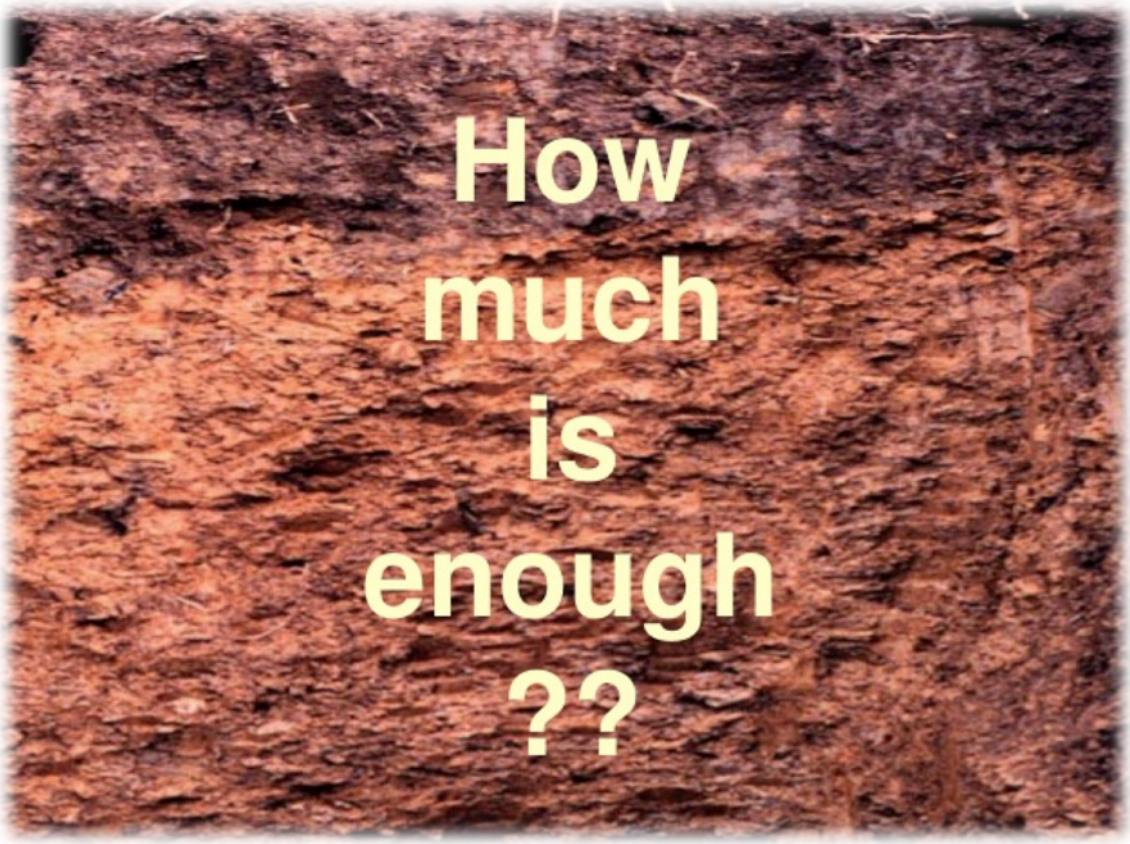
# Soil Policy in Vermont

## *Drivers & Action*

2016




Composting Association of Vermont

cover photo credit: http://www.slideshare.net/jbgruver/understanding-soil-organic-matter

**About the Composting Association of Vermont (CAV)**

The Composting Association of Vermont is an education and advocacy 501(c)(3) founded in 2002. CAV advances the production and use of compost as vital to water quality, resilient communities, and as a climate change adaptation strategy. compostingvermont.org

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## Acknowledgements

The Composting Association of Vermont (CAV) is indebted to Healthy Soil visionaries and practitioners who contributed to the Soil Policy Project. Farmers, educators, policy makers, state and federal agencies' staff, scientists, municipal officials, and advocates of all stripes generously contributed time to the project: community and watershed activists, non-profit organizations, engineers, and Extension Technical Assistance providers. This paper is a summary of findings, and recommendations: the culmination of exploring conversations, advocacy, and research.

Special thanks to the project Strategy Team, who provided expertise, thoughtful questions, data, and served as a sounding board:

- Julie Moore P.E., Stone Environmental
- Amy Macrellis, Water Quality Specialist, Stone Environmental
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- Doug Lantagne, Ph.D., UVM, Dean of Extension
- Jim Woods, former Assistant State Conservationist, USDA/NRCS, and
- Cary Giguere, Agrichemical Program Manager, Agency of Agriculture, Farms, & Markets.

Additional special thanks to:

- Trey Martin, former Deputy Secretary, Agency of Natural Resources, who kindly oriented me in the maze of Agencies and their respective charge
- Representative Amy Sheldon, whose persistent advocacy led to establishing a statutory definition of Healthy Soil in Act 64
- Ava Jordon, project intern, who did what was asked of her with a spirited 'can do' style.

None of this would have been possible without funding support. Heaps of gratitude always to our project funders: High Meadows Fund, Harris and Frances Block Foundation, and CAV Solid Waste District members.

Your passion and dedication is the stuff of transformative action and a future where, to quote Aldo Leopold, "we see land as a community to which we belong."

# Executive Summary

## Silent Ally

It was an auspicious coincidence when, shortly after launching the Soil Policy Project, the United Nations declared 2015 the International Year of Soil. So, too, were the remarks of U.N. Food and Agriculture Organization Director-General José Graziano da Silva's at the kickoff event: "[W]e are not paying enough attention to this important silent ally."[1] While his perspective is agricultural, the "silent ally" metaphor applies to life itself: "man…owes his existence to a six-inch layer of topsoil and the fact that it rains."[2]

> ***Managing for soil health is mostly a matter of maintaining habitat for the myriad of creatures that comprise the soil food web.***
>
> *-USDA NRCS*

This interplay between soil and water has never been more important: we have abused the former and are at the mercy of the latter with unprecedented uncertainty. From this pained truth climate change adaptation emerged as the overarching framework to examine Vermont's soil policy. The 2015 passage of Act 64—the 'water bill'—created opportunities to address soil health in policy: within agencies, municipalities, non-profit organizations, and the private sector.

> ***"Improving soil health is the single most impactful thing we can do to reduce stormwater runoff and improve overall ecosystem health at all scales."*** [3]

If soil health is so important, why isn't it more evident in state policy? As this paper documents: the how-tos and whys we choose will ultimately reflect our capacity to, in the words of Wendell Berry, "do unto those downstream as you would have those upstream do unto you."

Through a less poetic lens, one might ask: How will Vermonters galvanize the political will to act? How will they challenge complicity, and insist on more than one 'public good' from every dollar invested? Hours of interviews and research leads us to believe this is achievable even as we face decades of investment to right decades of neglect.

Implementing specific actions at the state and local level will drive the transition from 'flow management' to a 'storage' (infiltration) model. **Soil function is the mechanism to make this transition.**

## Build the Sponge

The Soil Policy Project identified practices and policies that together could dramatically increase infiltration. Think of the land as a fat sponge stretching the length and breadth of the state—soaking up water, holding it, so infiltration can occur. Deceptively simple in concept, it nevertheless can be a measure of Vermont's 'livability': achieve water quality goals with a priority climate change adaptation strategy –improved soil function.

## Key Findings

- To improve soil function first create the most favorable habitat for the soil food web[8]
- There is a lack of soil function "intellectual infrastructure."[4]
- The major problem is insufficient infiltration, not runoff.[5]
- The majority of Vermont's impervious surface area is unregulated.[6]
- Lack of soil organic matter negatively affects revegetation success.[7]
- Soil organic matter (SOM) is typically <6% of soil by weight but controls 90% of soil function.[8]
- Agricultural lenders understand the importance of soil health to farm viability.[9]

***The major problem is not runoff but infiltration.[5]***

-Lake Champlain, TMDL, Implementation Plan

**A one percent increase in organic matter in the top six inches of soil can hold approximately 27,000 gallons of water per acre--about the amount that falls on one acre from a 1" rain event.**

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082147.pdf

## Recommendations

These recommendations are representative of the 100+ listed in Appendix 1, beginning on page 28. Additional agency funding is not needed for many of them. Some can be implemented with Lake Champlain TMDL Implementation Plan funding. Others lend themselves to community action. Used in place of more familiar management practices, they are often less expensive and achieve superior results.[10]

- Establish a revegetation performance standard for state and municipal construction projects.
- Include soil organic matter greater than 4% at 4" as a runoff reduction practice in the VSMM.
- Finance municipal runoff reduction incentive programs with a discharge fee.
- Create 'Watershed Action' grant program to leverage volunteer driven initiatives that decrease runoff from private land into town maintained ditch networks.
- Provide soil function outreach and training to policymakers, municipalities, professionals, businesses, advocates and property owners.

**This is what we need to do:**
**Create the most favorable habitat for the soil food web.**
**Store precipitation where it falls…..and if you can't,**
**slow it down and infiltrate it as quickly as possible.**

Fortunately Vermont's low population density and commitment to livable communities and a thriving agriculture sector makes this easier to achieve. Adopting new strategies (some already in progress as a result of Act 64) will also help Vermonters 'connect the dots' between soil health, nutrient management, organics diversion, reducing peak flows, water quality, and climate change adaptation. We want – need – to work *with* nature, restoring and mimicking the systems that nature has perfected over eons.

Executive Summary End Notes

[1] Exact quote: "healthy soils are critical for global food production, but we are not paying enough attention to this important silent ally."
http://www.fao.org/global-soil-partnership/resources/news/detail/en/c/379262/

[2] Source: http://forum.quoteland.com/eve/forums/a/tpc/f/99191541/m/3901083831

[3] http://dec.vermont.gov/watershed/cwi/green-infrastructure/gsi/infiltration#SoilRestoration

[4] Intellectual Infrastructure is defined as nonrival input into a wide variety of outputs.
*Infrastructure: The Social Value of Shared Resources*, Brett M. Frischmann

[5] Lake Champlain TMDL Implementation Plan, Phase I, pg 160
http://dec.vermont.gov/sites/dec/files/wsm/erp/docs/2016%20Draft%20Phase%201%20Implementation%20Plan.pdf

[6] *Understanding the Failure to Reduce Phosphorous Loading in Lake Champlain,* Gail Osherenko, J.D.
http://vjel.vermontlaw.edu/publications/understanding-failure-reduce-phosphorous-loading-lake-champlain-lessons-governance/

[7] *Colorado Department of Transportation, Revegetation Practices for Highway Construction Projects* https://www.codot.gov/programs/research/pdfs/2015-research-reports/assessment-of-cdot-revegetation-practices-for-highway-construction-sites/view

[8] http://landstewardshipproject.org/repository/1/555/managing_soil_biota_nichols.pdf

[9] Interview with Sara Isham, Director of Lending, Vermont Agricultural Credit Corp.

[10] *Working With Nature* http://ucanr.edu/sites/urbanwatermgmt/files/228951.pdf

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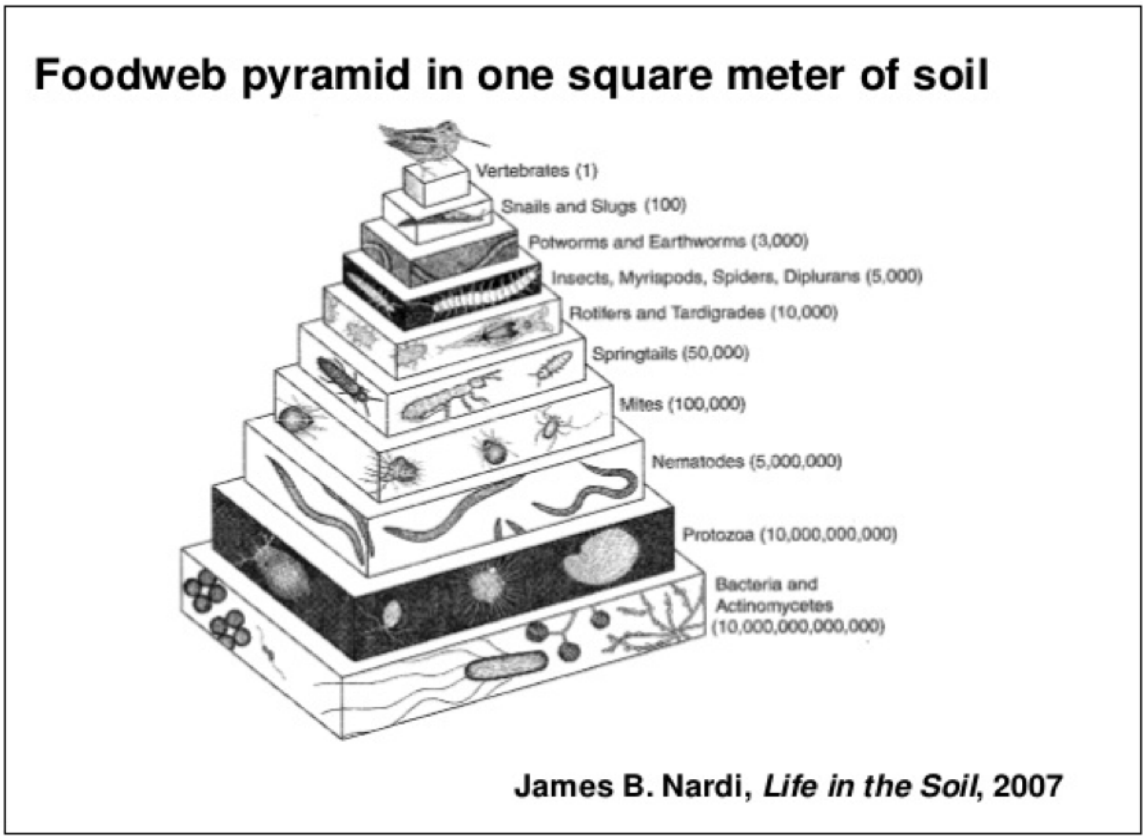


# Glossary

**Government**
ACCD – Agency of Commerce and Community Development
AOT/VTrans – Agency of Transportation/VTrans
ANR – Vermont Agency of Natural Resources
AAFM – Agency of Agriculture Farms and Markets
BGS – Buildings and General Services
DEC – Department of Environmental Conservation
FPR – Department of Forests, Parks, and Recreation
F&W – Department of Fish and Wildlife
NRB – Natural Resources Board
US-EPA – US Environmental Protection Agency
USDA/NRCS or NRCS – US Department of Agriculture/Natural Resource Conservation Service
USFS – US Forest Service

**Organizations:**
AVCC – Association of Vermont Conservation Commissions
CAV – Composting Association of Vermont
LCBP – Lake Champlain Basin Program
VACC – Vermont Agricultural Credit Corporation
VACD – Vermont Association of Conservation Districts
VBSR – Vermont Businesses for Social Responsibility
VLCT – Vermont League of Cities and Towns
VRC – Vermont River Conservancy

**Terms:**
AD – Anaerobic Digestion/Digester
AMP/s – Accepted Management Practice/s
BMP/s – Best Management Practice/s
CWFB – Clean Water Fund Board
CPG – Certificate of Public Good (Section 248 – energy generation permit)
CSA – UVM Center for Sustainable Agriculture
GSI- Green Stormwater Infrastructure
MRGP – Municipal Road General Permit
RAPs – Required Agricultural Practice/s
RPCs – Regional Planning Commission/s
SOM – Soil Organic Matter
TMDL – Total Maximum Daily Load (measure of pollutants in water)
TS4 – new AOT permit for Highway construction and maintenance
http://dec.vermont.gov/watershed/stormwater/draft-transportation-general-permit
VSMM – Vermont Stormwater Management Manual
http://dec.vermont.gov/watershed/stormwater/manual_update

**Glossary of Soil Health and Soil Ecology Terms**
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/?cid=nrcs142p2_053848

## Introduction

Speculation dominated news cycles in the Fall of 2014 as Vermonters grappled with how to reduce nutrient and sediment loading in Lake Champlain, mandated by the Environmental Protection Agency (US-EPA). The subject crept into the most casual exchanges: at the general store, in farmhouse kitchens, within Agencies of jurisdiction, and among water quality advocates. Missing from media reports and commentaries about what a 'Water Bill' might include was any mention of *soil*.

> ***"The history of every Nation is eventually written in the way in which it cares for its soil."***
>
> *– Franklin Delano Roosevelt, 1936*

In response, the Composting Association of Vermont (CAV) began a multi-year project to articulate soil health policy and elevate the necessity.

**Healthy Soil = Clean Water**

This policy paper quantifies the 'how' to link soil health and water quality within the context of implementing these three (3) priority state mandates:

- Meet U.S. EPA nutrient and sediment load reduction goals
- Revisions to the Vermont Stormwater Management Manual
- Landfill ban on organic residuals[3]

**When healthy soil is part of Vermont's response, these policy mandates also contribute to our climate change adaptation capacity.** Thoughtful investment can restore and strengthen what we have destroyed. The result is enhanced ecosystem services that buffer the environmental effects – *and cost* – of more unpredictable weather. **The common denominator is soil function.**

### Project Background

Roots, fungal hyphae, & microbial glues stabilize soil macroaggregates and promote good soil structure

Photo: João Carlos de Moraes Sá
Universidade Estadual de Ponta Grossa, Brazil

In December, 2014, CAV tested a soil health policy framework on four senior policy representatives: David Mears, DEC Commissioner; Doug Lantagne, Ph.D., Dean, UVM Extension; Jim Woods, Assistant State Conservationist, USDA/NRCS; and Carey Giguere, Agrichemical Program Manager, Agency of Agriculture, Farms, and Markets. They affirmed a climate change adaptation framework was inclusive of the state mandates and that linking soil health and water quality through policy was a worthy effort. A strategy team was formed and met in March 2015 to review a draft of policy changes and actions. ANR Deputy Secretary at the time, Trey Martin, facilitated a one-hour discussion with key ANR staff to inform the strategy team's work. Research began in earnest in the fall of 2015 after project funding was secured.

We didn't anticipate legislation – Act 64 – would provide a statutory driver for changes of practice we envision: institutionalize soil health within agencies, municipalities, non-profit organizations and the private sector. The law includes a first for Vermont: a statutory definition of "healthy soil."

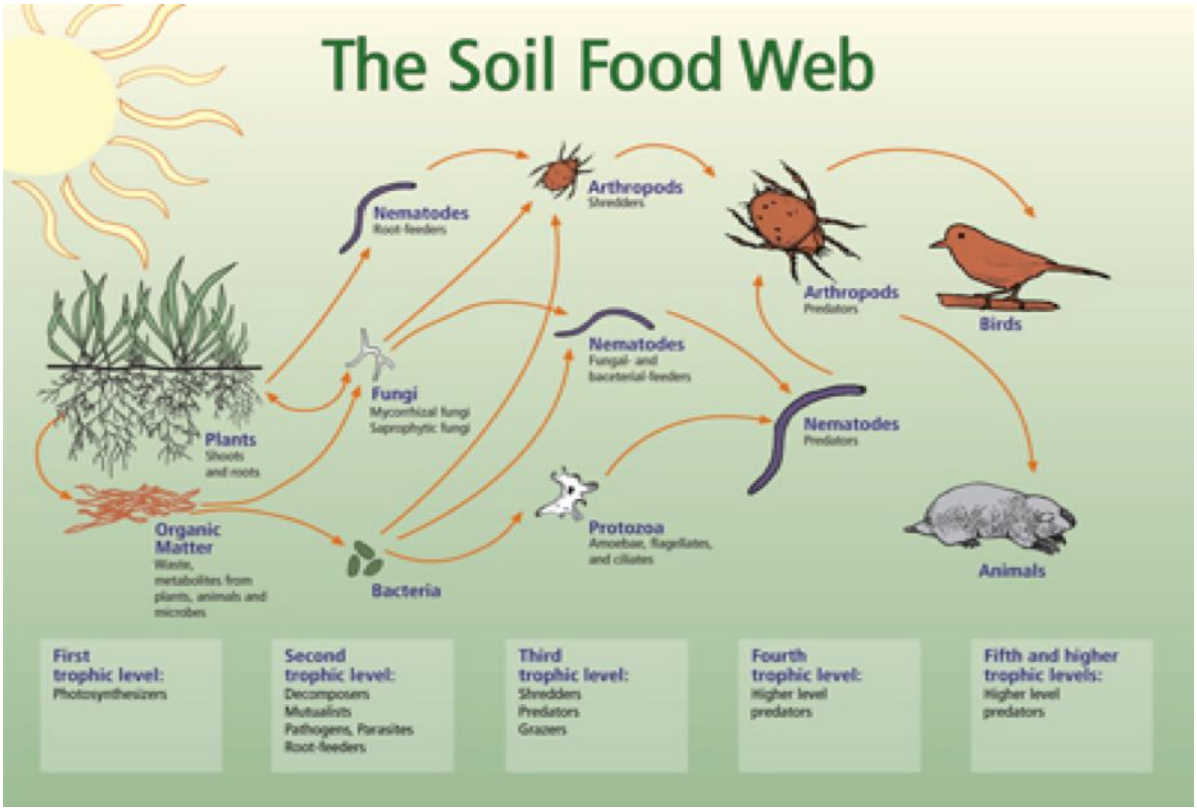
The project benefited from concurrent actions by others – globally, nationally, and in Vermont:

- The United Nations designates 2015 as the "Year of Soil"
- USDA/NRCS "Unlock the Secrets of Soil" Campaign[4]
- California's Healthy Soils Initiative[5] (see Appendix)
- Washington State's Soils for Salmon program[6]
- Soil Health theme for the 2015 Farm to Plate Gathering, and 2016 NOFA Winter Conference
- Introduction of Regenerative Agriculture bill in the 2016 Vermont Legislature
- US Forest Service 2016 release of *Effectiveness of best management practices that have application to forest roads: a literature synthesis.*

> ***"'Healthy soil' means soil that has a well-developed, porous structure, is chemically balanced, supports diverse microbial communities, and has abundant organic matter."***
> *-from Act 64*

Vision at the state and local level to advance soil policy requires: understanding soil function and capacity; and, adapting to a collective action learning curve. Other state, national and international leaders' success can give Vermont's policymakers and advocates confidence and knowledge to inform their actions.

Vermont has high-level sustainability, resiliency, and water quality policy framing documents, and websites where one would expect to find the state's commitment to soil health articulated. Yet few give the topic more than a sentence or two, if that. Two exceptions are the Agency of Commerce and Community Development's Green Landscaping Tool Kit[7] and the Department of Forests, Parks and Recreation's Soil Quality webpage.[8]




*Graphic Credit: USDA NRCS*

The USDA/NRCS *Secrets of Soil* Campaign, launched in October of 2012, includes a suite of healthy soil web-based materials. The frequency with which they are referenced in this paper is testament to their value as a resource for non-scientist policymakers, landowners, and advocates. The UVM Center for Sustainable Agriculture is incorporating more focus on soil health in its technical assistance to farmers and supporting that with research to better quantify economic benefits.

*Soil Flora and Fauna*

***"When you manage organic matter you also manage the water cycle, carbon cycle, nutrient cycles, [and] climate."***

Working *with* Nature - http://ucanr.edu/sites/urbanwatermgmt/files/228951.pdf

## How Much is Enough?

If policymakers embrace the *Secrets of Soil* message then nothing short of a paradigm shift is the way forward. The financially quantifiable benefits of soil health practices are compelling, and the research demonstrating benefits is well established and ongoing.

The dozens of recommended actions in this report break down the heavy lift of a paradigm shift into manageable increments.

**"45% greater porosity increases the infiltration rate by 167% for the first inch and 650% for the second inch."**[12]

### Paradigm Shifts

1) Stop treating the symptoms of soil dysfunction; solve the problem of dysfunctional soil.

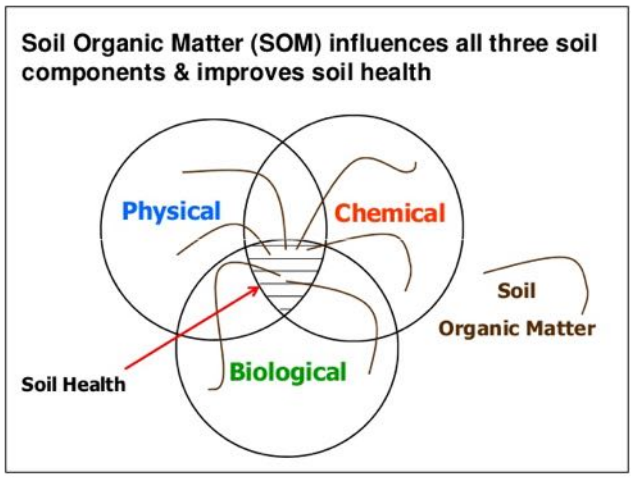
2) Restoring soil function can be accomplished without going broke.
   - Apply basic principles of ecology to create quality habitat.
   - There is no waste in nature.

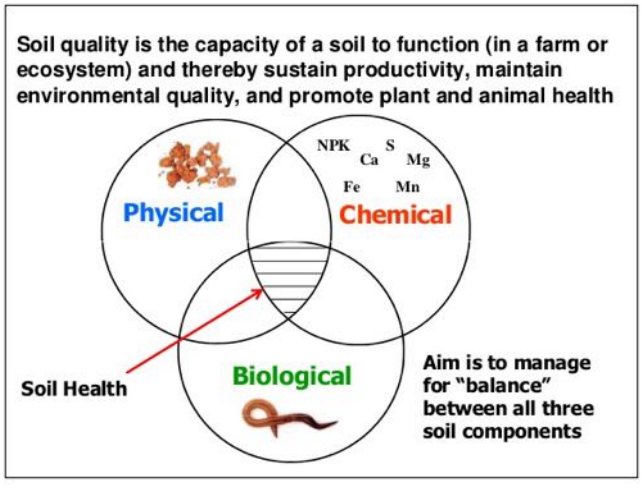
3) Conservation practices do not restore soil health, understanding soil function restores soil health.

-NRCS, Changing Our Paradigms About Soil
http://ctrcd.org/pdf/Soil_Health_March_2016_Presentations/1SHBasicsOrganicTalk.pdf

### Managing for soil health yields reduced peak flows and clean water

Vermont has the requisite high level policy goals to advance a soil health agenda as part of the solution to its water quality woes. Where the state comes up short is on specific actions to incorporate soil health into 'business as usual'. What are the dynamic properties of soil that can be changed? This is at the heart of the Soil Policy Project's recommended policy changes and actions.




Graphic Source: http://www.slideshare.net/MauraMcDW/managing-organic-matterforsoilhealthandfertility42812

***"The major problem is not runoff but infiltration."***

*-Lake Champlain, TMDL, Implementation Plan*

**How do we institutionalize policies throughout state government to effect change of practice in:**

- development permitting;
- municipal planning;
- road maintenance, and;
- soil disturbance that requires intentional management of water flows.

These policies may apply to residential, business, agriculture, forestry and state owned land (recreational, transportation, building grounds, etc.) Implementing actions at the state and local level will drive transition from 'flow management' to a 'storage' (infiltration) model. This model is also driving proposed changes to the Vermont Stormwater Management Manual (VSMM).

## Soil Function is the mechanism to make this transition.

***"Soils stockpile 1500 gigatons of carbon in soil organic matter (SOM), more than Earth's atmosphere and all plants combined."***

-NRCS, Changing Our Paradigms About Soil

***"A one percent increase in organic matter in the top six inches of soil would hold approximately 27,000 gallons of water per acre (about the amount that falls on one acre from a 1" rain.)"***

-
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082147.pdf

### Soil Governance

The United Nations (UN), Food and Agriculture Organization's Global Soil Partnership (GSP) offers a soil governance framework adaptable to Vermont's needs.[9] **Soil governance** refers to "policies and strategies and the processes of decision-making by nation states and local governments on how the soil is utilized." Underpinning this definition are "coherent policies that encourage practices and methodologies that regulate the usage of the soil resource to avoid conflict between users."[10]

### Global Soil Partnership

The *Global Soil Partnership* was launched in 2001, with the mandate "to improve governance of the planet's limited soil resources in order to guarantee agriculturally productive soils for a food secure world, as well as support other essential ecosystem services, in accordance with the sovereign right of each State over its natural resources."

California Governor Jerry Brown's Healthy Soils Initiative[11] is an example of how a state can align healthy soil policy within the Global Soil Partnership framework.

Five strategies could begin to align Vermont's soil health efforts with this global one:

- State agencies include soil health criteria as internal performance measures and as regulatory compliance measures.
- State agencies adopt policies that support change of practice to improve soil health.
- Economic development and planning entities have policy support and financial incentives for soil health practices that strengthen community resilience with regard to food systems, water quality, and climate change adaptation.
- Soil health policies are part of agency, municipal and private sector response to Act 64 mandates.
- 'Healthy Soil' trainings and demonstration sites are available for professionals (policy makers, engineers, farmers, loggers, architects, etc.), advocates and property owners.

### Soil Story

**The Harvard Yard Soils Restoration Project**

In September of 2009 a *New York Times* article reported on a Harvard University experiment to shift from chemical pest controls and synthetic fertilizers to compost and compost tea.

In response to an email inquiry, Paul Smith, Harvard's Associate Manager of Landscaping Services wrote: "Our main concern was cutting down on pesticide use and building our soils. I can tell you that we have not added any more labor associated with an organic approach towards the landscape. It really doesn't cost us any more than a conventional approach to landscaping."

The project website states: "Our experience convinced us that chemicals and synthetics can be systematically eliminated and replaced by programmed encouragement of the natural cycles of support."[13]

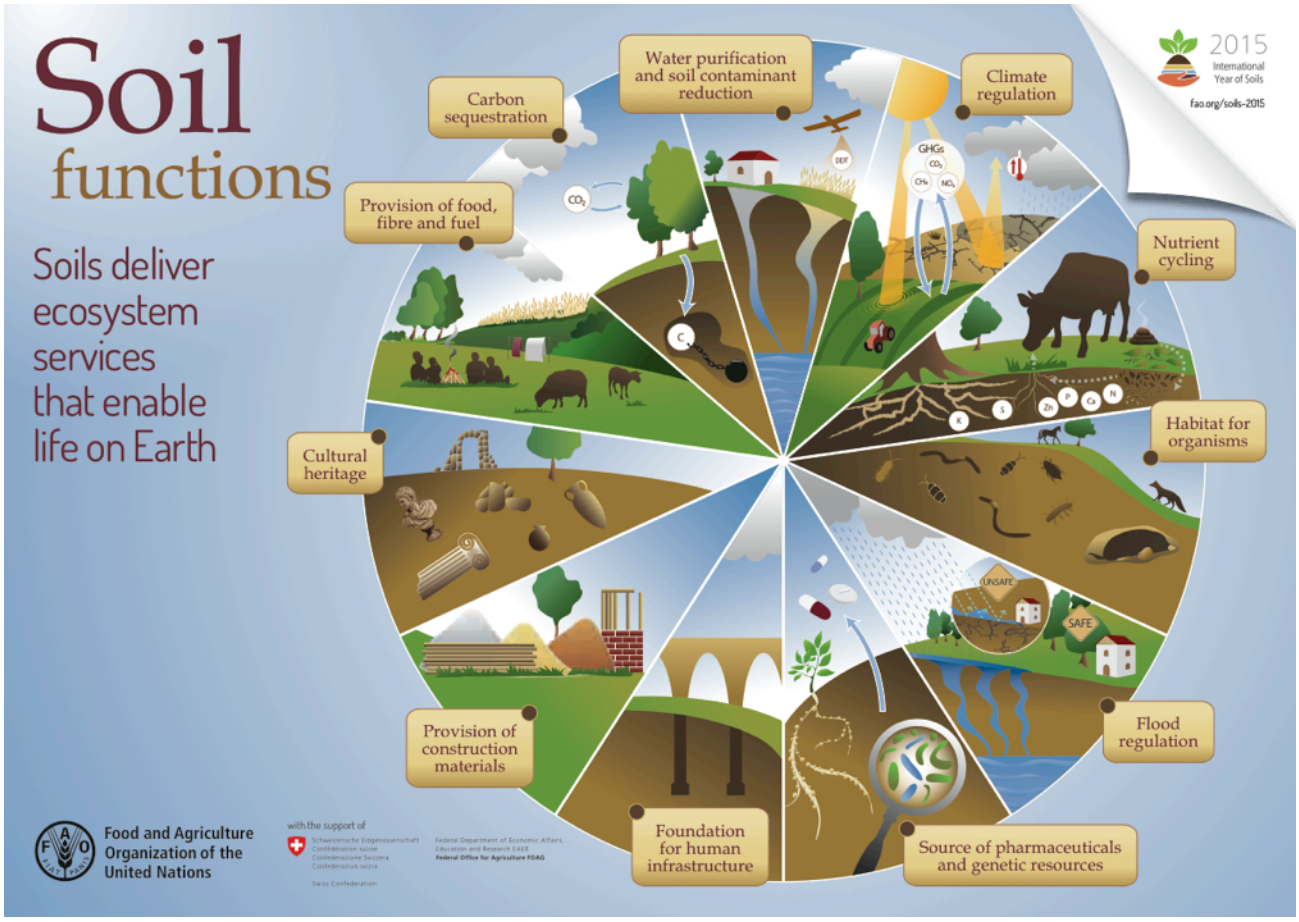
## Intellectual Infrastructure[14]

The lack of understanding about soil function is perhaps the most troublesome project finding. It was not evident with everyone interviewed, but it was pervasive. Vermont's response will require collective action, and to be effective, will require educated citizens. This Intellectual Infrastructure, defined as nonrival input into a wide variety of outputs, is a non-negotiable for success, much like Universal Recycling mandates. You can't make a paradigm shift if the majority isn't on board.

**It will require a radical shift in thinking to work with soil as an ally.**

***"Considering the long list of benefits organic matter has on soil health and crop production, increasing organic matter may well be the most important management step a producer can take to improve a farm's profitability and sustainability."***

***http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1193043***




Soil Function

"Only 'living' things can have health, so viewing soil as a living ecosystem reflects a fundamental shift in the way we care for our nation's soils. Soil isn't an inert growing medium, but rather is teeming with billions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem. Soil is an ecosystem that can be managed to provide nutrients for plant growth; absorb and hold rainwater for use during dryer periods; filter and buffer potential pollutants from leaving our fields; serve as a firm foundation for agricultural activities; and provide habitat for soil microbes to flourish and diversify to keep the ecosystem running smoothly."[15]

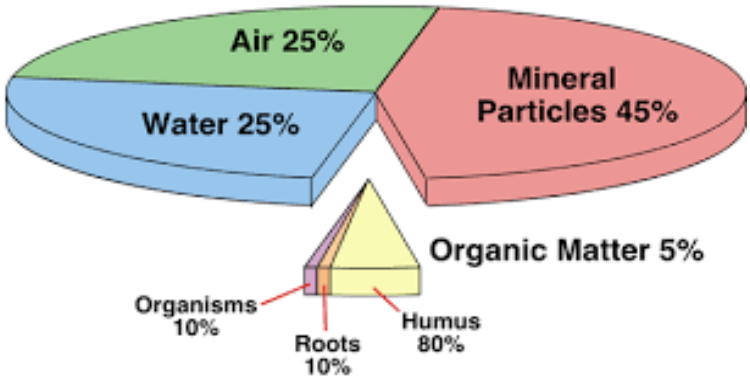
***Healthy Soils are High in Organic Matter- Soil Organic Matter Controls 90% of Soil Function.***[16]

The stories on the next two pages reflect an approach to agriculture driven by soil function.

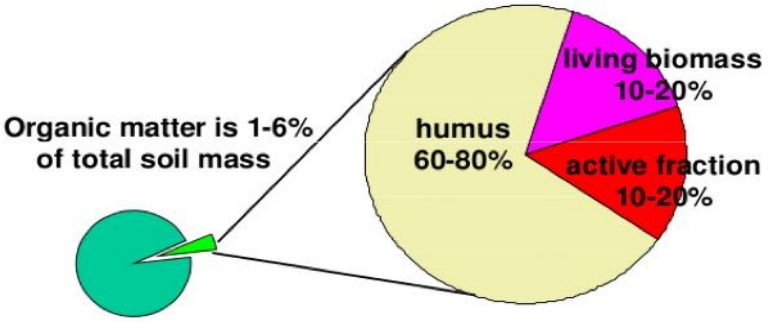
***"There may be no other component that's more important to a healthy soil than organic matter."***[16]

Indiana corn and soybean farmer, Dan DeSutter's explanation of soil health principles is more visceral: "your soil is alive and all those microbes need to be fed with living roots and biomass 365-days-a-year, or it will starve, producing fields that are too sick to resist wind and water erosion, prone to drought and eventually unable to produce decent yields even when receiving heavy applications of petroleum based fertilizers."[17]

**Soil Composition**




**Soil Organic Matter**




"*The living, the dead, and the very dead*"
Vermont Agric Exp Sta Bullletin 135, 1908

## Soil Story

*Tales of the "Subterranean Herd"*

"[W]e're all livestock farmers when it comes to soil biology."[18]
- Dan DeSutter, Indiana crop farmer

"I want my soil feeding my crops, not me feeding my crops."[19]
- Duane Hager, Minnesota farmer

**Economic Benefit**

Gabe Brown represents that juncture where public good meets private incentives. On a September day, the Burleigh County, ND producer shows off a stand of corn that's thriving despite droughty conditions. During the past decade, Brown has raised his soil organic matter content from less than 2 percent to nearly 6 percent. Now his soils make better use of moisture and cook up their own fertility. Brown has not relied on commercial fertilizer since 2008. That's good for the environment. And it's money in the bank.[20]

He grows corn at $1.51/bushel and also has reduced his herbicide use 75% and his fuel use 66%.
NRCS Changing Our Paradigms

From our human vantage it seems what we do – fertilizing, watering, weeding, etc. makes plants 'grow.' In fact the success of our toil is largely dependent on **how well the soil food web is fed**. **Providing plenty of accessible food to soil microbes helps them cycle nutrients that plants need to grow.** Microbial food is exuded by plant roots to attract and feed microbes that provide nutrients (and other compounds) to the plant at the root-soil interface where the plants can take them up. Since living roots provide the easiest source of food for soil microbes, growing long-season crops or a cover crop following a short-season crop, feeds the foundation species of the soil food web as much as possible during the growing season.[21]

A study of soils in Michigan demonstrated potential crop-yield increases of about 12% for every 1% organic matter.

In a Maryland experiment, researchers saw an increase of approximately 80 bushels of corn per acre when organic matter increased from 0.8% to 2%. **The enormous influence of organic matter on so many of the soil's properties—biological, chemical, and physical—makes it of critical importance to healthy soils.** [22]

### The Soil Food Web in Non-Agricultural Soils

A robust soil food web is also necessary in the built environment. Grading, removing vegetation and topsoil, and compaction impair soil function. Where location and terrain preclude adapting agricultural practices, there are others delivering impressive cost-effective results. Collectively these practices are referred to as 'Green Infrastructure', 'Green Stormwater Infrastructure' (GSI) or 'Low Impact Development' (LID), and include soil and compost – based practices.

**Though these soil and compost-based practices are still not common in Vermont, they 'mimic nature' to:**

- **filter and store stormwater**
- **promote strong plant growth and deeper root systems**
- **increase resilience to withstand weather extremes such as flooding, erosion, and drought**
- **protect disturbed soils from erosion until vegetation is established,**
- **increase the rate and density of revegetation.**

(See Texas case study, pg 18)

## Soil Story

*Iowa*

**Mob Grazing for Healthy Soil and Livestock, and Quality Pasture**

"With a longer rest period (for grass), it's amazing what grows. Eventually you get such a healthy stand you don't have weeds because they are crowded out by new grass species. I have just about tripled my grass production… haven't used any chemical de-wormers for four years and I have encountered very little pink eye or foot rot."[23]

-Bill Totemeier, Iowa farmer

*West Virginia*

"I don't make compost because it makes me feel good. I do it because composting is the only thing I've seen in farming that costs less, saves time, produces higher yields and saves me money."[24]

-Cam Webb, WV beef and crop farmer

Excerpted from *Building Soils for Better Crops*

**Case Study: Texas Department of Transportation**

In May 1999, TxDOT and the Texas Natural Resources Conservation Commission (now Texas Commission on Environmental Quality), worked jointly to demonstrate the application of compost along roadsides to the public, potential contractors and other interested parties. The demonstration was held in the West Texas town of Big Spring at a site where TxDOT had tried five times — unsuccessfully — to establish vegetation on a steep, severely eroded overpass. There were 6-inch gullies running the entire length of the slope. Compost made from feedlot manure, cotton burrs and yard trimmings wood chips was applied with a blower truck at a depth of 3-inches, and was used to fill the gullies. Grass seed was mixed in with the compost prior to application. By mid-June 1999, thick grass was growing on soil that was barren since the highway was constructed over 30 years before. Compost was the only application that provided a successful growing **media over that time.**

https://www.landandwater.com/features/vol52no2/vol52no2_2.html

Improving the water holding capacity of soil in built environments by increasing organic matter is – same as on a farm – *the* most important action to advance a responsive healthy soil policy. The recommendations for practices to use in the build environment are focused on Vermont's most chronic and costly environmental degradation: loss of infiltration capacity (from compaction and impervious surface), erosion, nutrient mobility, and increasingly uncertain weather extremes.

## Olmstead Green, Boston MA

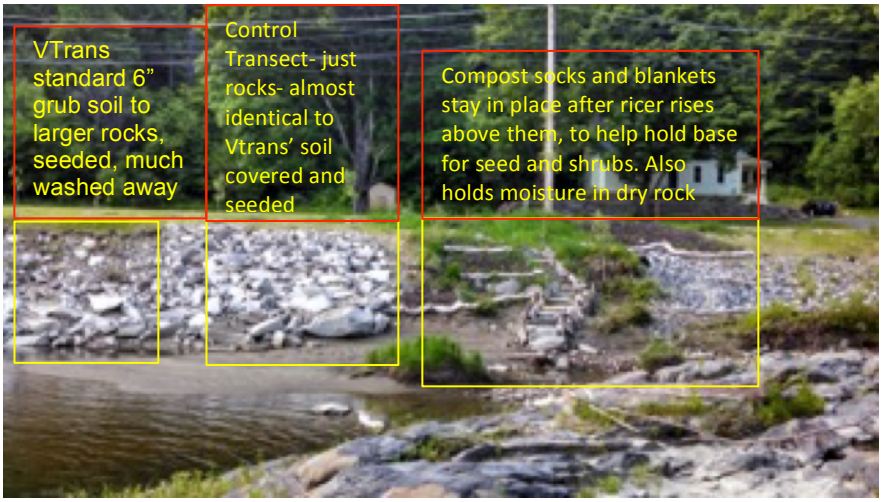
Installing 2" Compost Blanket

Two days later, no erosion after 6" rain

*Photo Credit: Bob Spencer*

# Streambank Stabilization

**Compost Sock and Blanket Demonstration**




The far left transect represents the typical treatment after placing rock riprap to protect the bank from fluvial erosion. In December 2013, the riprap in this transect had been covered with 6" of grub soil, seeded and covered with straw mulch down to the larger rocks. The river had taken almost all of that cover away by May. The "control transect" is a small area that had no soil and seed covering added, but doesn't look very different than the "planted" area upstream. The third area shows compost "socks" and "blankets" a month after placement. These compost products are formulated to EPA standards to retain moisture for the new plants survival on bare unimproved soil. More than 60 trees and shrubs are thriving with the compost treatment at the end of the summer season, with 99% survival.


Compare the level of lush greenery two months later. Trees and willow shrubs are thriving- those stream bank areas will better withstand fluvial erosion and protect water quality from road runoff, than bare rock or standard treatment of 6" soil cover and grass seed that washed away - a waste of time and money. Another winter season and some strong storms will offer further tests of the section planted with compost.

Spring, 2-years later. Note loss of riprap and soil on VTrans section; soil with compost blanket not eroding due to vigorous vegetative cover and root growth.

(Note: This case study was organized by Community-Resilience.org with CAV and the White River Partnership to compare VTrans' standard cover approach with the alternative approach of using compost blankets and socks)

*Photo Credit: Peg Elmer Hough*

## Does Vermont Need To Regulate More Impervious Surface?

This is a big question for Vermont communities. In her 2013 research paper[25], *Understanding the Failure to Reduce Phosphorous Loading in Lake Champlain,* Gail Osherenko, J.D, a Project Scientist at the Marine Science Institute, University of California, Santa Barbara, brought attention to Vermont's impervious surface conundrum. At the time the state only regulated "six percent of impervious cover in the Lake Champlain Basin, [and is] about twelve percent when including MS4 permits for stormwater flowing into impaired waters." Act 64 will bring more impervious surface under regulation. Kari Dolan, Manager of the Vermont Clean Water Initiative, whom Osherenko interviewed, confirmed that even with increasing regulated impervious surface under the new municipal roads general permit and the developed lands general permit "The amount of impervious cover not regulated will still be much, much higher than the amount of impervious cover regulated."

**Increasing infiltration capacity by adding compost to aerated turf, and a revegetation performance standard for disturbed sites are cost-effective strategies to hold, divert, and infiltrate millions of gallons of stormwater every time it rains.**

Vermont's Universal Recycling Law ban on landfilling compostable materials is expected to increase the amount of compost available in Vermont. With a ready market, the new Required Agricultural Practices may result in the composting of livestock manure suitable for amending turf, remediating soils on construction sites, planting beds and green roof growing medium.

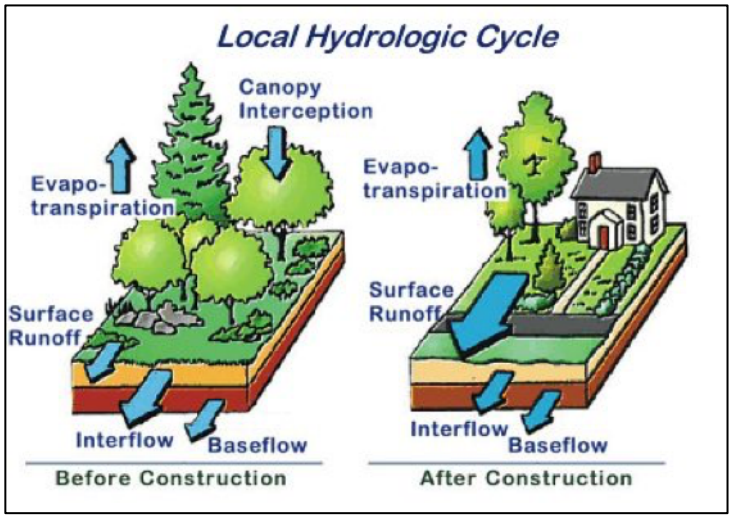
### Soil Story

*Wanaukee, WI*

**Sixmile Creek Golf Course**

Within three years of annual aeration and application of compost: Replaced 100% of synthetic fertilization and 95% of chemical herbicides. Increased organic matter in compost reduced irrigation costs, and improved turf quality.

golfsixmilecreek.com/eco-friendly-golf/




## Cooperation Instead of Regulation

Vermont communities are already takings steps to adapt to climate change. Much of this is happening outside the regulatory arena, through Conservation Commissions, Town Energy Committees, and personal initiative. Vermonters have a strong social ethic to 'do our part.' With knowledge and incentives to reduce runoff on their property, there is reason to believe many Vermonters would on behalf of the common good –caring for the soil, so it can take care of us.


Katahdin sheep in East Randolph perform triple duty as they manage invasive wild chervil, build soil health, and maintain roadside ditches.

Photo by Jenn Colby.

## A No Bare Soil Policy

Now that we know how important roots are to soil function - particularly the ability of soils to withstand erosive forces - should Vermont consider a No Bare Soil policy? Revegetation research by the Colorado Department of Transportation (CDOT) highlights the financial costs if revegetation isn't established on the first try. "Lack of soil organic matter is negatively affecting soil quality and revegetation success. Forensic survey sites that previously used compost were shown to experience successful revegetation results. Organic matter is responsible for many aspects of good vegetative establishment and growth. These aspects include increased soil water retention, increased soil aggregation, increased infiltration, increased macro and micronutrient supply, increased nutrient retention, and decreased compaction."

The report recommended**: "**In general, greater rates of compost should be added to the revegetated areas…. ***Compost application on the disturbed areas should be highly monitored*** [under the contract] ***since it is one of the most important items identified to reach maximum revegetation success.***[26](Emphasis added)

## About Compost

In addition to improving revegetation rates, compost can filter toxins and nutrients out of water. This capacity has increased the use of products such as compost blankets, berms and filter socks in built environments. Vermont's elevated phosphorous level has led to confusion about when and how to use compost. Its physical, biological, and chemical properties in the soil matrix contribute to the all-important structure that keeps soil particles – and the phosphorous attached to them – from eroding. In other words, if the soil is functioning – infiltrating water and preventing erosion- then the nutrients, or anything else shouldn't be leaving the site in surface water. That said,

compost-based BMPs aren't a silver bullet. The Royalton, Vermont case study on page 19, is an example of using compost-based practices to achieve multiple water quality benefits.

The US-EPA, USDA/NRCS, and some state stormwater and green infrastructure programs provide compost product specifications and use guidelines. (see **Resources**, pg 35) Vermont has yet to issue compost specifications for stormwater and erosion control BMPs. Draft revisions to the Vermont Stormwater Management Manual (currently in rulemaking) includes a post construction soil standard that will require amending disturbed soils to a minimum 4% organic matter in the top four inches.

### Grow Deep-Topsoil Watersheds

Vermonters will continue their multi-decade commitment to improve the quality of state waters. Lessons learned elsewhere, and demonstration projects, will speed the adoption of unfamiliar soil health practices, in agriculture and in the built environment. Doing so will clean up the water while providing long-term environmental benefits: soil-based ecosystems services that are our first defense against uncertain future climate. In most cases these practices are less expensive over time than current nutrient, stormwater, and erosion control practices. We need to: **Create the most favorable habitat for the food soil web so water infiltrates where it falls; if you can't, slow it down and infiltrate it as quickly as possible.**

## Soil Story

**Connecting the dots…soil health, farm profitability, renewable energy**

Composting with heat capture is an example of innovation and environmental protection working in tandem: improving soil health, crop yields, disease resistance, and water quality while generating hot water and bedding from a renewable resource. In Vermont this technology is primarily benefitting farmers and commercial organics recycling sites. This scalable technology uses aerated static pile compost processing to reduce operating costs, capture continuous predictable thermal energy (hot water) and produce heaps of compost. On farms this becomes a way to export stabilized nutrients, or use on the farm to increase soil organic matter. [27]

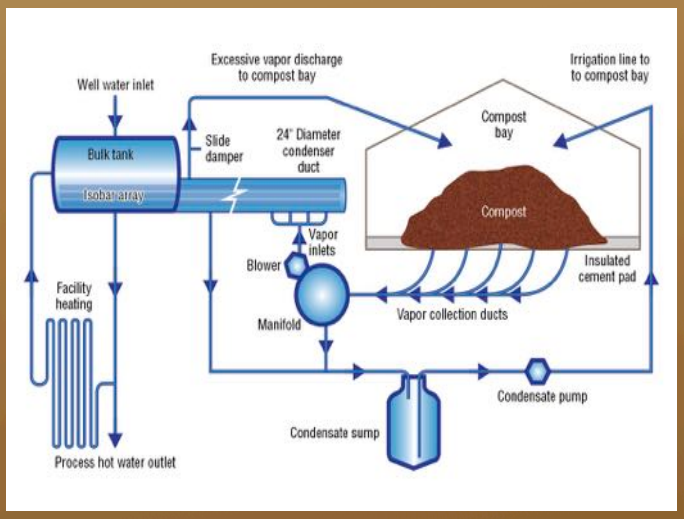



Illustration Credit- Agrilab Technologies

Vermont's low population density and commitment to livable communities and a thriving agriculture sector makes this easier to achieve.

***If soil were a plant or animal it would be an endangered species. More accurately, soil is an endangered ecosystem.*** [28]

## Findings

Project findings emerged from research reports; interviews with regulators, technical assistance providers, practitioners, and; from existing policy documents (Vermont's, other states, and national.) The project findings are congruent with relevant findings in Act 64.

> ***"Sufficiently addressing, improving, and forestalling degradation of water quality in the State in a sustainable and effective manner will be expensive and the burden of the expense will be felt by all citizens of the State, but without action the economic, cultural, and environmental losses to the State will be immeasurable."***
>
> -Act 64, Finding #9. Page 2

**Key Findings**

- To improve soil function, first create the most favorable habitat for the soil food web**.**
- There is a lack of soil function 'intellectual infrastructure'
- The problem is insufficient infiltration, not runoff.
- The majority of Vermont's impervious surface area is unregulated.
- Lack of soil organic matter negatively affects revegetation success.
- Increasing infiltration by improving soil health and function is a broadly adaptable strategy to address negative impacts of erosion, stormwater, nutrient mobility, and weather extremes.
- Soil organic matter (SOM) is typically <6% of soil by weight but controls 90% of soil function.
- Agricultural lenders understand the importance of soil health to long-term farm viability.
- Improving soil function protects aquatic habitat from sedimentation caused by erosion and excess nutrients exported with eroded soil.

# Recommendations

The Policy & Action Matrix beginning on page 28 lists actions, practices and policies by agency, municipality, or organization, and includes options for businesses, and property owners. Those listed below are a representative sampling. Additional agency funding is not needed for many of them. Some can be implemented with Lake Champlain TMDL Implementation Plan funding. Others lend themselves to community action. Used in place of more familiar management practices, they are often less expensive and achieve superior results.[29]

## Categories of Recommendations:

- Treat soil as an investment, as an ally.
- Build soil health Intellectual Infrastructure. Educate about soil function at all policy levels.
- Increase infiltration by improving soil function on public and private lands.
- Focus on soil health in general to improve soil function on farmland, not one practice.
- Coordinate Policy and Action to leverage more than one 'public good' for each dollar invested.
- Provide incentives for personal and community driven volunteer action.

## Recommendations are included if:

- There are credible advocates for the practice. (e.g. USDA/NRCS, UN-FAO, US-EPA, Extension).
- The practice achieves goals mandated in Act 64, and/or the TMDL Implementation Plan.
- The practice achieves runoff reduction/ infiltration targets in the revised VSMM.
- The activity increases awareness and action to mimic nature on disturbed land.
- There is in-state first hand experience with the practice through demonstration projects.

Soil Story

**Roots to the Rescue**

Going cold turkey on tillage may produce conservation benefits on the surface, but the soil underneath is likely to be so biologically unhealthy that it lacks the ability to carry out basic functions like provide nutrients and minerals to plants while making good use of water. "You're going to struggle in any system if your soil fails to function," says Barry Fisher, a USDA/NRCS soil health specialist.

**That's when he and other soil conservation experts realized they were going to have to focus on soil health in general,** and not just one tool or method, such as no-till. Getting farmers excited about soil bacteria, root interactions and organic matter is one way to avoid the trap of farmers seeing planting rye after corn harvest as the end-all solution. Seeing radish roots

"bio-drill" through what was thought to be an impenetrable soil hardpan caused by years of plowing, wheel traffic and lack of biological activity can be a real eye-opener.

Of particular interest to soil scientists is the role of **mycorrhizae fungi** in building soil health. By interacting with a plant's roots in a symbiotic fashion, such fungi can create a diverse biological universe that's resilient and able to cook up its own fertility. "We're finding out plants send out all sorts of signals underground," says Ray Weil, co-author of the seminal textbook, The Nature and Properties of Soils. We didn't really appreciate the role of roots in building soil until relatively recently."

From: Land Stewardship Project Blog, http://landstewardshipproject.org/posts/blog/804http://landstewardshipproject.org/posts/blog/804

High value recommendations achieve two or more public goods. For example: increasing infiltration reduces flooding and maintains moisture availability in dry spells; increasing soil organic matter increases farm profitability, infiltration *and* reduces erosion. The following Actions – of more than six dozen identified – are representative of the types of responses needed: policy driven change of practice, education, and behavior change incentives.

- Establish a revegetation performance standard for state and municipal construction projects.
- Include a soil function standard in the anti-degradation of state water's policy.
- Allow SOM greater than 4% at 4" as a stormwater runoff reduction practice in stormwater permits
- Include Compost Blankets as a post construction site stabilization BMP in VSMM
- Establish financial incentives at the municipal level for reducing discharge (runoff), and 'zero discharge' sites - new and existing.
- Finance municipal runoff reduction incentive programs with a discharge fee.
- Create 'Watershed Action' grant program to leverage volunteer driven initiatives that decrease runoff from private land into town maintained ditch networks.
- Provide soil function outreach and training to policymakers, municipalities, professionals, advocates and property owners.
- Coordinate public outreach with the Lake Champlain Basin Program's Healthy Soil Campaign.

## Conclusion

Globally, our relationship to natural resources such as water and soil must change for life on earth – for life in Vermont – to continue. Demonstration projects and peer-to-peer learning are proven strategies to alter behavior by helping individuals 'see' the alternative. Demonstrations can also influence motivation and self-efficacy beliefs that are critical to society-wide behavior change.[30]

Climate change challenges us to rethink how we care for agricultural land, forests, waterways, and built environments. Actions that improve soil resiliency – soil function – also prepare us for uncertain future climate. We now have decades of research, as noted throughout the paper, to support the recommended practices. Healthy, high functioning soils have more biological activity, produce more resilient plants with stronger root systems and disease resistance, and has a greater capacity to withstand weather extremes - drought and torrential rains. Vermonters, and most of us who inhabit this planet, need to learn – relearn – how to take care of this life-giving natural resource on which life - and wealth creation - depend. Climate change demands behavior change. Policies and practices proposed in this paper are steps that can cost-effectively improve the resiliency and function of Vermont's soil resources, and thus the quality of our water resources. Together, they form the foundation of our capacity to adapt.

*"Whether we and our politicians know it or not, Nature is party to all our deals and decisions, and she has more votes, a longer memory, and a sterner sense of justice than we do."* – *Wendell Berry*

## End Notes

[3] **Organic residuals**, sometimes called 'organics' or 'organic materials,' refers to one or more of the following – horticulture/garden material, food scraps, manures, field crop residuals, animal mortalities, paper products, etc.

[4] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/sd/home/?cid=stelprdb1261962

[5] https://www.cdfa.ca.gov/oefi/healthysoils/

[6] http://soilsforsalmon.org/

[7] http://accd.vermont.gov/sites/accdnew/files/documents/CD/CPR/CPR-VERI-Toolkit-GreenLandscaping.pdf

[8] http://fpr.vermont.gov/forest/ecosystem/soil_quality

[9] http://www.fao.org/global-soil-partnership/en/

[10] http://www.fao.org/soils-portal/policies-governance/ru/

[11] https://www.cdfa.ca.gov/oefi/healthysoils/

[12] http://landstewardshipproject.org/repository/1/555/managing_soil_biota_nichols.pdf

[13] http://energyandfacilities.harvard.edu/facilities-services/landscape-maintenance/organic-maintenance-program
http://www.nytimes.com/2009/09/24/garden/24garden.html

[14] Intellectual Infrastructure is defined as nonrival input into a wide variety of outputs.
*Infrastructure: The Social Value of Shared Resources,* Brett M. Frischmann

[15] Modified from http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/

[16] http://compostingvermont.org/the-connection-between-healthy-soil-clean-water/
(Multiple docs on this page)

[17] http://landstewardshipproject.org/posts/843

[18] http://landstewardshipproject.org/posts/843

[19] http://landstewardshipproject.org/posts/792

[20] http://www.dnr.state.mn.us/mcvmagazine/issues/2014/jan-feb/roots.html

[21] Modified from http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/

[22] http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Organic-Matter-What-It-Is-and-Why-It-s-So-Important/Why-Soil-Organic-Matter-Is-So-Important

[23] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ia/home/?cid=stelprdb1186272

[24] http://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Organic-Matter-What-It-Is-and-Why-It-s-So-Important/Why-Soil-Organic-Matter-Is-So-Important

[25] *Understanding the Failure to Reduce Phosphorous Loading in Lake Champlain,* Gail Osherenko, J.D. http://vjel.vermontlaw.edu/publications/understanding-failure-reduce-phosphorous-loading-lake-champlain-lessons-governance/

[26] https://www.codot.gov/programs/research/pdfs/2015-research-reports/assessment-of-cdot-revegetation-practices-for-highway-construction-sites/view

[27] **agrilab**tech.com
http://vtdigger.org/2016/07/25/vernon-farm-takes-cow-energy-in-a-different-direction/

28 https://www.newscientist.com/article/mg22830423-300-endangered-earth-the-secret-battle-to-save-our-soils/
http://bioscience.oxfordjournals.org/content/50/11/947.full

[29] http://ucanr.edu/sites/urbanwatermgmt/files/228951.pdf

[30] Behavior Change references
http://reflectd.co/2014/01/20/self-efficacy-beliefs/
http://www.unco.edu/cebs/psychology/kevinpugh/motivation_project/resources/graham_weiner96.pdf
http://www.nationalforum.com/Electronic%20Journal%20Volumes/Lunenburg,%20Fred%20C.%20Self-Efficacy%20in%20the%20Workplace%20IJMBA%20V14%20N1%202011.pdf

## Appendix - 1

### Soil Policy in Vermont

# POLICY & ACTION MATRIX

This is a living document. Half of the proposed Actions are under consideration or in rulemaking. A few have already been adopted. Act 64, Act 148, and revisions to the Vermont Stormwater Management Manual (in rulemaking) have provided water and soil advocates new statutory drivers to leverage action. Agency and Organization websites are good sources for updates on legislatively mandated policy changes.

| | POLICY | Statute | Action/Next Steps |
|---|---|---|---|
| **AGENCY** | | | |
| | | | |
| **AAFM** | | | |
| | Definition of Agricultural Waste | 10 VSA | • Amend definition. Reclassify materials such as manure, compost, crop debris as soil amendments, not 'waste' |
| | RAPs | Act 64 | • The importance of soil health is included<br>• Soil Management activities identified |
| | RAPs Field gully erosion | Act 64 | • Adopt practices (e.g. no-till) that increase soil water storage in gully 'watershed'<br>• Training and demonstration projects to use compost blanket and filter socks per NRCS recommendations in treatment train |
| | The Secretary may require soil monitoring | Act 64 | • Monitoring eligible for CWF funding<br>• F2P Soil and Water Task Force advocate for funding monitoring |
| | Funding for innovative or alternative technologies to improve water quality including community-based methane digesters that utilize manure, wastewater, and food residuals to produce energy; | Act 64 | • Evaluate higher permitting and processing costs with mixed residual AD<br>• Fund practices that improve soil function, priority for infiltration<br>• Fund thermal heat capture from composting<br>• Priority for near-stream soil BMPs |
| | Tile Drainage Systems | Act 64 | • Priority investment for practices that increase soil storage of water; reduce nutrients and sediment in runoff over 'end of pipe' treatment of discharge |
| | Require cropland on the farm to be cultivated in a manner that results in an average soil loss of less than or equal to the soil loss tolerance for the prevalent soil. | Act 64 | • Provide incentives for improving soil health, increasing SOM<br>•Assistance to prepare farmers for more extreme weather |
| | Establish standards for site-specific vegetative buffers that address water quality needs based on consideration of | Act 64 | • Add soil health/resiliency criteria to standard |

| | | | |
|---|---|---|---|
| | soil type, slope, crop type, proximity to water, and other relevant factors. | | |
| | Training classes or programs for owners or operators of small farms, medium farms, or large farms | Act 64 | •Include economic and climate adaptation benefits of healthy soil and soil function; cover cropping; managed multi-species rotational grazing; economically valuable buffer species; agro-forestry |
| **ACCD** | | | |
| | Flood Readiness Resources | | Toolkit includes soil- and compost-based BMPs to improve infiltration |
| **ANR** | | | |
| | Act 64 ANR/AAFM MOU | Act 64 | •Stakeholders provide input on MOU performance measures |
| **DEC** | | | |
| Clean Water Program | Clean Water Fund Board<br>Fund ANR, AAFM, AOT staff positions to achieve or maintain compliance with water quality requirements<br>Provide funding to nonprofit organizations, regional associations, and other entities for implementation and administration of community-based water quality programs or projects. | Act 64 | • CWFB trained on cost of GSI and soil - based BMPs<br>• Soil Health stakeholders provide input on funding priorities<br>• Include soil health in funding criteria for community-based project |
| Stormwater | VSMM – Vol I revisions in rulemaking | Act 109 | • Require use of non-structural practices first<br>• Post Construction Soil Depth and Quality Standard requires minimum 4% organic matter in top 4", scarification of subsoil |
| | Construction site GSI standards<br>Report to legislature includes standards for the management of stormwater runoff from construction sites and other land disturbing activities. Due **12/31/17** | Act 64 | • Track development of policy<br>• Stakeholder support for BMPs<br>• Provide technical info on soil-based BMPs |
| | Practical and cost-effective best management practices for the control of stormwater runoff and reduction of adverse water quality effects from the construction, redevelopment, or expansion of impervious surface that does not require a permit under 10 V.S.A. § 1264 – Due **1/16, Postponed** | Act 64 | •Include soil-based BMPS in VSMM<br>• Demonstrate soil-based BMPs<br>• Replicate/build on leading state's BMPs<br>• Credit zero discharge sites<br>• Partner with LCBP Healthy Soils Campaign for resident outreach |
| | Focus on the prevention of pollution; relies on structural treatment only when necessary | | • Soil-based BMPs training and outreach for engineers, contractors, towns, property owners |
| | MRGP - Criteria, technical standards for stormwater improvements of municipal roads includes soil based BMPs and revegetation performance standard | Act 64 | • Include soil based BMPs and revegetation performance standard<br>•Reduce need for expensive riprap by reducing upstream flows |

| | | | |
|---|---|---|---|
| | | | • Landowner incentive programs to store more water on site, reduce downstream flow<br>• Reference 2016 USFS road BMPs (see **Resource**s page for citation)<br>• Partner with LCBP Healthy Soil Campaign and Watershed groups for outreach |
| Planning | Phosphorous reduction in Basin Planning | Act 64 | • Prioritize improving soil function through increased infiltration |
| | Water quality staff positions | Act 64 | • Staff are trained in soil-based BMPs<br>• Use NRCS soil health outreach resources |
| Rivers | Link corridor function and protection investment with increasing infiltration out of corridor – upstream, as part of MRGP | Act 64 | • Demo projects – e.g., private and town roadside design/maintenance to reduce /disperse flows close to source |
| Solid Waste | Contracting:<br>Provide composters access to chipped woody material from state maintenance contracts:<br>Develop contract language w/ AOT, BGS, FPR | Act 148 | • Develop on-line 'notification of availability' registry. Require contractors to post location, date available, and approximate quantity |
| **FPR** | | | |
| | Develop education, outreach, demonstration, and access to tools recommendations for Acceptable Management Practices for Maintaining Water Quality on Logging Jobs | Act 64 | • Confer with soil and water advocates to develop trainings for loggers and landowners<br>• Link outreach to LCBP Healthy Soil Campaign<br>• Adopt relevant USFS road related BMPs<br>• Adopt GSI and compost-based BMPs to manage trails, roads, areas around structures, chronically erosive soils, protective strip along waterways for park infrastructure maintenance |
| | Landfill ban on compostable material Water Quality goals | Act 148 | • Include education about invasive worms, soil health/resiliency, organics diversion, AMPs in State Park education programs and outreach materials. |
| | Contracting | | • Amend construction contracts to include a revegetation performance standard |
| | Contracting:<br>Provide composters access to chipped woody material from state maintenance contracts:<br>Develop contract language w/ AOT, BGS, ANR | | • Develop on-line 'notification of availability registry. Require contractors to post location, date available, and approximate quantity |
| **F&W** | | VSA 10 | |
| | To protect and conserve our fish, wildlife, plants and their habitats for the people of Vermont | | •Outreach and collaboration with leaseholders in WMAs to reduce erosion and runoff using soil-based GSI practices |

| | | | |
|---|---|---|---|
| | | | • Include information about worms as invasives in materials distributed by F&W<br>• Mandate use of GSI practices for new construction and maintenance. |
| **Planning** | | | |
| **NRB** | Act 250 Permit Review | Title 10 | • Add 'Infiltration' to Criterion 4<br>• Provide soil-based BMPs training for District Commissions.<br>• Align sub-jurisdictional review with changes to VSMM; use of non-structural BMPs to improve infiltration, e.g., amend planting and turf areas; raise SOM to ≥ 4%; aerate turf, topdress with compost |
| | Section 248 Permit Review | Title 30 | • Add infiltration, SOM standard to review of solar projects<br>• Add periodic water quality testing for toxins on solar project sites water.usgs.gov/wrri/10grants/2010TX360B.html<br>•Include soil remediation in solar site decommissioning plans<br>•Develop data base of toxins present in solar site soils. |
| **AOT** | | | |
| | TS4 Permit (Developed jointly with ANR)<br>• Proactive approach to address "stressed" waters<br>• Fully integrate Green Stormwater Infrastructure into project delivery<br>• Address source control, pollution prevention, and stormwater at 65+ Transportation Maintenance Facilities | Act 64 | • Increase upstream infiltration<br>•Develop and Implement Revegetation Performance Standard<br>•Use of Compost Filter Sock to trap petrochemicals at Transportation Facilities<br>• Increase infiltration rates in turf areas around Facilities |
| | Municipal roads minimum 'resilience standard' is currently being developed by VTrans in consultation with ANR | Act 64 | •Training, technical resources to towns to slow flow/infiltrate within road/ditch networks<br>• Incentives for private landowners to infiltrate/store stormwater |
| | Contracting | | • Purchase/Use compost – guarantee purchase volume every year (like TX)<br>• Require use of compost and compost-based products in project bid specs |
| | Contracting | | Develop revegetation performance standard. Tie final payment to performance. |
| | MRGP | Act 64 | •Training, technical resources to towns to slow flow/infiltrate within road/ditch networks<br>•Reduce need for expensive riprap by reducing upstream flows<br>• Demo use of compost sock and blanket<br>• Demo rotational grazing in ditches |
| | Contracting: | | • Develop on-line 'notification of availability' |

| | | | |
|---|---|---|---|
| | Provide composters access to chipped woody material from state maintenance contracts:<br>Develop contract language w/ BGS, FPR, ANR | | registry. Require contractors to post location, date available, and approximate quantity |
| **BGS** | | | |
| | | | • Use of GSI practices, compost amended soils, compost products on state building grounds and new construction<br>• Use projects as zero/low discharge demonstration sites |
| | Contracting:<br>Provide composters access to chipped woody material from state maintenance contracts:<br>Develop contract language w/ AOT, FPR, ANR | Act 148 | • Develop on-line 'notification of availability' registry. Require contractors to post location, date available, and approximate quantity |
| | | | • Include a Revegetation Performance Standard in construction contracts |
| | | | • Priority use of Green roofs for new construction and renovation |
| | Building Community Grants Program | | • Add town stormwater flow reduction as eligible projects |
| **Dept of Taxes** | | | |
| | Financing clean water | Act 64 | Priority financing to:<br>• improve soil health and function<br>• incentives for zero/ reduced discharge<br>•public/private partnerships to infiltrate water |

| | | |
|---|---|---|
| **Federal** | | |
| **USDA/ NRCS** | Cost sharing for agronomic practices | • Provide financial assistance for soil health monitoring on farms<br>• Trial interim practices<br>• Use compost filter socks for immediate nutrient control at field tile drain inlets |
| | NRCS forest trails and landings cost share | •Include use of compost-based BMPs |
| **USFS** | Forest roads management, research | • Consider recommendations in **Effectiveness of best management practices that have application to forest roads: a literature synthesis.** |
| **Municipalities** | | |
| | Municipal Roads General Permit (MRGP) | • Training for compost-based BMPs for road stormwater runoff |
| | Stormwater management for developed sites (run-off reduction) | • Amend building permit to include amending turf and planting areas to increase organic matter, and aeration to increase infiltration capacity |

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|---|---|---|
| | | • Partner with LCBP Healthy Soil Campaign on outreach education<br>• Incentive programs for property owners to aerate lawns and add compost<br>• Have aerators available for property owners to borrow<br>• Zero discharge incentives |

The following list of organizations is not all inclusive of organizations that might include soil health considerations as mission driven actions. It is as much instructive of how Vermonters could respond to soil health concerns outside the regulatory structure, as an invitation to action.

| Organization | Mission/Policy | Action |
|---|---|---|
| | | |
| **AVCC** | Conservation and water quality advocates | • Offer compost based BMPs training<br>• In-kind for demonstration sites<br>• Partner with LCBP Healthy Soil Campaign on outreach education |
| **Farm to Plate** | Grow more food in Vermont for Vermonters | Soil and Water Task Force:<br>• Support development of regenerative agriculture practices<br>• Contribute to monitoring protocol<br>• Mmonitoring training/technical support |
| **Fishing & Hunting Groups** | Habitat Protection | • Link healthy soil to habitat protection in outreach/education<br>• Partner with LCBP Healthy Soil Campaign on outreach education |
| **Homeowner Associations** | Shared landscape maintenance | • Partner with LCBP Healthy Soil Campaign<br>• Include aeration and amending turf with compost to increase water storage and infiltration; reduce need for irrigation and fertilizer<br>• Lawn aerators to share |
| **Lake Champlain Basin Program** | Healthy Soils Campaign | • Mow lawns no shorter than 3 inches<br>• Include aeration and amending turf with compost to increase water storage and infiltration; reduce need for irrigation and fertilizer<br>• Partner with towns, advocacy groups and businesses on Healthy Soil Campaign |
| **Neighborhood Associations** | Cooperative neighborhood improvements | • Soil health education, advocacy,<br>• Demonstrate benefits<br>• Partner with LCBP Healthy Soil Campaign<br>• Community composting |
| **Preservation Trust of VT** | Strengthen Vermont's downtowns and village centers | • Add Soil Health requirement for projects with grounds |

| | | |
|---|---|---|
| **Rural Vermont** | Regenerative Farming Practices – education, advocacy, outreach grassroots organizing with small-scale, diversified farmers | • Advance healthy soil principals in outreach and advocacy |
| **UVM Extension** | •Education tailored to local needs<br>•Research-based programs and practical information | • Add web resources about soil resiliency<br>• Add 'how to' for homeowners and businesses to aerate and amend turf with compost<br>• Train/educate agency personnel in soil health fundamentals and concepts |
| **UVM Center for Sustainable Agriculture** | Advances sustainable food and farming systems through partnerships, support of innovative research and practices, and informing policy | •Explore role for Act 148 and Act 64 related outreach<br>•New Research: Economics of Resiliency BMPs<br>•Pending Research Project:<br>**Can CSA make an economic case for improving soil health instead of installing tile drain systems? 11/16 notification** |
| **VACD** | | • Partner with LCBP Healthy Soil Campaign on outreach education<br>• Composting outreach to horse farmers |
| **VBSR** | Empower members to solve environmental, social and economic problems. Provide members with resources. | •Educate members on soil-based BMPs<br>• Outreach to employees<br>• Partner with LCBP Healthy Soil Campaign on outreach education |
| **VLCT** | 1. financial and technical support to municipalities to fully implement Act 64 mandates<br>2. fair, effective, and efficient spending of state and federal dollars to achieve TMDL goals and mitigate TMDL-regulated discharges;<br>3. subject potential mitigation efforts to a cost-effective analysis; implementation based on that analysis | • Identify options/policy for watershed level response<br>• develop boiler plate documents, and outreach materials for municipalities to meet Act 64 mandates – e.g., infiltration BMPs to reduce runoff on existing and new development |
| **Vermont River Conservancy** | Water quality advocacy | •Leverage easements for watershed level water quality improvements<br>•Demonstration sites for near-stream vegetation management |
| **Watershed Groups** | Water quality advocacy | • Offer compost based BMPs training<br>• In-kind for demonstration projects<br>• Partner with LCBP Healthy Soil Campaign on outreach education |

# Appendix – 2

## RESOURCES

**Working With Nature to Manage Stormwater-** http://ucanr.edu/sites/urbanwatermgmt/files/228951.pdf)
Includes cost data, zero discharge case study

**How Compost reduces N and P Transport,** Insititute For Local Self Reliance
http://ilsr.org/wp-content/uploads/2013/05/Compost-Builds-Healthy-Soils-ILSR-5-08-13-2.pdf

**Growing Deep-Topsoil Watersheds**, Abe Collins, LandStream, presentation to VT-Senate NRE Committee, 2015
http://legislature.vermont.gov/assets/Documents/2016/WorkGroups/Senate%20Natural%20Resources/Bills/S.49/Witness%20Testimony/S.49~Abe%20Collins~Testmony~4-8-2015.pdf

**Vegetation and Soil Quality Effects** http://www.filtrexx.com/application/files/1214/5928/0052/113-2006-JSWC-Compost-Blanket-Hydromulch-Vegetation-and-Soil-Quality-Publication.pdf

**Recipe Development to Better Bound Nutrients in Compost**, Rodale Institute
http://www.newfarm.org/depts/NFfield_trials/2006/0413/compost.shtml

**Manure and Nutrient Management in Tile Drained Lands (six webinars, each 11 – 20 minutes)**
http://articles.extension.org/pages/72930/manure-and-nutrient-management-in-tile-drained-lands

**Understanding Soil Organic Matter**
http://www.slideshare.net/jbgruver/understanding-soil-organic-matter

**Organic Matter for Soil Health and Fertility**
http://www.slideshare.net/MauraMcDW/managing-organic-matterforsoilhealthandfertility42812

**NRCS Soil Health Resources**

**Soil Health and Sustainability: Changing Our Paradigms**
http://ctrcd.org/pdf/Soil_Health_March_2016_Presentations/1SHBasicsOrganicTalk.pdf

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1193043
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/
http://www.nrcs.usda.gov/wps/portal/nrcs/main/vt/soils/health/

**NRCS – 41 1-minute Secrets of Soil videos**
https://www.youtube.com/watch?v=2JZJB4zM3Y4&list=PL4J8PxoprpGbRi3gZ-fWN0dGD8bnnq3wM

**Ray Archuleta** –USDA/NRCS soil health specialist - videos
https://www.youtube.com/watch?v=OzcfYzvbhFA
https://www.youtube.com/watch?v=9uMPuF5oCPA

**Elaine Ingham, Ph.D, Soil Food Web Compost and Compost Tea**
https://www.youtube.com/watch?v=jErga1eP718

**Gabe Brown, farmer, ND, Keys to Building Healthy Soils**
https://www.youtube.com/watch?v=9yPjoh9YJMk

**Understanding Soil Microbes**
http://ohioline.osu.edu/factsheet/SAG-16

http://ctrcd.org/pdf/Soil_Health_March_2016_Presentations/1SHBasicsOrganicTalk.pdf

http://www.hoosierchapterswcs.org/wp-content/uploads/2012/06/1_SWCS-IN-11-16-12.pdf

**USDA Power Point: Managing Soil Biota for Economic and Environmental Sustainability**
**http://landstewardshipproject.org/repository/1/555/managing_soil_biota_nichols.pdf**

**Soil Health and Soil Biology in Regenerative Organic Systems**, Kristine Nichols, Ph.D.
https://www.youtube.com/watch?v=14fDrB8n08E

**10 year study, 3% organic matter from compost resulted in 50% less fertilizer use,** Monica Ozores-Hampton, U of Florida, http://www.dep.state.fl.us/waste/quick_topics/publications/documents/compost.pdf

**Soil Health Planning Principles, A Practical Approach to Farming in the 21st Century,**
https://www.ok.gov/conservation/documents/Soil%20Health%20%20101%20Planning%20Principles.pdf

**Compost Sock Fact Sheet**- http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1048852.pdf

**Compost Blanket Fact Sheet** - https://efotg.sc.egov.usda.gov/references/public/TN/TN-AgronomyNo8_CompostBlanketsforRunoffandErosionControl_Jan2014.pdf

**US-EPA – specifications for Compost Blanket material** https://www3.epa.gov/npdes/pubs/compostblankets.pdf

**California Healthy Soil Initiative Proposal**
http://calclimateag.org/wp-content/uploads/2015/04/Healthy-Soils-Initiative-Proposal.pdf

**The National Turfgrass Research Initiative** http://www.turfresearch.org/initiative.htm

TxDOT Compost Program
http://landscapeonline.com/research/article.php/1843
https://www.tceq.texas.gov/assets/public/compliance/monops/nps/projects/CMIP_Final_Report_09_29_09_1.pdf
ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/pdf/aashto_award02.pdf

**Colorado Department of Tranportation, Revegetation Practices for Highway Construction Projects**
https://www.codot.gov/programs/research/pdfs/2015-research-reports/assessment-of-cdot-revegetation-practices-for-highway-construction-sites/view

**Slow it. Spread it. Sink it. Store it!**
https://issuu.com/sonomarcd/docs/slowit.spreadit.sinkit.store.it.7.1

**Healthy Soils: Benefits of Compost & Applications -** http://carolinacompost.com/wp-content/uploads/2016/06/Healthy-Soils-Benefits-of-Compost-Applications-2016-NCCC-Members-Meeting.pdf

**Effectiveness of best management practices that have application to forest roads: a literature synthesis.** Edwards, Pamela J.; Wood, Frederica; Quinlivan, Robin L. in press. Gen. Tech. Rep. NRS-163. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 171 p.

***Understanding the Failure to Reduce Phosphorous Loading in Lake Champlain,*** Gail Osherenko, J.D.http://vjel.vermontlaw.edu/publications/understanding-failure-reduce-phosphorous-loading-lake-champlain-lessons-governance/

**Glossary of Soil Health and Soil Ecology Terms**
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/?cid=nrcs142p2_053848

**Status of the World's Soil Resources**
http://www.fao.org/documents/card/fr/c/f76e62e9-9ca1-4e99-9085-75ac4a81b107/

## Appendix – 3

**Administration/Department of Food and Agriculture Work Product**

# Healthy Soils Initiative Proposal

**Issue Statement:**
California is the nation's leading agricultural production state in terms of both value and crop diversity. Soils are fundamental for crop growth and food production. The importance of soils has been memorialized by the United Nations Food and Agriculture Organization after they recognized 2015 as the Year of the Soil. With limited new arable land that is capable of growing food crops in California and an ongoing drought, it is critical to ensure the soil system is sustainable long into the future, resilient to potential climate change impacts such as variable temperatures and precipitation, and to be able to produce crop yields to sustain a growing local and global population. The term "healthy soils" refers to ensuring that our agricultural soils have adequate soil organic matter (SOM). Increasing the amount of SOM, from its current levels, in soils can provide multiple benefits such as:
· Source of nutrients for plants – SOM contains important nutrients that contribute to plant growth and yields (e.g., nitrogen and sulfur).
· Water retention – SOM has the ability to hold up to 20 times its weight in water.
· Contributes to the environmental fate of synthetic inputs – SOM affects persistence and biodegradability of pesticides and other soil inputs.
· Carbon sink – Stabilized carbon stored in soil serves as a carbon sink, preventing the escape of carbon dioxide and methane greenhouse gases to the atmosphere.
· Soil structure stability and reduced erosion – Soil carbon can combine with the inorganic clay mineral fraction to form structural units called aggregates. Aggregated soils have improved aeration, water infiltration and resistance to erosion, dust control, as well as numerous other benefits.
· At least a quarter of the world's biodiversity lives in the soil.

**Conceptual Proposal**
Recently, the Brown administration recognized the importance of soil health in the Governor's 2015-16 proposed budget; "as the leading agricultural state in the nation, it is important for California's soils to be sustainable and resilient to climate change. Increased carbon in soils is responsible for numerous benefits including increased water holding capacity, increased crop yields and decreased sediment erosion. In the upcoming year, the Administration will work on several new initiatives to increase carbon in soil and establish long term goals for carbon levels in all California's agricultural soils. CDFA will coordinate this initiative under its existing authority provided by the Environmental Farming Act". Consistent with this initiative, several actions have been identified to:
· Protect and restore soil organic matter (soil carbon) in soils to ensure climate change mitigation and food and economic security
· Identify sustainable and integrated financing opportunities, including market development, to facilitate increased soil organic matter
· Provide for research, education and technical support to facilitate healthy soils
· Increase governmental efficiencies to enhance soil health on public and private lands
· Ensure interagency coordination and collaboration

**Short Term Actions (within a year)**

· Establish a short- and long-term goal for building soil organic matter in California's agricultural and degraded soils by December 2015. These goals will be established through stakeholder meetings with scientific input (lead CDFA and CalRecycle).
· Establish a soil health initiative coordinator position to facilitate interagency activities including interagency communication, collaborations and to ensure resources optimization and permit streamlining to build soil carbon

with carbon-based inputs (lead CDFA).

· Identify critical agronomic and economic research needed to fill knowledge gaps and build mapping tools for increasing soil organic matter throughout the state (lead CDFA).
· Identify demonstration projects and contract with University of California Cooperative Extension (UCCE) to begin the cycle of management practice adoption to implement research objectives that meet soil carbon goals (lead CDFA).
· Integrate incentives for improved soil management practices into the Sustainable Agricultural Lands Conservation Program (lead Department of Conservation).
·Encourage organic diversions from landfills to more beneficial uses, including composting facilities, by a tiered tipping fee or complementary mechanism that incentivizes the diversion of organics. (lead CalRecycle).
· Provide healthy soils guidance in the Climate Change Handbook for Agricultural Water Management Planning as well as in public and outreach and education efforts (lead DWR).
· Facilitate discussion on the benefits of compost use when managing nitrogen and include as a separate component in the nitrogen management plans required by the Irrigated Lands Regulatory Program (lead Water Boards).
· Grow CDFA's State Water Efficiency and Enhancement Program to promote soil management practices that improve water retention (lead CDFA).
· Add healthy soils as an Efficient Water Management Practice (EWMP) in the guidebook to assist Agricultural Water Suppliers to Prepare an Agricultural Water Management Plan, and as a co-benefit in water efficiency grant programs (lead DWR).
· Explore opportunities to implement healthy soil management on construction, maintenance and operation plans in DWR (lead DWR).
· Explore with other Agencies opportunities for implementation of healthy soil management on public lands.

**Long Term actions (1-5 years)**

**Identify sustainable and integrated financing opportunities, including market development, to facilitate increased soil organic matter**

Develop and fund incentive and demonstration programs with new and existing resources such as Resource Conservation Districts and UC Cooperative Extension, to promote GHG reductions, carbon sequestration, cover crops, crop rotation and organic amendments including compost to build soil carbon, increase water holding capacity and ensure crop yields for food production through on-farm management practices (lead CDFA).

**Provide for research, education and technical support to facilitate healthy soils**

Identify and secure resources to contract with the appropriate academic institution to develop a user-friendly soil management data base to incorporate research findings and practical applications.
Identify and secure short and long term funding sources to support a robust scientific research program that will fund research on topics such as carbon farming, subsidence reversal, wetland restoration, drainage issues, salt accumulation and multi-benefit farming to support and enhance healthy soils (lead CDFA).

**Increase governmental efficiencies to enhance soil health on public and private lands**

Increase the generation and use of compost in California to improve soil health, by permitting 100 new composting and anaerobic digestion facilities in California by 2020 (lead CalRecycle).

**Ensure interagency coordination and collaboration**

Include in the regular coordination between agencies the potential for broader discussions on soil health. Such as: include Healthy Soil Initiative practices to promote groundwater recharge and groundwater quality protection in DWR Sustainable Groundwater Management Program (lead DWR); with the ARB on dust mitigation as a key element in all Climate Change work across Cabinet.