0043 SUBSURFACE DRAINAGE (DESIGN)

1. General

1.1. Responsibilities

1.1.1. General

Control moisture fluctuations: Design the subsurface drainage system to control moisture content fluctuations in the pavement and/or subgrade within the limits assumed in the pavement design to maintain pavement strength and service throughout the design life.

Salinity prevention: In areas with salinity problems, design the subsurface drainage system to keep the groundwater table lower in the strata to avoid progressive deterioration of topsoil and upper layers soil condition caused by increased salinity levels from rising and/or fluctuating groundwater tables.

1.2. Cross References

1.2.1. General

Requirement: This is not a self-contained design document, conform to the following worksection(s):

- 0010 Quality Requirements for Design.

1.3. Standards

1.3.1. General

Subsurface drainage systems design: To Austroads AGPT10.

Road drainage design: To Austroads AGRD05A.

1.4. Interpretation

1.4.1. Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- CBR: California Bearing Ratio;
- IFD: Intensity-Frequency-Duration.

1.4.2. Definitions

General: For the purposes of this worksection the following definitions apply:

- Cleanout: A subsurface drainage inlet at the surface of the pavement, shoulder or surrounding ground surface. Also known as flushout riser and inspection point;
- Drainage blankets: A drain comprising a blanket of free-draining material. Typically used where a pavement intercepts a subterranean water source with substantial flows or the nature of the water-bearing strata is such that interception by formation or pavement drain is not possible. It is generally considered to be a structural component of the pavement system;
- Drainage types:
  - Subsoil drains: Drainage below the ground surface which collects subsurface water throughout its length of ground water or seepage from the subgrade and/or the subbase in cuttings and fill areas;
  - Formation drains: Drainage systems designed to intercept water before it reaches the road/pavement structure. They are generally deeper than pavement drains and are usually remote from the pavement structure. Also known as cut-off drains;
  - Pavement drains: Drainage systems designed to remove water from the subgrade and pavement materials.
- Filter layers: Used to prevent the loss of permeability in drainage layers from clogging by fine soil particles infiltrating from the subgrade (underlying soil);
- Formation: The surface of the finished earthworks, excluding cut or fill batters;
- Permeable base: A free-draining bound layer, capable of draining both surface water and preventing water accumulation from the subgrade below. The flow of water through this layer is retarded only by the cross slope and any obstructions.
- Prefabricated geocomposite drain: A proprietary product typically consisting of a plastic core wrapped in geotextile material, functioning as a single or second stage filter. Also termed as geocomposite edge drain and strip filter drain. These drains can be installed in narrower trenches than traditional pipe drain;
- Superelevation: A slope on a curved pavement selected to enhance forces assisting a vehicle to maintain a circular path.

2. Pre-Design Planning

2.1. Planning

2.1.1. Data Collection Generally

Moisture source: Identify possible sources of moisture to the pavement system, and how it can be stopped from reaching the pavement subsurface. Consider sources for investigation, including:

- Seepage, capillary suction or vapour movements from the water table (when in close proximity to subgrade/pavement);
- Seepage from ponded stormwater into embankment/pavement;
- Seepage from an aquifer or other groundwater flow;

- Infiltration from precipitation through pavement surface, including at joints, edges and cracks;
- Seepage from irrigated landscape features;
- Capillary moisture from verges;
- Leakage from water supply and drainage lines.

Quantify net flow by source: Determine net flow as a basis for design by including inflow from all possible sources.

Geotechnical investigations: Carry out geotechnical investigation to determine subgrade soil characteristics (such as permeability and soil water suction properties), permeability of materials around the pavement and ground water effects to inform selection of drainage units.

2.1.2. Scope of Investigation

Scope: Determine scope of investigation required for the development, depending on the pavement construction requirements and the following:

- Site conditions: For example, this may depend on the range of groundwater site conditions required to establish a predicted worst condition to use as a basis for design;
- Road functional classification and location: For example, this may affect the road in-service performance requirements;

Large scale investigation: If large scale investigation is required for the development, allow for two phases of investigation from geotechnical specialists as follows:

- Reconnaissance studies: Carry out in conjunction with pavement route location investigation to provide a basis for planning the second phase investigations;
- Quantitative subsurface investigations: Examine subsurface conditions along the chosen pavement route to obtain information required for detailed design;

2.1.3. Reconnaissance Studies

Requirement: Examine and record site subsurface features including topography, geology, surface water, springs, erosion and vegetation. Features to take note of include the following:

- Physical conditions of nearby roads;
- Vegetation in wet environments, location and class of wetlands;
- Erodibility of the land, particularly if there is evidence of batter erosion, drain siltation and scour in table drains of existing roads;
- Regional geology, including possible groundwater recharge areas, pressures and grade;
- Texture, substructure, hydraulic conductivity, infiltration, and stratification of soils, subsoils and substrata;
- Information available from previous investigations such as aerial photographs, geological and topographical maps and groundwater bore data.

Planning for the second phase investigations: Identify features which show possible moisture problems, such as groundwater or erosion, and require quantitative analysis.

2.1.4. Quantitative Evaluation of Drainage Needs

Requirement: Prepare survey(s) of the site to provide quantitative data for the drainage design by taking measurements of parameters which affect site drainage conditions, including the following:

- Traffic loading: Including volume and weight;
- Net moisture inflow into the subbase layer: Taking the following into consideration;
  - Climatic conditions such as rainfall and temperature at the site (e.g. over a period of 50 years);
  - Surface flow;
  - Groundwater table and conditions: This may include sampling and testing;
  - Roadway geometry: For example, slope, length and aspect;
  - Pavement type and condition: For example, pervious or impervious and age.
- Factors that increase the potential for moisture related pavement damage: Take the following into consideration:
  - Traffic loads;
  - Subgrade type, strength and condition;
  - Pavement material;
  - Design features.
- Roadway geometry to inform drainage system selection and layout;
- Soil type.

2.1.5. Existing Pavement

Drainage survey: Prepare a drainage survey to provide information on the pavement condition. Determine the extent of moisture related damage and critical factors that cause the damage.

2.2. Consultation

2.2.1. Council and Other Authorities

Council consultation: Before starting design, liaise with the Council's officer(s) to identify design requirements for the following:

- Flood prone areas;
- Council's policy for stormwater drainage;
- Roadway layout and traffic management;
- Landscaping.

Other authorities: Consult with and seek approval for the scheme development from relevant state government authorities as required.

2.2.2. Utilities Service Plans

Existing services in the development area/precinct: Liaise with the utility authorities affected by the scheme and if required, obtain service plans from the authorities of the proposed development area for above ground and below ground services.

Utility services location: Contact DIAL BEFORE YOU DIG and Council to identify the locations of underground utility services pipes and cables.

2.2.3. Development Design Team

Integrated development planning: Liaise with members of the development design team preparing the design of the following:

- Works in or close to a watercourse;
- Layouts of lots, roads, cycleways and pedestrian pathways;
- Structural and pavement design;
- Stormwater drainage systems;
- Services installations;
- Geotechnical considerations.

2.2.4. Other Stakeholders

Existing roadway maintenance personnel: Liaise with maintenance personnel for investigative input on existing pavement condition.

3. Design Criteria

3.1. General

3.1.1. Design Objective

Requirement: Design subsurface drainage system for the proposed development road pavements to meet the following objectives:

- To keep the base, subbase, subgrade, and other susceptible pavement materials from becoming saturated or exposed to constant high levels of moisture over time by:
    - Preventing moisture from entering the pavement structure, including infiltration from pavement layers, verges, shoulders, medians and lateral groundwater seepage;
    - Using materials that are insensitive to the effects of moisture;
    - Incorporating design features to minimise moisture damage;
    - Quickly removing moisture that enters the pavement structure.
- To avoid premature pavement failures;
- To avoid surrounding pavement layer with materials of a lower permeability;
- With pavement drains in direct contact with all pavement layers;

- If pavement drain cannot be in direct contact with all pavements layers, design drainage system so that the flow path to subsurface drains passes through materials of increasing permeability;
- To ensure the system capacity is adequate for disposing of the estimated water quantity from surface infiltration and other surfaces;
- Based on source and quantity of water that is likely to enter the pavement structure.

Moisture related problems: Use a combination of control measures in the pavement structure and subsurface drainage system design to effectively control moisture related problems over the design life of the pavement, so that road performance can be maintained.

3.2. Selection of Subsurface Drainage System

3.2.1. System Selection

Requirement: Select and design subsurface drainage system based on the data collected for the development site for the following factors:

- Road geometry;
- Climate data;
- Pavement materials;
- Other factors.

3.2.2. Roadway Geometry

Requirement: Design the subsurface drainage system to suit the geometry and path of water flow in pavements, based on the geometric design features of the pavement and other related subsurface drainage. Roadway design features (which affect the subsurface drainage system) to consider include:

- Longitudinal grades: If grading is less than 0.5%, grade subsurface drains independently;
- Transverse grades (including superelevation);
- Widths of pavement and shoulder surface, base and subbase;
- Required thickness of pavement elements, based on normal structural design practice for the region/area, and hydraulic conductivity;
- Slope and depth of cuts and fills: Allow for cuts that can be properly drained, and fills which are high enough to inhibit capillary rise and accommodate subsurface drainage outlets;
- Details of ditches and other surface drainage facilities;
- Traffic volume and weight expected on the pavement, including cumulative traffic loading expected on the pavement during its design life.

Design of permeable base: Use the true slope and length of the permeable layer.

Pavement design: Liaise with members of the development design team preparing the pavement design so that adequate cross and longitudinal pavement slopes are provided. This is so that infiltration into pavement structure is minimised as moisture can quickly drain from the pavement surface.

- Design features: Consider design features which reduce infiltration by minimising stress/traffic loads on longitudinal edges and cracking in pavements, for example, widened traffic lanes.

Subsurface drainage geometry: From the detailed survey and geological evaluation of the subsurface, establish the nature and limits (especially the subsurface boundaries) of the flow domain.

3.2.3. Climate Data

Hydrological data: Determine precipitation and run-off based on frequency, intensity and duration of precipitation for the development site, using an appropriate rainfall IFD chart for the required ARI and duration.

Temperature fluctuations: Determine daily and seasonal temperature variation for the development area and allow for this in the pavement and drainage system design.

3.2.4. Pavement Materials

Hard surfaced pavements: Design drainage system based on whether the pavement is flexible or rigid.

Rigid pavements: Design subsurface drainage system to minimise this pavement pumping, especially in areas where traffic speed and volume is likely to increase; to allow water entering the subgrade material to drain at a rate equal to, or faster than, inflow rate; and to suit the pavement crack control requirements.

Flexible pavement: Design pavement subsurface drainage system to maintain a water free subbase during the design life of the pavement structure with the following components:

- Permeable base layer (permeability > 300 m/day);
- Dense-graded aggregate separator layer;
- Edge drain collector system with an outlet pipe and headwall; or permeable base that drains directly into the ditch;
- Roadside channels/ditch with adequate depth, or stormwater drain connected to the outlets.

3.2.5. Other Factors

Factors to consider: Design pavement and subsurface drainage system based on the following factors for the development:

- Subgrade type;
- Functional classification: Pavements which carry high volume and heavy traffic have higher potential for moisture related damage;
- Design life: Subsurface drainage systems affect pavement performance and service life;
- Topography: This affects the longitudinal grade and cross slope of the roadway, and hence the removal of excess water;
- Life cycle cost: Cost of subsurface drainage system may be offset by increased service life and maintenance cost of pavement;
- Location: For example, urban or rural;
- Initial cost;
- Soil properties: Consider pavement subgrade strength, deformation, gradation, and permeability properties;
- Maintainability of the system and expected performance.

3.3. Types of Drainage Systems and System Properties

3.3.1. System Types

Systems based on function: Select from the following drainage system types based on pavement moisture control requirements for the development:

- Groundwater control systems or formation drains: Drainage systems designed to remove and/or control the flow of groundwater. These systems are designed to intercept moisture before it reaches the pavement structure;
- Infiltration control systems or pavement drains: Drainage systems designed to remove water that seeps into the pavement structure (subgrade and pavement material).

Systems based on location and geometry: Select from the following drainage system types based on drain location, component and geometry requirements:

- Longitudinal edge drains: Located parallel to the roadway centreline, for both horizontal and vertical alignments. Collects water that infiltrates the pavement surface and drains water away from pavement outlets;
- Transverse and horizontal drains: Drains that run laterally beneath the roadway, generally at 90° to the roadway centreline but can be skewed;
- Permeable base: An open graded drainage layer with minimum permeability of 300 m/day;
- Drainage blankets: A permeable layer used to control both groundwater and infiltration. For example, it can be used to effectively control the flow of groundwater from cut slopes and beneath fills on the side of hills;

- Well systems: Systems of vertical wells used to control groundwater flow and relieve pore water pressures from slope areas;
- Earthworks options: Widen cutting embankments to remove the topsoil. Cut deeper table drains with grader. Consider impediments such as environmental concerns with vegetation clearing and locations of road fence boundaries requiring widening of the road.

3.3.2. System Performance

Requirement: Design pavement drainage system to meet the following performance criteria required for the development, derived from the data collection process:

- Required time-to-drain: For the permeable layer;
- Pipe size and outlet spacing requirements;
- The gradation for a graded aggregate separation layer or the opening size, permeability, endurance, and strength requirements for geotextile separators;
- The opening size, permeability, endurance, and strength requirements for geotextile filters, or the gradation of the granular filters (to be used in the edge drain).

3.3.3. System Components

Elements: Allow for a subsurface drainage system consisting of the following:

- A permeable drainage layer, e.g. a permeable base/subbase or drainage blanket layer;
- A filter or separator layer between subgrade and permeable base/subbase;
- A collector system comprising of a longitudinal edge drain and, if required, interceptor drains;
- Outlet or discharge pipe (to carry water from pavement to the stormwater drain or surface ditch);
- Headwall and outlet marker to protect outlet pipes from damage.

3.3.4. Longitudinal Edge Drains

Network performance: Allow for drainage system with the hydraulic capacity required to handle water discharged from the permeable base. So that there are no weak links in the drainage system, allow for an increase in capacity for each element as the water moves towards the outlet.

Pipe edge drains: Allow for drainage system that collects water which infiltrates the pavement surface and drains it away from the pavement through outlets. Select from the following types of system:

- Pipe drains in an aggregate filled trench;
- Pipe drains with porous concrete filled trench;
- Prefabricated geocomposite drains in a sand backfilled trench;
- Aggregate trench drain.

3.3.5. Salinity Mitigation

Outlets: Where possible, allow for discharge on the downhill side of the embankment or in the cut-fill area to reduce the risk of recharge to the subsurface water table.

Developments in salinity affected areas: Consider allowing for a separate drainage system for subsurface drains to discharge to a basin, where controlled release or desiccation treatment and removal can be facilitated as a maintenance operation.

Saline subsurface drainage: Do not allow drain to discharge directly into natural watercourses.

Water quality targets: Allow for targets matching those of downstream watercourses. Provide advice on discharge operations and maintenance which is compatible with water quality targets and the requirements of the state land and water resource authority.

3.4. Location, Layout and Grade of Drains

3.4.1. General

Drainage layout: Design drainage systems to suit the three-dimensional geometric road layout. Identify conditions where water could be trapped by unusual geometrics, or where water may meander for long distances before reaching an outlet, including locations such as reverse superelevated curves, long sustained grades and sag vertical curves.

Subsurface drainage provision: Allow for subsoil drainage for the development in the following locations:

- Cut formations with depths to finished subgrade level 400 mm or more below the natural surface level;
- In locations of known hillside seepage, high water table, isolated springs or salt affected areas;
- Irrigated, flood prone or poorly drained areas;
- Areas with subgrades which are highly susceptible to moisture, including those with high plasticity or low soaked CBRs;
- Areas with pavement materials which are susceptible to moisture;
- Existing pavement areas where subgrade conditions show deterioration from excess subsurface moisture;
- At cut-to-fill transition areas.

3.4.2. Longitudinal Edge Drains

Pavement edge: Allow for drains along the following locations:

- In road sag points;
- On both sides of the pavement near any cut-to-fill line;

- On both sides of kerbed pavements;
- On both sides of the pavement where the crossfall is flatter than 0.02 m/m in superelevation developments;
- The high side of pavement where there is seepage, or where water may enter from batters, full-width pavement, service trenches or abutting properties;
- Joints between an existing pavement and pavement widening where depths or permeability may create moisture traps;
- On both sides of pavements for major arterial roads.

Medians: Allow for drains along the following locations:

- The low side of a dished median if the median drain invert level is less than 0.2 m below subgrade level of the adjacent pavement;
- The low side of a kerbed median if the cross slope is 0.10 m/m or more;
- Sides of a median more than 2 m wide;
- Sides of a median with a fixed watering system;
- Centre of flat grassed medians without fixed watering systems and less than 6 m wide.

3.4.3. Transverse Drains

Locations: Consider locating drains in the following locations:

- Approximately 5 m upstream of cut-to-fill lines;
- Along changes of pavement depth or permeability;
- At both ends of bridge approach slabs:
  - Immediately behind the bridge abutment, to the full depth of the abutment;
  - In the subgrade at the interface of the road pavement and the approach slab.
- At superelevation changes, to limit the length of the longest drainage path within the pavement to approximately 50 m.

3.4.4. Trenches

Minimum trench width: 300 mm.

Minimum depth below finished subgrade level:

- In earth: 600 mm;
- In rock: 450 mm.

Level: Locate below the invert level of service crossings.

3.4.5. Outlet Pipes

Location: Locate pipe so that there is no interference (from topographical or geometric road layout features) with free gravity flow from the system. If there is interference from natural or man-made features, use longer spacing between outlets, sumps and pumping outlets.

Outlets: Join into gully pits or outlet headwalls.

Ditches: Locate pipes high enough on slopes of ditches so that there is free gravity flow.

Spacing: Allow for pipes at intervals suitable for conveying water received to a suitable and safe exit point.

Subsurface drain outlet through fill batters: Allow for unslotted plastic pipe of the same diameter as the main run.

3.4.6. Formation Drains

Location: Consider providing in the following locations:

- Along both sides of cuts where the road is below the water table or where seepage is expected in wet weather;
- Transversely at any expected seepage areas, and further downgrade if required. The transverse drains may be laid in a herringbone pattern to achieve the minimum grade.

Trench dimensions:

- Minimum width: 300 mm;
- Minimum depth: To suit the application and ground conditions of the development site.

Minimum outlet diameter: 150 mm.

Minimum grades: Allow as follows:

- Generally: 1.0%;
- Non-corrugated pipes: 0.5%.

3.4.7. Drainage Blankets

Location: Allow for blankets underneath or as an integral part of the pavement structure where required to remove infiltrated water or groundwater from gravity and artesian sources.

3.4.8. Access to Subsurface Drains

Urban areas: Allow for drainage pits at the start and end of subsurface drains.

Rural areas: Consider allowing for flushout riser inlets as intermediate access and outlets.

Inlet and outlet pits: Locate as follows:

- Clear of traffic lanes;
- Inlets in shoulders: Allow for a trafficable steel cover;

- Inlets: Do not locate where stormwater can enter the subsurface drainage system;
- Outlets: In easily accessible areas, visible from the road, and where road maintenance activities (e.g. grass cutting, cleaning of table drains) will not be hindered;
- Pit spacing: Maximum 150 m apart.

Minimum pit width: Allow as follows:

- Pit depth less than 1.5 m: 0.6 m;
- Pit depth more than 1.5 m: 1.05 m.

Cleanouts or flushout risers: Allow as follows:

- Location: At the start of each subsoil drain line run and directly at the rear of kerb or at the edge of shoulder;
- Spacing: Maximum 120 m intervals.

3.5. Materials and Size of Drains

3.5.1. General

Material selection: Allow for drainage materials compatible with the local conditions so that pipes and other components will not corrode, rust, disintegrate or be attacked by the chemical content of the soil, water or foreign matter.

3.5.2. Permeable Base

Material performance: Allow for permeable base/subbase which intercepts and removes water that infiltrates the pavement structure quickly, preventing it from entering the lower pavement structure and causing weakness there. Design permeable base with the following properties:

- Sufficient permeability for the layer to drain within the design time period;
- Sufficient air void space to prevent pumping, and erosion of fines when the pavement is under heavy axle loads to prevent general pavement weakening;
- Stable enough to support the pavement during construction without causing premature distress of the surface layer;
- Provides stability and the required support for the pavement over its design life;
- Provides a dry base to minimise moisture related distresses in the layers above it, such as bitumen stripping in pavements;
- Include drainage for water to flow away from the pavement structure, e.g. through longitudinal edge drains with outlet pipes.

Aggregates: Durable crushed, angular aggregate with few or no fines and good mechanical interlock.

Thickness: 100 mm or sufficient to overcome any construction variances and provide an adequate hydraulic conduit, to transmit the water to the edge drain.

Design criteria: Design permeable base based on the following:

- Estimated traffic load, especially where heavy vehicle volume is anticipated;
- Subgrade soil type;
- Pavement type;
- Pavement functional classification.

3.5.3. Drainage Blankets

Properties: Consisting of specially graded aggregate layers to prevent clogging and erosion with the following features:

- A drainage outlet for the water collected to drain water away from the pavement structure;
- May have one or more protective filter layers.

Aggregates: With high coefficient of permeability to remove water that infiltrates the pavement structure and to meet the outflow capability required.

3.5.4. Drainage Pipes – Properties

Dimensions of longitudinal collector pipes: Dependent on outlet spacing.

Pipe drain features: Design pipes with the following features:

- Relatively high flow capacity;
- Easy to maintain;
- Supported at edges of pavement so that they are not damaged when drain is installed;
- So that the material adjacent to the drain is sufficiently permeable to allow free water to reach the longitudinal drain;
- Protected at exit points from hazards such as debris deposit, birds and other animals, e.g. through a combination of screens;
- Designed to be displaced outwards.

3.5.5. Drainage Pipes –Material, Size and Application

Perforated pipes: To AS 2439.1.

Corrugated polyethylene:

- Size: Minimum 90 mm;
- Class: Class 1000 subject to traffic, construction and maintenance vehicles.

Smooth PVC-U: Allow where longitudinal gradients are flatter than 0.5%.

- Size: 100 to 300 mm diameter.

Concrete: Allow where groundwater flows require diameters that are not available in plastic pipes.

- Size: 300 to 750 mm.

Smooth plastic slotted and unslotted pipes: Allow where subgrade gradients are flatter than 0.5%.

- Unslotted pipes: Allow for conveying flows beneath pavement to outlet or as collector pipe.

Perforated corrugated steel: May be allowed for formation drains where soil and water are not highly corrosive.

Cleanouts and outlets: 100 mm diameter unslotted pipe.

Pipe class: Select pipe class based on expected live loading at the surface.

PVC-U pressure pipe and fittings: To AS/NZS 1477.

- Intra-pavement drains: Allow for slotted PVC-U pipes with wall thicknesses to AS/NZS 1477 for the crush rock subbase loading.

Prefabricated geocomposite drains and fittings:

- Type: Rigid or flexible;
- Rigid geocomposite drain: To ASTM D7001;
- Load bearing: Select the appropriate drain based on its load bearing characteristics.

3.5.6. Filter Material

Separator or filter materials: Allow for granular materials/aggregate or geotextile fabric to supplement the subsurface type selected, using one of the following combinations:

- Granular single stage filter;
- Wrap geotextile under pipe and along sides of the trench before backfill of aggregate. Wrap material around aggregate and pipe;
- Geotextile first stage filter with coarse granular second stage filter;
- Fine granular first stage filter with geotextile second stage filter;
- Fine granular first stage filter with coarse granular second stage filter.

Material performance: Select filter material with the following properties:

- More permeable than the surrounding material but fine enough to support the material and prevent penetration by the surrounding soils;
- Stable under flow so that it does not segregate during placement and piping or wash into perforations, inlets or joints in drainage pipes;

- Permeable enough to carry anticipated flow, so that the base course can drain within the designed period;
- Strong enough to provide a work platform during construction of permeable base;
- Able to protect permeable base from contamination by fines from underlying layers.

Areas with soils known to be stable: Determine if under adverse conditions, jointed or fissured materials are stable enough to dispense with filter material.

3.5.7. Geotextile

Application: Allow where subgrades have a high percentage of fines.

Material performance: Allow for geotextile fabric with enough strength to survive the construction phase and pore openings sized to retain the larger soil particles, from one of the following categories (of manufacture):

- Woven;
- Non-woven;
- Composite;
- Knitted.

Filtering capability: Select fabric with pore openings sized to retain larger soil particles to facilitate soil bridging action, whilst at the same time allow smaller soil particles to pass through the geotextile without clogging the fabric. Consider fabrics with permeability several times greater than that of the subgrade.

Compatibility with pipes and soils: Select fabric based on the following criteria:

- Equivalent opening size (EOS);
- Retention (piping) based on soil grain size;
- Permeability;
- Clogging, including by salt and soil;
- Survivability;
- Durability, including tensile strength, and exposure to alkali or acidic soils and spilt fuels.

3.5.8. Backfill

Material selection: Select filter material for trench backfill (for subsoil, formation and pavement drains) based on the permeability of the pavement layers and/or subgrade and the expected moisture flow rate.

3.6. Maintenance Requirements

3.6.1. Inlets

Location: Allow for access to the upstream end of the pipeline.

Openings in stormwater pits: Locate high enough so that surface run-off does not enter pavement drainage pipe.

Separate openings: If required, locate so that they do not interfere with other maintenance operations. Do not locate where surface run-off can enter.

3.6.2. Outlets

Inspection: Consider allowing subsurface drainage to flow into permanent stormwater pits or concrete culvert end walls, at a level above the normal stormwater flow, to minimise inspection requirements. This allows both systems to be inspected at the same time.

Area around the outlet: Allow for paving to prevent scouring and grass growth, and to facilitate outlet visibility.

Outlet pipe: Allow for pipes with sufficient strength to bear maintenance plant.

3.6.3. Access Points

Maintenance access points: Locate at the start of a pavement drainpipe run and at intervals of 100 m to 140 m.

Access type: Allow for pits, risers or outlets.

Connection of the drainage system to the stormwater system: Allow for the following:

- Entry points not less than 100 mm above the invert level of the stormwater pipe, to prevent pavement drainpipe from silting up with stormwater debris and prolonged flooding of the pavement drainage system;
- Risers: Constructed by bending flexible plastic pipe or by using the curved length of pipe or T-fittings;
- Rigid pipes: If required, use curved lengths of pipe or special T-fittings;
- Pits rather than risers: For easy access;
- Pit and riser location: Locate in unsealed shoulders, drain inverts or on batter faces.

3.6.4. Markers

Requirement: Allow for markers for future outlet identification by maintenance personnel. Allow for markers immediately adjacent to the outlet to Austroads AGPT10 Section 6.4.

4. Documentation

4.1. Statutory Documentation Requirements

4.1.1. Approvals

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- Council for:
    - Drainage layout and design details;
    - Access points for maintenance;
    - Subsurface drainage design in relation to the stormwater drainage and roadway layout design/system.
- The EPA for salinity mitigation measures;
- Utility authorities for any public or private utility affected by the development.

4.2. Drawings

4.2.1. Drawing Content

Requirement: Provide the following drawings, describing the subsurface drainage design for the development:

- Drainage layout plans: Showing the proposed location of all subsurface drains with the following details:
    - All drain types clearly defined, including formation drains;
    - Flow paths, pipe length;
    - In relation to the geometric road layout;
    - Pipe/drain sizes and inverts;
    - Pits, pit sizes, outlets and access points;
    - Connections to stormwater drainage system, if any.
- Cross sections (transverse and longitudinal) of drains in relation to the pavement structure with the following details:
    - The nominal depth and width of the trench;
    - The location of the kerb/gutter or edge of pavement;
    - Pipe type, diameter and class;
    - Pipe gradient;
    - Velocity, actual discharge and pipe capacity;
    - Extent of backfill;
    - Invert levels and finished surface level;
    - Formation drain details.
- Large scale design details of drains, e.g. edge drains, pipes, trenches and cleanouts.
- Supporting design documents.

4.2.2. Design Reports

Requirement: Provide a design report incorporating the design criteria/assumptions, drainage needs analysis, calculations, computer studies, and references supporting the design and maintenance.

Maintenance program: Include in the report a recommended maintenance program covering the following procedures:

- Routine inspections and monitoring;
- Routine preventive maintenance;
- Spot detection of problems;
- Repair;
- Continued monitoring and feedback.

4.2.3. Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction worksection templates from the National Classification System workgroups 02, 03, 11 and 13.

4.2.4. Design Certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, verifying that the designed drainage system for the development site meets the Council and statutory requirements.

Use Council's standard certificate (if available) or the template provided in 0010 Quality Requirements for Design.

4.3. Work as Executed

4.3.1. Work as Executed Documents

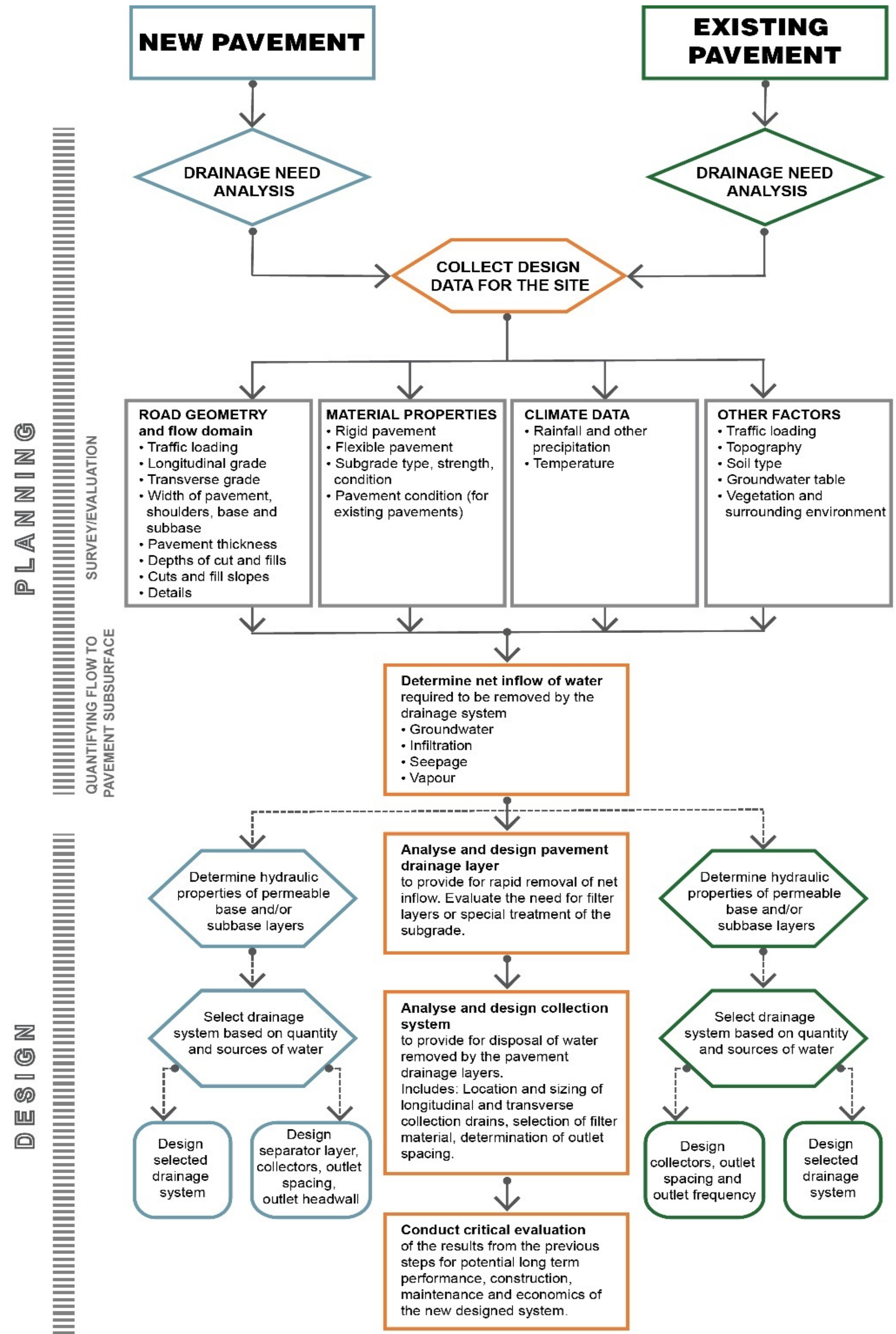
Work as Executed drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor.

Work-as-executed drawing format: pdf

Digital drawing/data format: AutoCAD .dwg

5. Subsurface Drainage Design System

5.1. Guide Outline of the Design Procedures for Subsurface Drainage Systems for Pavements



6. Annexure

6.1. Annexure – Referenced Documents

The following documents are incorporated into this worksection by reference:

AS/NZS 1477	2017	PVC pipes and fittings for pressure applications
AS 2439		Perforated plastics drainage and effluent pipe and fittings
AS 2439.1	2007	Perforated drainage pipe and associated fittings
Austroads AGPT		Guide to Pavement Technology
Austroads AGPT10	2009	Subsurface Drainage
Austroads AGRD		Guide to Road Design
Austroads AGRD05A	2021	Drainage – Road Surface, Networks, Basins and Subsurface
ASTM D7001	2020	Standard Specification for Geocomposites for Pavement Edge Drains and Other High-Flow Applications