Session 5

Sediment Basins and Dewatering

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Sediment Basin Test

- The need for a (Type 1) sediment basin should determined early in the project design process
- IECA White Book sediment control standard (Section 4.5.1) – sediment basin required if:
  - Catchment disturbance area is >2,500m^2 and the estimated soil loss rate is likely to exceed the equivalent of 150 t/ha/yr (RUSLE) during the construction period
- Some small and flat sites may not warrant construction of a sediment basin i.e. those of short duration or where the actual construction timing can be regulated

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Sediment Basin Design Procedure

- Sediment basin test
- If required, consider location(s)
- Define catchment (divert clean water)
- Determine basin design criteria
- Determine basin geometry and outlet system
- Design ‘emergency’ spillway
- Determine basin access and maintenance requirements
- Different basin designs and maintenance regimes for Types C, F and D basins

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Sediment Basins

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Purpose

- Collect sediment-laden stormwater runoff and retain pollutants
- The most effective of all sediment control devices due to their large settling volume and sediment storage capacity
- Generally used on larger (>2,500 m^2 construction sites)
- Types C (coarse) and F (non-dispersive) and D (dispersive)

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Permanent Basins

- Designed by experienced professionals, having regard to the volumes of runoff, quantity and types of sediment expected
- Size includes a sediment settling and a sediment storage zone, mark with pegs
- Prioritise public safety
- Optimal length/width ratio > 3:1 – use baffles if necessary
- Ensure inlet/outlet structures are stabilised against erosion

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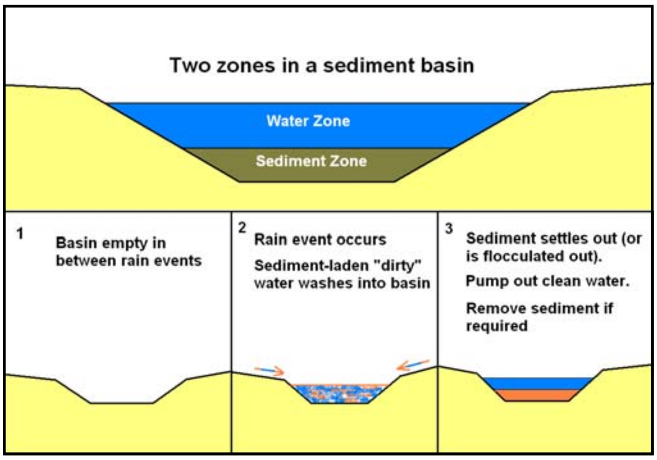

Wet Basins

- Watertight structures that store water for sufficient time to allow settling of fine and dispersed suspended solids
- Complete 'storm capture' devices
- Typically for Type F and Type D sediments
- Settling volume based on design rainfall depth, sediment storage volume = 50% of settling volume
- Often flocculated to enhance performance if sediments are dispersive (colloidal)
- Pump clarified water out once settling has occurred

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Example – Wet Basin

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Maintenance

- Pump out wet basins after sufficient settling time / flocculation has occurred, to restore design capacity in time for the next storm
- Inspect / test the quality of outlet waters to assess performance
- Remove sediment once the sediment storage zone reaches 'trigger' level
- Regularly check the integrity of the basin, particularly inlet/outlet structures, and repair any damage

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Dry Basins

- Only effective for coarse (Type C) sediments where shorter settling times are required
- Can be built of earth, rock or gabions
- Drain naturally through a geotextile-lined permeable wall or slotted riser

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Example – Dry Basin

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Temporary Basins

Temporary Basins

Basin Sizing Procedure

IECA White Book Design requirements:

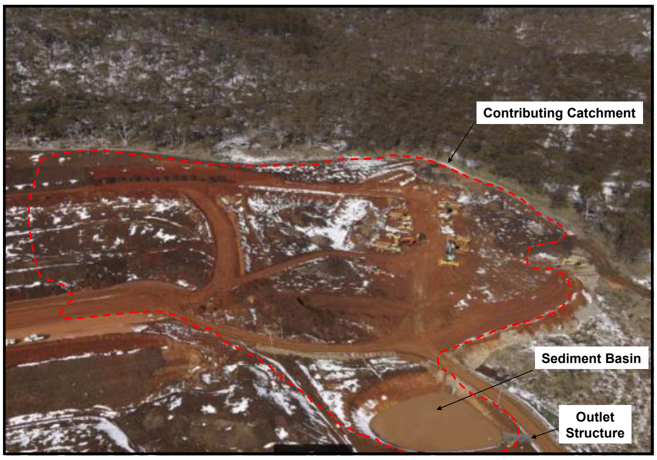
- Site details
- RUSLE soil loss estimation (t/ha/year)
- Catchment and disturbance areas (ha)
- Soil analysis (Type C or F/D)
- Rainfall data (Table 5 IECA or BOM)
- Sediment basin design criteria
- Sediment basin volume calculation

RUSLE Factors

- Rainfall erosivity (R-factor)
- Soil erodibility (K-factor)
- Length/gradient (LS-factor) – calculated
- Erosion control practice (P-factor) – default
- Ground cover (C-factor) – default
- Estimated annual soil loss = t/ha/year
- >150t/ha/yr + >2,500m^2 = basin required

Catchment Analysis

- Contributing catchment = effective surface area directed to basin (ha)
- Disturbance area = total area generating sediment within catchment
- Design storm depth (mm) – 1mm = 1L/m^2 (10,000L/ha)
- C_v (Volumetric runoff coefficient) (proportion of rainfall that runs off as stormwater) – typically 0.5 for Australian sites



Soil Analysis - texture

- Clay particles are <0.002mm
- Silt particles are 0.002 – 0.02mm
- Fine sand particles are 0.02 – 0.2mm
- Coarse sand particles are 0.2 – 2.0mm
- Sediment fence typically has pore openings typically ~ 0.035 mm
- Which particles would you expect to be trapped and which to pass through?
- Clay, slit and fine sand will pass through

Soil texture group

- Type C: Coarse
  - Easier to capture or settle out
  - <33% clay and silt
  - Sediment basin not likely required or design relatively simple
- Type F: Fine
  - Harder to capture
  - Require longer time to settle out
  - >33% clay and silt
  - Require “total storm capture” sediment basins
  - Higher emphasis on erosion control

Soil texture group

- Type D: Dispersible
  - Structurally unstable (slaking and dispersion)
  - Primarily affects clay and silt fraction
  - Not all clays are dispersible
  - Use Emerson test to check
  - Highly erodible if exposed
  - Hard setting and low permeability
  - Particles are kept apart by negative electrical charge

IECA White Book

Table B2 – Selection of basin type

Soil and/or catchment conditions [1]	Basin type
Less than 33% of soil finer than 0.02 mm (i.e. $d_{33} > 0.02$ mm) and no more than 10% of soil dispersive. [2]	Type C basin
More than 33% of soil finer than 0.02 mm (i.e. $d_{33} < 0.02$ mm) and no more than 10% of soil dispersive. [2]	Type F basin
More than 10% of soil dispersive [2], or when a Stormwater Management Plan (SMP), or adopted Water Quality Objectives (WQOs) specify strict controls on turbidity levels and/or suspended solids concentrations for discharged waters.	Type D basin

- Dispersion percentage
- Percentage of whole soil dispersible
- Derives Soil Texture Group

Design Rainfall Data Type F/D basins

- IECA White Book – Section 5b and Tables B4 to B6
  - <6 month design life = 5 day, 75th percentile
  - >6 month design life = 5 day, 80th percentile
  - 85th percentile for highly sensitive receiving waters or sub-optimal geometry possible
  - >90th percentile (or higher) at the discretion of the regulator
- Consider better erosion and drainage controls rather than just making basins bigger

Design Rainfall Data
Type F/D basins

Table B5 – Queensland 1 year, 5-day rainfall intensity, and default values for 75%, 80%, 85% & 90% 5-day rainfall depth

Location (North to South)	South	East	Intensity (mm/hr) (1yr, 120hr)	Default 5-Day Rainfall depth "R" (mm)			
				75th%	80th%	85th%	90th%
Brisbane	**27.467**	**153.017**	**1.34**	**27.2**	**33.9**	**43.7**	**59.0**
Bulimba	27.533	153.133	1.54	29.8	37.3	48.3	65.7
Toowoomba	**27.567**	**151.950**	**0.86**	**21.0**	**25.8**	**32.5**	**43.0**
Ipswich	27.617	152.783	0.94	22.1	27.2	34.4	45.6
Beenleigh	**27.717**	**153.200**	**1.56**	**30.1**	**37.7**	**48.8**	**66.4**
Southport	27.967	153.417	1.68	31.6	39.7	51.6	70.4
Beaudesert	**27.983**	**153.000**	**0.96**	**22.3**	**27.5**	**34.9**	**46.3**
Canungra	27.983	153.150	1.68	31.6	39.7	51.6	70.4
Boonah	**28.000**	**152.683**	**0.87**	**21.2**	**26.0**	**32.8**	**43.3**
Nerang River	28.000	153.300	1.70	31.9	40.0	52.0	71.1
St George	**28.050**	**148.583**	**0.61**	**17.8**	**21.6**	**26.7**	**34.6**
Back Creek	28.117	153.183	1.84	33.7	42.4	55.3	75.7
Warwick	**28.217**	**152.033**	**0.69**	**18.8**	**22.9**	**28.6**	**37.3**
Inglewood	28.417	151.083	0.67	18.6	22.6	28.1	36.6
Goondiwindi	**28.550**	**150.300**	**0.64**	**18.2**	**22.1**	**27.4**	**35.6**
Stanthorpe	28.667	151.933	0.75	19.6	23.9	30.0	39.3

Selecting Rainfall Data

- Note the significant increase in 'design rainfall depth' (mm) with change of design criteria (e.g. from 75th to 90th percentile)
- In what circumstances might different storm duration (i.e. 2-day or 20-day) rainfall figures be used?
- What implications does using the 5-day, 75th percentile rainfall depth have for basin maintenance?
- How quickly must flocculation, settlement and emptying occur?

Sediment Basin Calculation

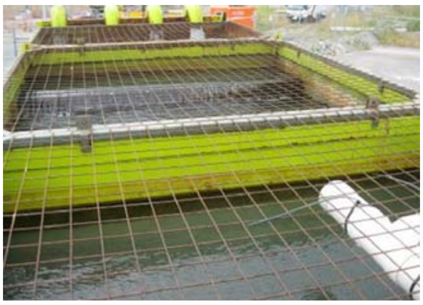
- Settling Zone volume (V_s) =
  (10) x Design rainfall depth (mm) x Runoff coefficient (C_v) x Effective Catchment Area (ha)
  – For Beaudesert = (10) x 22.3mm x 0.5 x 2.5
  = 278.75m^3
- Storage (soil) zone design = 50% settling volume (or >2 months sediment generation from RUSLE)
  – For Beaudesert = 139.4m^3
- Total Basin size = 278.75 + 139.4 = (420m^3)

Sediment Basin Design Criteria

- Basin structure and outlets designed to be stable up to 10-year; time of concentration (TOC) event (depends on catchment area)
- Emergency spillways designed for the 20-year (or greater) TOC events
- Overflow / outlet structures must be sufficiently stable to cope with 'peak' velocities during larger or extended wet rain events

Basin Alternatives - Dewatering Bag

Basin Alternatives - Settling Tanks



Basin Alternatives - Plate Separators

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Basin Alternatives - Floc Socks, Floc Blocks

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Rainfall Activated Flocculant Dosing

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Basin Alternative - Example

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Stormwater Discharge Requirements

Typical discharge water quality requirements:

- Oil and grease: Nil
- pH: 6-5 - 8-5
- Total Suspended Solids (TSS): 50mg/L
- TSS can be monitored by establishing a site specific relationship with turbidity e.g. TSS = 0.7 x Turbidity
- i.e. TSS 50mg/L = 72 NTU (RMS Pacific Highway Upgrade, 2014)

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