NUTRIENTS, ENERGY, WATER AND SUSTAINABLE MANAGEMENT (NEWS) CONSIDERATIONS

PRESENTATION TO SW ONSITE CONFERENCE, JAN 2014

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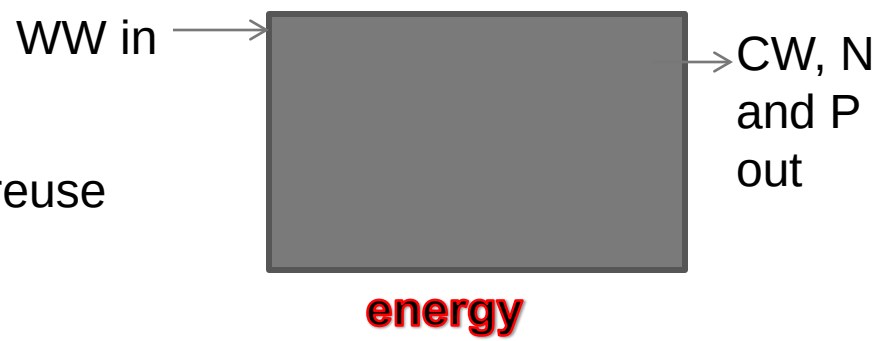
HANDS DOWN – BEST AVAILABLE – BB(G)B FOR NEWS APPROACH

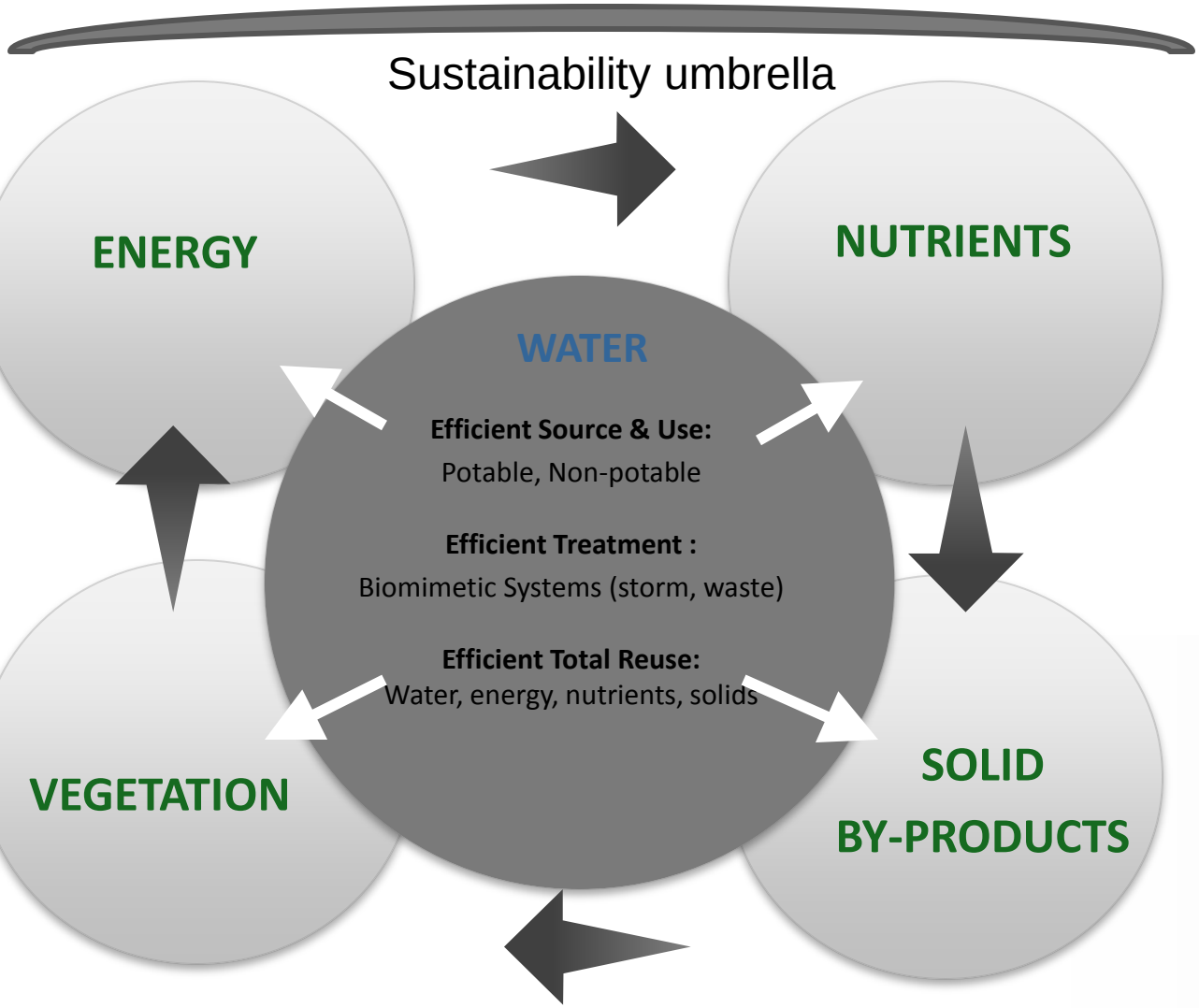
Bob's Blue (gray) Box



- BOD, TSS, TN, Coli – ND
  - Suited for unrestricted reuse
- No Odor, Low Power
- No sludge
- No management or oversight required
- Low cost
- NSF or ETV unnecessary

- All fiction

THE FUTURE: WATER-CENTRIC INTEGRATED INFRASTRUCTURE:



http://www.storyofstuff.com

NEW PRODUCTS/SERVICES

ENERGY:
Renewable: Biogas
Efficiency
- Production (Heat Pump)
- Use (Audit/Conservation)

NUTRIENTS:
Nitrogen
Phosphorus
Potassium
Soil Addatives

SOLID BY-PRODUCTS:
Disposal Destruction
Inorganic Stuff
Organic Stuff

VEGETATION:
Inedible, Edible
Carbon Sequestration
Biomass

REGARDLESS OF SCENARIO REUSE AND RECOVERY EMERGING

INDEPENDENT OR INNER CITY

Communities will operate resource recovery facilities (RRF)

Water

- Reclaimed at source
- Reclaimed at RRF

Energy

- digestion

Nutrients

- Urine harvest at home and business
- Biosolids derived at resource recovery

NYC PROJECTS RECOVER WATER

NUTRIENTS, ENERGY AND WATER

Nutrients

- **N and P**

Energy

- **Septage and FOG digestion**

Water

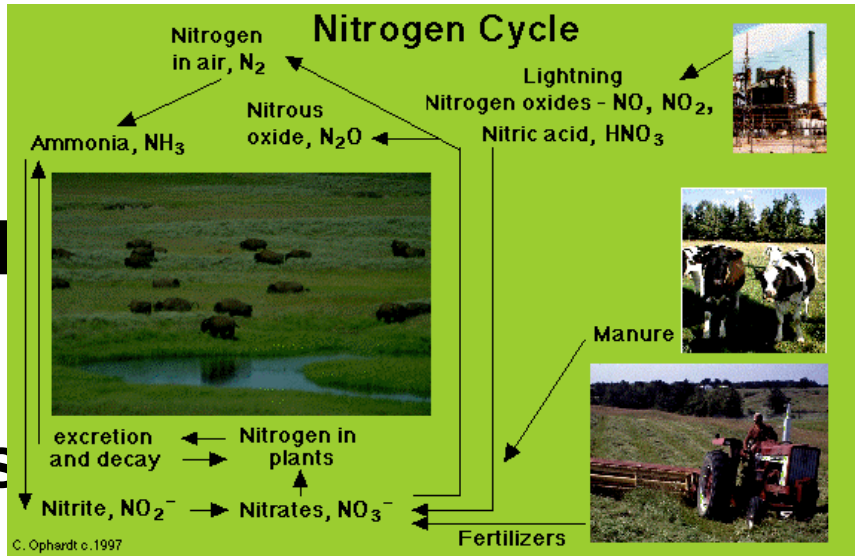
- **Reuse potential**

NUTRIENTS – N, P AND 14 OTHERS

16 essential nutrients

Cycled through production, consumption and decomposition

Emerging P crisis



NUTRIENT REMOVAL?

Is it necessary? Does receiving environment dictate removal?

Can N and P be manages onsite as nutrient – plant uptake

CNMP-

- **crop removal**
- **nutrient characteristics (ON, NH_4^+, NO_3^-)**
- **placement – root zone???**
- **timing – all year long???**

ENERGY

Are energy recovery facilities available through local POTW?

Is there opportunity for private sector??

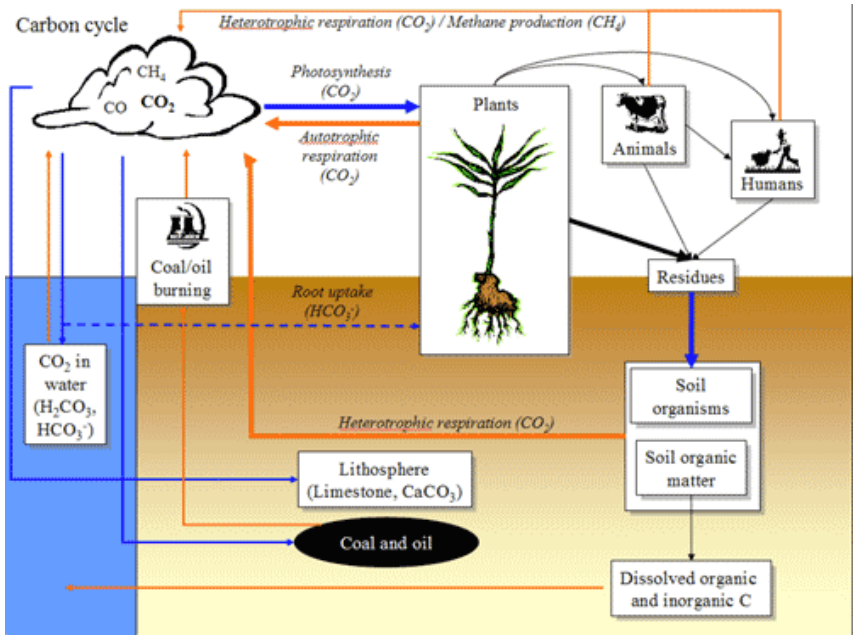
Anaerobic digestion technologies are well developed.

Is there market for heat or power???

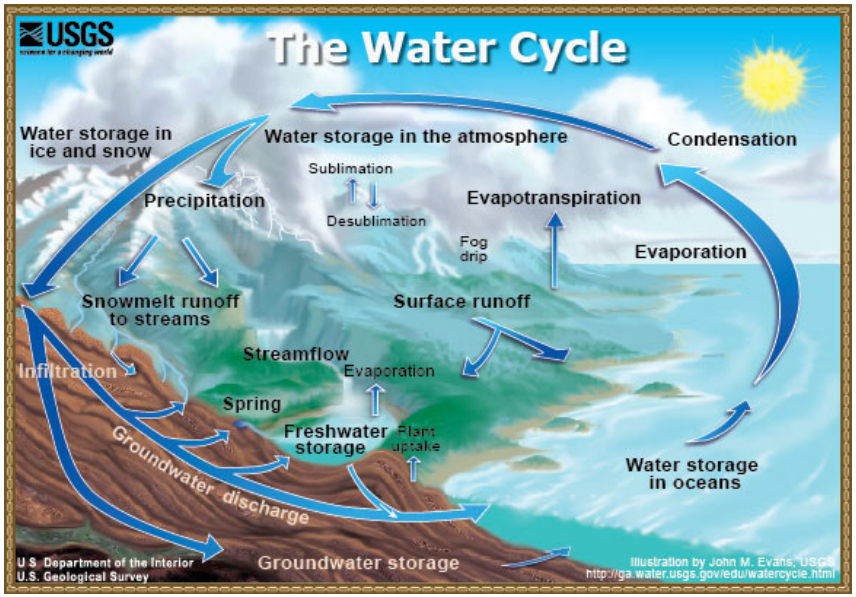
CARBON/ENERGY

Carbon vs. renewable resources

Anaerobic processes and associated energy recovery



THE HYDROLOGIC CYCLE



Water recycled continuously for billions of years

Supply has not changed

Distribution has

- Weather patterns
- Changing climate

WATER TREATMENT

Aerobic and anaerobic

Varying levels attainable

Simple to complex

Emphasis on resource recovery

REUSE GUIDELINES

Guidelines because NO mandate

Variety of end uses

Recent interest in direct and indirect potable use

This document is available via the internet:

http://www.waterreuseguidelines.org

TECHNICAL WASTEWATER ISSUES

TREATMENT

Septic tank

AS

Reuse

high level treatment and disinfection

DISPERSAL

Traditional SAS

Alternative SAS

- LPP
- Drip

NONTECHNICAL WASTEWATER ISSUES

O AND M

Solids management

Competent Personnel

Supplies and Equipment

Monitoring, Measuring, Reporting

Corrective action

PROGRAM MANAGEMENT

Sustainability

Finance

Improvement

SCIENCE AND ENGINEERING

BOD

Compounds containing organic Carbon

Energy for microorganisms

Oxygen required to degrade

1.5 Units O/Unit BOD

Easily removed in properly managed systems

Alkalinity necessary

NITROGEN

Organic and inorganic forms of N in wastewater

Both aerobic and anaerobic conditions necessary to degrade

Oxygen converts R-NH to NO

4.6 Units O/unit R-NH

Sensitive processes

Alkalinity necessary

ONSITE WASTEWATER TREATMENT

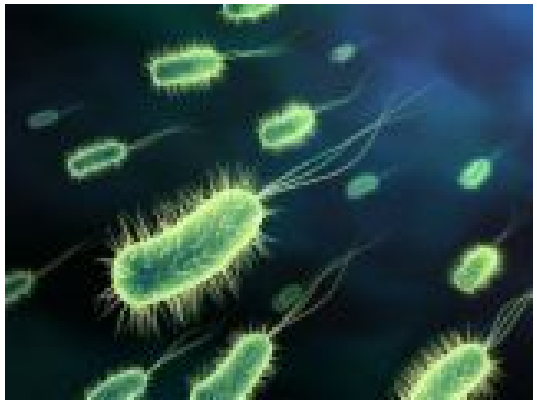
Physical – solids removal

Chemical – P removal

Biological – BOD removal

Aerobic/anaerobic

conditions necessary for N removal



**** Soil systems remain vital part of the dispersal component***

THE BEST SYSTEM IS DESIGNED TO ADDRESS SITE AND SOIL LIMITATIONS

Proper design addresses most limiting of the site and soil limitations and allows assimilation of all constituents on intended receiver site – Recommendations from Soils Consultants, agronomists, hydrogeologists, and farm/land manager

- Hydraulic
- Nutrient
- Organic and Inorganic

BIOCHEMICAL OXYGEN DEMAND (BOD)

Rate that organisms use oxygen to break down organic matter

High BOD levels indicate high levels of organic matter which rob O2 from water

Low DO undesirable and unhealthy for aquatic ecosystem

The best system removes BOD/COD/TSS to desired level

NITROGEN (N)

Four forms of N occur in wastewater

- Organic nitrogen
- Ammonia (NH_3) / ammonium (NH_4^+)
- Nitrite (NO_2^-)
- Nitrate (NO_3^-)

Organic N is converted to NH_4^+

NH_4^+ is then converted to NO_2^- and NO_3^-

In C rich environment under anaerobic conditions nitrate converted to N gas

The best system removes nutrients to desired level

PHOSPHOROUS (P)

Three forms occur in wastewater

- orthophosphate
- polyphosphate
- organic phosphate

Usually measured as total P

The best system removes nutrients to desired level

N AND P

In surface waters, these nutrients promote growth of algae and aquatic plants

P greatest concern in most fresh water environments

NSF PROGRAM OVERVIEW

Certification

- Testing
- Standards and Protocols

Environmental Technology Verification (ETV)

Research Services

Professional Accreditation

Field Effluent Monitoring:

- PA DEP Program
- National Standard

Field Service and Maintenance Monitoring

NSF-ANSI WASTEWATER STANDARDS

NSF/ANSI 41 -2011 *Non-liquid saturated treatment systems* (1978)

NSF/ANSI 46 -2010 *Evaluation of components and devices used in wastewater* (1997)

NSF/ANSI 240 -2011 *Drainfield trench product sizing for gravity dispersal onsite wastewater treatment and dispersal systems* (2011)

NSF/ANSI 40 -2010 *Residential wastewater treatment systems* (1970)

NSF/ANSI 245 -2010 *Wastewater treatment systems – nitrogen reduction* (2007)

NSF/ANSI 350 -2011 *Onsite residential and commercial water reuse treatment systems* (2011)

NSF/ANSI 350-1 -2011 *Onsite residential and commercial graywater treatment systems for subsurface discharge* (2011)

NSF/ANSI 360 -2010 *Wastewater treatment systems – field performance verification* (2010)

More may be developed as needed

TREATMENT SYSTEM VERIFICATION

NSF

Establishes standard – NSF/ANSI

40, 240, 245, 350

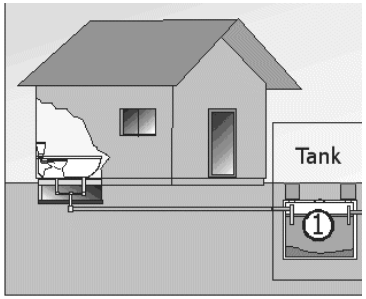
Certifies technology to standard

MASSACHUSETTS TEST CENTER

Tests specific technology against NSF/ANSI standard

Verifies performance through rigorous testing

Performance of Onsite Treatment Technologies



WASTEWATER FROM HOME

BOD: 110 - 400 mg/L

TSS: 100 - 350 mg/L

TN: 40 - 100 mg/L

TP: 5 - 15 mg/L

Fecal: 10^6 - 10^9 col/100 ML

SEPTIC TANK EFFLUENT

BOD: 110 - 200 mg/L

TSS: 50 - 100 mg/L

TN: 40 - 100 mg/L

TP: 5 - 15 mg/L

Fecal: 10^6 - 10^8 col/100 ML

SEPTIC TANK EFFLUENT, WITH RECYCLE

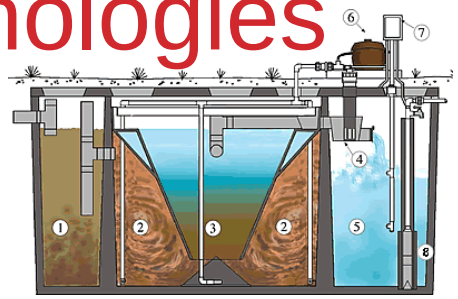
BOD: 80 - 120 mg/L

TSS: 50 - 80 mg/L

TN: 10 - 30 mg/L

TP: 5 - 15 mg/L

Fecal: 10^6 - 10^9 col/100 ML



AEROBIC UNIT EFFLUENT

BOD: 5 - 50 mg/L

TSS: 5 - 100 mg/L

TN: 25 - 60 mg/L

TP: 4 - 10 mg/L

Fecal: 10^3 - 10^4 col/100 ML

SAND FILTER EFFLUENT

BOD: 2 - 15 mg/L

TSS: 5 - 20 mg/L

TN: 10 - 50 mg/L

TP: <1 - 10 mg/L

Fecal: 10^1 - 10^3 col/100 ML

FOAM/TEXTILE FILTER EFFLUENT

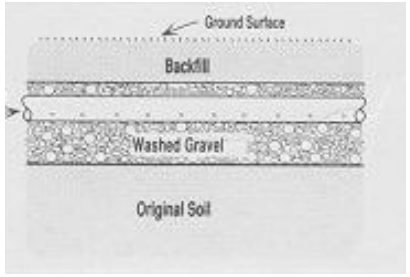
BOD: 5 - 15 mg/L

TSS: 5 - 10 mg/L

TN: 3 - 60 mg/L

TP: 5 - 15 mg/L

Fecal: 10^1 - 10^3 col/100 ML



FURTHER ATTENUATION BY SOIL

BOD: >90%

TSS: >90%

TN: 10 TO 20%

TP: 0 - 100%

Fecal: >99.99%

PRETREATMENT

THE “TANK”

THE SEPTIC TANK PROVIDES

40% reduction of BOD

50% reduction of solids

Typical <u>residential</u> effluent

- 150 mg/l BOD
- 80 mg/l TSS
- 60 mg/l TN (most ammonia)
- <10 mg/l TP
- <10 mg/l FOG
- >1,000,000 FC organisms/ 100ml

ADVANCED TREATMENT

In general, advanced treatment systems describes various technologies/designs to further reduce BOD, nutrients and solids in effluent

How?????

- By providing an “aerobic” and “anaerobic” environments
- Proper balance of organic matter, nutrients, alkalinity

ADVANCED TREATMENT

Aerobic Treatment Units (ATU's)

- Suspended growth
- Fixed growth

ADVANCED TREATMENT

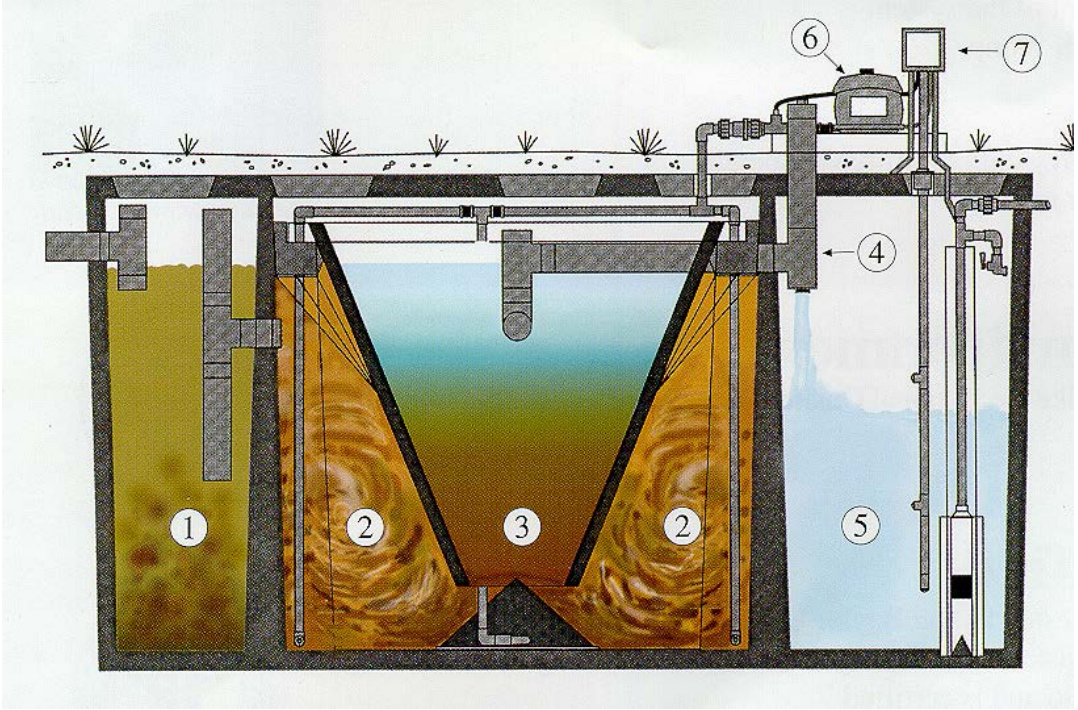
Aerobic Treatment Units (ATU's)

- Use air compressor and air diffusers to "inject" oxygen into the effluent mix
  - More oxygen = more rapid digestion of "organic" material= less time and space
  - Suspended growth…..organisms floating in liquid
    - Air required as O2 supply and to maintain suspension,
    - energy required to supply air and suspend organisms
  - Fixed (attached) growth…structure provided for organisms to attach
    - Air supplied as liquid migrates into media,
    - energy necessary only to pump

ADVANCED TREATMENT

Aerobic Treatment Units (ATU's)

- Suspended growth unit



ADVANCED TREATMENT

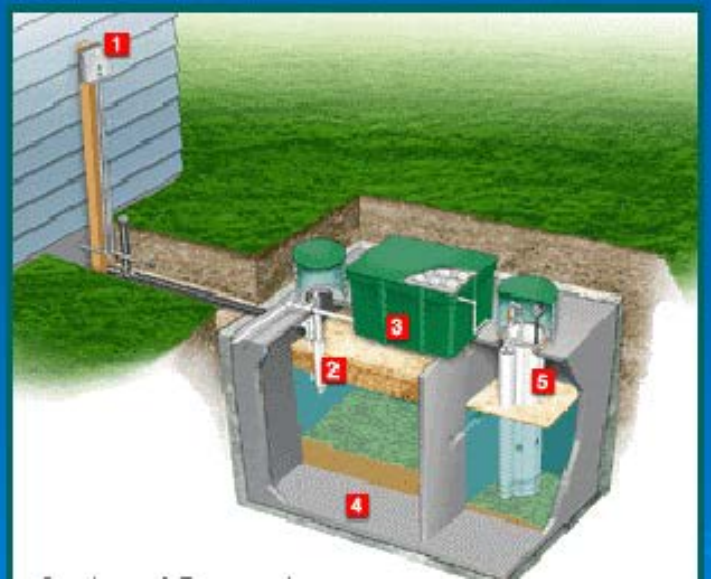
Media/ packed bed filters

- Generally introduction of oxygen is “passive”
- Often use pumps to “dose” media
- Sand…gravel…..peat….fabric……plastic…foam…..coconut husks
- Sometimes effluent recycled back through filter

ADVANCED TREATMENT

Media Filter

- **Textile sheets/chips** Or Foam Cubes



HYBRID ADVANCED TREATMENT

Aerobic Treatment Units (ATU's) and media

- Fixed (attached) growth and Suspended Media hybrid unit

ADVANCED WASTEWATER TREATMENT

PROCESSES

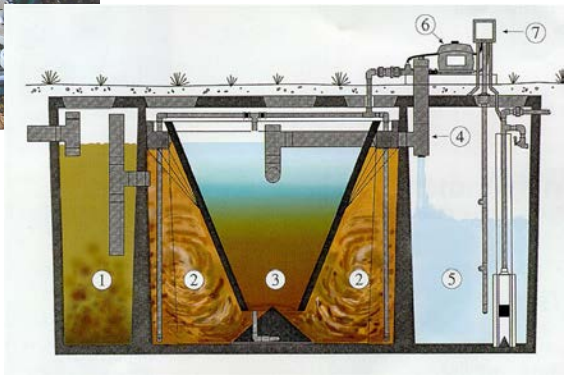
Process capabilities (BOD, TSS, Nutrients, Biologicals)

- NSF
- State Rules

Parameter	BOD	TSS	Coliform	N
TS1	15 mg/l	15 mg/l	10000	10 NH4
TS2	10 mg/l	10 mg/l	1000	20 TN
Reuse	5 mg/l	5 mg/l	14	20 TN

PRETREATMENT

Fixed Media

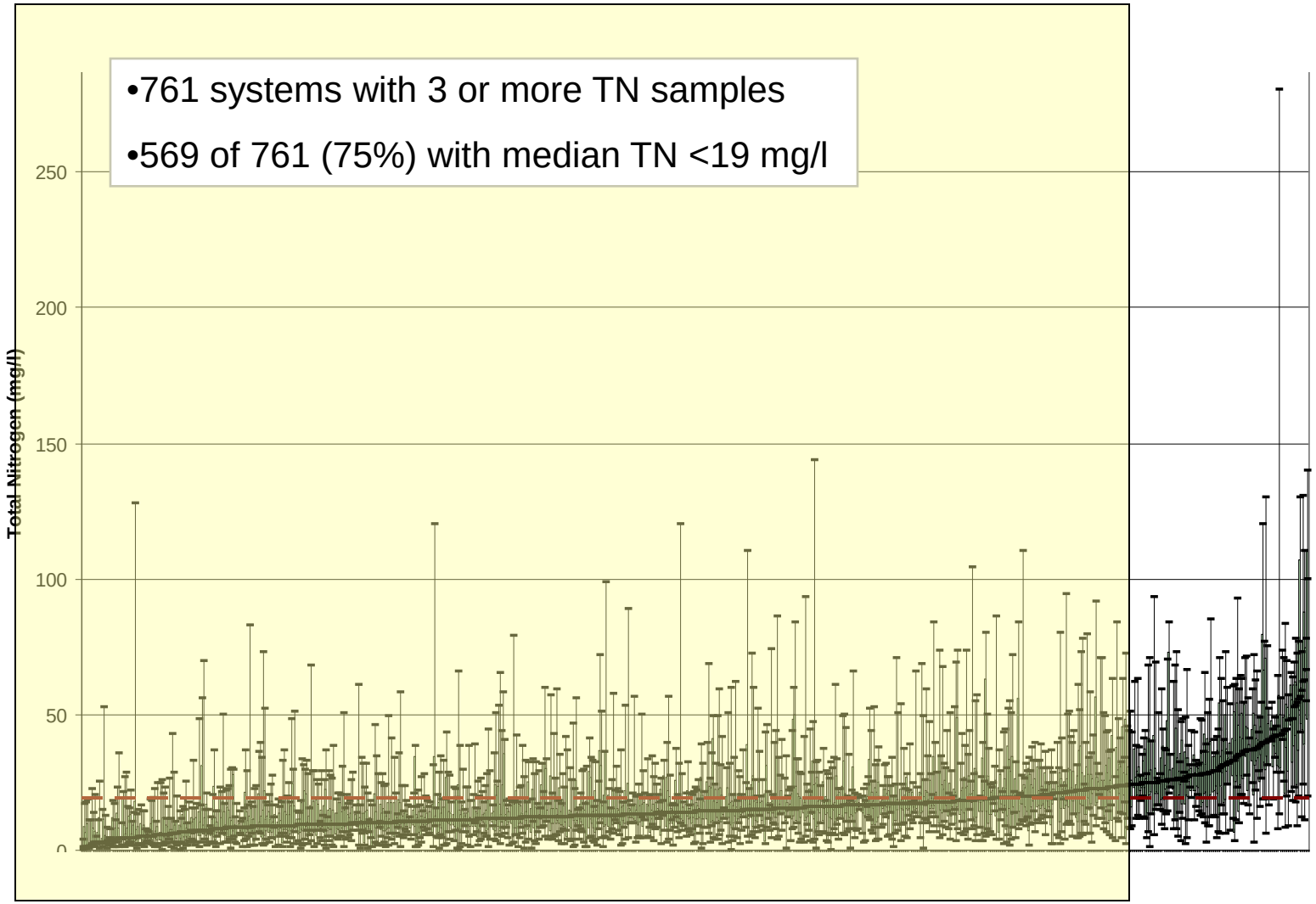


Suspended media

High level of N and P possible w/added Carbon and Anaerobic conditions

SINGLE FAMILY ALL TYPES BY INDIVIDUAL SYSTEM

Three or More Samples with Full Nitrogen Series (Barnstable County)



Single Family all Types by System Type

Three or More Samples with Full Nitrogen Series (Barnstable Co)

System Type	Total with 3+ Samples	Total below 19mg/l	Percentage
All Types	761	569	75%
Advantex	27	21	78%
Amphidrome	4	3	75%
Bioclere	43	32	74%
FAST	442	355	80%
OMNI RSF	51	30	51%
RSF (Generic)	16	9	56%
RUCK	22	11	50%
Septitech	45	15	33%
Singulair	90	81	90%
Waterloo	11	9	90%

APPROVED OPTIONS

BAT System	Standard	Removal (%)	Concentration PPM
Advantex RT	3 rd party	76	14
Advantex AX 20	3rd party	71	17
SeptiTech	ETV/245	67	20
HOOT BNR	3 rd party	64	21
Retrofast	ETV	57	25
Singulair(Norweco)	245	55	27
NSF Data - (Reuse)			
Biomicrobics MBR	350	80+	<10

FIELD VERIFICATION

System	Verification
HOOT ANR	NSF 245
Nitrix (add-on)	3rd Party
Bionset	NSF 245
Microfast	NSF ETV
AquaKlear	NSF 245
EcoPod EN1	NSF 245
Hydroaction	NSF 245

REDUCE N – HARVEST URINE???

1.5 l/person/day

10 g urea (N)/person/d or about 12 lb/yr

Family of 4: 48 lb – N/yr

Who picks it up, who processes, use

Solid waste companies, Ostara, Inc, fertilizer

- Sustainable source for N, P and K
- Yuck factor???

SOIL – INITIAL RECEIVER

SITE

Slope

Distance to water

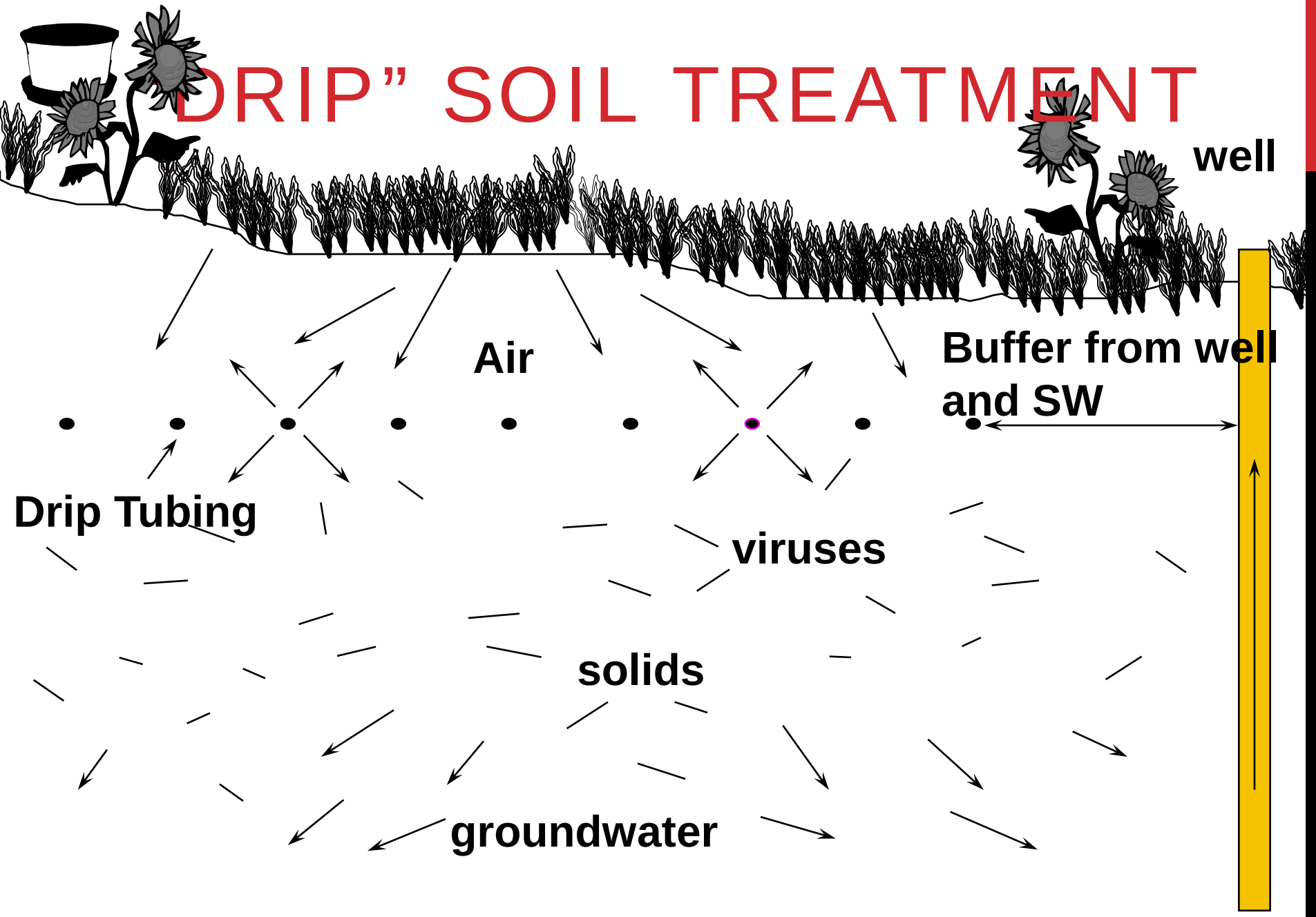
- Groundwater
- Surface water

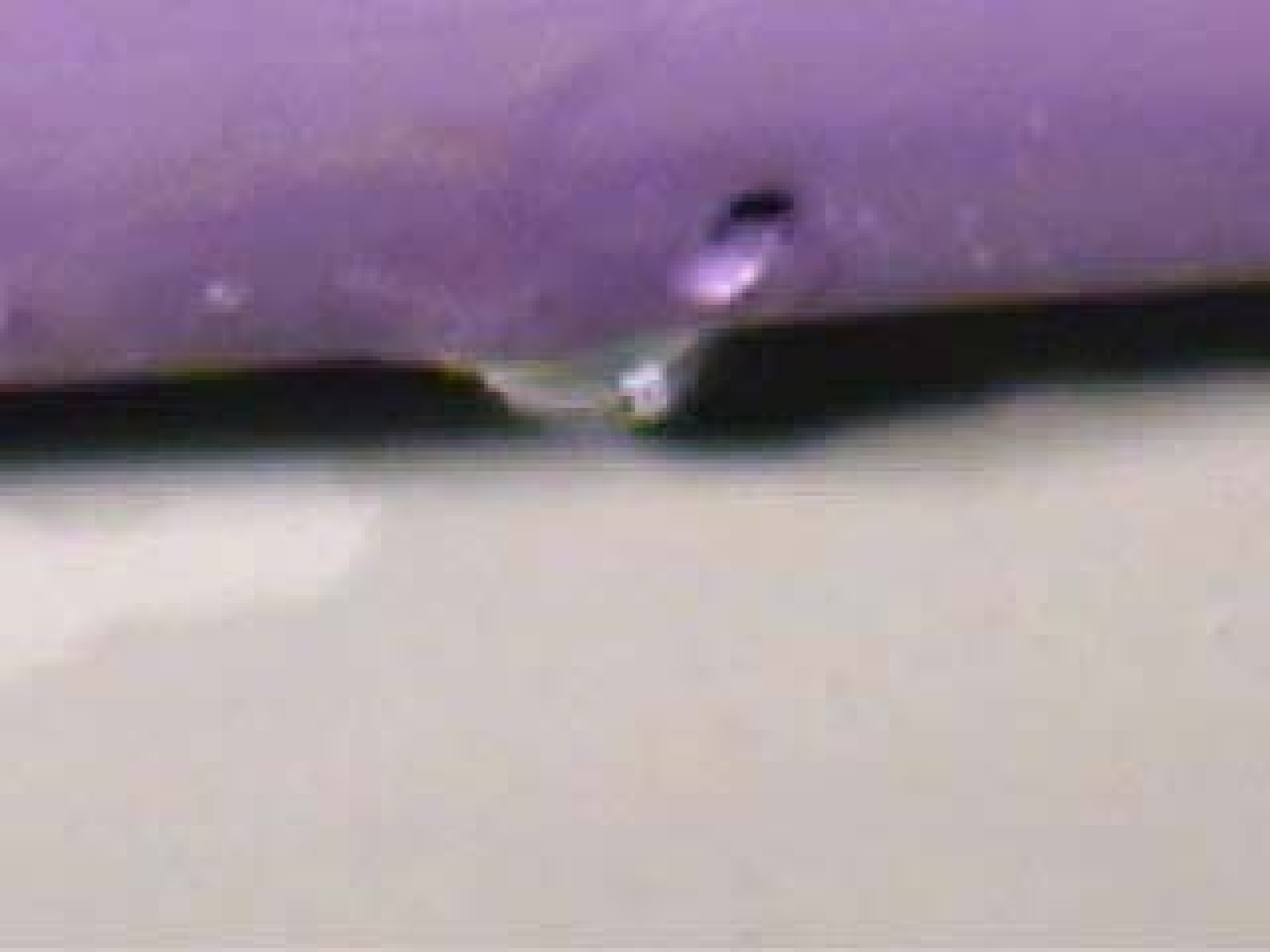
SOIL

Depth, Color, Texture, Structure, Consistence


Up Slope
Down Slope

DRIP” SOIL TREATMENT





FINAL RECEIVER

Air? Cooling towers?

legionella?

Groundwater

Quality implications

Transmissivity

Surface water

Quality (303 & 305)

Use

MANAGEMENT

Operator

Organization

Long term sustainability

Onsite is the Infrastructure

EPA Management Guidelines

MANAGEMENT PROGRAMS

Program Level	Feature
1. Inventory/awareness	Traditional system, low risk environment
2. Contract	Mechanical systems, low risk environment
3. Performance	Performance base, moderate risk environment
4. RME Operation	Performance base, professional operation
5. RME Ownership	Performance base, professional operation, high risk

ADVANCED TREATMENT

Cost

- Equipment
- Energy
- Maintenance

Benefit

- Significant Nutrient Removal Possible
- Soil “friendly”

BEST TECHNOLOGIES

Reliable and robust

Meets present and future need

Managed as part of infrastructure

It IS the wastewater infrastructure for the host site

And Bob’s Blue (gray) box is a myth…