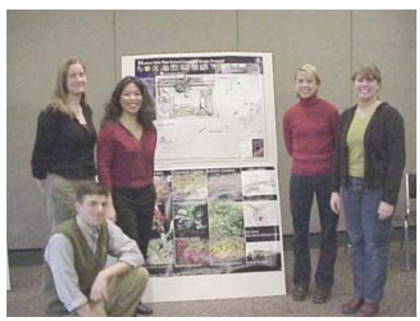
Nathan Hale High School Courtyard Renovation Proposal



Prepared By:

University of Washington: EHUF 480, Selection and Management of Landscape Plants
Center for Urban Horticulture, under the direction of Dr. Linda Chalker-Scott
Autumn, 2002

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Site History and Current Usage

Nathan Hale High School was built in 1963 in an area that was historically hunted, logged, farmed, and golfed! The project area, Courtyard A, has remained relatively unchanged since it was built forty years ago. The high school is located on a boggy flat, adjacent to Thornton Creek—a perennial, salmon-bearing drainage. The courtyard is predominantly hardscaped and has suffered from benign neglect throughout most of its existence. Currently individuals and small groups infrequently use the courtyard in good weather.

Seattle School District Ordinances and Regulations

Seattle School District requires that any improvement project be reviewed by their newly established Design Review Team. Each school has it's own Design Review Team led by the principal and comprised of students, faculty, administrators, parents, and community members. The Design Review Board created this process to allow each school to assess their design needs individually—to allow for greater flexibility and ultimately to achieve designs that are more apt to suit the needs of the school. Additionally, this project must be reviewed by the Seattle School District's Self Help Review Team. This team reviews each project that is initiated by volunteers to assess the project's feasibility. If accepted by both of these review teams, it will be possible to implement the Nathan Hale Courtyard A Project.

Existing Vegetation

Forty species exist on site, most of them are weedy and do not require preservation. Most woody plants are stressed, diseased, or inappropriate for the site. Species performance suggests a combination of moist or saturated soils and summer drought. Horsetail and quaking aspen will provide ongoing maintenance problems unless removed. Retention of the European birch is recommended.

Microclimate Assessment

There is a clear light and heat gradient across the courtyard, with shaded cool conditions to the south and bright, hot conditions to the north. Soil moisture likely follows a similar pattern. No significant water sources exist on site. An existing drain system should be preserved.

Hydrology Report

The hydrological qualities on the site reflect two environmental factors. First, water (rain being the single source of water) varies according to the seasonal dry and wet seasons in Seattle region. Second, the clay soil causes poor drainage. As a result, the design proposes ways to increase water resources and improve drainage.

Soil Analysis

The existing soils in the courtyard are healthy and functional. Soil was tested for heavy metal contamination and tests reveal that lead levels are low and pose no threat to human health. Because the entire site sits on waterlogged clay soils, raised beds must be constructed on this site to bring plants above grade. These raised beds will be filled with imported topsoil that is as unamended as possible.

Design Process and Narrative

The design development process occurred over the course of a six-week period and involved extensive input from N.H.H.S students (particularly Earth Service Corps students), members of the PTA, teachers, members of the N.H.H.S. Horticulture Program, and students from the University of Washington. The proposed design responded to six significant design criteria: 1) student and faculty program desires and needs, 2) environmental circumstances, 3) construction costs, 4) existing architectural gestalt, and 5) contextual qualities. As a result, we developed a design that creates a series of outdoor rooms which allow students and faculty to interact with native vegetation and natural processes while increasing opportunities for enjoyable individual and group activities.

Site Preparation

In order to begin construction, a substantial amount of demolition must take place. The preparation requires removing all vegetation and large sections of concrete pavers. Recycling woody debris for mulch and aerating the soil will significantly improve the soil quality and plant health.

Plant Selection Abstract

Plants were chosen for this site to create three different rooms in the courtyard. The native garden will be filled with shade tolerant native plants that will give the garden a lush native feel. The classroom garden is filled with very hardy plants that will thrive even if students pick the flowers and leaves. These plants can thrive with plentiful morning sun and afternoon shade. The butterfly garden contains drought tolerant plants that will attract butterflies. The plants in this section of the courtyard will create a very colorful, open environment.

Installation

Installation can be divided into two or more phases based on incremental creation of new planting beds. Careful phasing of hardscape installation may reduce short term costs, but there is a risk of undermining previous efforts. A sequence of site installation is proposed.

Aftercare and Maintenance

Maintenance is both a practical and a sociological challenge. A maintenance plan must successfully institutionalize the skills and organization to support garden survival in a changeable institutional environment. A series of tasks are presented, discussed and distributed over a calendar year.

Academic Integration

Integration of academic programs into the garden supports both learning and the survival of the garden. A brainstorm of academic project ideas is offered.

Introduction

A group of five students from the University of Washington, Selection and Management of Landscape Plants class (Fall Quarter, 2002) led by Dr. Linda Chalker-Scott, have developed a landscape renovation proposal for Nathan Hale High School (N.H.H.S.), Courtyard A. This public high school (supporting 1050 students) is located on 110th and 30th Avenue NE in the Maple Leaf neighborhood of north Seattle (Figure 1: http://hale.ssd.k12.wa.us/stats.htm).

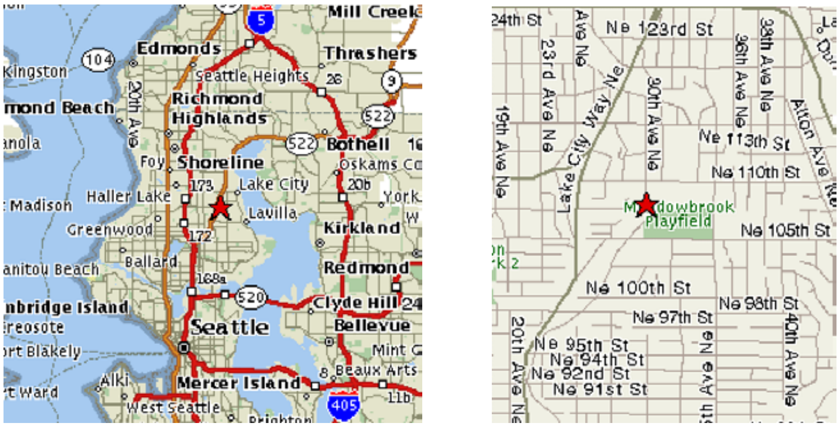


Figure 1. Context maps

The area to be redeveloped is the largest of three courtyards on campus. Courtyard A is located in the interior of the main building, completely separated from the exterior of the school (Figure 2).

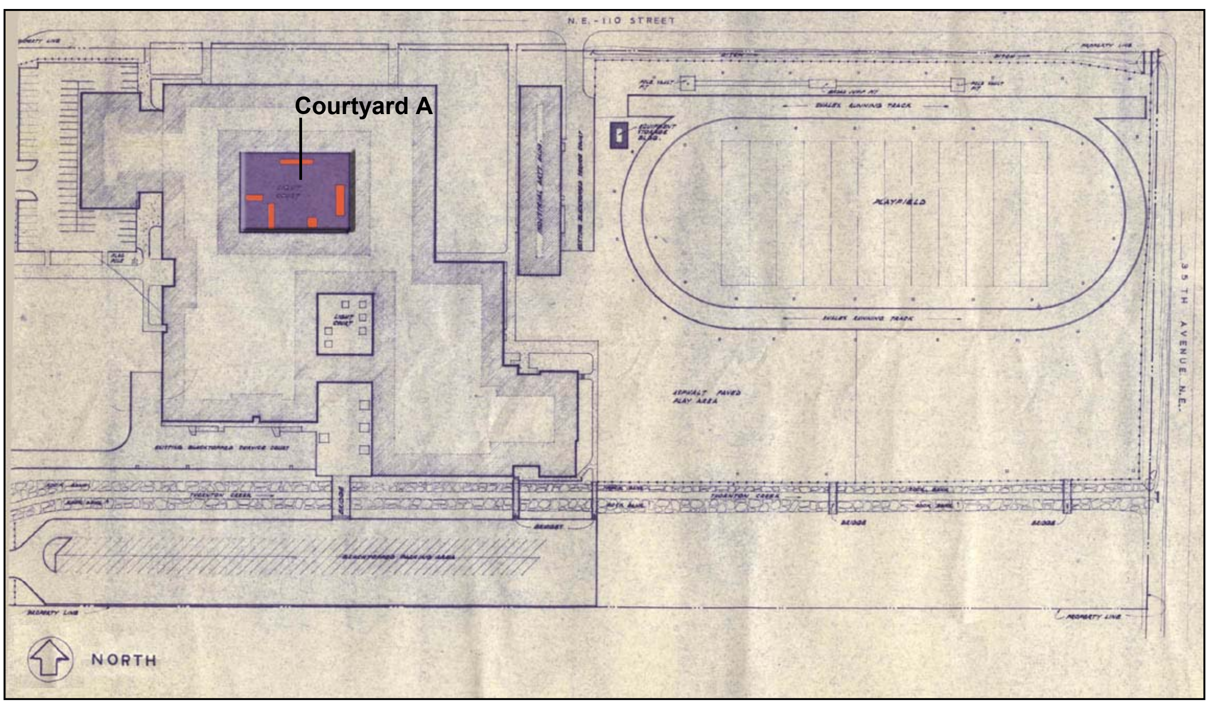


Figure 2. 1962 Plan view of Nathan Hale High School

The project was initiated by the Earth Service Corps club—a student club affiliated with the YMCA Earth Service Corps. The national club is a ten-year-old service-learning program for teens "grounded on the building blocks of leadership development, environmental education and action, and cross-cultural awareness" (http://www.yesc.org/about.cfm). The Nathan Hale Earth Service Corps Club recognized the opportunity for environmental education and service-learning in their own school and contacted Dr. Chalker-Scott for assistance. The club requested the following proposal to address the goal of beautifying the neglected courtyard to increase student use and enjoyment and to provide opportunities for native plant education. They received a $500 grant from Seattle Public Utilities, a $400 grant from the Parent Teacher Association (PTA), and are actively seeking more grants from Earth Service Corps and other groups. They are also working with the PTA to coordinate volunteer labor and materials within the community (personal communication, Jessica Torvik—Club Faculty Advisor).

This proposal contains recommendations for the design, installation, maintenance, and budget for a phased renovation of Courtyard A. These recommendations are intended to be submitted to the Seattle School District's Self-Help Review Board prior to construction. Following the review board's approval, the project will be implemented by members of the Earth Service Corps club, N.H.H.S. Horticulture students, other students, teachers, administrators, parents, and community members.

This landscape management proposal has several goals. Most importantly, it proposes a framework for a site-appropriate, sustainable outdoor classroom that creates a place for students to learn about native plants, stormwater harvesting, as well as seasonal variations in vegetation and sun movement. The design, installation, and maintenance is intended to be a process in which many volunteers play an active and ongoing role. Because of the inability for the School District to pay for or maintain this project, it is our belief that this communal process will enhance a sense of ownership of the courtyard and ultimately reveal itself to be the key element in the project's success.

The following proposal is organized into four main sections. The first section is comprised of a detailed site analysis that addresses site history and city ordinances, existing vegetation, hydrology, and soils. The site analysis is followed by a site proposal which includes a design narrative, site preparation, plant selection, and hardscape items such as retaining walls, water-catchment systems, and trellises. The fourth section details installation requirements and the report closes with recommendations for successful aftercare. Appendices provide details on plant inventory, school ordinances, design drawings, budget, and a maintenance calendar.

Site Analysis—Existing Site Conditions

Site History and Current Usage

Prior to 1850, the area around Nathan Hale High School was undeveloped and inhabited by ancestors of the present-day Muckleshoot and Tulalips Indian Tribes. It was not until the Land Claim Act of 1850, that the area around Nathan Hale began to be significantly altered by humans. The European-descended settlers who moved to the area, logged most of the valuable timber. After the timber was extracted, the area began to be settled by farmers. Around the turn of the century, the Fischer family settled the land on which Nathan Hale and the Meadowbrook Playfield currently reside (Seattle Public Utilities 2000). Al Blindheim, living grandson of August Fischer—the owner of the farm, remembers when his grandfather "raised asparagus, rhubarb, corn, and potatoes on the fertile lowlands that were to become the Meadowbrook playing fields". (Oral interview: http://northonline.sccd.ctc.edu/cl/reports/Historical/Interviews/Blindheim.htm)

Figure 3. 1961 aerial photograph of Meadowbrook Golf Club

Following World War II, when Seattle's population more than doubled to support war industries, population rapidly increased in the neighborhoods surrounding Nathan Hale High School. Population in the Thornton Creek Watershed (in which Nathan Hale resides) jumped from 2,898 in 1920 to 43,680 in 1950 (Lake City Journal 5.18.1977). This boom lead to suburban development, and the once rural area was transformed into a single-family-residence dominated landscape. It was during these post-war years that a portion of the Fischer Farm (including the Nathan Hale School site) was developed into a golf course—Meadowbrook Golf Club (Figure 3).

Meanwhile schools and parks were built to support the areas burgeoning population, and in the late 1950s, the private Meadowbrook Golf Club was purchased by the City of Seattle and divided into the future Nathan Hale High School and Meadowbrook Playfield. In 1963 Nathan Hale High School was built on its current 18-acre site (Seattle Public Utilities 2000).

Courtyard A, the largest of three courtyards at the high school, was originally designed to emit light into the surrounding classrooms and teachers lounge. It was, and is still, accessible by only two doors—one in the teachers lounge, the other in an interior hallway. When school is not in session, this courtyard is neither visually nor physically accessible. The design of the courtyard has changed very little since it was originally built. In 1963 the majority of the courtyard was surfaced with 5' x

5’ x 3.5” concrete pavers. Five rectangular planting beds were orthogonally placed within the paving pattern and a few benches were interspersed, but the layout was predominantly open to allow light to enter the building (Figure 4).

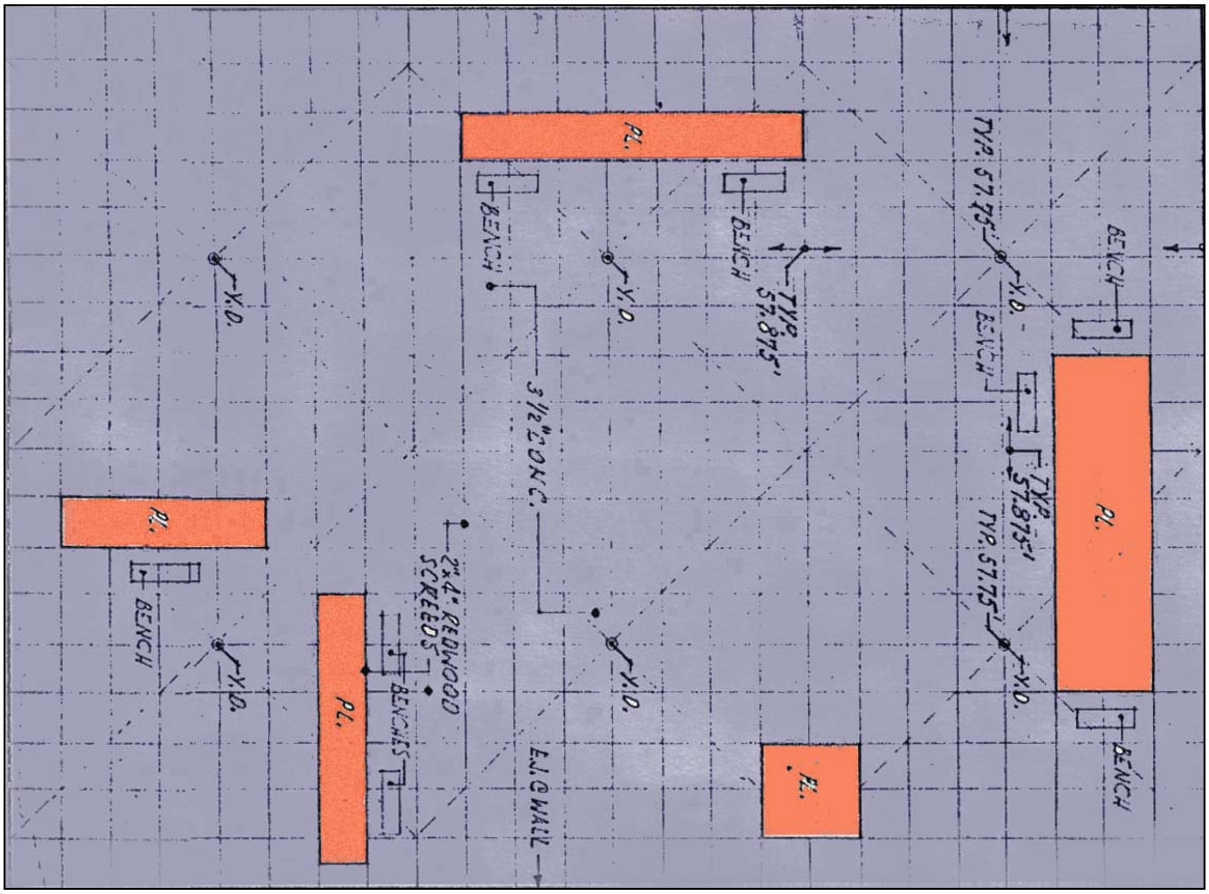


Figure 4. 1962 Courtyard A plan map

Since construction, the courtyard has endured forty years of benign neglect interspersed with periodic bursts of maintenance and replanting efforts (Principal Eric Simpson, Personal Communication). Most recently, Lindsey Reynolds (Class of 1999 and Earth Services Corps club member) focused her senior project on replanting the existing raised beds in Courtyard A with native plants. Unfortunately maintenance practices did not change after Miss Reynolds’ installation, and in a matter of a few short years the courtyard has once again fallen into a pattern of neglect.

Last year, the Nathan Hale Bicycle Club adopted part of the courtyard to house a new shed that currently shelters bikes in varying stages of disrepair. When complete, the shed will serve as a bike storage/repair area and will be the location for the future bicycle recycling program (Student Allison Driver, personal communication). Occasionally students or teachers will use the space during sunny lunch periods (a few loose chairs and a picnic table currently provide seating in the courtyard), but for the most part the courtyard is not used.

Figure 5. Existing conditions facing west

Figure 6. Existing conditions facing north

Figure 7. Panoramic from hallway entrance

Figure 8. Panoramic from Teachers Lounge entrance

Seattle School District Ordinances and Regulations

Any landscape to be installed on Seattle school grounds must receive approval from a Design Review Team. This design review process was recently transformed by the District's School Design Team in the Fall of 2001 (Seattle School District 2002). The mission of this group was to create guiding principles to assist architects and school design teams in planning, renovating, and constructing school facilities. This design process enables each school to have more autonomy and flexibility in renovating or constructing. Each school will create its own design team comprised of a variety of members from both within and outside of the school. The school principal leads this diverse group of teachers, program representatives, support staff, PTSA representatives, students, and community members. All designs are required to address the following categories: *learner-centered environment, personalizing environment, program adaptability, community connections, aesthetics, safety, and collaboration* (see Appendix C: School Design Standards for the Seattle School District—School Design Checklist, for more details). The design team is required to follow District policy or standards such as educational specifications, design standards, and material standards. The team also needs to plan for changes that are within the scope, budget, or schedule of the project (Seattle School District 2002). To ensure that this project complies with the Seattle School District Design Team standards, it is necessary to involve Principal Eric Benson—who leads the N.H.H.S design team.

This project is designated as a "Self Help" project, which requires an additional review process with the Seattle School District. This courtyard redevelopment proposal can serve as the required application for Self Help projects. It includes all of the necessary sections: a description of the project, the individuals proposing the project, design drawings, individuals or groups implementing project, overall budget, timeline, and maintenance strategy. After this document is submitted to the Self Help Review Team, they will assess the package, detail any concerns regarding safety, construction requirements, maintenance, etc. If all of these concerns are addressed by N.H.H.S., then the Self Help Review Team will give approval to proceed.

A conversation with Gretchen Dedecker, the District's Self Help Coordinator, revealed issues specific to this project. Gretchen requested that composting must either occur on site or a strategy for removing yard waste will need to be applied. She mentioned the extraordinarily high costs of water, and brought up the possibility of installing a deduct-meter which will calculate the exact amount of water used for the garden and allow the District to only pay for the water used and not the non-existent, corresponding sewer use. Planting issues such as maintaining enough open exposure to allow light in the building and not planting poisonous or messy fruit-bearing plants were also discussed. Because this courtyard is inaccessible when school is not in session, planting to reduce the risk of criminal or dangerous activity is not an issue. Finally, Gretchen emphasized the need for a solid maintenance plan that includes scheduling and volunteers. She stressed the impossibility of the District in assisting with the maintenance.

Existing Vegetation

In the autumn of 2002, the Nathan Hale courtyard was inventoried for vascular plant species. The site was divided by existing planting areas. Species were identified expeditiously and in several cases placement in a genus was based on withered foliage or shattered seed capsules. With the exception of Dutch white clover, all species in the courtyard were found in one of the five major planting areas. See Appendix A for the detailed inventory, read below for a summary.

A total of 40 distinct species were identified (Table 1). Thirteen were native and 18 were naturalized exotic species. Five species were specific to the ornamental plant trade, and were likely planted. Several of the native species were likely planted as part of previous beautification efforts. The nativity of four species was not determined.

Of the five tree species present, few are in good health or appropriate for the site. Red alder has volunteered, but due to its rapid growth, and brittle wood, is not appropriate for an urban courtyard. Quaking aspen is aggressively rhizomatous and has begun to spread beyond the planting beds. Despite its vigor, many of the older stems are showing heart rot. Without maintenance this site would likely convert to an aspen and alder forest over time. Aspen will be a continuous maintenance problem in any managed landscape (except where an aspen grove is desired.) The cherry is showing signs of insect damage (frass) and has oozing cankers that indicate a fungal infection. The jack pine does not appear to be in decline, but has some significant broken branches exposing trunk tissue. The yellow needle color indicates some stress likely related to the poorly drained soils on this site (see soil analysis). *Pinus banksiana* prefers well-drained soils. Only the European birch appears to be growing vigorously with no signs of defect or weakness.

Most shrub species are showing signs of stunted growth or branch dieback. The exceptions include red-twig dogwood and vine maple. Both species are widely adapted and tolerant of the wet soil and summer drought condition present on this site. Ornamental juniper and heath are also growing well on elevated (well-drained) parts of the site. Numerous invasive exotic species are performing well, including Himalayan blackberry, English plantain, and creeping buttercup all of which indicate moist soils.

The greatest maintenance problems will be of the rhizomatous species: common horsetail and quaking aspen, which will continuously invade plantings unless controlled. An exotic violet will also prove troublesome to remove, but is not highly competitive. English ivy is present and should be removed. No rhizomatous grasses were observed, but the existing seed bank is presumed well stocked with the Eurasian forbs and grasses that appear to dominate the understory of this site.

Any existing soils on site should be buried or well mulched. The advantages of retaining any of the existing plant material on this are minimal compared to the advantages of a more complete renovation involving elevated planting beds. The exception is the birch, which appears quite healthy and provides habitat for native birds (Lockery, 2002). Retention of the pine and cherry could be justified as transitional wildlife habitat.

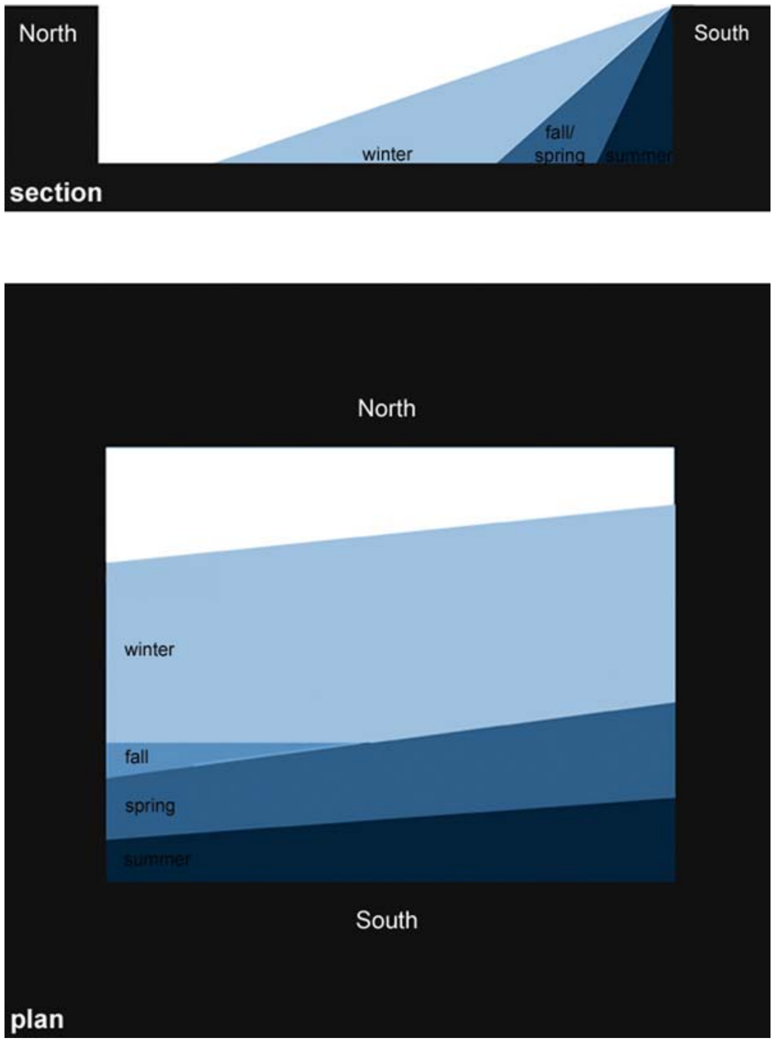
Table 1. Number and type of existing plants

Type	Exotic	Native	Ornamental	Unknown	Total
Tree	1	2	2	0	5
Shrub	4	5	3	0	12
Forb	10	3	0	3	16
grammanoid	3	0	0	1	4
fern/fern ally	0	3	0	0	3
Total	18	13	5	4	40

Microclimate Assessment

Plant species should be placed in the courtyard based on their preference for specific microclimate conditions. The regular shape of the courtyard and building creates predictable gradient of light and heat. The northern edge receives direct sun and reflected light all year while the southern edge never receives direct sunlight (Figure 9). Sun angle can be multiplied by the 25 foot height of the building to determine the length of shadow at any point in time (Formula 1).

Figure 9. Sun-shade diagrams; noon on solstices and equinoxes



The pit shaped courtyard will complicate the distribution of rainfall. Prevailing rain winds blow from the SW. When wind accompanies rain, a rain shadow will be created in the windward side of the courtyard (Figure 9: plan). This effect will be most pronounced during light rains, but the effect will change depending on wind direction. The net effect of this rain-shadow is uncertain, and accentuates the need for a reliable source of water, particularly during plant establishment. Monitoring of soil moisture or rain collection devices (tuna fish cans placed in variable locations before a rain) can be used to empirically observe rainfall patterns.

No roof runoff appears to flow through the courtyard, either in gutter drains or as uncontrolled runoff. No source of pressurized city water was found in the courtyard. The closest access to city water is in the sinks of the chemistry laboratory—one of the classrooms abutting the courtyard. The only source of water concentration is the run-off of the bicycle shed (calculated at 5,500 gallons over a typical water year). Unfortunately this water is delivered to the site primarily during the rainy season and storage would be necessary to alleviate summer drought. A portion of this flow may be useful for reducing the rain-shadow effect mentioned above.

An existing drain system removes water that accumulates higher than the current concrete surface. The function of this system will need to be preserved to prevent seasonal flooding of this site. Six drains are present on the site. Four of these six are retained as-is in the proposed design. The remaining two are used for disposal of surplus water in the raised planting beds.

Soil Analysis

This site consists of two very different soils, the soil in the planting beds and the soil underneath the entire courtyard. The five planting beds are filled with imported topsoil. Each bed has been bermed to create a planting area that is 4-8” above grade at the center of the bed and slopes down to be even with the grade. The soils in the beds were analyzed for nutrient content, organic matter, pH and heavy metal contamination. Because this site has been neglected for many years, the organic matter content is very high at 12.6%. The weeds that have colonized the area have contributed to the high organic matter content as they grow and die annually. This dead plant matter and leaf litter from the trees on site has produced a rich soil. Cation exchange capacity is also in the desirable range, 23.7 Meq/100g. High organic matter contributes to a desirable CEC. Soil macro-nutrients and soil micro-nutrients are in plentiful supply to plants. Soil pH is also desirable at 6.1. The most important aspect of this analysis is that the lead levels were low, meaning that lead is not a danger to human health and soil removal is unneeded. See Appendix B for Soil Analysis Lab Report.

The second important soil on this site is located underneath the concrete hardscape. The entire courtyard (as well as the school) is located on top of an historically boggy lowland. With careful excavation, observation of physical characteristics, and a feel test, the soil was identified as clay. Clay soils pose a challenge to the planting of ornamental landscapes because they do not allow for good infiltration of water. This explains why the five existing beds are bermed—raising the plants above grade, and above the water-table. Unfortunately these berms have subsided and plant health has declined because the plants now have “wet feet”—roots in anaerobic conditions. Clay particles bind to plant nutrients and water molecules making both unavailable to plant roots. Clay also absorbs and holds onto water creating waterlogged soils and anaerobic conditions during the rainy season.

To grow and establish a healthy ornamental landscape on this site, raised beds must be constructed. The raised beds should be approximately 18" above grade to give plant roots room to grow in well drained soils. These beds will be filled with imported topsoil that is as unlamented as possible. This topsoil should be unamended, no organic matter added, to prevent subsidence and sinkage in the large raised beds. It will be very important to add mulch, wood chips or compost to the new raised beds to establish an organic layer, which will insulate plant roots and create microbial habitat. This organic material added to the top of the beds will also replace organic matter and nutrients that naturally leach from the beds.

Hydrology Analysis

Sources of Water

The single source of water in the courtyard is rain which follows a seasonal dry and wet pattern typical of the Puget Lowland region. Several environmental factors specific to the courtyard contribute to sub-optimal levels of water.

From July through September, the courtyard receives less than 4" of rain resulting in drought conditions. The heat reflected from the concrete ground and adjacent walls along with low wind levels increase the average temperate resulting in evapo-transpiration or water loss. The north side of the courtyard is impacted more than the south side.

From October through June the courtyard receives 33 inches of rain resulting in very wet conditions. During this period, some areas have standing water. Hydrophytes are present as a weeded species indicating very moist micro-environments. The south side of the courtyard is impacted more than the north side.

Soil Water Interaction and Drainage

Nathan Hale High School was sited on top of a bog and constructed with a foundation made of wood pilings similar to a bridge or dock. Above the wood pilings was laid a base of highly compacted fill most likely composed of clay. As a result, water will not percolate through the highly compacted clay base layer which causes pools of water to form during the rainy season. Currently, the courtyard is designed to direct water toward the six centrally located drains, which are piped directly into Thornton Creek, approximately 200 feet to the south.

Design Solutions

- To improve the current hydrological conditions, the design proposes to increase water resources and to improve soil water interaction. Rain barrels positioned to collect rainwater from the bike shed roof and a drip irrigation system connected to a school hose will allow for watering to take place during summer months. To improve the soil water interaction, the design includes raised planting beds of 18”above grade to allow for an increased percolation rate as well as perforated pipes beneath the planting beds that connect to the existing drains.

Site Proposal

Design Process

Taking into account all of the physical and human needs of the site, we developed a design that creates a tactile, seasonally responsive, outdoor classroom that will allow students and faculty to interact with native vegetation and natural processes while increasing opportunities for enjoyable individual and group activities.

The design development process occurred over the course of a six-week period and involved extensive input from N.H.H.S students (particularly Earth Service Corps students), members of the PTA, teachers, members of the N.H.H.S. Horticulture Program, and students from the University of Washington.

In our initial meeting with the Earth Service Corps, we were familiarized with the goals of the project. On our second meeting we coordinated a quick, lunch-hour design charrette to get as many ideas from the broadest spectrum of students as possible. Twenty-five students willingly showed up on the day of the charrette, most of whom were members of the Earth Service Corps. We used the Nominal Group Technique (Dunham 1998). The core of the technique is to use index cards that in this case allowed students to anonymously write down their answer to the question: “What do you want to see in the redesigned courtyard?” These cards were collected then written on the board for the entire group to see. The group then determined which of the 25 ideas they liked the best, and through a voting process ranked these ideas. The following table (Table 2) represents the 25 ideas generated by the students organized in order of preference of the group as a whole. Given the briefness of the 45 minute lunch break, the nominal group technique allowed us to quickly process contributions from each of the students in the room.

Table 2. Top 25 ideas developed by N.H.H.S. students using the nominal group technique

1. Butterfly Habitat—27
1. A Pond—27
2. Hanging Gardens of Babylon—26
3. Bird Sanctuary—23
4. Ancient Rome style—22
4. Mosaic Stepping Stone—22
5. Bamboo—18
6. Ancient Japanese Style—17
6. Mural/Student Art—17
6. Fruit Trees or Berry Trees—17
7. Social space/benches/hang out—14
7. Meditation Area w/ Flowering Vines—14
7. Everything Green—14
7. Stone Path—14
8. Swings—13
8. Like Pike Place Market—13
9. A Fountain—11
10. Plant Different Colored Trees—8
11. Tables—6
11. Plant Lots of Trees—6
11. Vine Maple Trees—6
12. Bird Feeder—4
13. Bonsai—3
14. Skate Park—0
15. Sculptures by Students—0

Following the mini-charrette, we had a follow-up meeting with the Earth Service Corps, the head of the Horticulture Program, members of the PTA, and informal meetings with the head custodian and the principal. We compiled the desires of all of these project proponents as well as the physical requirements of the site, into a phased design.

Design Narrative

The proposed design responded to six significant design criteria: 1) student and faculty program desires and needs, 2) environmental circumstances, 3) construction costs, 4) existing architectural gestalt, and 5) contextual qualities.

As a response to the charrette and meetings with student, faculty, and parents, the following program elements were determined: an outdoor classroom, a butterfly garden, a native plant garden, and a series of social and individual spaces for eating lunch, studying, repairing bikes etcetera. Each element was placed according to the environmental factors required. For instance, the butterfly garden faces south while the native plant garden faces north. Each construction detail was thoroughly researched to require minimal labor and material cost. The retaining wall is made of recycled concrete from the existing pavers and the trellises are made of rebar. In addition, Nathan Hale Horticulture students under the guidance of Brad Wade have agreed to construct artistic pavers for the seating wall capstone.

The form of the design is a response to both the gestalt and the context of the site. The gestalt or architectural principles of organization include the concrete blocks that line the ground at 5' intervals and the extruded columns that line the exterior wall at 7.5' intervals. As a result the two primary spatial organizers, the retaining wall, and trellis, actualize as multiples of 5' and 7.5', respectively. The design of the retaining wall in response to the existing 5' grid allows for the re-use of the existing grid paving system and reads as a comprehensive space. The trellis design at 7.5' intervals extends the existing columns into the site and expresses a relationship with the inside of the classroom.

Additionally, the openings into the site received special spatial definition which included the extension of the inside of the building into the courtyard and the addition of another level of enclosure. The spaces adjacent to the openings respond to the architectural program inside the building. Thus, the teacher's lounge and narrow hallway extend into the courtyard. Following the spatial extension is a gateway defined by the retaining wall and trellis to provide for another opening into the courtyard presenting yet another place.

Site Preparation

Before construction and pant installation begins, the following steps must take place. First, all existing trees and vegetation must be removed. Second, the concrete pavers as shown in the site Preparation/Demolition Plan, Appendix D, should be scored and cut into 20” sections. Third, woody debris should be recycled for wood chips and last, all soil must be scarified and aerated.

Hardscape Elements

Retaining wall: The primary goal for the seatwall design is to sustainably re-use the existing concrete 5’x 5’ x 3.5” pavers and to minimize construction costs.

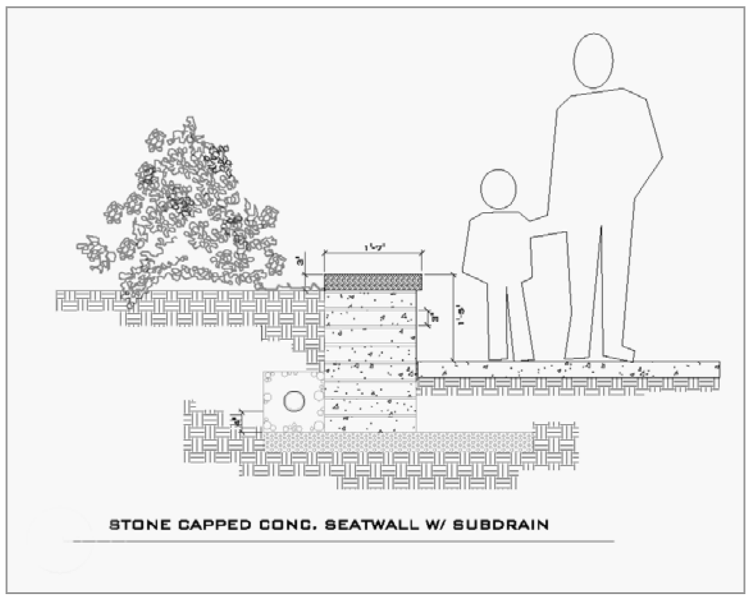


Figure 10. Detail of concrete paver seatwall

The excavated, on-site 5’x 5’ pavers will need to be cut into 5’x 1.5’ sections. A 4” prepared subgrade will first need to be installed below the base of the first laid concrete paver. (Poured concrete is not necessary for this design.) The already cut 5’x 1.5’ pavers will then be stacked, and sealed with EPOXY. The retaining seatwall will then be capped with a (19” x 19” x 3”) stone or concrete paver that could possibly be made by the Nathan Hale advance Horticultural students. For better drainage, a 4” perforated pipe will also be incorporated at the base of the seatwall where excess water will dump into the existing drainage system. See Appendix E for construction details.

Filtration Garden: The waterscape element within the Native Garden is intended to reveal how stormwater runoff affects our watersheds. Considering Nathan Hale’s close proximity to Meadowbrook Pond and Thornton Creek, this feature helps to remind students about water quality in an urban environment.

The waterscape element incorporates a recycling water fountain that would not only give aesthetic value to this space, but also help reveal sensory qualities of water. A stream of rocks adjacent to the water feature forms a symbolic gesture of moving water. Moving from the water feature, the eye is follows this stream of rocks and a series of paving patterns towards an existing drain that reveals water disappearing into the city's engineered drainage system. Words and pictures relating to the watershed can be embedded into pavers to further enhance this conceptual idea. This space functions as a natural, vegetated water filter that reduces some of the sediments and pollutants from the water before it enters the city's drainage system.

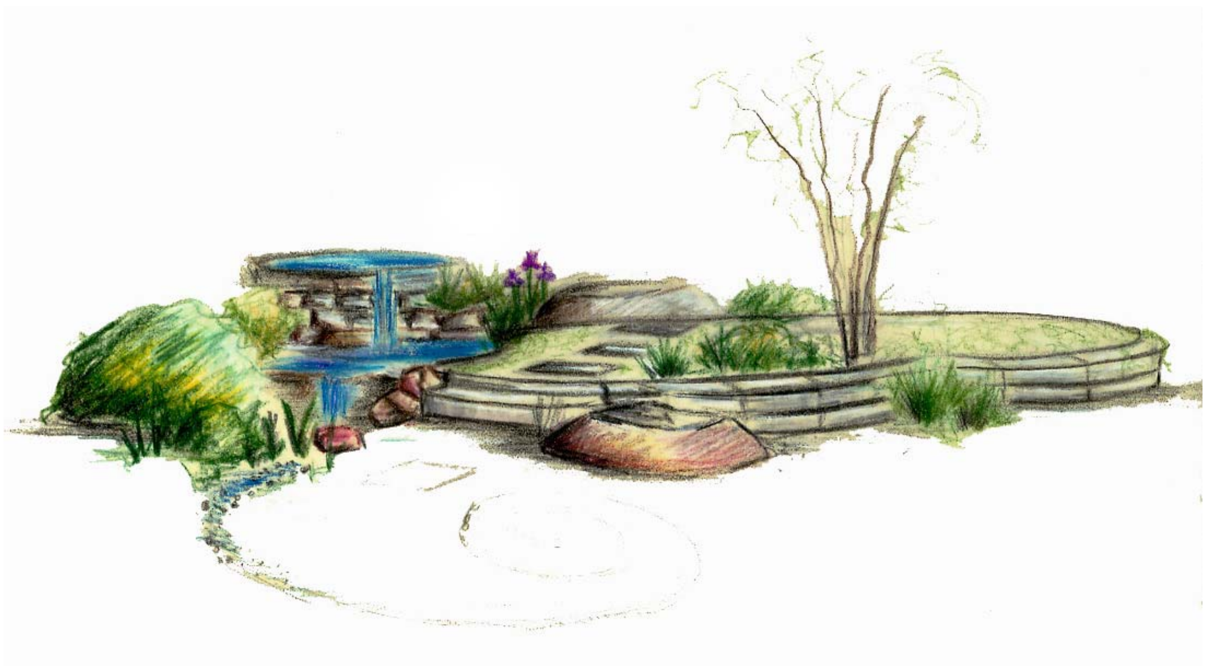


Figure 11. Filtration garden

The bike shed rain barrel design: The bike shed rain barrels are designed to cut water costs and demonstrate an environmentally simple solution to minimizing water flushes which destroys salmon habitat in Thornton Creek. Ten 50 gallon barrels on the side of the bike shed will collect enough water to irrigate 500 square feet during the 16 week dry season. The construction requires two steps. First, the bike shed would need a gutter. And, second, the barrels would need to be retrofitted to catch water and direct overflow. See Appendix E for construction details.

The bike shed green roof: The bike shed green roof will be an environmental demonstration of aesthetics mixed with stormwater management. The rooftop will mimic hydrologic processes where plants capture rainwater in their foliage and absorb it in their roots, preventing much stormwater from ever entering the storm drains. The green roof comprises 3 basic layers: waterproofing and root barrier layer, drainage and filter layer, and the soil and plant layer. This green roof is an extensive system of Sedum with a soil layer of 2 to 4 inches. See Appendix E for construction details.

Trellises: A series of four re-bar trellises ranging from 25'-long to 120'-long and all 7.5'-wide create an overhead canopy in parts of the courtyard. The layout of the trellises is intended to reflect the architecture of the building—mimicking the column width and dimensions along the walls defining the courtyard. Boston ivy will be planted to grow on and around the trellises, further defining the overhead plane, and helping to create smaller, intimate spaces in the courtyard. See Appendix E for construction details.

Plant Selection

Plants were selected to enhance the function and qualities of the three different rooms described above in *Design Narrative*. Shrubs, perennials and groundcovers were selected to give visual dynamics and structure to the gardens. See Appendix F for selected plant images and forms.

The native garden is located in the southern half of the courtyard. Buildings shade this area and shade tolerant plant species can survive in this environment. These plants in general also require a bit more moisture than plants in the rest of the site, but the shady conditions will help protect the plants and the soil from water loss through transpiration. Plants chosen for this area include *Acer circinatum* (vine maple), *Vaccinium ovatum* (evergreen huckleberry), *Polystichum munitum* (sword fern), *Tellima grandiflora* (fringe cup), *Linnaea borealis* (twin flower) and *Iris douglasii* (native iris). These plants will flower in the spring, typical of shade tolerant species, and provide a lush native feel to this garden.

The classroom garden is full of native species that are very hardy and more tolerant of sunlight. This area will receive morning sun, but will be shaded by buildings in the afternoon. Hardy plants are very important to this area. Ideally, classes will be held in this area and students may be inclined to pick flowers or leaves from the surrounding plants. Fragile plants would not stand a chance but these hardy selections should thrive. Plants selected for this area include *Ribes sanguineum* (red flowering currant), *Gaultheria shallon* (salal), *Mahonia aquifolium* (Oregon grape), and *Arctostaphylos uva-ursi* (kinnikinnick). The main species plant chosen for this garden is *Cercis canadensis* (red bud). The red bud flowers in the spring and will provide a flush of early season color. This tree will eventually grow above the roofline as it reaches a height of 30', but because the site is very protected from wind, a future blow down is very unlikely.

The butterfly garden lies in the sunniest section of the courtyard. It is crucial to choose more drought tolerant species for this area because sun will beat down on this garden all summer. To function as a butterfly garden, plants are massed together and the garden has a very open savannah-like feel. Perennials in this garden were chosen to attract native butterflies and provide them with both larval host plants and nectar sources. Perennials chosen include *Achillea spp.* (yarrow), *Coreopsis grandiflora* (baby sun), *Solidago spp.* (golden rod), and *Echinacea purpea* (purple coneflower). *Symphocarpus albus* (snowberry) was added to this section to give winter interest to the area after the perennials have died for the year. *Helictotrichon sempervirens* (blue oat grass) was chosen because it is drought tolerant and because butterflies are attracted to the vertical lines of the plant.

Some of the plants selected are located in more than one garden to create unification within the entire site. *Acer circinatum* (vine maple) is located in both the native garden and the classroom garden to distribute beautiful fall color to the courtyard. *Polystichum munitum* (sword fern) provides a vertical foliage accent in all three gardens. *Arctostaphylos uva-ursi* (kinnikinnick) was chosen as a ground cover in the classroom garden and the butterfly garden for its drought tolerant qualities and to unify the two spaces.

Table 3. Plant Selection: native shade garden

Species	**Common name**	**Light requirements**	**Bloom Time**	**Height**	**Spread**
Acer circinatum	vine maple	Part sun to part shade	Early spring Good fall color	15'	20'
Vaccinum ovatum	evergreen huckleberry	Sun to shade	Late spring	12'	10'
Polysticum munitum	sword fern	Part sun to deep shade		3-4'	4'
Tellima grandiflora	fringe cup	Sun to partial shade	Late spring to early summer	32"	12"
Linnaea borealis	twin flower	Partial shade	summer	3"	indefinite

Table 4. Plant selection: classroom garden

Species	Common name	Light requirements	Bloom time	Height	Spread
Ribes sangunieum	red flowering currant	Sun	spring	6'	6'
Gaultheria shallon	salal	Sun to partial shade	Late spring to early summer	4'	5'
Mahonia aquifolium	Oregon grape	Sun to partial shade	spring	3'	5'
Arctostaphylos uva-ursi	kinnikinnick	Sun to part shade	summer	4'	20"
Cercis canadensis	red bud	Sun to light shade	spring	30'	30'

Table 5. Plant selection: butterfly garden

Species	Common name	Light requirements	Bloom time	Height	Spread
Symphocarpus albus	snowberry	Full sun to part shade	Summer winter berries	6'	6'
Helictotrichon siempervirens	blue oat grass	Full sun		4.5"	24"
Achellia spp.	yarrow	Full sun	Summer to autumn	18-36"	24"
Coreopsis grandiflora	baby sun	Full sun to partial shade	Early summer to autumn	18-36"	18"
Soildago spp.	golden rod	Full sun	summer	24-30"	18"
Echinacea purpea	purple coneflower	Full sun to part shade	mid summer to early autumn	5'	18"

Installation

How quickly or completely installation is completed is dependant on the availability of resources and money. A single path toward installation would not reflect the creativity and adaptability that will be required to renovate this site. Existing beds can be weeded and mulch can be applied, but this will have a minimal impact on this landscape and may not fundamentally change use patterns. However, to instantly create a new 9,600 square foot landscape in this setting is a formidable task. There are several significant constraints:

- Materials must be imported through the halls, increasing the cost of everything brought to the site
- Sub-soils are heavy clay and provide an insufficient rooting substrate for most species – importing soil will be necessary for creating a more hospitable root zone
- Massive boulders make modification of existing beds difficult
- Irrigation is critical for plant establishment in our Mediterranean climate, but there are no convenient water sources

This design offers a vision to work toward rather than a fixed course of action. Keeping an endpoint in mind while making incremental steps insures that the end product is cohesive—the whole becomes greater than the sum of its parts. The key elements of this design are the series of raised planting beds which re-use existing modular paving as stacked retaining walls and seat walls. Cutting concrete and stacking a retaining wall will require focused and skilled landscape labor. Concrete blocks may weigh several hundred pounds and will need to be massive to provide for a stable wall. Furthermore, it will require significant resources to import the volume of soil needed to significantly raise the soil elevation.

This community is faced with the choice: a single massive construction effort requiring many tens of thousands of dollars, or a slow piecemeal project requiring diligent organizational resources and savvy campaigning.

Table 6. Summary table of draft cost estimates by type and element (see Appendix G for a detailed cost estimate.)

Element	Labor	Materials	Service	Grand Total
Demolition	$ 7,920.00	$ -	$ 3,960.00	$ 11,880.00
Irrigation	$ 1,424.00	$ 645.00	$ -	$ 2,069.00
Mulching	$ 1,500.00	$ -	$ -	$ 1,500.00
Planting	$ 1,935.00	$ 1,646.00	$ -	$ 3,581.00
Raised Beds	$ 6,000.00	$ 5,092.00	$ 7,400.00	$ 18,492.00
Soil interface	$ 2,700.00	$ 950.00	$ 1,930.00	$ 5,580.00
Trellis	$ 1,440.00	$ 871.00	$ -	$ 2,311.00
Water Storage	$ 720.00	$ 1,292.96	$ -	$ 2,012.96
Walls	$ 15,720.00	$ 1,363.00	$ 150.00	$ 17,233.00
Grand Total	$ 39,359.00	$ 11,859.96	$ 13,440.00	$ 64,658.96

Sequencing

To implement the proposed design over time the sequence of installation is important. Some steps do not gracefully follow other steps, and a thoughtful sequence of action can maximize the efficient use of limited resources. An installation sequence should attempt to reach the following objectives for any given phase:

- Only move materials once (or as few times as possible if you must)
- Install hardscape features first (build walls before working on soils and plants)
- Consider where materials will be staged for future construction, and allow paths of access for materials and tools
- Allow for 'working space' around zones of future construction and don't invest much work in finishing these areas
- Only start phases of construction that you can finish with existing resources
- Make best use of good weather for hardscape construction and soil movement, or rain for planting

The following sequence suggests the progression of tasks needed to construct the basic raised planting beds that this site requires for landscape plant health.

Table 7. Sequencing table

Task	Description
1. Demolition	Remove redwood edging Cut concrete into three strips and stack nearby Remove plants and stack into two piles, wood that can be reused and other materials that will be chipped for mulch. Move boulders onto paving that will be retained Spread out the existing topsoil
2. Hardscape and trellis	Install sub-grade, footings, build retaining walls, install new paving and other hardscape features, except where these features will limit access or movement of materials (particularly importation of soils).
3. Soil interface preparation	For the purpose of reducing abrupt soil type interface – import a 3" lift of topsoil (possibly using existing topsoil on site) and till to a 6" depth to create a mixed interface between the clay subsoil and imported un-amended topsoil.
4. Soil import	Import un-amended topsoil for planting beds. Be sure to mark subsurface features you want to find again.
5. Irrigation Supply Line	Install irrigation lines to supply emitters on flexible pipe.
6. Planting	Stage, place and install plant material. Plant large stock before smaller stock. Work from center of bed outward.
7. Irrigation	If a drip emitter system is to be used it can be installed after planting. Flexible pipe distribution lines can be placed under mulch, above the soil surface for ease of maintenance and relocation.
8. Mulching	Use recycled tree service chips, available for free.
9. Finishing	Make sure there is no exposed soil. Hose off surfaces. Fill gaps between pavers with a clean crushed rock aggregate. Celebrate!

An understanding of the nature of installation tasks and the goals of installation phasing offers two strategies for implementation of the proposed design.

Phasing by area – the project is completed one section at a time. Each new addition fits like a puzzle piece and leads to the next project. Edges adjoining successive projects are left rough or finished using inexpensive, temporary materials.

Phasing by hardscape element – expensive hardscape features installation can be deferred while planting beds are built until resources are secured. Some features are less easily deferred than others. With hardscape features, the potential disruption caused by a second wave of construction should be weighed against the feasibility gained by breaking up construction into phases.

Table 8. Hardscape phasing

Hardscape Feature	Considerations for incremental construction
Retaining Wall	Retaining walls can be installed in sections that correspond to phases of raised bed installation. Retaining walls are key features and should be installed as part of planting bed installation.
Filtration Garden	The filtration garden can be installed as a 'soft-scape' using soil shaping and planting alone. Plants can be removed, temporarily stored, and reinstalled after construction hardscape elements.
Trellises	Footings can be installed at any time, except where footings are integrated into retaining walls. If retaining wall installation precedes trellis construction, location of future trellis footings should be considered and attachment point created so that walls do not need to be modified and jury-rigged solutions can be avoided.
Water Catchment	Can be installed at any time. Water catchment off of the bike shop roof will not be sufficient for establishment of plantings unless storage is massive (expensive), and plantings extremely small (approx. 10 x 15 feet). This element is fun, but primarily educative.

A Proposed First Project

A single section of planting bed could be constructed first to develop the value of the site. The butterfly garden in the NE corner of the property has several advantages as first phase:

- It is located in the warmest, sunniest portion of the courtyard
- It is close to the student entrance to the courtyard,
- It does not contain any of the significant boulders that might complicate construction,
- The butterfly planting offers blooms with color,
- construction begins in a corner and expands outward,

Many costs can be mitigated by using volunteer labor and donations. However, skilled leadership is necessary for the effective use of volunteer labor The greatest costs lie in construction of retaining walls and importation of soil.

An un-amended loam soil should be purchased and moved during the dry season when water weight is low. Access to this site increases the cost of soil import by an order of magnitude. Either a fleet or workers with wheelbarrows or a dirt conveyance system need to be employed.

Irrigation Specifications

Irrigation is required on this site for plant establishment. A source of irrigation water will need to be developed and a system of distributing the water throughout the planting will need to be installed.

Attaching to a water source inside the building may be the only option for irrigation. A slop sink in a custodial closet may offer a source of irrigation water. A long length of hose connecting the water source to an irrigation supply line buried In the planting beds may suffice, given that the water is under sufficient pressure. Any supply line must be connected to a drip line through a filter and possibly a pressure regulator if supply pressure exceeds manufacturers specifications. An irrigation system will need to be designed based on the pressure and flow available. Loss of pressure over the distance between the source and the garden will need to be accounted for.

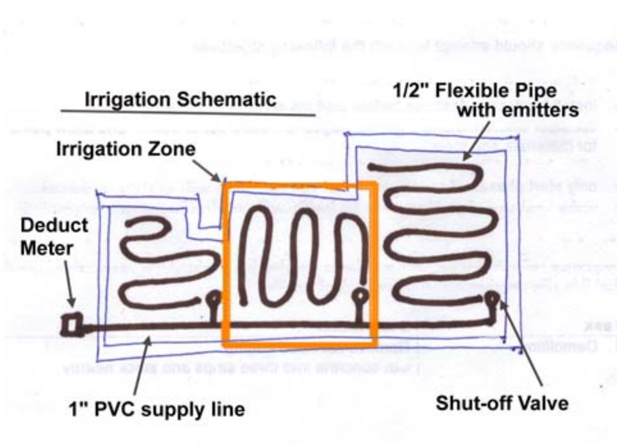


Figure 12. Components of a drip emitter system

A residential grade drip emitter irrigation system is sufficient for establishment of a planting. These systems accommodate low flows by releasing water at a slow rate. The system can be easily designed for any pressurized irrigation source. Each emitter releases a specific amount of water per hour (1/2 gal per hour is a common level). And so a given water source can supply a limited number of emitters. To overcome this limitation, the planting bed is divided into a number of zones, each of which can be turned on or off with a shut off valve (Figure 12). Half-inch flexible poly-pipe can be used to distribute water from this trunk line throughout an irrigation zone. Water is delivered specifically to planted material, increasing water use efficiency and reducing weed growth. A rough price estimate for materials and installation can be found in Appendix F.

Renovation of Edging

The existing redwood edging between unit pavers is rotten and has been pushed up by tree roots and colonized by weedy species, particularly clover, plantain and grasses. Quaking aspen has used these gaps in the paving to spread roots that send up new shoots. Replacing these old boards and controlling weeds will likely be part of any aesthetic renovation.

A washed crushed aggregate would be the most appropriate material to replace the rotting wood. A washed crushed aggregate allows water to flow freely, will not migrate like pea gravel, and does not provide a fine textured surface for colonization by weeds. Even after aspen removal and site renovation, control of quaking aspen shoots will be necessary. An ingenious method involves a tin can and a brick. New shoots are covered with a coffee can, which is weighted with a brick. The shoots continue to grow, searching for light, while starving the root systems from which they grew. Diligent 'canning' of aspen shoots should eventually starve the root system.

Weeds will always grow in cracks. The presence of these cracks demands continuous maintenance. A propane powered roofing torch can be used to rapidly kill weeds in a single pass. Two treatments in spring before weeds set seed may be sufficient to maintain this site, once control is attained. As the courtyard drains directly into Thornton Creek, use of herbicides or even vinegar sprays should be considered very carefully.

Plant Installation Specifications

Plants should be installed in the courtyard after all hardscape changes have been made, the new raised beds are filled with soil, and the entire planting area has been mulched. Mulch will help the soil retain moisture and prevent soil compaction. Planting at this time will ensure minimum damage to newly installed plants. This site should be planted in the fall so new plants will have a chance to establish with plentiful moisture available to newly expanding roots. Plants will be purchased bare root, balled and burlaped, or containerized depending on the species.

It is crucial to the survival of the new plants that they be installed correctly to minimize failure in the landscape. The root balls of small trees and shrubs should be thoroughly examined to prevent problems from occurring in the future. If there are any significant root problems, like circling or girdling roots, these problems must be corrected by root pruning before the plants are installed. If these plants are containerized, remove all nursery growing media and bare root the plants. This will encourage the plants to establish in native soil and outgrow their dependence on the nutrient rich nursery media.

Planting holes should be a deep as the root ball and twice as wide as the root ball. The ideal shape of a planting hole resembles a shallow dish. This will ensure that the crown of plants does not become buried over time and that plant roots will be able to spread laterally giving the plants good support.

Once the planting hole has been dug, a small mound of soil should be created in the center of the bottom of the planting hole. Place the plant on top of the small mound of soil and spread the roots out in the planting hole. The roots should resemble spokes on the wheel of a bicycle. Fill the planting hole with unamended native soil (soil imported to the site) and gently tamp down the planting hole with both hands. It is not necessary to stomp or jump on the planting hole. Using firm pressure with both hands will be sufficient. Finally, examine the plant to make sure it is centered in the planting hole and that the crown is at the correct height. Water the plant well and monitor the newly installed trees and shrubs for problem that may arise in the future.

Perennials and ferns will be purchased containerized, but it important to take the correct steps in their installation. It is more beneficial to the plant if the root ball is loosened before installation. If the plant is removed from the container and placed directly into the soil, it is unlikely that the plant will grow into the surrounding native soil. Once the wide, shallow planting hole has been prepared, remove the plant from the container. Loosen the root ball and remove as much of the nursery growing media as possible. Place the plants on top of the small mound in the center of the planting hole and spread the roots evenly. Fill the planting hole with native soil and water well.

Monitor plants in the months that follow installation to minimize failure in the new landscape.

Aftercare and Maintenance

Who and When?

Organized aftercare and maintenance is perhaps more critical to the success of this courtyard than proper design and installation. Oversights in design and installation can be corrected over time. Lack of maintenance will destroy the best-laid plans. As the school district will be largely unable to coordinate and direct efforts, community members will need the skills, foresight and tools to provide for landscape care. Adult volunteers often know less about landscape maintenance then they would like to admit, teachers change jobs, students grow up or lose interest, administrations reallocate priorities, complex systems breakdown and plants die. Landscape design for sustainability must create simple but elegant systems composed of appropriately hardy plant communities. The organization of community for sustainability must institutionalize the practice of landscape stewardship to insure landscape survival.

A community based maintenance plan must consider several functional goals:

1. Coordination of tasks based on the changing needs of the landscape which must be monitored consistently
2. Transfer of skills from those who know to those who need to know
3. Transfer of responsibility through generations of community members
4. Maintenance and repair of tools
5. Maintenance of a small capital budget for replacement of tools, mulch and plants

This report only offers suggestions for the first step. Implementation of a functional plan is dependant on your community, and must be developed explicitly within the context of community culture and resources. Discussion of maintenance capacity and resources should precede installation and maintenance must fit both the ecological needs of the garden and the abilities of the maintenance community. Some tasks are more time sensitive than others. (See Appendix H: Maintenance Calendar).

How?

Mulching

Mulch should be applied to a depth of 4-6 inches. Mulch should be replaced whenever it becomes less than 1 inch in depth. This will usually require a mulch application every year, or for cool sites, every two years.

Chipped tree prunings, as provided by a commercial tree service are most appropriate for the planting beds specified in this design. Composted yard waste (Cedar Groves or similar) is more appropriate for annual beds where annual planting might accidentally incorporate mulch into the soil.

Mulch delivery can be arranged for free with several weeks lead time. Once a reliable supply has been located through a tree service, future deliveries become more expedient. High quality free mulch should be free of weedy material (English ivy or morning glory), be finely chipped and contain no sticks.

Tasks:

- Refresh mulch
- Inspect mulch depth
- Arrange for mulch delivery and inspect on arrival

Irrigation

There is no substitute for observation of soil to determine when irrigation is needed. The north side of the courtyard will need more frequent irrigation than the south side. The systems should be calibrated for deep watering. The depth of water penetration should be observed over time, and the time required to saturate the top 12 inches of soil noted. Irrigation should be deep but infrequent to train roots to penetrate deeper soil layers. The site should be visited once a week for the first dry season after installation.

Tasks:

- Monitor soil moisture
- Calibrate irrigation system
- Run irrigation as needed

Weeding

Weeds should be removed before seeds are released (“one years seeds equals seven years weeds”). Mulch application dramatically reduces weed problems. Thorough weeding and mulch application should precede the end of the school year, as most weeds will release seed over summer if left untended. Frequent weeding reduces labor over the long term, as small weeds are easier to remove than large weeds.

Some weeds are worse than others. Rhizomatous grasses should receive the highest priority for consistent removal. Re-growth of poplar roots will be a chronic problem only solved by consistent maintenance (see site preparation section).

Weeds will continue to establish in the cracks between paving units. A regular schedule of crack maintenance might involve vinegar spray, manual removal, or use of a asphalt torch by an adult volunteer.

Tasks:

- Remove weeds
- 'Tin can' poplar shoots
- Crack maintenance

Propagation and infill planting

Plants continually grow and propagate. Several species present may root easily or be easy to divide. Relocation of plant is best done at the beginning of the rainy season so that roots can reestablish before the next drought. Propagated plants can be used to fill empty planting area, or potted and sold to provide capital for maintenance costs.

Tasks:

- Layer cuttings
- Pot-up cuttings and divisions
- Transplant
- Collect seed
- Plant sale

Soil protection

Compaction caused by foot traffic reduces soil poor space, reducing drainage, root health, and oxygen supply to plantings. Traffic across planting beds should be quickly discouraged with friendly but education signage or temporary fencing. Maintenance access should minimize foot traffic and use stepping-stones or established paths whenever possible. Physically levering soil with a turning fork can reduce compaction. Regular traffic may indicate poor design, and reconsidering the layout of access paths should be considered.

Tasks:

- Monitor social trails
- Maintain signage
- Resolve problem areas

Fertilization

In a healthy soil system, annual application of mulch should be sufficient for plant growth. Signs of nutrient deficiency should be monitored, but most issues of plant health will be related to water or flood stress.

Tasks:

- Monitor plant health

Pruning

Most plants will not require pruning except to correct poor pruning in nursery production. All cuts should be heading cuts. Trained and skilled workers should be used for pruning. Pruning should not be left to volunteers who may not be familiar with best practices for long term plant health. Pruned branches may be used for propagation of some species.

Tasks:

- Yearly inspection for healthy growth patterns

Irrigation system maintenance

If you are using a near-surface drip emitter irrigation system it is easy to irrigation during routine maintenance. Such systems are also easy to repair. A sprinter system is more reliable but more difficult to repair. A temporary sprinkler system offers less control over water distribution and higher labor costs, but will not breakdown.

Tasks:

- Inspect system function at each watering
- Drain system for winter
- Spring inspection before drought

Composting

Gardens produce organic debris. Chopped up plant material will wilt, dry and bleach in the sun, becoming aesthetically uniform and contributing to the mulch layer. Most garden waste can be disposed of on-site, in-place in this way with minor chopping with a pair of hand pruners. If weeds are in flower, the flowering heads may produce seed as a dying stab at survival, and should be managed accordingly. Organized composing may become useful if the community decides to start diverting organic wastes like leaves or food waste into the courtyard landscape.

Tasks:

- Import compostable materials

Pest Management

Most plants suggested were selected for hardiness and disease resistance. Problems that are suspected to result from insects, fungus or disease should be completely diagnosed. Usually a non-toxic solution is available for most pest problems and many problems will resolve themselves given a healthy ecology. Chronic problem plants often indicate poor plant selection and should be removed or relocated to better habitat.

Tasks:

- Monitor plant health

Academic Integration

- Numerous education opportunities exist in a landscape. Academic integration of landscapes not only increases active use of landscapes, but also provides the justification for maintenance and upkeep. A number of tasks lend themselves to the involvement of a learning community. Some suggestions will be discussed briefly:
- Quantification of materials – Volume of mulch needs to be estimated, ordered and distributed, necessitating conversion between cubic yards and depth over square feet.
- Propagation of plant materials offers lessons in plant physiology.
- Managing the production and sale of propagated plants offers lessons in consumer education, business management and marketing.

- Plants can be viewed as a collection. Both planted and volunteer plants can be used to build a herbarium. All plant species have ecological origins and ethnobotanical uses. Student research can build increasing knowledge of plant species. Animal species which use the site can similarly be monitored, building an understanding of urban food chains and energy transactions in ecological systems.
- Natural plantings offer a variety of unique opportunities for line drawing, still life sketching and observation of natural patterns of growth and form.
- Animal usage, rates of plant growth, patterns of plant growth and biomass allocation, changes in soil characteristics like pH, bulk density, and organic matter content will all change over the course of a year and between years. Analysis of previous data, combined with continued collection and refinement of observational protocol will build over time.
- The gradient of sunlight across the courtyard offers an opportunity for comparing sun to shade. Plant growth increments, moisture, soil temperature, weed species composition, leaf size and many other variables will demonstrate this gradient.
- Wind direction will modify distribution of rain across the courtyard influencing a number of biological phenomena mentioned above.

Resources

Washington State University agricultural extension office

Seattle Tilth

Center for Urban Horticulture

Plant Amnesty

Washington Native Plant Society

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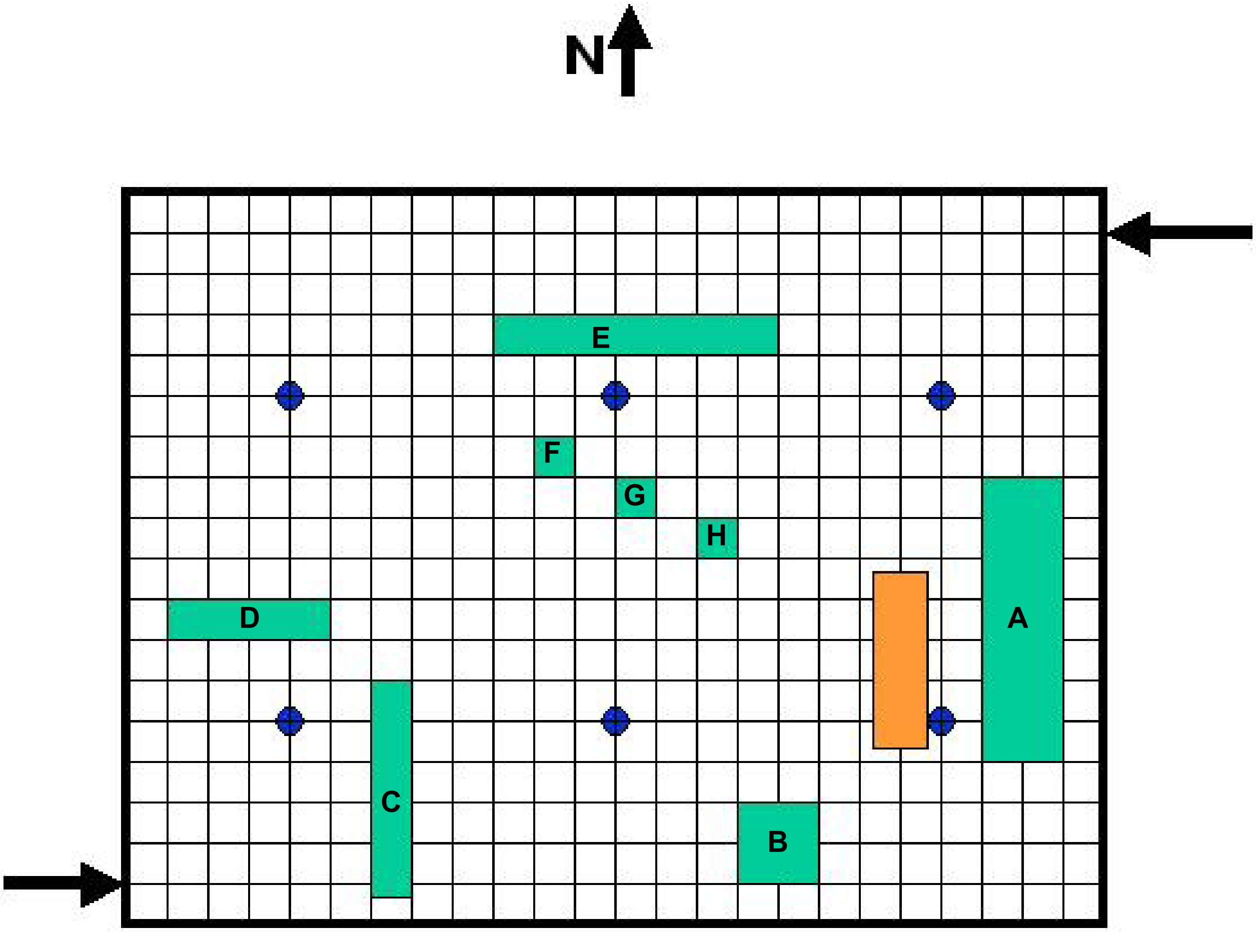
Appendix A: Existing Vegetation



Existing vegetation inventory: species, nativity, and location (location relates to the planter boxes mapped and labeled A-H above).

TREES

Species	Common Name	Nativity	A	B	C	D	E
Alnus rubra	Red Alder	N	x				
Betula pendula	European Birch	O	x				
Pinus banksiana	Jack Pine	O				x	
Populus tremuloides	Quaking Aspen	N		x	x	x	x
Prunus spp.	Cherry (Sour?)	E	x				

SHRUBS

Species	Common Name	Nativity	A	B	C	D	E
Acer circinatum	Vine Maple	N					x
Berberis nervosa	Low Oregon Grape	N			x		
Clematis spp.	Invasive clematis	E	x				
Cornus stolonifera 'variegata'	Variegated Red-twig Dogwood	O					x
Erica spp.	Heather	O		x			
Gaultheria procumbens	Wintergreen	E			x		
Gaultheria shallon	Salal	N		x			x
Hedera helix	English Ivy	E		x	x		
Juniperus spp.	Juniper (cultivar)	O	x				
Ribes sanguineum	Redflowering Currant	N			x		
Rosa nutkana	Nootka Rose	N					x
Rubus discolor	Himalayan Blackberry	E	x		x		

FORBS

Species	Common Name	Nativity	A	B	C	D	E
Asteraceae	Aster family	E				x	
Epilobium ciliatum	Purple Willowherb	N	x				
Hypocharis radicata	Hairy Cat's-ear	E	x	x		x	x
Iris spp. (douglasinana?)	Iris	U					x
Lactuca muralis	Wall Lettuce	E		x	x		
Liliaceae	Lilly Family	U			x		
Lotus corniculatus	Bird's-foot Trefoil	E	x				
Lupinus spp.	Lupine	U					x
Oxalis spp.	Oxalis	E	x				
Plantago major	English Plantain	E	x				
Ranunculus repens	Creeping Buttercup	E		x	x		
Taraxacum officinalis	Dandelion	N	x		x		x
Trifolium pratense	Red Clover	E					x
Trifolium repens	Dutch White Clover	E					
Viola adunca	Meadow Violet	N			x		
Viola spp.	Violet	E		x			

GRAMANOIDS

Species	Common Name	Nativity	A	B	C	D	E
Agrostis stolonifera	Creeping Bentgrass	E			x		x
Festuca spp. (=Vulpus spp.)	Annual Fescue	U			x		
Holcus lanatus	Velvet Grass	E	x				
Lolium perenne	Perennial Ryegrass	E					x

FERNS and FERN ALLIES

Species	Common Name	Nativity	A	B	C	D	E
Athyrium felix-femina	Lady Fern	N		x			
Equisetum arvense	Common Horsetail	N				x	
Polystichum munitum	Sword Fern	N			x		

Appendix B: Soil Lab Analysis Results

```
SOIL ANALYSIS REPORT FOR PERENNIALS                                11/01/02

SOIL AND PLANT TISSUE TESTING LAB               LAB NUMBER: S021028-231
WEST EXPERIMENT STATION                         BAG NUMBER:  52271
UNIVERSITY OF MASSACHUSETTS
AMHERST, MA 01003

                                                SOIL WEIGHT:  4.48 g/5cc
                                                CROP: NONE REQUESTED

   KATHRYN MURPHY                        COMMENTS: VISIT OUR WEBSITE FOR UPD
   10024 20TH AVE NE APT A               ATED ORDER FORMS AND SAMPLING INSTR
   SEATTLE, WA  98125                    UCTIONS. www.umass.edu/plsoils/soil
                                         test

SAMPLE ID: NATHAN HALE SOIL
--------------------------------------------------------
 RECOMMENDATIONS FOR PERENNIAL HERBS AND FLOWERS:

SOIL PH ADJUSTMENT:

Soil pH is in the desired range. No adjustment required.

FERTILIZER

The organic matter in this soil is adequate for many herbaceous
perennials. The level should be increased for plants requiring
humus-rich conditions.

NEW BED PREPARATION: In the fall preceeding planting incorporate
1 part finished compost or composted manure into 7 parts soil
along with 5 cups bone meal and 5 cups wood ash per cubic yard of soil;
OR in early spring incorporate 1 part peat moss into 2 parts soil along
with 7 cups 5-5-5 fertilizer per cubic yard of soil.

ESTABLISHED BEDS: In the fall topdress soil with 1/2 inch finished
compost along with 2 cups bone meal and 3 cups wood ash per 100 square
feet and gently scratch into the soil surface; OR in early spring
and early June sidedress 2.5 cups 5-5-5 fertilizer
100 square feet, taking care not to damage foliage and water afterward.

-------------------------------------------------------------------------
 SOIL pH     6.1        NITROGEN: NO3-N =    4 ppm      NH4-N =    3 ppm
 BUFFER pH   6.3        ORGANIC MATTER: 12.6 % (Desirable range  4-10%)

NUTRIENT LEVELS: PPM |       Low   Medium__________High_______   Very High
Phosphorus  (P)   10 |XXXXXXXXXXXXXXXX
Potassium   (K)   85 |XXXXXXXXXXXXXXXXXXXX
Calcium    (Ca) 2324 |XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Magnesium  (Mg)  205 |XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CATION EXCH CAP       PERCENT BASE SATURATION           MICRONUTRIENT LEVELS
 23.7 Meq/100g          K= 1.1 Mg= 8.0 Ca=54.9            ALL NORMAL

EXTRACTABLE ALUMINUM:   36 ppm  (Soil range: 10-250 ppm)

The lead level in this soil is low.

COMPUTER PROGRAM & RECOMMENDATIONS BY DEPT OF PLANT & SOIL SCI UMASS-AMHERST
For further information contact the Soil Testing Lab at (413) 545-2311.
```

SOIL ANALYSIS REPORT FOR ESTABLISHED TURF 10/31/02

SOIL AND PLANT TISSUE TESTING LAB
WEST EXPERIMENT STATION
UNIVERSITY OF MASSACHUSETTS
AMHERST MA 01003

LAB NUMBER: S021028-231
BAG NUMBER: 52271

SOIL WEIGHT: 4.48 g/5cc
CROP: NONE REQUESTED

KATHRYN MURPHY
10024 20TH AVE NE APT A
SEATTLE, WA 98125

COMMENTS: VISIT OUR WEBSITE FOR UPDATED ORDER FORMS AND SAMPLING INSTRUCTIONS. www.umass.edu/plsoils/soiltest

SAMPLE ID: NATHAN HALE SOIL

LIMESTONE AND FERTILIZER RECOMMENDATIONS FOR ESTABLISHED TURFGRASS

Apply 80 lb of calcitic limestone/1000 sq ft in split application.
Do not apply more than 50 lb/1000 sq ft at one time.
Split application between early spring and mid-autumn.

Recommendation: 0 lb/1000 sq ft P2O5, and 2 lb/1000 sq ft K2O.

To provide the above recommendation you may follow the directions below, or you may devise your own fertilizer program using the recommended amounts of phosphorus (P2O5) and potassium (K2O) along with one pound of Nitrogen per 1000 sq feet. It may necessary to raise nutrient levels over several applications.

Apply a 20-3-12 fertilizer @ 5 lbs/1000 sq ft in late April, late June, and very late August.
If more convenient you may substitute the late April recommendation with the same application made 1 to 2 weeks after your last fall mowing.
Following year apply a 30-3-3 fertilizer @ 3 lbs/1000 sq ft at the three application dates given above.
Retest in two years.

Consult the interpretation sheet enclosed or obtain one of the Turf Guides referenced on the backside of the interpretation sheet.

SOIL pH 6.1 NITROGEN: NO3-N = 4 ppm NH4-N = 3 ppm
BUFFER pH 6.3 ORGANIC MATTER: 12.6 % (Desirable range 4-10%)

NUTRIENT LEVELS:		PPM	Low Medium High Very High
Phosphorus	(P)	10	XXXXXXXXXXXXXXXX
Potassium	(K)	85	XXXXXXXXXXXXXXXXXXXXX
Calcium	(Ca)	2324	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Magnesium	(Mg)	205	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CATION EXCH CAP 23.7 Meq/100g

PERCENT BASE SATURATION K= 1.1 Mg= 8.0 Ca=54.9

MICRONUTRIENT LEVELS ALL NORMAL

EXTRACTABLE ALUMINUM: 36 ppm (Soil range: 10-250 ppm)

The lead level in this soil is low.

COMPUTER PROGRAM & RECOMMENDATIONS BY DEPT OF PLANT & SOIL SCI UMASS-AMHERST
For further information contact the Soil Testing Lab at (413) 545-2311.

)IL ANALYSIS REPORT FOR HOME GARDENS

'OIL AND PLANT TISSUE TESTING LAB
'EST EXPERIMENT STATION
NIVERSITY OF MASSACHUSETTS
MHERST, MA 01003

AG NUMBER: 52271

CROP: NONE REQUESTED

ATHRYN MURPHY
0024 20TH AVE NE APT A
EATTLE, WA 98125

'OMMENTS: VISIT OUR WEBSITE FOR UPD
TED ORDER FORMS AND SAMPLING INSTR
JCTIONS. www.umass.edu/plsoils/soil
est

SAMPLE ID: NATHAN HALE SOIL

RECOMMENDATIONS FOR HOME GARDENS:

SOIL PH ADJUSTMENT:
INCORPORATE 20 lbs of ground dolomitic (magnesium-rich) limestone per 100 sq ft as early as possible prior to planting. Because your soil pH is low, an additional 3 lbs of lime will be required to achieve the proper pH for vegetables. Split this remaining amount into small applications over succesive tillings in spring and fall. Avoid mixing in lime when the soil is very wet. Retest soil pH periodically.

** Potatoes should not be limed.**

FERTILIZER:

** VEGETABLES: Apply 2-3 lbs 10-10-10 per 100 sq ft in early spring.
OR, ORGANIC FERTILIZER:
If you prefer INSTEAD to provide nutrients from organic sources, apply the following materials per 100 sq ft prior to planting:
NITROGEN: 1-2 bushels well-rotted manure PLUS 1 lb dried blood
PHOSPHORUS: 3.5 lbs steamed bone meal OR 10 lbs rock phosphate
POTASSIUM: 5 lbs wood ash

** ANNUAL FLOWERS: Apply 1.0 lbs 10-10-10 per 100 sq ft in early spring. Alternatively you may use one-half the ORGANIC recommendation given above.

** ROSE BUSHES: Apply 3 tablespoons of 10-10-10 per bush in early June and early August. None after August 15.

Avoid overfertilizing which can cause plant toxicity and can contribute to insect and disease problems.

SOIL pH 6.1 NITROGEN: NO3-N = 4 ppm NH4-N = 3 ppm
BUFFER pH 6.3 ORGANIC MATTER: 12.6 % (Desirable range 4-10%)

NUTRIENT LEVELS:		PPM	Low Medium High Very High
Phosphorus	(P)	10	XXXXXXXXXXXXXXX
Potassium	(K)	85	XXXXXXXXXXXXXXXXXXX
Calcium	(Ca)	2324	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Magnesium	(Mg)	205	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CATION EXCH CAP 23.7 Meq/100g

PERCENT BASE SATURATION K= 1.1 Mg= 8.0 Ca=54.9

MICRONUTRIENT LEVELS ALL NORMAL

EXTRACTABLE ALUMINUM: 36 ppm (Soil range: 10-250 ppm)

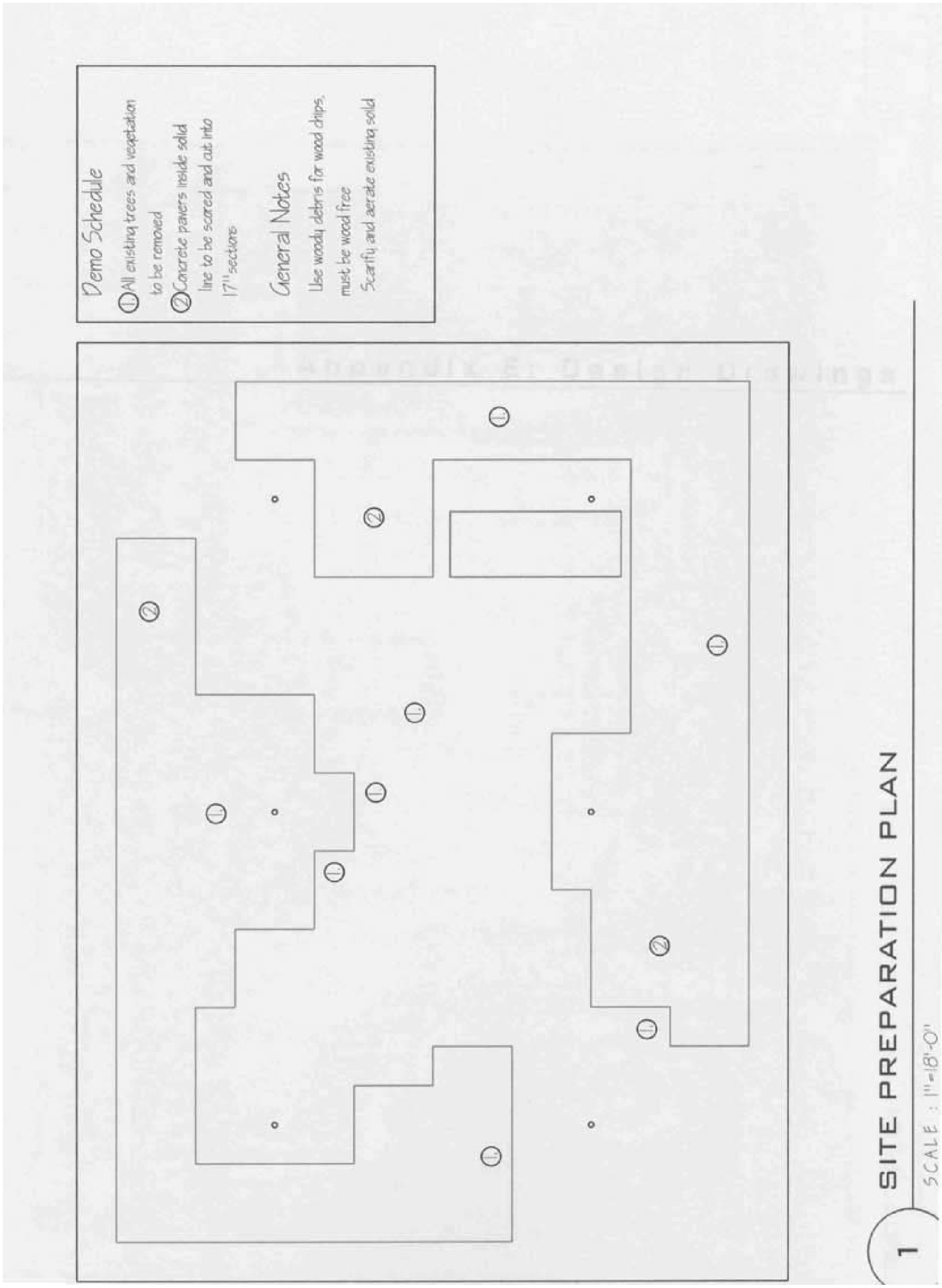
The lead level in this soil is low

COMPUTER PROGRAM & RECOMMENDATIONS BY DEPT OF PLANT & SOIL SCI UMASS-AMHERST.
For further information contact the Soil Testing Lab at (413) 545-2311.

Appendix C: Seattle School District Design Review Information

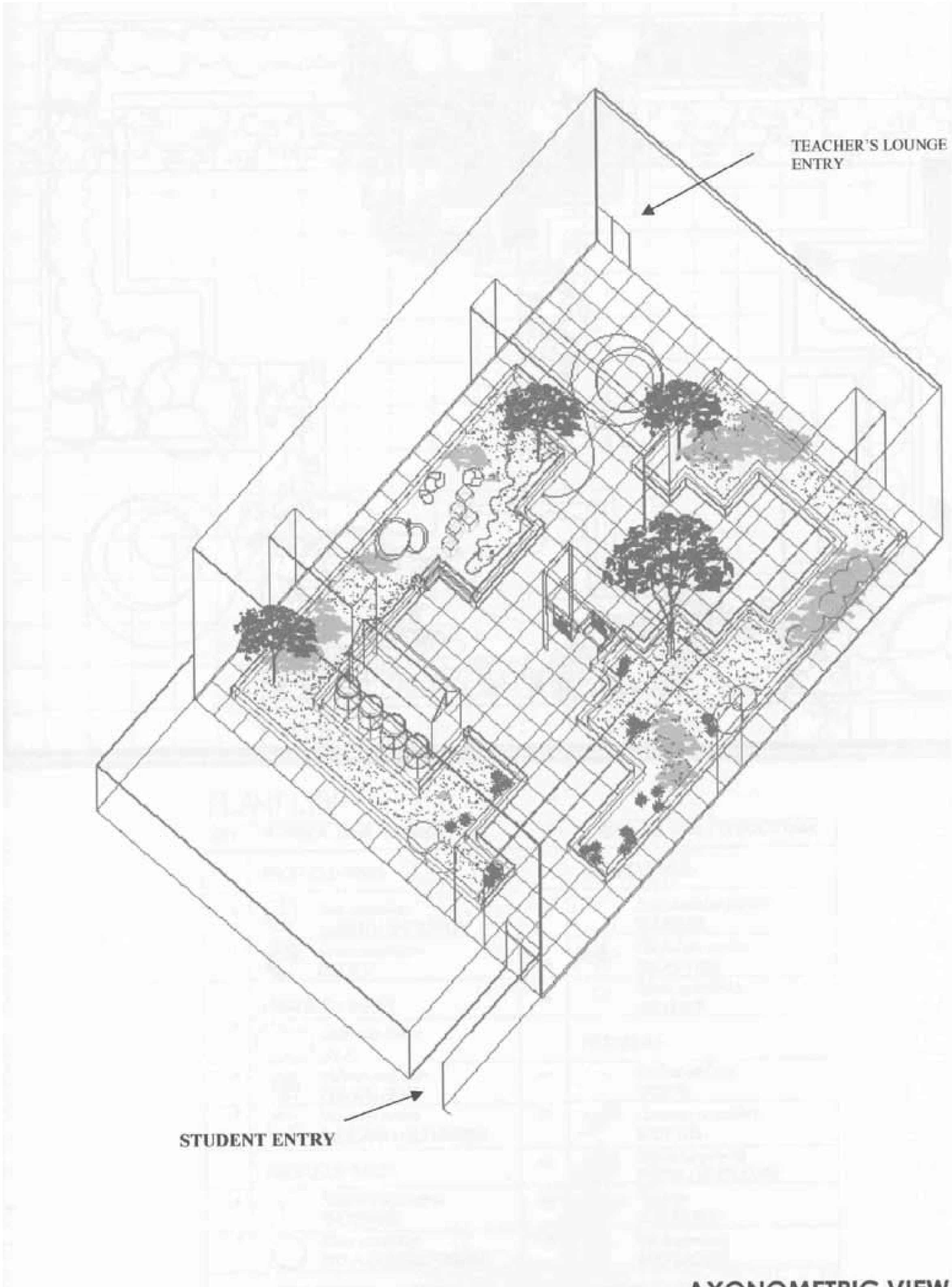
* Note – this was not scanned, but is available at:
http://www.seattleschools.org/area/facilities/DesignStandards/SchoolDesignManual.pdf

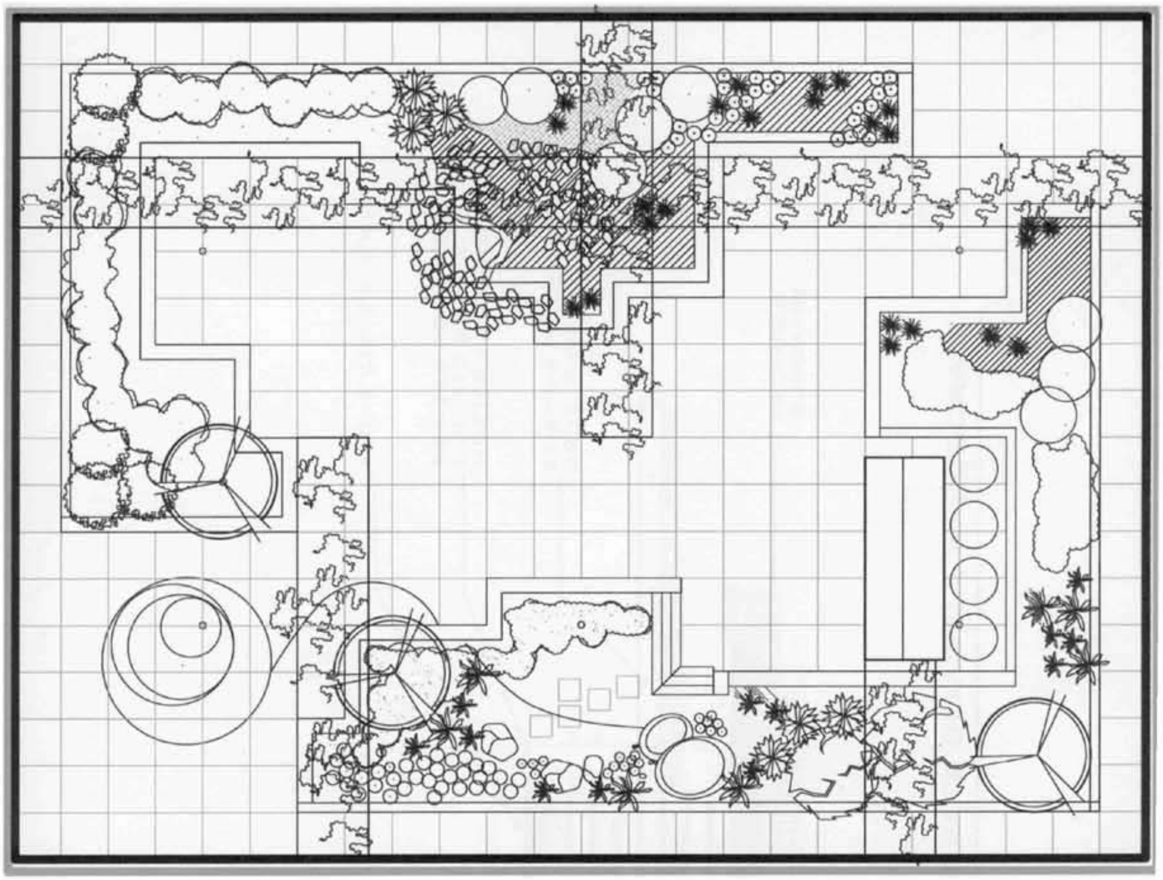
Appendix D: Demolition Plan



Appendix E: Design Drawings

ILLUSTRATIVE PLAN


TEACHER'S LOUNGE ENTRY
STUDENT ENTRY
AXONOMETRIC VIEW



PLANT LIST

QTY.	BOTANICAL NAME / COMMON NAME	QTY.	BOTANICAL NAME / COMMON NAME
	DECIDUOUS TREES		GROUNDCOVERS
3	Acer circinatum COMMON SNOWBERRY	90	Arctostaphylos uva-ursi KINNIKINICK
1	Cercis canadensis RED BUD	14	Polystichum munitum SWORD FERN
	EVERGREEN SHRUBS	33	Tellima grandiflora FRINGECUP
15	Gaultheria shallon SALAL		PERENNIALS
6	Mahonia aquifolium OREGON GRAPE	37	Achillea millifolium YARROW
2	Vaccinium ovatum EVERGREEN HUCKLEBERRY	30	Coreopsis grandiflora BABY SUN
	DECIDUOUS SHRUBS	60	Echinacea purprea PURPLE CONEFLOWER
	Symphoricarpos albus SNOWBERRY	30	Solidaqo GOLDENROD
5	Ribes sanquineum RED FLOWERING CURRANT	18	Iris douglasiana DOUGLAS IRIS
	GROUNDCOVER (ACCENTS)		CLIMBING VINES
24	Helictotrichon spp. BLUE OAT GRASS	10	Helictotrichon spp. BOSTON IVY
20	Linnaea borealis TWINFLOWER		

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Appendix F: Plant Images

Appendix G: Rough Cost Estimate

Rough Draft Budget for Design Elements

This worksheet is intended as a rough survey of costs, ment to demonstrate the order of magnitude of this project

Type	Element	Item	Unit Cost	Quantity	Total	Vendor
Materials	Water Storage	Gutter - aluminum 6" x 0.032" - linear foot	$ 2.50	181	$ 452.50	Classic Gutter Systems
Materials	Water Storage	Rain chain - 1" zinc tenso chain	$ 0.29	5	$ 1.45	Home Depot
Materials	Water Storage	Rain Barrel	$ 75.00	10	$ 750.00	Green Venture
Materials	Water Storage	Concrete Block			$ -	
Materials	Water Storage	5 gallon watering bucket	$ 2.60	3	$ 7.80	Home Depot
Materials	Water Storage	Window Screen - fiberglass 36"x84"	$ 5.98	2	$ 11.96	Home Depot
Materials	Water Storage	Spigot w/ ¾" pipe threads			$ -	Home Depot
Materials	Water Storage	1" Standard hose fitting			$ -	Home Depot
Materials	Water Storage	1 ¾" x ¾" coupling : $0.90	$ 0.90	10	$ 9.00	Home Depot
Materials	Water Storage	1 ¾" x 1/2" bushing: $0.95	$ 0.95	10	$ 9.50	Home Depot
Materials	Water Storage	1 ¾" pipe thread:			$ -	Home Depot
Materials	Water Storage	1" hose adapter: $2.96	$ 2.96	10	$ 29.60	Home Depot
Materials	Water Storage	1 ¾" lock nut: $0.86	$ 0.86	10	$ 8.60	Home Depot
Materials	Water Storage	4 metal washers: $.024 x 4 = $0.96	$ 0.96	10	$ 9.60	Home Depot
Materials	Water Storage	1 tube silicon caulk: $2.92	$ 2.95	1	$ 2.95	Home Depot
Labor	Water Storage	Water storage materials purchase	$ 30.00	8	$ 240.00	
Labor	Water Storage	Water barrel assembly	$ 30.00	16	$ 480.00	
Materials	Trellis	#9 Rebar: 432'	$ 324.00	1	$ 324.00	Salmon Bay Sand and Gravel
Materials	Trellis	#4 Rebar: 464'	$ 348.00	1	$ 348.00	Salmon Bay Sand and Gravel
Materials	Trellis	#3 Rebar: 150'	$ 21.00	1	$ 21.00	Salmon Bay Sand and Gravel
Materials	Trellis	Tie-wire: 400' coil	$ 2.08	1	$ 2.08	Dunn Lumber
Materials	Trellis	Pak Mix Concrete: 8 bags	$ 15.92	1	$ 15.92	
Materials	Trellis	Welding rod #7018: 40lbs	$ 160.00	1	$ 160.00	Interstate Steel
Labor	Trellis	Trellis assembly	$ 30.00	48	$ 1,440.00	
Service	Demolition	Saw rental and blade purchase	$ 120.00	33	$ 3,960.00	
Labor	Demolition	Concrete Cutting @ 1 block per hour	$ 30.00	264	$ 7,920.00	
Materials	Walls	Pea Gravel	$ 15.00	14	$ 210.00	
Materials	Walls	Filter fabric	$ 0.20	665	$ 133.00	
Materials	Walls	3/8 minus crushed rock	$ 15.00	16	$ 240.00	
Materials	Walls	sand	$ 15.00	16	$ 240.00	
Materials	Walls	portland cement	$ 60.00	9	$ 540.00	
Service	Walls	Compacter rental	$ 50.00	3	$ 150.00	
Labor	Walls	Subgrade excavation	$ 30.00	100	$ 3,000.00	
Labor	Walls	Subgrade installation	$ 30.00	48	$ 1,440.00	
Labor	Walls	Materials import per yard	$ 60.00	55	$ 3,300.00	
Labor	Walls	Stacking and mortar 5' per hour for crew of 2	$ 30.00	266	$ 7,980.00	
Materials	Soil interface	Unammended topsoil	9.50	100	950.00	Pacific Topsoil

Service	Soil interface	Rototiller rental	$ 130.00	1	$ 130.00	Hertz AA rental
Service	Soil interface	Conveyer belt rental/ 20' section/day	$ 90.00	20	$ 1,800.00	
Labor	Soil interface	Loading conveyer and spreading	$ 30.00	80	$ 2,400.00	
Labor	Soil interface	Tilling in soil interface	$ 30.00	10	$ 300.00	
Materials	Raised Beds	Unammended topsoil	$ 9.50	536	$ 5,092.00	
Service	Raised Beds	Soil delivery per truckload	$ 50.00	40	$ 2,000.00	Pacific Topsoil
Service	Raised Beds	Conveyer belt rental/ 20' section/day	$ 90.00	60	$ 5,400.00	
Labor	Raised Beds	Loading conveyer and spreading	$ 30.00	200	$ 6,000.00	
Materials	Irrigation	1" PVC schedule 40 per linear foot	$ 0.27	320	$ 86.40	HD Fowlers Irrigation
Materials	Irrigation	assorted 1" fittings	$ 0.60	40	$ 24.00	HD Fowlers Irrigation
Materials	Irrigation	PVC all weather cement	$ 5.00	1	$ 5.00	HD Fowlers Irrigation
Labor	Irrigation	Excavate trench per lf (@ 40' per hour)	$ 0.75	320	$ 240.00	
Labor	Irrigation	lay supply line, glue and test	$ 30.00	12	$ 360.00	
Labor	Irrigation	Fill trench per lf (@ 80' per hour)	$ 0.33	320	$ 104.00	
Materials	Planting	1 gallon pots	$ 4.00	329	$ 1,316.00	Unspecified wholesale price
Materials	Planting	5 gallon pots	$ 14.00	15	$ 210.00	Unspecified wholesale price
Materials	Planting	Trees	$ 30.00	4	$ 120.00	Unspecified wholesale price
Service	Planting	Delivery charges	free			
Labor	Planting	Purchasing and order managment	$ 30.00	8	$ 240.00	
Labor	Planting	Receiving, inspection and import	$ 30.00	10	$ 300.00	
Labor	Planting	Staged plant maintenance @ 4 hours/week	$ 120.00	2	$ 240.00	
Labor	Planting	Installation cost per 1 gallon pot	$ 3.00	329	$ 987.00	
Labor	Planting	Installation cost per 5 gallon pot	$ 8.00	15	$ 120.00	
Labor	Planting	Installation cost per B&B	$ 12.00	4	$ 48.00	
Materials	Irrigation	1/2" polypipe per linear foot	$ 0.10	1000	$ 100.00	HD Fowlers Irrigation
Materials	Irrigation	1/2" gph drip emmiters per plant	$ 0.38	950	$ 361.00	HD Fowlers Irrigation
Materials	Irrigation	1/2" in-line shutoff	$ 1.75	20	$ 35.00	HD Fowlers Irrigation
Materials	Irrigation	assorted 1/2" compression fittings	$ 0.84	40	$ 33.60	HD Fowlers Irrigation
Labor	Irrigation	Lay polypipe @ 400' per hour	$ 30.00	4	$ 120.00	
Labor	Irrigation	install emmiters @ 100' per hour	$ 30.00	10	$ 300.00	
Labor	Irrigation	test and bury @ 100' per hour	$ 30.00	10	$ 300.00	
Labor	Mulching	Mulch delivery and storage area managment	$ 30.00	20	$ 600.00	
Labor	Mulching	Mulch import and spreading per yard	$ 45.00	20	$ 900.00	
Materials	Edging	3/8 crushed clean aggregate per yard	$ 14.35	3	$ 43.05	
Service	Edging	Delivery	$ 75.00	1	$ 75.00	
Labor	Edging	Board removal	$ 30.00	24	$ 720.00	
Labor	Edging	Weed control	$ 30.00	24	$ 720.00	
Labor	Edging	Hauling and spreading per yard	$ 60.00	3	$ 180.00	
				TOTAL	$ 66,397.01	

Appendix H: Maintenance Calendar

Maintenance Calendar

Areas with red suggest critical times for completing maintenance tasks, areas in yellow suggest alternate times. Hours are listed in person hours.

Task	hours	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Refresh mulch	60												
Run irrigation as needed	30												
Remove weeds	30												
'Tin can' poplar shoots	15												
Crack maintenance	15												
Layer cuttings	0-20												
Pot-up cuttings/divisions	0-20												
Transplant	0-15												
Collect seed	0-5												
Plant sale	var												
Monitor social trails	var												
Maintain signage	var												
Pruning as needed	10												
Monitor plant health	var												
Drain irrigation system for winter	2												
Spring inspection before drought	2												
Import compostable materials	var												