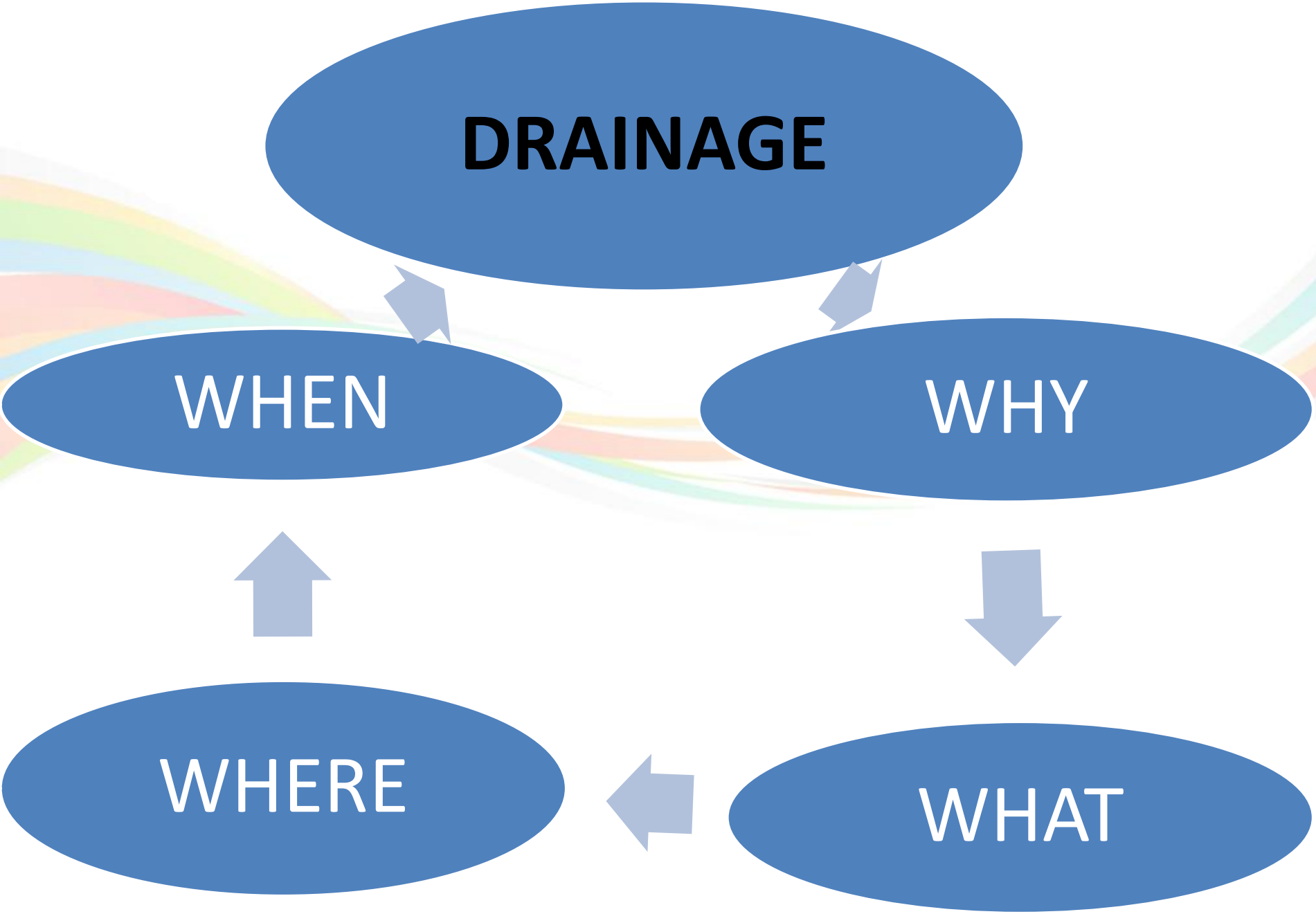
Sports Field Drainage

What are your options??

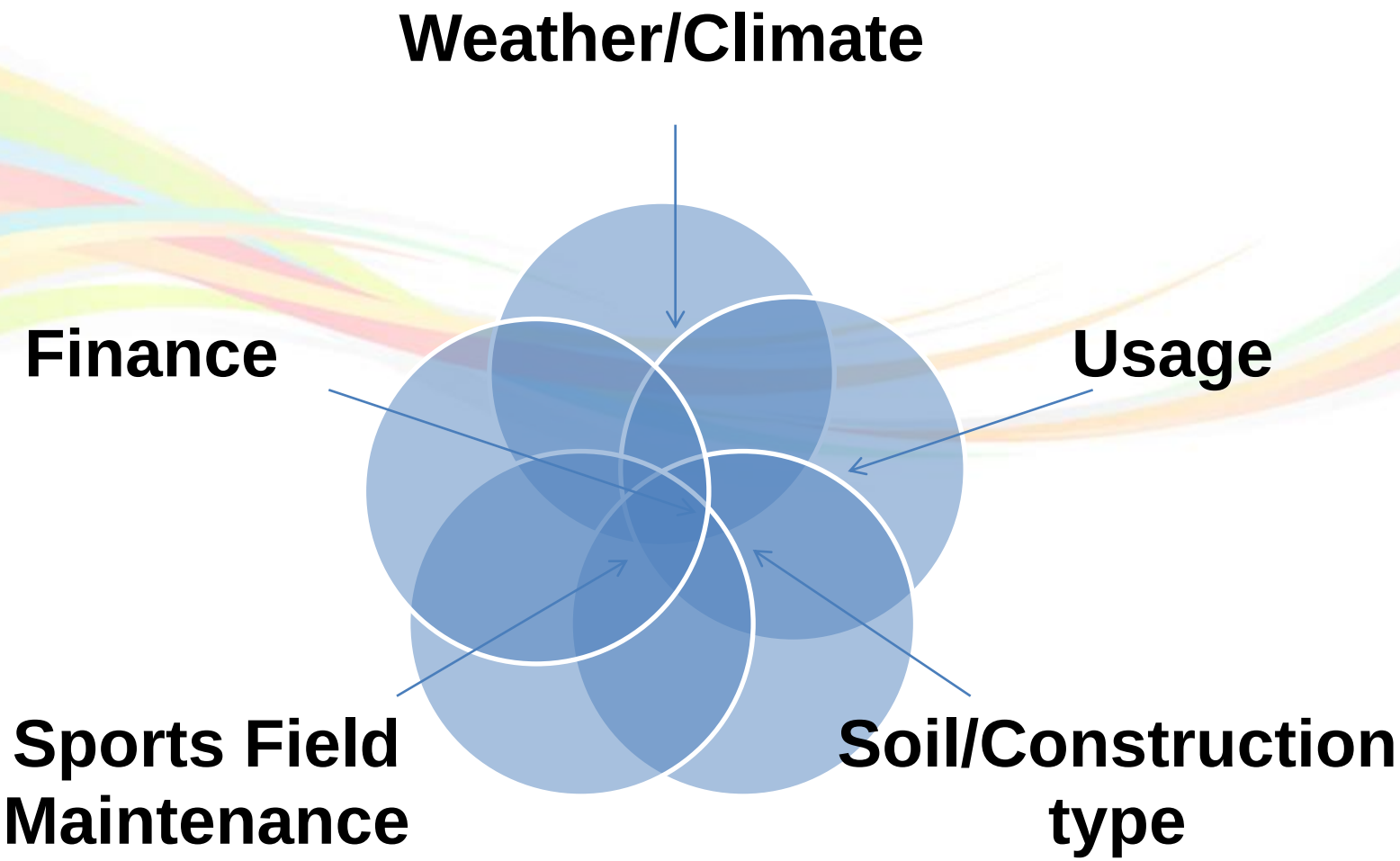
Ian Lacy

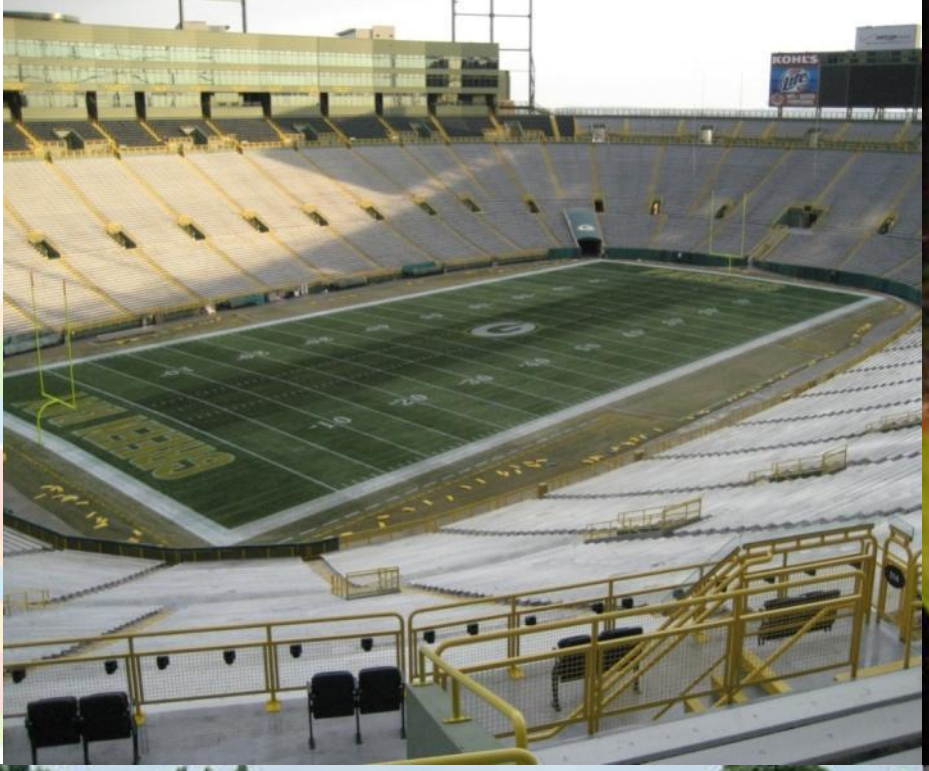

We could just build a Roof!!!!

Drainage issues, sometimes they creep up on you….. Silently!!!!


DRAINAGE
WHY
WHAT
WHERE
WHEN

Issues affecting drainage



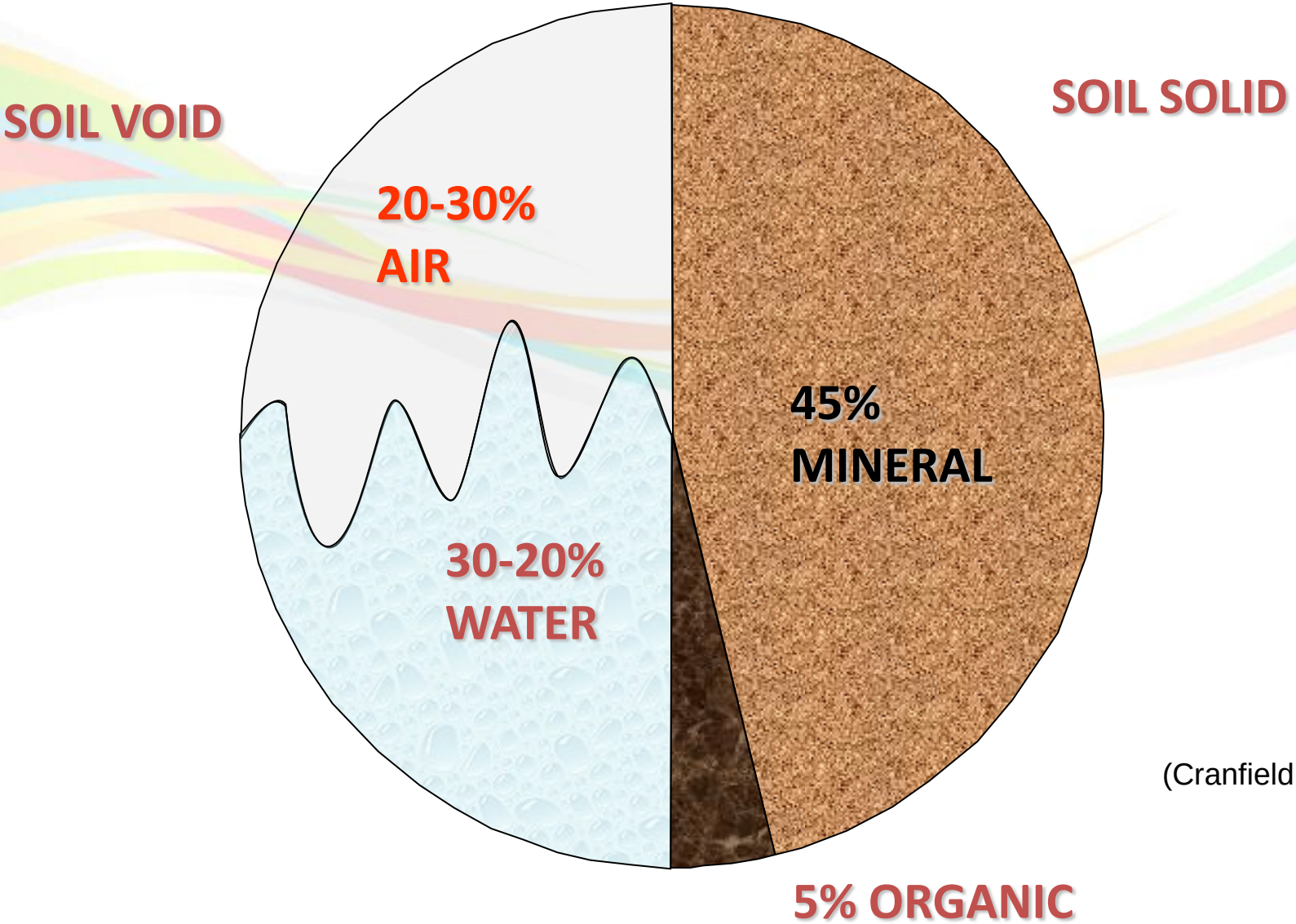

KOHL'S

Lets do the sciency bit First……

Let's begin with the basics…!

$$h = \frac{sv}{K}\frac{1}{1-(v/k)}\frac{1}{\pi}\left\{\ln\frac{s}{\pi r} + \sum_{m=1}^{\infty}\frac{1}{m}\left(\cos\frac{m2\pi r}{s}\right)\left(\coth\frac{m2\pi D}{s} - 1\right)\right\}$$

Soil composition



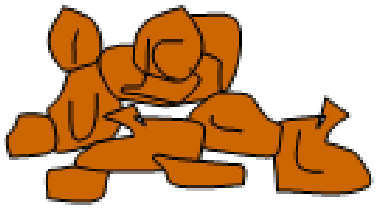
(Cranfield 2005)

Particle size

- SAND

  Coarse - rough granular particles

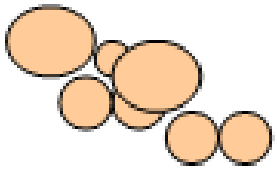
  2.00 - 0.020mm



- SILT

  Smooth - spherical particles

  0.02 - 0.002mm

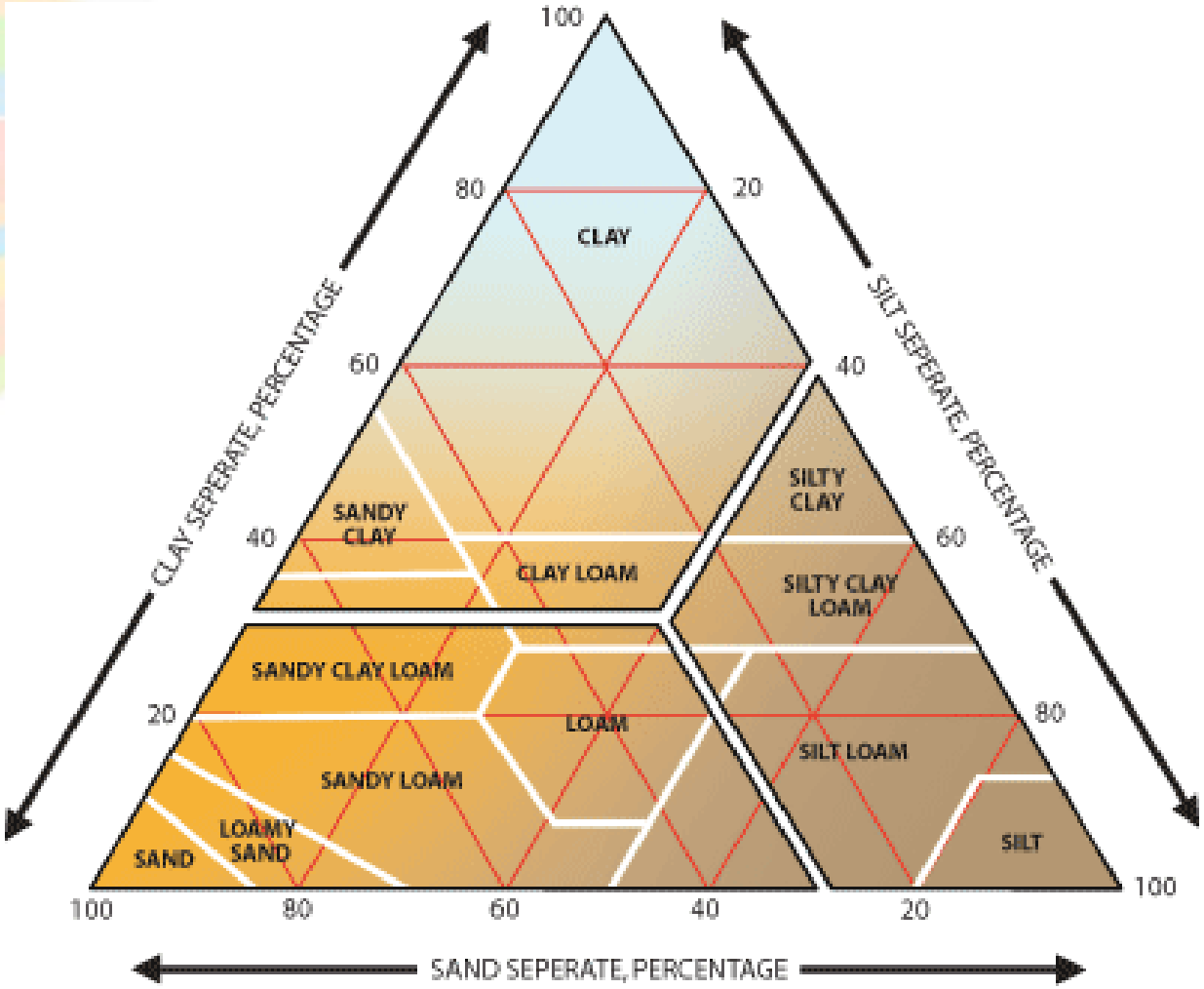


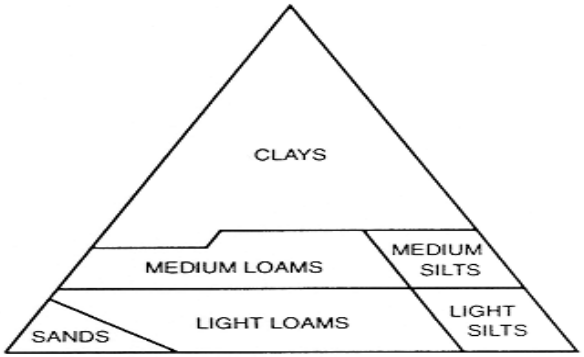
- CLAY

  Flat - plate like particles

  < 0.002mm

Textural Classification





SUBGROUPS

Infiltration

- If rain falls at a rate higher than the soil can absorb, then the following could occur:

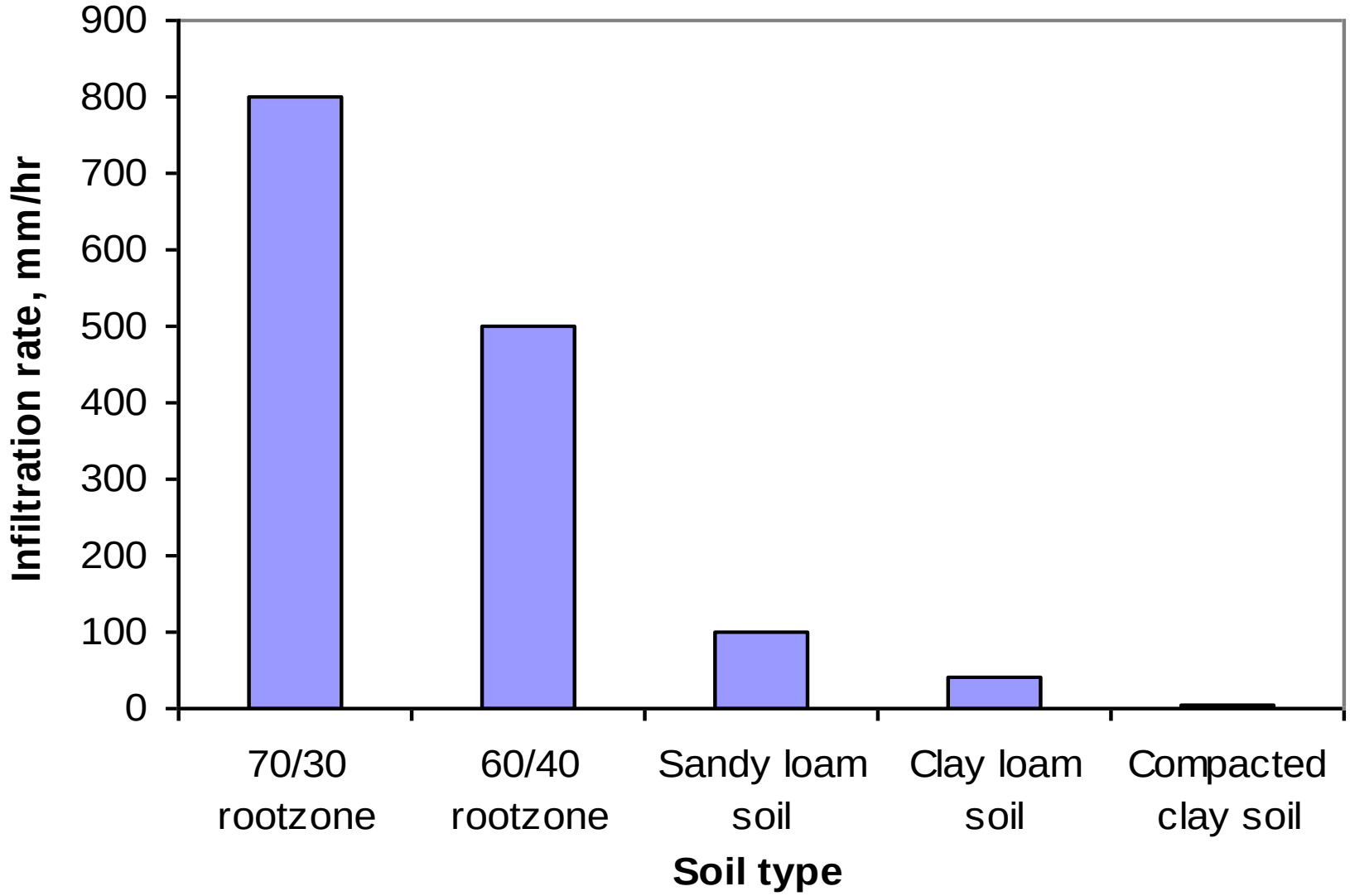
  Surface run-off

  Excess lost through Drainage

  Surface damage

- Irrigation needs to be applied at a rate less than the infiltration rate of the soil

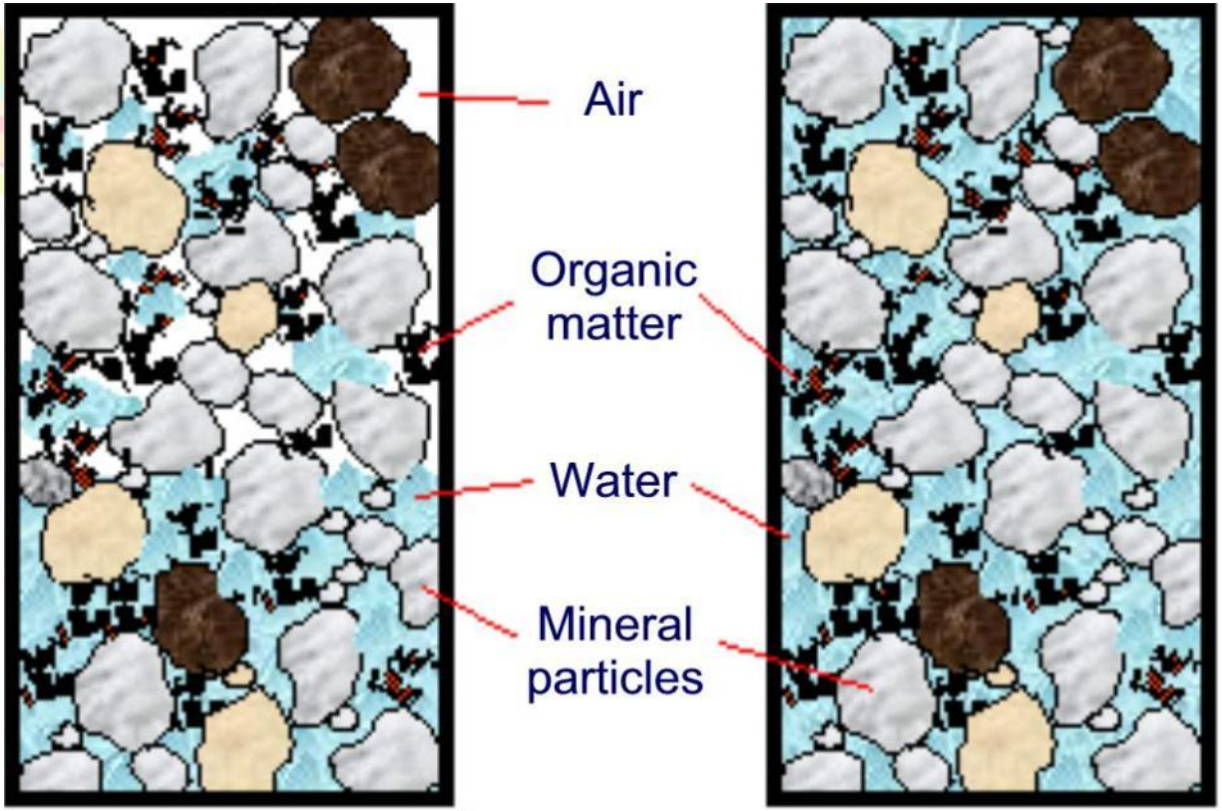
Infiltration rates of sports surface materials



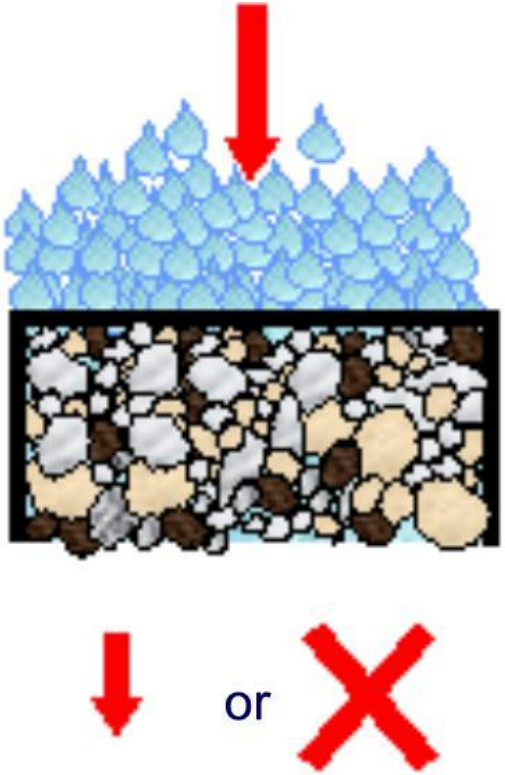
Soil Water

- **Field Capacity**: macro soil pores are empty of water owing to natural drainage. Micro pores still hold water against the force of gravity
- **Permanent Wilting Point:** all available water has been extracted from the soil. Plant death now results.
- **Available Water:** water available to the plant held in the soil between Field Capacity and Permanent Wilting Point.

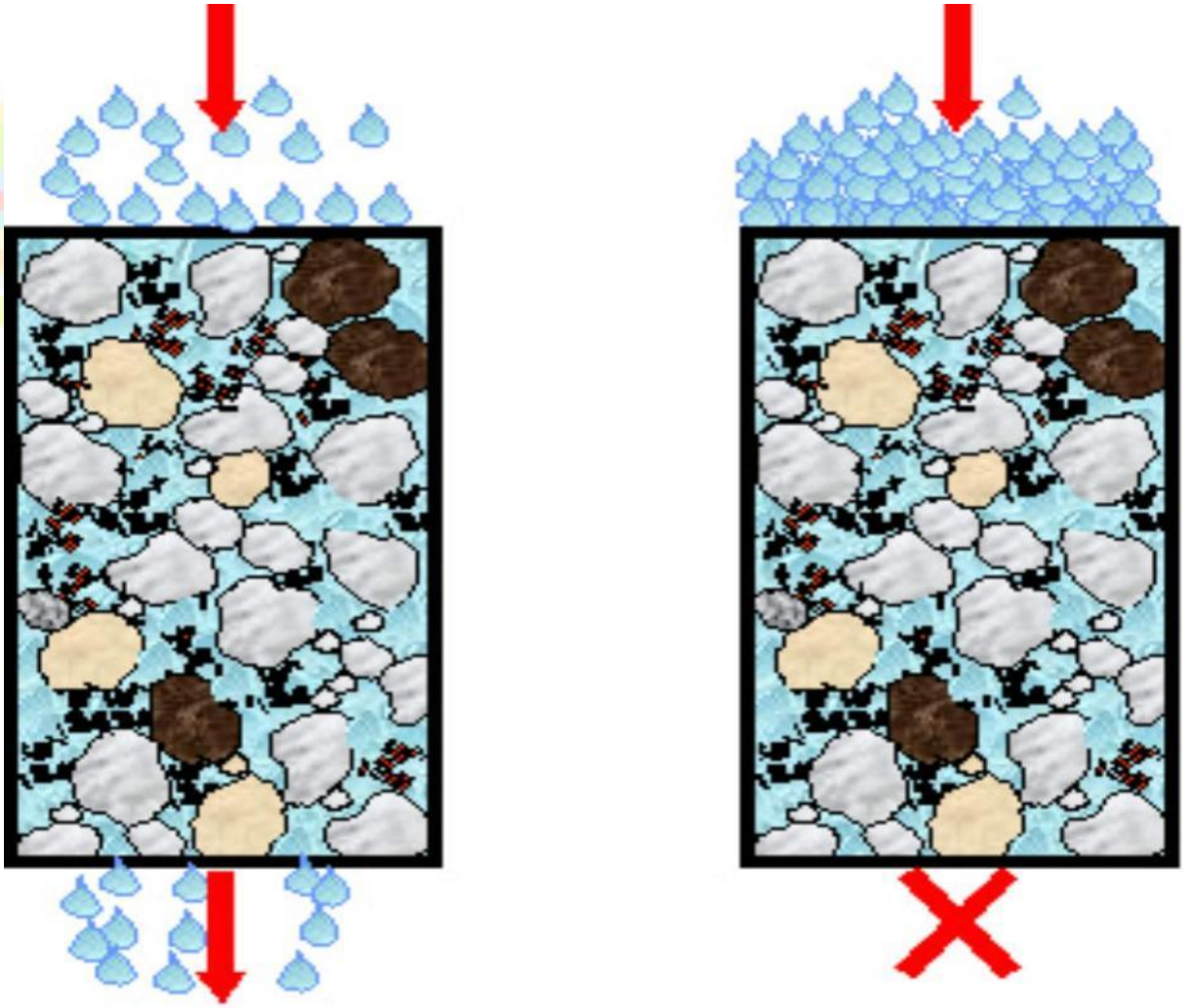
Water movement in soils



Surface water problems

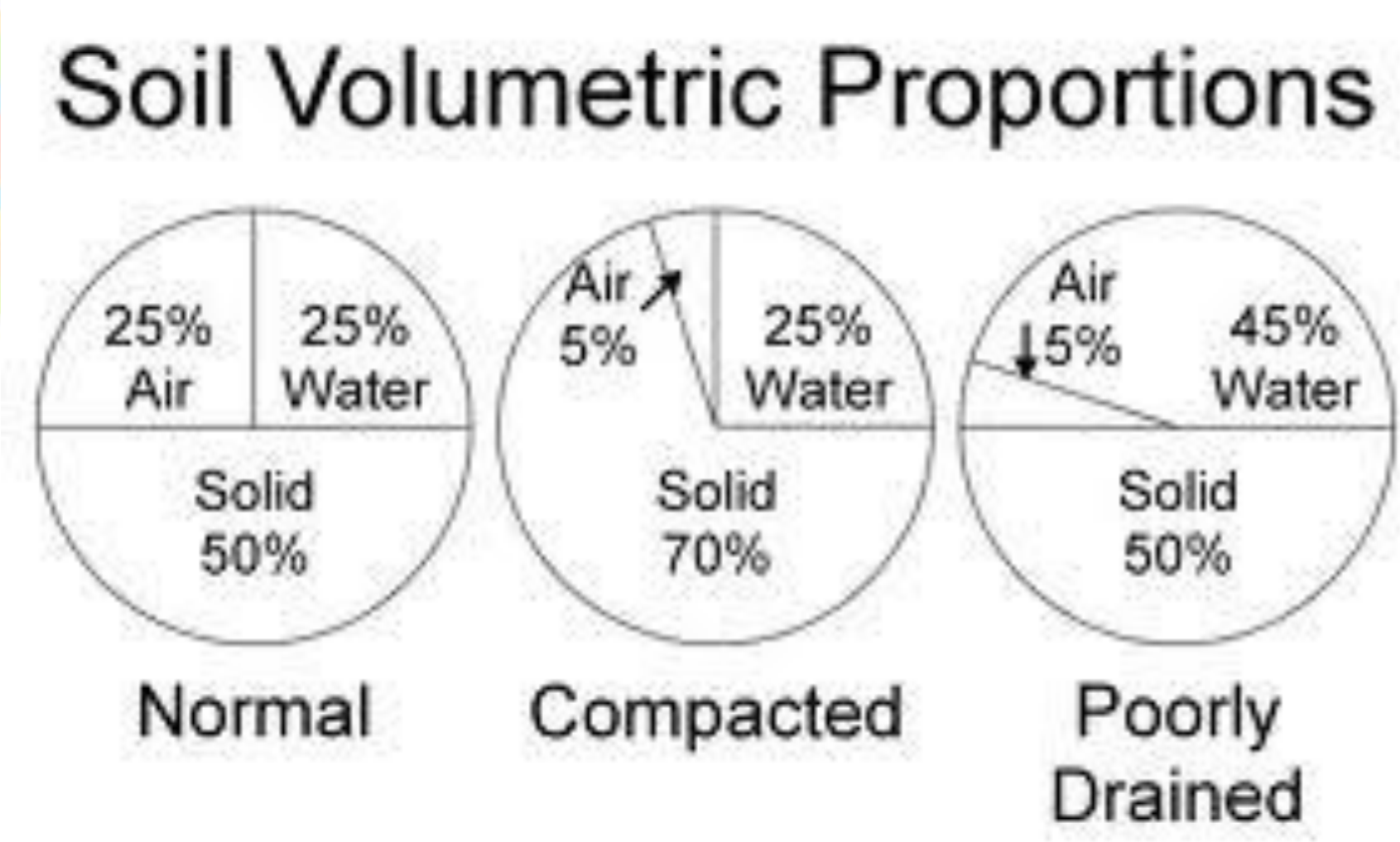


Groundwater Drainage Problems

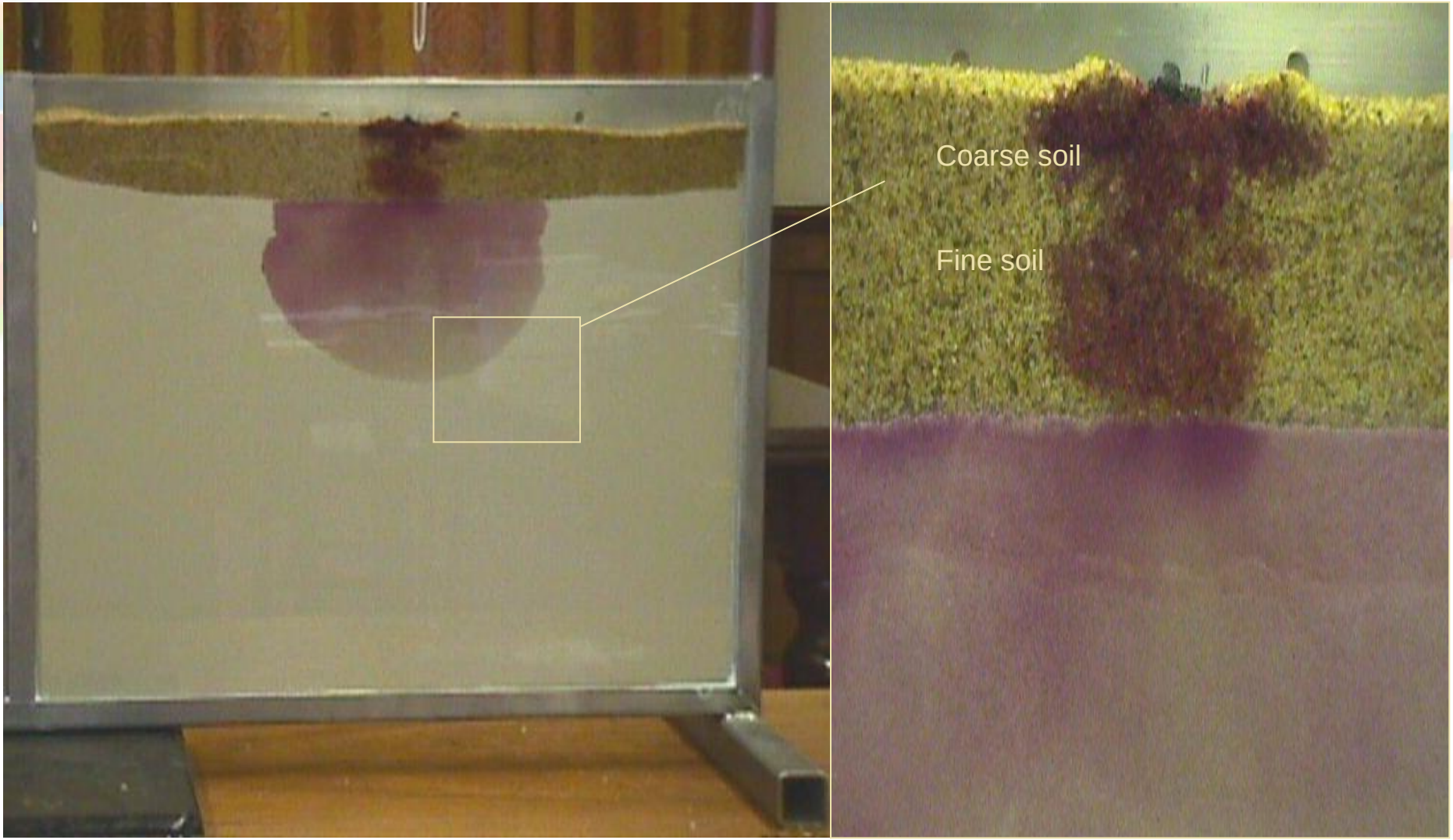


(a) (b)

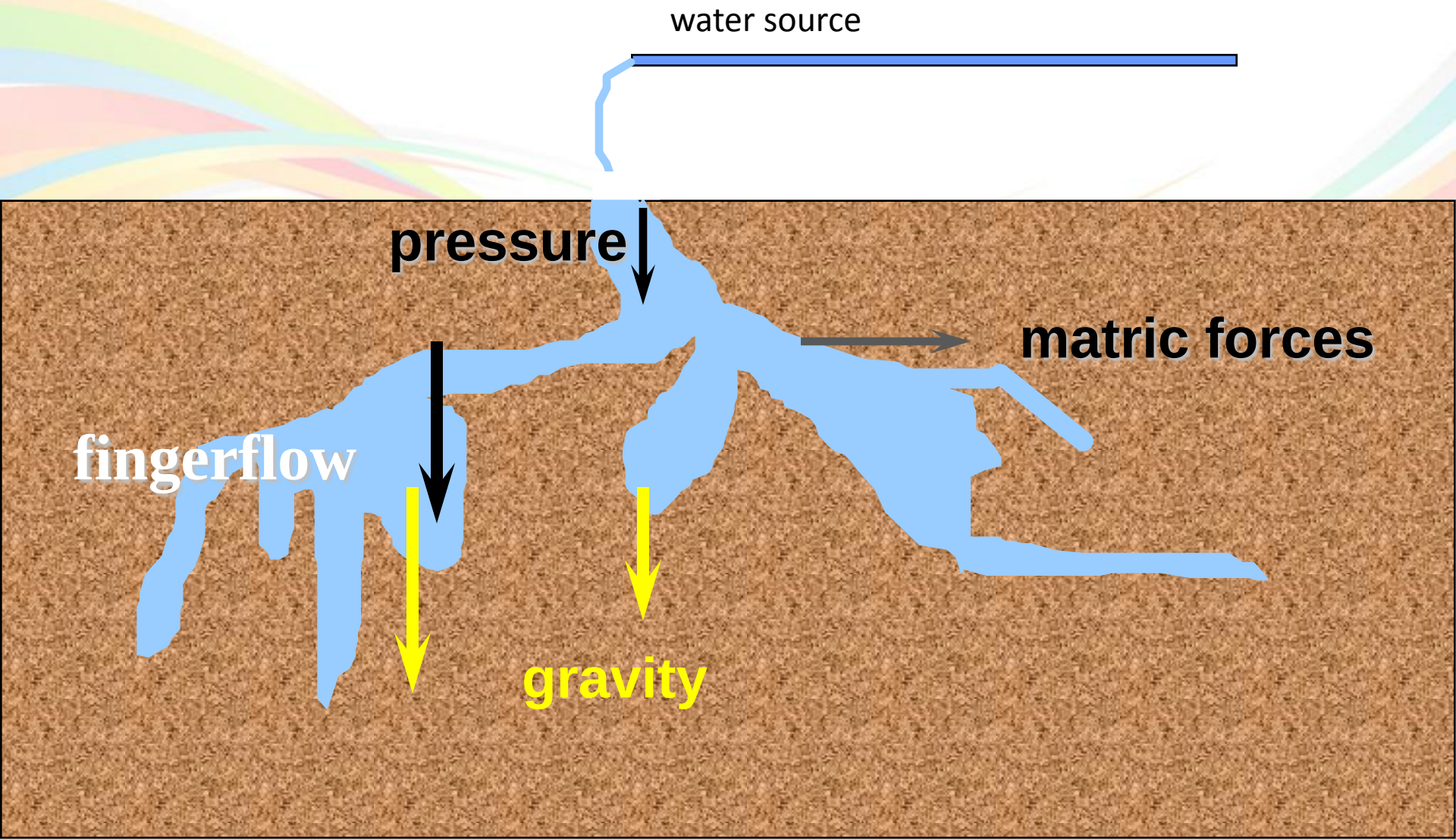
Its worth it……


Soil Volumetric Proportions
25% Air
25% Water
Solid 50%
Normal
Air 5%
25% Water
Solid 70%
Compacted
Air 5%
45% Water
Solid 50%
Poorly Drained

Layering: Coarse over Fine

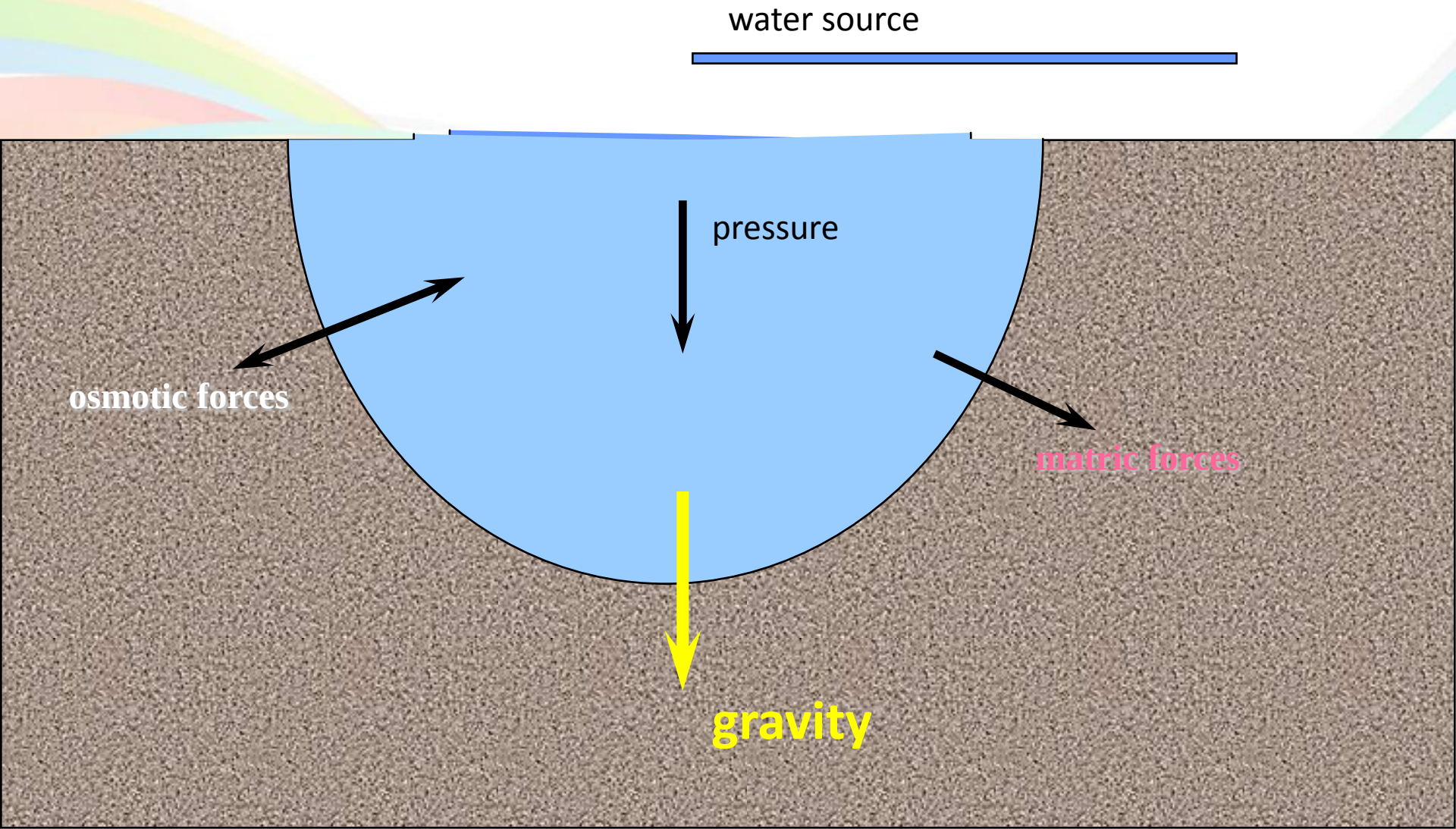


MOVEMENT OF WATER THROUGH SOILS
COARSE SOIL LARGE PORES

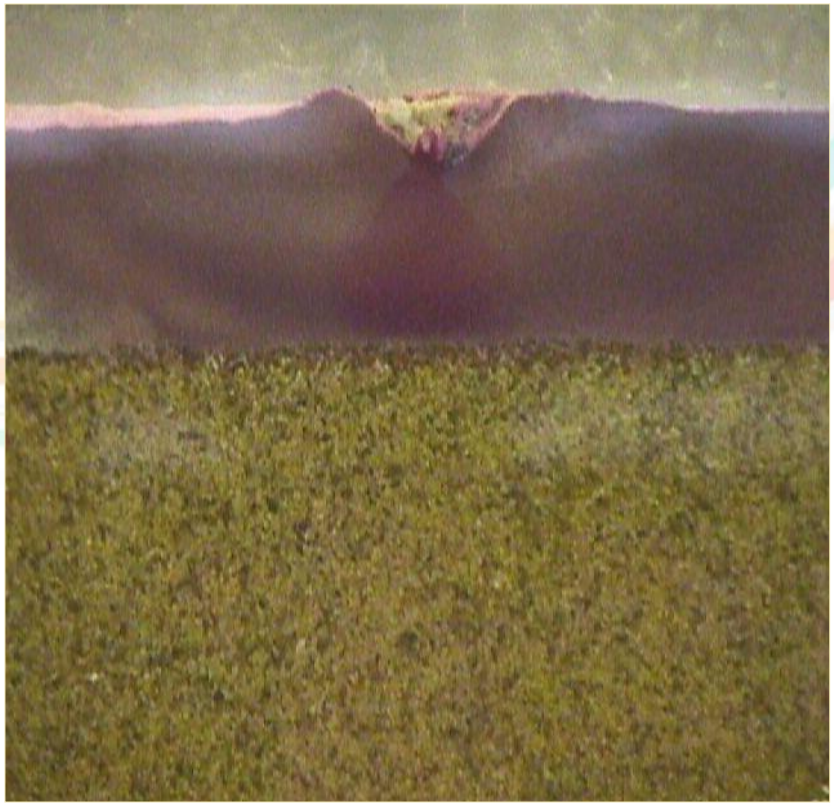


Water Movement Through Coarse Textured Soils

MOVEMENT OF WATER THROUGH SOILS
FINE SOIL SMALL PORES

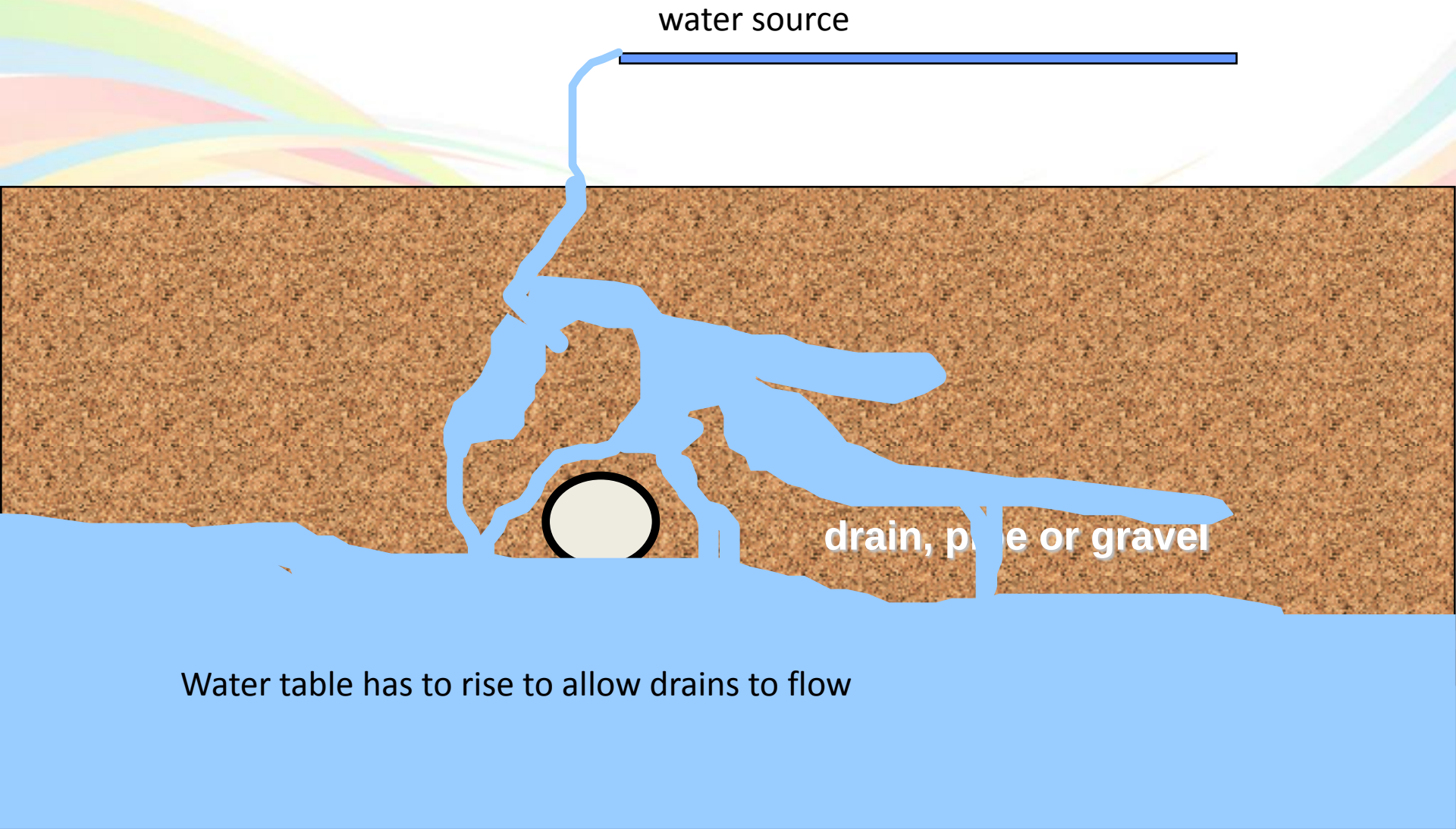


Layering: Fine over Coarse



Movement of water through large pores (e.g. coarse sand)

MOVEMENT OF WATER THROUGH SOILS TOWARDS DRAINAGE OUTLET



Water table has to rise to allow drains to flow

The why??

Why do we need drainage?

Why do surfaces fail?

- Specification
- Construction
- Management/maintenance

Poor specification or maintenance?

Where has all this water come from….?

Warwickshire C.C. (Daily Mail)

Water water everywhere


MCFC - The Mancunian Way
Manchester City Football Club
totalbet.com totalbet.com totalbet.com
Thomas Cook
Thomas Cook
Manchester City Football Club
mcfc.co.uk
Manchester City Football Club
mcfc.co.uk
SERGIO TACCHINI
SERGIO TACCHINI
Thomas Cook
Thomas Cook
Thomas Cook
Thomas Cook
Thomas Cook

How Much..?

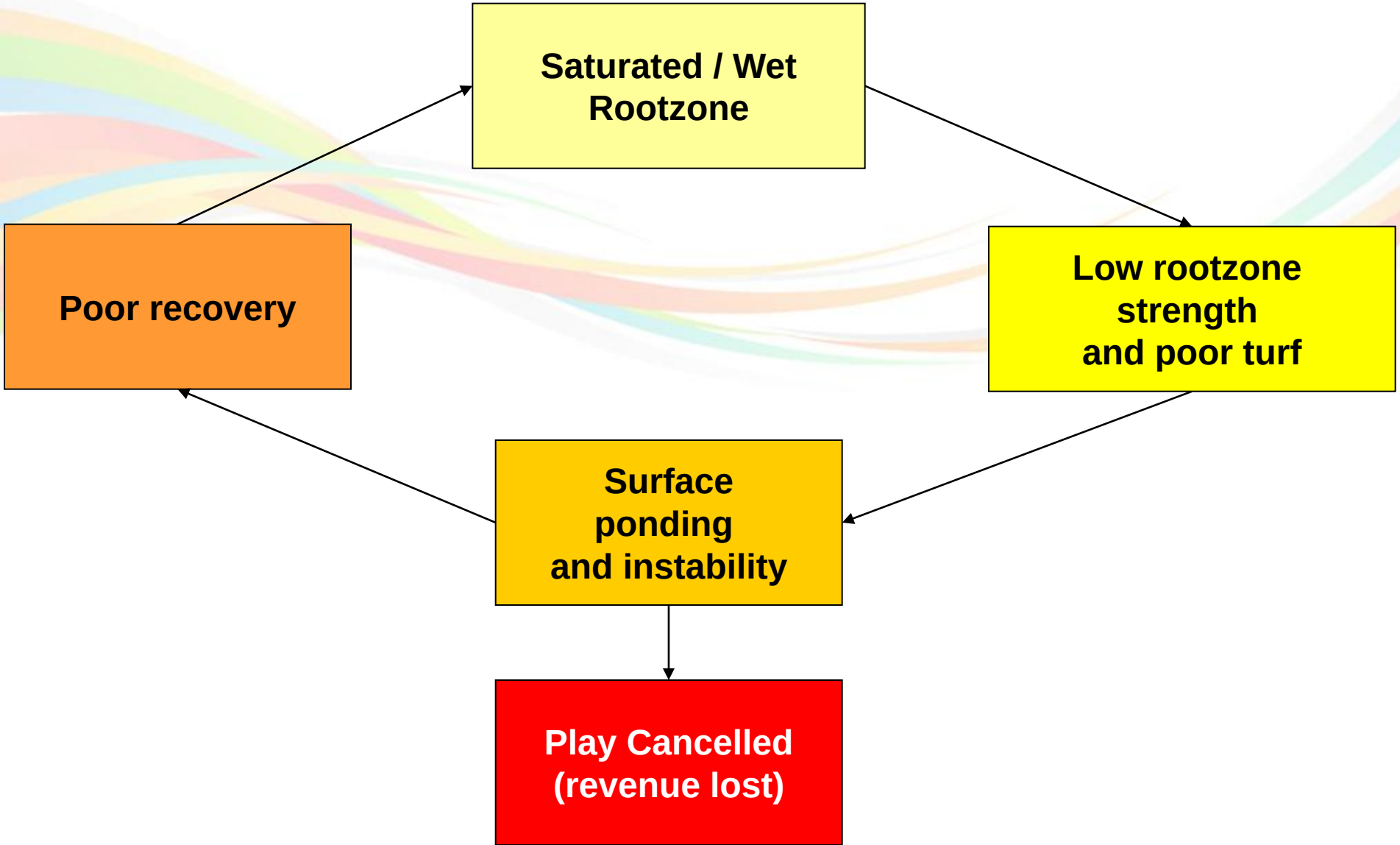
(Football pitch approx 7,500m²)

1mm of rain = 70 tonnes of water.

Snow!!!!!!

More Snow!

Why do we need drainage?



Increasing prizes/penalties

Abandonment of major events:

- Test matches - £4M
- Major horse race - £17M
- Premier football match - £0.5M

- Cost of injury
- Players (e.g. W - £20M?)
- Horses - £10M
- Local level a championship team reduced player injury from 24 hospitalised injuries to 7 in the same time period after installation of new pitch

Thatch

- Is the build up of partially decomposed organic matter in the upper profile of the rootzone.
- Factors that encourage this;

Poor drainage

Excessive fertilizer applications

Dramatic lowering of mowing height

Poa annua

Only 20% comes from returned grass clippings

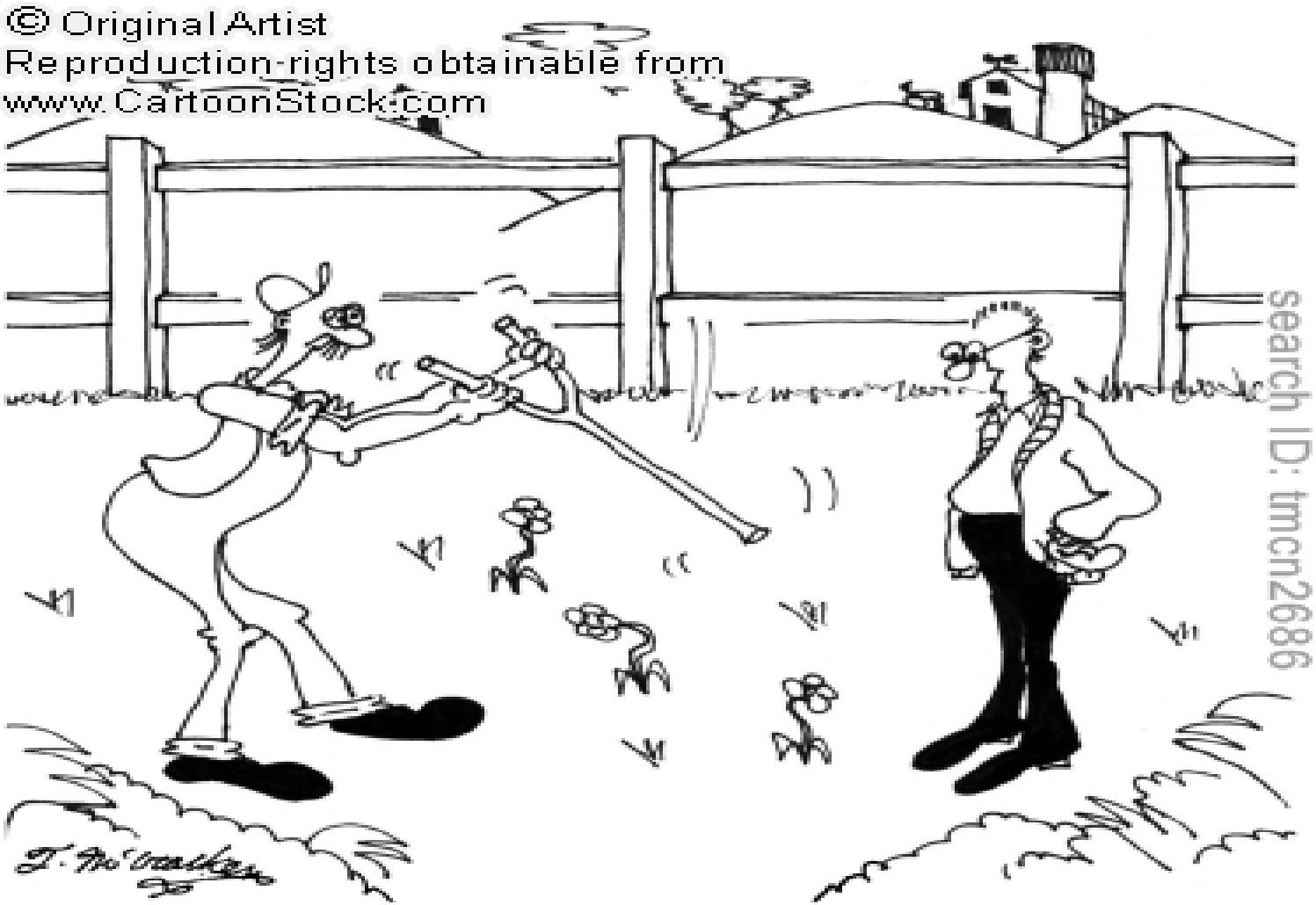
The effects of thatch

Identification of the cause of drainage problems…

- Is there existing drainage infrastructure? - Is it working?

Capping over sand slit

Carry out an investigation!



"Great. You found my septic tank."

Poor playing surfaces

- Reduced enjoyment at all levels
- Games called off, courses closed
- Poor/erratic playability
- Dangerous situations
- Poor technique
- Liability
- Lost revenue

Surface-water or Groundwater?

- Groundwater problems
  - High/rising water tables
  - Confined aquifers
  - Temporary water table

- Surface-water problems (can be up to 80% of problems*)
  - Poor infiltration rate
  - Excess/ high intensity rainfall
  - Perched/suspended water tables
  - Saturated ground conditions
  - Watershed problems

*estimate, based on consultancy cases

Identification of the cause of drainage problems…

- Dig a hole!
  - Does the water appear at the bottom of the hole and move upwards?
  - Do you have coarse-over-fine or fine-over-coarse?
  - Soil structure - are there impermeable layers (e.g. compaction)?
  - Is there any evidence of black layer or mottling?

Inadequate outfall

Orientation of surface drains

Poor conditions

Identification of the cause of drainage problems…

- Look around you
  - How does the land lie – where are the slopes?
  - Is water being shed into the area from other areas?

Identification of the cause of drainage problems…

- Is there existing drainage infrastructure? - Is it working?

Identification of the cause of drainage problems…

- Is there existing drainage infrastructure?
  - Is it working?

Identifying cost effective alternatives

- Need a solution that is both:

  - Cost effective (principally through reduced cost)

  and

  – Achieves a minimum drainage performance

What about the cost??

Problem looks like surface water

Sand slit solution = £18 000 /pitch + on-going maintenance

4 x pitches, solution = £100 000

Problem turns out to be groundwater:

Groundwater pipe solution = £25 000 /pitch

4 x pitches, solution = £100 000

What about the cost??

Full pipe Installation on a football/soccer pitch 7500m2:

Including the following:

- Catch water/interceptor drain
- Main Drains
- Laterals @ 5m centres

Average cost £20-25 000

What about the cost??

- Sand Slits [pure sand] @ 1m centres =

Average cost £18-20 000

- Sand Slits [50% gravel-50% sand] @ 1m centres=

Average cost £15-18 000

- Sand bands @ 30cm centres =

Average cost £5 000

What about the cost??

- Mole ploughing @ 1m centres

Average cost £3-5 000

- Sports turf maintenance

Average cost £10 00 per annum

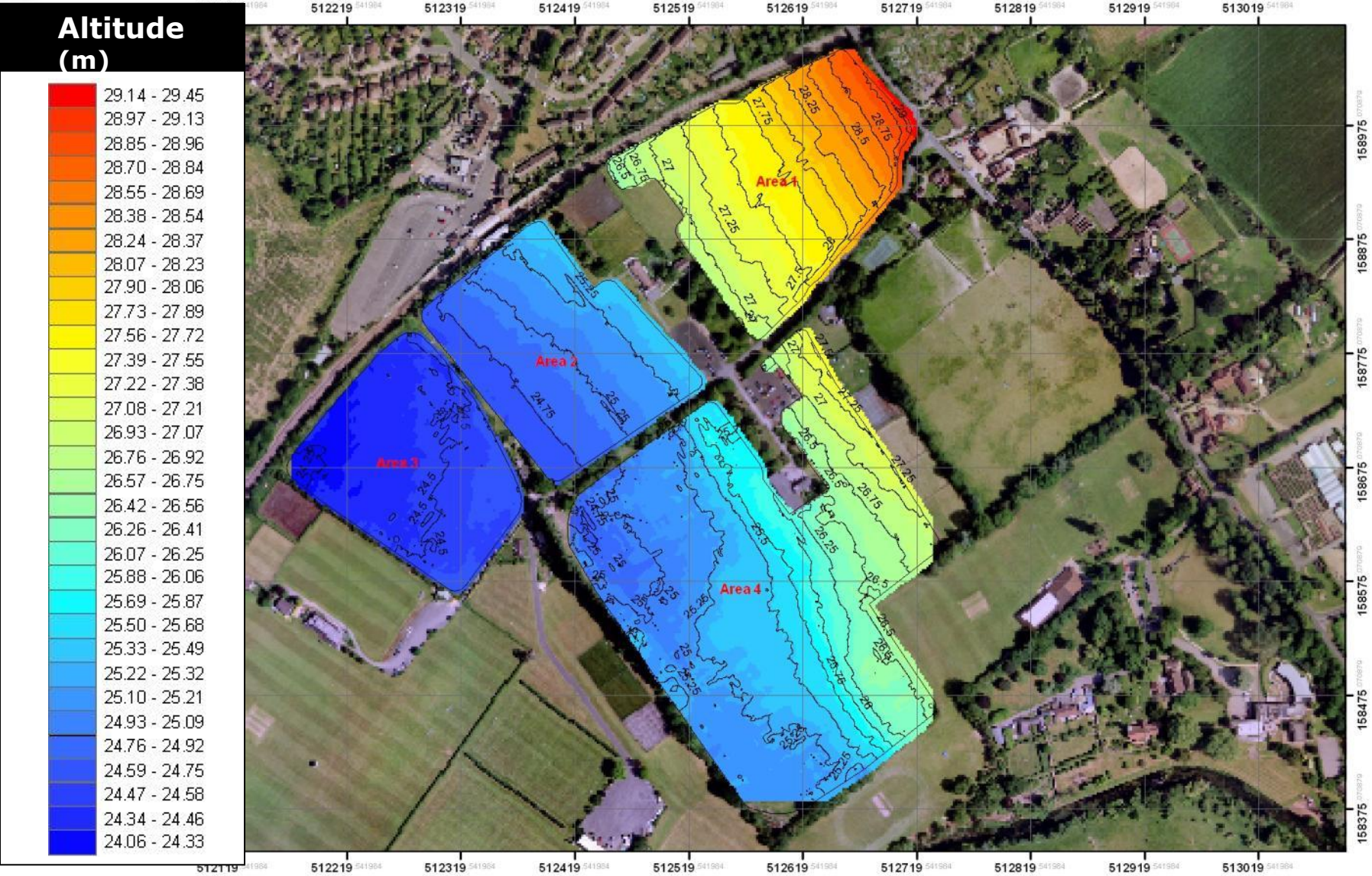
Specification

Natural soil - can produce good surfaces but variability in soil properties

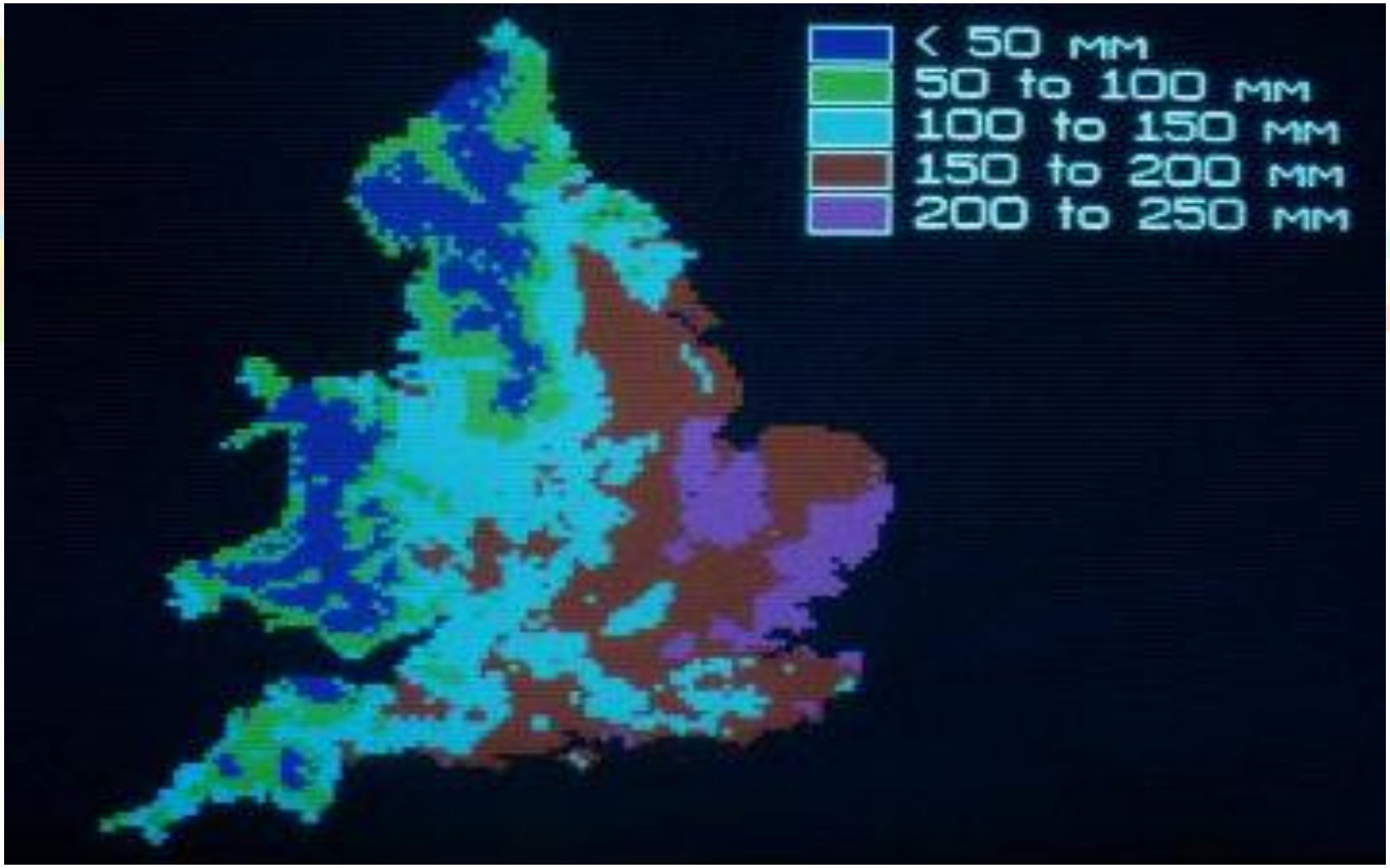
- Constructed soils-specifications for:
- Blend of soil particle sizes
- Blends to be used for different layers
- Mechanical strength
- Water movement

Is a perched water table construction appropriate?

Determine the issues - Slope/Grade



Weather data average



Concerts !!!

Photos by Steve Legros

Concerts!!!!!

The good old days!!

Beauty and the beast!!!

Drainage

Factors affecting drainage:

- Type of Rootzone/Soil
- Surface levels/Gradient
- Compaction
- Groundwater levels

THE WHAT?

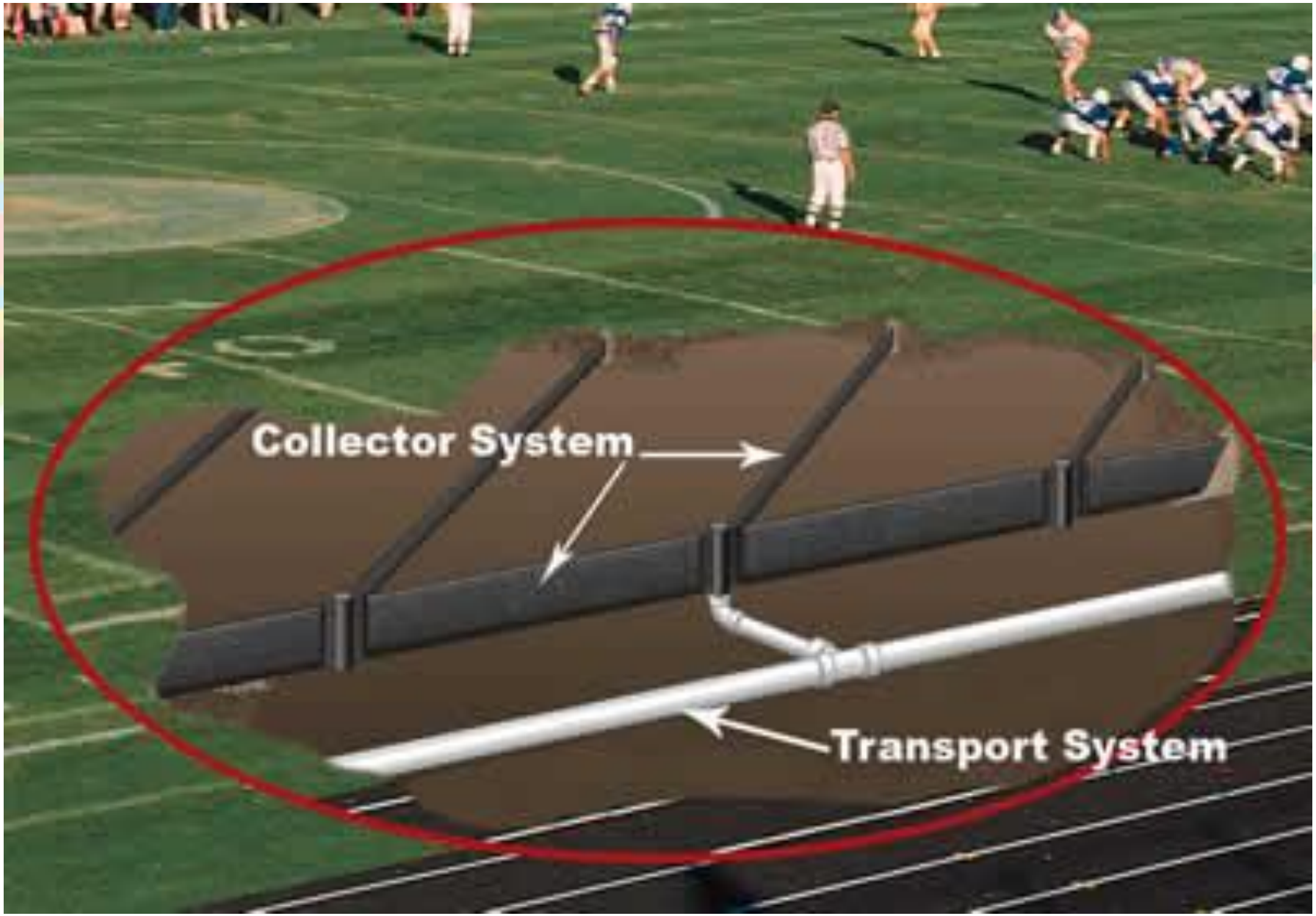
Drainage suitability for soil types

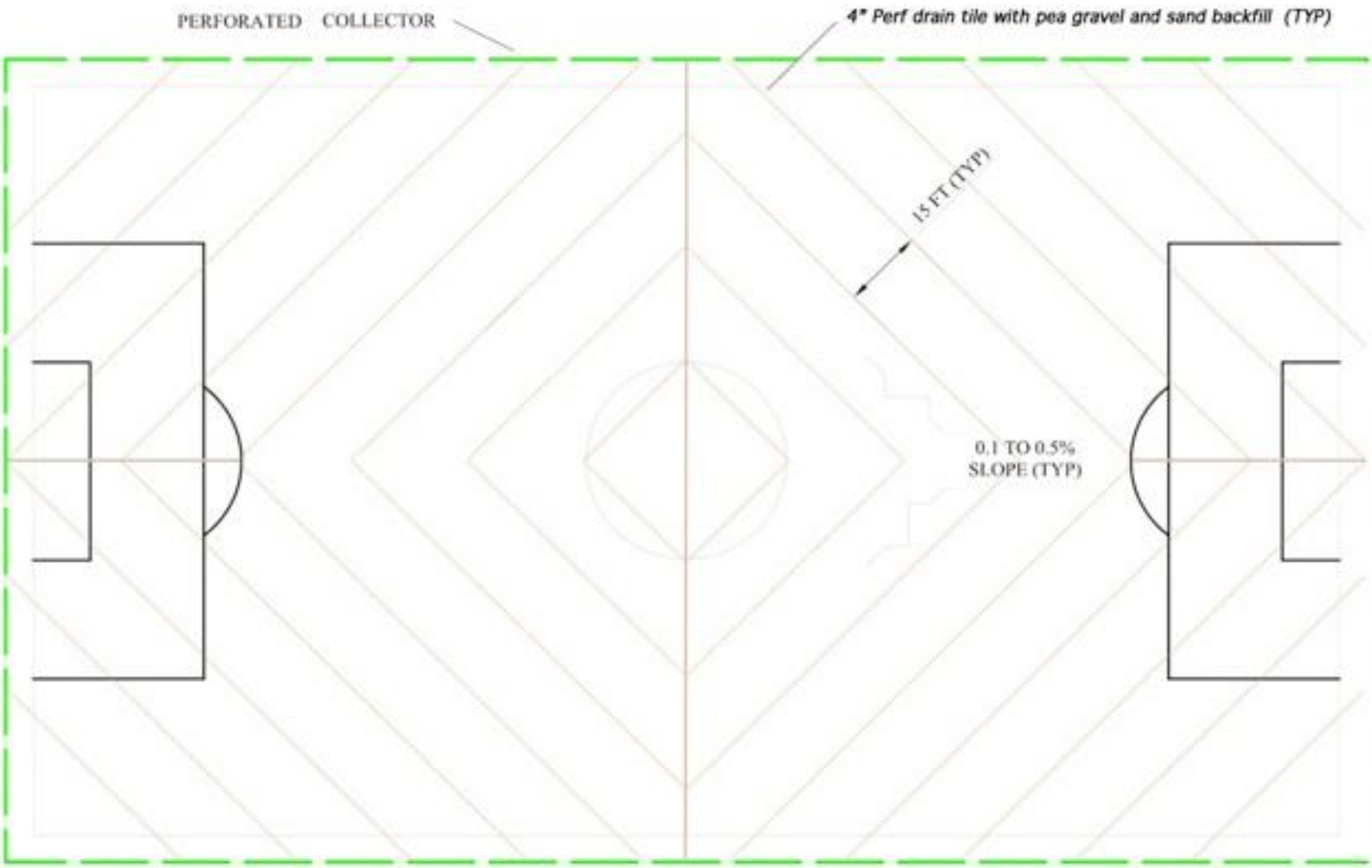
Different soil types require a different drainage approach

	Mole Drainage	Mole Drainage lined	Sand Grooving	Sand slitting piped	Lateral Collectors	Carrier	Decompacting	OM Incorporation	Rotoknife
S (sands)									
C (clays)									
Z (silts)									
SCL									
SL									
LS									
ZCL									
SZL									
CL									
ZC									
ZL									

Key

Optional
Recommended


Collector System
Transport System


PERFORATED COLLECTOR
4" Perf drain tile with pea gravel and sand backfill (TYP)
15 FT (TYP)
0.1 TO 0.5%
SLOPE (TYP)

Incorporation of recycled compost

Organic matter incorporation

- Some soils, specifically silts and sandy silt loams, become de-structured due to excessive play and pedestrian/machinery traffic.

- Therefore, the use of organic matter incorporated in to the profile may improve surface structure thus drainage and performance.

- This material, whilst having significant benefits to performance of the playing surface, can be obtained very cheaply from recycled green waste.

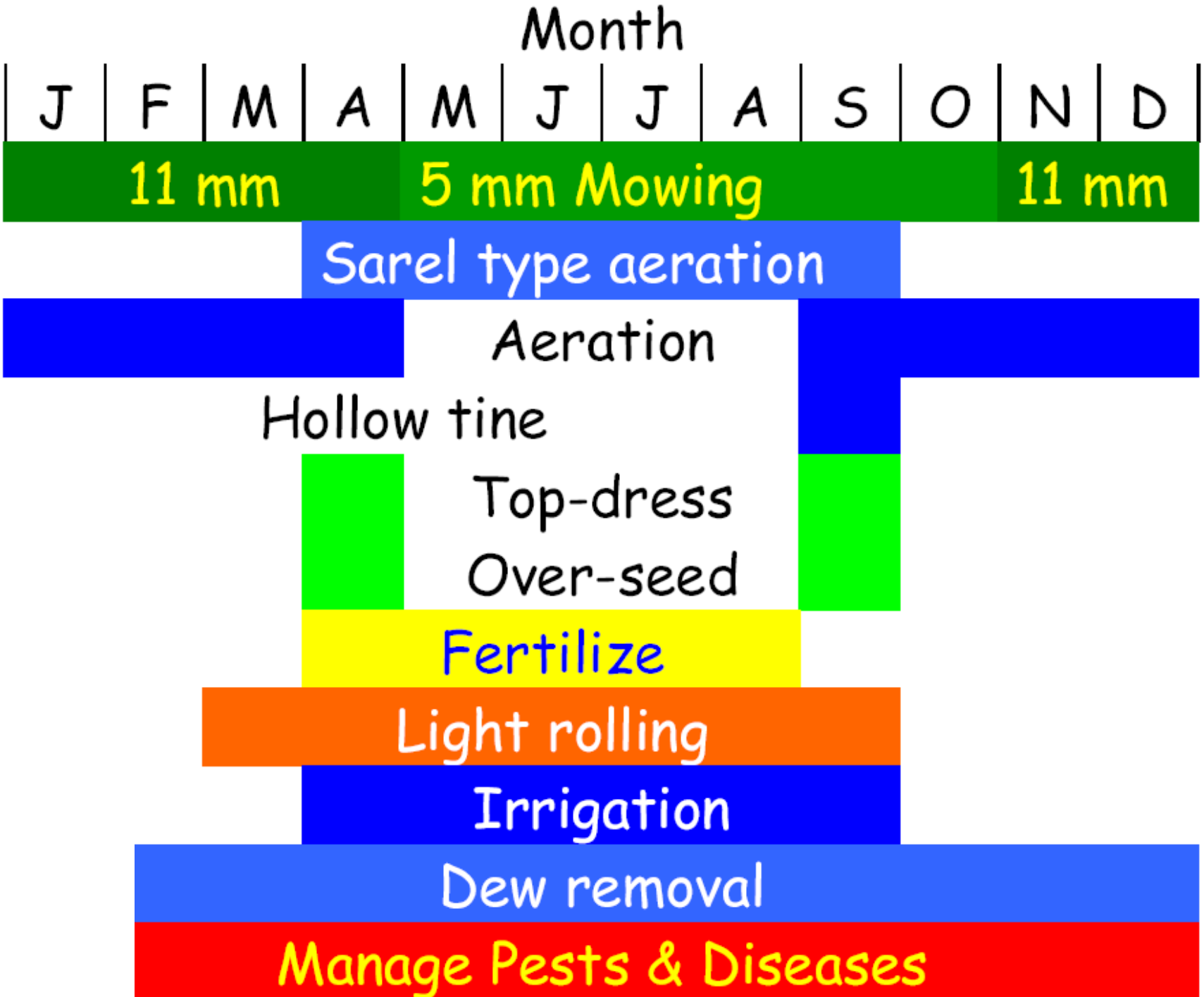
Specialist organic matter machinery in action

Poor structure leads to shallow rooting, poor wear tolerance and poor playability

Aeration equipment

Sports Field Maintenance

- Soil Survey/sampling.
- Setting Out/Marking out.
- Mowing.
- Aeration.
- Scarification/Verti-cutting.
- Brushing/Drag-matting/Harrowing.
- Rolling.
- Irrigation.
- Fertilising.
- Seeding.
- Top dressing


Month
J
F
M
A
M
J
J
A
S
O
N
D
11 mm
5 mm Mowing
11 mm
Sarel type aeration
Aeration
Hollow tine
Top-dress
Over-seed
Fertilize
Light rolling
Irrigation
Dew removal
Manage Pests & Diseases

Calendar of Operations

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Mow	1	2	2	2	2	1	2	2	2	2	2	1
Mark out	2	2	2	2				2	2	2	2	2
Brush	3	3	2	2		1				2	4	4
Verti-Drain					1					1		1
Slit-tine		1									1	
Hollow-tine					1							
Solid-tine												
Fungicide			1							1		
Herbicide												
Fertilise					1 6:9:6		1 10:6:6				1 6:9:6	
Overseed					1							
Top dress					1							
Irrigation					2	2	2	2				

Soil survey/sampling

Pitch Assessment

Aeration

- Suitable for localised work
- Not practical for larger areas

Aeration

Aeration

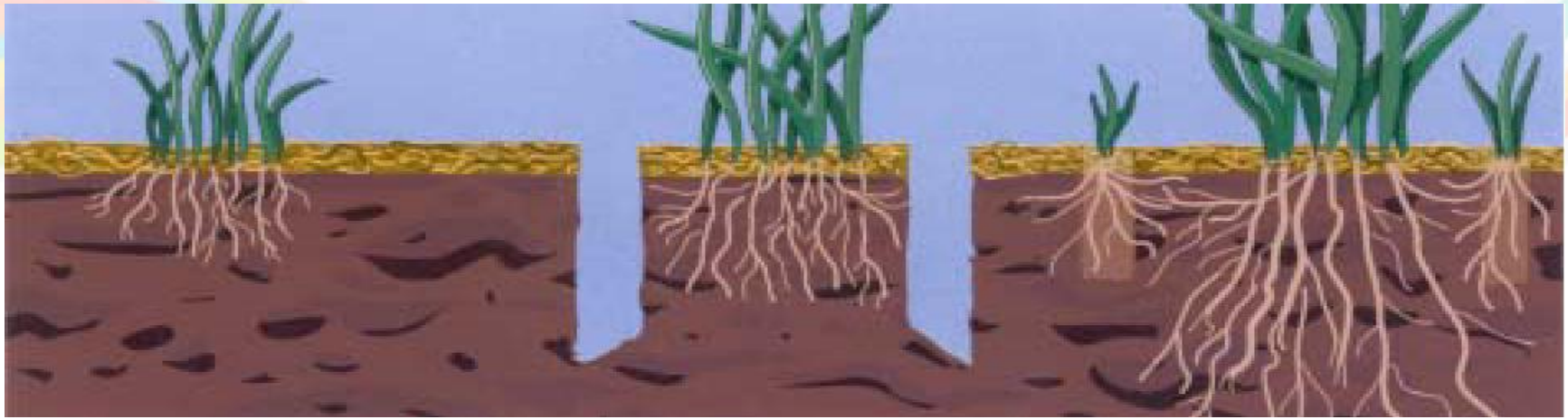
Aeration


your website
.chaptereight.com
The event security people
G4S
Abid's
ESS

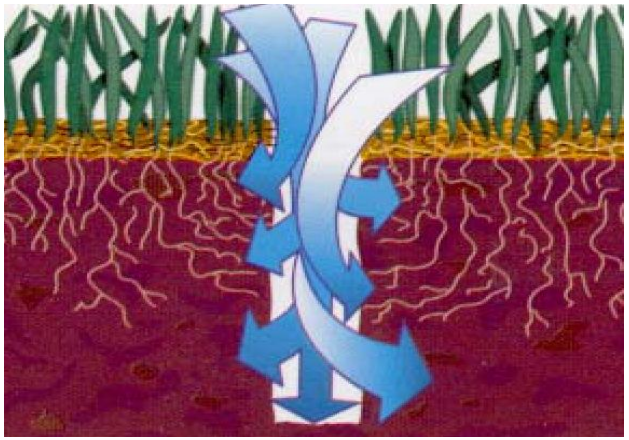
Aeration

- Deeper rooting;

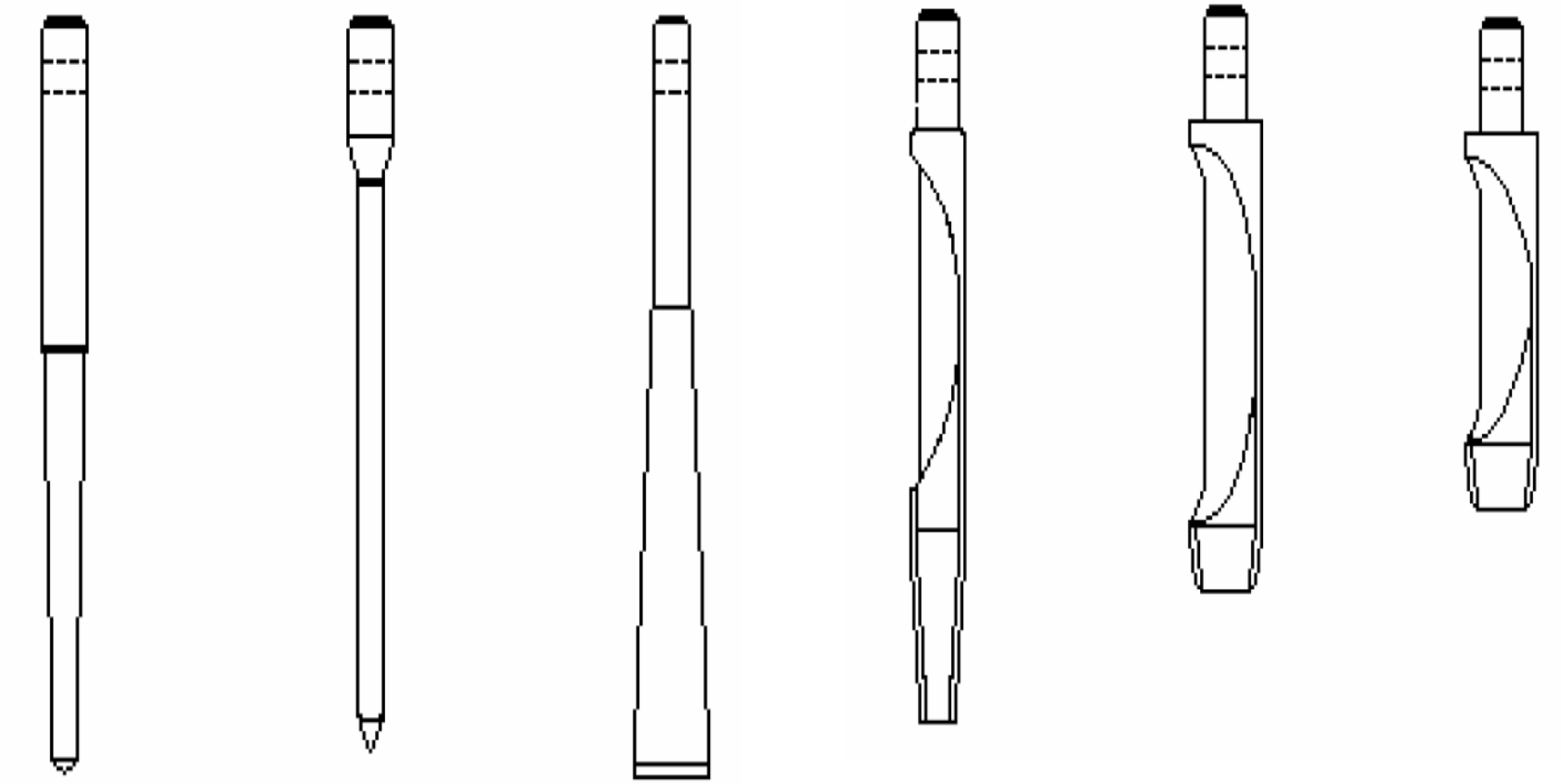
  creates pore spaces for root activity.



- Improved infiltration of water, air & fertilizer.



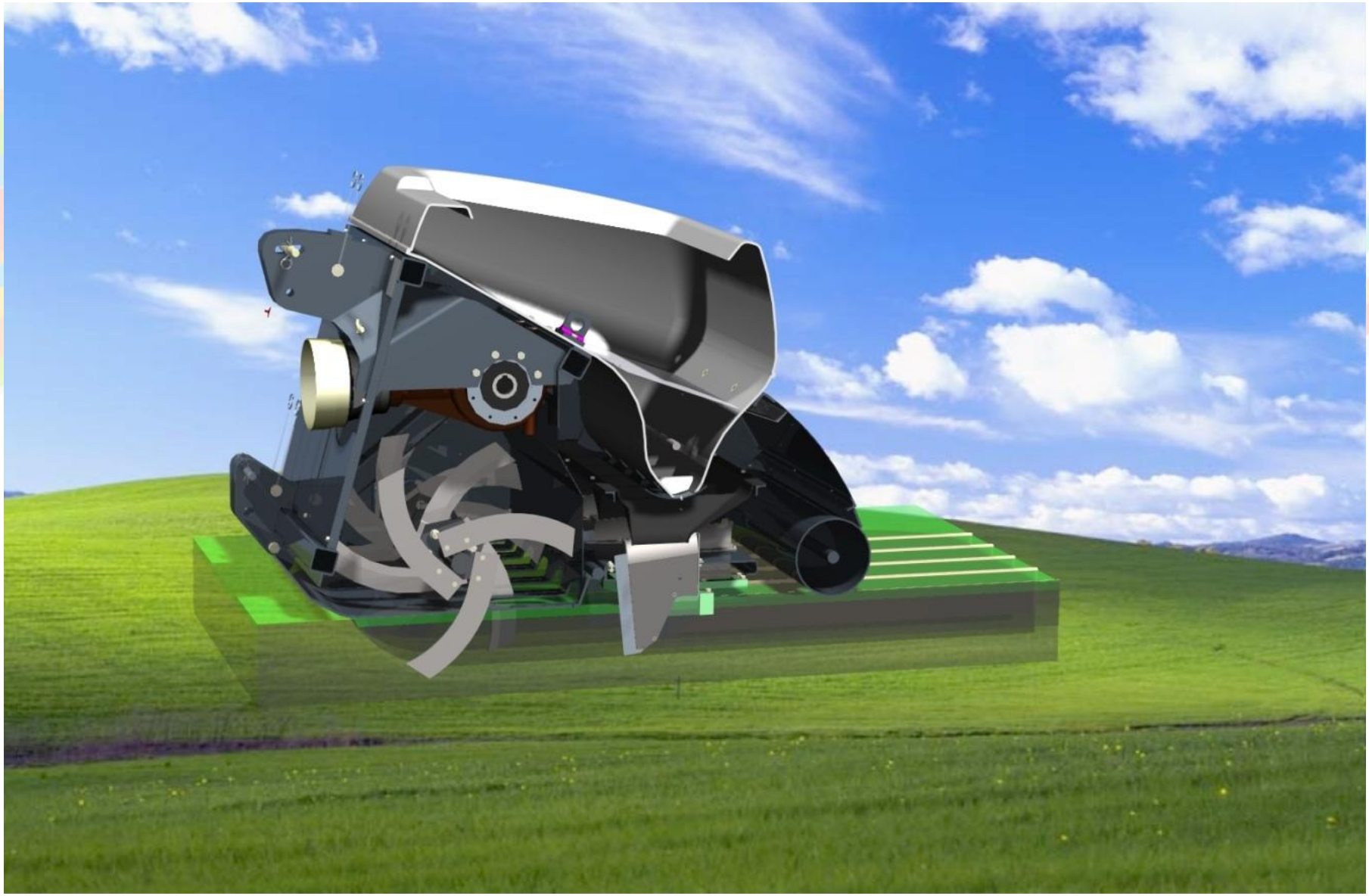
Aeration tines



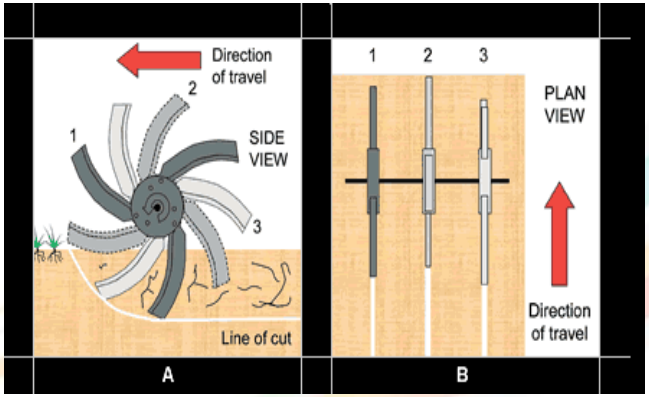
Solid | Solid | Chisel | Hollow | Hollow | Jumbo Hollow

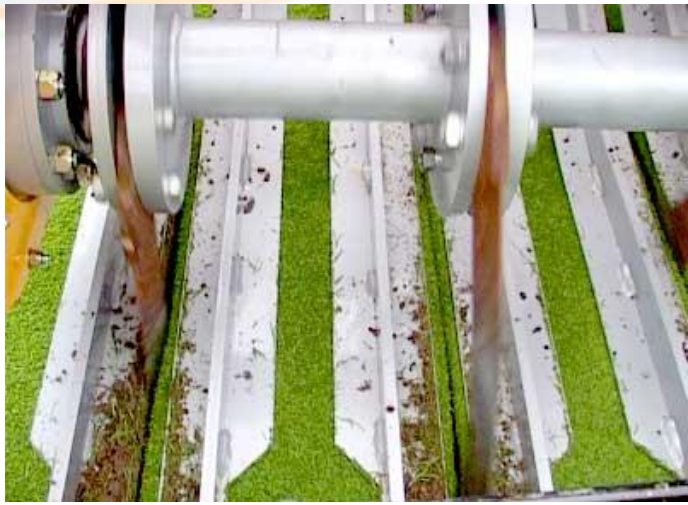
Linear Aeration equipment

Linear Aeration equipment



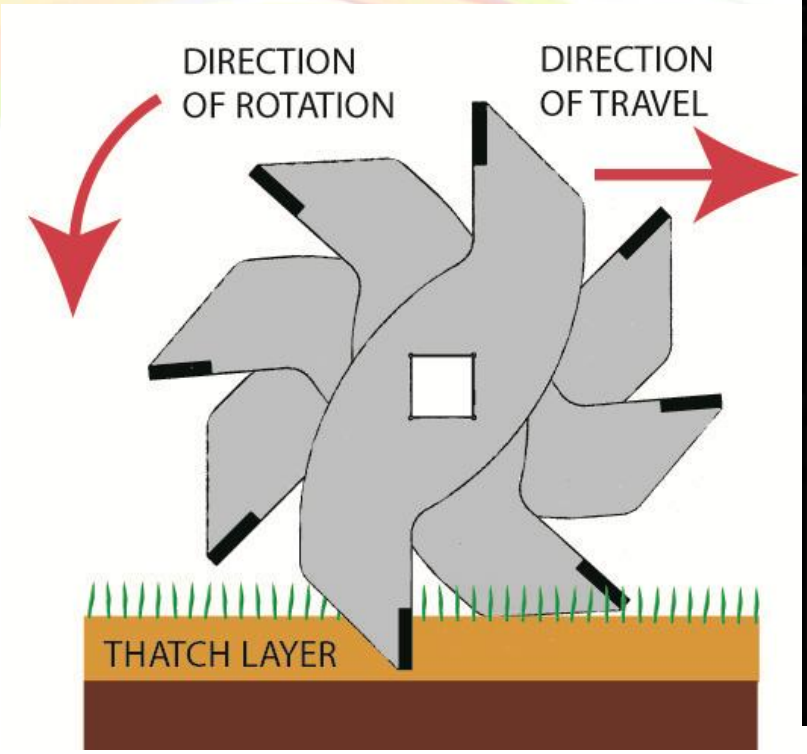
Compaction Relief - Earthquake

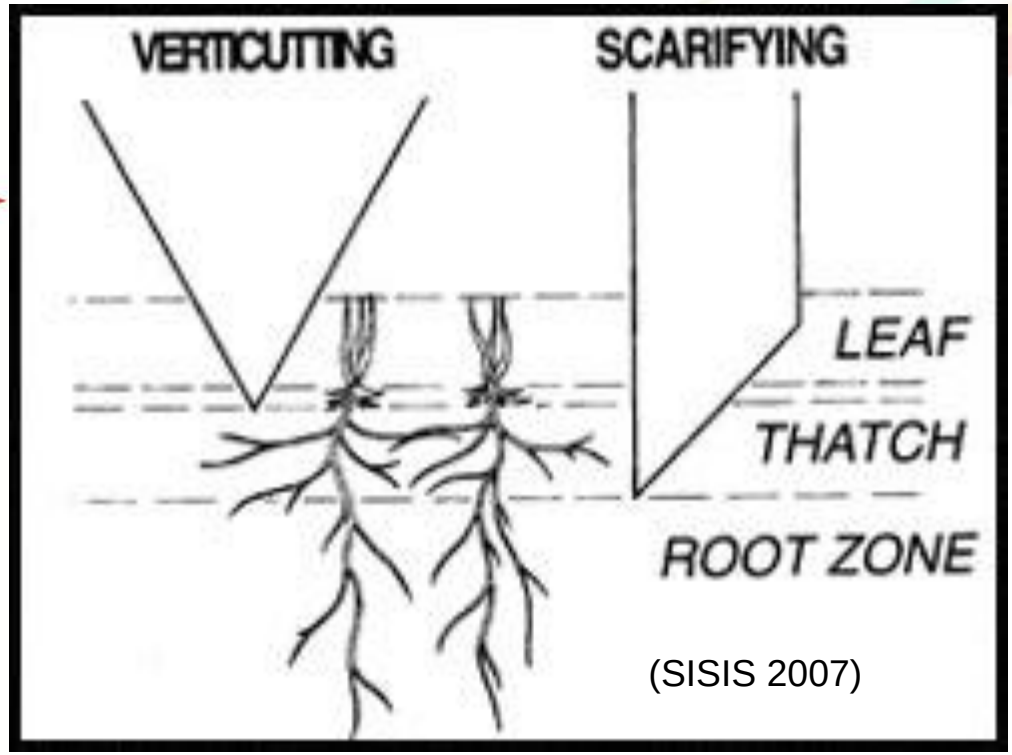




Verticutting/Scarification

- Verticutting: Between the leaves of the plant
- Scarification: Cutting into the rootzone





(SISIS 2007)

Scarification?

Brushing

Removal of excess surface water

Mole Drainage

- Most drainage problems associated with heavy soils tend to be caused by poor surface infiltration.

- The most commonly adopted method for removing surface water is sand slitting into an existing drainage infrastructure.

- However, mole draining is a cost effective alternative to this approach and gives the following advantages;

  - Increasing infiltration rates
  - reduces surface ponding,
  - increases playability and
  - reduces pitch wear.

Mole drainage

Advantages

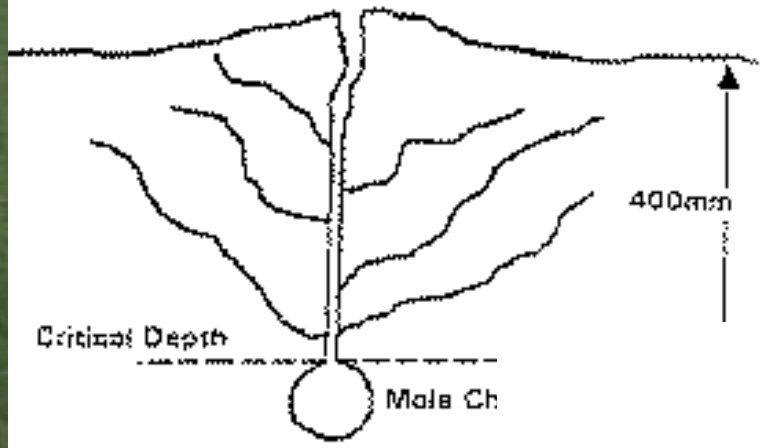
Very affordable equipment.
Low skill level (1 man operative).
Very affordable installation.
Repeatable.
Can last 5-8 years.
Minimum top dressing required.
Ready for play immediately.
Can be done without an existing infrastructure.
No arisings

Disadvantages

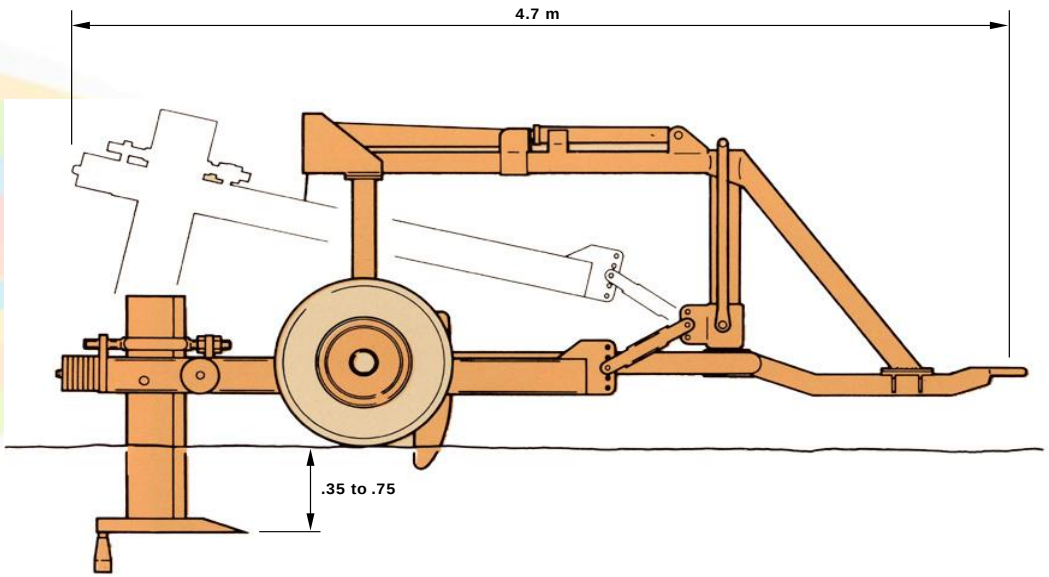
Soils can crack badly if undertaken in wrong conditions.
Correct machinery has to be used specific sports mole drainage systems plus top surface management systems
Narrow window of installation.
Soil type specific.

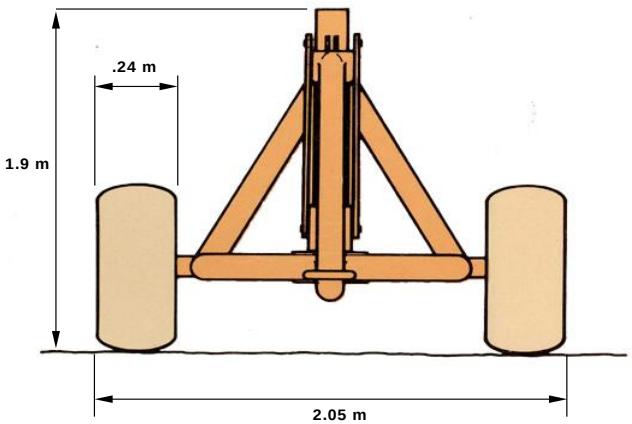
Mole drainage

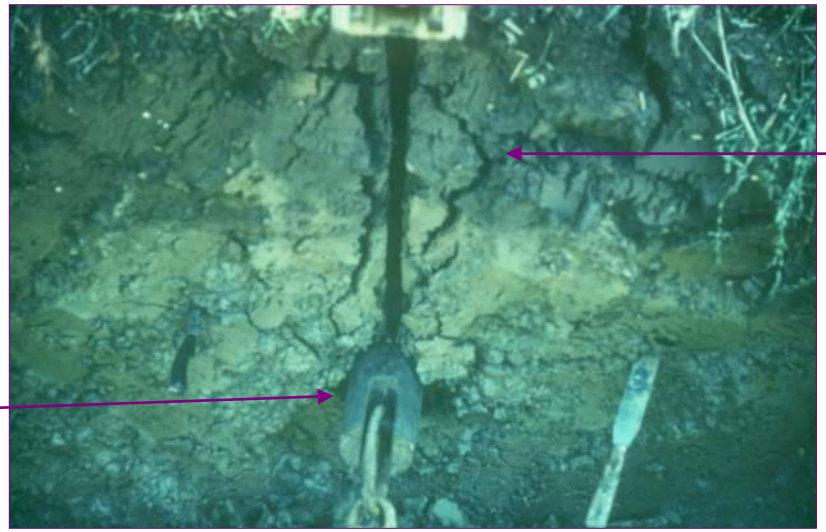
Mole ploughs offer a cheaper surface drainage solution for pitches on indigenous soils with a high clay content



A typical mole plough design







Cracks created by the mole plough allow movement of water through the profile

Mole channel

Mole plough foot

Aeration: Groundbreaker

Sand slitting

Advantages

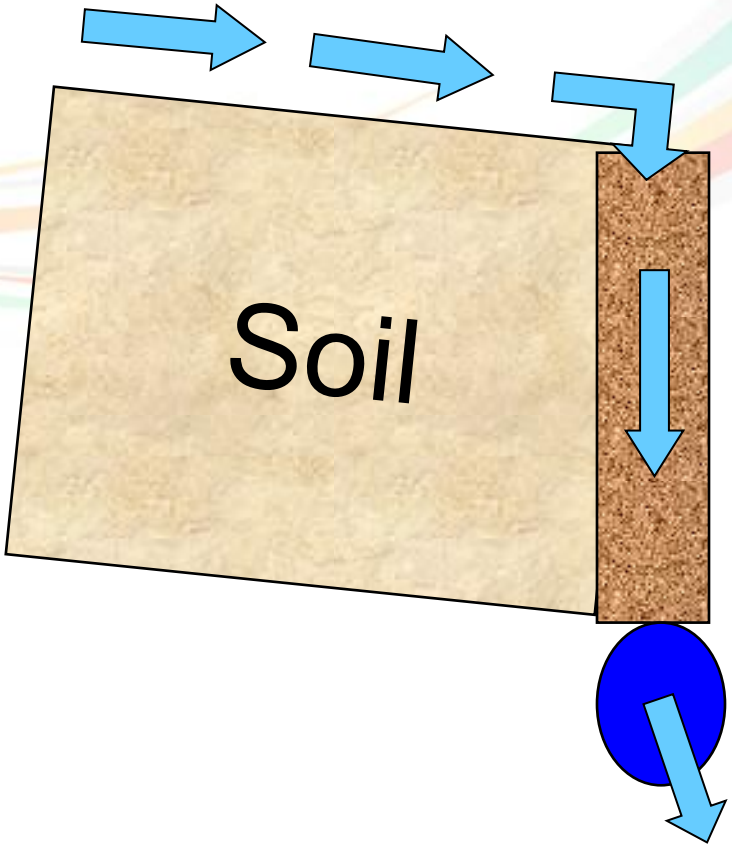
Very effective in all soils.
Can last 10 years.
Wide window of installation.

Disadvantages

Expensive to install and maintain.
Can last only 1 season if not maintained correctly.
Sinkage due to shrinkage of soils.
Arising's up to 140 tonnes per pitch
Sand depth critical.
3 man operation.
Not ready for play until grass cover complete.
Requires existing or new main drainage infrastructure.

Surface-water solutions

- Sand slitting / gravel banding



Surface-water solutions

Sand slit excavation

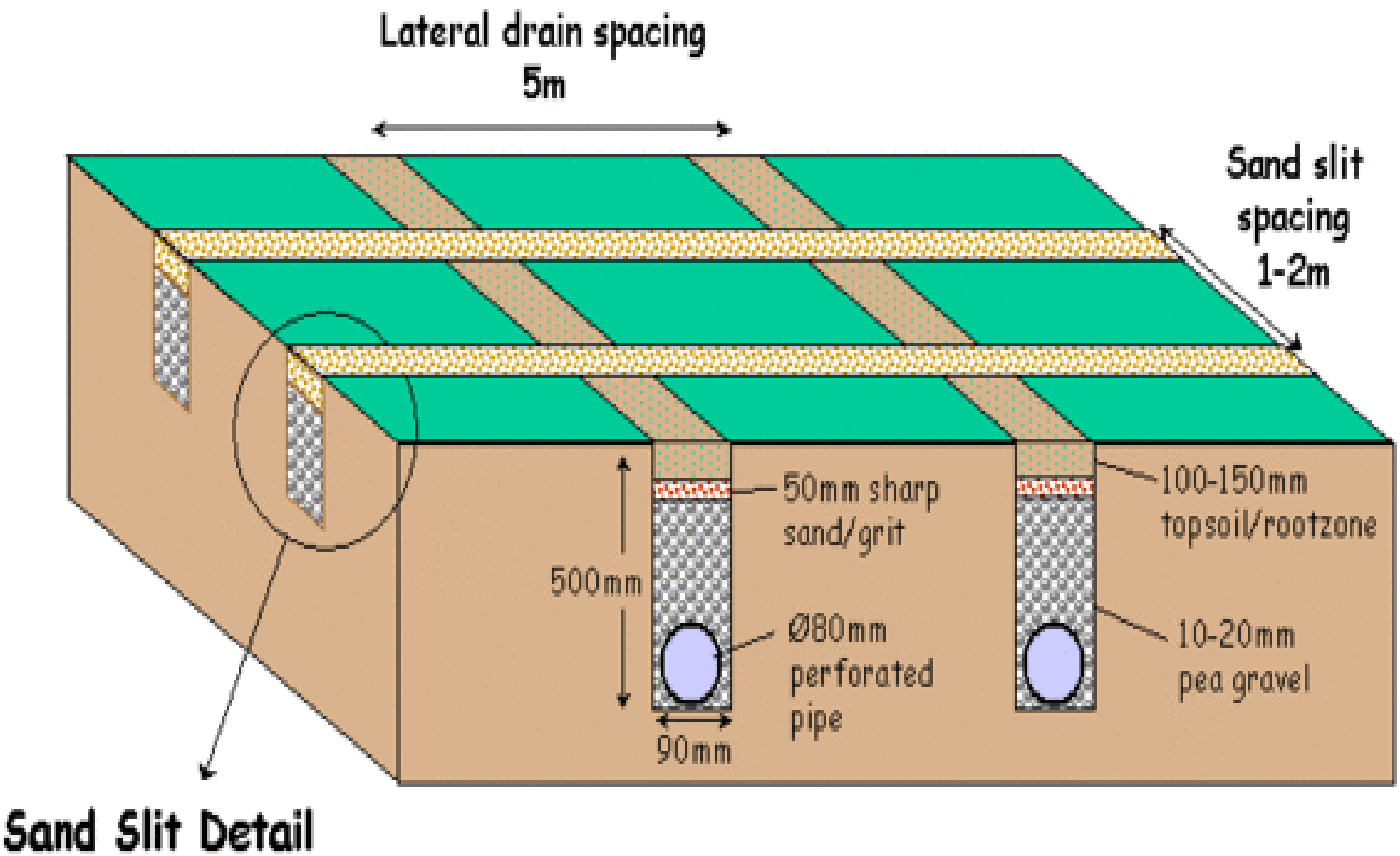
(c) Cranfield University (NSRI), 2004

Installing sand slits

Sand slits

Topping up sand slits

Sand slits


Lateral drain spacing
5m
Sand slit
spacing
1-2m
50mm sharp
sand/grit
100-150mm
topsoil/rootzone
500mm
Ø80mm
perforated
pipe
10-20mm
pea gravel
90mm
Sand Slit Detail

Sand Banding

Sand banding

Trench and pipe drainage

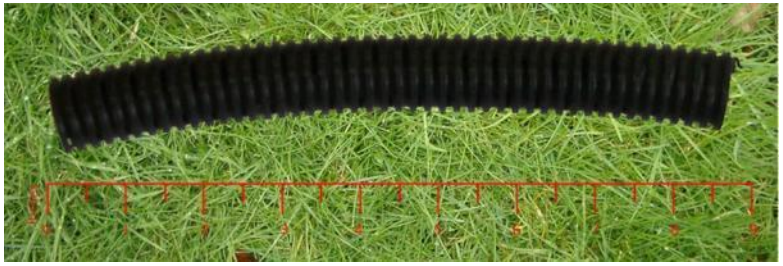
Certain soils will require a full interceptor, lateral and carrier drainage system. Calculations show that the conventional 80 mm pipe is over sized for conventional sports pitch drainage.

The table below shows the diameter size of lateral pipe for a range of spacings on a full size football pitch for 30 mm of rainfall per day.

Groundsman use micro pipes at the base of all their interceptor drains (sand slits) as well as reducing the size of the lateral drains. This means less arisings and less cost without compromising drainage efficiency.

Diameter of pipe at grade (mm)	Lateral spacings (m)					
	6 m	8 m	10 m	12 m	15 m	20 m
0.5%	≤ 20	≤ 30	30	35	40	≤ 45
0.1%	≤ 30	35	40	45	50	55

Source: ADAS FDEU Nomographs



Drain trenching equipment

Pipe drainage

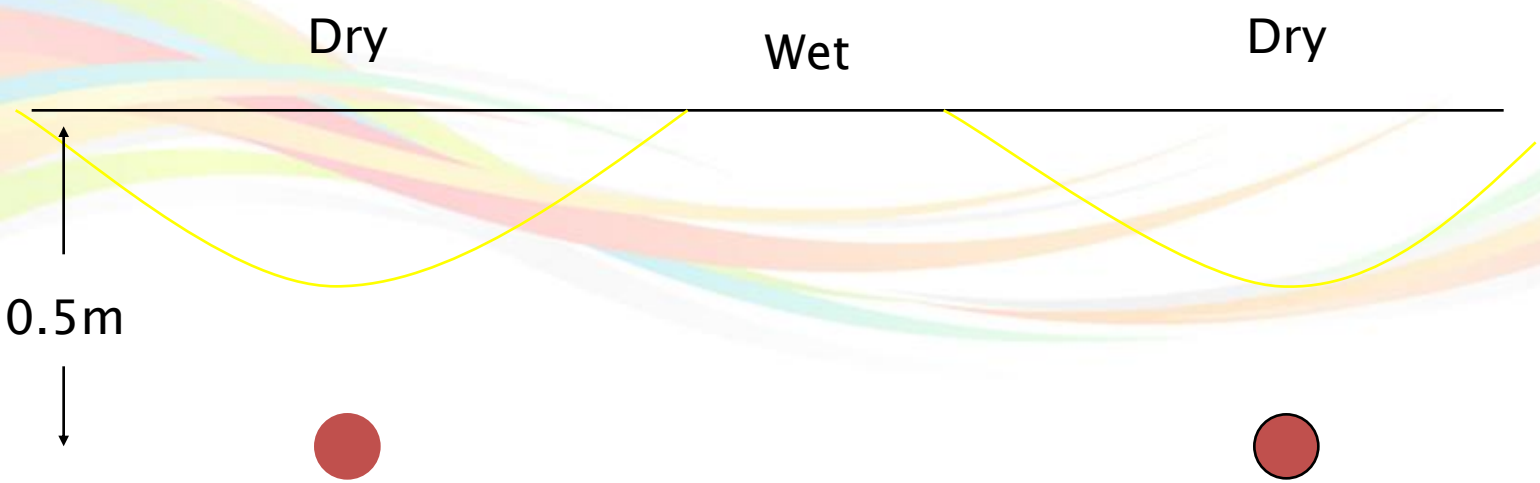
Installing pipe drainage

Main drain cutting and laying

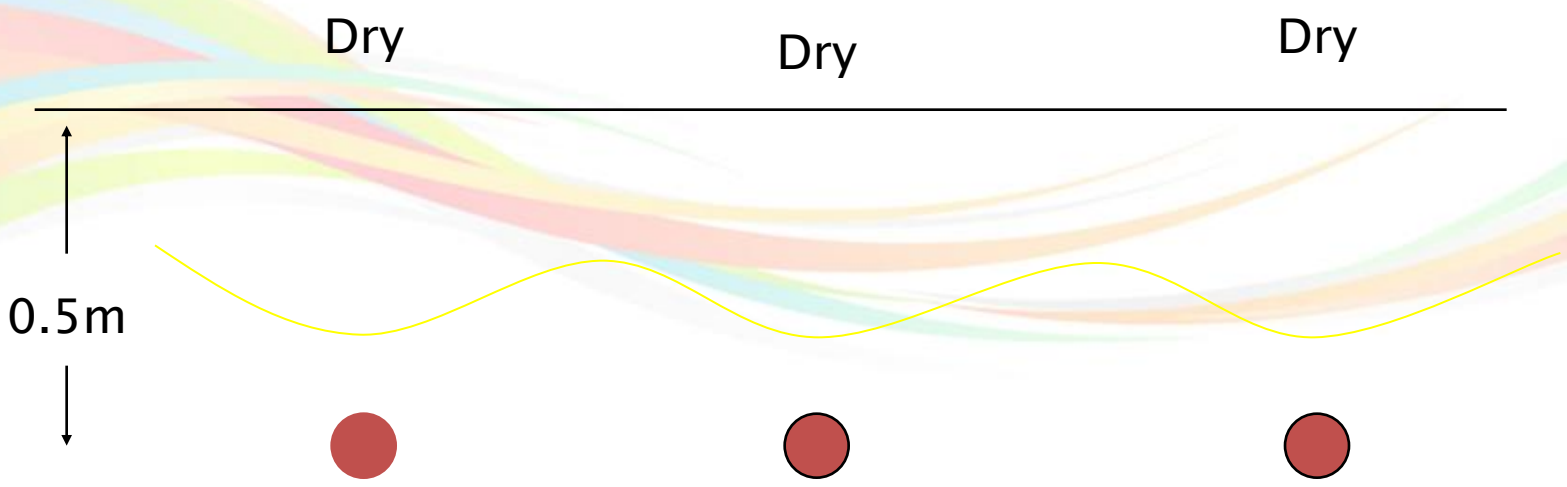
Pipe drain backfill

Consolidation of backfill

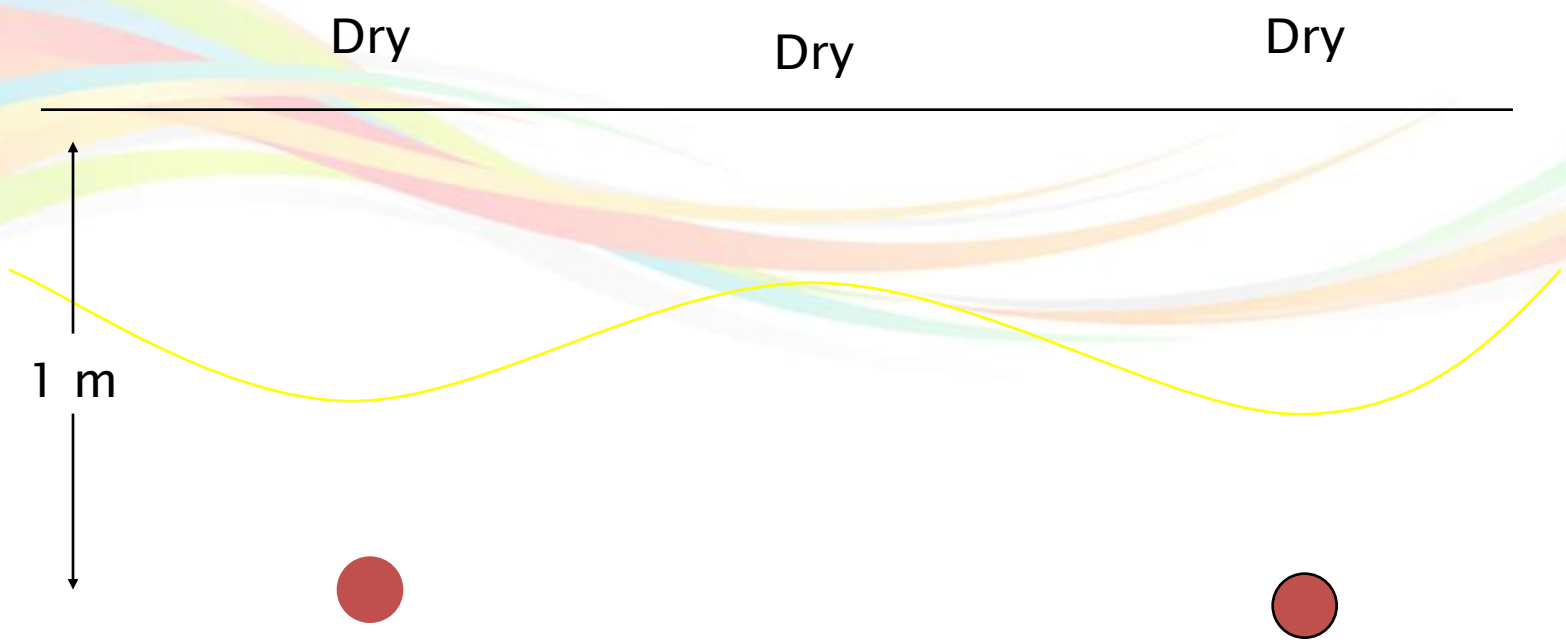
Effect of depth on drain spacing



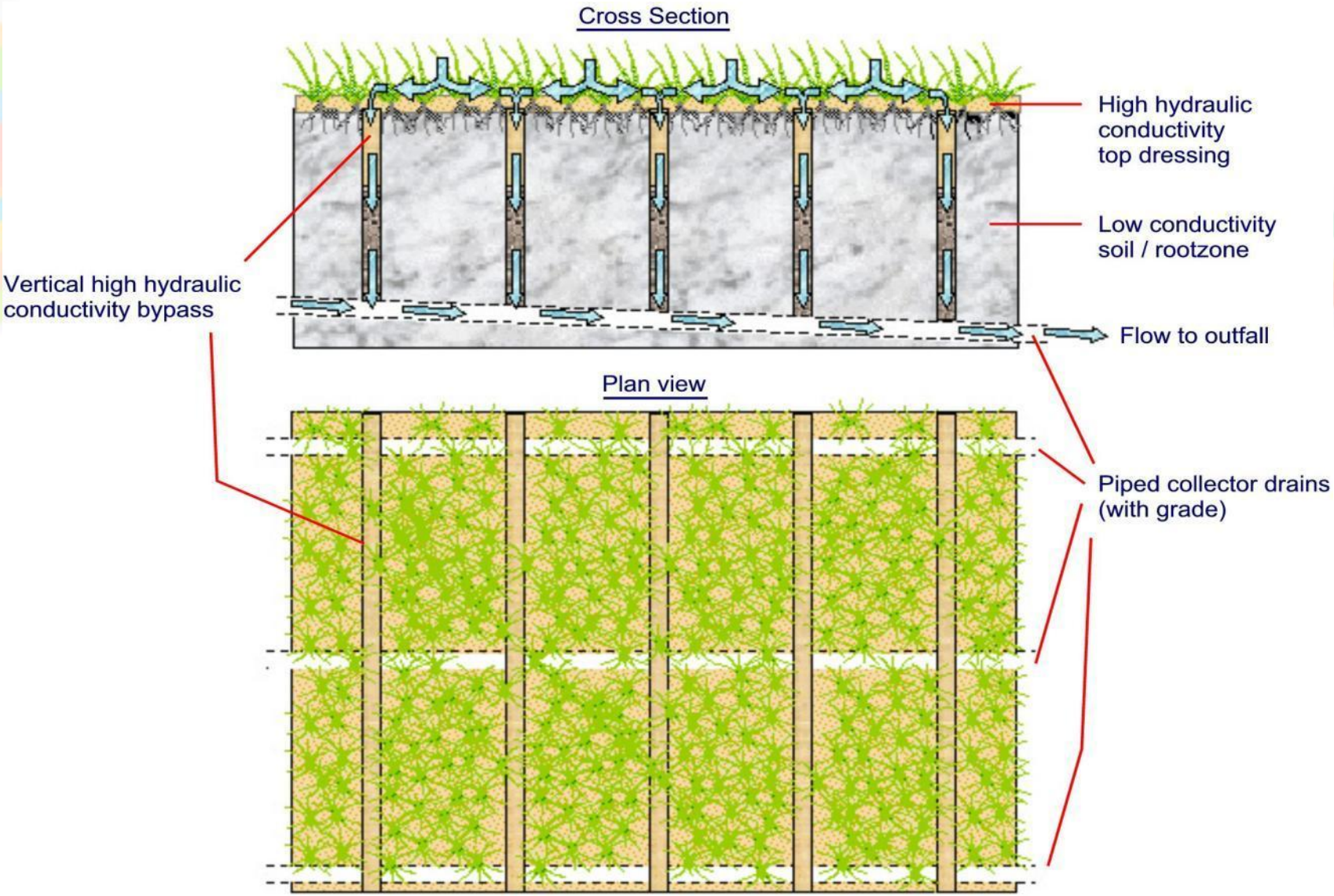
Effect of depth on drain spacing

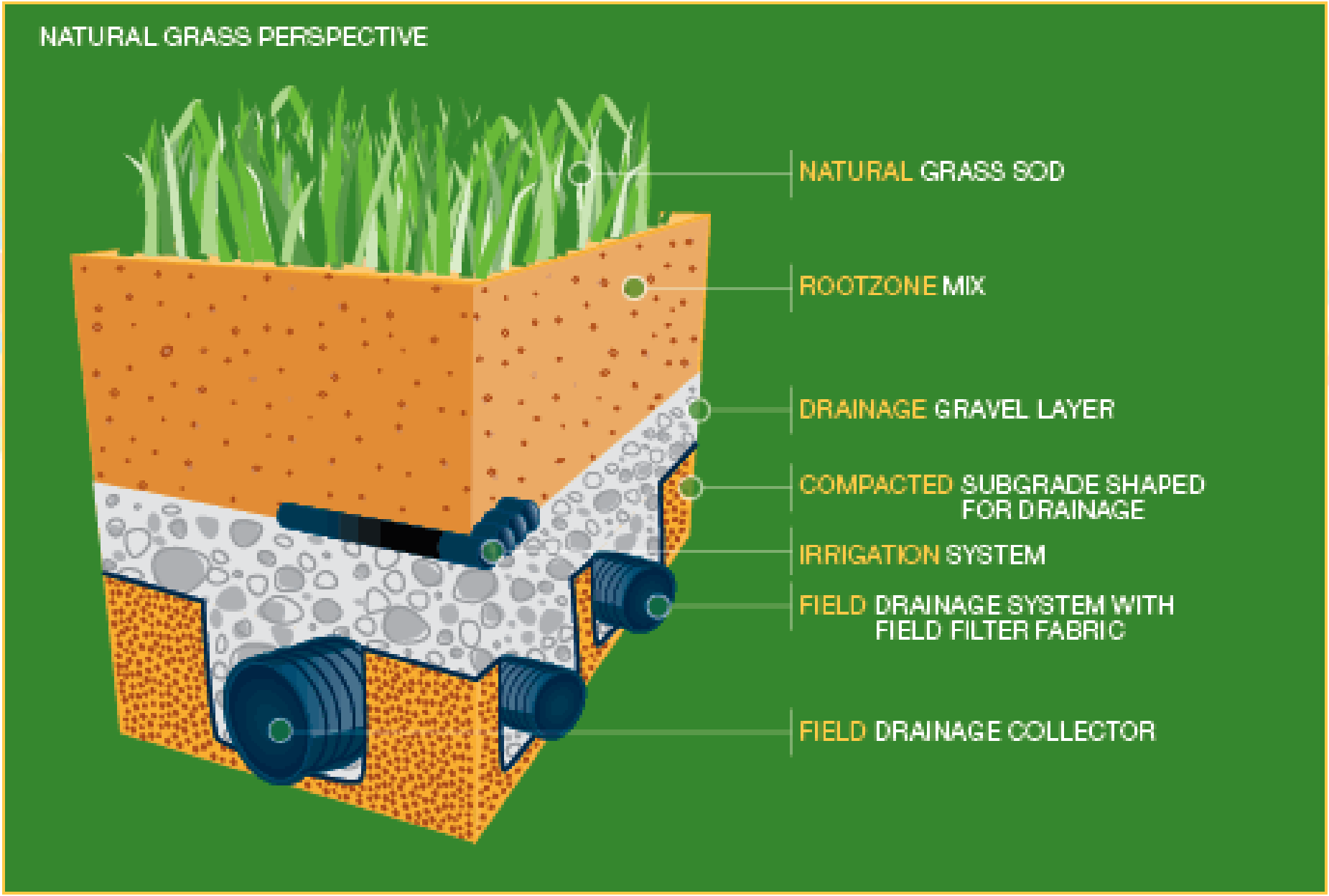


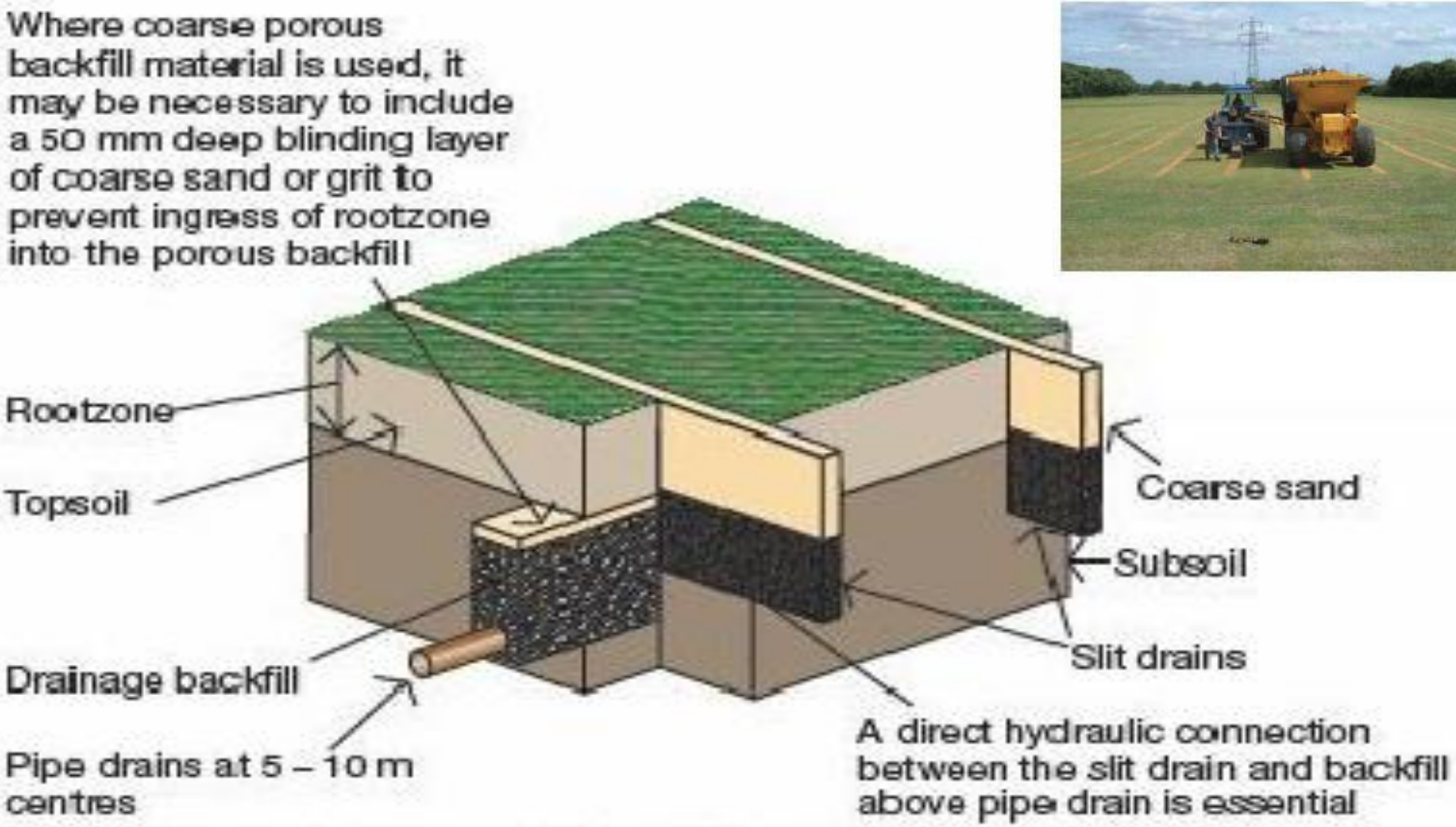
Effect of depth on drain spacing



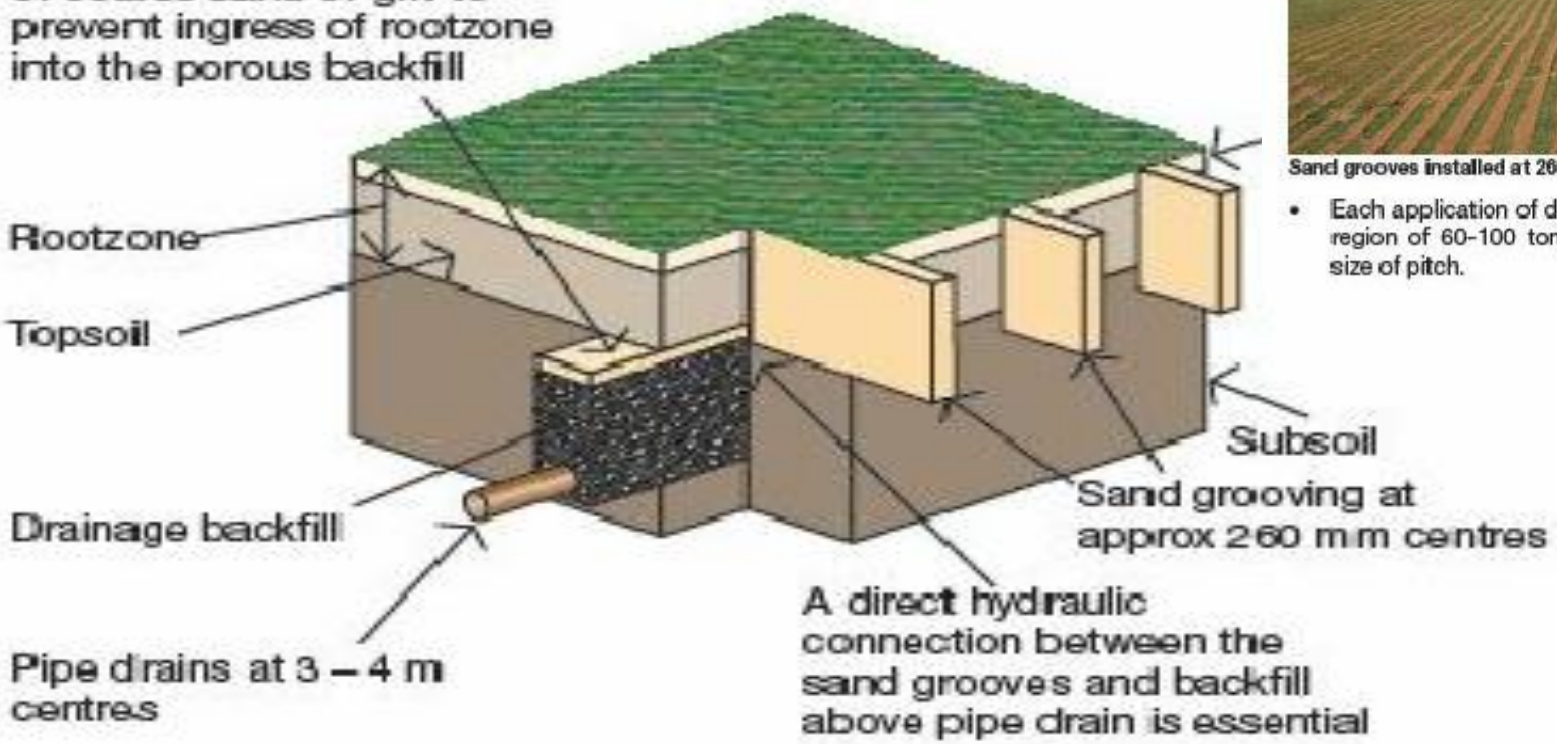
Surface water problems – bypass drainage solutions




NATURAL GRASS PERSPECTIVE
NATURAL GRASS SOD
ROOTZONE MIX
DRAINAGE GRAVEL LAYER
COMPACTED SUBGRADE SHAPED FOR DRAINAGE
IRRIGATION SYSTEM
FIELD DRAINAGE SYSTEM WITH FIELD FILTER FABRIC
FIELD DRAINAGE COLLECTOR



Pipe drainage and slit drainage construction on cultivated topsoil



Sand grooves installed at 260 mm centres

- Each application of dressing should be in the region of 60-100 tonnes, depending on the size of pitch.

Pipe drainage construction on cultivated topsoil with supplementary sand grooving

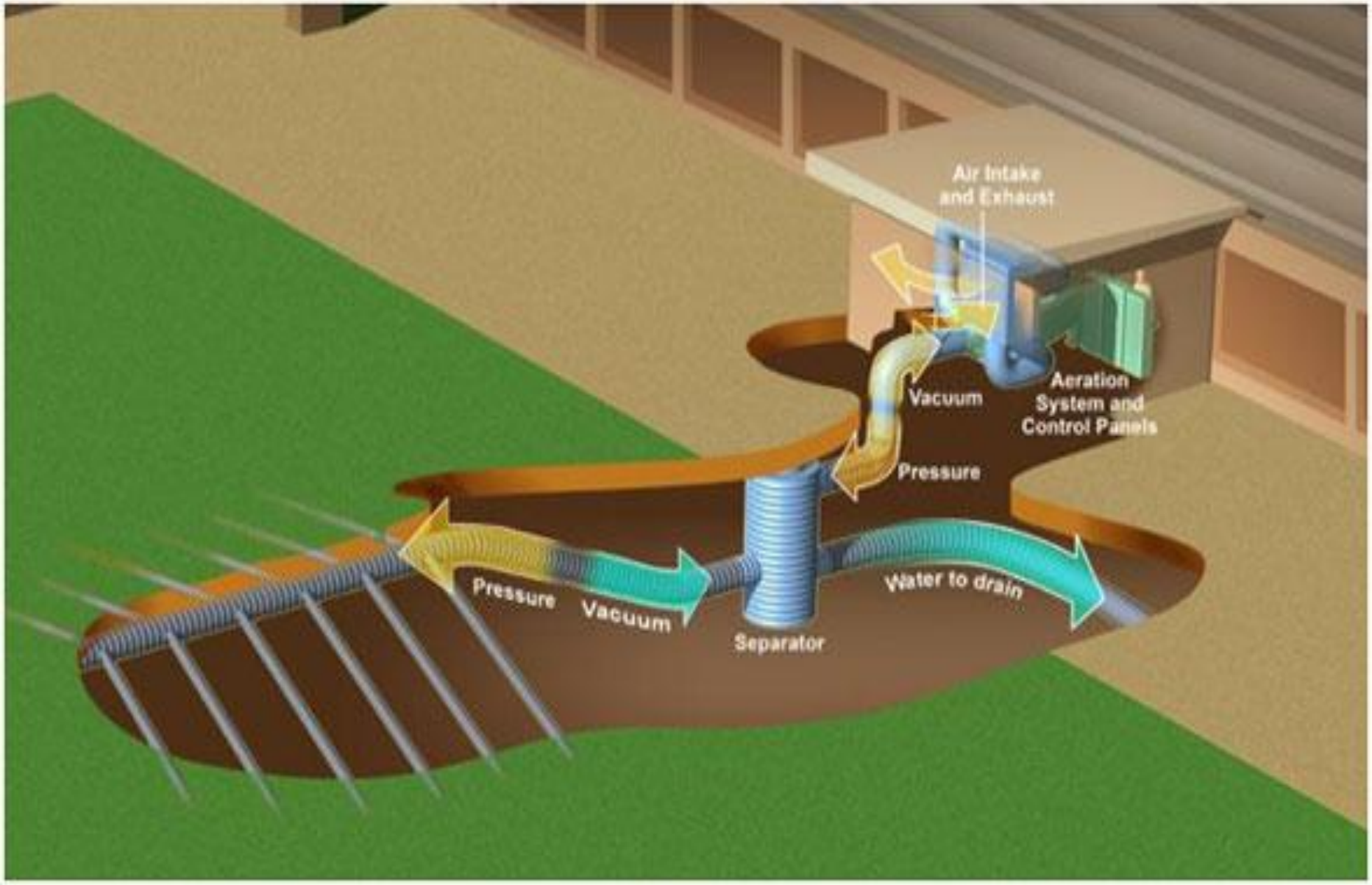
Materials

Herringbone system

Herringbone

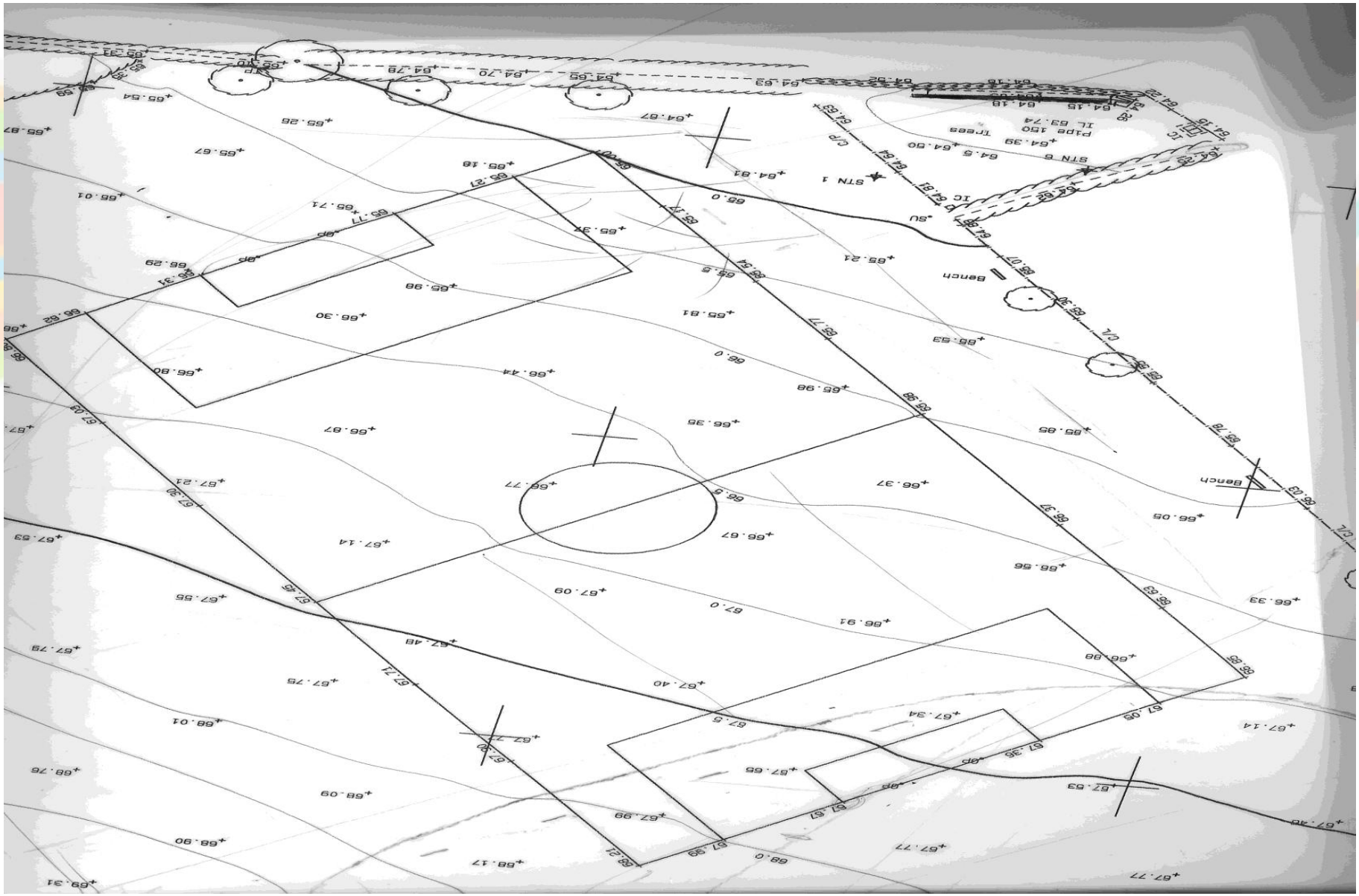
Sub air!!!!!!

Sub air!!!!!!


Air Intake
and Exhaust
Vacuum
Aeration
System and
Control Panels
Pressure
Pressure
Vacuum
Water to drain
Separator

THE Where?

A plans what we need..

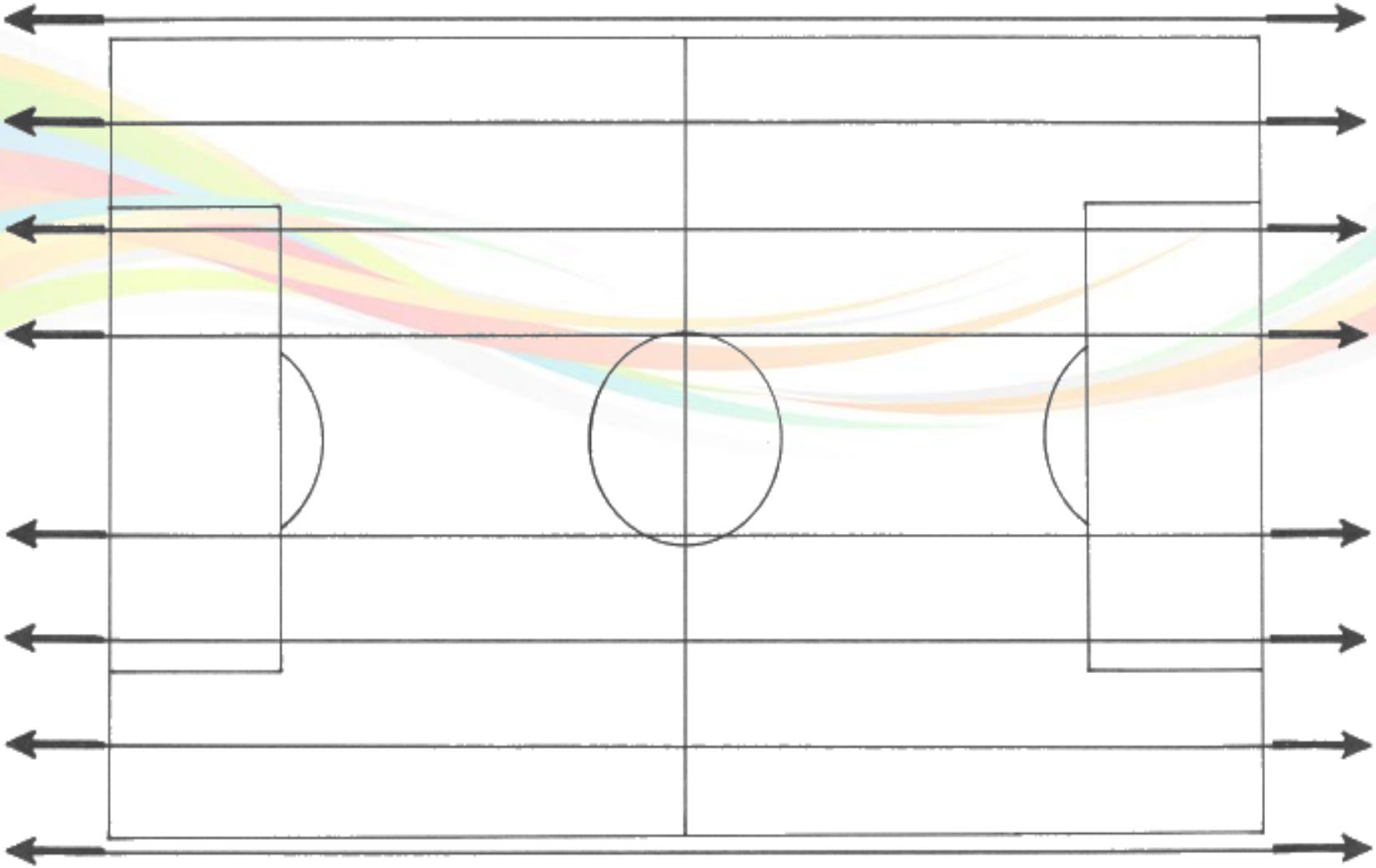


X marks the spot

A Feasibility Study

- The Planning Process
- Planning Policy Guidance
- Development Plans
- Environmental Assessment
- Geographic Area and Demand.
- Assessment of Existing Facilities
- Specific Location
- Current Land Use
- Land Area
- Landscape Quality Assessment
- Type and Proposed Scale of Development/design

Which way to go



Specification

Natural soil - can produce good surfaces but variability in soil properties

- Constructed soils - specifications for:
- Blend of soil particle sizes
- Blends to be used for different layers
- Mechanical strength
- Water movement

Is a perched water table construction appropriate?

Construction

Can dictate ultimate success or failure

- Adhering to the specifications?
- Moisture status during construction?
- Keying in layers?
- Development of good rootzone?

Construction

Can dictate ultimate success or failure

- What does it cost?
- Who designed it?
- How do you tender?

Construction

Can dictate ultimate success or failure

- What does it cost?
- Who designed it?
- How do you tender?
- Have the drainage issues been identified correctly?

Construction

Construction

Can dictate ultimate success or failure

- What does it cost?
- Who designed it?
- How do you tender?
- Have the drainage issues been identified correctly?
- What type of drainage; pipes or moles, or pipes and slits or both?

Construction-installation of subase pipe drainage

Pipe installation

Laser levelling of lower rootzone

Distribution of upper rootzone

Consolidation of upper rootzone

Laser leveling upper rootzone

The Results?

A winning formula..

What a result..

Testing,Testing,Testing……

And Remember after construction……

THE When?

Prevention better than cure

- Surface water problems:
  - Try and keep infiltration rates above approx 15 mm/day
  - Keep the surface open – harrowing, decompaction etc.
  - Encourage and look after grass roots
  - Herd management – rotation of pitches, defining walkways, controlling practice areas.
  - Understand your soils and their structure
  - Managing hydrophobicity
  - Control watershed onto sports surfaces

Prevention better than cure

- Ground water problems:
  - Divert water supply sources (springs etc)
  - Check and clear outfall
  - Check and maintain drainage network
  - Understand your soils and their structure

Problems and solutions

- Groundsman need to tailor the solution to the drainage problem which is why all projects start with a diagnosis.

- Different soils will have very different drainage properties and will therefore require a unique design approach to the solution.

- Managing “groundwater” drainage is managing “top water” drainage.

THE Future?

Aeration equipment


THE
END