Hatchet & Seed
Edible Landscaping & Applied Permaculture

White House Stables:
Integrated Water Management

Pilot Project

Project Follow Up Report

Published By:
Tayler Krawczyk & Solara Goldwynn
Hatchet & Seed
www.hatchetnseed.ca
November 2014

Prepared For: CRD Making a difference...together

With Funding From: RBC Blue Water Project™

Table of Contents

This report summarizes educational outreach, design, consulting, and implementation activities completed by **Hatchet & Seed** for the **Capital Regional District's Integrated Watershed Management Program** from March 2014 - November 2014.

1. Project Overview

1.1. Project Rationale

The Integrated Watershed Management Program is seeking innovative ways to reduce the volume of nutrient and water runoff during extreme precipitation events in the CRD. Farmers, as large-scale land-managers, can play a vital role in this cause. It is important that solutions to address storm-water management fit into farmers' existing production models. This is where a permaculture design approach can help find multi-functional solutions.

Hatchet & Seed is a small business specializing in permaculture design & regenerative agriculture. Our approach to land design draws best practices from the fields of **permaculture design**, **agro-forestry**, **silvo-pasturing, keyline design,** and **myco-filtration.** *(See section 2.2 for definitions)*

Through a **CRD** Sponsored Pilot Project, **Hatchet & Seed** has partnered with **White House Stables**, a family farm located in North Saanich, BC. As a retail farm store, White House Stables is a hub for local farmers in North Saanich, and as such, makes a great venue for a pilot project of this nature. We hope that it can be a lasting learning experience for everyone involved.

1.2. Regional & Global Context

✔ Local Climate Models Predict Increased Intensity of Rainfalls and Droughts

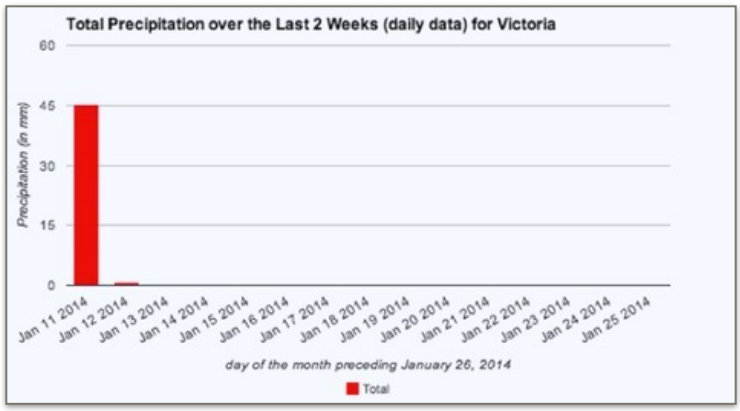
Highlights from the CRD's Regional Climate Modelling. *(right)*

Highlights from the findings include:

- Extreme temperatures (32°C to 35°C) are projected to occur almost four times as often in future CRD.
- The amount of precipitation falling during very wet days is projected to increase by 20%; with precipitation during extremely wet days projecting to increase by 25% in CRD.
- More extreme precipitation events (with 3-hour duration) are projected to occur on average three and a half times as often in future in CRD.
- There will be fewer Heating Degree Days and a substantial increase in Cooling Degree Days in CRD.

Source: https://www.crd.bc.ca/about/what-we-do/sustainability/climate-change-indicators

Examples of this phenomenon can be seen with patterns like we see here from January 2014. Nearly all of the month's rainfall (45 mm) occurred in a single day. *(right)*. This rain simply falls too fast for soil to absorb it.



✔ Soils with Low-Biological Activity Increase Surface Runoff

Soil carbon and the biological activity that cycles carbon are crucial to the ability of soil to soak up heavy rains.

Table 1. Change in the capacity of soil to store water (litres/ha) with changes in levels of soil organic carbon (OC) to 30 cm soil depth. Bulk density 1.2 g/cm^3

Change in OC level	Change in OC (kg/m^2)	Extra water (litres/m^2)	Extra water (litres/ha)	CO_2 sequestered (t/ha)
1%	3.6 kg	14.4	144,000	132
2%	7.2 kg	28.8	288,000	264
3%	10.8 kg	43.2	432,000	396
4%	14.4 kg	57.6	576,000	528

Source: 'Managing the Carbon Cycle' NATIONAL Forum 22-23 November 2006 Carbon and Catchments: Inspiring REAL CHANGE in Natural Resource Management. Dr. Christine Jones

This table shows the net benefit of increasing organic matter (made up largely of carbon) in both water holding capacity and CO2 storage.

✔ High Surface Runoff Causes Excess Nutrient Runoff and Unhealthy Watersheds

Agricultural runoff often contains elevated levels of nitrates, phosphates and e-coli that can pose serious threats to aquatic and marine environments. Increasing flood and drought regimes can exacerbate this trend as soils become hydrophobic in drought and shed more surface runoff in extreme rain events.

2. Design Overview

White House Stables, ran by the Wylie family has many characteristics that make it a great

location for a pilot project of this nature.

The following is some information about the farm and its history, from their website (**http://whitehousestables.com/**).

> " White House Stables is a family run operation that offers a wide range of services from farm feed and products to farm raised livestock, hay delivery to educational workshops.
>
> From raising champion racehorses to rare breed chickens, White House Stables takes pride in feeding the animals only the best quality feed and treating them with respect. Our accomplishments and those of our customers, extend within the agricultural community in the Saanich Peninsula, creating a tight-knit and personable family.
>
> The environment is one of our greatest passions and we try to do as little damage as we can. Herbicides and pesticides have no home at White House Stables, and haven't for the 29 years we have lived here. The products we sell are consciously selected for their environmental standards, ranging from Canadian made pet foods to long-lasting wheelbarrows.
>
> Our exceptional work ethic and responsibility have gained us respect within our community; our old fashioned services and deep-rooted product knowledge have kept our customers happy and they keep coming back!
>
> We moved onto the farm in 1984 when it came up for rent after 20 years with the previous tenants. It hadn't been farmed since our landlady was a little girl and her parents farmed here. We have slowly changed things as time and money allowed, building the barn for our racehorses, fencing paddocks and fields, planting an orchard,adding other animals like chickens and then as we raised our family, food production became more important. The landscape is always changing around here and multi purpose use for all the areas has been very important, adapting a stable from foaling a mare to raising day old chicks to housing a sow when she births in winter to a draft horse stall. "

2.1. Design Factors

Site Design Factor	Response
✓ **Current Main Source of Income From Horse Training**	- leave good access and circulation for horses ; fencing around tree belts; choosing tree crops that animals can eat (silvo-pasture).
✓ **Existing Irrigation Pond**	- requires spillway upgrade for safe and controlled discharge of extreme rain events - accepts runoff from large barn catchment
✓ **Dynamic Mixed Farm**	- opportunity to add new tree crops to farm stand and use tree crops to feed animals - trees provide shade and fodder for animals

Site Design Factor	Response
✓ Ecologically Sensitive Owners	- no herbicides or pesticides used; produce and tree crops can fetch higher prices
✓ High Quality Topsoil, Slow Draining Subsoil	- tree roots will penetrate subsoil and allow better infiltration through subsoil - tree mounds create loose soil and help trees get started in penetrating clay subsoil
✓ Elevated Nutrient Load Leaving Property via Drainage Ditch	- mycofiltration swales (see diagram below); continued water sampling by CRD to test for improvement.
✓ Farm is Open to Public 3 Days per Week	- great for pilot project; signage will be included to provide information for visitors

2.2. Design Goals, Features & Functions

This project employs a number of best management practices from the following fields:

Approach	Definition (Source: Wikipedia)
Keyline Design	Keyline can be seen as a collection of design principles, techniques and systems for development of rural and urban landscapes. Keyline design was developed in Australia by farmer and engineer P. A. Yeomans, and described and explained in his books The Keyline Plan, The Challenge of Landscape, Water For Every Farm and The City Forest *See Appendix for hyperlinks.*
Agro-forestry	Agroforestry is a land use management system in which trees or shrubs are grown around or among crops or pastureland. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land-use systems.
Silvo-pasturing	Silvopasture is the practice of combining forestry and grazing of domesticated animals in a mutually beneficial way. Advantages of a properly managed silvopasture operation are enhanced soil protection and increased long-term income due to the simultaneous production of trees and grazing animals.
Permaculture Design	Permaculture is a branch of ecological design, ecological engineering, environmental design, construction and integrated water resources management that develops sustainable architecture, regenerative and self-maintained habitat and agricultural systems modelled from natural ecosystems.
Myco-Filtration	Mycofiltration is the process of using mushroom mycelium mats as biological filters.

Using these strategies & techniques, our goals are to:

- Improve storage and infiltration of storm runoff from extreme rain events.
- Reduce nutrient load leaving the property through drainage ditches in extreme rain events.
- Slow, sink and spread excess surface runoff.
- Create a deep, carbon rich soil ecosystem underneath the swales capable of retaining & cycling nutrient flow through the property.
- Create 'animal grazing cells' to encourage periodic grazing and rest cycles.
- Establish multi-functional contoured hedgerow for shade, animal fodder, fuelwood and human crops.
- Improve the water retention capability of the pasture to better withstand summer drought.

The design features we've chosen to accomplish these goals are as follows:

Design Features	Functions & Specifications
Irrigation / Wildlife Pond (*existing)*	- approximately 350,000 L when full; accepts storm water from barn roof; can be used for irrigation - required spillway upgrade
Level Sill Spillway	- passively directs overflow from pond through bottom myco-filtration swale for treatment and infiltration before leaving property
Sinuous Channels / Silt Traps	- silt traps to keep sediment out of the pond - planted to juncus reeds to filter excess nitrates and phosphates - planted to blueberries and cranberries
Planting Berms with Perennial Polycultures	- huge diversity of plants to ensure full coverage of berms with trees - experimental trees to pilot to the public - contoured dynamic rhizosphere to infiltrate water held in swales
Myco-filtration Swales	- approx. 5,000 - 7,000 L of added water volume storage ('surge protection') for extreme rain events - swale bottom filled with wood chips and inoculated with Stropharia rugosoannulata mushroom mycelium - this technique has been proven to biologically degrade environmental pollutants like 'e-coli', which frequently test high on farms with animals
Grazing Paddocks	- 3 distinct grazing paddocks suitable for cross-fencing and holistic planned grazing of animals (most suitable for small birds)

2.3. Final Design Plans

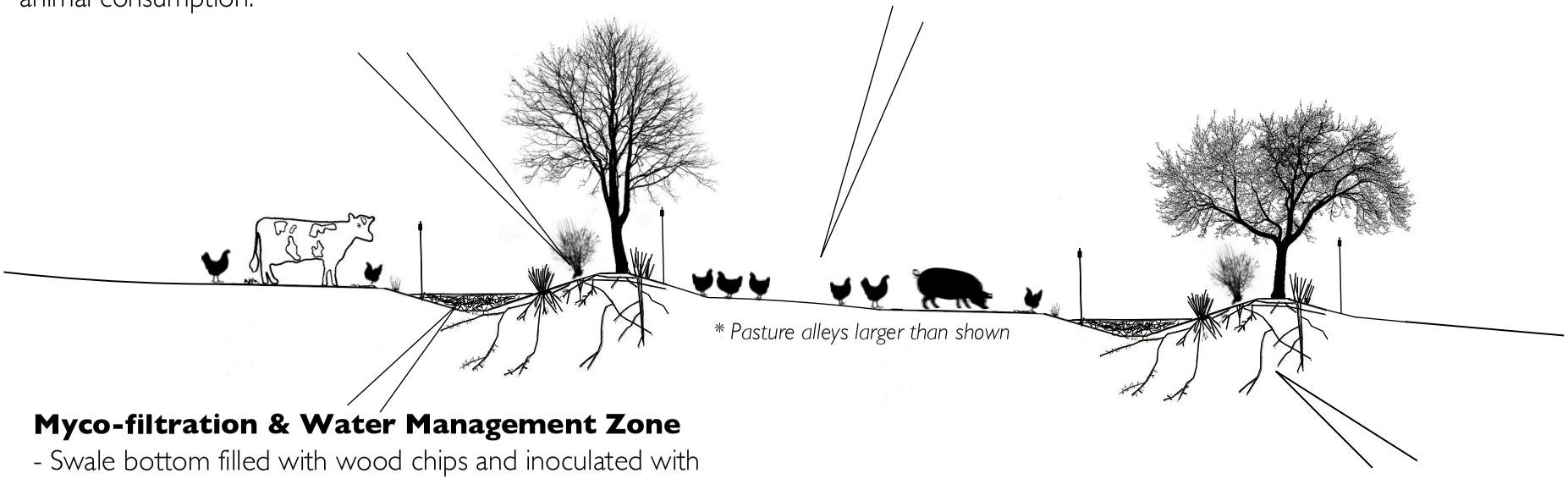
(see next page)

Agro-Forestry Test Crops
Fenced with Electric Fencing

- Testing the suitability of over 30 species of multi-functional trees and shrubs for human and animal consumption.

Silvo-Pasture Grazing Alleys

- Combining agro-forestry and the grazing of domesticated animals in a mutually beneficial way; trees provide shade for pasture, wind & erosion protection, human staple crops and fodder for animals.



** Pasture alleys larger than shown*

Myco-filtration & Water Management Zone

- Swale bottom filled with wood chips and inoculated with *Stropharia rugosoannulata* mushroom mycelium.
- This technique has been proven to biologically degrade environmental pollutants like 'e-*coli*', which frequently test high on farms with animals.
- Swales on contour also provide up to 8,000 L of extra 'surge protection' for large surface runoff events.

Dynamic & Deep Rhizosphere

- Increases infiltration of water through subsoil via root tunnels.
- Increases depth of soil food web as trees use sunlight to convert atmosphereic CO2 into carbon-based sugars and release them as root exudates deep into the soil.

Hatchet & Seed

www.hatchetnseed.ca

Functional Cross Section

White House Stables
9774 West Saanich Rd.
North Saanich, BC

Project proudly support by:

CRD Making a difference...together

With funding from:

RBC Blue Water Project™

White House Stables

9774 West Saanich Rd.
North Saanich, BC

Concept Plan

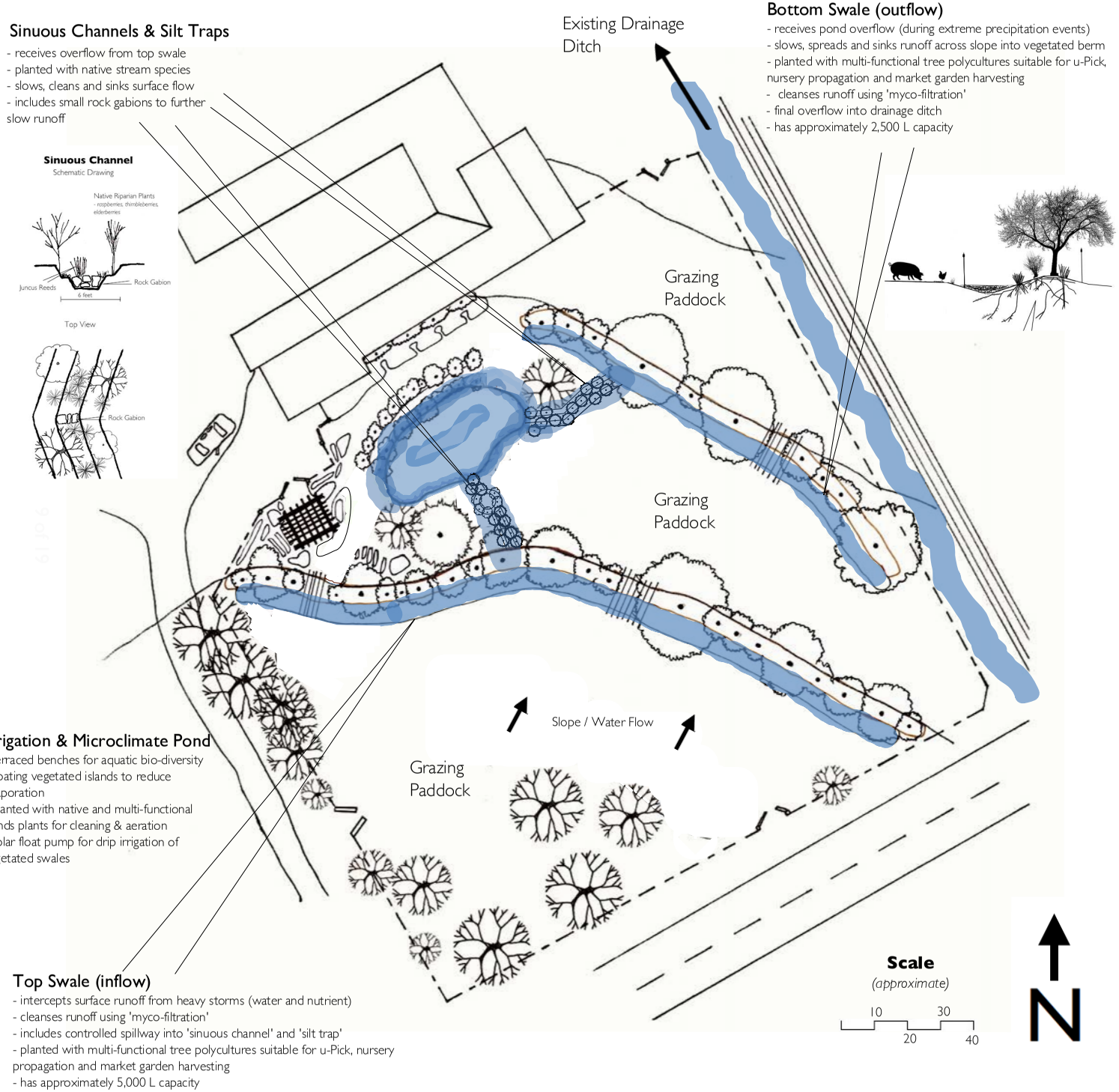
Overview

This one *acre* pilot project is designed to test the effectiveness of a unique combination of integrated water management strategies. They include: a wildlife / irrigation pond with barn roof water catchment, myco-filtration swales, multi-functional shelterbelts, sinuous channels overflows and silt traps. These strategies are designed to help improve year-round water storage, infiltration and nutrient retention on the farm, while putting these resources to productive use.

Based on CRD Climate Model data, the design assumes a 3.5 fold increase in the number of extreme precipitation events yearly as well as a 25% increase in precipitation during these events.

Objectives

1. increase pond catchment by intercepting surface runoff into pond
2. reduce & cleanse nutrient flow into pond through vegetated swale and silt trap
3. manage pond overflow through the installation of silt trap and vegetated swale
4. reduce overall water and nutrient leaving the property by sinking, slowing and spreading runoff



Design Consulting by:

Hatchet & Seed

www.hatchetnseed.ca

Proudly Supported by:

CRD

Funded with Grant from:

RBC Blue Water Project

3. Project Activities & Documentation

3.1. Project Schedule Work Schedule

Outcome	Details	Timeline (tentative)
Design Planning Completed	- print 18" x 24" base map	May 15
	- draft Work Plan	by May 26
	- review meeting	May 26
	- DRAFT concept plan	by June 16
	- laser level setup, contour line staking, spillway level checking, staking pond wall height, consulting with landowners	September 22-23
	- review meeting	June 16
	- detailed drawing of pond and swales	by June 20
	- final Earthworks Plan	by June 20
	Design Phase Complete	
Material Sourcing Consulting	- logistics planning & preparation with White House: book excavator, source plants, cover crop seed, mulch, manure	July - September
Site Layout	- laser level setup, contour line staking, spillway level checking, staking pond wall height, consulting with landowners	October 21-22
Excavation	- guiding excavator driver, setting up laser level to set critical level of swale bottoms, berms, spillway and pond wall	October 23
Permaculture Earthworks Workshop	- hosted by Hatchet & Seed	October 25
Site Reclamation Work Blitz	- guiding a work blitz to reclaim the site with manure, cover crop seed, straw, and planted tree crops	October 26
Follow-Up Report		by December 15th
	Implementation Phase Complete	

3.2. Earthworks Work Plan

Outcome	Tasks	Resources Needed	Specs *(see drawings)*
Top Swale Complete	- mark out contour lines with flags or paint - remove topsoil and place to the side for re-use - shape swale bottom and create berm - hand shape to suit with rakes & shovels - add topsoil while shaking & pulling large grass clumps out - sow ground cover seeds and plant roots cuttings - planting & mulching	- stakes, flags, paint - excavator - landscape rakes, shovels - 20 yards of manure/ straw	*- berm = 4-5.5 feet wide* *- swale = 2-3 feet* * avoid subsoil and topsoil mixing
Spillway, Sinuous Channel & Silt Trap Complete (inflow)	- mark out sinuous channel - dig spillway from top swale into sinuous channel - dig small, meandering ditch into pond - hand shape to create small planting benches - add rock gabions to slow water flow & reduce erosion	- stakes, flags, paint - excavator - landscape rakes, shovels - 10-20 juncus reed plants - 1-2 yards of blast rock	*- sinuous channel 4-5 ft* *- freeboard = 6" (distance between top of berm and spillway)* ** avoid subsoil and topsoil mixing*
Pond Wall Raised and Levelled	- remove topsoil and place to the side for re-use - dig in a clay 'key' for pond wall - re-shape pond wall and create berm - raise pond wall on N-W side by 1-2 feet (depending on fill available) - create walking path on top, with 1:3 slope on either side	- stakes, flags, paint - excavator - landscape rakes, shovels	* avoid subsoil and topsoil mixing
Spillway, Sinuous Channel & Silt Trap Complete (outflow)	*- same as above*	- stakes, flags, paint - excavator - landscape rakes, shovels - 10-20 juncus reed plants - 1-2 yards of blast rock	* avoid subsoil and topsoil mixing
Bottom Swale Complete	- same as above	- stakes, flags, paint - excavator - landscape rakes, shovels - 20 yards of manure/ straw	* avoid subsoil and topsoil mixing
One Culvert for Tractor Access (Installed)	- add 3" road base - add culvert materials - cover with 3" road base - add 3/4 " crush	- 1 large culverts or suitable replacement - 1 yard of 3" road base or suitable replacement - 0.5 yards 3/4" crush	

3.3. Photo Documentation

White House Stables (WHS) Pond — March 2014.
Here we see the effects of nutrient leaching into the pond. During the "Working on Contour — Holistic Water Management for a Changing Climate" workshop with Hatchet & Seed, participants were introduced to site factors and the proposed design for WHS.

Participants learned how to use an A-Frame and a Laser Level to map out the contour lines on the property.

WHS in early October, 2014. The yellow flags mark out contour lines where the excavator will build the swales.

During excavation, swales with planting mounds on contour are created. The bottom of the swale is levelled so that water runoff from the upper slope will be slowed, spread out, and can sink slowly into the ground before heading into the pond. Mounds will be planted with a variety of edible and medicinal trees and shrubs.

Permablitz (work party) participants and White House Stables owner Nikki Wylie (far right) standing in front of the nursery stock to be planted on berms.

Pond overflow planted to Juncus Reed Grass, a filtration species. This area also was planted with riparian species such as elderberries. The cardboard is used for "sheet-mulching" a practice of layering cardboard with mulch to smother unwanted grasses and weed species which would compete with the planted species.

Berms planted to a variety of perennial edible trees and shrubs. Sheet mulch added around the trees and mulch applied on top.

Inflow to the pond from the top swale planted to Juncus Reed Grass for filtration, as well as some riparian species (blueberries and high and low bush cranberries).

Pond with inflow to the right and overflow to the centre of the photo.

3.4. Project Metrics

Activity	Metric Type	#
March 2014 Workshop: "Working on Contour: Holistic Water Management for a Changing Climate"	# of attendees	19
Excavation of Swales	Litres of water storage ('surge protection') added	~ 5,000 - 7,000L
Excavation of Swales & Addition of Inoculated Wood Chips	Area of Runoff Catchment Now Filtered by Myco-filtration Swales	~ 3,300 m2 or 0.80 acres
Permablitz Work Party	Number of Volunteers	12
Permablitz Work Party	Perennial Plants Planted	105
Site Visits	Annual Visitors to White House Stables per year	> 2,000
Fruit & Nut Tree Planting	Maximum Potential CO2 sequestered per year in kg (19 KG / tree x 32 trees)	~ 608 kgs of CO2
Fruit & Nut Tree Planting	Potential kgs of food produced / year at maturity: Low Estimate: (20 kg / tree) Med. Estimate (30 kg / tree) High Estimate (40 kg / tree)	Low Estimate: ~ 640 kg Med. Estimate ~ 960 kg High Estimate ~ 1280 kg + berry yield

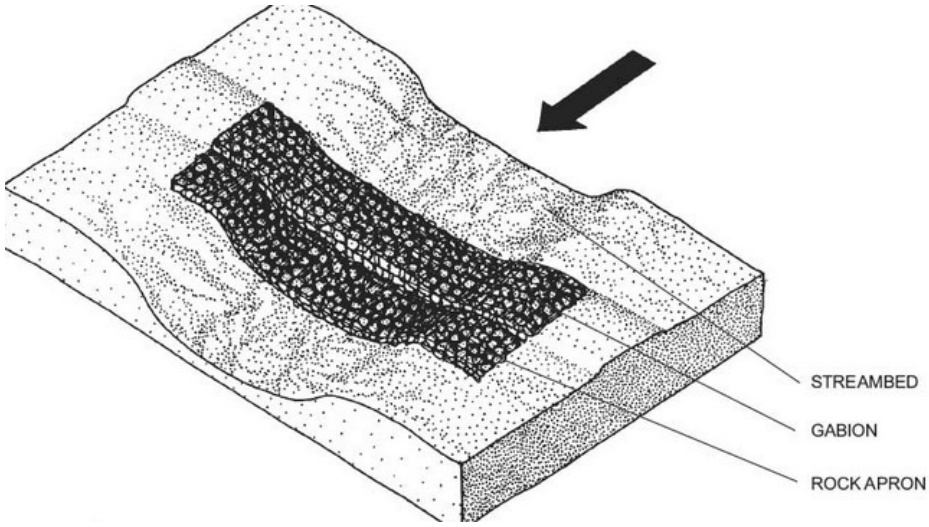
3.5. Species List

Common Name	Latin Name	Qty.
Chinese Chestnut	*Elaeagnus umbellata*	3
Blueberries	*Vaccinium, var.*	6
Goumi	*Elaeagnus multiflora*	2
Fig (Desert King)	*Ficus carica*	6
Grapes	*Vitis vinifera.*	4
Autumn Olive	*Elaeagnus umbellata*	2
Apple	*Malus domestica*	3
Mulberry (Illinois Everbearing)	*Morus alba x rubra*	3
Pawpaw	*Asimina triloba*	2
Honeyberries	*Lonicera caerulea*	4
Quince	*Cydonia oblonga*	2
Almond (Hall's Hardy)	*Prunus dulcis*	3
Hardy Pecan	*Carya illinoinensis)*	2
Pear	*Pyrus boissieriana*	2
Olive	*Olea europaea*	2
Cherry	*Prunus avium*	3
Plum	*Prunus domestica*	2
Gooseberry	*Ribes uva-crispa*	2
Currants	*Ribes nigrum*	2
Low-Bush Cranberries	*Vaccinium oxycoccos*	15
High Bush Cranberry	*Viburnum opulus*	2
Cornelian Cherry	*Cornus Mas*	2
Hucklberries	*Vaccinium parvifolium*	10
Asian pear	*Pyrus pyrifolia*	1
Elderberry	*Sambucus Nigra*	2
Hazelnut	*Corylus avellana*	8
Kiwi	*Actinidia deliciosa*	2
Juncus	*Juncus effusus*	30
Comfrey	*Symphytum officinale*	30

4. Moving Forward

4.1 Finalizing Installation

- Fill swales with mixed (*ramial*) wood chips. These can be sourced from local tree companies seeking a place to empty their chip trucks.
- Inoculate with several bags of garden giant (*Stropharia rugosoannulata*). These can be sourced from DIY Fungi at http://diyfungi.wordpress.com/.
- Add rocks gabions to outflows swales to further slow runoff in extreme rain events.
- Complete access way through bottom swale by installing simple culvert.
- Complete final overflow into existing drainage ditch. Add simple (loose) rock gabions. (*See right*)



Source: City of Tucson Water Harvesting Guidance Manual

4.2 Management Recommendations

- Deep summer watering for the first two years will be crucial to health of the tree system
- Irrigation options include:
  - Flood irrigating swales with pond water for 1-3 days every 3-4 weeks
  - Hand watering berms for several hours every week in drought
  - Installation of a drip line on the berms with timer option
- Tree care: Keep grass away from trees by continuing to sheet mulch with cardboard and by cutting grass down with hand scythe.
- Encourage clover cover crop as nitrogen fixing ground cover
- Trees must be fenced from animals using either electric fencing or other livestock fencing. Livestock can and will do serious damage to fruit trees.
- Monitor spillway in extreme rain events to ensure proper functioning.
- Signage: A plan view and cross section view should be placed at the entrance to the pond area, from parking lot. This will provide an excellent educational opportunity for patrons to the farm.

APPENDICES

I. Actual Expenditures

These are the costs associated with project initiation, consulting, design, management, implementation and reporting.

Project Expenditure Description **- deliverables** (Contributor)	**'Silver'**
Implementation Consulting & Follow-Up Report Writing 86 hours x $40/hr (CRD)	3440
Plants & Seeds (CRD)	2000
Implementation Labor *(in-Kind)* @ $100 /day/person x 12 people (estimated) (Volunteer Permablitz)	1200
Implementation Labor *(in-Kind)* @ $20 / hr / person (White House)	1600
Plants & Seeds (White House)	500
Excavator Costs (White House)	600
Culvert Materials (White House)	300
Manure, Mulch, Earth Materials, Mushrooms Spawn *(in-Kind)* (White House) - *estimated* *	1000
Fencing *(in-Kind)* (White House) - *estimated* *	400
Irrigation Lines	100
Total Project Value (including in-kind contributions)	**11140**

II. Additional Resources

Keyline Design Resources

Keyline Design Online Articles
http://www.permaculturenews.org/resources_files/KeylineArticle.pdf
http://permaculturenews.org/2009/11/30/keyline-swales-a-geoff-lawtondarren-doherty-hybrid/
http://permaculturenews.org/2013/02/22/before-permaculture-keyline-planning-and-cultivation/
http://permaculturenews.org/2013/12/09/keyline-design-organizing-pattern-permaculture-design-part-1-sweden/

Pond Construction Resources

Design and Construction of Small Earth Dams by KD Nelson
http://soilandhealth.org/files/hFNMkjOivU/030229.earth.dams.pdf

Water from Roads by Erik Nissen-Petersen
http://www.samsamwater.com/library/Book6_Water_from_roads.pdf

Water from Small Dams by Erik Nissen-Petersen
http://www.samsamwater.com/library/Book4_Water_from_Small_Dams.pdf

Myco-Filtration Resources

Fungi Perfecti - Myco-filtration Project Press Release
http://www.fungi.com/blog/items/mycofiltration-for-urban-storm-water-treatment-receives-epa-research-and-development-funding.html

Fungi Perfecti - Myco-filtration Project Technical Report
http://fungi.com/pdf/articles/Fungi_Perfecti_Phase_1_Report.pdf