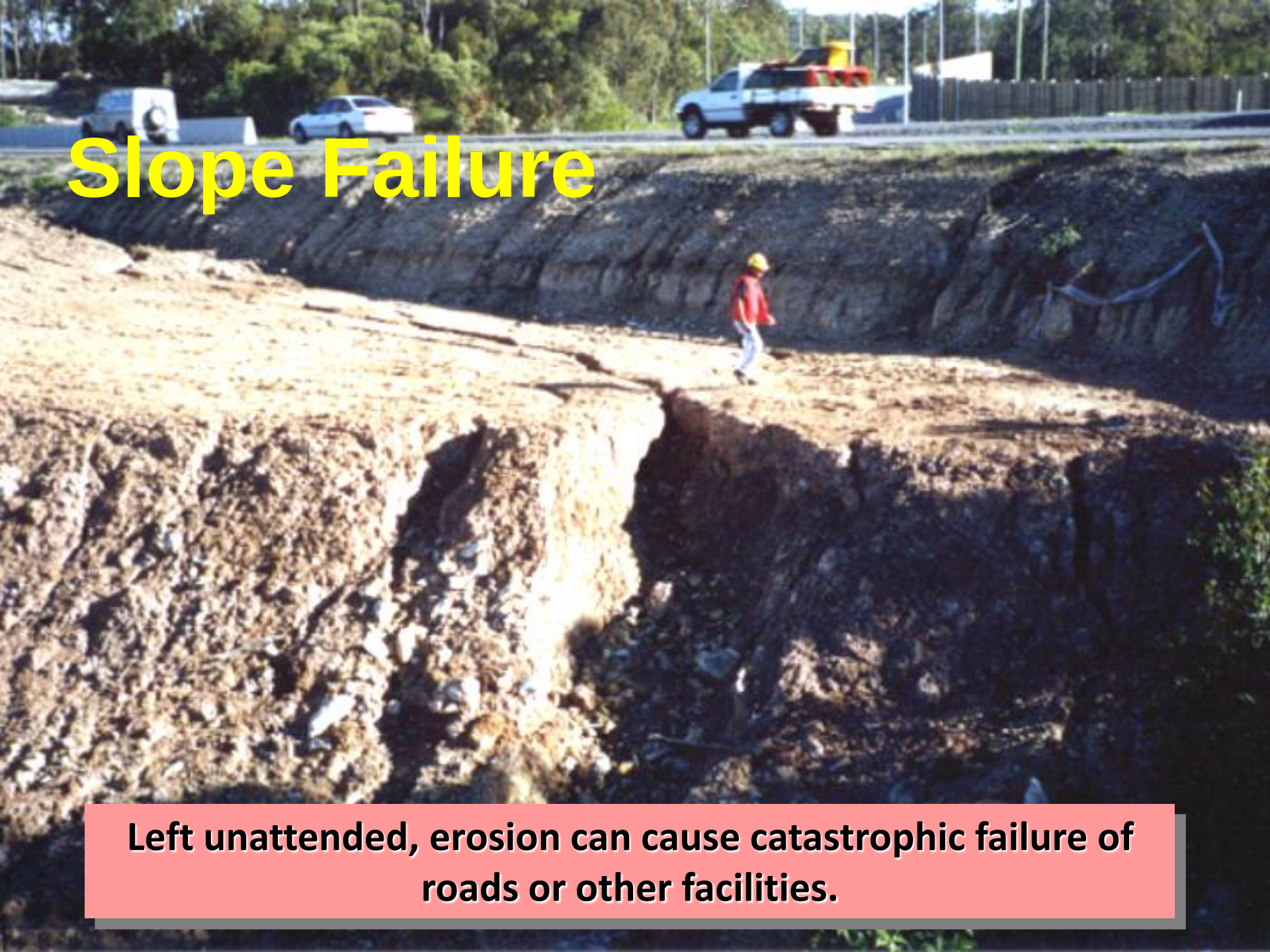
Gully Erosion

Gullies are formed when Runoff cuts rills deeper and wider or when flows from several rills come together and form a large channel.

Rill Erosion to Gully Erosion

Channel Erosion

Channels may become unstable due to increased flows or changes in upstream sediment load.


Slope Failure
Left unattended, erosion can cause catastrophic failure of roads or other facilities.

Natural Erosion

Natural erosion is generally considered to be due to the influence of climatic forces on the surface of the earth.

Natural Erosion

If we didn't have natural erosion, we wouldn't have beaches...

PELAN KAWALAN HAKISAN DAN KELODAK

SERTA STRUKTUR – STRUKTUR YANG ERRKAITAN

The Erosion & Sediment Control Plan (ESCP)

- A plan that details **temporary measures** that will be implemented during the earthwork, foundation, 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

The Erosion & Sediment Control Plan

The Requirements

- Any development more than 1ha is required to produce ESCP
- Shall be submitted by the Developer
- Submitted at least 2 months in advance of development activity. Approval obtained at least 7 calendar days in advance of development activity.
- Submission must fulfill:
  - Submission Checklist for Stormwater Management in Malaysia (DID, 2008)
  - all legislative requirements underlined in related rules and regulations for development
  - Address & control all environmetal requirements underlined in related EIA reports (development > 50ha)

The Erosion & Sediment Control Plan

The Content of ESCP

Site Assessment

- Hydrological & hydraulic assessment
- Soil Loss assessment

Design Calculation

- Selection of ESC Facilities
- Detailed Design of ESC Facilities

Site Plans & Drawings

- Pre Bulk Grading Plan
- Post Bulk Grading Plan
- Detailed Drawings of designed ESC Facilities

Monitoring & Maintenance Plan

- Schedule for Monitoring & Maintenance
- State responsibility of each stakeholder
- Record Keeping

The Erosion & Sediment Control Plan

The Content of ESCP

Site Assessment

1. Soil Loss Assessment

Soil Loss assessment of the site for:

a) existing site condition,

b) during construction

- Before any ESC (only earthwork)
- After ESC (temporary & permanent)
- Analysis for every phase
- Analysis for each design point

c) Post Construction (upon completion & removal of temporary facilities)

The Erosion & Sediment Control Plan

The Content of ESCP

Design Calculation

1. **Selection of ESC Facilities**
   State the choice of ESC facilities location, sizing, materials etc, based on the analysis performed earlier.

2. **Detailed Design Calculation**
   Presents the design calculation for
   - drainage facilities (temporary & permanent)
   - sediment containment structures (check dams, sediment trap/basin, ponds, GPTs)

3. **Other details to be included**
   - Phasing & Earthwork Schedule
   - Site Operation (Access Points, traffic flow/layouts, washbays)

The Erosion & Sediment Control Plan

The Content of ESCP

Site Plans & Drawings

1. **Pre Bulk Grading Plan**

- Pre development topology – drainage pattern, contour, and catchment delineation
- Areas (with quantity) in which grading (cut & fill) will be performed
- Specify grading phasing.
- Specify stockpile management (location, protection etc)
- Perimeter controls including buffer, hoarding and site perimeter drains.
- Delineate new catchment area based on graded topology (to be used for ESC facilities design)
- Identify and delineate waterway buffers
- Specify ESC facilities (size, location etc) to be implemented at this stage

The Erosion & Sediment Control Plan

The Content of ESCP

Site Plans & Drawings

2. Post Bulk Grading Plan

- The graded contour (topology after major earthworks)
- Project development phasing
- Proposed drainage patters and catchment delineation
- Specify ESC facilities (size, location etc) to be implemented at this stage

3. Engineering Drawing for ESC Facilities

- Typical drawings for Erosion Control Facilities with Specification
- Engineering/ construction drawing for designed sediment containment facilities
- Engineering/ construction drawing for designed sediment containment facilities

The Erosion & Sediment Control Plan

The Content of ESCP

Monitoring & Maintenance Plan

1.Schedule for Monitoring & Maintenance

A work schedule that indicates the basic inspection & maintenance by Contractor/Consultant

2.State responsibility of each stakeholder

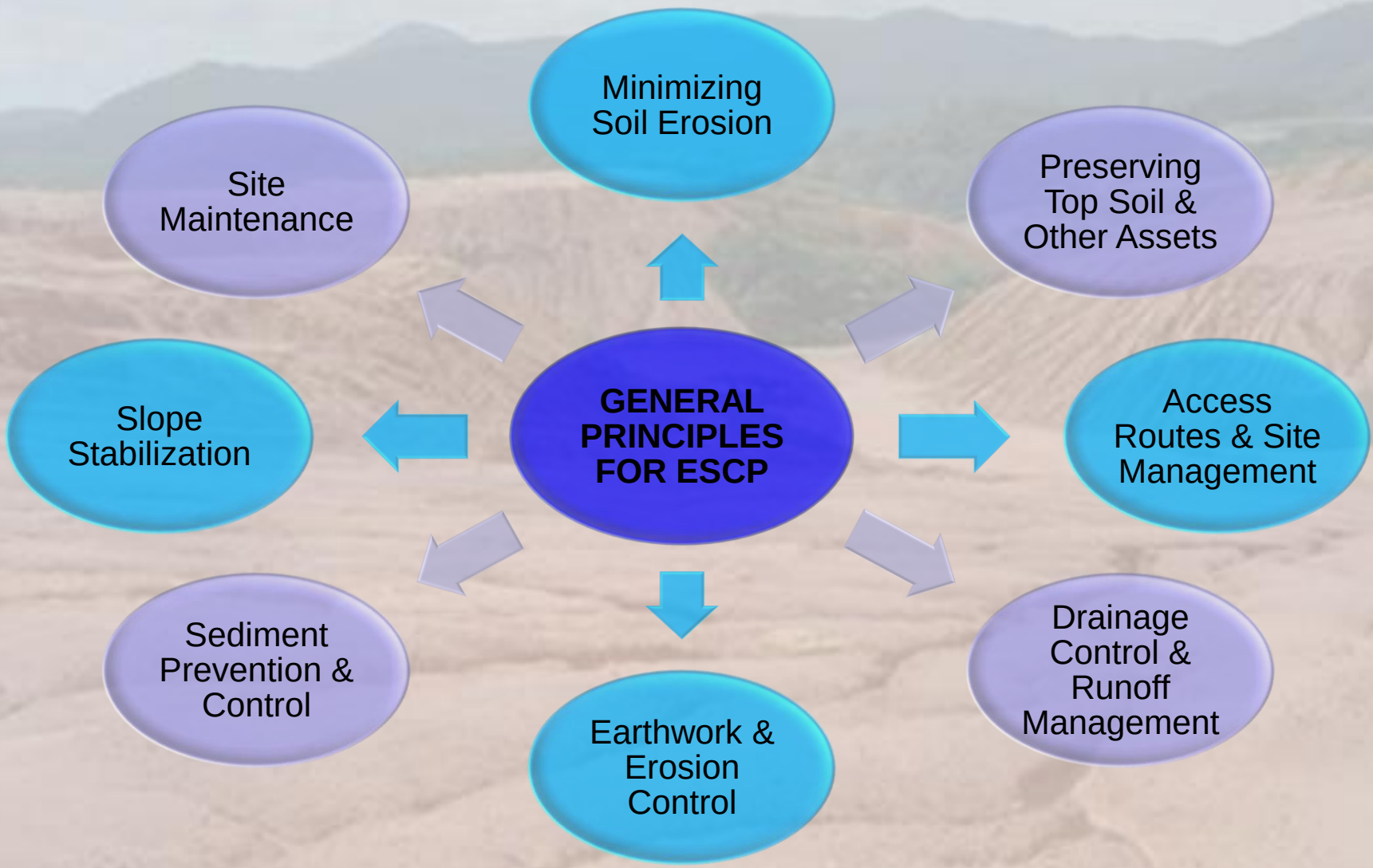
A list of contacts for every aspect of ESC such as structural maintenance, site traffic control, in-house inspection, etc.

3.Record Keeping

The system used to store all ESCP records including construction/ as-built drawings, inspection results, maintenance log etc.

The Erosion & Sediment Control Plan

The Principles



The Erosion & Sediment Control Plan

1. Minimizing Soil Erosion

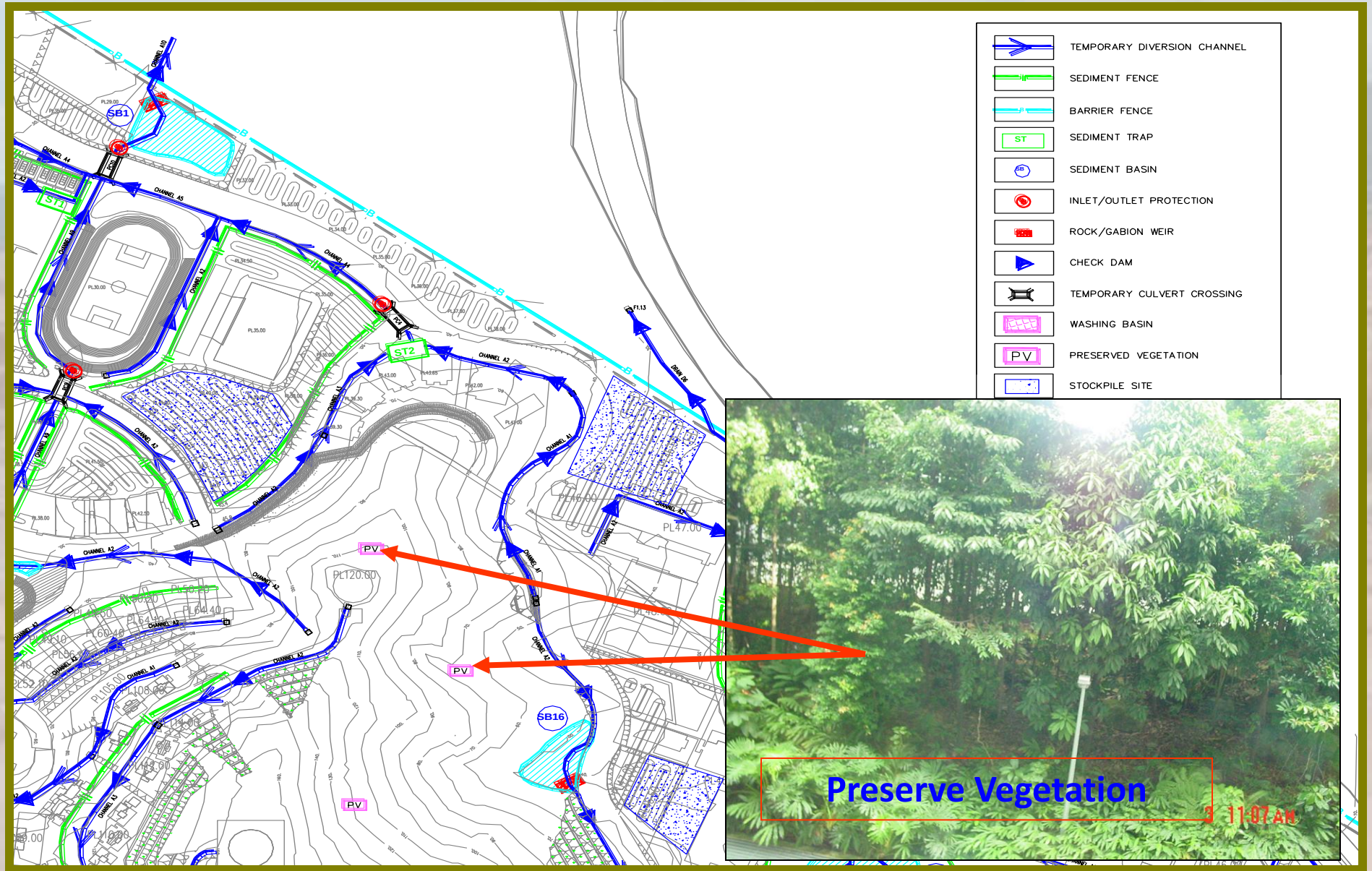
1. Reducing the working area.
2. Regulate phases of development.
3. Timing of the development.
4. Consideration the hydrological and climatic conditions.
5. Existing vegetation shall be preserved.
6. Stream buffers shall be retained in accordance to DID river reserve requirements.

The Erosion & Sediment Control Plan

2. Preserving Top Soils & Other Assests

1. Identify & protect ecological sensitive areas
2. Top soil removed shall be stockpiled for future use. Secure with proper erosion control measures
3. Trees with high ecological, social or economic functions shall be preserved or planned for trans-planting if necessary.

Model ESCP (Preserve Vegetation)

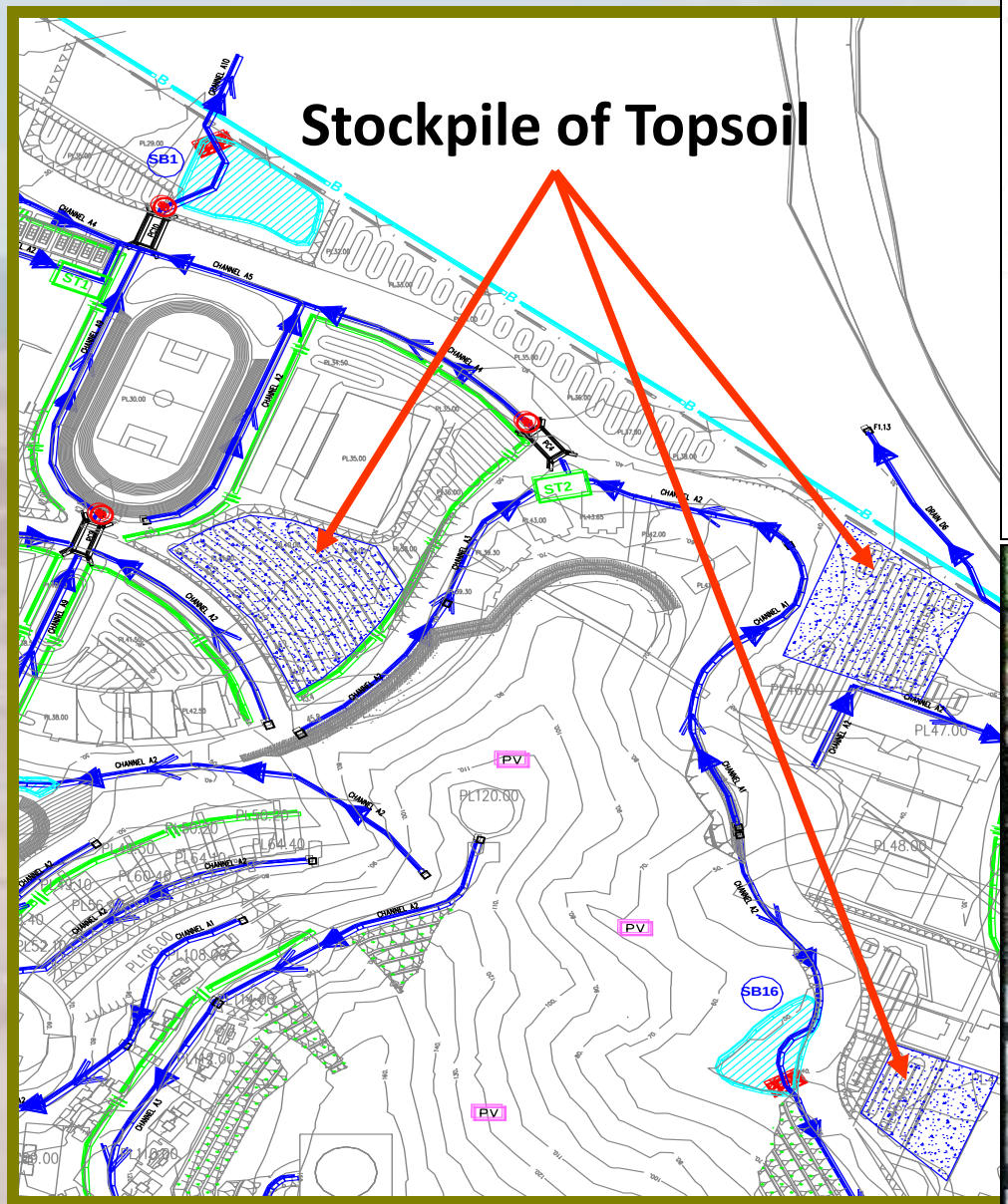


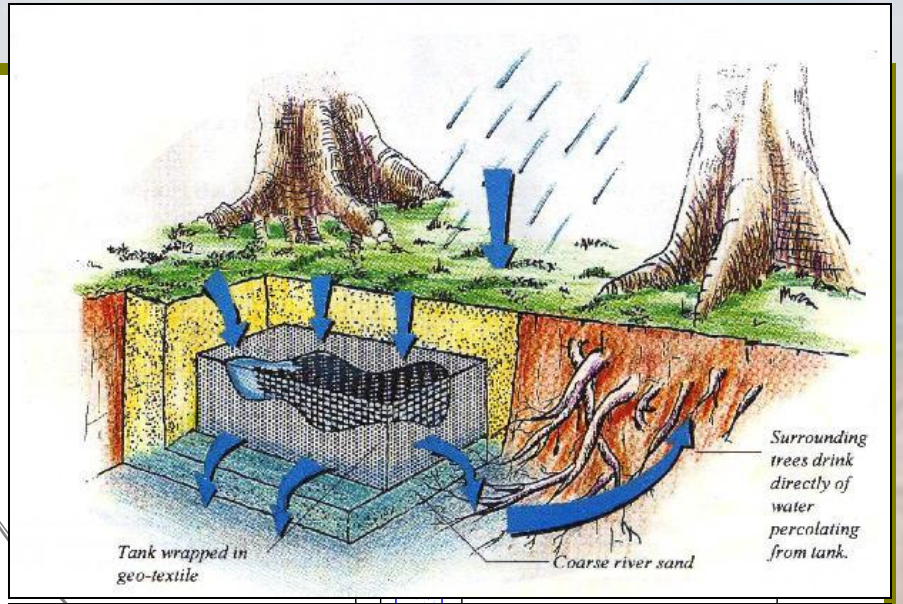
Preserved Vegetation

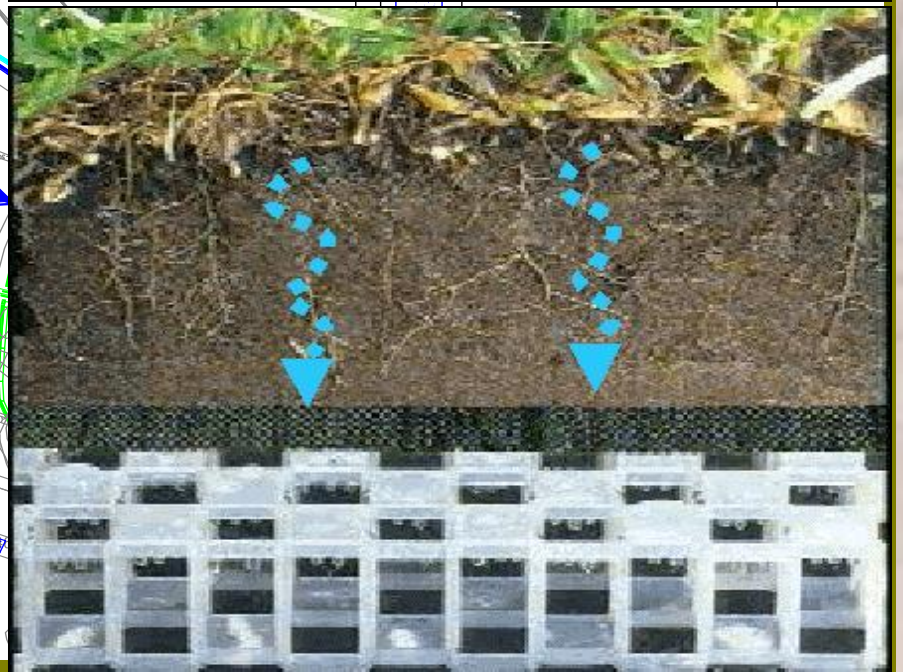
Preserved Vegetation 1

Preserved Vegetation 2

Model ESCP (Stockpile of Topsoil)







Stock Pile 1

Stock Pile 2

Stock Pile 3

The Erosion & Sediment Control Plan

3. Access Routes & Site Management

1. Minimise amount of access points and control traffic
2. Roads & drains shall be installed at earliest chance.
3. Access Points shall be paved up to 10m to minimize exporting sediments
4. Washing bay shall be provided & used by all vehicle passing through access points.

Washing Bay/ Wash trough

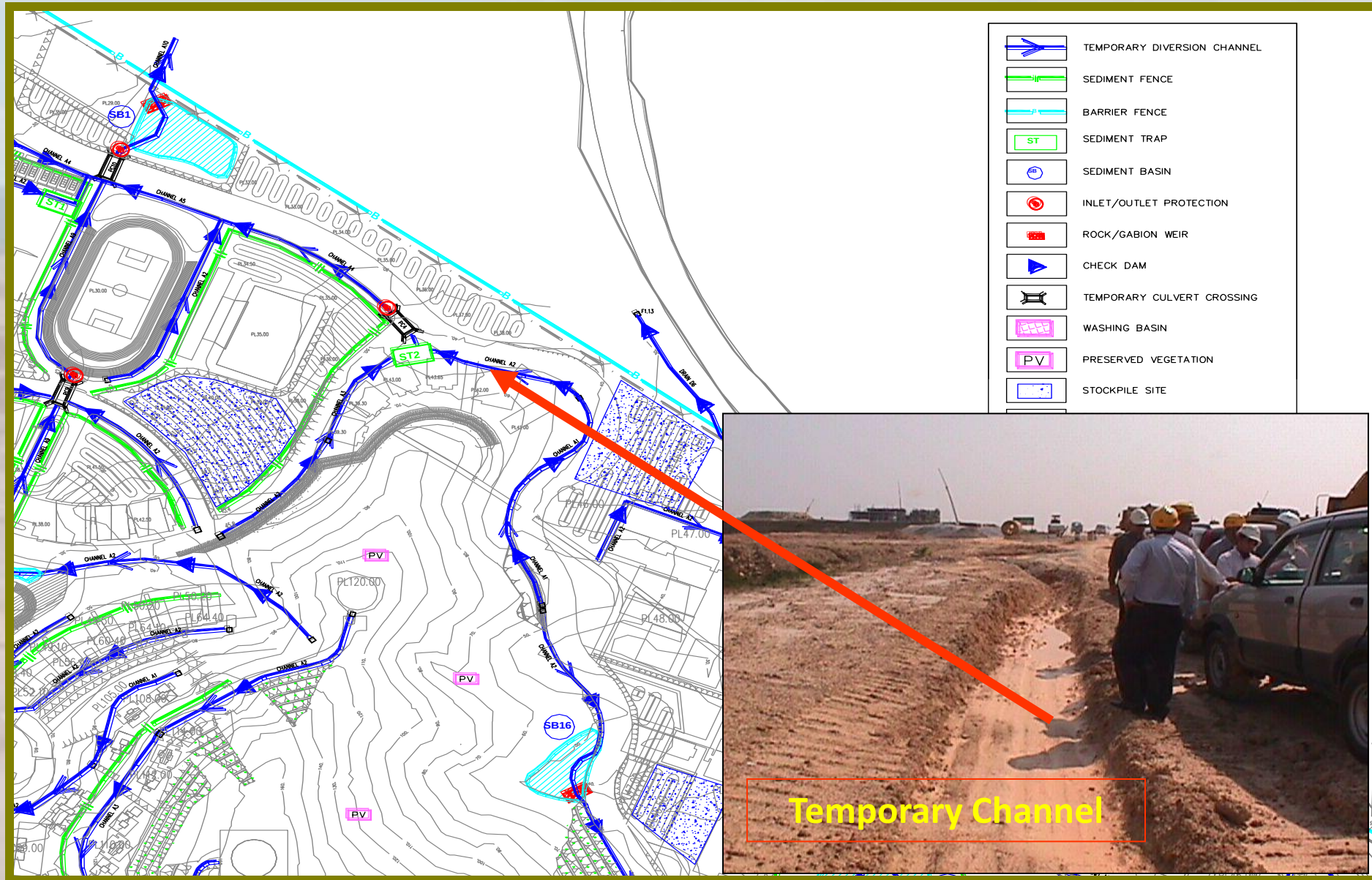
Washing Bay/ Wash trough

The Erosion & Sediment Control Plan

4. Drainage Control/ Runoff Management

1. Hydrology & Hydraulic of existing catchment shall be studied.
2. Segregate runoffs from disturbed & undisturbed areas.
3. Watercourse and its reserves shall be remained undisturbed. Any form of disturbance shall obtain approval from DID.
4. In disturbed site, runoff should be manage such that its design does not contribute to additional erosion/ sediment yield.
5. Temporary drainage network shall be designed to manage runoff in the development site, in accordance to MSMA.
6. Conveyance system shall be properly inspected and regularly maintained

Model ESCP (Temporary Channel)



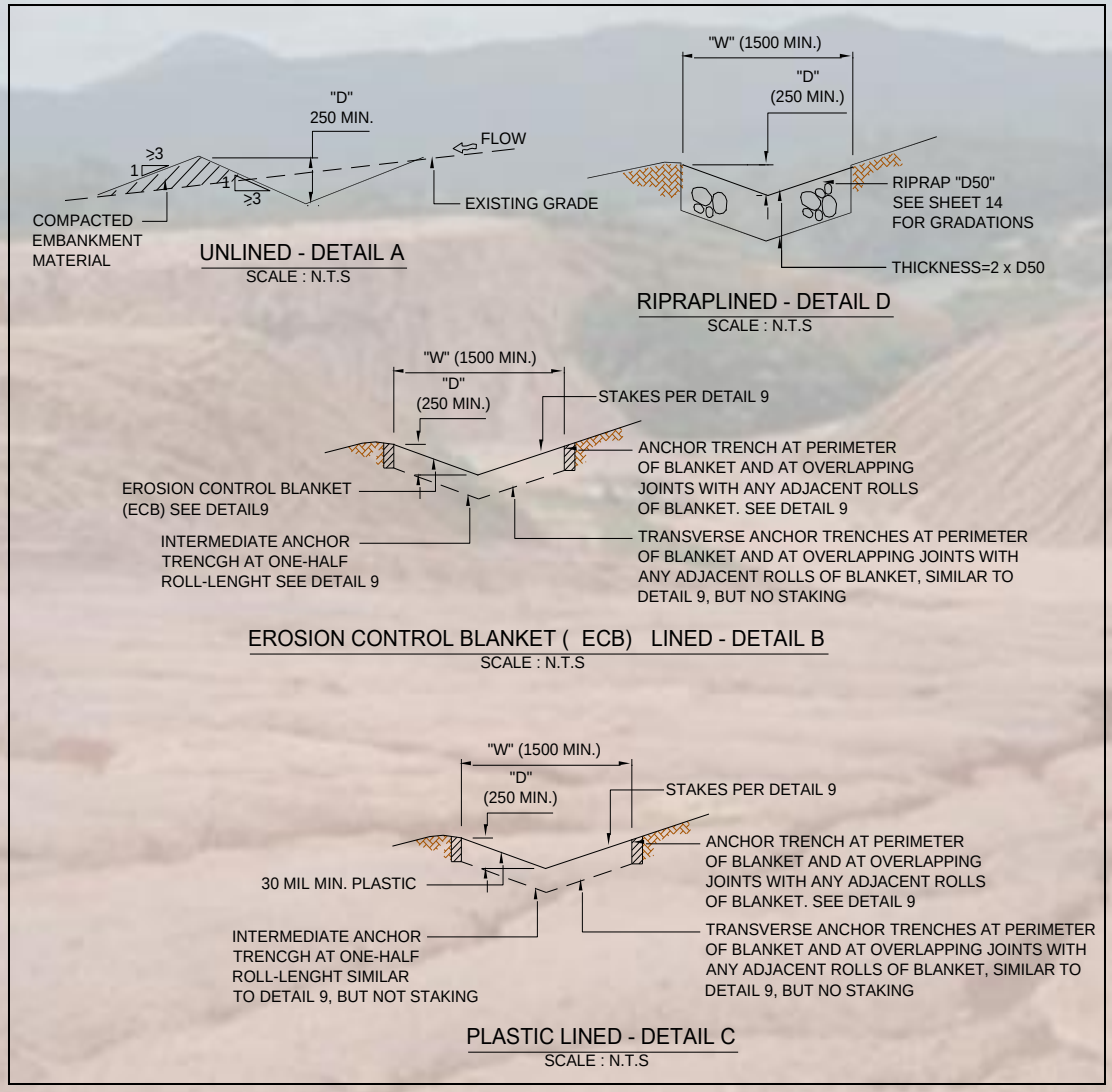
Temporary Diversion Channel

Runoff Management Facilities

Diversion Channel

Runoff Management Facilities

Diversion Channel



Runoff Management Facilities

Drainage Outlet Protection

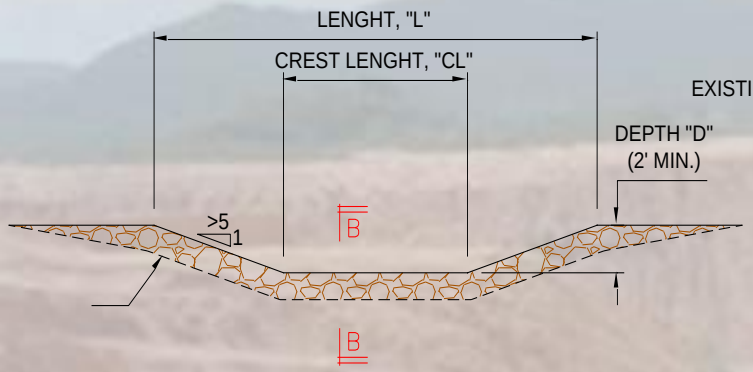
Outlet /InletProtection 1

Outlet /InletProtection 2

Outlet /InletProtection 3

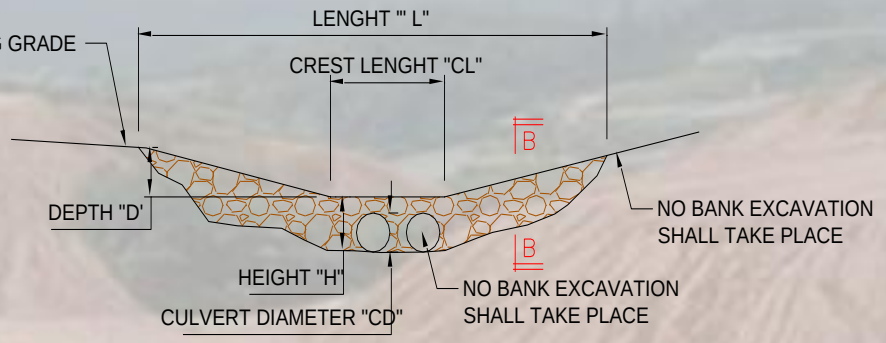
Runoff Management Facilities

Temporary Waterway Crossing



FORD CROSSING - DETAIL A

SCALE : N.T.S



CULVERT CROSSING - DETAIL A

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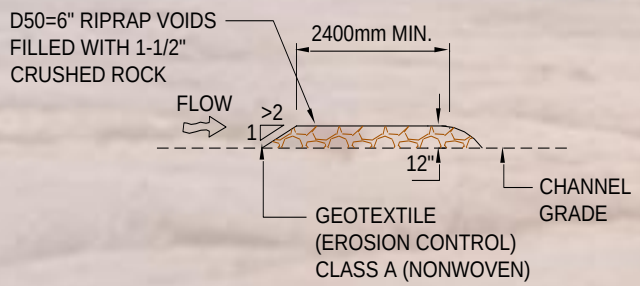

FORD CROSSING - DETAIL B

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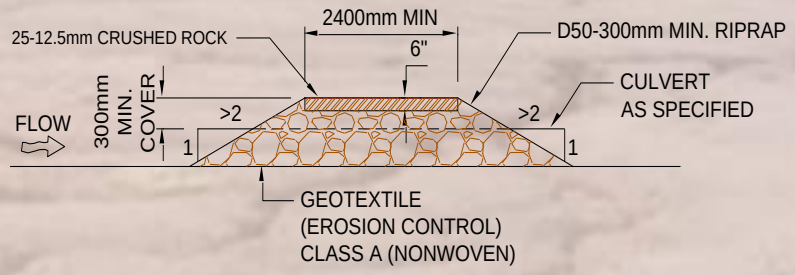


CULVERT CROSSING - SECTION B

SCALE : N.T.S

RUNOFF MANAGEMENT: “Green” River Channel Protection

The Erosion & Sediment Control Plan

6. Earthwork & Erosion Control

1. Preferably, earthwork is only carried out when a site is ready to be worked.
2. Earthwork shall be phased to minimize land exposure. The period, stabilization method shall be specified in ESCP for each phase.
3. Land clearing works shall not be commenced within natural water reserves. On no account that sediment, cleared vegetation, logs or any unwanted waste are allowed in natural waters.
4. All cut & fill shall be performed to design specification, including materials, height & slope steepness (maximum of 1(v) to 2(h))

Erosion Control Facilities

Seeding & Planting

Erosion Control Facilities

Seeding & Planting

Scientific Name	Local Name
Trees	
Andira surinamensi	Kedondong Hutan
Cassia surattensis	Yellow Cassia
Cassia Fistula	Rajah Kayu
Cassia spectabilis	Cassia
Fagraea fragrans	Tembusu
Khaya senegaliensis	Khaya
Mellettia atropurpurea	Tulang daing
Pheltophorum pterocarpum	Batai Laut
Shrubs	
Cassia biflora	Bushy Cassia
Caesalphina pulcherrima	Jambul
Dillenia suffruticosa	Simpoh Air
Dillenia indica	Simpoh
Hymenocallis littoralis	Spider lily
Heliconia spp	Siantan
Mussaenda eryhrophylla 'Dona luz'	Janda Kaya
Melastoma malabathricum	Senduduk
Ground Cover	
Arachis pintoi	Arachis
Wedelia trilobata	Wedelia
Pandanus pygmaeus	Pandanus

(Source: Jabatan Landskap Negara)

Erosion Control Facilities

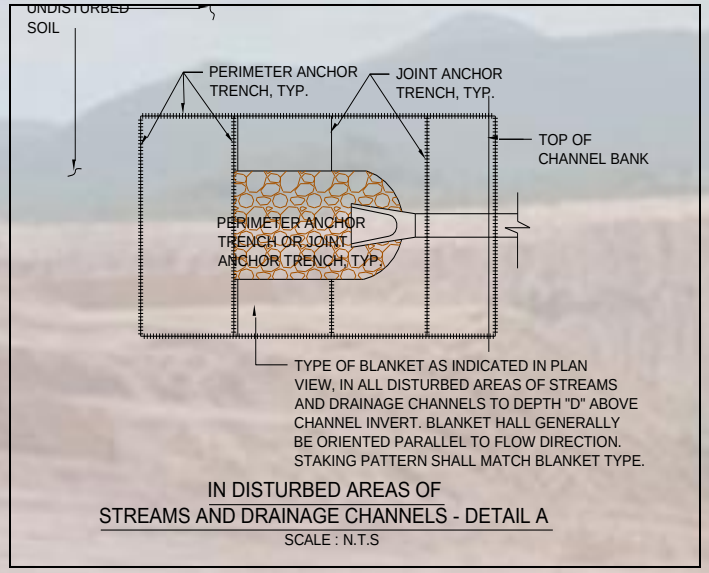
Mulching

Erosion Control Facilities

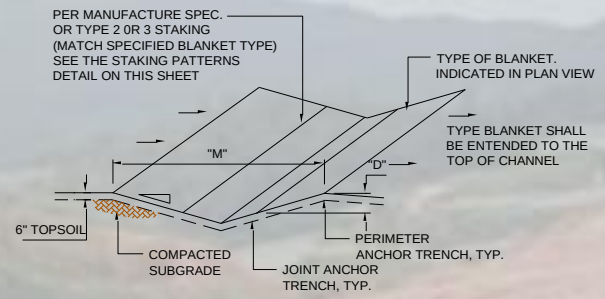
Geotextile & Mats

Erosion Control Facilities

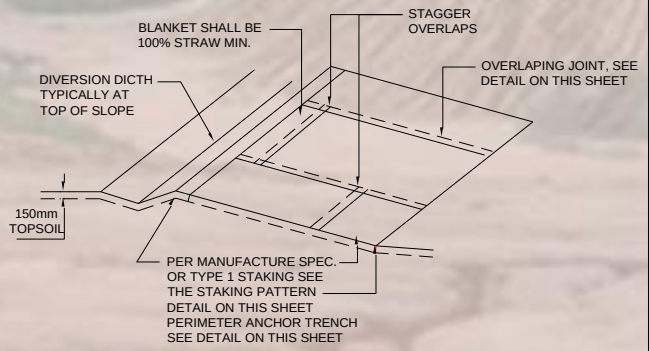
Geotextile & Mats



IN DISTURBED AREAS OF
STREAMS AND DRAINAGE CHANNELS - DETAIL A
SCALE : N.T.S



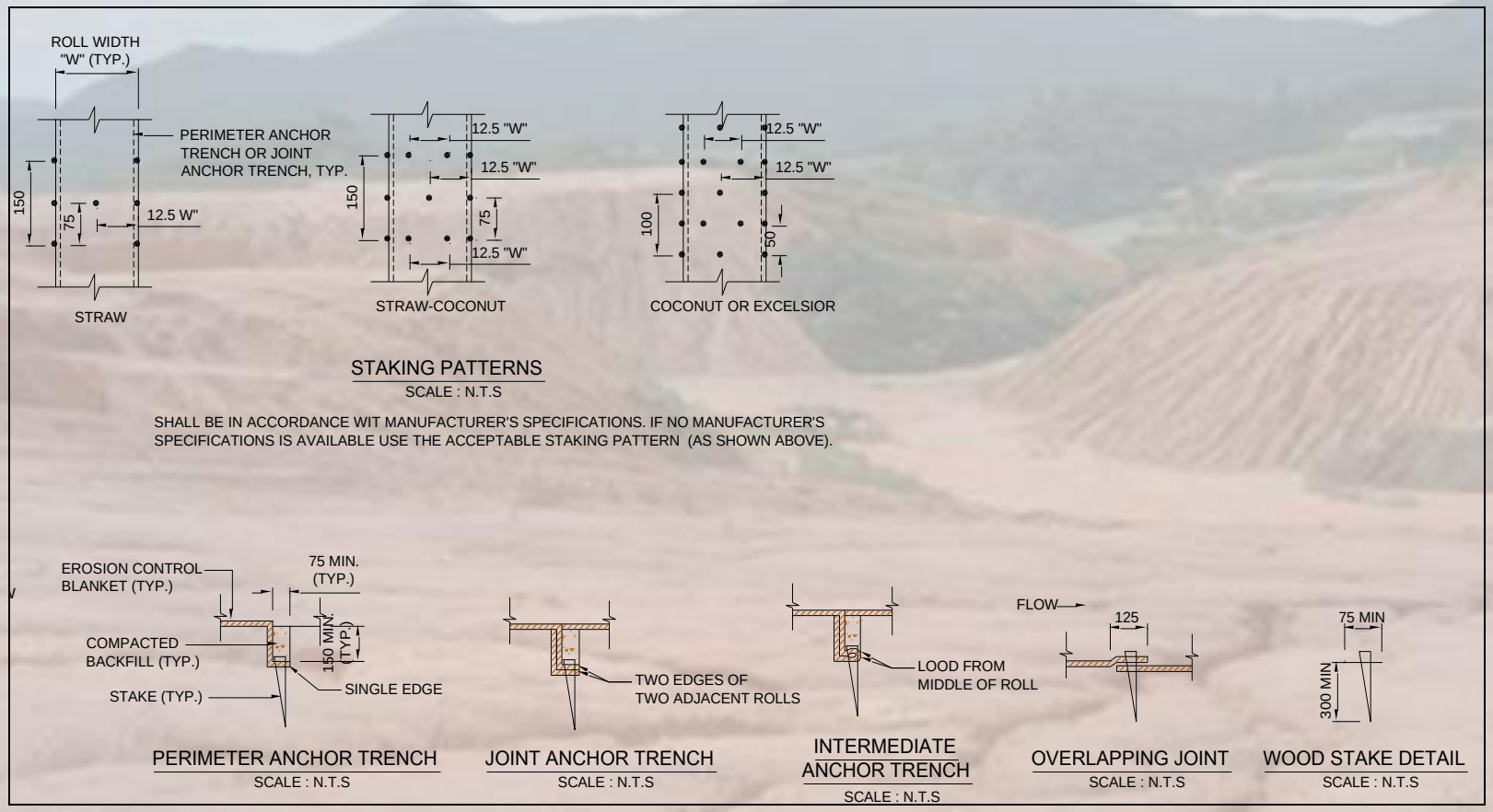
IN DIVERSION DICTH OF
SMALL DICTH DRAINAGEWAY- DETAIL B
SCALE : N.T.S



OUTSIDE OF STREAMS
AND DRAINAGE CHANNELS - DETAIL C
SCALE : N.T.S

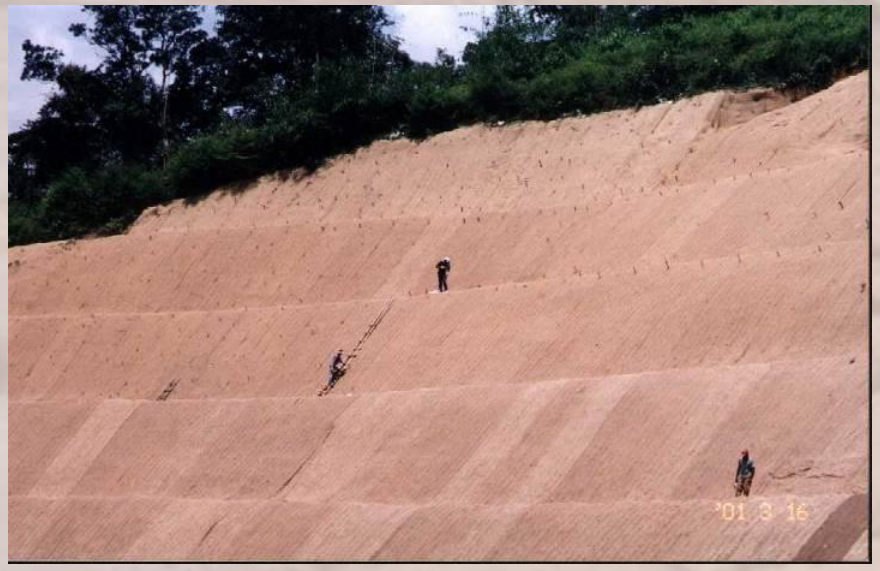
Erosion Control Facilities

Geotextile & Mats



Erosion Control Blanket (ECB) fibrous blanket of straw, jute, coconut, palm oil fibre trenched in and staked down over prepared, seeded soil. The blanket reduces both wind and water erosion and helps to establish vegetation.

EROSION CONTROL METHOD:
Erosion Control Mattress with Hydro-seeding

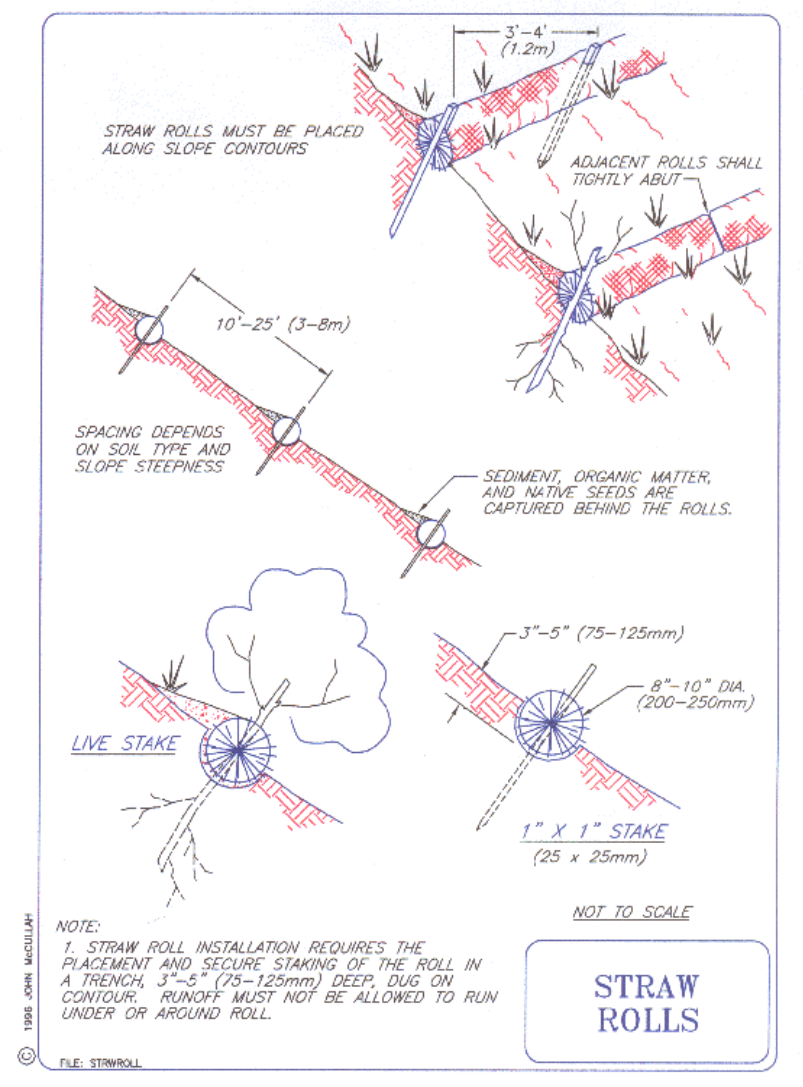


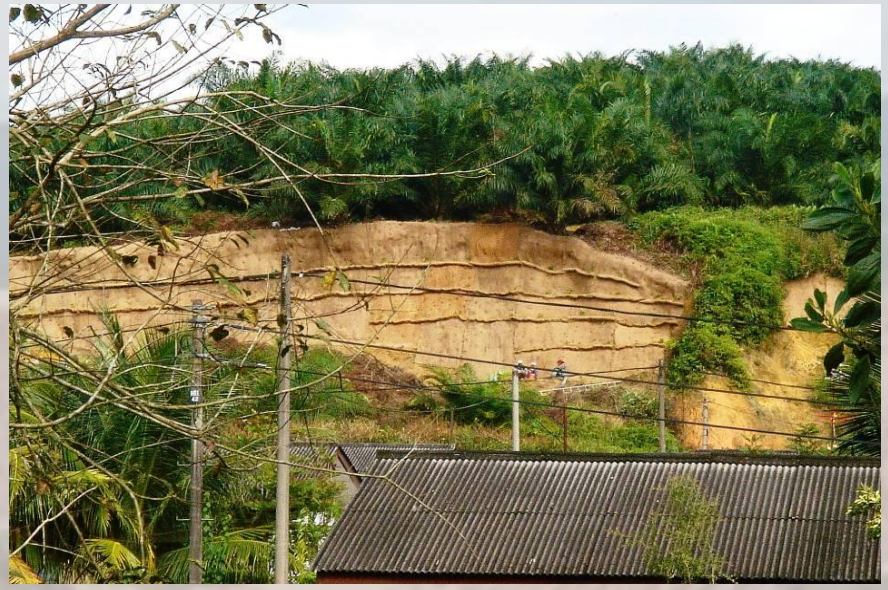
EROSION CONTROL METHOD:

Erosion Control Mattress with deep root shrubs & trees

Erosion Control Method: Biotechnical Engineering

Erosion Control Method: Natural Fiber Wattles

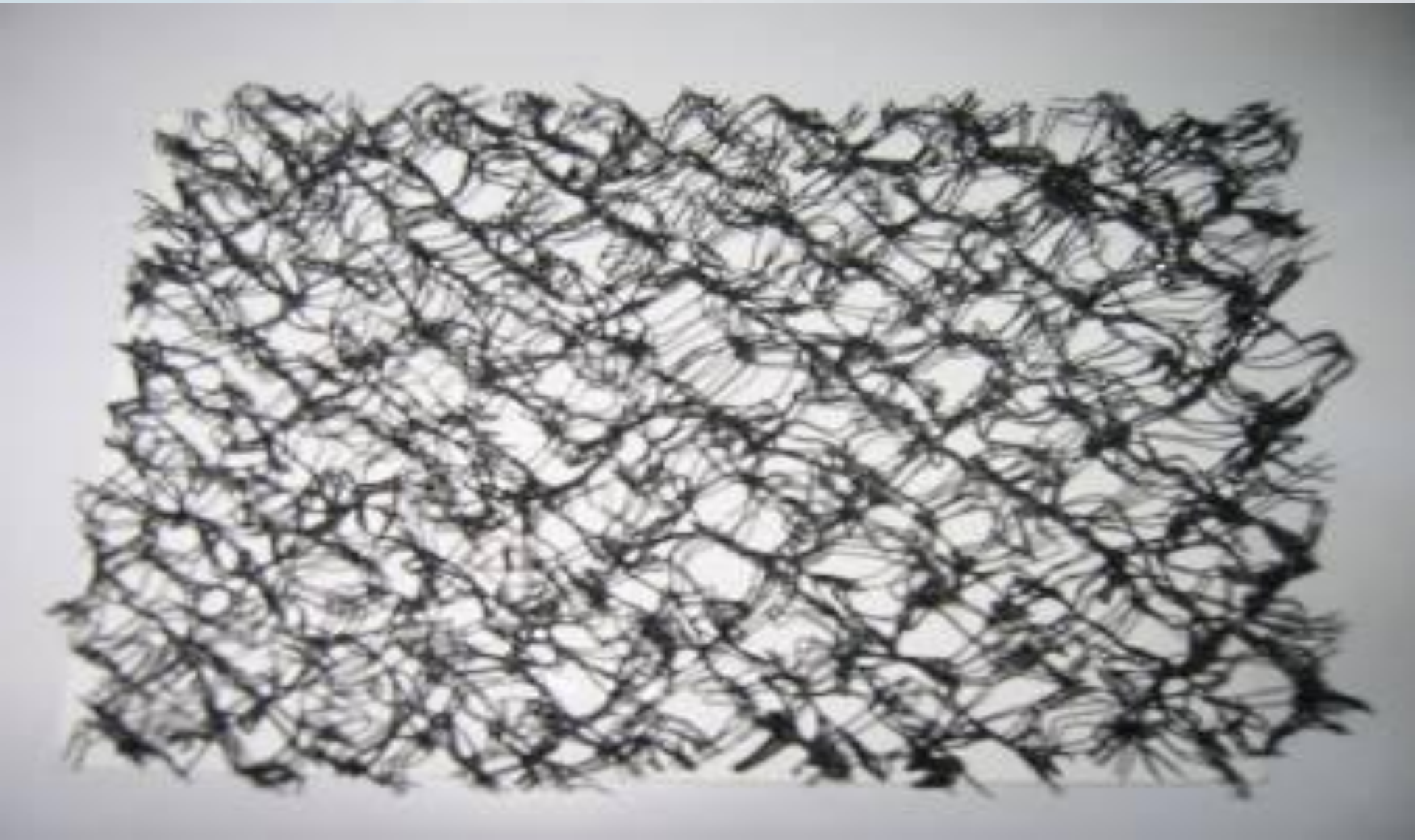




Turfing

Reinforced Turfing - condition

Reinforced Turfing -materials



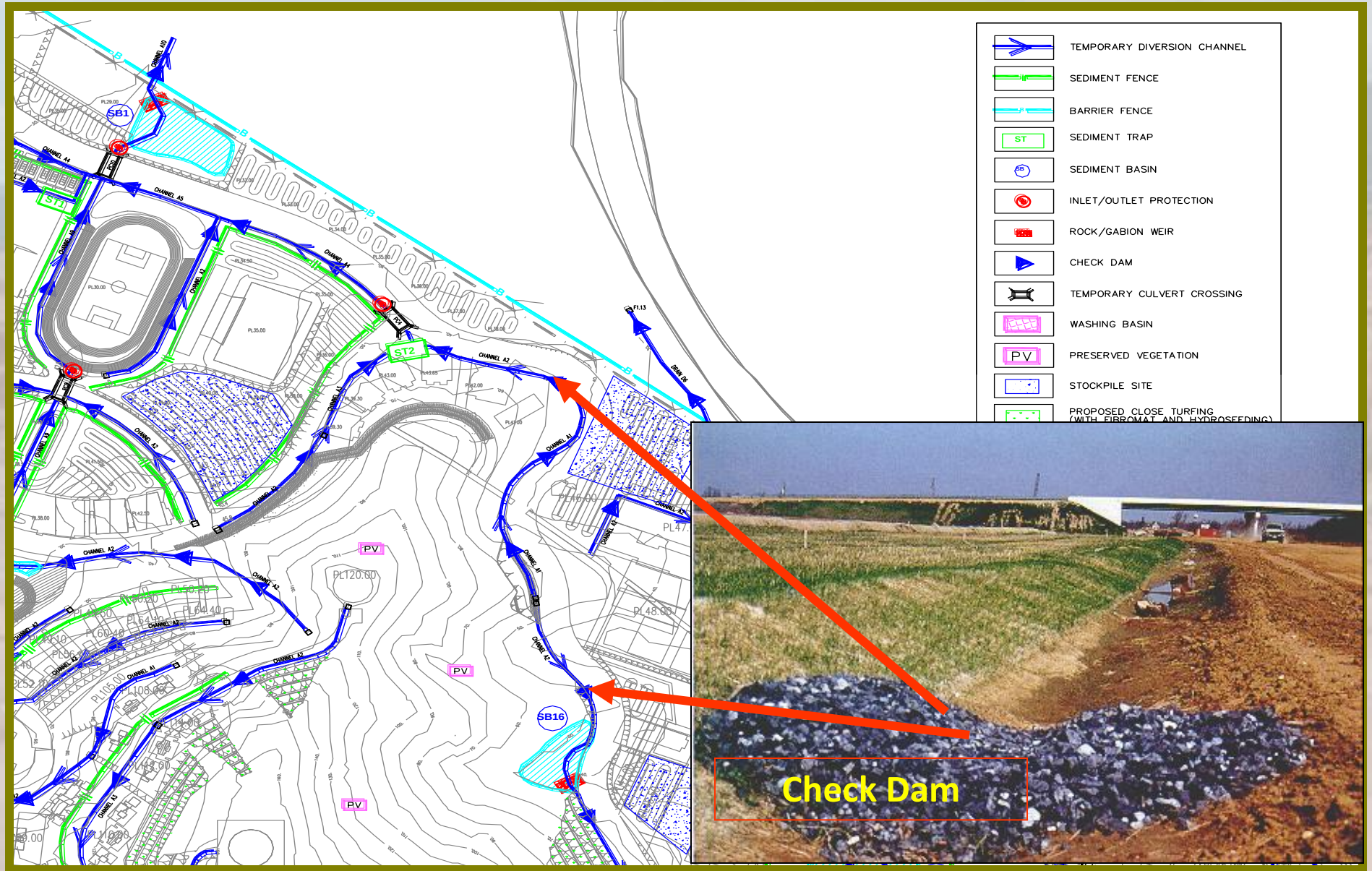
Reinforced Turfing

The Erosion & Sediment Control Plan

6. Sediment Prevention & Control

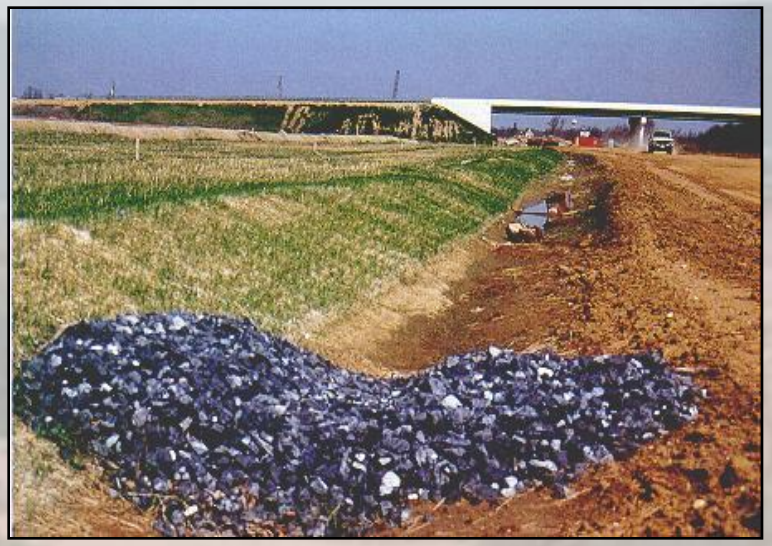
1. Proper sediment containment structures MUST be installed at site.
2. Permanent BMPs (Ponds, GPT etc) can be utilized if well maintained during construction.
3. Temporary ESC Facilities shall be designed, installed and maintained throughout construction period.
4. Temporary facilities can only be dismantled after site has been thoroughly stabilized.

Model ESCP (Check Dam)



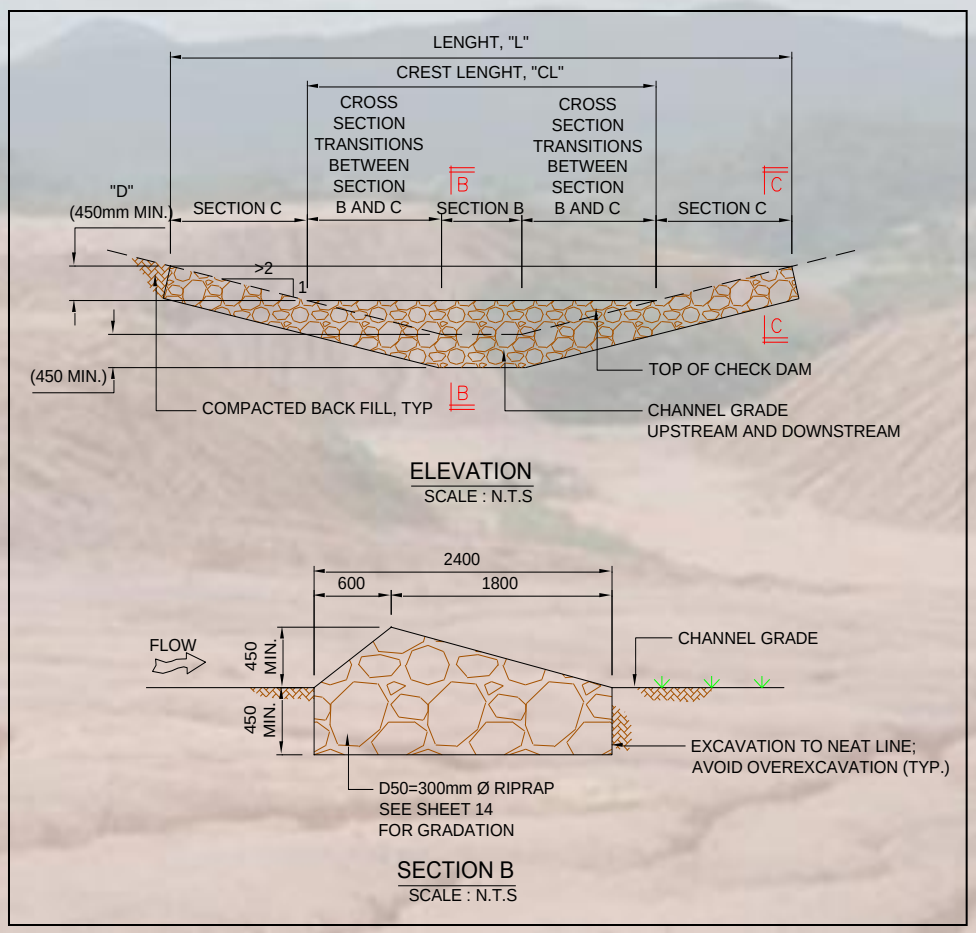
Sediment Control Facilities

Check Dams



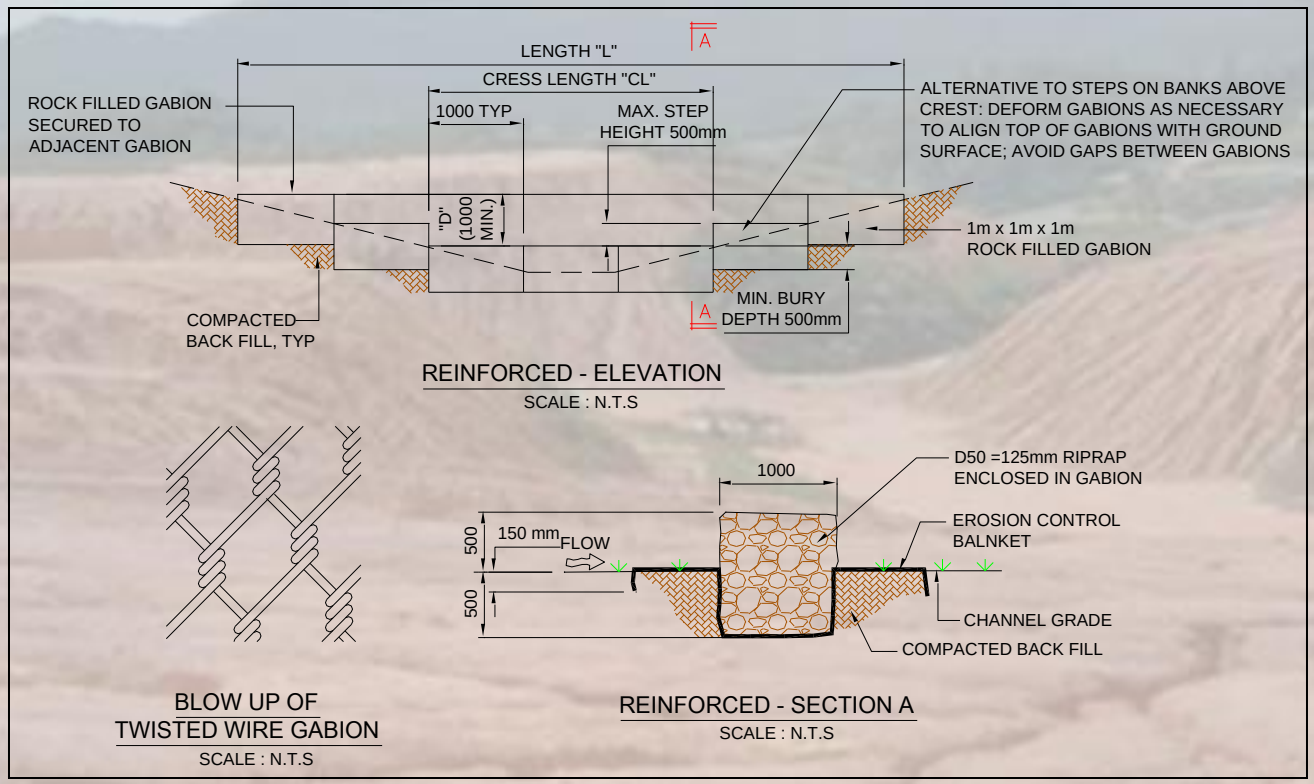
Sediment Control Facilities

Check Dams



Sediment Control Facilities

Check Dams



Check Dam 1

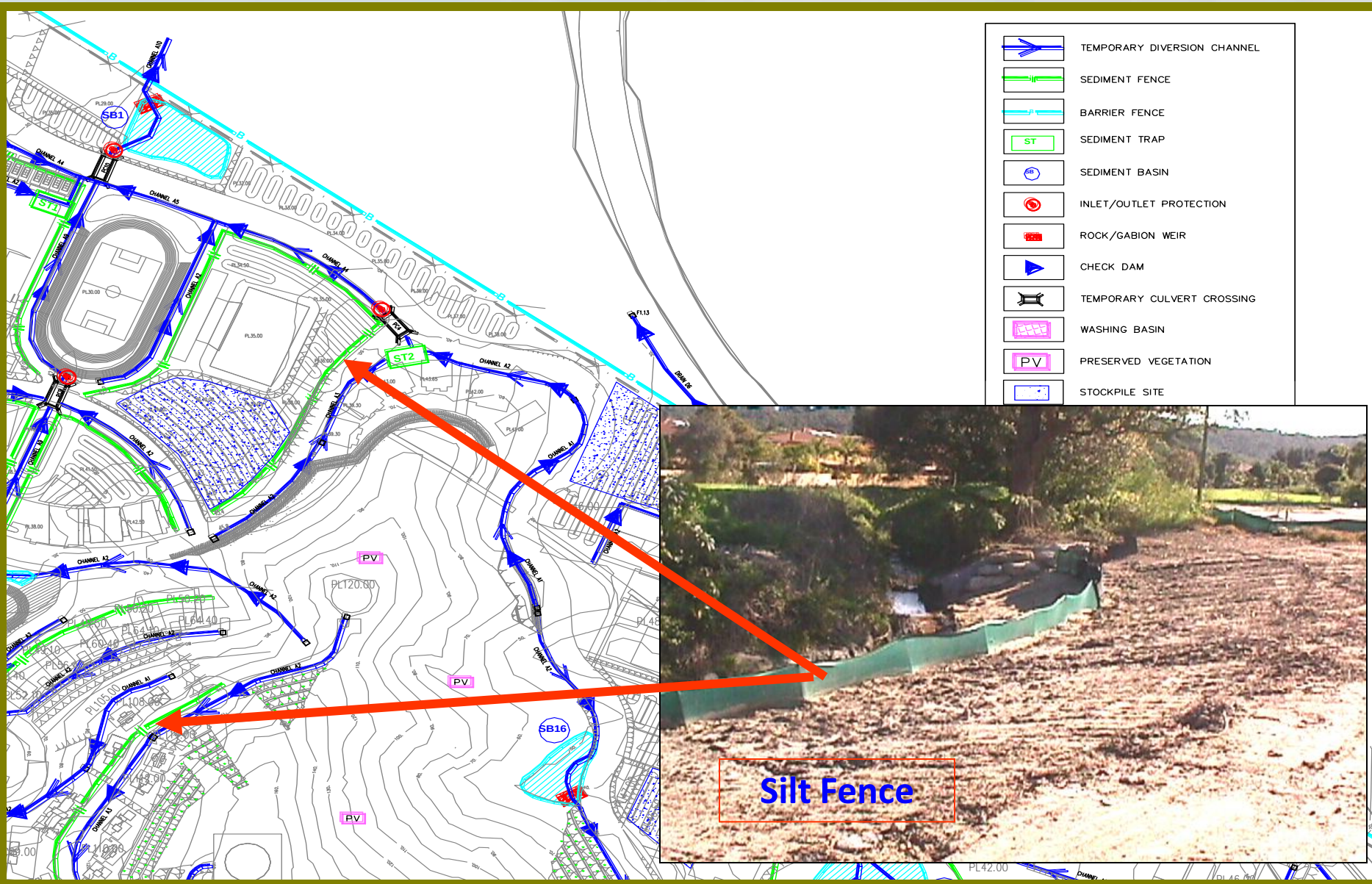
Check Dam 2

Check Dam 3

SOFT CHECK DAM

“KERBAU” CHECK DAM
&
WATER-CROSSING

Model ESCP (Silt Fence)

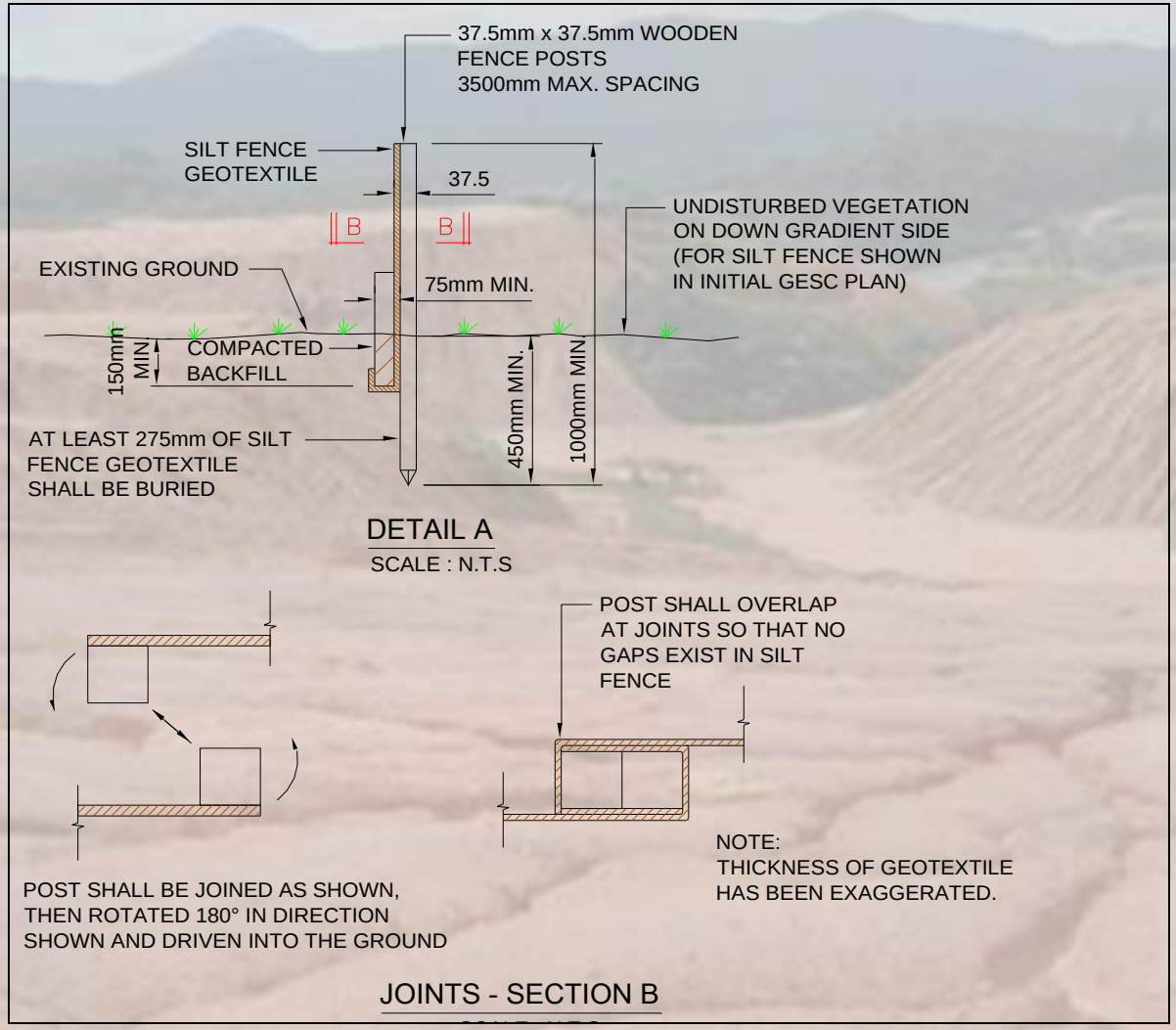


Sediment Control Facilities

Silt Fence

Sediment Control Facilities

Silt Fence



Silt Fence 1

Silt Fence 2

Silt Fence 3

Silt Fence 4

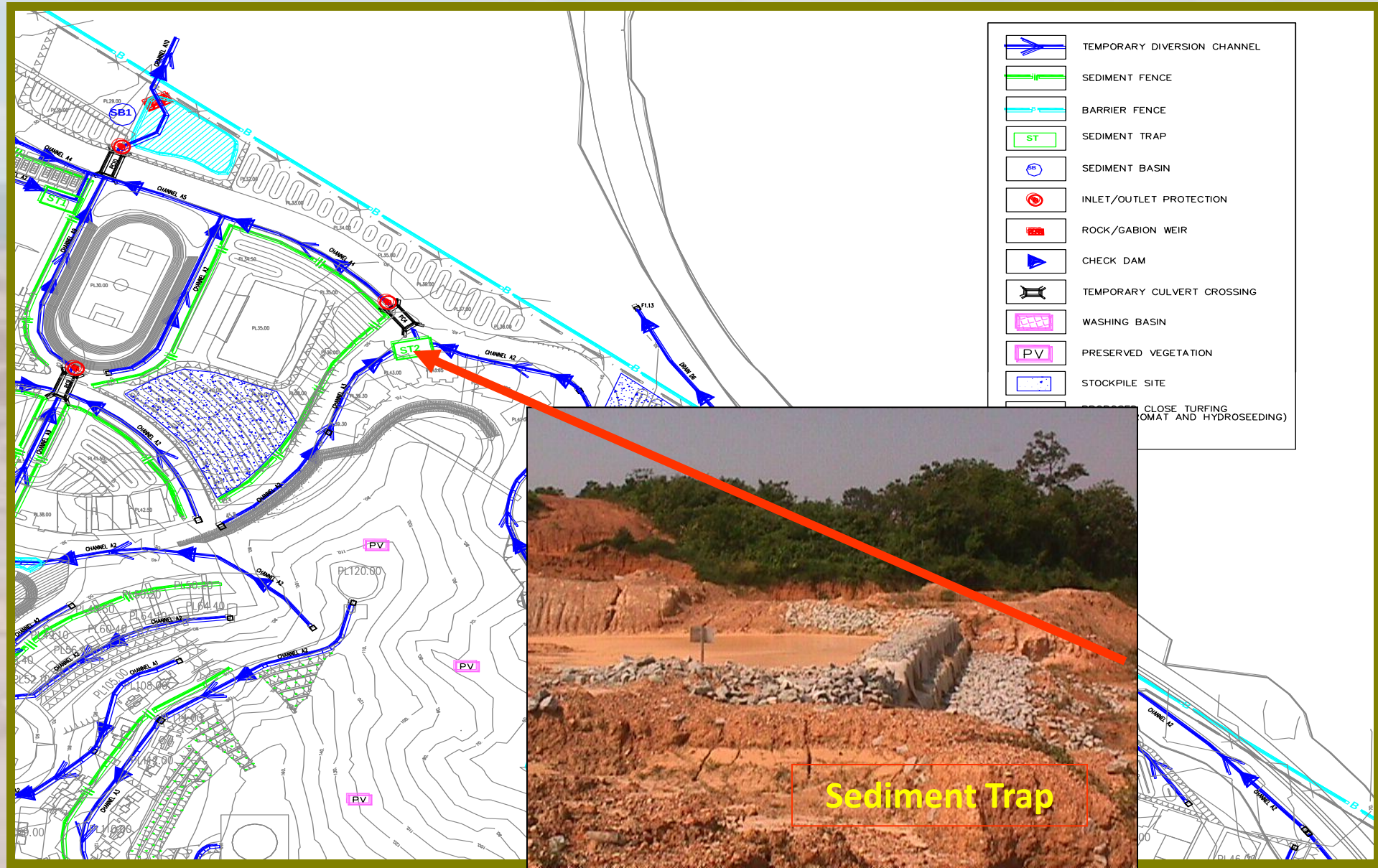
Sediment Control:
Silt Curtain: Construction within sensitive waters

SEDIMENT CONTROL
Drainage Protection Structures






Model ESCP (Sediment Trap)

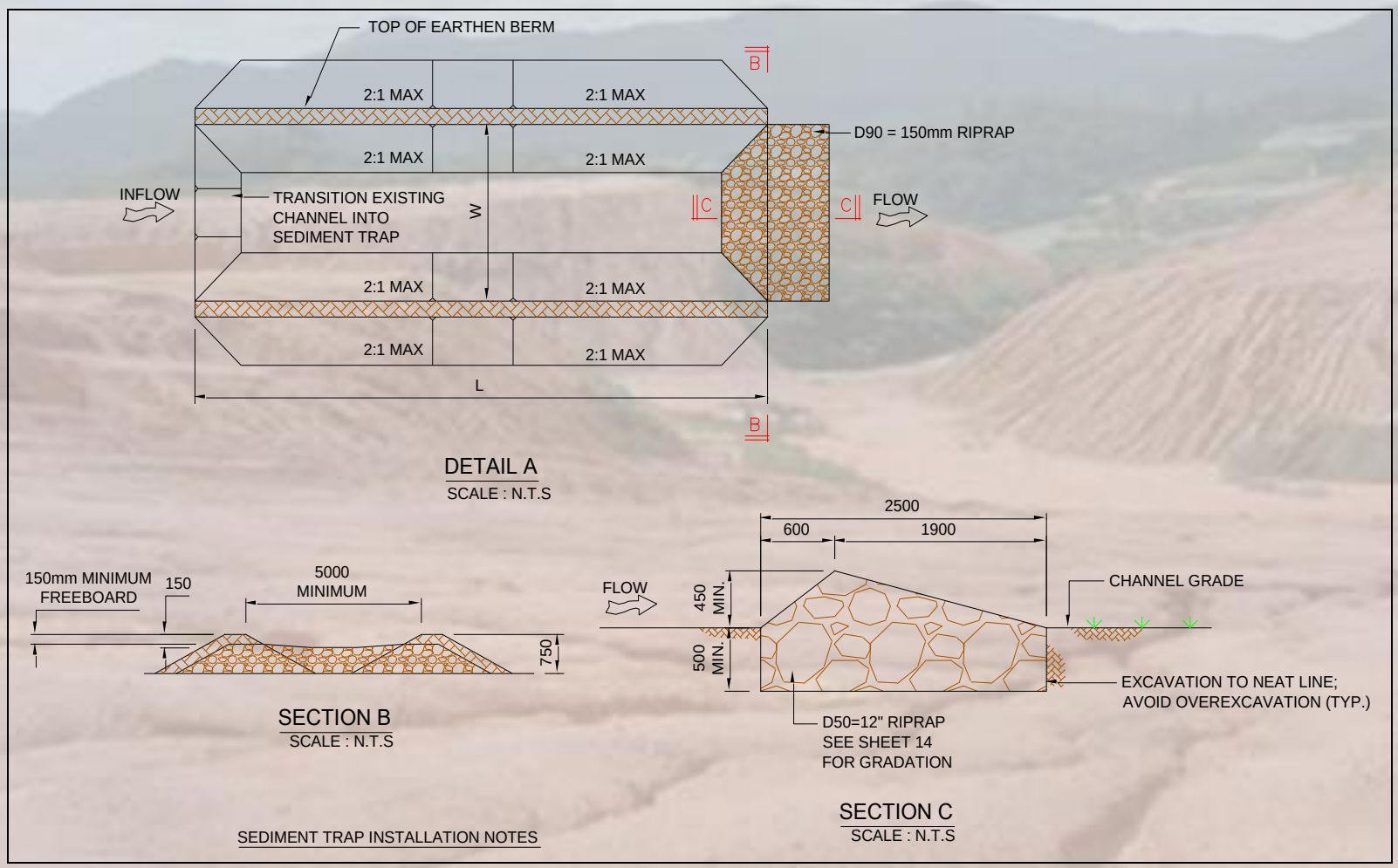


Sediment Control Facilities

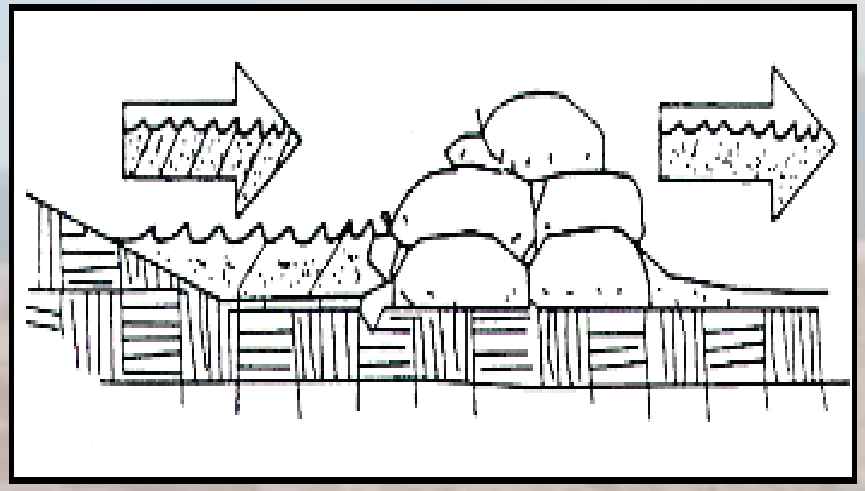
Sediment Traps

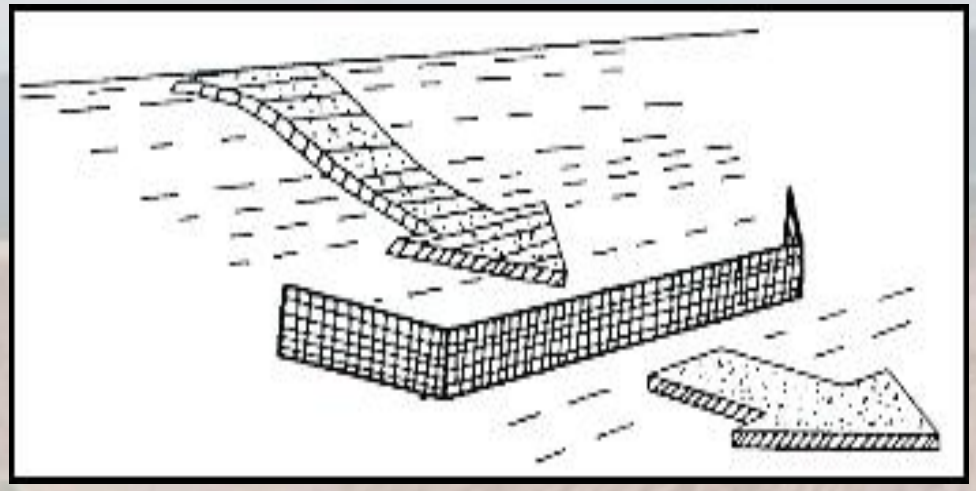
Sediment Control Facilities

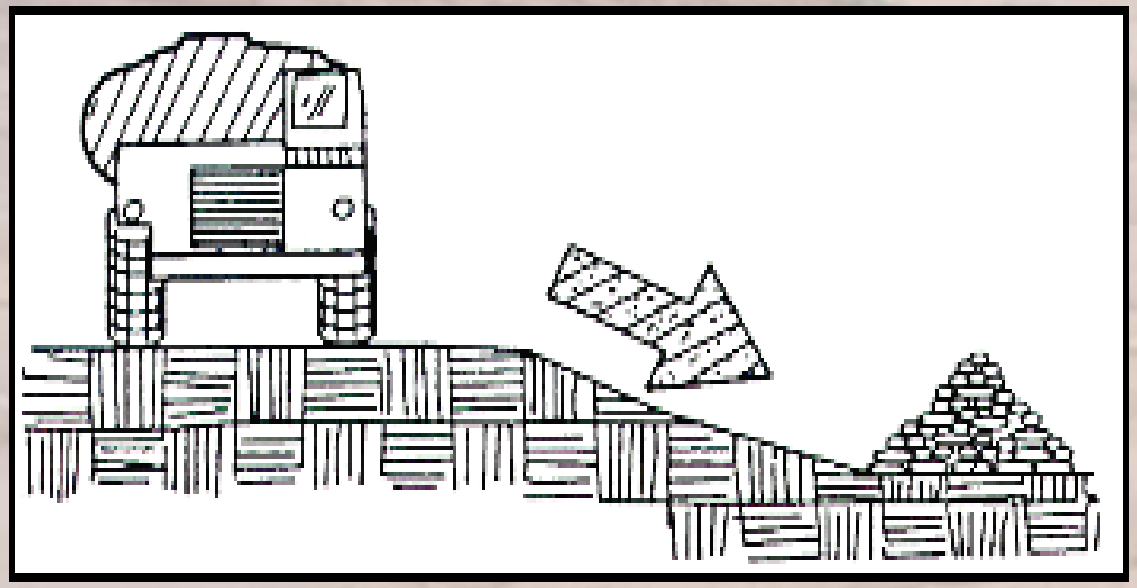
Sediment Traps



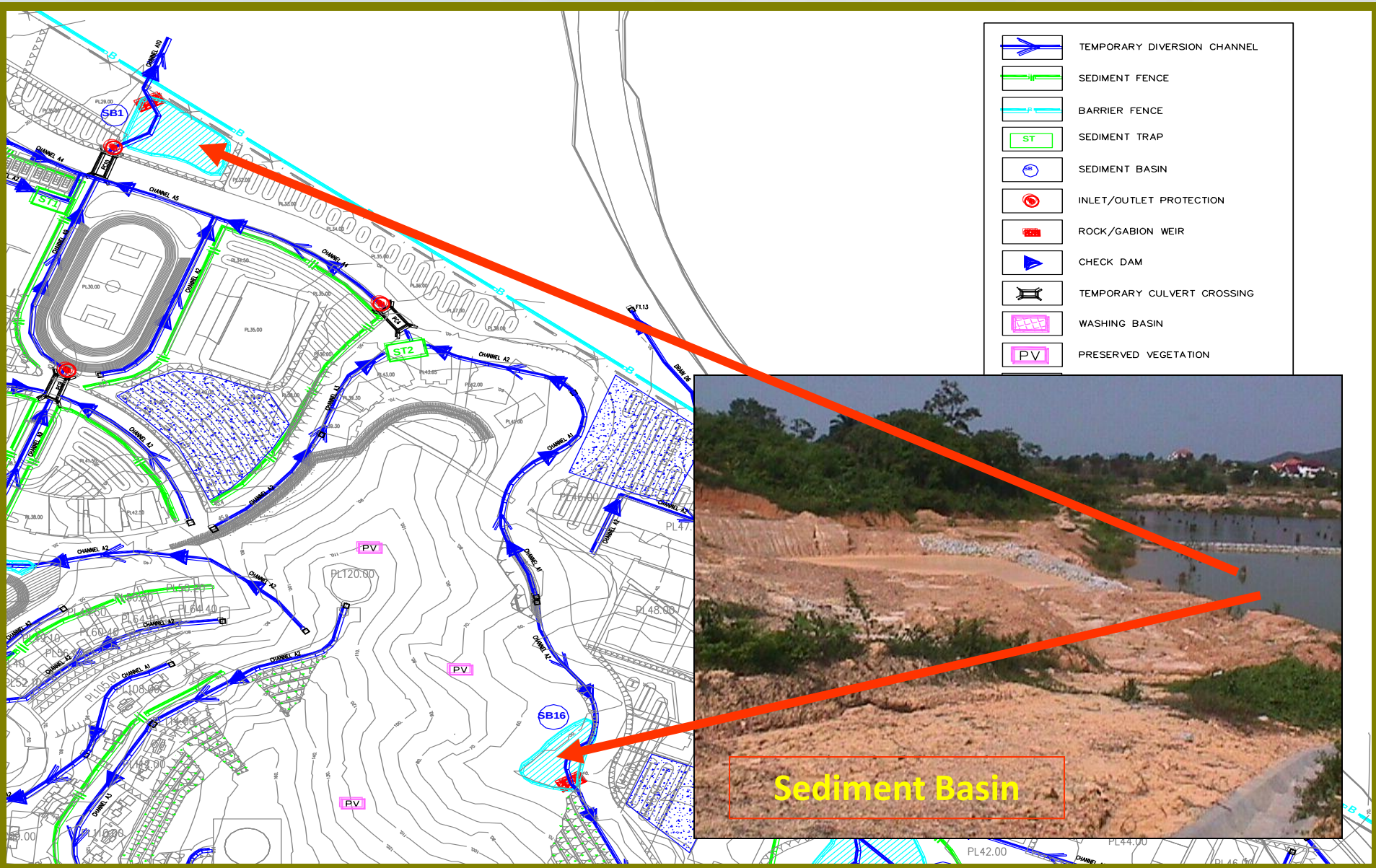
SEDIMENT TRAP







Model ESCP (Sediment Basin)

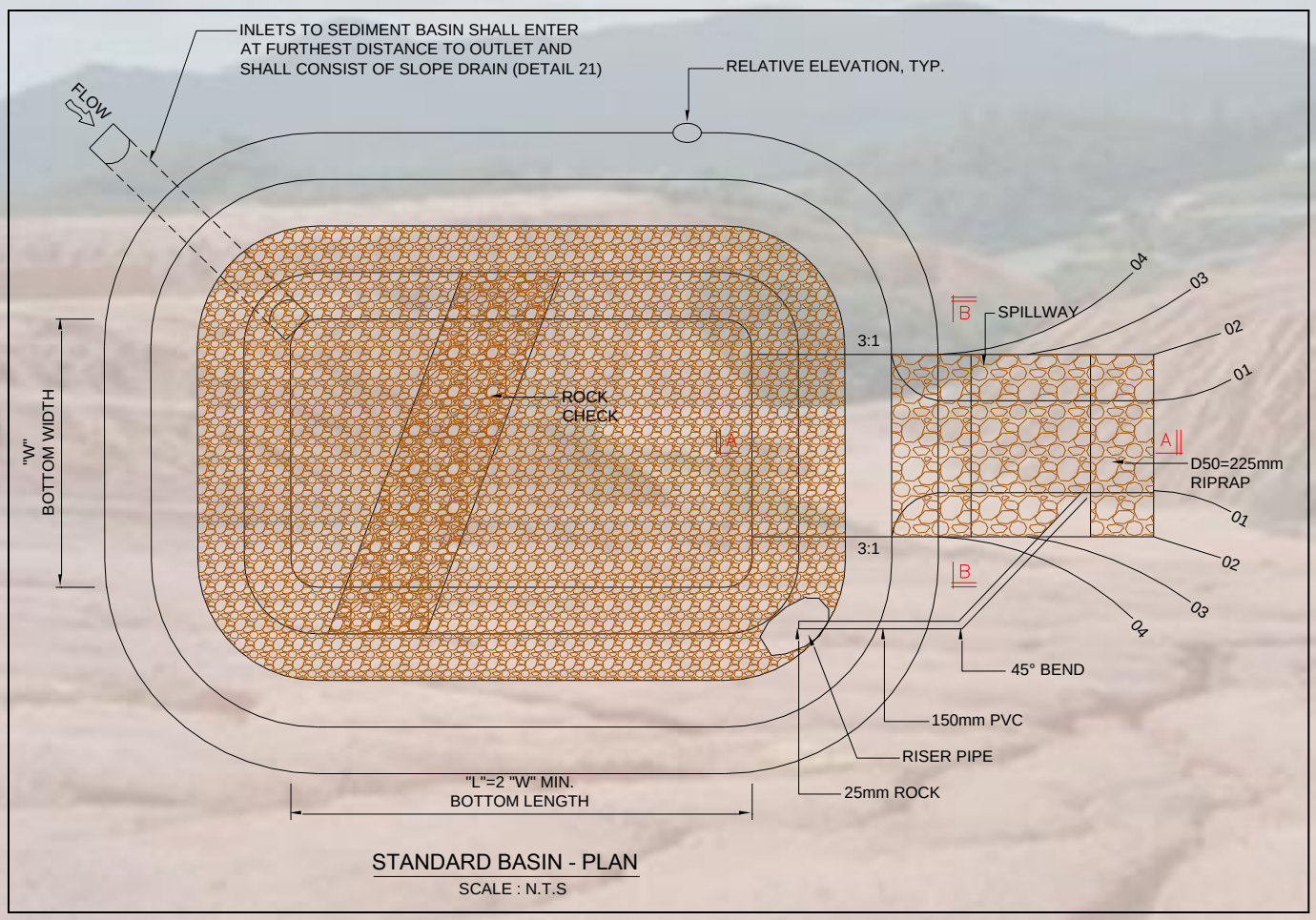


Sediment Control Facilities

Sediment Basins

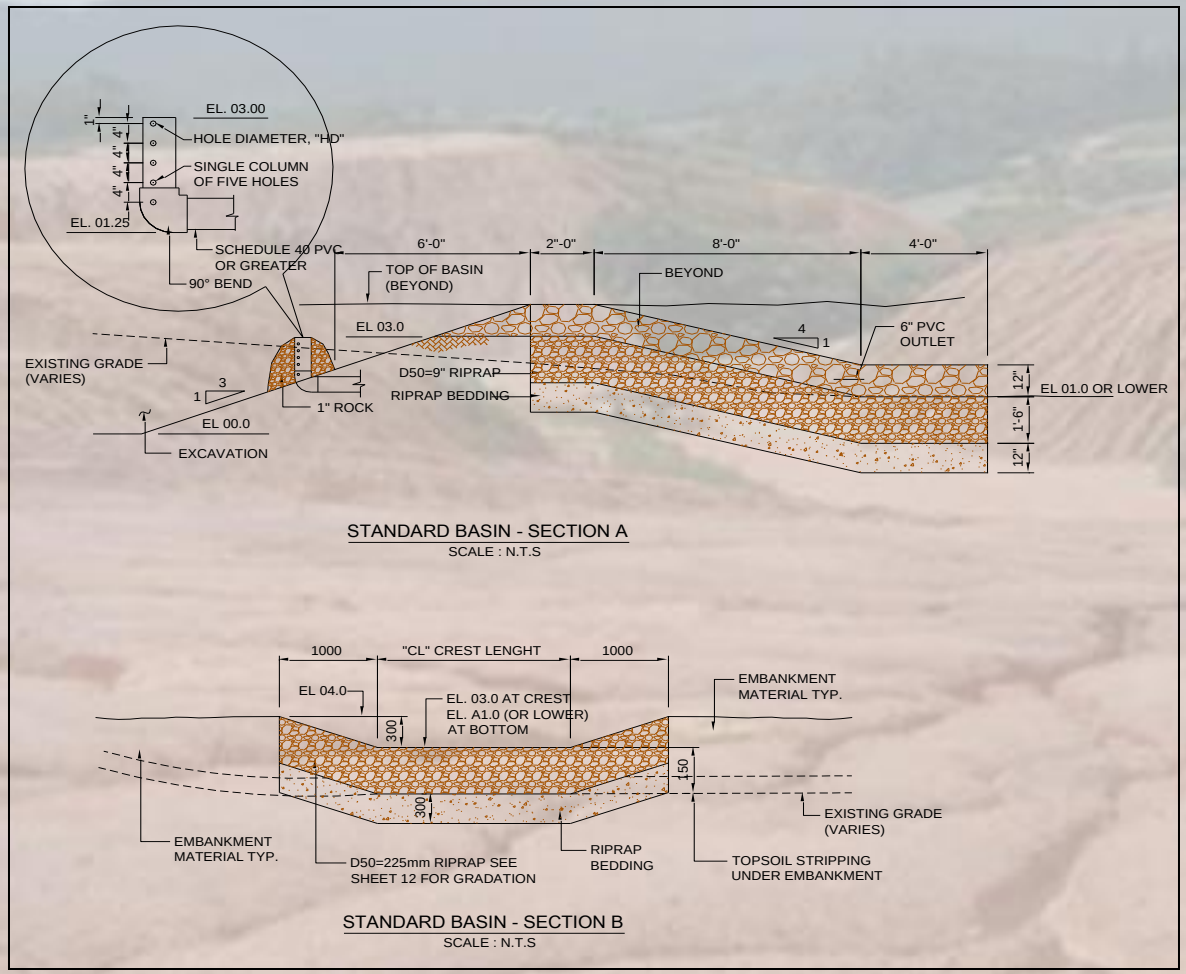
Sediment Control Facilities

Sediment Basins

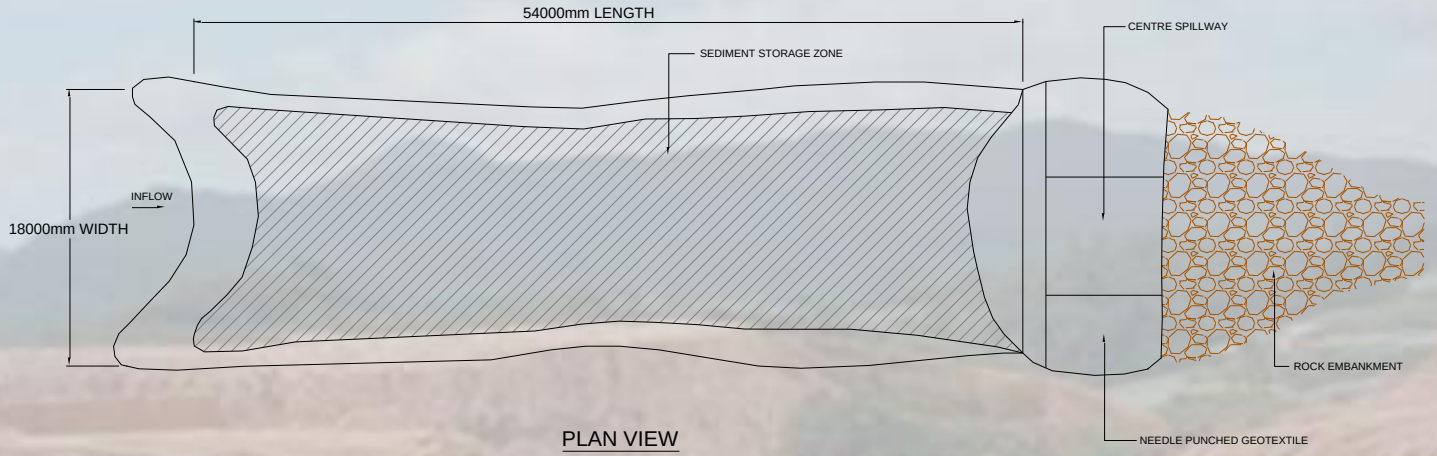


Sediment Control Facilities

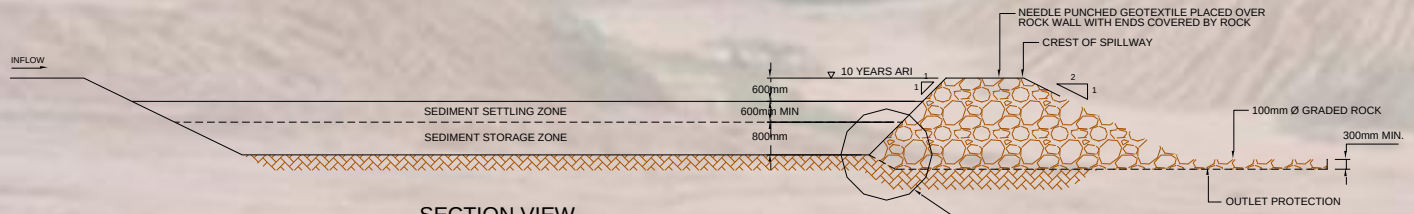
Sediment Basins



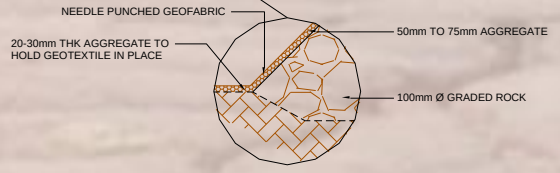
Dry Sediment Basin Layout

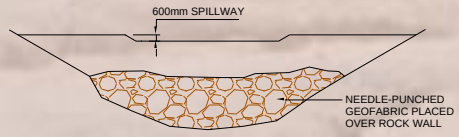


PLAN VIEW



SECTION VIEW





DOWNSTREAM ELEVATION

Sediment Basin 1

Sediment Basin 2

Sediment Basin With Riser 1

Sediment Basin With Riser 2

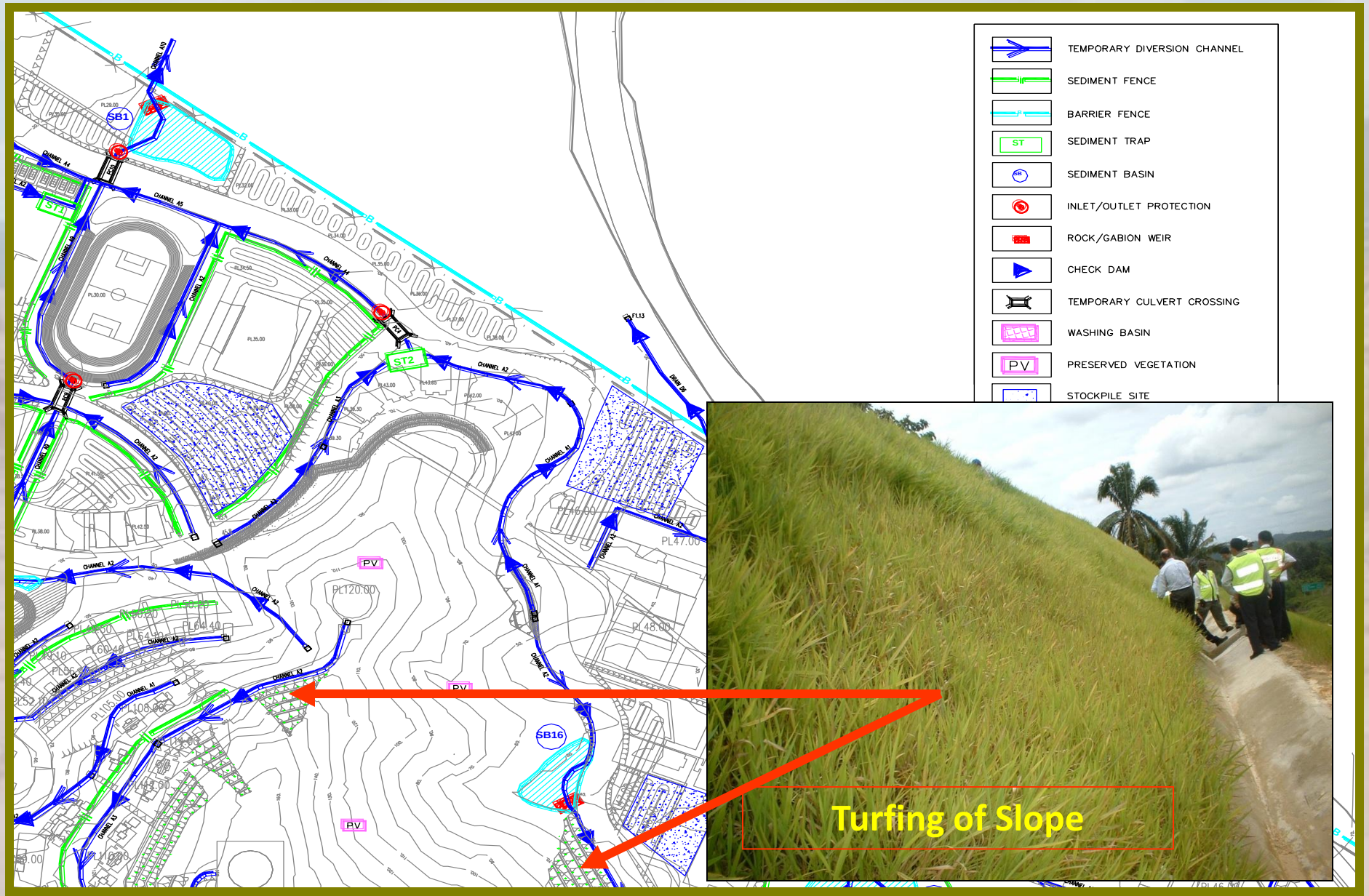
Sediment Basin With Riser 3

The Erosion & Sediment Control Plan

Slope Stabilization

1. Stream stabilisation shall be scheduled during periods of dry weather flow whenever possible.
2. All temporary and permanent practices for stabilising waterways shall be defined in ESCP.
3. All worked slope shall be protected with vegetation and/or chemical stabilisers and/or approved retention structures.
4. All stabilization shall be properly inspected and maintained throughout construction.
5. Where a road is to be cut across a river or stream, bridges and culverts as prescribed by the enforcement authority shall be constructed and maintained according to specifications.
6. Slope $\geq 35^{o}$ SHALL NOT be worked, and should be stabilized
7. For hilly land (12^{0} and greater) terracing shall be practiced. Proper cover and drainage facilities shall be provided.

Model ESCP (Slope Turfing)



The Erosion & Sediment Control Plan

8. Site Maintenance

1. A maintenance programme for the ESC facilities shall be prepared. Disposal of collected sediment shall be planned for.
2. All erosion and sediment control measures shall be constructed and maintained by the Contractor.
3. Site final discharge shall comply with ambient standards for National Water Quality Standard for Malaysia.

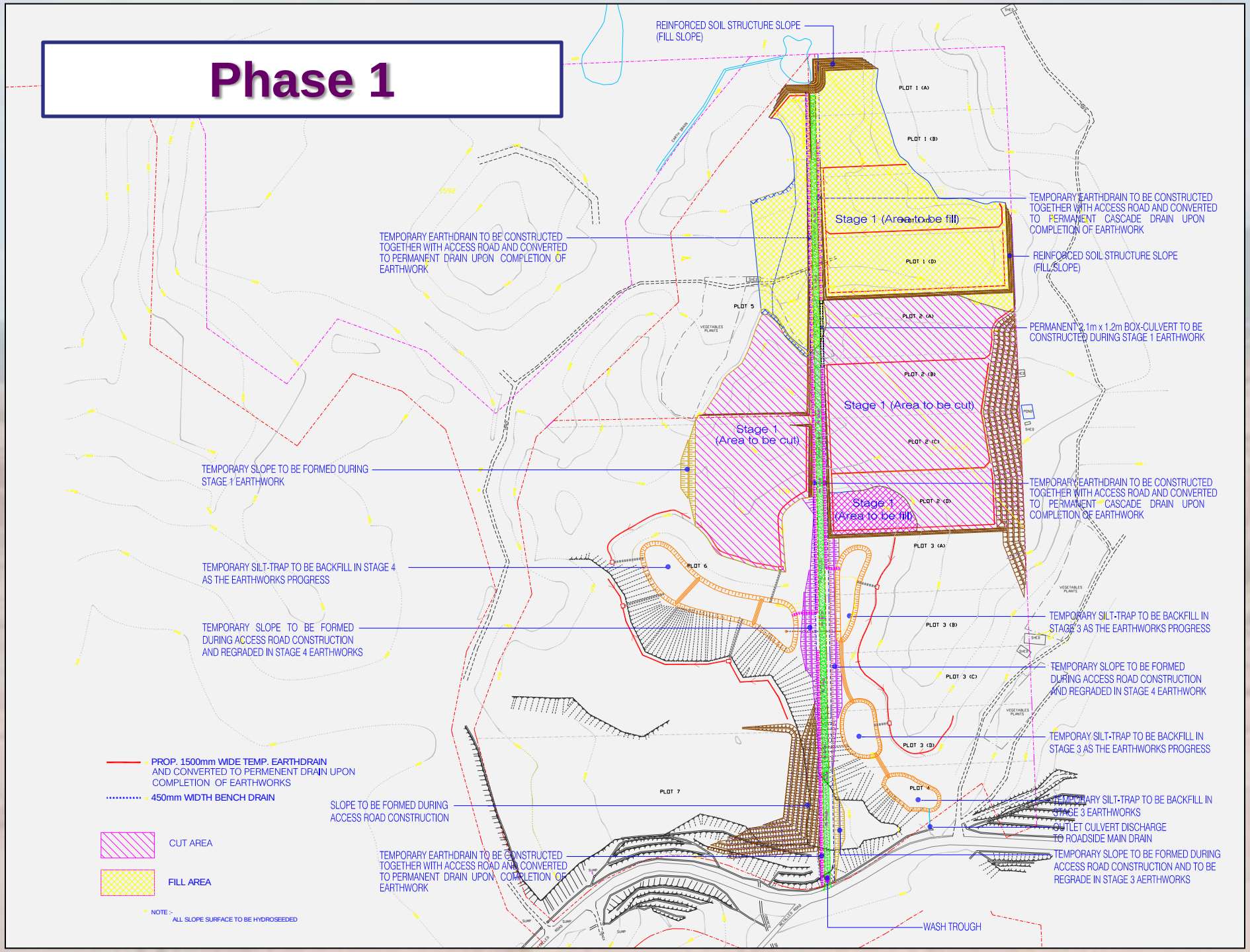
Class	TSS (mg/l)	Turbidity (NTU)
I	25	5
II A	50	50
II B	50	50
III	150	-

Contoh Projek Yang Melaksanakan Pelan Kawalan Hakisan dan Kelodak (ESCP)

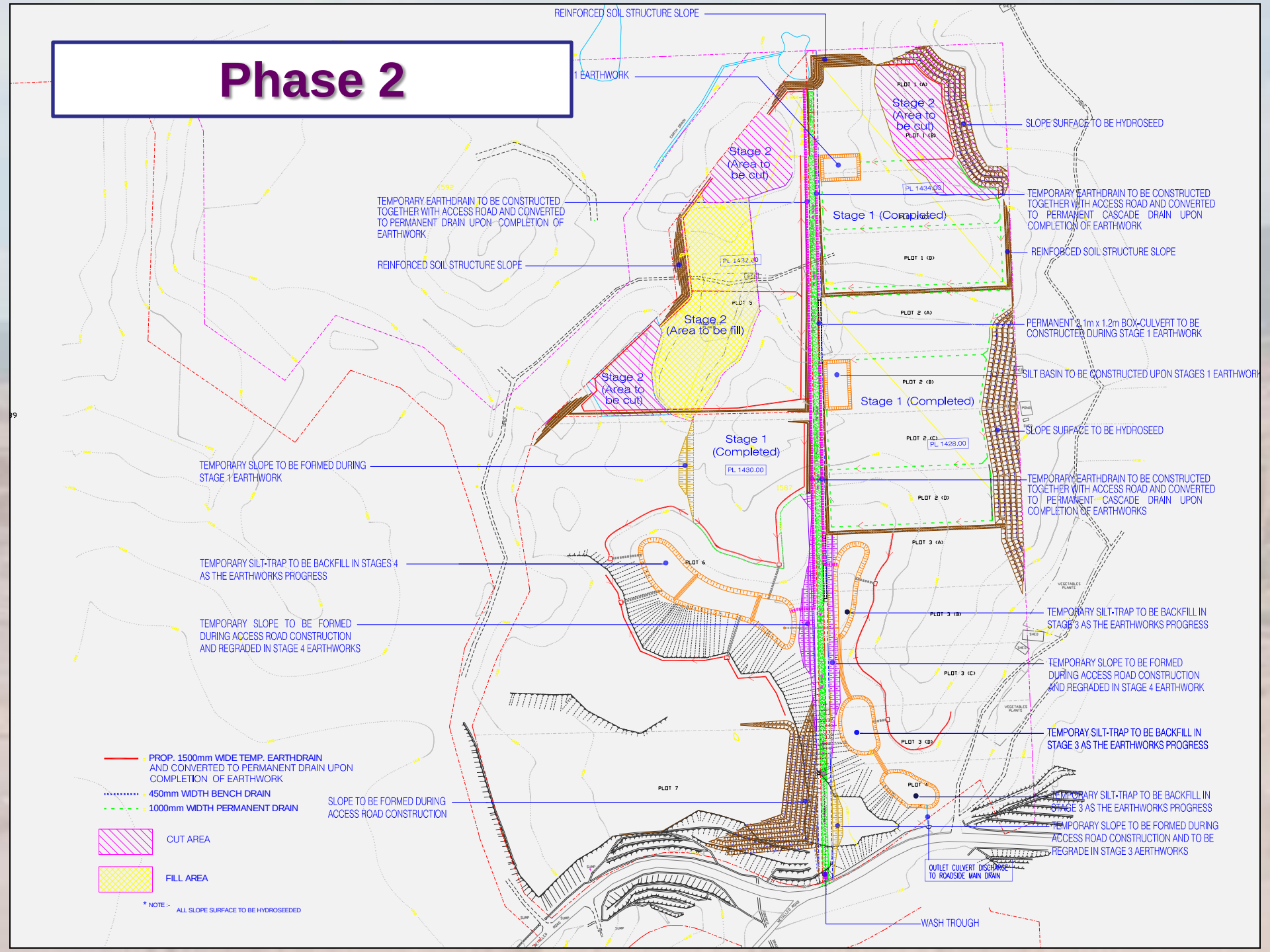
Site Introduction

- A development is proposed for construction of a hydrophonic farm in Blue Valley, Cameron Highlands, on Lot 1587.
- The Consultant proposed 4 stages of earthwork activity, each with individual ESCP.
- The ESCP mainly consists of
  - Erosion Control – Hydroseed/ Turfing
  - Runoff Management – Temporary Earth Drain
  - Sediment Control – Dry/ Wet Sediment Basin & Silt Fence

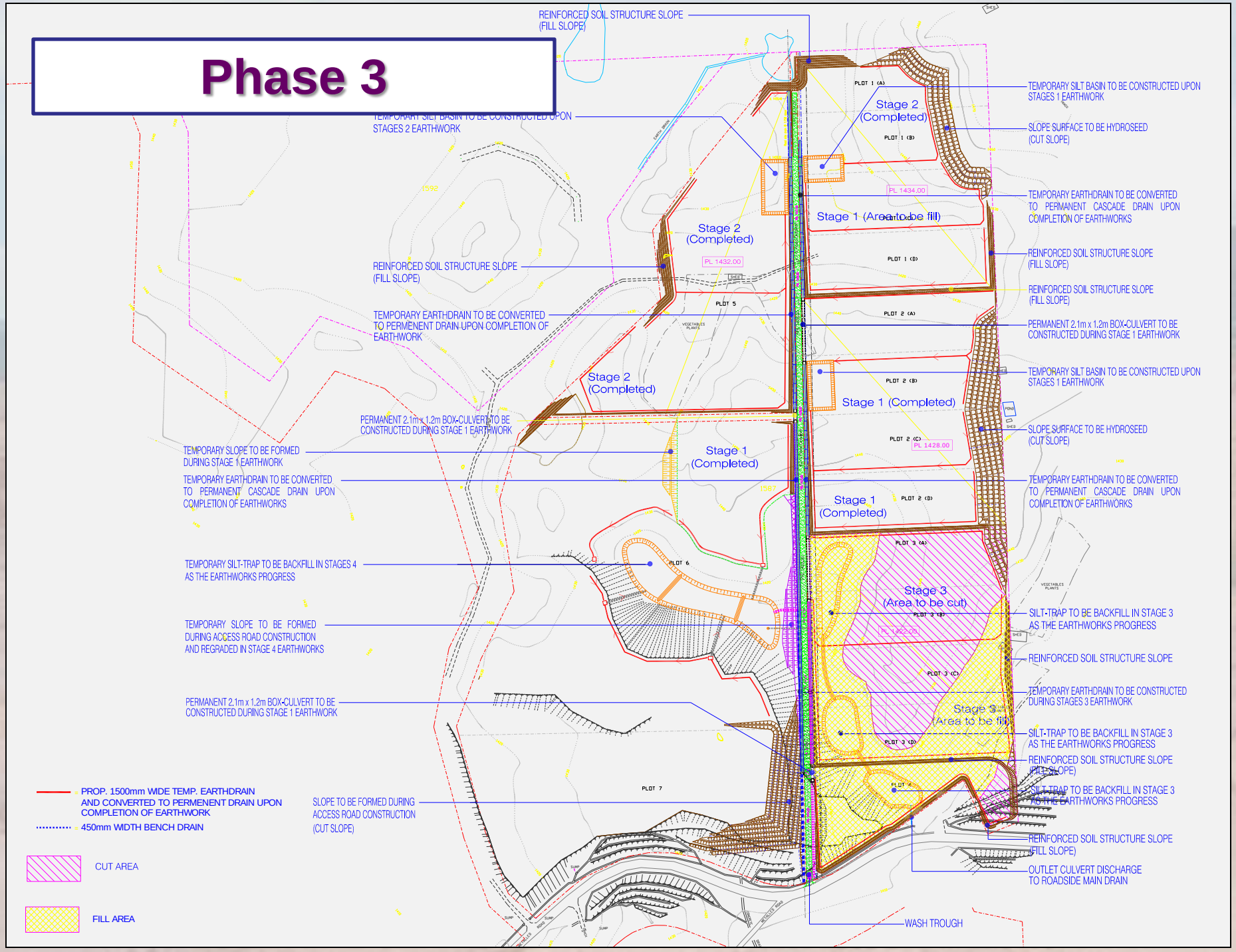
Phase 1


REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
PLOT 1 (A)
PLOT 1 (B)
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORK
Stage 1 (Area to be fill)
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT DRAIN UPON COMPLETION OF EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
PLOT 1 (D)
PLOT 5
PLOT 2 (A)
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 1 EARTHWORK
PLOT 2 (B)
Stage 1 (Area to be cut)
Stage 1 (Area to be cut)
PLOT 2 (C)
TEMPORARY SLOPE TO BE FORMED DURING STAGE 1 EARTHWORK
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORK
Stage 1 (Area to be fill)
PLOT 2 (D)
PLOT 3 (A)
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGE 4 AS THE EARTHWORKS PROGRESS
PLOT 6
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND REGRADED IN STAGE 4 EARTHWORKS
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
PLOT 3 (B)
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND REGRADED IN STAGE 4 EARTHWORK
PLOT 3 (C)
TEMPORAY SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
PLOT 3 (D)
PLOT 7
PLOT 4
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGE 3 EARTHWORKS
OUTLET CULVERT DISCHARGE TO ROADSIDE MAIN DRAIN
SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT DRAIN UPON COMPLETION OF EARTHWORK
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND TO BE REGRADE IN STAGE 3 AERTHWORKS
WASH TROUGH
PROP. 1500mm WIDE TEMP. EARTHDRAIN AND CONVERTED TO PERMENENT DRAIN UPON COMPLETION OF EARTHWORKS
450mm WIDTH BENCH DRAIN
CUT AREA
FILL AREA
NOTE :-
ALL SLOPE SURFACE TO BE HYDROSEEDED

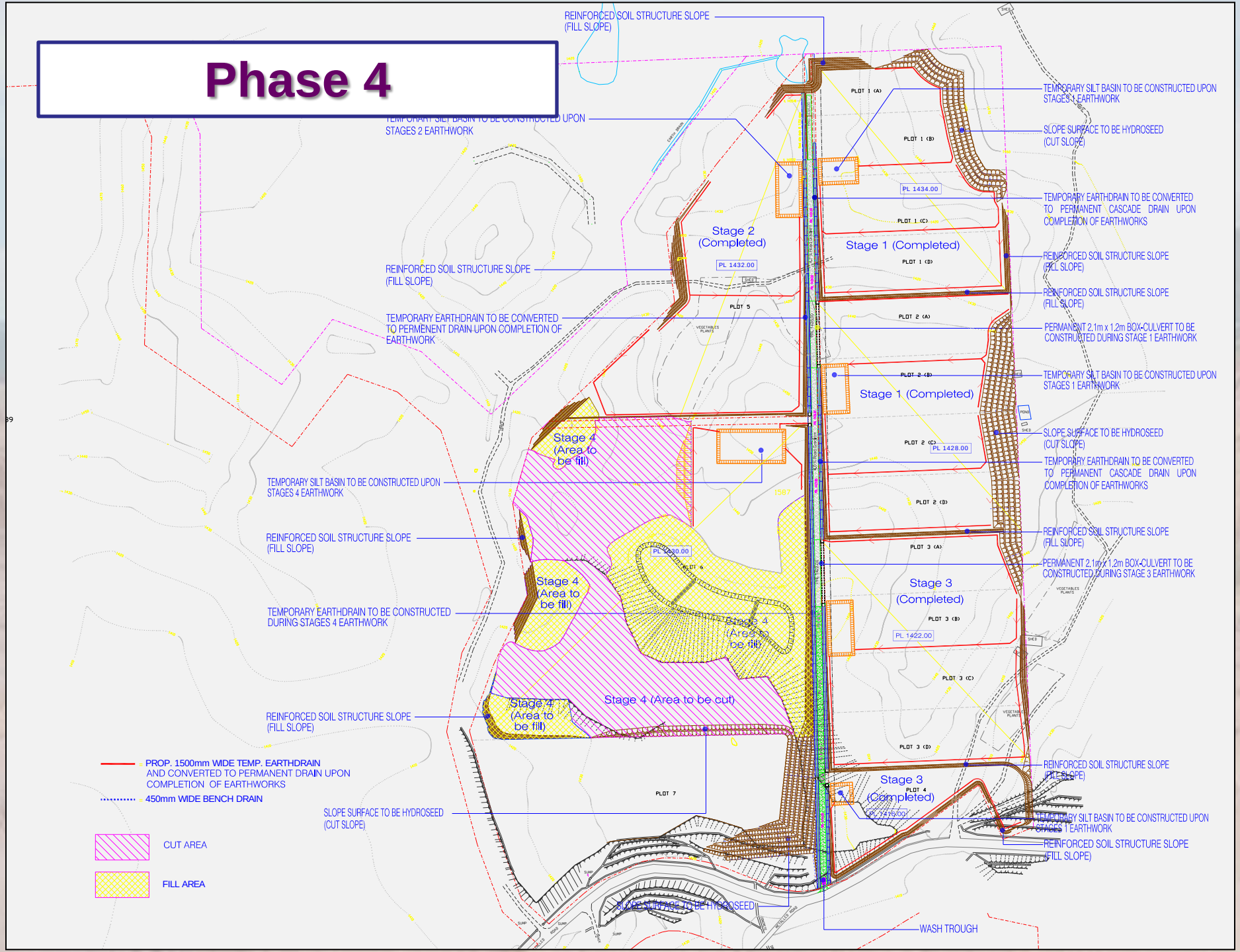
Phase 2


REINFORCED SOIL STRUCTURE SLOPE
1 EARTHWORK
SLOPE SURFACE TO BE HYDROSEED
Stage 2 (Area to be cut)
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT DRAIN UPON COMPLETION OF EARTHWORK
Stage 1 (Completed)
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE
Stage 2 (Area to be fill)
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 1 EARTHWORK
SILT BASIN TO BE CONSTRUCTED UPON STAGES 1 EARTHWORK
Stage 2 (Area to be cut)
Stage 1 (Completed)
SLOPE SURFACE TO BE HYDROSEED
TEMPORARY SLOPE TO BE FORMED DURING STAGE 1 EARTHWORK
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED TOGETHER WITH ACCESS ROAD AND CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORKS
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGES 4 AS THE EARTHWORKS PROGRESS
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND REGRADED IN STAGE 4 EARTHWORKS
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND REGRADED IN STAGE 4 EARTHWORK
TEMPORAY SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND TO BE REGRADE IN STAGE 3 AERTHWORKS
OUTLET CULVERT DISCHARGE TO ROADSIDE MAIN DRAIN
WASH TROUGH
PROP. 1500mm WIDE TEMP. EARTHDRAIN AND CONVERTED TO PERMANENT DRAIN UPON COMPLETION OF EARTHWORK
450mm WIDTH BENCH DRAIN
1000mm WIDTH PERMANENT DRAIN
CUT AREA
FILL AREA
* NOTE :- ALL SLOPE SURFACE TO BE HYDROSEEDED

Phase 3


REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 2 EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMENENT DRAIN UPON COMPLETION OF EARTHWORK
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 1 EARTHWORK
TEMPORARY SLOPE TO BE FORMED DURING STAGE 1 EARTHWORK
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORKS
TEMPORARY SILT-TRAP TO BE BACKFILL IN STAGES 4 AS THE EARTHWORKS PROGRESS
TEMPORARY SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION AND REGRADED IN STAGE 4 EARTHWORKS
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 1 EARTHWORK
SLOPE TO BE FORMED DURING ACCESS ROAD CONSTRUCTION (CUT SLOPE)
PROP. 1500mm WIDE TEMP. EARTHDRAIN AND CONVERTED TO PERMENENT DRAIN UPON COMPLETION OF EARTHWORK
450mm WIDTH BENCH DRAIN
CUT AREA
FILL AREA
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 1 EARTHWORK
SLOPE SURFACE TO BE HYDROSEED (CUT SLOPE)
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORKS
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 1 EARTHWORK
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 1 EARTHWORK
SLOPE SURFACE TO BE HYDROSEED (CUT SLOPE)
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORKS
SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
REINFORCED SOIL STRUCTURE SLOPE
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED DURING STAGES 3 EARTHWORK
SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
SILT-TRAP TO BE BACKFILL IN STAGE 3 AS THE EARTHWORKS PROGRESS
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
OUTLET CULVERT DISCHARGE TO ROADSIDE MAIN DRAIN
WASH TROUGH
Stage 2 (Completed)
Stage 1 (Area to be fill)
Stage 2 (Completed)
Stage 2 (Completed)
Stage 1 (Completed)
Stage 1 (Completed)
Stage 1 (Completed)
Stage 3 (Area to be cut)
Stage 3 (Area to be fill)
PL 1434.00
PL 1432.00
PL 1428.00
PL 1422.00
PLOT 1 (A)
PLOT 1 (B)
PLOT 1 (D)
PLOT 2 (A)
PLOT 2 (B)
PLOT 2 (C)
PLOT 2 (D)
PLOT 3 (A)
PLOT 3 (B)
PLOT 3 (C)
PLOT 3 (D)
PLOT 4
PLOT 5
PLOT 6
PLOT 7

Phase 4


REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 2 EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMENENT DRAIN UPON COMPLETION OF EARTHWORK
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 4 EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
TEMPORARY EARTHDRAIN TO BE CONSTRUCTED DURING STAGES 4 EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
SLOPE SURFACE TO BE HYDROSEED (CUT SLOPE)
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 1 EARTHWORK
SLOPE SURFACE TO BE HYDROSEED (CUT SLOPE)
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORKS
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
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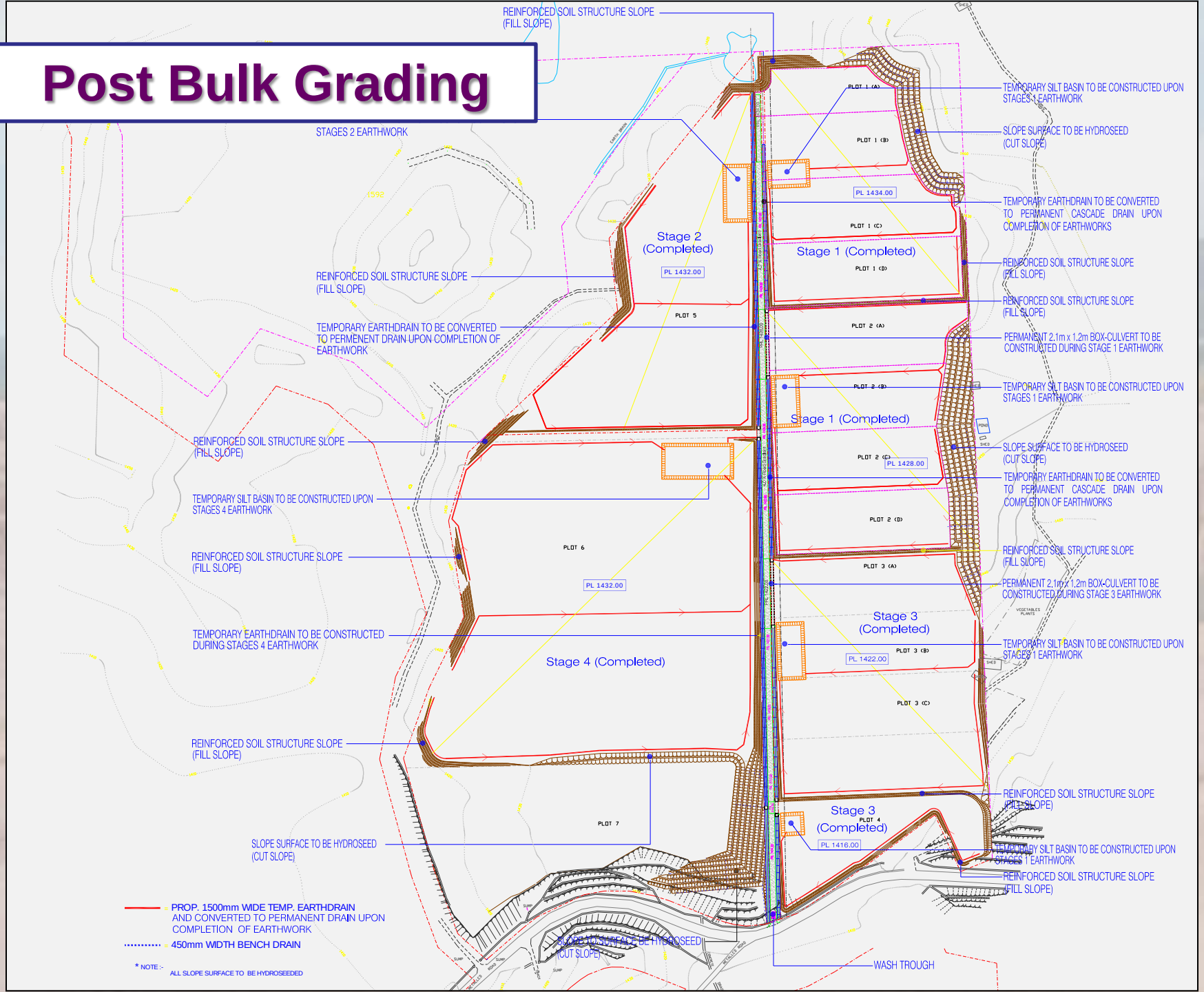
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 1 EARTHWORK
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 1 EARTHWORK
SLOPE SURFACE TO BE HYDROSEED (CUT SLOPE)
TEMPORARY EARTHDRAIN TO BE CONVERTED TO PERMANENT CASCADE DRAIN UPON COMPLETION OF EARTHWORKS
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
PERMANENT 2.1m x 1.2m BOX-CULVERT TO BE CONSTRUCTED DURING STAGE 3 EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
TEMPORARY SILT BASIN TO BE CONSTRUCTED UPON STAGES 1 EARTHWORK
REINFORCED SOIL STRUCTURE SLOPE (FILL SLOPE)
WASH TROUGH
Stage 2 (Completed)
Stage 1 (Completed)
Stage 1 (Completed)
Stage 3 (Completed)
Stage 3 (Completed)
Stage 4 (Area to be fill)
Stage 4 (Area to be fill)
Stage 4 (Area to be fill)
Stage 4 (Area to be cut)
Stage 4 (Area to be fill)
PL 1434.00
PL 1432.00
PL 1428.00
PL 1422.00
PL 1420.00
PROP. 1500mm WIDE TEMP. EARTHDRAIN AND CONVERTED TO PERMANENT DRAIN UPON COMPLETION OF EARTHWORKS
450mm WIDE BENCH DRAIN
CUT AREA
FILL AREA

Post Bulk Grading



Soil Loss Prediction

Equation

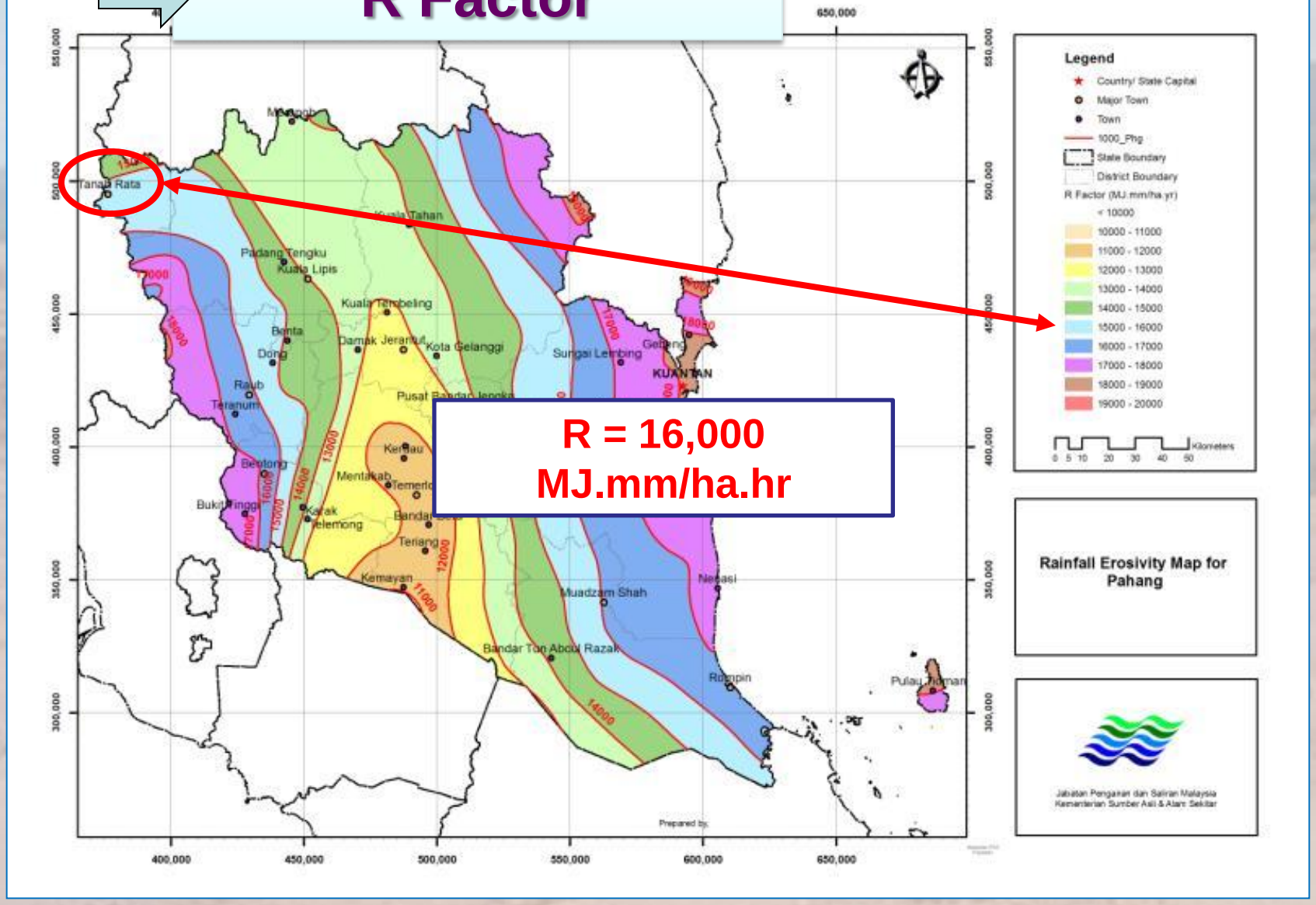
Universal Soil Loss Equation (USLE):

$$A = R. K. L. S. C. P$$

A – Annual Soil Loss in tonnes/ha/year
R – Rainfall/Runoff Erosivity Factor
K – Soil Erodibility Factor
L – Slope Length Factor
S – Slope Steepness Factor
C – Ground Cover Factor / Erosion Control Factor
P – Supporting Practices Factor/ Sediment Control Factor

Soil Loss Prediction

R Factor



Soil Loss Prediction, A=RKLSCP

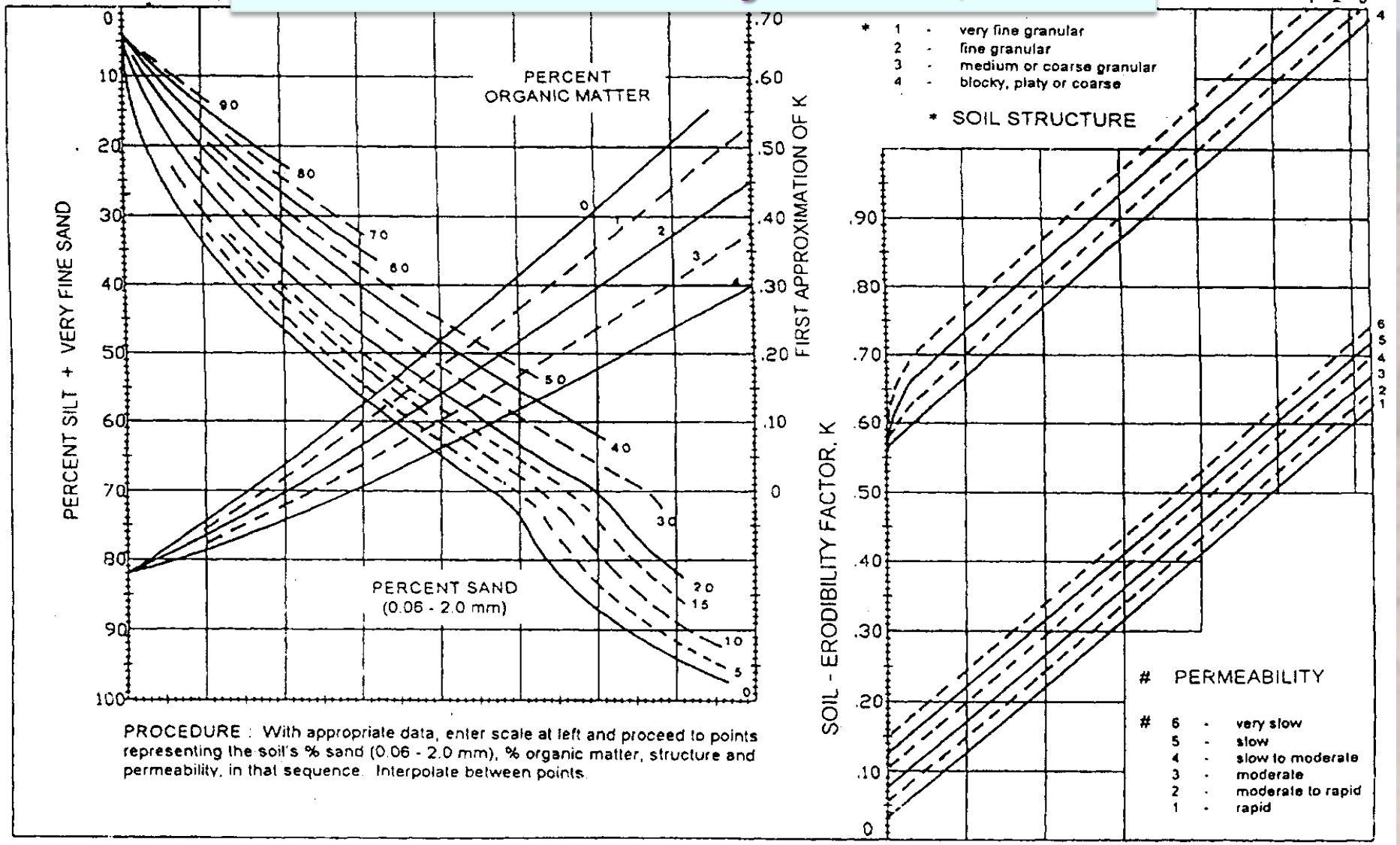
Soil Erodability Factor, K

From Soil data obtained from SI:

Hand Auger No.	Sample Number	Depth (m)	Particle Size Distribution (%)			Organic Matter (%)	Structure Code (S)	Permeability Code (P)	K Factor
			Clay	Silt	Sand				
HA 1	A	0.5	12.83	35.99	51.19	0.1	2	3	0.0244
	B	1.0	15.94	42.11	41.95	0.1	2	3	0.0266
HA2	A	0.5	5.48	33.90	60.62	0.1	2	2	0.0142
	B	1.0	2.14	27.33	70.53	0.1	2	2	0.0113
HA3	A	0.5	7.03	33.30	59.67	0.1	2	2	0.0136
	B	1.0	14.85	41.51	43.64	0.1	2	3	0.0266
HA4	A	0.5	8.61	32.25	59.14	0.1	2	2	0.0128
	B	1.0	4.70	36.06	59.24	0.1	2	2	0.0155
HA5	A	0.5	13.25	30.18	56.57	0.1	2	2	0.0110
	B	1.0	24.23	28.18	47.59	0.1	2	3	0.0190
HA6	A	0.5	18.04	65.93	16.03	0.1	3	3	0.0387
	B	1.0	20.42	65.67	13.91	0.1	3	3	0.0377

Soil Loss Prediction, A=RKLSCP

Soil Erodability Factor, K



Soil Loss Prediction, A=RKLSCP

Slope Length & Steepness Factor, LS

Slope Steepness, s (%)	Slope Length, λ (m)											
	2	5	10	15	25	50	60	75	100	150	200	250	300
0.1	0.043	0.052	0.059	0.064	0.071	0.082	0.089	0.094	0.102	0.108	0.113	0.117
0.5	0.055	0.067	0.076	0.083	0.092	0.106	0.114	0.121	0.131	0.139	0.146	0.151
1.0	0.057	0.075	0.093	0.105	0.122	0.150	0.170	0.185	0.209	0.228	0.243	0.257
2.0	0.089	0.117	0.144	0.163	0.190	0.234	0.264	0.288	0.325	0.354	0.379	0.400
3.0	0.100	0.144	0.190	0.224	0.275	0.362	0.426	0.478	0.563	0.631	0.690	0.742
4.0	0.135	0.195	0.257	0.302	0.371	0.489	0.575	0.646	0.759	0.852	0.932	1.002
5.0	0.138	0.218	0.308	0.377	0.487	0.688	0.843	0.973	1.192	1.376	1.539	1.686
6.0	0.173	0.273	0.387	0.474	0.612	0.865	1.059	1.223	1.498	1.730	1.934	2.119
8.0	0.255	0.404	0.571	0.699	0.903	1.277	1.564	1.806	2.212	2.554	2.855	3.128
10.0	0.353	0.559	0.790	0.968	1.250	1.768	1.935	2.165	2.499	3.061	3.535	3.952	4.329
15.0	0.525	0.909	1.378	1.757	2.388	3.619	4.616	5.486	6.997	8.315	9.506	10.605
20.0	0.848	1.470	2.228	2.841	3.860	5.851	7.463	8.869	11.311	13.442	15.368	17.145
25.0	1.249	2.164	3.279	4.183	5.683	8.613	10.986	13.055	16.651	19.788	22.623	25.239
30.0	1.726	2.991	4.533	5.782	7.855	11.906	15.185	18.046	23.017	27.353	31.272	34.887
40.0	2.911	5.045	7.646	9.752	13.250	20.083	25.614	30.440	38.824	46.139	52.749	58.846
50.0	4.404	7.631	11.567	14.753	20.044	30.382	38.749	46.050	58.733	69.798	79.798	89.023
60.0	6.204	10.751	16.296	20.784	28.239	42.802	54.590	64.875	82.744	98.333	112.420	125.416
70.0	8.312	14.404	21.833	27.846	37.833	57.344	73.138	86.917	110.856	131.741	150.615	168.026
80.0	10.728	18.590	28.177	35.938	48.827	74.008	94.391	112.174	143.070	170.025	194.383	216.854
90.0	13.451	23.309	35.329	45.060	61.221	92.793	118.350	140.648	179.386	213.182	243.723	271.898
100.0	16.482	28.560	43.289	55.212	75.014	113.700	145.016	172.337	219.803	261.214	298.637	333.159

Soil Loss Prediction

C Factor

Erosion control treatment		C Factor
Bare soil / Newly cleared land		1.00
Cut and fill at construction site		
Fill	Packed, smooth	1.00
	Freshly disked	0.95
	Rough (offset disk)	0.85
Cut	Below root zone	0.80

P Factor

Site Management /Sediment Control Measures	P Factor
Bare soil	1.00
Disked bare soil (rough or irregular surface)	0.90
Wired log / Sand bag barriers	0.85
Check Dam	0.80
Grass buffer strips (to filter sediment laden sheet flow)	
Basin slope (%)	
0 to 10	0.60
11 to 24	0.80

Soil Loss Prediction

Summary

Parameters	Value
Rainfall Erosivity, R	16,000
Soil Erodability, K	0.0266
Slope Length & Steepness, LS	1.935
Ground Cover, C	1
Supporting Practices, P	1
Annual Soil Loss	**823.536 ton/ha/yr**

Sediment Yield Prediction

Sediment Yield Prediction

$$Y = 89.6\,(VQ_p)^{0.56}(K.LS.C.P)$$

- Y – Sediment Yield
- V – Runoff Volume
- Q_p – Peak Discharge
- K – Soil Erodibility Factor
- L – Slope Length Factor
- S – Slope Steepness Factor
- C – Ground Cover Factor / Erosion Control Factor
- P – Supporting Practices Factor/ Sediment Control Factor

Sediment Yield Prediction

Runoff Volume, Q_p

Peak Discharge is estimated using Rational Method:

$$Q_p = C.I.A/360$$

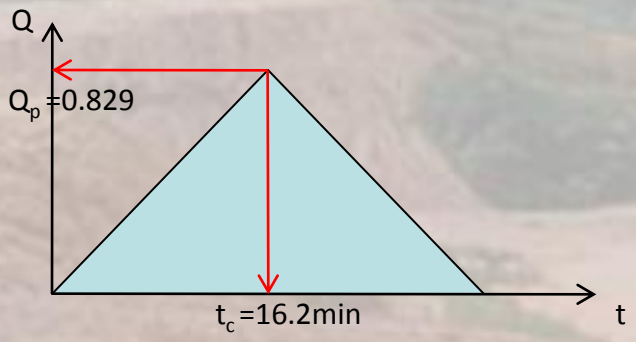
C – Runoff Coefficient
I – Design Average Rainfall Intensity, mm/hr
A – Catchment Area, in hectares

C = 0.74 (Refer Chapter 14, MSMA)
I = 104.8 mm/hr (average 3 months ARI intensity @ 16.2minute)
A = 3.85 ha
Q_p = (0.74 x 104.8 x 3.85)/360
= 0.829 m^3/s

Sediment Yield Prediction

Runoff Volume, V

Runoff Volume is estimated using Rational Method's Triangulate Hydrograph:



V = 0.829*(16.2*60)

= 805.79 m^3

Sediment Yield Prediction

Summary

Parameters	Value
Runoff Volume, V (m^3)	805.79
Peak Discharge, Q_p (m^3/s)	0.829
Soil Erodability, K	0.0266
Slope Length & Steepness, LS	1.935
Ground Cover, C	1
Supporting Practices, P	1
Sediment Yield, Y	**176.09 ton/ha**

SEDIMENT BASIN DESIGN

Procedure

Determine Basin Type

Sizing the Basin

Sizing Emergency Spillway

Check Trapping Capacity

Determining Basin Type

%Clay (<0.002mm)	%Silt (0.002 – 0.05m)	%Sand (0.05 – 2mm)
15.94	42.11	41.95

Category	Soil Description	Hydrological Soil Group	Basin Type	Design Considerations
I	Coarse-grained sand, sandy loam: less than 33% <0.02mm	A	Dry	Settling velocity, sediment storage
II	Fine-grained loam, clay: more than 33% < 0.02mm	B	Wet	Storm impoundment, sediment storage
III	Dispersible fine-grained clays as per type F, more than 10% of dispersible material	C, D	Wet	Storm impoundment, sediment storage, assisted flocculation

Sizing The Basin

Parameter	Design Storm	Time of Concentration of Basin Catchment (minutes)				
		10	20	30	45	60
Surface Area (m^2/ha)	3 month ARI	333	250	200	158	121
	6 month ARI	n/a	500	400	300	250
Total Volume (m^3/ha)	3 month ARI	400	300	240	190	145
	6 month ARI	n/a	600	480	360	300

The surface area required = 250 x 3.85 = **962.50 m^2**

The total volume required = 300 x 3.85 = **1155 m^3**

Sizing The Basin

a) SETTLING ZONE

Required volume, V_1 = **578 m³** (half the total volume)
Settling zone depth, y_1 = **0.6 m**

To get dimension of basin (a rectangular basin):
Try a settling zone average width W_1 = **18 m**
Then the length can be worked out:
length $L_1 = V_1 / (W_1 \times y_1)$ = 53.5 m , say **54 m**

Check total area
Average surface area = 54 x 18 = 972 m² > 962.5 m² ; **OK**

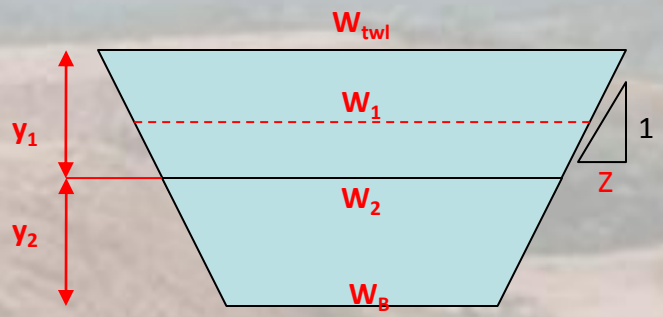
Check settling zone dimensions:
L_1/y_1 ratio = 54/0.6 = 90 < 200; **OK**
L_1/W_1 ratio = 54/18 = 3 > 2; **OK**

Sizing The Basin

b) SEDIMENT STORAGE ZONE

Required volume, V_2 = **578 m³** (half the total volume)

Assuming side slope, Z = 2 (2H:1V), The top surface of storage zone can be estimated:



$W_2 = W_1 - 2 \times (d1/2 \times Z) = 18 - (2 \times (0.6/2) \times 2) =$ **16.8m**

$L_2 = L_1 - 2 \times (d1/2 \times Z) = 54 - (2 \times (0.6/2) \times 2) =$ **52.8m**

Depth of storage zone can be estimated by,

$V_2 = Z_2(Y_2)^3 - Z(Y_2)^2(W_2+L_2) + Y_2(W_2.L_2)$

$578 = 4Y_2^3 - 139.2Y_2^2 + 887Y_2$

Using Trial & Error,

Y_2 = 0.8m, **V_2 =623m³** Y_2>0.3 and V_2>578; **OK**

Sizing The Outlets

Determining Required Q for spillway

Basin design up to 10-year ARI, anything greater is bypassed (emergency)
Therefore,

$$Q_{spillway} = Q_{10} - Q_{riser}$$

Q_{10} $=(C.^{10}I_{20}.A)/360$
$=(0.85 \times 115 \times 3.85)/360$
$= 1.05 m^3/s$

$Q_{riser} = C_0 A_0 \sqrt{2gH_0} = 0.6 \times \frac{\pi (0.9)^2}{4} \times \sqrt{2 \times 9.81 \times 0.3} = \mathbf{0.93 m^3/s}$
(See MSMA for Riser Design)

$Q_{spillway}$ $= 1.05 - 0.93 = 0.12 m^3/s$

Sizing The Outlets

Dimension for spillway

Spillway is designed as weir. Hence,

$$Q_{spillway} = C_{sp}.B.H_p^{1.5}$$

Try with B= 1.5m, Hp = 0.3m and Csp =1.65 (See MSMA)

$Q_{spillway} = 1.65 \times 1.5 \times 0.3^{1.5} = 0.41\ m^3/s$ **>0.12 m^3/s; OK**

Total Basin Depth = $y1+y_2+H_o+H_p = 0.6+0.8+0.3+0.3 =$ **2m**

Trapping Efficiency & Capacity

WQ Design = 3 months ARI
Sediment Yield, Y = 176.09 tonne

Assuming 85% efficiency,
Total sediment trapped = 176.09 x 0.85 = 149.68 tonne
@ 576.25/1.6 = 93.54 m^3

Total sediment storage volume is 623m^3, > 93.54; **OK**

Terima kasih !

Slides oleh:
BSMA, JPS Malaysia