10 Things You Didn’t Know about Subsurface (Tile) Drainage

Drainage Engineers Conference

October 27, 2017
#10
WHAT IS SUBSURFACE DRAINAGE?
SUBSURFACE DRAINAGE
WHAT IS IT?

• Series of pipes installed beneath the land surface
• Minimum depth is 600mm (2 ft)
• Typical depth is 750mm (2.5 ft)
• Spacing varies depending on crop, soil, drainage need and economics
#10

WHAT YOU DIDN’T KNOW:

SUBSURFACE DRAINAGE FUNCTIONS COMPARABLY TO THE HOLES IN THE BOTTOM OF A FLOWER POT
#9 HISTORY OF SUBSURFACE DRAINAGE
Major increase in subsurface drainage activity in Ontario in the late 60’s and 1970’s. Increase due to:

- Invention of plough machines
- Invention of plastic pipe
- Invention of laser grade control systems.

• Today, over 100 million feet of pipe installed annually
1920 – 1970’s - clay tile installed with wheel machines
Late 1800’s to early 1900’s - clay tile installed by hand
Early/mid 1800’s: Clay tile or any form of conduit installed by hand

John Johnston from New York State - First to promote tile drainage in North America – 1835
Earlier records of subsurface drainage:

- North America: Some sporadic references prior to John Johnston in 1835
- 1600’s – Monastery gardens in France
- Some references to subsurface drainage in Scotland back to 1400’s.
- Palladius – Roman writer on agriculture in 3rd or 4th century - wrote on drainage
- Lucius Columella – AD 4 – 70 – provide directions for agricultural drainage
The Earliest:
Marcus Porcius Cato, 234 – 149 BC

“Of Draining

If the land is wet, it should be drained with trough shaped ditches dug three feet wide at the surface and one foot at the bottom and four feet deep. Blind these ditches with rock. If you have no rock then fill them with green willow poles braced crosswise. If you have no poles, fill them with faggots. Then dig lateral trenches three feet deep and four feet wide in such way that the water will flow from the trenches into the ditches.”
#9

WHAT YOU DIDN’T KNOW:

SUBSURFACE DRAINAGE DATES BACK AS EARLY AS THE SECOND CENTURY B.C.
Primary purpose of subsurface drainage is to drain the “gravitational” water from the root zone:

- Typical Tile Spacing = 40 ft. (12 m)
- Typical Tile Depth = 2.5 ft. (0.75 m)
- Minimum Cover over tile = 2 ft. (0.6 m)
How it works

- Before rain: tiles are not flowing
- When water level drops below tile, tile do not flow
- Crops still supplied by capillary action
Rain begins: Soil infiltration – still no tile flow
Very little runoff: Soil is storing water
An agricultural stormwater management pond
- Rain continues: Tiles begin to flow
- Note ditch acts in same manner as a tile
- Rain continues: Soil now saturated
- Tile are flowing
- Soil is saturated; Surface runoff begins
• Rain ends: Surface runoff also ends
• Tiles are still flowing; gravitational water in soil is being drawn down
• Tiles are still flowing; gravitational water in soil is continues to be drawn down
• Quickest over tile; slowest between tiles
- Gravitational water in soil is drawn down almost to tile level
- Flow in tile slows down
- Gravitational water in soil drops below tile level
- Tile flow ends
#8

WHAT YOU DIDN’T KNOW:

• SUBSURFACE DRAINAGE REDUCES OVERLAND FLOW AND THE MOVEMENT OF SEDIMENT
#7

WHAT YOU DIDN’T KNOW:

• SUBSURFACE DRAINAGE ONLY FLOWS WHEN WATER TABLE RAISES TO THE BOTTOM OF PIPE

• DRAINED SOIL = AGRICULTURAL STORM WATER MANAGEMENT
#6
POLLUTION
HOW MUCH DOES THIS ROAD POLLUTE THE AIR?
HOW MUCH DOES THIS ROAD POLLUTE THE AIR?
HOW MUCH DOES THIS SUBSURFACE DRAINAGE SYSTEM POLLUTE THE WATER?
#6

WHAT YOU DIDN’T KNOW:

SUBSURFACE DRAINAGE ACTS AS A CONDUIT FOR WATER – IT DOES NOT POLLUTE WATER.
#5

SUBSURFACE DRAINAGE IN DRY CONDITIONS
Improved Drought Resistance

**UNDRAINED LAND**
- Spring
- Summer

**Free water level**

**TILE DRAINED LAND**
- Spring
- Summer

**Free water level**
Impacts are usually visibly noticeable; Also noticeable through crop yield monitors.
WHAT YOU DIDN’T KNOW:

SUBSURFACE DRAINAGE ENCOURAGES CROPS TO DEVELOP STRONGER ROOT SYSTEMS WHICH HELP THEM IN DRY CONDITIONS
#4 LICENSING
AGRICULTURAL TILE DRAINAGE INSTALLATION ACT

• Purpose: Regulate contractor workmanship
  ✓ Act applies to installation of tile drainage systems on agricultural land only
  ✓ Licenses not required when individual installs tile drainage on their own land

• The following licenses are required:
  ✓ Business License
  ✓ Machine License
  ✓ Machine Operator License
Operators must successfully:
- Complete an 8-day Primary Drainage Course
- Complete an 8-day Advanced Drainage Course
- Pass a field test

Courses ensure that participants:
- Are able to survey
- Are able to design and layout a tile drainage system
- Are aware of applicable laws
• Each year, Ontario contractors install over 100 million feet of tubing beneath the surface of agricultural land.

• Equivalent to going across Canada (east coast to west coast) 5 ½ times.

• Tile drainage machines produced in Ontario are marketed as “licensed in Ontario”
#4

WHAT YOU DIDN’T KNOW:

ONTARIO IS ONE OF THE ONLY JURISDICATIONS IN THE WORLD THAT REQUIRES TILE DRAINAGE CONTRACTORS TO BE LICENSED
OTHER BENEFITS
SUBSURFACE DRAINAGE: WHY DO FARMERS DRAIN?

- Improved Trafficability
AGRICULTURAL DRAINAGE: WHY DO FARMERS DRAIN?

OTHER BENEFITS:

• HIGHER SOIL TEMPERATURE
• BETTER SOIL STRUCTURE
  – Reduced Soil Compaction
• IMPROVED DISEASE AND WEED CONTROL
AGRICULTURAL DRAINAGE
WHY DO FARMERS DRAIN?

Earlier Planting Dates

Expected No. of Field Workdays on Drained Soil
2 yrs out of 3 (clay loam soil)
SUBSURFACE DRAINAGE: WHY DO FARMERS DRAIN?

No till and conservation tillage practices are dependent on well drained soils.
WHAT YOU DIDN’T KNOW:
THERE ARE BENEFITS OF SUBSURFACE DRAINAGE THAT EXTEND BEYOND JUST INCREASED CROP PRODUCTIVITY
#2

SUBSURFACE DRAINAGE INCREASES PRODUCTIVITY
SUBSURFACE DRAINAGE INCREASES CROP PRODUCTIVITY

INCREASED CROP PRODUCTIVITY

• Corn – 29%
• Soybeans – 26%
• Winter Wheat – 38%
• Spring Wheat – 33%
• White Beans – 21%

Source: Land Improvement Contractors of Ontario
www.drainage.org

SO WHAT?
World Population Growth

Population (Billions)

Year

1650
1700
1750
1800
1850
1900
1950
2000
2050

1.75 billion

1911

2011
7 billion

1.75 billion

1911
Available Agricultural Land

YEAR

1650 1700 1750 1800 1850 1900 1950 2000 2050
IN NORTH AMERICA:
• Biofuels production increasing cereal crop demands
• Loss of prime agricultural land due to urban development
• Retirement of environmentally sensitive agricultural lands.
HOW DO WE PRODUCE ENOUGH FOOD?

- Genetic crop modifications
- Added nutrients
- Improved disease control (e.g. pesticides)
- Converting environmentally sensitive land to agricultural production
- Improving the production environment of existing agricultural land (e.g. drainage or irrigation)
#2

WHAT YOU DIDN’T KNOW:

SUBSURFACE DRAINAGE IMPROVES CROP PRODUCTIVITY WHICH REDUCES PRESSURE ON LAND CONVERSION AND IMPROVES OUR ABILITY TO PRODUCE FOOD FOR A GROWING POPULATION.
#1

JACK MINER
JACK MINER 1865-1944

A noted naturalist, John Thomas Miner was born in Dover Centre, Ohio, and in 1878 settled on this property. In 1904 he established this world famous bird sanctuary, primarily for the conservation of migrating Canada geese and ducks. Five years later he began banding waterfowl to determine their subsequent movements. During his life Miner lectured extensively throughout North America on wildlife conservation. To perpetuate his work, the Jack Miner Migratory Bird Foundation was incorporated in the United States in 1931 and in Canada in 1936. Author of two books on bird life and conservation, he was awarded the O.B.E. in 1943 "for the greatest achievement in conservation in the British Empire".

Archaeological and Historic Sites Board of Ontario.
Jack Miner is sixty-two years of age and, as he says in his book, was “born in the United States and made in Canada.” His birthplace was at Dover Centre, Ohio, from which place he moved to Canada when but only thirteen years of age, with his parents. As the land in Essex county, Ontario, Canada, is very level, there was a huge market for drain tile and, his father being a drain tile manufacturer in the United States, Jack Miner followed that profession. When he grew to manhood, under financial difficulties, he started what he called “a one-horse tile yard,” which he and his sons still operate. As the clay is excavated, the cavities are made into artificial ponds for the ducks and geese to feed and drink.
“TILE”
Written by Jack Miner, Naturalist
Founder of the
Jack Miner Migratory Bird Foundation
I am only a hole in a humble vocation,
   Yet I greatly control your civilization;
I am very tenacious and hard as stone,
   And am like old Horatius in holding my own.
So lay me down, keep me straight in the ditch,
   And while you are sleeping I’ll be making you rich.

Every farmer of pride dearly loves to provide
   For the future, the son and the daughter;
So give me the chance and I’ll greatly enhance
   Every acre I drain of its water.
And here’s my great beauty – I’m always on duty,
Out of reach of the bulls and the bears;
And when you’re in your grave I’ll continue to slave
For the children – their children – and theirs.

My habits are good, I require no food,
(My joints are all made without mortar)
And I always abstain, when deep in the drain
From everything stronger than water.
If your land is too wet and you’re burdened with debt
   And encumbrance begins to accrue,
Obey Nature’s laws, by removing the cause,
   Drain your farm or it will drain you.

‘Tis so foolish to plant where the Goose and Brant
   Might paddle from March to September,
You might as well sow on a November snow,
   And expect seed to grow – in December.
Some farmers are failing, and weeping and wailing
And blame the Good Lord without reason,
When if they would stop sowing seed in the slop
They might raise a good crop every season.

Most farmers lament the money they’ve spent
For things only made to beguile;
But never as yet did a farmer regret
The money expended for tile.
WHAT YOU DIDN'T KNOW:

JACK MINER RECOGNIZED THAT CONSERVATION GOALS CAN CO-EXIST WITH AGRICULTURE AND SUBSURFACE DRAINAGE.