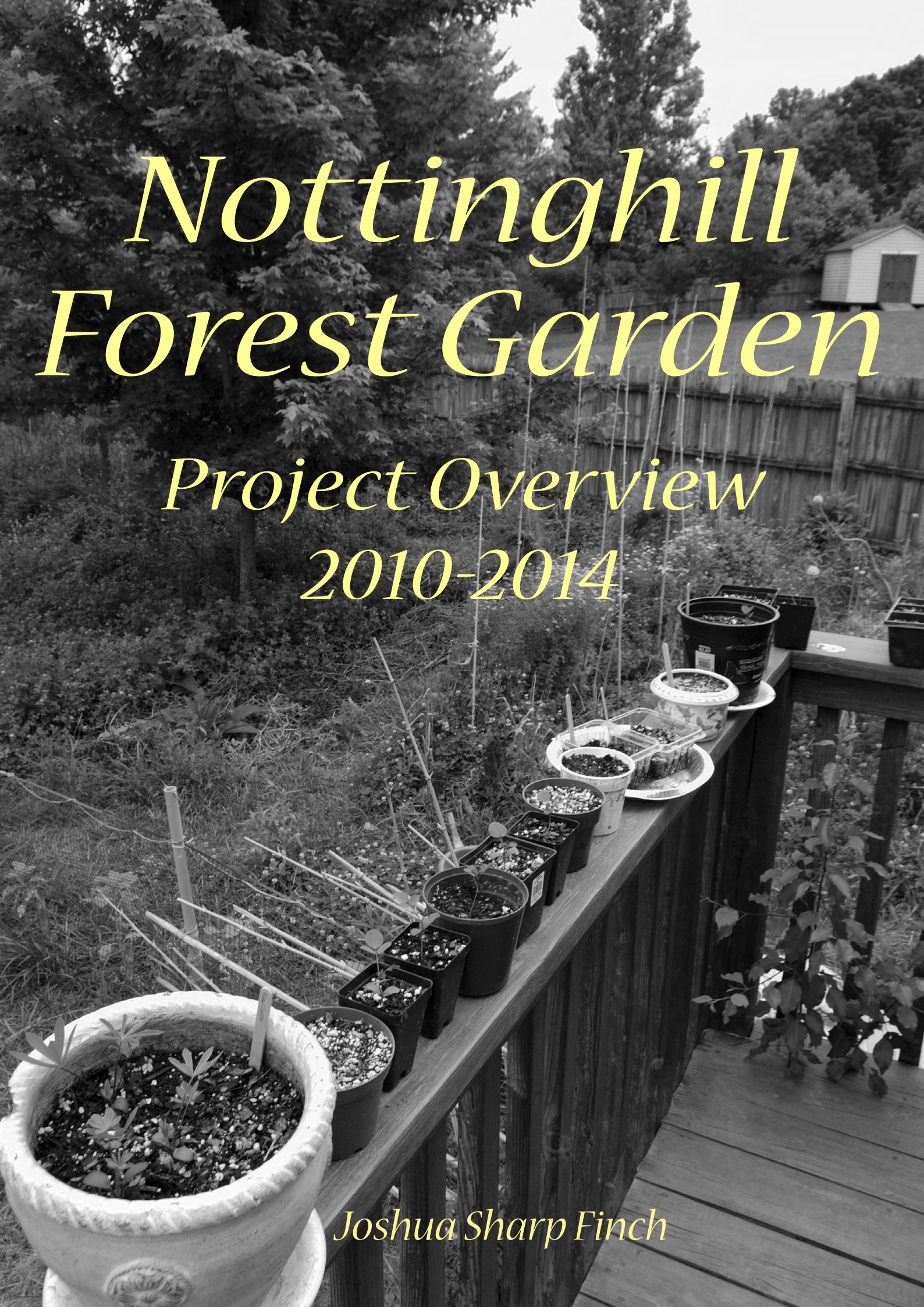

Nottinghill Forest Garden

Project Overview 2010-2014

Joshua Sharp Finch

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Note: There are too many photographs to list although they follow the same numbering system as everything else.

Fall 2010: Initial Site Analysis & Goal Setting

An initial site analysis for our property was much easier than at others due to a variety of factors: a) we have lived and observed (albeit with less attention to detail than now) the property throughout the past decade, b) the yard is mowed and trimmed regularly, making line of sight observation straightforward, and c) due to its location, high quality satellite imagery could be coupled with accurate climate data for meta data gathering.

From my perspective, it is beneficial to begin observation from afar- gathering information about the region in general before assessing details. This method allows the forces which interact with the property on a larger scale to be internalized into your thinking about the place before becoming wedded to any one potential future, only to realize later that due to outside factors, that vision is inviable.

Global & Regional Context

Winston-Salem is located 36°N of the equator in the Piedmont region of North Carolina in the United States of America. Situated in the foothills of the Appalachian Mountains, our site's elevation is just above 900' (274m). Classified as Köppen Cfa (Humid Subtropical), the climate is hot and humid during the summer. Temperatures rising past 100°F (38°C) are not uncommon. However, the term "sub-tropical" is at first misleading since the average minimum temperatures can drop to between 0 and 5°F (-17 and -15°C) during the winter, leading a USDA hardiness zone of 7a/b (average minimum temperature is one of the most determining factors in plant survivability). Rapid warming and cooling from autumn until spring require careful consideration of flowering times: sudden freeze/thaw events triggered by shade from buildings should be accounted for. The dominant weather patterns arrive from the southwest, following the Appalachian Mountains northeastward bringing warm, moisture laden air from the Gulf of Mexico. Average precipitation for Winston-Salem is 43 evenly dispersed inches (1092mm), with 182 average frost free days; however, highly variable winters allow the possibility of year round production.

In terms of biology, the region will generally succeed towards oak and other hardwoods (hickories) or pines (with warming trends), even when climate projections are taken into consideration. Winston-Salem falls well solidly within the Southeastern Mixed Forest Province. The height of the foothills will moderate the effects of climate change on our species composition.

Before the arrival of Europeans, Indians managed the forests throughout the eastern United States. Fire was a primary management tool. Studying the relationship between fire and many native species is an important research topic by State universities. Shifting cultivation often followed these burns, which would then regenerate into forest ecosystems under management. Native peoples knew the plants intimately, having planted or facilitated them in the first place.

Due to the Outer Banks' well deserved reputation as the "graveyard of the Atlantic" and North Carolina's rivers becoming unnavigable past the fall line (which divides the Piedmont from the Coastal Plain), European settlement was less intensive than elsewhere in British North America. The colonist's presence, was, however, no less disastrous for Native people. The Piedmont generally supported subsistence farming by small land holders largely because of poor transportation (access) as well as soil quality.

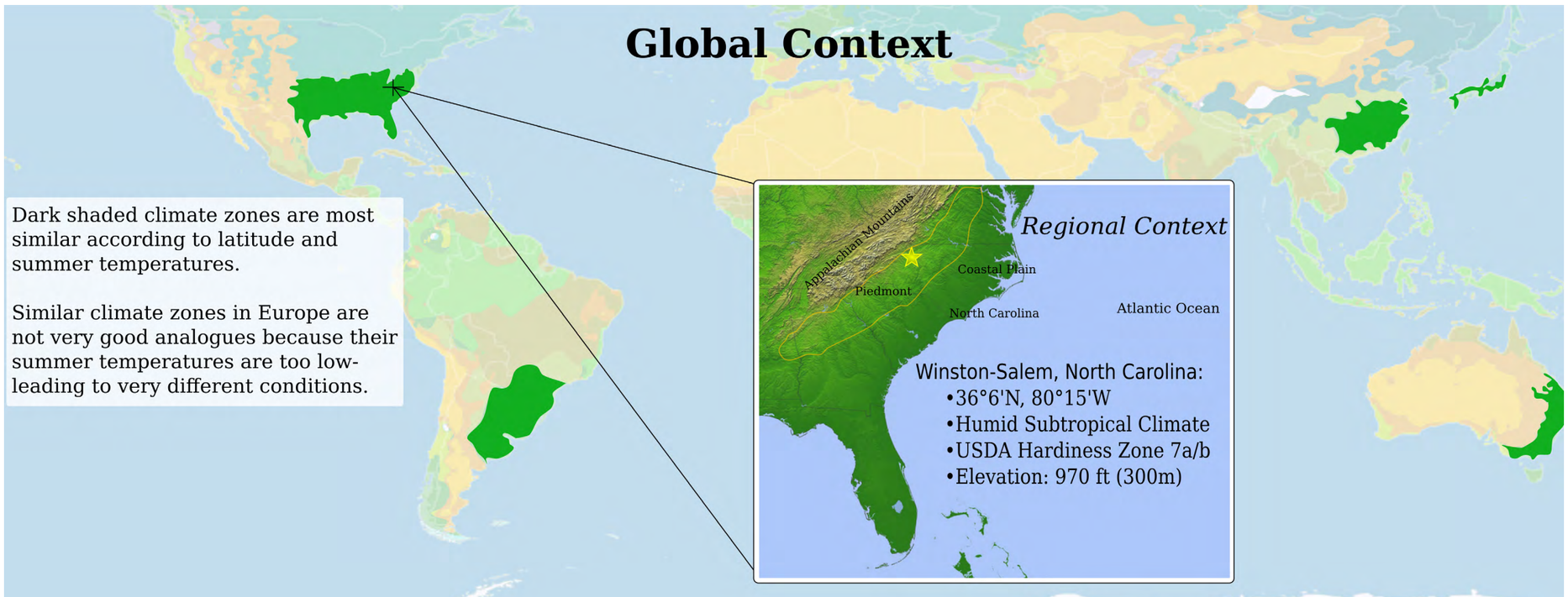
North Carolina is dominated by ultisols. These are soils which were spared glaciation rendering them continuously exposed to weathering

for over ten thousand years. In addition, the parent material is generally low in minerals necessary for agriculture, leaving these soils particularly vulnerable to nutrient loss. The slash and burn agriculture practiced by Indians, when accelerated by Europeans (over 90% of North Carolina east of the mountains has been cleared and farmed), destroyed what little fertility the soil had managed to accumulate. Much like the tropics, soil nutrients are bound in organic matter. As the forests were burned and erosion worsened, fertility washed away in the summer. Additionally, the soils have been further abused by mismanagement during the mild winters. Unlike tropical ultisols, where continual plant growth stores nutrients in living organic matter year-round, the unpredictable winters of North Carolina mean that without an emphasis on erosion control and year-round cropping (cover cropping), nutrients can be rapidly leached by winter precipitation events.

Even today, with all of our knowledge regarding agroecology, human beings continue to ignore these historical and physical realities. Everywhere one looks- be it a suburban development, urban blocks, or even multi-generational small farms, the gravity of our situation is evident. Erosion, flash flooding, simplified ecosystems, and fragmentation of the landscape proliferate. American lawn culture is still the dominant landscape use. Nutrients, most often in industrially synthesized forms, are imported only to be leached away year in and year out. Transitioning away from this culture of degeneration towards accumulation of natural capital is one that requires tactful social relationships more than anything else. Natural forces, knowledge, and purchasing power make accumulation in our place of the world simple, but convincing others that new land practices are both necessary and desirable is another story altogether.

North Carolina is considered a "battle ground state" in American politics and culture, where perceived values of the so-called "left and right" are in constant struggle. As otherworldly as it sounds, the way in which a person or family cares for their land can place them- in the eyes of neighbors and society- into one or the other camp. Transcending the illogicality of such a situation (where an organic gardener must be a liberal and a lawn enthusiast must be conservative), to address the ecological and physical reality that has been described above without damaging social ties is difficult. Striking a balance between stereotypes can never be a long lasting solution, however, paying close attention to the world views of others and talking to rather than past them can go a very long way towards making new land use practices acceptable to as many people as possible. Care must be employed.

Figure 1-1 Global Context. Earth divided into Köppen's climate classifications. Note- there are no direct climate analogues in Africa or South Asia



Local Context

In this section, the site's landform, hydrological situation, and relative location to biological activities will all be discussed in addition to other details such as species composition, previous site management, and human management. Keep in mind that all of these are sketches- they are not the final design. Site analysis aims to put complex information into context so that relationships and parameters for design are revealed.

Physical Location

The site is located at the northern foot of a 550 yard (roughly equal in meters), gently sloping hill. Below is a series of satellite images with additional descriptive layers describing the site. The contour lines in *Figure 1-2* allow us to see that the property sits at the base of the hill, and that this location is another type of ridge- the dividing line between two valleys (both of which are sources of streams). This means the site should be drier as water would run away from the site rather than accumulate. The amount of human influence is quite dramatic. Although the contours show the outlines of the landform, housing construction has changed the site's specific features, which will be discussed shortly. An interstate highway cuts the valley in two and the other roads for the subdivisions are laid out in a typical grid pattern, further disrupting the hydrological cycle. Without these human infrastructure projects, the property would sit right alongside a stream.

These subdivisions (pink, right) were developed starting in the early 1990's. Prior, the area was dominated by agricultural fields. The remaining forests have been preserved due to having steep slopes (north across the highway) or as private property for horses and hunting (south side of the highway). The orange area represents a former field that was to be converted to a shopping center, but after the economy crashed in 2008, there has been little interest in developing the site. Unfortunately, the preparations were completed before selling. This included clear cutting the long, thin strip of forest directly adjacent to the interstate highway on the south side in order to lay a storm water pipe. Our close proximity to a fairly large forest and field mosaic held as private property means that we are unlikely to see changes there in the short term. The family that owns the property has already sold the majority of their farmland to real estate developers and appears to want to keep a remainder of their land. This is good for us as we now sit on an edge between two land use patterns, which allows us to benefit from both.

A Neighborhood Sector Analysis provides information about how other local factors can influence the site. For example, a formerly forested wildlife corridor was logged all the way to our property. Although hard to discern, there is a storm water pipe which dumps both the new construction site (see *Figure 1-3*) and our street's storm water in the same location. This detail will be easier to observe in the site specific analysis section. The clearcut dates back to late 2007 and has since remained in an oldfield pattern, maintained through regular mowing by our family. However, since this project has begun, we are moving towards reforestation. Undirected, reforestation will provide a wind break during the growing season; directed, we could plant evergreens to provide year round reduction in cold northern winds. In *Figure 1-4*, I have also included wind vectors and potential biological colonizers to the map. Our proximity to the interstate highway leads to an incredible level of sound pollution that takes its toll on the enjoyment of the landscape. Building a sound-impeding berm is cost prohibitive (as would a soundproofing wall). It should be noted that the wildlife corridor is also often traveled by pedestrians.

Local Context: Landform & Hydrology

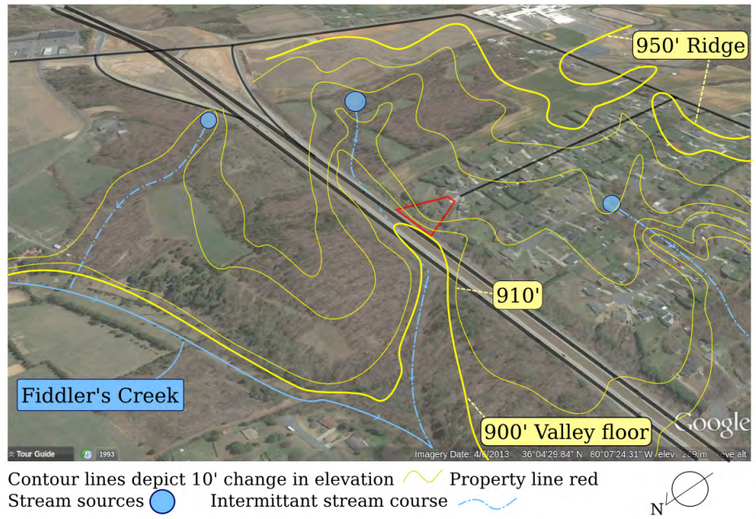


Figure 1-2 Local Context: Landform and Hydrology. All three intermittent stream sources were likely sites of perennial springs before the land was denuded and farmed as their feeder slopes would have been heavily forested with soils rich with deep organic matter

Local Context: Landuse Patterns

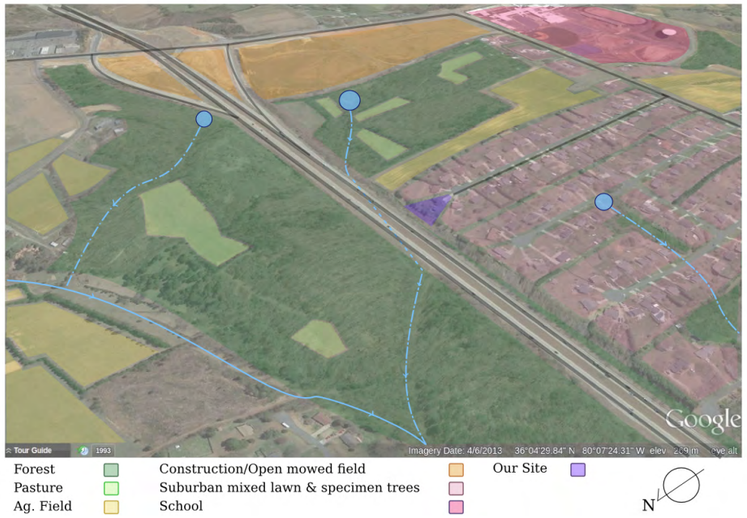
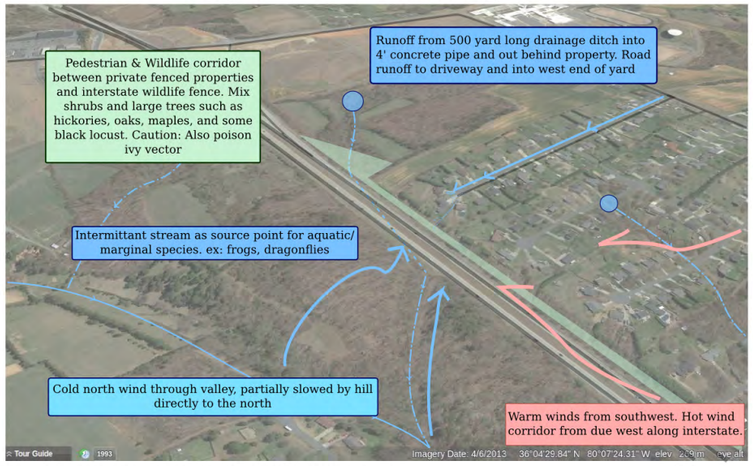


Figure 1-3 Local Context: Landuse Patterns reveal large continuous zones of use sharply divided by the interstate highway

Local Context: Neighborhood Sector Analysis



Basic wind, water, and biological assessment for "neighborhood"

Figure 1-4 Local Context: Neighborhood Sector Analysis

Site Specific Sector Analysis

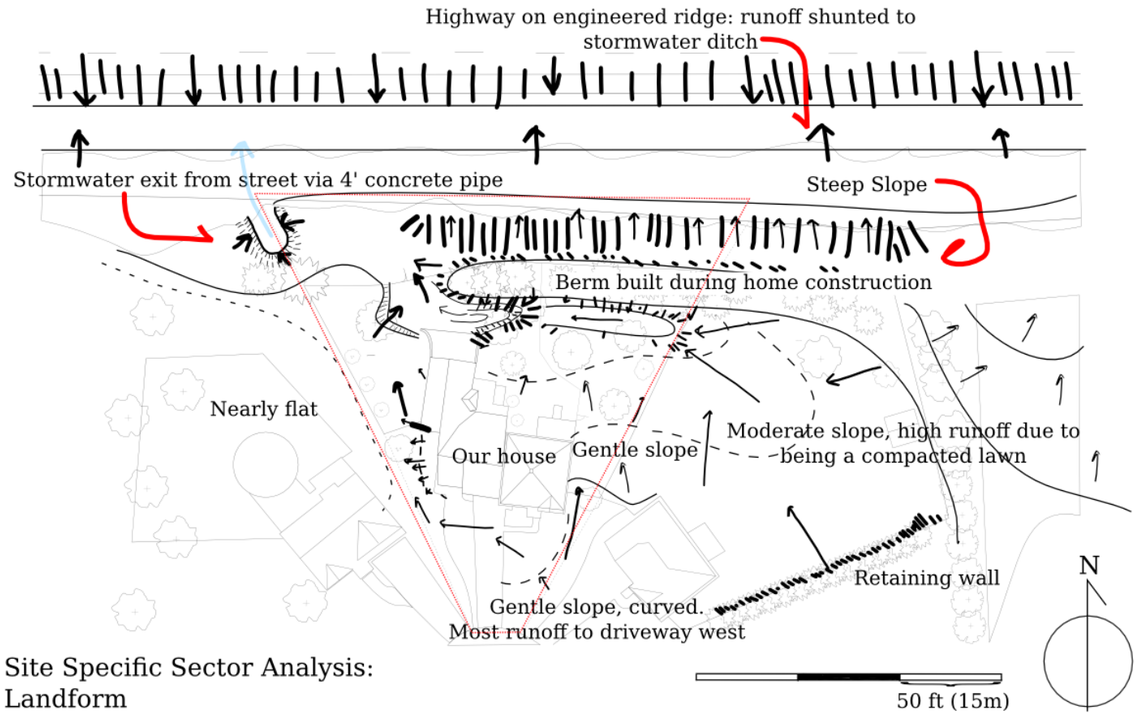


Figure 1-5 Site Specific Sector Analysis: Landform

Landform

The total area of our property is .67 of an acre, or 29,000 sq ft (just under 1/3 of a hectare or 3000 sq m), of which a single family home with an attached apartment covers 3,400 sq ft (~193 sq m). In addition, there is a 1,200 sq impervious concrete driveway (another 300 sq ft is an impervious concrete slab leading into the basement). Altogether, roughly 1/6 of the property is impervious.

The property (outlined, red) sits at the foot of a ridge (see *Figure 1-2*), but since the eastern neighbor's back yard is shaped like a bowl, the dry conditions one would expect are alleviated. While mostly gently sloping, the fact that our soils are compacted and maintained in short-grass lawns means that with within half an hour of significant rainfall events (anything over ¼ inch [6.35 mm]), we have surface runoff. On the southern side of house towards the road, the land is very gently sloping and divides into half with a curved slope moving water at once into the bowl and across the driveway into the western yard. Only a small amount of water escapes the bowl and enters the back yard under the fence. The western yard is also very gently sloping until you reach the area north of the addition; here both the main yard and the western yard sharply slope to a very low point and then gently descends out the back fence.

The elevation change (about 15 foot [4.5m] drop from the road to the north end of the property) makes the gentle slope deceiving as it provides no resistance to water movement. It should also be noted that behind the northern fence and the constructed berm is very steep and unaccommodating for easy planting.

The lack of steep slopes throughout the fenced property facilitate diverse landform use and provides ample opportunities for water harvesting. The peculiar bowl shape of the neighbor's property, even if water harvesting was devised for her property, will mean that our back yard has an effectively doubled catchment area: very good for being on ridge as well as being in a location where all the run off from the street is taken immediately away; see the next section. In addition, the gentle slope also means that even with our high clay content soil, plants will have good drainage.

The entire property sits on the northern aspect of this long hill, with the exception of the berm that forms the bowl. In this case, we have a solid 50 feet of southern-facing, gentle slope. This is exceptional in that it will allow us to have some fenced area directly facing the sun, and so should be considered prime location for garden beds before the canopy closes.

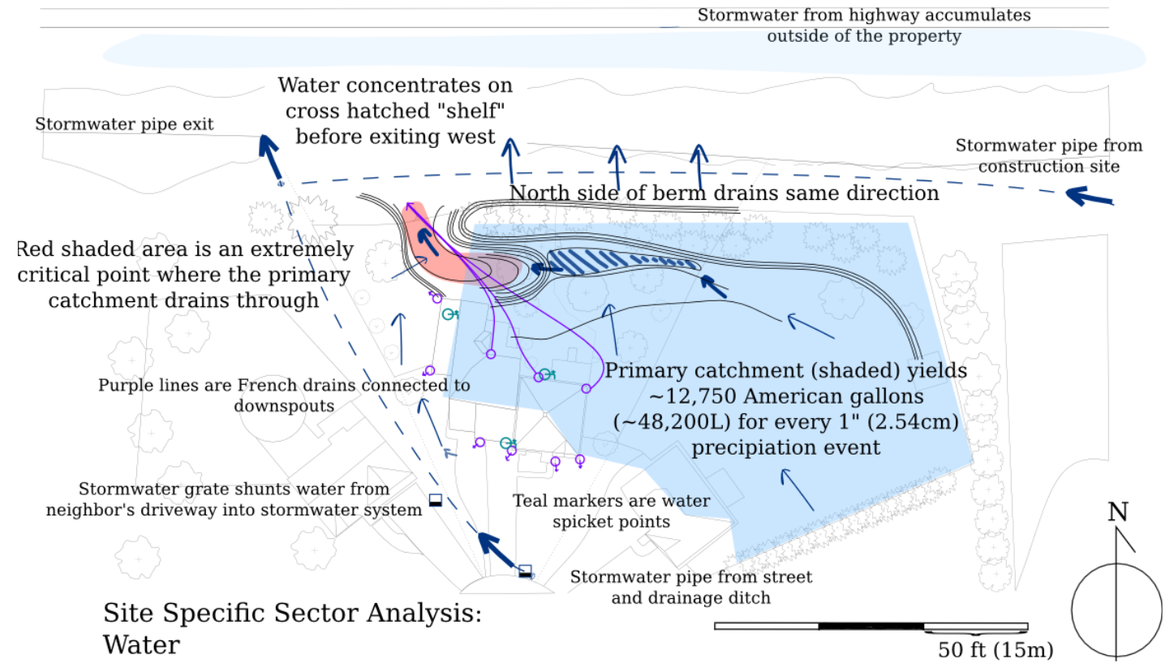


Figure 1-6 Site Specific Sector Analysis: Water

Additionally, the location of the house higher up the slope than the majority of the yard makes it possible to include gravity fed irrigation systems from roof catchment. The house, set back from the road, also creates its own wind break for the southern portion (front yard) of the property. It should be considered a distinct landform in and of itself. By interrupting the otherwise unimpeded slope, the house creates multiple microclimate opportunities (see *Figure 1-10*).

Water

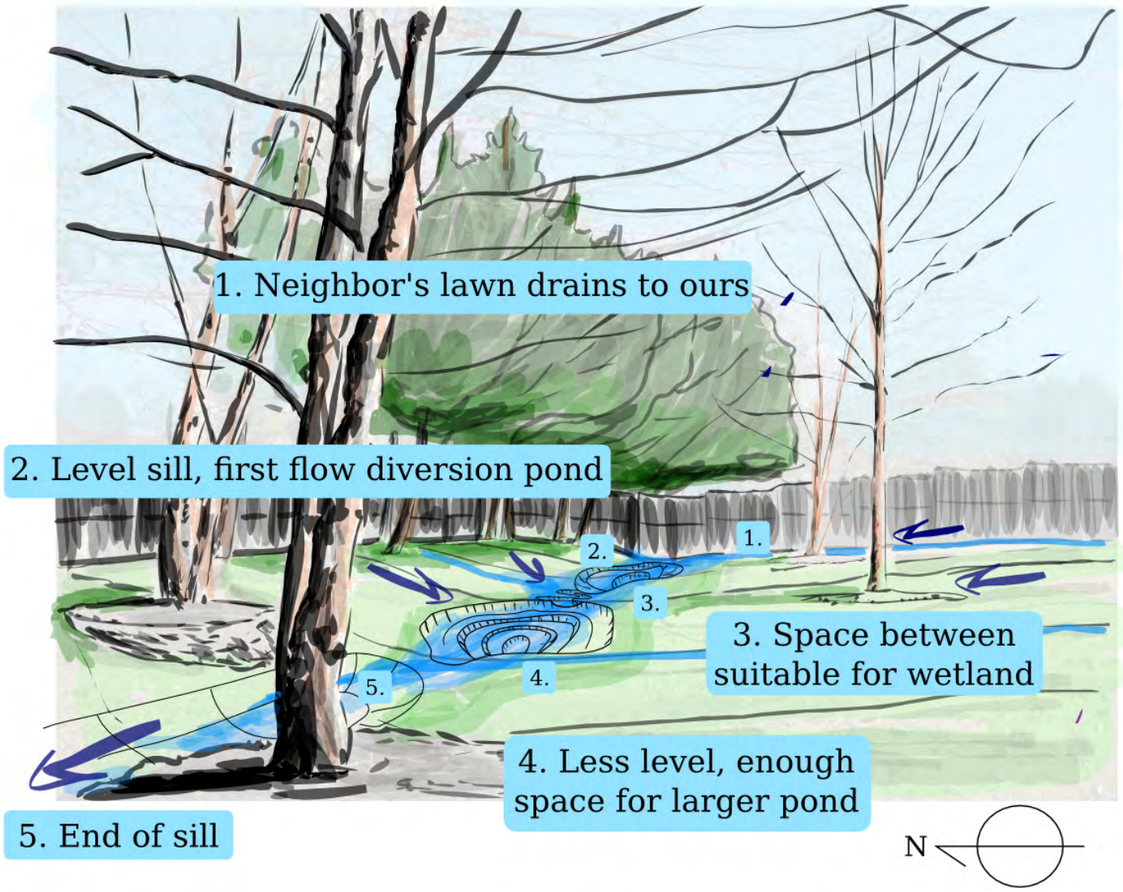
Water in our neighborhood is treated, as in most modern developments, as a problem. It should be drained from the area as fast as possible, with little thought as to what it will do after it leaves. Water is seen as a dangerous element to built infrastructure and the loss of hundreds of thousands of gallons of water per year from the living landscape is not considered.

On our property, however, French drains (purple lines)- with their perforated pipes- allow for slight water infiltration before exiting. Still, the developers created a situation where the street channels 10,000 gallons of water (for each 1") event towards our property. Any water that manages to make it that far as sheet run off is directed to square drainage grates at the edge of the street, which connect to a storm pipe. In addition, all of the houses on either side of the road shed large proportions of their landscape's catchment into storm water ditches on either side of the street, which is connected to the same storm pipe in the front of our property. This pipe is buried until it exits between our western neighbor and our property line. The amount of water heading downhill to our site is phenomenal, however, attempting to bring in any water from the street could create problems with our foundation as the front yard slopes downward to the house. A significant precipitation event could easily damage our home if planned poorly.

Figures 1-5 & 1-6 reveal that the combination of a bowl feature and standard American lawn (cut very short with little return of organic matter) create a situation where significant rain events of 1" (2.54cm) will send 12,756 American gallons of water down through the main back yard. Even more common precipitation events generate enormous amounts of water. It should be noted that my 60% efficiency for the lawns may be understating the situation given their slope and degraded state: they may be acting upwards of 75% or higher runoff. Still, over the course of a year, 43" (109cm) of precipitation adds up to 548,508 gallons (2,076,328L) for just this section of our property alone.

Given this situation, shortages of water in normal years should not become an issue. Also, our high clay content soils, if protected from the elements and supported with living organic matter, should be able to maintain high levels of moisture even through drought conditions.

Drawing 1: Potential Pond and Wetland Site



Drawing 1-1 Potential Pond and Wetland Site

The elevation changes between the southern end of the site (10ft from the southeastern house corner) and the bottom of our main garden area are large enough to incorporate gravity irrigation if the source of irrigation is raised.

The low shelf-like area, which already becomes a temporal stream given enough rainfall, is a good candidate for pond and wetland development. Its naturally low setting (*Figure 1-5*) and large surface area permit the inclusion of highly valuable water features. *Drawing 1-1* illustrates the potential creation of integrated water features.

Access & Circulation

Access & circulation throughout most of the site is easy. The west side of the property has vehicle access to a finished garage and basement, which makes transporting bulk material by trailer trouble free. The hook in the black line from the finished basement to the street (south) is the only difficult point because of the slope (*Figure 1-5*).

The east side of the property has an access gate which is wide enough for wheel barrow traffic. From there, the rest of the yard is unobstructed due to being maintained as a lawn.

Access from the main house to the addition is simple as well: the addition's deck is connected to the main house. Traffic between the two homes usually utilizes this connection (dotted red line). All three the doors on the north side of the house have access to kitchens and main living quarters.

Blue lines suggest typical foot traffic. Both yards are used infrequently and gets most of its traffic during the growing season when it is mowed. The gentle slope of the site allows us freedom when creating new pathways for the garden. The entire back yard is fenced with a six foot (~180 cm) high privacy fence, preventing intrusion by large animals (including people). Our front yard is unfenced, but because it is on the public side of the house and adjacent to the street, we do not have many issues with herbivores there.

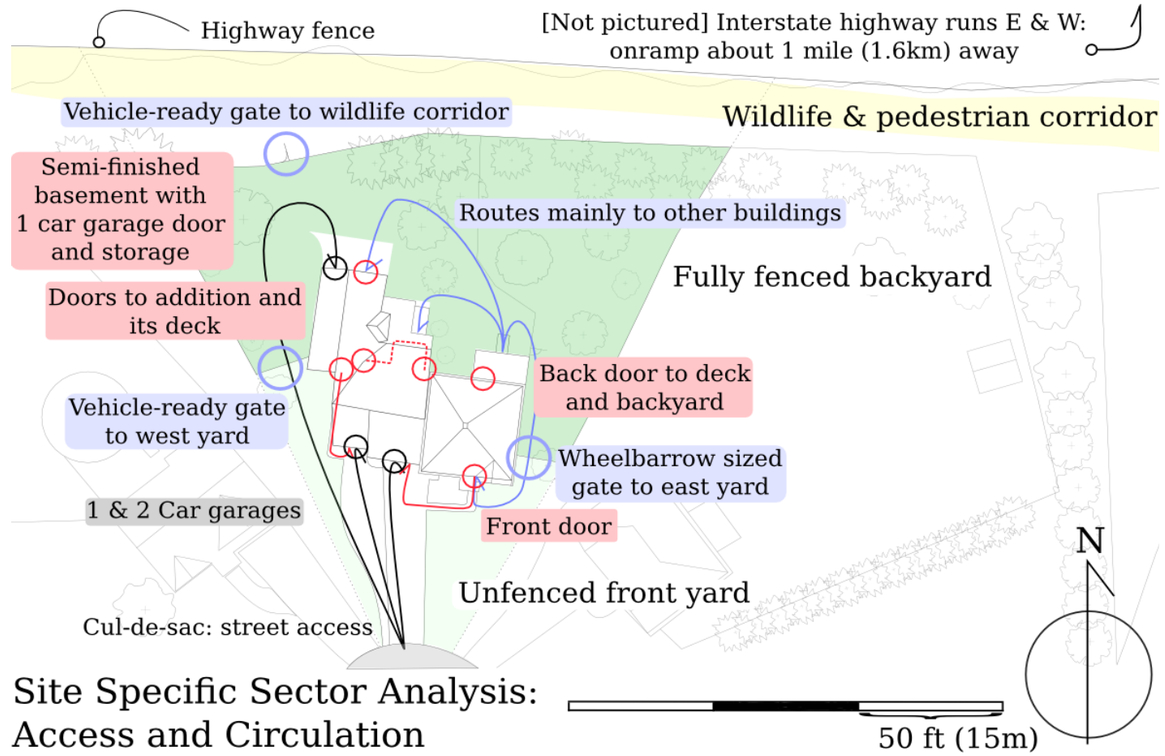


Figure 1-7 Site Specific Sector Analysis: Access and Circulation

Vegetation & Wildlife

There is not very much to be said about wildlife pressure on the property due to the privacy fence keeping out the largest browsers. With the recent clear cut of the area behind the fence, which is now going through the first stages of succession, pressure from squirrels and other climbing animals is much lower as they no longer have direct access from trees. Smaller animals can still dig underneath the fence or make their way through smaller broken boards. More than likely, the most pressure we will experience will come from birds who are drawn to the mixture of open space and young trees to find seeds and small plants.

Other pressures will come from being situated within a suburban lawn matrix that has fragmented the our forested ecosystem. Most lawns are biological deserts. They do not have structural diversity, well established nectary calendars, and deprive their soils of organic matter. In this sense, our garden will be a haven for wildlife, but at the same time, will perhaps draw more attention than it can support. As berries, fruits, and nuts become available, the lack of local resources for wildlife will increase competition for these resources. A willingness to share with the community will be important, as will identifying which crops we desire to protect through netting or other methods.

The north side of the fence, with the oldfield mosaic and mixed mature forest species alongside the interstate, is a vector for seeds of many varieties of plants. Wind from the north and west will disperse seed into our garden for the foreseeable future. An evergreen windbreak could, perhaps, prevent the flow of some of these seeds.

When speaking of vegetation, as mentioned previously, our neighborhood is dominated by the American lawn. While there are trees, they are not supported by fellow forest species resulting in direct competition with the grasses for resources. The dearth of organic material in the soil leads to stressed plants, increasing their vulnerability to environmental stresses: drought, herbivorous insects, and disease. The idea behind most of these landscapes is tidiness and "order" at the expense of resiliency. Due to these circumstances, plants in our system will be exposed to greater risk of herbivory and disease.

Mostly the same can be said for our previous landscape management as well. Luckily, we rarely used chemicals and were easy on so-called weeds. Healthy populations of dandelions, chickweed, henbit, dead nettle, white clover, crow garlic, and other species introduced from Europe are present. They compete well with the fescue and Bermuda

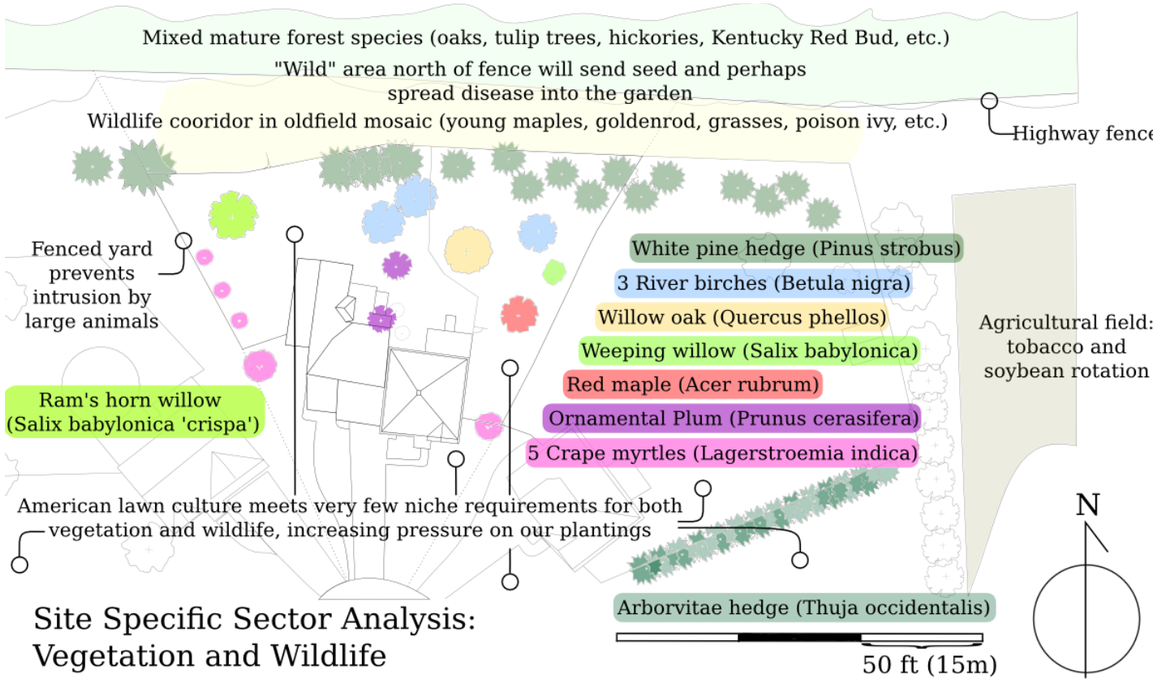


Figure 1-8 Site Specific Sector Analysis: Vegetation and Wildlife

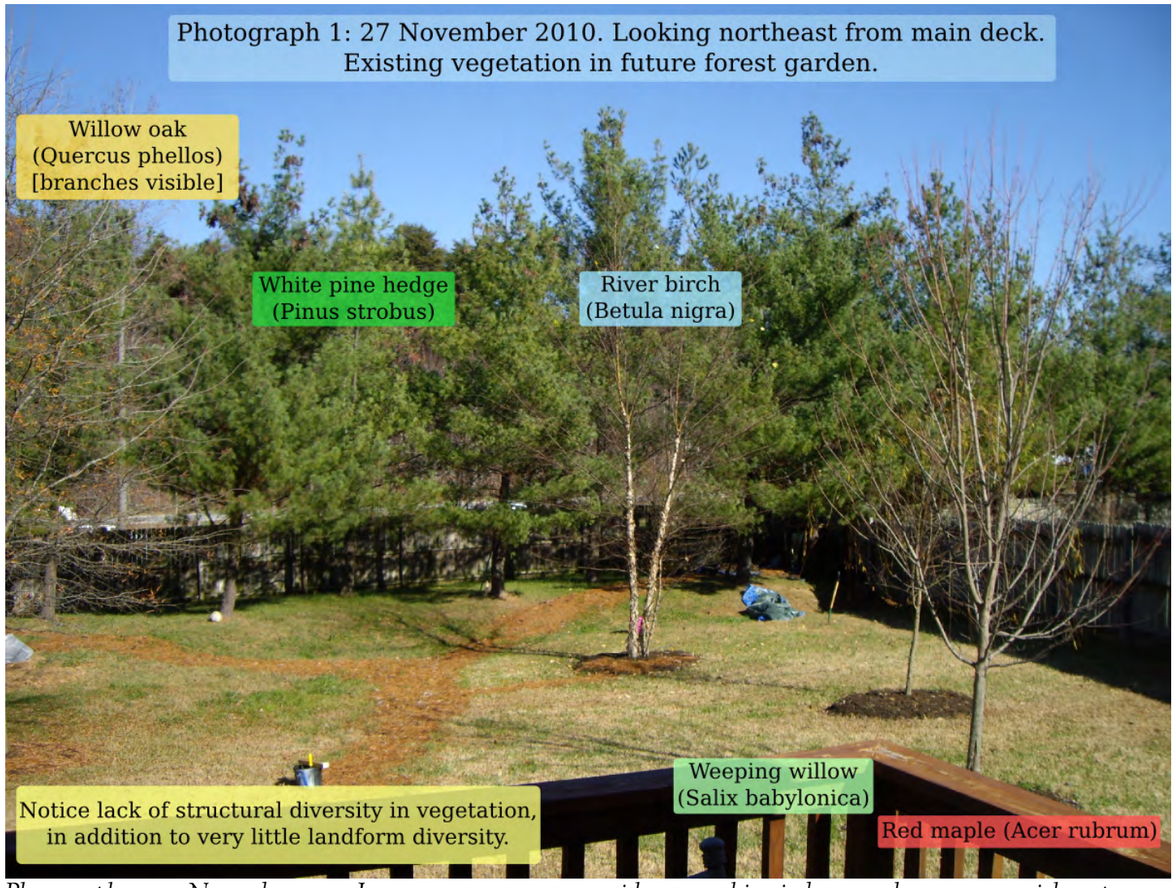
grasses which make up the majority of the lawn. Eradication of any of these species would be difficult. Instead, it would be better to understand that they are early succession species and as the system matures, their niches will disappear. Still, Bermuda grass- with its creeping rhizomes- and mock strawberries (introduced from east Asia) are quick to colonize patches of the garden and can even thrive in partial shade. Successfully competing with these species will require patience and plenty of overseeding/stacking of desired species throughout the next few years.

One species of note, however, is the ubiquitous poison ivy. This plant enjoys the edge environments that are typical in suburban properties. With their berries serving as a popular bird food, they are easily dispersed. This is one plant where chemical control may be necessary if intentional set backs through the use of a dedicated pair of loppers fails to manage them. Combating poison ivy will, unfortunately, remain as one of the constant management practices due to its high mobility and strong resiliency. The only way I have managed to defeat the plant is to cut it back continuously, pull out many of the roots by twirling them around bamboo (highly labor intensive), sheet mulching the area, and finally piling on 6 inches (15 cm) of mulch on top of the cardboard. Even then, this does not prevent the return through berries deposited by birds as they perch on fences or branches. Early identification of the plant and routine follow ups seem to be the best means short of bringing in goats. However, goats have to managed closely to prevent serious damage to desired species and are only well suited to being used behind our property where the dogs cannot bother them.

Moving on to the tree/shrub layer, our property's main growing area will soon have a completely closed canopy comprised of red maple, weeping willow, river birch, willow oak, and white pine. These are typically early succession species, but are sometimes found in canopies of more mature forests. I say "more mature" simply because there are zero old growth forests in the Piedmont region of North Carolina. One nice thing about these plants, save the willows, is that they are all native to our region. While I am not a proponent of natives only, it is desirable to find plants which have resided in an region for very long periods of time. Naturalized plants that play significant roles in their ecosystems are highly useful. For instance, the willow oak is an excellent provider of acorns- producing them nearly every year in abundance. These trees become totems of stability within ecosystems and are quite useful in this regard. Next, the crown density of each species is slightly different, which will eventually create a canopy with varying levels of light transmission allowing for diverse patches within the garden.

One potential downside to the selection of trees is that the river birches and maples are highly dispersive. We have already had a tremendous increase in the number of saplings emerging from

our soil after just a few years. The silver lining here is that until we establish our desired species for the shrub and small tree layers is that these young trees can provide structural diversity above and below ground. Saplings provide additional perennial support for our soil because as they are excellent coppice species. We can allow them to grow a reasonable size, cut them down, and allow the act of root shedding to loosen our soil and feed soil organisms. Their resulting timber can either be left as dead wood, staked into the soil to loosen the topsoil further, or even for edible mushroom production. Seen in this light, our river birches and red maples become a resource for rapid ecosystem development rather than a potential nuisance!



Photograph 1-1 27 November 2010: Low grass to young trees without anything in between leaves many niches open

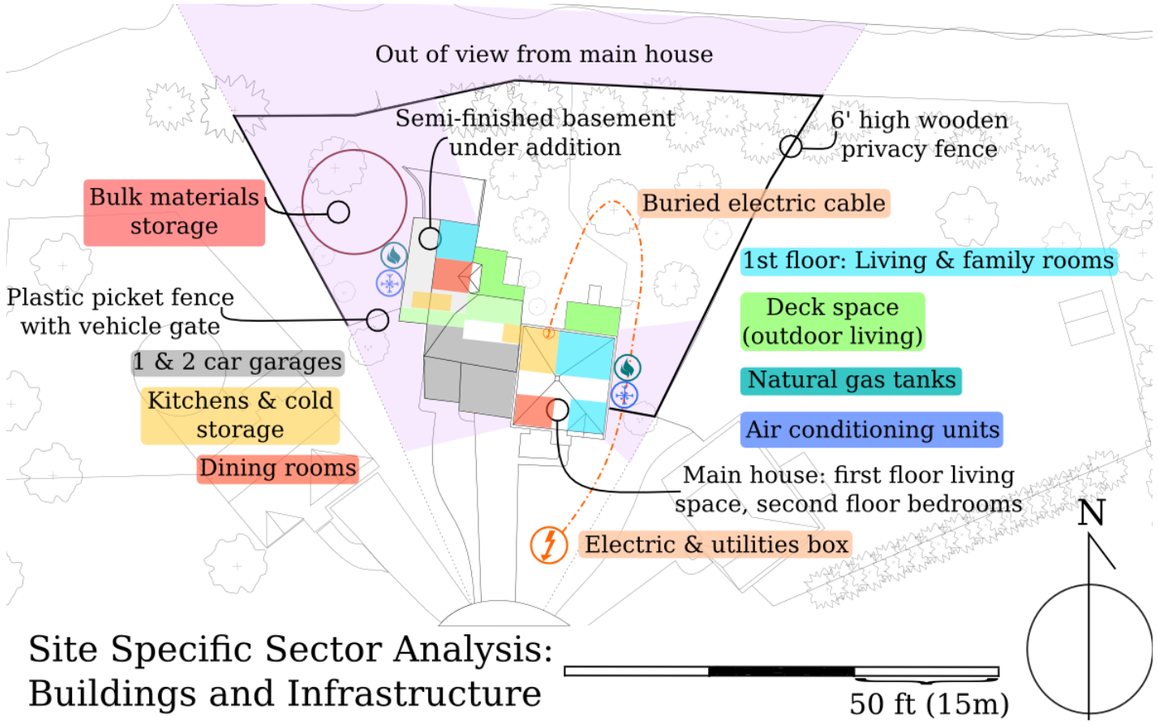


Figure 1-9 Site Specific Sector Analysis: Buildings and Infrastructure

Buildings & Infrastructure

The main house is two stories with a high roof. As it sits even ten feet above the lowest point in the main back yard, the amount of shade (see *Figure 1-10*) it casts is quite extensive in winter. Other limitations stemming from infrastructure include the buried electric cable which runs from the utility box to the back of the house. The front yard, with its utility box, has more buried cables which need to be marked again by calling 811. Buried water infrastructure has been marked in *Figure 1-6*. *Figure 1-9* also marks the location of air conditioning units and natural gas tanks. Air conditioning units are possible sources of hot air (microclimate buffering) as well as condensation (water harvesting). Natural gas tanks need to be kept accessible at all times.

The roofs of the buildings are universally asphalt shingles which reduce the quality of rainwater catchment. They may even be impregnated with fungicides which further diminish rainwater quality. Healthy soil biology may be able to filter out some of the hydrocarbons (especially fungi), but if the shingles do have a fungicide component, then this is obviously mitigated. Time will tell how the roof water quality truly affects the garden. Before investing in storage, we need to make sure that the water is able to be stored as high as possible (on platforms preferably near the southeast side of the house) and even attached to a good sand filter to help improve water quality.

The house and driveways appear to be in good condition. There are many ways to improve efficiency in the home, which are beyond the scope of this paper. Still, *Figure 1-9* labels some of the room locations which may have design considerations (*Figure 1-13*).

Microclimates

Already on a north facing slope, the addition of a tall house and the earthworks during site construction has created a solid five large microclimates, with variations within due to vegetation.

Beginning from the access road, the southern section of the property is the hottest and driest due to its unmitigated solar access as well as exposure to the prevailing winds from the southwest. In addition, the south face of the buildings are brick, which increase solar gain. This microclimate is probably best suited for stretching the hardiness zone towards USDA 8 or even 9. Not only is this microclimate exposed to the elements, it is also fully visible year round by the rest of the neighborhood. These factors necessitate a well planned design for this microclimate that would be instated quickly: vast amounts of material would be necessary to properly sheet mulch and detail the pathways for an

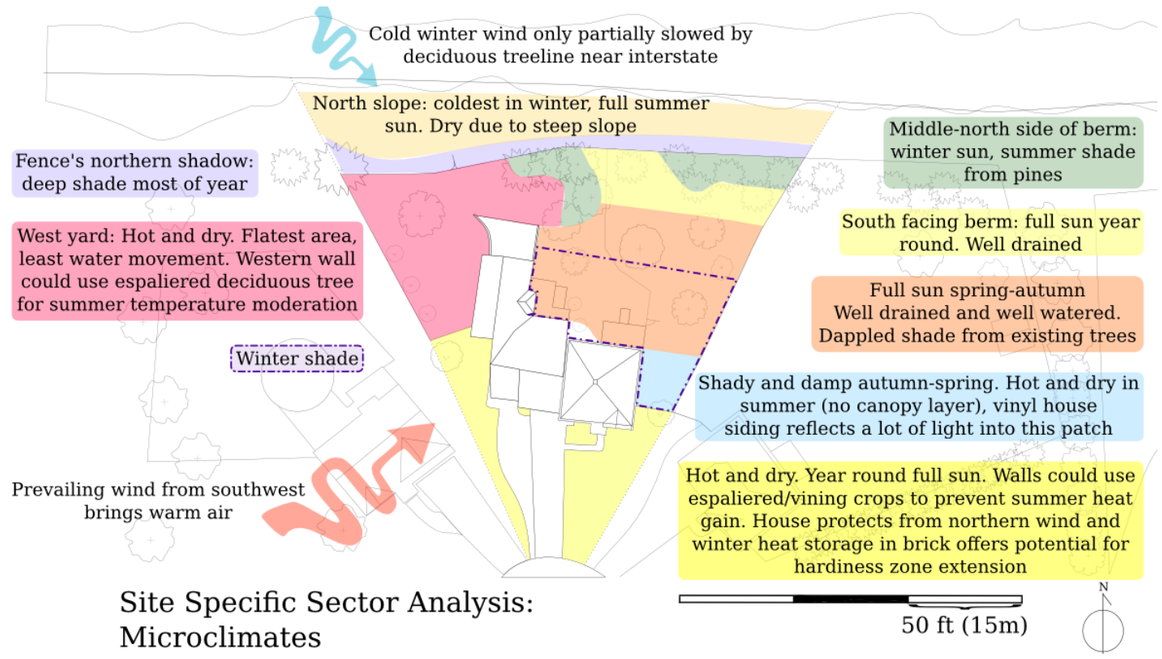


Figure 1-10 Site Specific Sector Analysis: Microclimates

attractive look. This will be covered in 2015: Future Projects, Front Yard Development on page 147.

Moving counterclockwise, as one enters the back yard from the southeast, you reach the complete opposite microclimate: cool, shaded, and moist. The neighbor's house to the east combined with the privacy fence shade this section throughout the morning. This area is subject to the sudden and total shade that buildings cast, which make the choice for flowering fruit species a little more difficult. They need to tolerate poor solar exposure along with the dramatic temperature shifts. In this microclimate it may be possible to stretch annual greens and other tender plants further into summer by utilizing shade. In summer, however, this patch is relatively dry because of the amount of sun reflected into it from the vinyl siding and the lack of any canopy layer.

North (and downhill) from there, the orange zone represents the bulk of the garden. This area has year round full sun, although in the winter the combination of a tall building and downhill north slope creates a very large shadow in the afternoon. Still, with good solar access, this area will allow very healthy growth. North from there is a yellow shaded zone which represents the southern-facing slope of the berm that was created during housing construction. While not very large, this is the only true southern facing aspect on the property (discounting the southern walls of the house). Year round production is possible here with season extension through cold frames and other miniature heat trapping structures. Interestingly, this area may also be the site of a cold air trap as it is the intersection between the northern slope and berm. As you can see in *Photograph 1-2 (next page)*, there are snowless pockets directly underneath the pines, which may be acting as heat traps (depending on the severity of the weather) because of their dense crowns. It should be noted that the presence of built infrastructure, combined with fences significantly alters the movement of frost down the slope.

Furthest north is a severe north facing slope which remains shaded throughout the winter, but is fully exposed to the sun come summer. This microclimate is best suited for a well designed evergreen windbreak to shield the rest of the property from northern winds (and block seed dispersal).

Lastly, the area in red represents a western aspect microclimate. By the time the area receives full sun during the summer, temperatures have climbed to their daily high and so make this area very hot and dry. It is also in red because it is the best area for vehicle access to both the basement and bulk material storage. Therefore it should mostly remain lawn/wildflower mixture. At the same time, the western wall of the addition could be a very

Photograph 1-2 Microclimate detail February 21st, 2012

good site for an espaliered tree to reduce summer electricity consumption.

Current Zones of Use

For the purposes of site analysis, zones of use do not necessarily need to correspond with permaculture zones of use, which will be described later.

The most frequently used areas of the property prior to implementation were the driveway, houses themselves, and the decks on the north side of the houses. Interaction with the land itself was mostly limited to maintenance of the lawn, including the raking of leaves in the fall. Our dogs used the fenced in yard on a daily basis to explore, chase birds, and just enjoy being outdoors. Infrequently, the lawn would be used to play games of croquet and such during the summer. This is partly due to the climate: in the summer, with temperatures in the 90s F (30+ C) and high humidity, the best times of day are in the morning and evening. Mornings are usually spent at work and evenings for daily household tasks. I would also add that the lack of interaction with the landscape was that, as a lawn, there really is not much to do there of any interest! As the existing trees mature and close the canopy, a very pleasant microclimate will be created that will see more use. However, as mentioned earlier, the decks are used very often during the year for both pleasure and as a place to dry clothes safe from the neighbor's eyes.

Soils

When we first decided to commence a change, North Carolina was still offering free soil sample analysis (paid with tax dollars) to residents. North Carolina was the last state in the country to offer this service. Now, in 2014, if you send samples during the peak season, December-March, you will pay a $4 fee for your samples. Which is absolutely affordable (even if charged per box!), but you can always wait until after this period to send them in for no direct charge! While it is possible to "read" the landscape according to which species are found growing there, scientific soil testing is the best way to know for certain what the state of your soils are. There are many different kinds of soil tests, and this one is an "industry" standard. No one soil test type can give you a 100% accurate state of your soils. Since these results are primarily geared towards farmers who are in the modern industrial agriculture model, the results need to be taken with a grain of salt. They also offer precious little information regarding the status of the soil food web. Results regarding organic matter percentage and cation exchange ratio offer a rudimentary understanding of this critical factor.

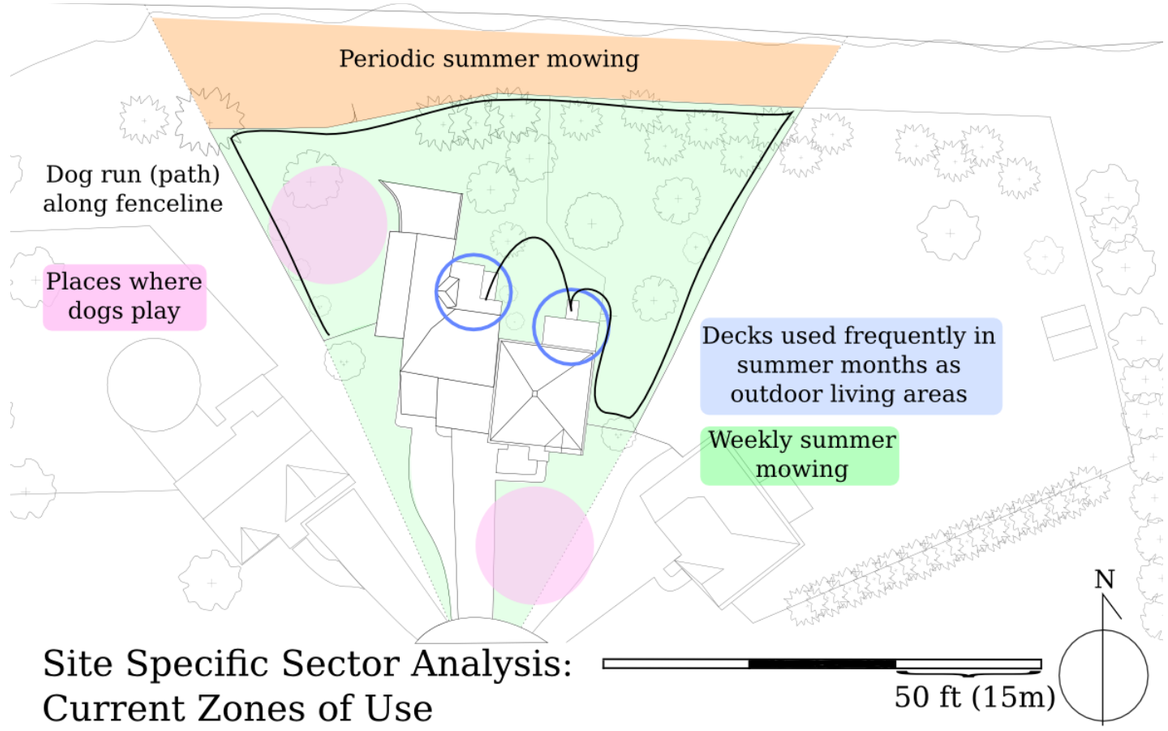


Figure 1-11 Site Specific Sector Analysis: Current Zones of Use

Photograph 1-3 Typical topsoil profile: very little soil OM and only in top inch. Low lying area, January 29th, 2011

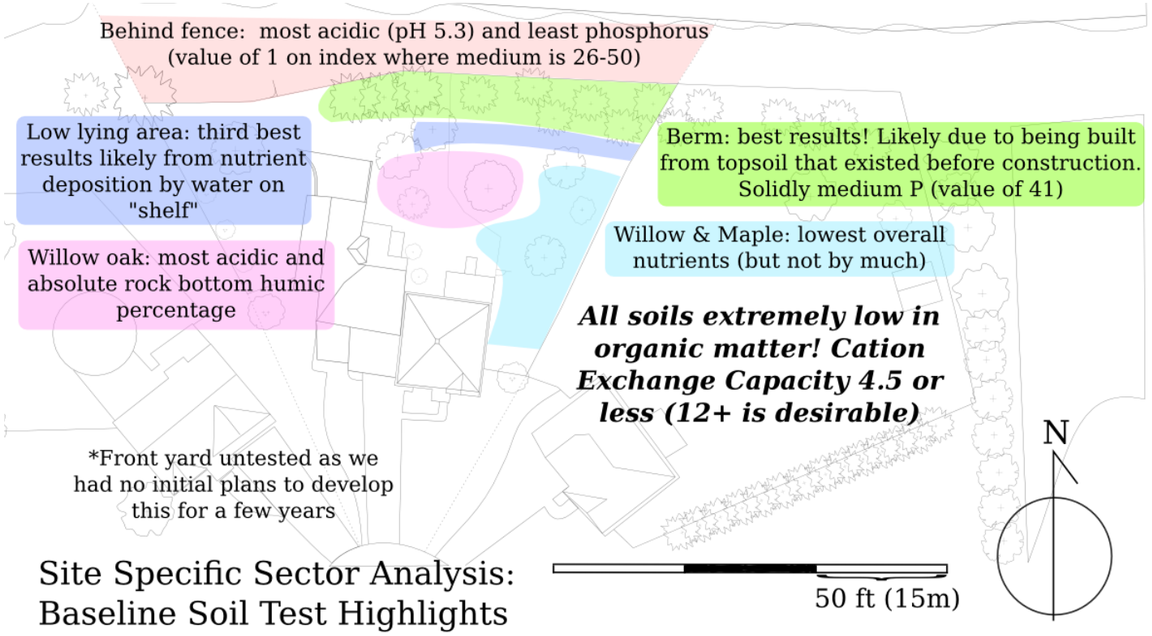


Figure 1-12 Site Specific Sector Analysis: Baseline Soil Test Highlights

2010 Soil Sample Sample IDs	
Sample Location	Location Description
Behind Fence	Clear cut, shares the same slope and aspect, as well as history of having been forested
Berm	Built during home construction, probably out of original topsoil. Shares same aspect, slope, and white pine vegetation
Low Lying area	As a corridor for water runoff, I suspected that this area would have higher organic matter levels as well as nutrients due to solubility of nutrients. During small rain events, water would merely puddle here, so I figured there would be nutrient deposition.
Willow Oak	Shares the same willow oak and is a little more flat. I believed that the different trees would change the soil nutrient levels so I wanted to keep the largest trees in separate samples
Willow	This area also used samples from around the Red Maple tree. Generally level and even slope, different nutrient loads and depositions from canopy trees.

Table 1-1 2010 Soil Sample IDs

With that in mind, we sent six samples to the state lab in the fall of 2010. You will note that the sixth sample does not appear in *Figure 1-12*. That is because it corresponds to the raised bed garden that my parents had; whose topsoil was brought in from a farm. Those results will be given later. The rest of the sample sites were chosen based on common features (*Table 1-1*).

Now that I have explained where and why the samples were taken, let me also say that we did not test the front yard, nor did we test the west side of the property. This is because we were not ready to begin changing the management of these areas of the site.

Before I delve into the numbers from the report, let us examine what kind of soil we are dealing with on the property. According to the Natural Resources Conservation Service, the site's soils are classified as NaB (nathalie sandy loam) and has been surveyed as ~50% sand, 30-35% clay, remainder ~20% silt. Also according to the NRCS, we have over 6 ft (>200cm) before reaching any restrictive layers in the soil. In addition, the parent material is "saprolite derived from granite and gneiss and/or schist." Taken together, the NRCS classifies our property as "prime farmland" due to the combination of well drained soil, low wind erosion, and deep soil profile. On site inspection of the soil, however, reveals that

our clay percentage is likely higher.

However, our site is in a suburban development where the standard practice is to remove the topsoil from the old farmland (recall the regional context's history of North Carolina) before compacting the soil for safe construction and foundation laying. The removed topsoil is then sold to landscaping companies rather than being returned to the land, depriving the new neighborhood of its inheritance. To add insult to injury, typical American lawn culture does not encourage the retention (let alone accumulation) of organic matter in the soil, nor does it promote species diversity. This leads to dependence on chemical fertilizers, which help burn through soil organic matter, further depleting the soil. In addition, the use of "weed and feed" is a deadly one-two combo in which this fertilizer is mixed with herbicide to prevent the sprouting of weeds. Applied year after year, these products destroy the living soil.

Without any organic matter and an assault on the living foundation of soil, the soil itself becomes compacted through the years. Organic matter is essential in decompacting the soil, allowing nutrient capture & storage, water storage, and other life supporting processes. Organic matter (OM) also buffers the soil's pH, the loss of OM helps explain the acidification of soils (to an extent, parent material is the decisive factor as to what pH the vast majority of soil will be). All of these benefits are actively discouraged by standard yard care, which includes robbing plants of their leaves in the fall in order to satisfy a cultural demand for "tidiness." Upon visual inspection, poking and prodding with shovels and garden forks, I confirmed that we were dealing with extremely poor soil.

Analysis of the soil is probably the most important element to get right before moving on with site development. Our climate offers year round opportunities for production, but if the soil is poor, we will see poor results. Poor not only in quantity and quality of yields- the humidity of our region in combination with poor soil vastly increases the chance of disease and unwanted herbivory pressure. When the samples returned from the lab, the evidence was overwhelming: before even imagining the site with long-lived desirable perennials, we would have to engage in serious soil rehabilitation for a number of years.

The scientific lab report on our soils revealed the following:

2010 Soil Sample Results						
Soil ID	Behind Fence	Low Lying Area	Raised Bed	Berm	Willow Oak	Willow
Soil Class	Min	Min	Min	Min	Min	Min
HMA Result	0.13	0.18	0.36	0.32	0.09	0.18
W/V Result	0.94	1.11	1.12	1.18	1.05	1.06
Cation Exchange	3.1	3.7	8.8	4.5	3.6	4.5
Base Saturation	68	73	94	78	56	76
AC	1	1	0.5	1	1.6	1.1
pH	5.3	5.6	6.7	5.9	4.9	5.6
P	1	10	47	41	6	5
K	50	49	111	58	61	37
Ca%	40	51	67	52	34	56
Mg%	20	15	21	20	14	16
Mn	516	320	199	252	436	295
Zn	34	82	153	103	36	81
Zn Available	34	82	153	103	36	81
Cu	50	50	30	43	33	79
S	105	42	23	38	113	42
Na	0.1	0.1	0.1	0.1	0.1	0.1

Table 1-2 2010 Soil Analysis. NOTE: The top 2 inches of the soil is removed from samples because it mostly consists of the roots of grass and other vegetation. This top layer would undoubtedly have much higher OM% (HMA Result), but we are interested in the soil itself and not testing the O layer. Therefore, tests are taken from 10-15 different sites within each sample patch, down to 8 inches (20cm), and mixed together for an average view.

All the soils are classified as MIN, or mineral, because their organic matter percentage is less than 3.37%. In fact, all of our soils are practically devoid of OM: their percentages (HMA Result) are less than 0.4%! OM% is directly related to the Cation Exchange Capacity (CEC) of soil- carbon binds nutrients in a more stable form. Without OM, our soils have very low CEC ratios. According to the interpretation paper above, the lowest CEC is 2.5 for sand and 25 for clay. According to the NCRS, our soils are about 50% sand, with the remainder clay, which would give us a desirable CEC ratio of about 12.5-15. The addition of organic matter to our soils is imperative.

Next, our soil pH's are between strong and mildly acidic. The addition of lime will quickly raise pH and the accumulation of OM should help maintain a more moderate pH over time. Soil

pH directly affects the availability of nutrients to plants and fungi. Searching for "pH availability of nutrients" online will return many charts which clearly show how acidic soil, less than 6, severely limits the uptake of key nutrients. Phosphorus, one of the most important, only begins to be easily available after 6.25, with full availability right at 6.5. Only the soil in the raised bed meets this requirement and we only have about a few cubic yards of it. Likewise, calcium (also increased through the use of lime) and magnesium are only full available after 6.25 as well.

Phosphorus levels are all but non existent. They are listed as an index, with 26-50 being classified as medium. Only the berm has medium phosphorus levels, but it still suffers from low pH and low OM%, which relates to low ectomycorrhizal activity (OM% specifically). All mycorrhizal fungi are a primary pathways for phosphorus to reach plants and ectomycorrhizal fungi thrive in high organic content soils that avoid compaction. The rest of our test sites are completely within the "very low" phosphorus range. As phosphorus is a primary resource for plants, this helps explain their poor health (lack of resistance to destructive fungal attacks to both woody structure and leaves). The addition of bone meal is the traditional method of increasing phosphorus. Bringing these levels up is essential, as is making certain that we encourage healthy mycorrhizal networks in our gardens to make the best use of any phosphorus we add.

The rest of the tested nutrients look to be in good shape. Increasing their availability through increasing soil pH and soil life, especially mycorrhizae, is more important than raising their levels (besides perhaps calcium). One last note: the micronutrient quantities are unknown since our tests the not analyze for them. These can be applied by binding different rock dusts and kelp into finished vermicompost immediately prior to spreading.

Aesthetics

With almost the entire site visible from the house, the project can always come under scrutiny. In terms of pressure, the front yard is the most difficult. The space is fully public: all of our neighbors, about six homes, have good views of it. As our property sits at the end of a cul-de-sac, we have a lot of people slowly turning around right in front of our house. It is one thing to begin shifting our property out of the public's eye (in the back yard), but another in the public sphere. We have to contend with socially conservative standards of beauty. Deviations from American lawns are not looked on too fondly. Lawns serve as a social barometer for certain subsets of the population. Allowing the grass to grow even a few inches higher than normal signals something is wrong. Openly abandoning a lawn for other types of landscaping can set off alarm bells.

So any changes in the front yard will have to be considered down to the finest detail. This includes budgeting for rhizome barriers to reduce work and contain certain species. It means investing in landscape fabric underneath well mulched pathways to keep at least those aspects looking "clean." In addition, bringing in good looking stone to line pathways and add other features will score points. These are signals to the neighbors that there is a well thought out plan that won't "ruin their property value." If there is year round seasonal interest, if things are at least visually pleasing, the transformation to lawn to productive system may go smoother. Luckily, NC has growing interest in native plants and wildlife gardening, so if pitched along these lines, we may avoid a lot of flak. Again, these will be covered later in the paper when we look at potential designs for this location.

Pressure to conform is much lower in the back yard as it is almost completely withdrawn from the public eye; the privacy fence and northward slope keep all herbaceous species, low shrubs, and earthwork features from being noticed. Here, we are able to loosen our control and allow things to develop more naturally. Experimentation and gradual filling in of niches is welcome. This decreases costs and is less stressful. We spend a lot of time outdoors on the deck- which has a wonderful view of the entire garden- so seasonal interest, especially through a full nectary calendar, will meet ecological as well as cultural needs. Still, visitors will ask many questions and we should be careful to at least keep pathways obvious and clear. Even this small gesture makes the seemingly wild succession more appealing. In fact, it should be noted that in many cities, the idea of allowing strips of what used to be lawn to flower and seed for wildlife habitat is catching on. Cities like it because it saves them extraordinary amounts of money on fuel- in Europe in particular. When questioned, residents are overwhelmingly positive. The tight, managed lawn and the stark contrast with the "wild" section is visually and emotionally satisfying. So we are just being trendy!

Now, there are two related things that we should take into consideration as particulars we want to mitigate: highway noise and visibility. The interstate behind our property is fully visible from the house, not just the second floor. Before

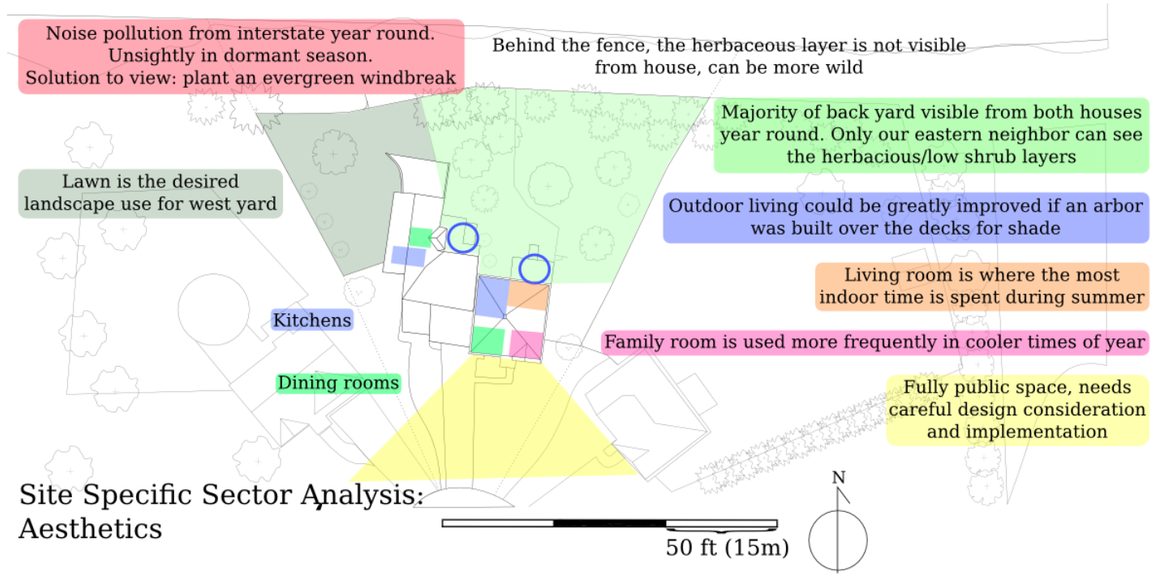


Figure 1-13 Site Specific Sector Analysis: Aesthetics

the wildlife corridor was clear cut, visibility in the summer was almost completely nil. Now, however, even in summer, traffic is visible. Traveling at highway speeds means that they don't really pay any attention to us. So screening the highway out is mostly for our own peace of mind. An evergreen visual screen behind the fence would be perfect. Thick evergreen living architecture is a wonderful wildlife habitat, especially for birds. As this section is on the far north side of the property, productivity will not be diminished, but could even be assisted through the ecological services provided by overwintering and nesting sites there. In addition, the north winds will be slowed and the rest of our property, including the house, will benefit. Lastly, the cars will be reduced to noise pollution.

Noise pollution from the highway cannot be solved without a major investment in building either a sound wall or trucking in more soil to build a massive earthen berm. The addition of a thick, evergreen wall of life will not significantly diminish road noise. It should also be noted that the road noise is also amplified by the steep ridge which rises on the north side of the highway, reverberating noise pollution back at us. The south side of the house does not suffer as much from noise pollution and we may want to consider designing additional outdoor living spaces there. The southern exposure would allow enjoyment even during winter and early spring. During those months, we would increase our observation and interaction with the warm microclimate plants there. It would also signal to neighbors that the new garden there is being enjoyed and taken care of.

Conclusion

The size of the property, climate, landform, and existing vegetation allow for a lot of flexibility in design. They also provide enough design parameters to make design easier. On the edge between cold and subtropical climates, we have access to a wide range of species. We even have space for trees of all size, including nuts- if desired. However, this flexibility will only materialize once the current steady state of soil degradation and ecological simplicity is overturned in favor of regeneration. While some designers may be advocates of an "instant succession," the state of our soil is simply too grim to justify that kind of intervention. Planting full on fruit trees and other long-lived plants into soil with less than .5% OM, acidic pH, almost non-existent phosphorus, and intense compaction is a recipe for disaster. Our neighborhood suffers from fragmented ecology and planting high-value crops into a weak system would only increase the chances of failure, disappointment, or both. For these reasons, I recommend a course of soil building and ecosystem regeneration before investing in long lived species whose growth would be unnecessarily curbed by premature introduction into our system. Only once the soil has been taken off of life support will outlays on perennial crops be justified.

This period of transition, from lawn to forest garden, should be gradual to give us time to adjust our lifestyle to an outdoor oriented one. The site's ecosystem will need a period of transition too. A mortgage is paid not only on the house itself, but the land it sits on. With property taxes constantly on the

rise, it makes sense to maximize the value you gain from the land in addition to the home. Integrating the two is the only logical response.

Key take aways from the site analysis:

1. The landscape has been severely disrupted by human behavior;
2. The back yard is heading towards a predetermined closed canopy;
3. If the system is to be rejuvenated, we must be quick to harvest as much sunlight as possible before the canopy closes (as we want to keep the canopy trees);
4. The poor state of the soil, hydrology, and local ecology mean that unless significant investment in off-site compost and nutrients is made, it will take time to produce a healthy ecosystem in which to place high-value crops;
5. Even if significant investments are made, it will take a few years for healthy biology to develop.

According to resilience science, systems- through biological and physical processes- move towards stable states. They may shift around in each "bowl," but remain generally the same. Only outside energy can change stable systems. Our current system is relatively stable: the dominant culture still embraces lawns and ecologically lawn maintenance will continue to prevent the system from diversifying. To achieve a paradigm shift, abundant material and energy input is required. Once these physical and cultural boundaries are cleared, the system can begin to settle into a new stable state: one in which resources are accumulated and ecological health is managed for. I have made this new stable state a little more shallow than the current one. This is because our dominant culture still militates against deviations from the lawn culture (consumption) and against prudent co-evolution, as represented by the resilient ecosystem. One can imagine site preparation and management change as carefully retreating from a morass. Years of biomass export, soil compaction, and water loss have to be accounted for prior to achieving a new stable state; knowing how we came to this stage is essential to avoid repeating the same mistakes.

One last parting analogy: the current system is like a sick patient whose health is spiraling downward. Dehydrated, weak bones, and little stamina. Would it be wise to enroll this patient in a Cross-fit training course at the gym? Sure, it may look nice to get all dressed up in a new outfit- we got our shoes (rain barrels), hi-tech clothing (copious mulch and compost), and performance tracking gadgets (fruit and nut trees)- but when the rubber hits the road, all of these trappings only patch over the fact that there is no phosphorus (energy), no water storage (stamina), and general degeneration (fractured ecosystem). It will take years for the soil to build and self-organize, water storage to be improved and expanded, and for the billions of soil organisms to begin shifting towards a fungi-dominated, forest species preferred population matrix. The last thing we want to do is put inordinate demands on a sick patient. A wiser course of action is to give the patient time to adjust, while appropriate measures are taken that lay the foundation for long-term health.

Note: this advice may seem- at first glance- at odds with the prescribed stress test, but keep an open mind!

Goals

When we first discussed changing our management methodology, I emphasized that after initial expenditures of energy and material, we will have a landscape that requires less work and actually provides useful returns instead of constant inputs. We talked about how no one in the family actually enjoys lawn work. Maintaining expensive fossil-fuel powered machines to perpetuate a lawn that is rarely used for recreation, but rather preserved for the sake of the neighbor's opinions on what a property is supposed to look like is a poor use of resources- after alternatives are discovered, that is. Time, money, energy, and happiness are all sacrificed to keep up the veneer the all is well in the household. While we are more fortunate than most, the fact remains that lawns were born from the British and French aristocracy's desire to demonstrate their wealth by purposefully setting aside productive land for leisure. In a time when the price of food, especially clean food, is steadily on the rise and subject to the whims of the commodity market- a market that is routinely manipulated so a select few can profiteer over the staples of human life- this idea seems preposterous. Another reason lawns are nonsensical is this: we do not own the land. The bank still receives a large check every month. Most people tend to think they are paying for the house, when in fact they are paying for the property and everything on it. Improvements to the house are seen as beneficial, while landscaping is generally left as a side item (although Americans spend over $400/year on lawn care). Lawns that typically do not provide anything useful besides a place to relax. Which, of course, can be done in a garden as well.

It makes much more sense to make a decision: leave a certain percentage of the property as a lawn to be used for recreation and use the other for actual productive activity. This doesn't

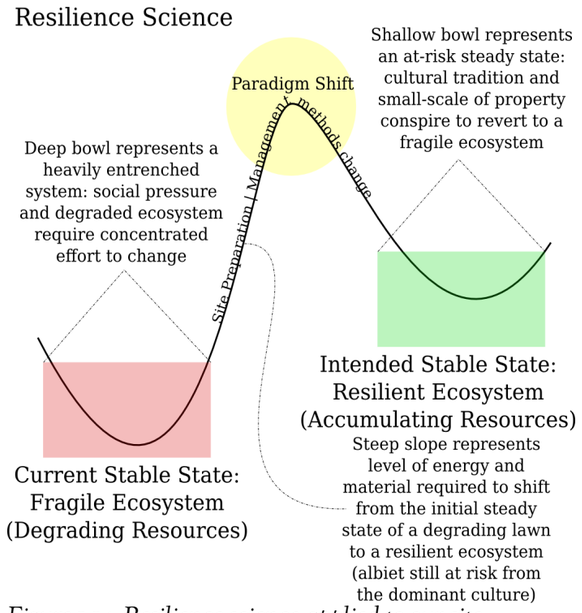


Figure 1-14 Resilience science applied to our site

mean we should be aiming to produce 100% of our needs from less than an acre of land, but it does mean that any land removed from the lawn need not be maintained with as much fuel, expensive machinery, and precious time; in return, it becomes at least neutral in cost:benefit terms. Luckily, the site is large enough to accommodate multiple types of landscape use. The varied microclimates already in existence can be leveraged to gain even more productive space. Transitioning from consumption to production, from passivity to action, benefits not just the ecosystem, but our monetary lives as well.

Beyond "big picture" reasons for implementing change is reality: the specimen trees already here will eventually close a canopy and shade out the lawn underneath them anyway. Implementing a forest garden here makes most sense: trees, even pioneer species, prefer to have a rich and developing ecosystem about them with fungi-dominated soils. Without any changes, they would have continued to grow while being robbed year in and year out of organic matter and the ecosystem diversity they need to live healthy lives. Weak trees, reaching over 120 ft (36m), are not necessarily the best thing to have growing next to the house. Better to choose a landscape maintenance paradigm that will return the health of the ecosystem and trees- reducing the risk of damage to the home. It is also nice to know that the trees will be key drivers in changing gears towards accumulation: they are large enough to self mulch and have extensive root-fungi networks that only need to be nourished.

Long-term Goals

As suggested by many permaculture designers, articulating goals in the present tense and active voice makes a lot of sense, so here goes!-

"Our forest garden provides our family with healthy produce of all kinds and is a place of relaxation. Shade provided by a canopy of oak, maple, birch, and willow allow us to enjoy most of the yard during the warm springs and hot summers. Underneath, shade tolerant fruits and shrubs provide the forest-like architecture that provides many of the produce we enjoy. A diverse layer of herbaceous plants blooms throughout the year. We help the ecosystem provide for the needs of all organisms while emphasizing the importance of native varieties for the most beneficial interactions possible. A series of small ponds and wetlands provides additional enchantment and benefits for everyone. Our system also provides genetic material for the regeneration of our local community at large. The garden's design is simple and maintenance is kept to a minimum. We work an average of two hours per week during the spring and summer, less during the fall in winter as the garden is left to recover for the following year."

Long-term goals guide our day-to-day actions in the garden and help us to envision the future we are co-creating. Reconciling these long-term goals with the present state of the property is the job of design. In other words, what will it take to reach a two-hour per week maintenance regime?

What comes next is not a full-on event horizon design set 20 years in the future, but rather a lengthy period of site remediation which will allow us more time to more fully consider the possibilities.