Rainwater Catchment Proposal

ENVS 410 - Capstone Project

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Problem statement:

Past, present and reasonably foreseeable future projects are increasing on-site water demand.

Problem background:

Composting on Humboldt State University started at CCAT in 1978, and while the location and responsible group has changed over time, the goal has been to divert compostable waste on the campus. The Campus Recycling Program (CRP) collaborated with the Campus Center for Appropriate Technology to manage HSU's compost. During the construction of the BSS building, from 2002 to 2007, composting at CCAT was canceled while it was being relocated. During this time the CRP restarted composting on the northwest side of the Jenkins house, but in 2007, the campus administration was interested in ending the project due to rodent infestation. TC Comet was able to temporarily relocate the composting site to the Redwood Bowl and drop-in compost was initiated. It took until 2010 for CRP, now WRAPP, to create a permanent composting site behind the Student Recreation Center, on the southern corner of the HSU's upper playing field. After its relocation in 2007, CCAT's newly constructed house restarted composting and initiated many other projects on it's permanent site.

When the CRP transitioned to WRAPP, the compost from the site was donated to the grounds or establishments in the community. WRAPP is interested establishing a use for their compost at the permanent site for their organization in the southwestern corner of the upper playing field. The goal for WRAPP is to interested in adding raised bed gardens and the complimentary components that will sustain its operation reduce it's burden on the HSU infrastructure. In addition, WRAPP intends to use this site to educate students and faculty on sustainable gardening. W.R.A.P.P has requested the proposal and construction of a water supply, such that, not withstanding the site and students, it will allow WRAPP to operate the site independent of University resources.

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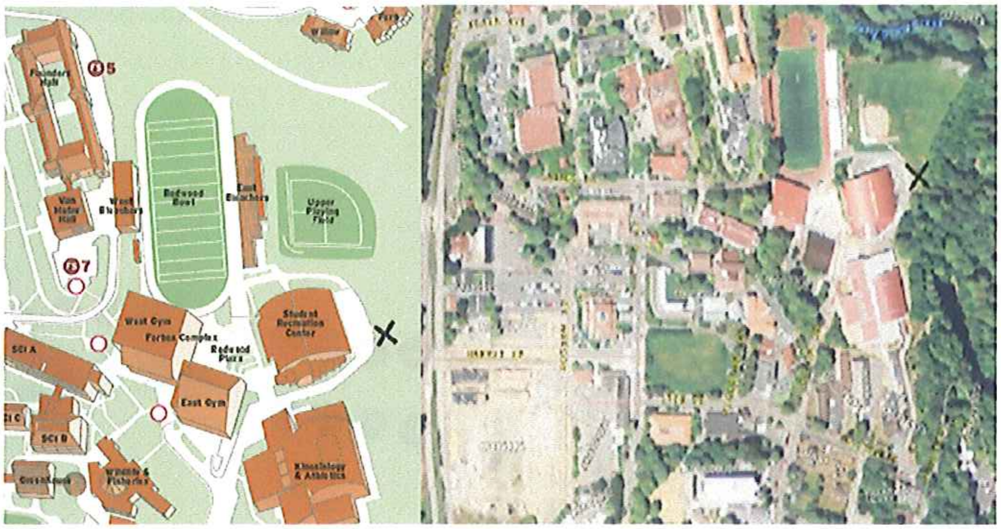
X denotes current authorized **W.R.A.P.P.** site location.



Source: Humboldt State University Campus Map **Source:** Google Earth

WRAPP's increased demand for water, is based on geographic location, and is primarily during the summer months when precipitation averages less than roughly one half of one inch per month. Like most climate classifications, the low precipitation occurs in conjunction with increased air temperatures, and in Arcata California the project site location, it causes for five months (May-Sep) the Potential EvapoTranspiration to exceed the rainfall creating a deficit in the region, reducing local water tables until the rainfall increases. The decreased relative humidity hampers the ability of biota to extract water from the atmosphere and in conjunction with less ground water uptake due of lowering water tables, the demand for an already diminished resource increases over the summer months.

The included weather data indicates that the project area receives more rainfall in the winter than can be absorbed by the terrestrial environment creating an increased volume of runoff on impermeable surfaces and a potential source of water during the drier summer months which can reduce our dependence on HSU's resources during times of annual resource scarcity.

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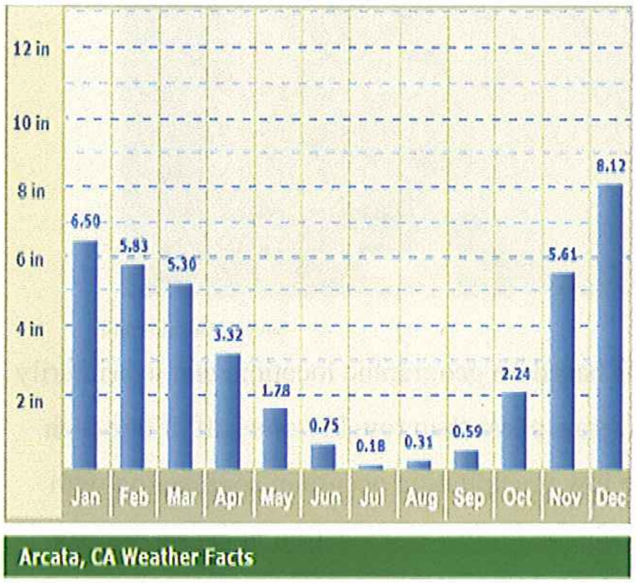

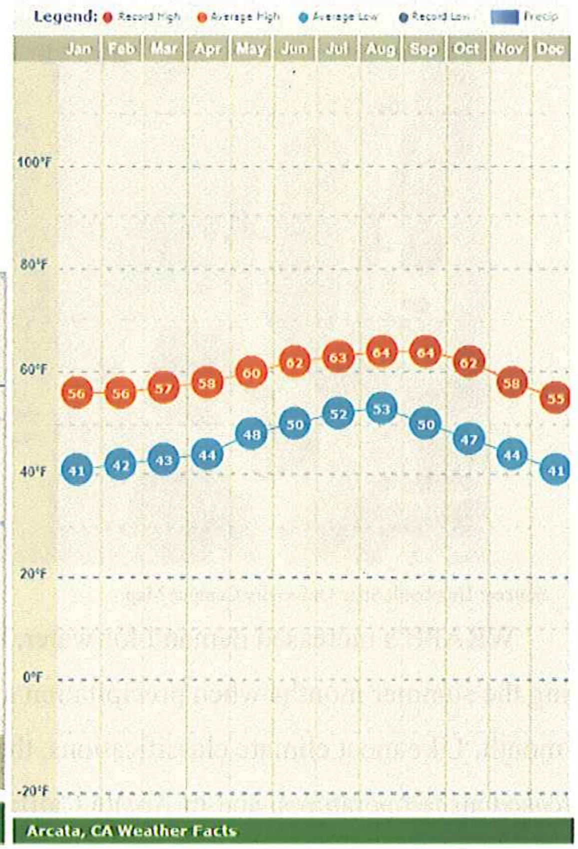

http://www.weather.com/weather/wxclimatology/monthly/graph/USCA0041

Arcata exists in a Marine West Coast (Csb) Climate, according to the Koppen Climate Classification System. The prevailing westerlies constantly bring in moisture from the oceans and even with a cold ocean current present off-shore, the climate is more moist and mild than others in this classification. This climate (Csb) attributes its mild climate to the climate regulating effects of the ocean, leading to small seasonal extremes of temperature, with cool summers and mild winters.

Observation of WRAPP's current location shows the site is across a parking lot to the west of the Student Recreation Center (SRC). This parking lot creates a large impermeable surface with a drain that is connected to the HSU drainage system. To the north of the existing site is HSU's upper playing field, which is generally out of the range of any potential influence from its typical operation. Bordering the project site is a fence and treeline running from NE to SW, ending in the northeast at a location that hosts track and field athletes, but also outside the range of potential impacts. The treeline and fence separates the project site from a trail that leads into the Arcata Community Forest, minimizing the impact on HSU of rats and other pests associated with gardening, composting and water storage.

With a complex organizational structure and HSU being a "public" institution, all projects and construction ultimately become the responsibility of the campus itself. With final approval of our particular project resting with Doug Kokesh, Manager of Plant Operations, Humboldt State University.

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Objectives and Goals:

Goal:

To collect, filter and store water from an untreated sustainable source for the use of gardening and maintaining compost. (Not for potable use.)

Objectives:

While there is a municipal water source on site, WRRAP is requesting an alternate water source to:

- Lower the CO_2 emissions resulting from energy used for the processing and transportation of municipal water.
- To store at least 200 gallons of water that will provide a water supply for a composting and garden area at Humboldt State University.
  - WRRAP has provided four 50 gallon barrels for storage
- Utilize HSU's runoff from impermeable surfaces, during major storm events.
  - Take advantage of current infrastructure to create a system that may reduce flow into impermeable surfaces.
  - Take advantage of the excess runoff that occurs during storm events.
  - Use water that may otherwise flow into creeks taking oils, sediments and other pollutants collected from impermeable surfaces.
  - Reduce the runoff HSU sends to the waste water treatment plant during major storm events, reducing peak processing demand experienced by our local water treatment plant.
- Prevent any increase in HSU's municipal water demand.
  - WRRAP garden site would require using municipal water.
  - Minimize chemicals that are introduced into their organic garden.
- The user friendly system will allow for two people per week to utilize the water.
  - Deliver water to the garden site via a hose.
  - Minimal maintenance of the system which will include:
    - Cleaning gutter system
    - Cleaning filter system

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In order to meet our objectives we have specific considerations that need to be looked into. the considerations we looked at for this project are: energy, storage, impermeable surfaces, water demand, and the systems functioning as a whole.

Energy

There is an unseen cost of tap water, embedded energy. This embedded energy is an estimation from the chlorination/treatment and transportation energy demands of tap water. The total energy required for using municipal water can be reduced by lowering the demand, which is one of this project's goals. Construction for a water catchment system requires materials that have embedded energy. In order to not add embedded energy to the system we will be using recycled materials which have already been used for their intended purpose, therefore lowering the systems embedded energy.

Storage

Storage is an issue for every water catchment system regardless of size. WRRAP donated four 55 gallon food safe storage barrels that can be used for a total of ~200 gallons of storage. Ideally 200 gallons could be collected during storm events and stored until summer. The water caught is to be utilized when it is needed most, during the summer growing season.

Impermeable surfaces

By exploiting impermeable surfaces and capturing water from a sustainable source, the project will prevent the garden from impacting HSU's current municipal water demand. By using this runoff we will be diverting the water that would otherwise go uncollected and potentially cause erosion and sediment transfer (Urban Runoff Nov.2011). The collection and use of non-municipal water will reduce the amount of chemicals that enter the organic garden, as well as redirecting runoff to reduce the burden on the water treatment plant. HSU pays for the square footage of impermeable surfaces this could result in a lowering of that fee.

Prevent an increase in water demand

A problem, although minimal, is that our system fills a need for water at a time when Humboldt county is endanger of losing our water rights. Utilizing water allotted to the county

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ensures water for years to come, making finding appropriate uses for Humboldt's water a high priority. Chlorine is a highly efficient disinfectant and is added to public water supplies to kill disease-causing bacteria which may be found in the water or its transport pipes. This property of reducing bacteria populations is transferred to the soil reducing the number of helpful bacteria that are necessary for healthy productive soil and composting. (Chlorination of drinking water Nov. 2011)

System

By creating a system that is easy to use we can bring forth behavioral changes encouraging the use of our system. Our system will have a traditional spigot and hose so use will be the same as a conventional system. Maintenance of the system must be easy to keep the system running efficiently. Our projects maintenance well be to insure that the gutters are clean and that the filter is clean. The maintenance of our project will be able to be done before each use, it will most often just be a visual check to insure water can flow through the system.

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Alternatives Evaluation

Criteria:

1. To collect and filter water from an untreated sustainable source for non-potable uses.
2. To store at least 200 gal. (eg. 4 barrels x50 gal) of water with the capability of expansion.
3. Efficient water delivery with a flow of at least 3 GPM.
4. Implement a system that requires, at most, 30 minutes of maintenance twice a year.
5. Utilize HSU's runoff from impermeable surfaces.
   Goal: Aiming to reduce runoff entering circulation during major storm events.
6. To prevent an increase in HSU's municipal water demand.
7. Affordable cost.
8. Ease of use.

X - Satisfies or does not impact criteria.

* - Alternatives which meet all criteria.

Collection	Crit. 1	2	3	4	5	6	7	8
1a. Location 1 - Student Rec Center-SRC Adjacent to eastern exterior wall *	X	X	X	X	X	X	X	X
b. Location 2 - Secured behind gate in SE corner of SRC exterior *	X	X	X	X	X	X	X	X
2. Build mist nets, catching morning dew and rain fall.	X	X	X	X		X	X	
3. Softball field drainage	X		X	X	X	X		X
4. Rerouting parking drainage	X	X	X	X		X		
5. Build a free standing roof. (Which would help keep the compost dry.)	X	X	X	X		X		X

b. Optional information kiosk.								

1a. The Student Recreation Center is a building on campus with a large footprint available for rain water collection through various gutters. Gutters can be rerouted, diverting water to be used at a time of demand. This project can be built between the existing landscaping along west wall.

Pros: Storage is with in close (less than 5 ft) proximity to collection site.

Cons: Collection/storage is far (more than 20 ft) from end use.

b. The Student Recreation Center has a caged area on the exterior south east corner of the building. This 25ft. x 20ft. area is being used for storage, including a garden shed two dumpsters and some WRAPP program equipment. This location would allow WRAPP to centralize their equipment and secure their equipment.

Pros: Fencing provides a secure area for water catchment system.

Cons: With limited space, placement of containers will be a barrier to design.

2. Mist nets are a passive form of water collection, capturing the water droplets in fog and morning dew. These can be placed on poles extending from a roof or on tall free standing supports. Although the elevation of our project site is to low to make mist nets an efficient alternative this could be a viable option for projects with more vertical clearance.

Pros: Water collection can occur even when rain is not falling.

Cons: Subject to regular replacement because nets are subject to deterioration and damage easily.

3. Excess water from the softball field currently empties into a drainage area. This water could be collected from a constructed well and then pumped to the garden site for use. Although digging wells to collect drainage water is practically out of the question because of funding and permitting constraints.

Pros: By draining this area the field would be better suited for use during the wet seasons. Aquifer is storage which removes demand for plastic barrels/other containers.

Cons: Getting approval to dig near the softball field would be difficult, as well as cost prohibitive.

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4. Using an existing surface, the parking lot, water draining to its underground network could be diverted and drawn up to storage containers. Because cars drive on this surface the water caught would need to be filtered because of potential oil contamination.

Pros: A large surface to catch from.

Cons: It would be very difficult to draw water from underground drainage, requiring a large pump. Also this water could be potentially contaminated with oils or other pollutants.

5. Free standing roof would be built over the compost piles and would help prevent compost from getting to wet. Unless we could get materials donated cost would be prohibitive. An optional informational kiosk or signage could be erected to inform users and curious people of the uses of and collection of rain water.

Pros: A roof would be beneficial for many uses, such as keeping people, compost and stored equipment dry.

Cons: Constructing a roof suited for water catchment would require many purchased building materials and

Transportation	1	2	3	4	5	6	7	8
1a. Clear flexible tubing	X	X	X		X	X	X	X
b. Flexible tubing (black or opaque) *	X	X	X	X	X	X	X	X
c. PVC (White or Black) *	X	X	X	X	X	X	X	X
d. Garden hose	X	X	X		X	X	X	X
e. Metal pipe	X	X	X		X	X		X
2. Below ground water transport.	X	X	X		X	X		X
3. Permanent PVC strung over the parking lot.	X	X	X		X	X	X	X

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1. Various tubing can be used for transportation, while flexible tubing is the most economical option rigid pipes such as PVC or metal tubing can be used for a longer lasting option on projects with budget.

a. Clear flexible tubing ($1.00/ft)

Pros: Available fittings and can minimize piping.

Cons: Potential algal growth because sun exposure could promote growth. Maintenance may require replacement.

b. Black or Opaque tubing. ($1.25/ft)

Pros: Variety of fittings, flexible piping allows for minimization.

Cons: Flexible piping can be difficult to work with, and maintenance may require replacement.

c. PVC (Donated)

Pros: Fitting variety, easy to work with, quick disconnects makes method easiest to maintain.

Cons: Chemically intensive to produce, can snap or break if shifted.

d. Garden hose

Pros: Easy to find recycled materials.

Cons: Low durability requiring more parts and maintenance.

e. Metal piping

Pros: High durability.

Cons: High cost, difficult maintenance.

2. Creating a permanent secondary tap on the garden site could be accomplished by digging a trench for piping to transport caught water across the parking lot. There are many barriers to this alternative such as; digging through newly placed asphalt, re-paving the trench, and permitting to start construction.

Pros: Underground piping is protected from the elements. Because this is transportation option is non-visible when finished it will be more aesthetically pleasing.

Cons: Hard to access for maintenance. Extensive construction equipment will be required.

3. By running a PVC tube over the parking lot between the SRC and the garden site a secondary tap can be placed on the garden site. This would require vast architectural design considerations, and would result in a structure less than pleasing to the eye.

Pros: Because this option runs over the parking lot it would not interfere with traffic. End use can be permanently connected to supply.

Cons: Requires vast infrastructure, may be considered aesthetically unappealing.

Storage Location	Crit. 1	2	3	4	5	6	7	8
1. Storage within 5 ft of collection site *	X	X	X	X	X	X	X	X
2. Storage within 5 ft of end-use.	X	X	X			X	X	X
3. Below ground water storage.	X	X	X			X		X

1. Being close to the collection site, the storage containers will blend in with the collection system and minimize the distance from collection to storage. However locating storage near the collection site may impact existing landscaping on the HSU campus.

Pros: Better aesthetics.

Cons: Shrubbery may hinder construction.

2. With storage near end use, WRAPP will have the ability to expand water storage in the future, providing greater flexibility with storage options. But, if the storage is located near the end use, a permanent hydro conduit must connect collection and storage.

Pros: Flexible placement and sizing requirements allow for a better suited catchment system (quantity of containers/volume of storage).

Cons: Transportation to storage will require a permanent piping system.

3. If storage is installed below ground, it would not visible to visitors and far less likely to be subject to damage. However the difficulty of future expansion arises when a single container is used.

Pros: Less likely to be damaged for human use/error. Unseen storage is better aesthetically.

Cons: Expansion cannot be easily made. Digging for an underground container will require large construction equipment.

Storage Containers	Crit. 1	2	3	4	5	6	7	8
1. 4 to 6 55 gallon barrels stacked on their sides in a frame (220-330 gal) *	X	X	X	X	X	X	X	X
2. 4 to 6 55 gallon barrels on end and in-line (220-330 gal) *	X	X	X	X	X	X	X	X
3a. A single container 330+ gallons (plastic)	X		X	X	X	X		X
b. A single container 330+ gallons (corrugated metal)	X		X	X	X	X		X
c. A single container 330+ gallons (ferrocement)	X		X		X	X		X
4. Cleaned and reclaimed septic tank	X		X		X	X	X	X

1. By placing 55 gal. containers horizontally they become very stable and with the lid facing toward the user plumbing would be a breeze. This containment system would require a frame in order to hold the barrels in place and could hold the containers in place during an earthquake event.

Pros: Low profile, high stability, connections on face/lid of barrel make plumbing easier.

Cons: Requires purchasing frame materials, eg. wood, screws, etc.

2. Placing containers vertically would remove the demand for a frame, and if elevated connections can be made under containers. This would allow for a greater water pressure when full and less building materials.

Pros: Greater water pressure when full, smaller footprint.

Cons: Could knock over and damage fixtures during an earthquake event.

3. Maintaining a single container can be more simple than multiple containers, although designing a single storage catchment system creates the problem of expansion.

a. Plastic

Pros: Maintaining and linking a single container is more simple than multiple containers. Cheaper than other materials.

Cons: Expansion cannot be easily made.

b. Metal

Pros: More resistant to sun degradation/damage.

Cons: High cost. Expansion cannot be easily made. Animals are rarely, if ever, capable of chewing through metal, potentially contaminating the water supply.

c. Cement

Pros: Cost is reduced due to labor/construction being done on site, but this requires a lot of time to complete. Building a container allows more flexibility in size and design.

Cons: Maintenance is more difficult with containers not designed for water storage. Expansion cannot be easily made.

4. If a reclaimed septic tank is found or donated this can be converted into a storage device. These tanks, originally designed to store waste water from houses, have input and output fixtures installed already and would allow for easy connections during construction.

Pros: Use of existing materials/promoting cradle to grave. Water hookups/connections present.

Cons: Septic tanks are normally very large which could make size and shape awkward.

Water Pressure	Crit. 1	2	3	4	5	6	7	8
1. Elevated secondary water storage on garden-site.	X	X	X		X	X	X	X

2. Elevated primary water storage on garden site *	X	X	X	X	X	X	X	X
3. Storage at ground level.	X	X		X	X	X	X	X
4. Elevated water storage on catchment site (using wood or metal frame).*	X	X	X	X	X	X	X	X
5. Elevated water storage on catchment site (using reused concrete a.k.a urbanite) *	X	X	X	X	X	X	X	X
6. Human powered pump *	X	X	X	X	X	X	X	X
7. Hard wired sump pump *	X	X	X	X	X	X	X	X

1. An elevated secondary water storage unit would be used to build water pressure for end use. Receiving its supply via pump from the main water storage by the SRC this secondary storage would be raised 4-6 ft high on a wooden frame. Although with two locations of water containers maintenance time may be slightly over a half hour.

Pros: With elevated water containers on the garden site this would allow watering to be done at any time by one person.

Cons: Complex transportation and structural issues to overcome.

2. Moving all water storage to the garden site would be an alternate placement of the storage containers. If stored on garden site containers could be stacked taller (increasing water pressure) with out consideration of how high the roof line is, although we would have to be mindful of stability, living in an earthquake hazard zone.

Pros: Without the consideration of SRC's low lying roof we could stack the containers, thus creating more storage and pressure with the same footprint.

Cons: Complex transportation issue to overcome.

3. With catchment on the ground there would be no earthquake risk, although fittings would have to be made solely through the lids on top, potential creating delivery difficulties.

Pros: Simplest design, easy installation.

Cons: Plumbing will have to be made through lids, a difficult situation when drawing water through from the bottom.

4. Building frames to hold the containers would require more materials and man hours in construction. On the other hand the containers would be very stable and resistant to shifting, which could potentially ruin the piping system.

Pros: Earthquake ready. Protected piping.

Cons: Extra cost and building materials.

5. Elevating the barrels with reused concrete foundation or pavement allows us to place spigots on the bottom of the containers, an easy option for delivery.

Pros: Easy connections from the bottom of containers.

Cons: Urbanite needs to be found and placed by hand, a laborious task.

6. This method may not achieve the goal of 3 GPM at times (if pumping rate is low) but this would be a trade off for using a system requiring no electrical input, or wiring system.

Pros: Simplicity. Requires no electrical wiring or pumps.

Cons: Flow rate may be less than our desired 3 GPM. Requires 2 people to operate.

7. Having an electric pump would require tapping into the SRC's electric system. This would enable us to build water pressure for delivery using a small submersed pump. Adding this pump would draw on the electrical grid, an estimate of energy used (kWh) will be estimated if this alternative is chosen.

(Time run)(wattage needed)=energy used. E*cost=cost acquired by the school.

Pros: Usability increases with the ease of operation from the electrical pump.

Cons: Electrical input is required. Electrical wiring is required (done by paid professional).

Delivery Method	Crit. 1	2	3	4	5	6	7	8
1a. Differing spigot type (Ball valve) (least resistant to flow) *	X	X	X	X	X	X	X	X
b. (Globe valve) (most common and affordable.) *	X	X	X	X	X	X	X	X
c. (Gate valve) (Good for on off) *	X	X	X	X	X	X	X	X

1. Different spigots can result in sizable flow differences. The internal structure of a global valve (b) results in resistance and slower flows when compared to ball valves(c). Although these are more costly $5.00 opposed to $3.00-4.00. While gate valves are the cheapest they only have 2 settings (on/off). In reality we are most likely going to use the valve we found or was donated.

a. Ball valve

Pros: Least resistance to flow

Cons: Highest comparative cost.

b. Globe valve (standard)

Pros: Most commonly found. Most likely to be donated.

Cons: Resistance to flow results from this valve.

c. Gate valve

Pros: Cheapest.

Cons: Only two settings, and gardeners may require a slow/medium flow.

Preferred Alternative

A. Constructing a freestanding roof will be dependent upon campus approval, but if allowed the construction of a simple roof will serve as a multi use structure and would benefit its users because of many reasons. With the catchment, storage, and end use within 5 foot of each other no electrical work or pumps would be required. To build a free standing roof would require many man hours and raw materials, but with the convenience and multiple uses it would provide the large amount of energy up-front would be paid back over time in water alone.

B. Using flexible opaque hosing or rigid PVC for water transfer we could a system with four to six 55 gallon containers within 5 feet of the Student Recreation Center. Using either a foot pump or electrical pump this would allow the system to be installed with a minimum amount of time and materials, yet still meeting our goals and objectives. Although transportation to end use would require electrical work, (the addition of an outlet for the electrical pump) or extensive man power (foot pump.) Also with barriers of bureaucracy, collection of materials, logistics of the electrical work and building concerns of this project will be difficult to accomplish.

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Implementation and Timeline

Preferred alternative A

Day 1: (/ /11)
Foundation and Roof Leg Installation

Dig suitably sized hole for foundation and post. (4"x4"x10'+). The success or failure of any outbuilding relies heavily on its foundation. We have chosen to use four posts for a free standing shed for easy access and storage.
Mix and pour in concrete with accordance to Quickcrete mix directions.

Repeat four times for each post ensuring front posts are taller than rear posts, thus creating an angled roof (45-60).

Estimated time: 2 hour installation. 24-48 hours to cure.

Day 2: (/ /11)
Install cross beams for stability of structure using metal brackets. In most cases, you'll want to determine the spacing between beams first, then if applicable use a joist size appropriate to that spacing.

Beam Spacing (round down to nearest foot)	**Minimum Beam Size (doubled 2" material may be used in place of 4" thickness)**
Up to 6 feet	**4x6** (Southern pine or Douglas fir) **4x8** (Western red cedar, S-P-F, Hem-Fir, redwood, or Northern white cedar)
Up to 7 feet	**4x8** (all species listed above)
Up to 9 feet	**4x8** (Southern pine, Douglas fir, Western red cedar, S-P-F, or Hem-Fir) **4x10** (redwood, Northern white cedar)

Estimated time: 1 hour

Install metal roof using roofing screws to attach sheeting to runners. Nails or screws with rubber heads will be used to ensure no leaks will result from attachment.
Estimated time: 1-2 hours

Day 3: (/ /11)
Ensuring our roof is leak free and results in a flow of water to be stored.
Estimated time: 10 minutes

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Install downspout onto gutter. To ensure that gutters drain properly, make certain they slope (½ inch for every 10 feet) toward a downspout.

Estimated time: 30 minutes

Hang gutter (Metal or Plastic)

Estimated time: 1 hour minutes

Install filter in downspout.

Estimated time: 30 minutes

*Later Addition if desired: A first flush can be installed after the filter to capture the first gallon of rain caught. This allows the settled dust to be washed into a secondary container, keeping our caught water even cleaner.

Estimated time: 1 hour

Day 4: (/ /11)

Supporting and securing water storage. It is important to note that although out project is not permanently stationary, it is essential that our project is secure. Building onto the rear a 4x4 wooden rack will be built to elevate and secure 4 horizontal water drums.

Estimated time: 2+ hours

Day 5: (/ /11)

Water containers will be placed into the wooden frame and strapped down to ensure stability in event of an earthquake.

Estimated time: 30 minutes

Tap barrels and insert PVC fittings.
Drilling into water drum lids piping will be fixed onto storage containers using appropriate fittings, suitable to pressure constraints and flow requirements. The system will need to be checked for leaks upon completion of this step.

Estimated time: 1 hour

Create PVC manifold structure to transfer water between barrels with quick disconnects between the manifold and storage.

Estimated time: 1 hour

Test water storage transfer and manifold system.

Estimated time: 2 hours (Waiting to get enough water with hose flow rate, based on personal experience)

Day 6: (/ /11)

Fix any problems identified in storage, transfer and/or roof system.

Estimated time: varies

Connect roof & filter system to storage system.
Estimated time: 1 hour

Day 7: (/ /11)
Test whole system @ 110% capacity to ensure that the system will hold up when the carrying capacity has been reached. Enough water will be collected to ensure overflow is functional and no leaks occur at any point of operation.
Estimated time: 15 min to 4 hours (pending on rain conditions)

Implementation B (Student Recreation Center)

Day 1
Meet with electrician to place a grounded outlet with a connected switch in the appropriate location.
Estimated Time: depends on electrician

Day 2
Stack cinder blocks, urbanite (reused asphalt), or design a wood frame to elevate water containers.
Estimated Time: 1 hour

Place barrels on foundation and use plumbers strap to attach to wall or frame.
Estimated Time: 1 hour

Tap storage containers where PVC will bring water in or out of container.
Estimated Time: 30 minutes

Connect overflow to drain onto the asphalt, in similar fashion to adjacent downspouts.
Estimated Time: 30 minutes

Day 3
Create PVC manifold to balance water between storage containers. The 3/4" PVC piping pulls double duty - 1) it transfers water between barrels (as the leftone fills the right one seeks the same level) (Assuming both valves open) 2) It delivers the water from both barrels to the hose for watering. The Union allows for easy winter tear down - otherwise you would need to move both barrels together which would weaken the manifold fittings
Estimated Time: 1 hour

Day 4
Adjust and re-route downspouts to feed into the water transfer system.
Estimated Time: 3-4 hours

Day 5

JJC

Install first flush filter and connect filter to storage.

Estimated Time: 3 hours

Day 6

Install pump in a storage container, later to be marked with "Contains submersible pump."

Estimated Time: 30 minutes

Connect pump to PVC and a reducer beneath lid, drilling hole for pump outlet.

Estimated Time: 30 minutes

Affix conversion to hose fitting and attach test hose.

Estimated Time: 10 minutes

Day 7

Test whole system @ 110% capacity.

Collecting enough water to ensure overflow is functional and no leaks occur at any point of operation.

Estimated time: 15 min to 4 hours (pending on rain conditions)

Potential barriers to implementation:

Need - If the garden/composting site is not being installed is there a need?

Approval - Pending on approval to build a free standing roof.

Electrical work - Only a barrier if using an electrical pump.

Materials - Without tubing, containers and other materials this project cannot move forward.

JJC

Monitoring and evaluation

The basics.

Who: WRRAP (compost) or garden users (garden).

When: During times of high rain fall (Nov. - Mar.), and high usage (Apr. - Oct.).

Where: At the catchment and storage site.

Why: To ensure stored water is sufficiently meeting the needs of garden/compost users. If not storage should be expanded to meet our goals and objectives.

The details.

The WRRAP group will assume responsibility for maintenance upon the projects completion. The group will need to perform maintenance before each use to insure the gutters and filter are clean. Project maintenance will be critical during times of heavy rainfall (November though March), monitoring storage levels as well as making sure that the system overflow is working properly and not causing erosion. Part of the monitoring of this project will be an annual inspection of the structure for structural stability. Included in the structural inspection would be: foundation soundness; roof, gutter, and plumbing connections to inspect for leaks or cracks; and overall structure durability.

Evaluation

Since we were unable to complete our project we won't be able to evaluate the systems effectiveness. We were able to create a theoretical table to show potential collection and storage values. Without empirical usage values we are unable to calculate actual storage amounts. The systems success will be determined by the number of months in which the system can be used to water the garden and cover the composting needs, this will be most significant during times of low rainfall (April through October).

Conclusion/summary:

Water catchment can be an excellent method of water collection in Humboldt, but appropriate storage is the most important consideration, with such a relatively long dry season. If a free standing roof is to be installed we suggest installing a water collection system to utilize the runoff that would otherwise go either back into the soil, onto the pavement ending in a stream or water processing plant, if exiting at high velocities this could even cause erosion.

Project Conclusion:

1. The past, present and future projects on the WRAPP's site are being reconsidered as the campus wants to centralize its sustainability efforts and demonstrational sites on campus. WRAPP is going to look at researching the energy required to ship or move the existing compost they are creating to CCAT. In addition, in the future they are going to work intimately with CCAT to collaborate on composting on the HSU campus to help consolidate the student composting and garden efforts on campus.

2. While water catchment is a sustainable way to provide a water source for your gardening & composting needs, it is hard to justify the *need* for it in an area with an established municipal water infrastructure. Regardless of the enthusiasm for sustainable projects, finding suitable demonstration sites for efficient systems are limited. Water catchment implementation should be done during construction. Creating a catchment system with the established infrastructure creates many issues that reduce the feasibility of projects.

3. We conclude that a free standing structure used in conjunction with the need of water, such as protecting gardening supplies or compost storage in a flat open area would be the best demonstrational site for base calculations on the potential efficiency of water catchment projects.Our project site was near a tree line and had a parking lot that separated it from the closest usable impermeable water catchment surface by approximately 50 feet. The introduced a greater complexity than necessary for a demonstrational site and created a unique environment for future projects.

What we learned:

Projects don't happen in isolation. All stakeholders must be involved from the start. If stakeholders in a project appear in the middle of a project and have the power, they have the ability to halt projects. Some stakeholders, like the public, often do not have this ability, however through tools such as the California Environmental Quality Act (CEQA) this is beginning to change slowly through scoping sessions and open door meetings. CEQA brings together project stakeholders, including the public, to evaluate the needs and purposes of projects to increase the sustainability of projects implements.

Had we included all the stakeholders from the beginning we may have created the best project possible with the most efficient use of resources to accomplishment of the established goals set forth by all the stakeholders.

Place higher consideration on potential barriers. While we focused on details such as placement and implementation barriers to this projects success should of ultimately received much more attention. The complicated nature of composting/garden sites should have been more thoroughly evaluated with more communication between CCAT/WRAAP and our team.

Existing infrastructure decreases feasibility of projects. Site location is one of the most important considerations for demonstrational systems.

Many people are enthusiastic and in support of projects like these, but getting a solid commitment is very difficult.

Appendix

Sources:

Websites
http://abe-research.illinois.edu/pubs/factsheets/SumpPumps.pdf

http://www.buypumpswholesale.com/page/tdhcalculator_w/help

http://www.appropedia.org/Old_Growth_Cellar_rainwater_catchment

http://www.appropedia.org/CCAT_yurt_rainwater_catchment

http://www.appropedia.org/M_Street_Eureka_rainwater_catchment

http://www.appropedia.org/Original:Rainwater_management

http://www.appropedia.org/Original:Rainwater_harvesting

"Chlorination of Drinking Water." *Drinking Water Testing Environmental Testing Lab Water Research Center*. Web. 29 Nov. 2011. <http://www.water-research.net/watertreatment/chlorination.htm>.

http://eartheasy.com/blog/2009/03/tips-for-installing-a-rainwater-collection-system/

http://www.greenandmore.com/ra-wp-gardn-gro.html

http://www.instructables.com/id/Elevated-Dual-Barrel-Rainwater-Collection-System/

http://www.mendeley.com/research/water-quality-rooftop-rainwater-harvesting-systems-review/
Journal of Water Supply Research and Technology AQUA (2006)
Volume: 55, Issue: 4, Publisher: IWA Publishing, London, SW1H 0QS, United Kingdom, Pages: 257-268
DOI: 10.2166/aqua.2006.008 Available from Journal of Water Supply Research and Technology AQUA

"Urban Runoff." *The Charles Edward Via, Jr. Department of Civil and Environmental Engineering*. Web. 28 Nov. 2011.
<http://www.cee.vt.edu/ewr/environmental/teach/gwprimer/group18/urbanr.htm>.

Time Logged

Dates	Initials	Description/Notes:	Individual hours:	Total hours	Research	Site Visit	Brainstorming	Writing/Editing
Week 3 (9/5)	JMK, SEJ, SJG	Project selection. Water catchment.						
	JMK, SEJ, SJG	Initial site visit.	0.5	1.5		X		
	JMK, SEJ, SJG, JJC	Background research. Each member spent over an hour researching water catchment through various media sources.	1.5	5-6	X			
	JMK, SEJ, SJG, JJC	Problem statement development. Brainstorming in class and on our free time a problem statement was created through collaboration.	2	6-8	X		X	
Week 4 (9/12)	JMK, SEJ, SJG, JJC	Goals and objective development. In class each member thought of possible solutions to supply the water desired by a compost/garden area to be placed on campus.	1.5	6	X		X	X
	SEJ, SJG	Site meeting with Lonny G. An hour on site allowed us to brainstorm on the location in which a garden was proposed.	1	2		X	X	
Week 5 (9/19)								
Week 6 (9/26)	JMK, SEJ, SJG, JJC	Problem statement/background creation. Collectively we wrote an introduction to our project and the problem statement.	2	6-8	X			X
	JJC	Meeting with Doug Kokesh	0.5	0.5	X			
Week 7 (10/3)								
Week 8 (10/10)	JMK, SEJ, SJG, JJC	Alternatives development. In class we thought of any potential ways to harvest water, reduce water demand, or create a new source of water.	1	4	X	X	X	X
Week 9 (10/17)	SEJ	Create Maps. Using Adobe Illustrator a representation of the water-catchment's foot print was created for display in class, and to show potential locations to stakeholders.	2	2		X		X
Week 10 (10/24)	JMK, SEJ, SJG, JJC	Weighing/evaluation of alternitives. As a group we each spent time focusing on a specific section within the alternatives section	2	6-8	X			X
Week 11 (10/31)	JMK, SEJ, SJG, JJC	Implementation strategies development and creation.	1	4-5	X	X	X	X
Week 12 (11/7)								
Week 13 (11/14)	JMK, SEJ, SJG, JJC	Discussion of project cancellation by oversight authority.	0.6	2			X	
Week 14 (11/21)		Thanksgiving Break						
Week 15 (11/28)		Second draft of proposal sections. Each member took on a specific section to edit and revise over Thanksgiving break.	2.0-1.0	5-8	X		X	X
	JMK	Problem background/statement						
	SJG	Goals and objectives						
	SEJ	Alternitives						
	JJC	Implementation						
Week 16 (12/5)		Monitoring and Evaluation plan development and creation.	1	4			X	X
	JMK, SEJ, SJG, JJC	Presentation. Each member contributed slides, photos, tables, or figures to a presentation which will be showed the 8th of December to ENVS 410 students. 1 hr each.	1	4-5	X		X	X
		Estimated total number of Hours:		72				

Arial view of SRC:
Proposed water catchment placement #1

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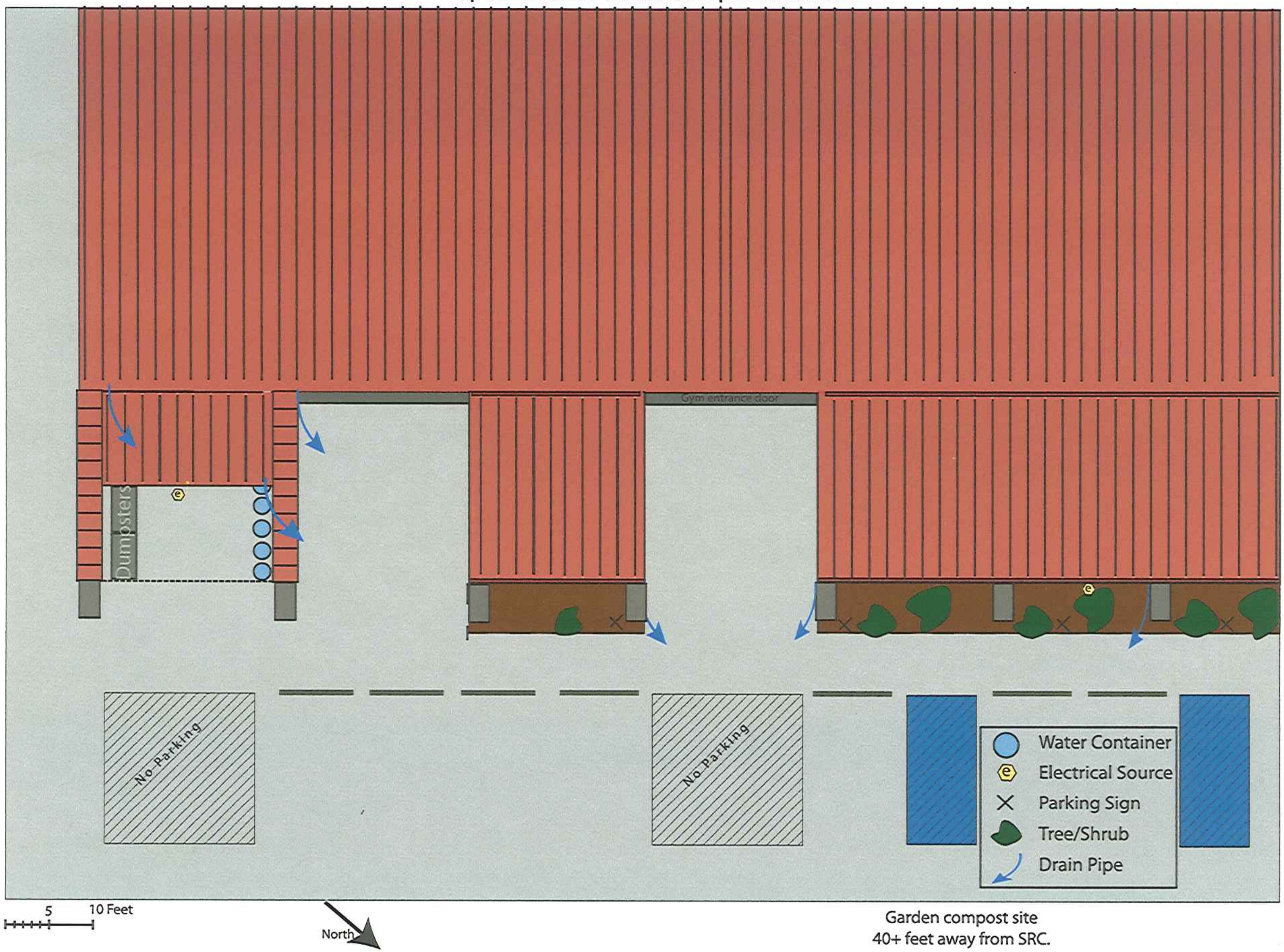
Arial view of SRC:
Proposed water catchment placement #2



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