# Install drainage systems

AHCDRG301

# Overview

By the end of this topic, you should be able to:

- Prepare for drainage system installation activities
- Coordinate installation work
- Prepare the site for installation of drainage system
- Undertake installation of drainage system
- Complete installation of drainage system

# Why install drainage systems?

- Drainage is the removal of excess water by surface or sub-surface systems
  - Excess water can result in:
    - Exclusion of air from the root zone, causing -
      - Less microbial activity
      - Restricted nutrient availability
    - Erosion due to fast moving water along slopes
    - Increased soil compaction and destroyed soil structure
    - Crop damage, loss of grasses, shrubs and trees due to ponding in flat areas
    - Damage to buildings and retaining walls, due to the rise of the water table

What is soil water?

Activity: Research rising water tables

# Why install drainage systems?

- Recognising drainage problems:
  - Visual pooling of water
  - Lack of vegetation
  - Yellow leaves on plants, caused by a lack of nitrogen and oxygen
    - This is known as the ‘permanent wilting point’
  - Smelly soil
    - This anaerobic state is caused due to the exclusion of soil air
  - Bogged areas

# Types of drainage systems

- There are two main types of drainage systems:
  - Surface drains, such as:
    - Spoon / dish drains
    - Swale systems
    - Contour drains
    - Diversion drains
  - Sub-surface drains, such as:
    - Culverts
    - Pit and silt trap systems
    - Sand slit
    - Rubble drains
    - Mole drains
    - Tile

# Types of drainage systems: Surface drainage

- There are a variety of different drainage systems that may be installed:

| Type | Description | Image |
|---|---|---|
| Spoon / dish drain | Machinery is used to shape the land to channel excess water (e.g. into sub-surface drain or stormwater drain).<br><br>These are used in smaller landscape areas. |  |
| Swale systems | Swales are linear depressions that are constructed to direct water towards a collection point or area |  |



Images: http://horticulture.tekura.school.nz/soils/soils-3/ht1033-soils-3-study-plan/drainage
https://s-media-cache-ak0.pinimg.com/originals/91/75/4b/91754b6bb5eb949cdfaab803aa975de6.jpg

# Types of drainage systems: Surface drainage

- There are a variety of different drainage systems that may be installed:

| Type | Description | Image |
|---|---|---|
| Contour drains | A water carrying or water holding channel or ridge constructed of earth, located on or near a contour line.<br><br>They are used to slow down the flow of water across a slope. |  |
| Diversion drains | An individually designed drain which intercepts a surface run-off and direct it to a known watercourse.<br><br>An example includes diverting stormwater. |  |



Images: http://i1.trekearth.com/photos/12113/jatiluwih_rice_terraces.jpg
http://www.pacificbasementwaterproofing.com/portals/2/Images/Drainage-MainImage.png

# Types of drainage systems: Subsurface drainage

- There are a variety of different drainage systems that may be installed:

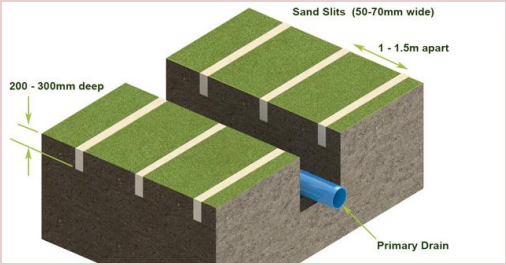
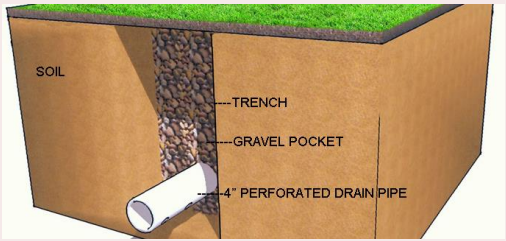
| Type | Description | Image |
|---|---|---|
| Culverts | A structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other side |  |
| Pit and silt trap systems | A water collection ‘pit’ or storage container<br><br>It is not designed to hold all the runoff, but needs to be large enough to contain the water pouring into it long enough to allow it to drain through the drainage pipes at a rate that keeps up with the flow of water. |  |



Images: https://s-media-cache-ak0.pinimg.com/736x/83/25/d0/8325d066843be5ebbc6faa621af40c97.jpg
http://cmd-ks.biz/wp-content/uploads/backyarddrainagepit_0380390001452467782.jpg

# Types of drainage systems: Subsurface drainage

- There are a variety of different drainage systems that may be installed:

| Type | Description | Image |
|---|---|---|
| Sand slit (used with sports playing fields) | Sand slits enable surface water to drain into the primary drainage system faster.<br><br>Sand slits are narrow trenches at 1-2m spacings crossing the primary drainage system. The sand slits are backfilled with ~50mm of granular backfill and topped up with a free-draining sand. |  |
| Rubble drain | A trench is dug, perforated pipe is laid and it is backfilled with coarse drainage gravel. |  |



Images: http://niallforanpitches.ie/wp-content/uploads/2016/03/secondary-srainage.jpg
http://www.schneiderconstructioninc.com/drainage/photos-drainage/detail-FrenchDrain-02_700.jpg

# Types of drainage systems: Subsurface drainage

- There are a variety of different drainage systems that may be installed:

| Type | Description | Image |
|---|---|---|
| Mole drains | Unlined circular soil channels formed in clay subsoil which function like pipe drains |  |
| Tile | Unglazed pipes laid end-to-end, prepacked carefully with soil or gravel.<br><br>Joints may be protected with hessian to prevent silt entry. |  |



Images: http://horticulture.tekura.school.nz/soils/soils-3/ht1033-soils-3-study-plan/drainage/
http://skylinemillarsltd.com/wp-content/uploads/2015/09/RCC-Small-Pipes.jpg

# Types of drainage systems

- To determine the most suitable drainage type to install, consider the following factors:
  - Topography
    - For example: A dish drain would not be effective on a slope, as it would not slow the water flow to reduce erosion. A contour drain would be more effective for a slope.
  - Amount of water to be channelled
  - What the water is being directed away from (e.g. buildings)
  - Land use

# Types of drainage systems

- Questions for determining which drainage system to install:
  - Is the soil suitable for subsurface pipe drainage?
    - Suitable soils for subsurface pipe drainage will be very permeable, free draining, down to depths greater than 1m
    - There will be sufficient depth and gradient (fall) to allow a suitable slope for the slotted drain pipe
  - Is the soil suitable for mole drains?
    - Suitable soils for mole drainage will have a suitable proportion of clay content down to moling depth (400 to 600 mm) and minimal rock or sand at mole draining depth
    - When the mole channel is "wetted up" during drainage it will not slake (collapse), and will not be dispersive and prone to tunnel erosion

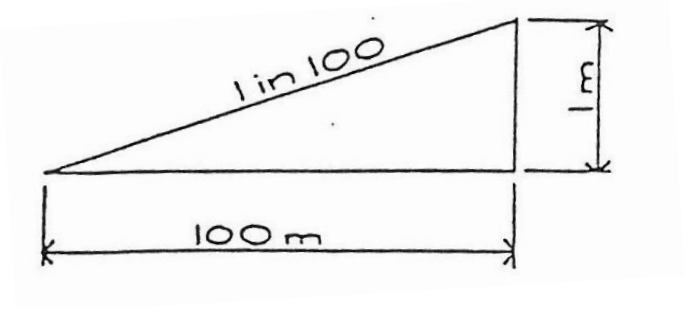

Source: http://agriculture.vic.gov.au/agriculture/dairy/managing-wet-soils/which-subsurface-drainage-system-to-use

- Questions for determining which drainage system to install:
  - Is the soil suitable for mole draining over a collector pipe system?
    - Soils suited to mole draining over a collector pipe system will have a suitable clay content and type partially suited to mole draining down to moling depth but will not sustain long mole drains (greater than 80 m) for a particular reason (e.g. presence of sand or small rock to varying degrees at or near moling depth)
  - Is the soil suitable for gravel mole drains?
    - These soils typically are not suited to mole drainage – they may slake after wetting up or may contain sandy or rocky layers or areas


Source: http://agriculture.vic.gov.au/agriculture/dairy/managing-wet-soils/which-subsurface-drainage-system-to-use

- Knowing the likely location and level of the outfall for the proposed drainage system is also essential
  - If there is no suitable outfall, then no drainage is possible unless very expensive sumps and pumps are used
  - The gradient of the land can also influence the drainage type and its design
    - The grade or fall of the system affects the flow of water
    - The minimum flow of water is 1 in 100 (rate of slope)

The grade of a slope is the rise or fall divided by the horizontal distance, expressed as a percentage

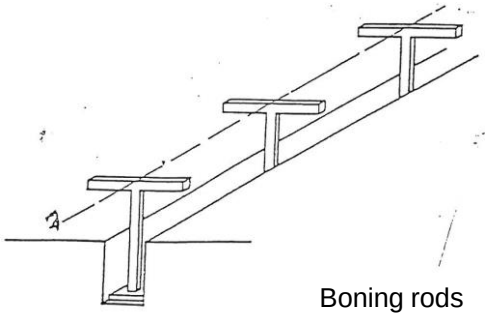


- When familiarising yourself with the task, refer to drainage system plans, taking note of the following:

| Feature | Description |
|---|---|
| Title block | Identifies:<br>• Project name and type<br>• Project location<br>• Number, date and revision version of the plans |
| Scale | Identifies the size of the plans in relation to the actual site.<br>• For example a scale of 1:100 means that 1cm on the plans reflects 100cm (or 1m) on site |
| North point | An arrow which indicates the direction of north in relation to the site |
| Legend | A key which identifies the meaning of certain symbols and/or shadings on the plans |

# Preparing for installation

- When familiarising yourself with the task, identify and check machinery, tools/equipment and materials:
  - Machinery may include: Trencher or Ditch-Witch
  - Tools/equipment may include: Crow bar; Formwork; Hammer; Hand saw; Knife; Levelling equipment (e.g. spirit level, string line level, water level, surveyor's level and staff; boning rods); Shovel; Trowel; Tape measure
  - Materials may include: Backfill (e.g. gravel/aggregate, loam, sand); Concrete/Cement; Glue; Fasteners; PVC pipe; Polypipe; Sock / Silt blanket;



Boning rods

# Preparing for installation

- Any faulty items should be reported to your supervisor
  - Follow the ‘Stop, Tag, Report, Record’ (STRR) approach:
    - Stop using the equipment
    - Tag the faulty equipment
    - Report the faulty equipment to your supervisor
    - Record the details of the fault

# Coordinating installation work

- When familiarising yourself with the task:
  - Identify any hazards and assess risks, such as:
    - Contact with underground services (e.g. telephone lines, gas, electrical, water, cable, sewerage)
      - Contact Dial Before You Dig to check the location of such services
    - Manual handling injuries
    - Environmental impact of proposed construction works (e.g. erosion, runoff into stormwater drains)
  - Implement controls to address hazards
    - This may be as simple as reporting hazards to your supervisor
    - You should also ensure you protect yourself using suitable PPE (e.g. boots, hi-vis protective clothing, gloves, goggles, hat, hearing protection, sunscreen)

- Risk is measured in terms of the seriousness of the possible **consequences** of the hazard and the **likelihood** that those consequences will occur, as in the matrix shown below:

| Extreme | High | Medium | Low |
|---|---|---|---|

**Consequences**
**A:** Death or Permanent Disability
**B:** Serious Injury
**C:** Lost Time Injury
**D:** Casualty Treatment
**E:** First Aid

**Likelihood**

**1:** Very Likely
**2:** Likely
**3:** Possible
**4:** Unlikely
**5:** Very Unlikely

| Matrix | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | E | E | H | H | M |
| 2 | E | H | H | M | M |
| 3 | H | H | M | M | L |
| 4 | H | M | M | L | L |
| 5 | M | M | L | L | L |

# Preparing the site

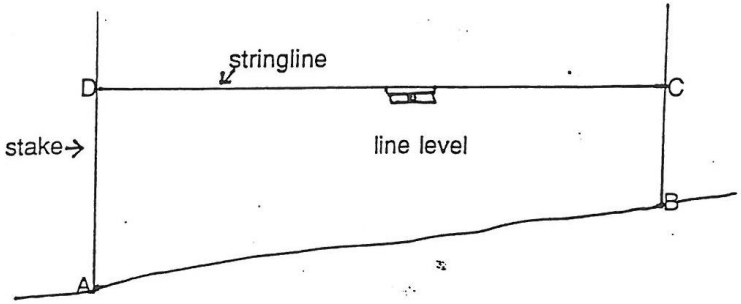
- Before commencing any work, you must orient yourself with the site:
  - Check the accuracy of the scale on the plans with what you see
    - Be sure to check measurements and depths, reporting any discrepancies to your supervisor
  - Locate where the services are (i.e. above and below ground)
  - Find the north point
  - Find the property boundaries
  - Identify major site features, which can be used as points for marking out the site, such as:
    - Buildings
    - Driveways
    - Fences
    - Paths
    - Trees and shrubs

# Preparing the site

- Mark out the shape of the proposed construction works on site
  - Use chalk on hard paved surfaces
  - Use stringlines and pegs over soil or turf
  - A long garden hose may also be useful for marking out shapes on both hard and soft surfaces

- Grades and slopes can be established in the field

1. Measure distance AD, DC and BC
2. Calculate vertical lift (i.e. AD – BC)
3. Calculate horizontal distance (i.e. DC)
4. Calculate gradient
   (i.e. [Lift ÷ Distance] x 100 = % grade)



# Preparing the site

- To determine the best type of drainage system to be installed, it is important to confirm the soil characteristics to ensure they are relevant to the system to be installed

- It is important to confirm:
  - Soil type, structure, profile
    - It is important to the know the clay content of the soil due to its poor drainage abilities
    - Testing involves taking soil cores so you have an understanding of what the soil types are below the surface

- It is important to confirm:
  - Soil permeability (ability to allow water to pass through), through
    - Digging holes
    - Collecting soil for slaking/dispersion testing
      - Slaking is the breakdown of the soil aggregates into much smaller aggregates when wet and indicates low organic matter in the soil
      - Dispersion is an indicator of sodic soils and occurs when excessive sodium (sometimes magnesium) is present. Measuring the rate of water inflow into the hole
    - To measure the soil water movement (hydraulic conductivity), calculate the following:

      *Water flow rate = Rise in water level (mm)… x 360 x time taken (sec)… =…….mm/hr*

# Preparing the site

- The table shown provides a guide of the rate of water movement through the soil through a saturated profile for a range of soil classes
- The water flow rate (mm per hr) can be used to decide which drainage type may be most suitable
  - As a rough ‘rule of thumb’, class 1 – 4 soils, being less permeable, may be suited to mole drainage (depending on clay mineral content, sand/stone presence, etc.) or moles over a collector pipe system
  - Classes 5 – 7 soils, being more permeable, may be most suited to subsurface pipe drainage

| Class | Water flow rate (mm/hour) | Approx. soil textural class |
|---|---|---|
| Class 1 Very slow | Less than 1 | Clay |
| Class 2 Slow | 1 - 5 | Clay loam |
| Class 3 Mod. slow | 5 - 20 | Silty clay loam |
| Class 4 Moderate | 20 - 60 | Silt loam |
| Class 5 Mod. rapid | 60 -125 | Loam |
| Class 6 Rapid | 125 – 250 | Sandy loam |
| Class 7 Very rapid | More than 250 | Sand |



Source: http://agriculture.vic.gov.au/agriculture/dairy/managing-wet-soils/which-subsurface-drainage-system-to-use

# Installing drainage system

- When completing excavations
  - Refer to plans to check depths and grades, following set out and markings
  - Avoid damage to:
    - Services
    - Facilities
    - Features
    - Established plants

# Installing drainage system

- When installing surface drainage
  - Complete excavations, creating contours, batters or benches
  - Confirm levels and fall angles for water to drain naturally

Activity: Research the advantages and disadvantages of differing drainage materials (i.e. concrete, plastic, grass)

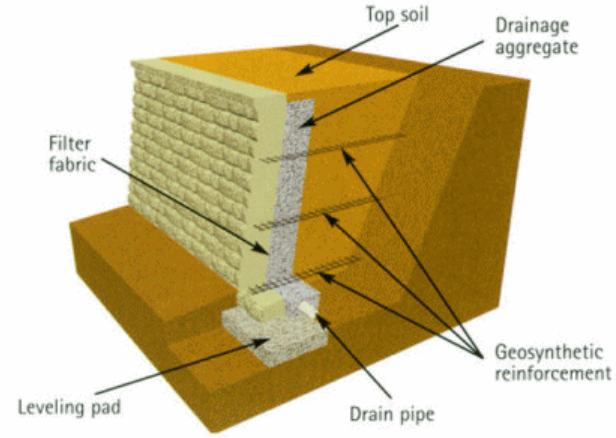
# Installing drainage system

- To install subsurface drainage
  - Complete excavations, creating contours, batters or benches
  - Identify the location of pits, trenches and sumps
  - Confirm levels and fall angles for water to drain naturally
  - Form drain lines (e.g. secondary lines, if required)
  - Form out the area to be worked in
  - Lay pipes, box drains or culverts
  - Fit out/connect drainage system components
  - Install packing
  - Prepare for backfilling (e.g. gravel or large aggregate >20mm)

- The methods for installing each drainage system type will differ, depending on the type of drain

Activity: Research methods for installing one (1) surface drain and one (1) sub-surface drain

Example shown to the right



# Installing drainage system

- It is important to test the drainage system
  - Test to ensure the system:
    - Meets the configuration requirements set out in the plans and specifications
    - Capacity and flow rate will meet the requirements of water intake
  - Testing can save time and money in the long run
    - If non-compliance is discovered after further construction has taken place, the system may need to be uncovered and re-laid to specification

- The drainage system should be tested after some initial backfilling
  - If the system is compliant, then remaining backfilling can be completed

# Completing installation

- As part of drainage installation tasks, you are required to complete the following practices:
  - Finish earthworks to restore the site
    - Choose machinery based on the material being imported, the type of pipe that has been installed, weight of the machine
  - Clean up the work area
    - Return any unused backfill materials to the storage area
  - Maintain, clean and store tools, equipment and machinery
    - Report faults that are discovered in logbook and/or site records
  - Dispose of materials that cannot be reused or recycled
    - Ensure that you follow the enterprise guidelines for handling and disposing of waste
  - Record and/or report your work outcomes to your supervisor
    - Identify any adjustments that were made