Rainwater Catchment System Design Manual

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High Tide Permaculture
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HIGH TIDE PERMACULTURE
Regenerative Land-Use Systems

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Memorandum of Understanding

The individual(s) utilizing this manual is responsible for any permitting requirements, professional assessments, adherence to state and local codes and regulations, and assumes all liability related to the information provided as well as any acts or omissions. The information provided are recommendations and not prescriptions of method or manner. The design diagrams are for demonstration purposes only.

INTRODUCTION

This manual introduces design recommendations for a rainwater catchment system. Rainwater catchment systems are a great way to provide irrigation for landscapes and gardens and other forms of non-potable water requirements. They are passive, integrated systems that need very little maintenance if designed and constructed appropriately.

Considering the catchment potential of any site - 1,000-square feet of surface will capture 600-gallons per 1-inch of rain - it is not necessary to store every last drop. A water budget, conservation efforts and bioregionally appropriate plantings will reduce the need for too many tanks. An integrated harvesting system (infiltration site) in conjunction with the system's overflow will recharge groundwater supplies and extend the capacity of the stored water.

SITE ASSESSMENT

Before designing or installing your rainwater catchment system it is important to conduct a site assessment to determine what system is appropriate to your needs.

Climate and Topography

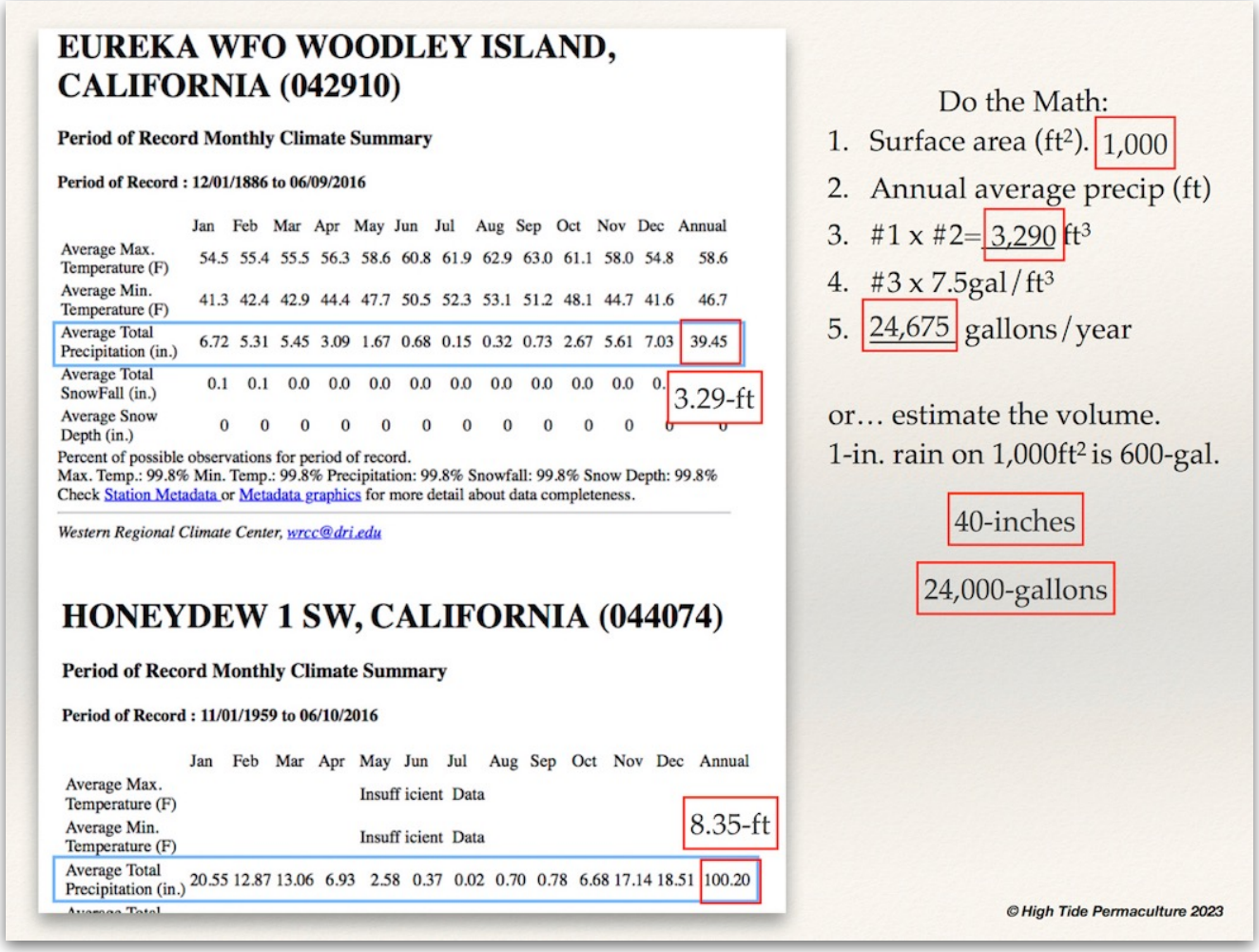
Collecting information related to annual precipitation rates, soil type and soil stability will ensure that the system you design is safe and effective.

- There are many internet sources that can provide you with climate data, specifically the amount of precipitation during an average year broken down by months. The Western Regional Climate Center (https://wrcc.dri.edu/summary/Climsmnca.html) is a good source of information.
- Understanding the type of soil on your property will aid you in determining the size of your water storage. For example, soils that are high in organic content or have low rates of infiltration will require less irrigating since they will retain moisture longer than well draining soils. The USDA Natural Resources Conservation Service (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx) has an online mapping tool to determine your soil type.
- Assessing the topography of your site will enable you to determine the best location for storing your rain water. For example, storing water higher in the landscape will allow for the

use of gravity fed systems. Assessing the topography will also help you avoid future issues such as unstable soil or sites of erosion.

Catchment and Storage Potential

It is important to do the math related to the catchment potential of a structure to determine the amount of storage you can invest in. The following example will help you calculate your catchment potential utilizing the climate data you collected for your region.



EUREKA WFO WOODLEY ISLAND, CALIFORNIA (042910)

Period of Record Monthly Climate Summary

Period of Record : 12/01/1886 to 06/09/2016

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	54.5	55.4	55.5	56.3	58.6	60.8	61.9	62.9	63.0	61.1	58.0	54.8	58.6
Average Min. Temperature (F)	41.3	42.4	42.9	44.4	47.7	50.5	52.3	53.1	51.2	48.1	44.7	41.6	46.7
Average Total Precipitation (in.)	6.72	5.31	5.45	3.09	1.67	0.68	0.15	0.32	0.73	2.67	5.61	7.03	39.45
Average Total SnowFall (in.)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	

3.29-ft

Percent of possible observations for period of record.
Max. Temp.: 99.8% Min. Temp.: 99.8% Precipitation: 99.8% Snowfall: 99.8% Snow Depth: 99.8%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

HONEYDEW 1 SW, CALIFORNIA (044074)

Period of Record Monthly Climate Summary

Period of Record : 11/01/1959 to 06/10/2016

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)					Insuff icient		Data						
Average Min. Temperature (F)					Insuff icient		Data						
Average Total Precipitation (in.)	20.55	12.87	13.06	6.93	2.58	0.37	0.02	0.70	0.78	6.68	17.14	18.51	100.20

8.35-ft

Do the Math:

1. Surface area (ft^2). 1,000
2. Annual average precip (ft)
3. #1 x #2= 3,290 ft^3
4. #3 x 7.5gal/ft^3
5. 24,675 gallons/year

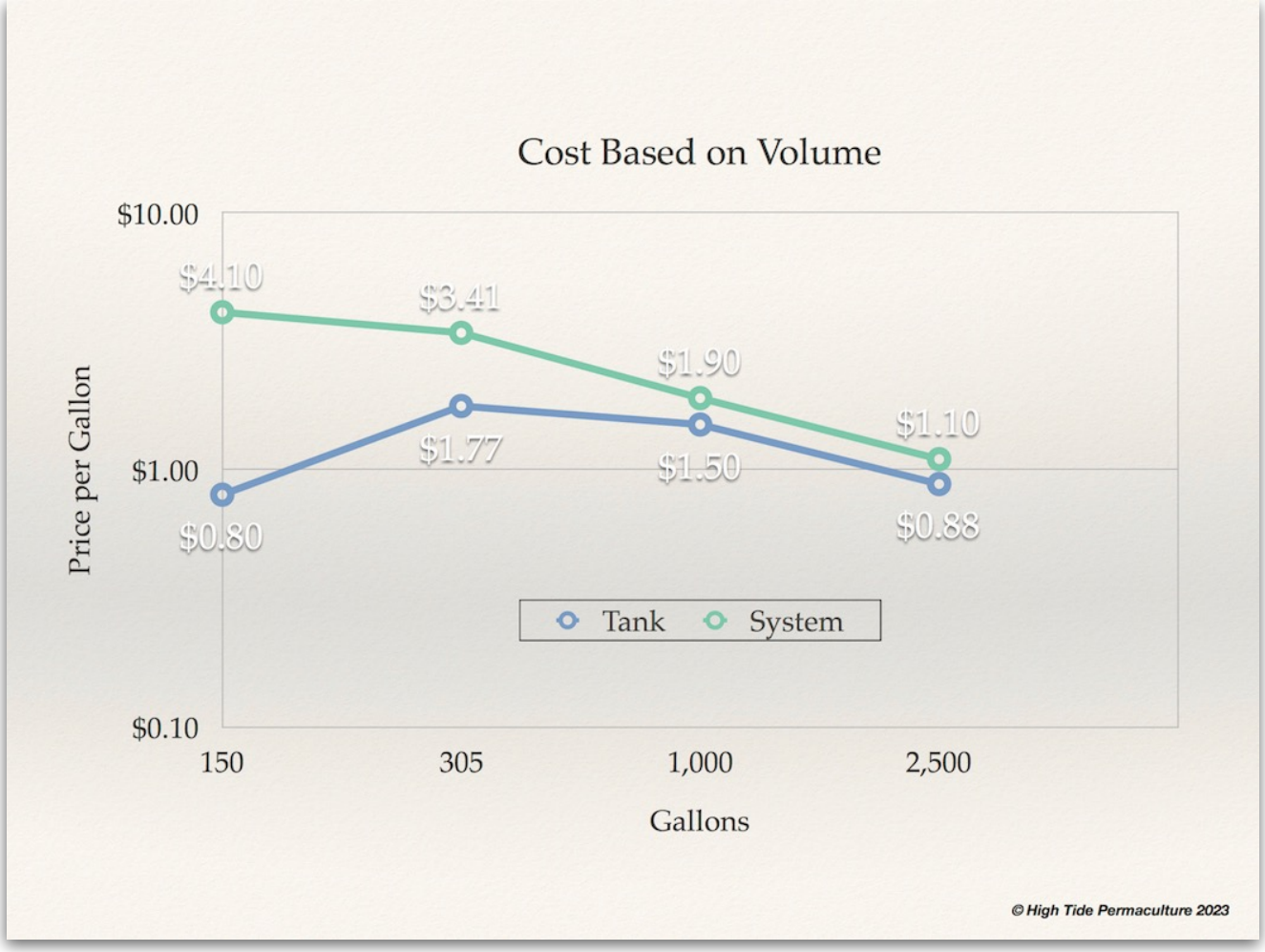
or… estimate the volume.
1-in. rain on 1,000ft^2 is 600-gal.

40-inches

24,000-gallons

Water Budget

The last assessment prior to designing and installing your system is to determine the cost. In areas with reliable water sources supplied by a municipal system, the cost of a rainwater catchment system might be better spent on upgrading your home's energy or climate control systems or expanding your onsite food production. It is important to point out that the figures



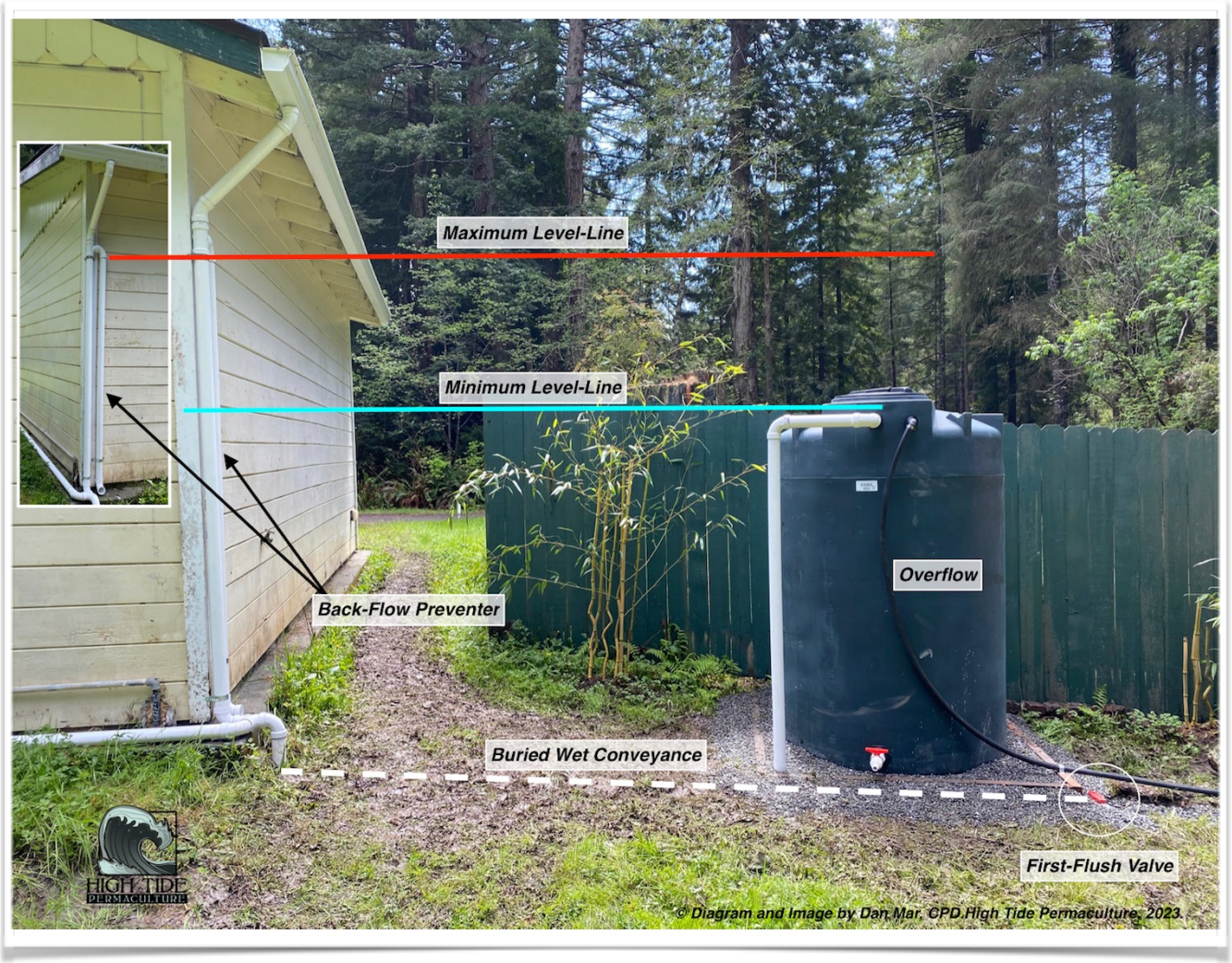
in the above chart represent cost per gallon. For example, a system consisting of three 50-gallon barrels (150-gallons) will cost you $615 in materials ($4.10 per gallon times 150-gallons). 150-gallons will only provide you with enough water to irrigate a few potted plants over the summer. However, the following year the cost of the system will be divisible by 300 because it is the same system but the second time it has filled up. Therefore, the system cost is reduced to $2.05 per gallon. That being said, installing a larger capacity system will give you more bang for your buck over the long term and a greater volume of stored water to do more with.

DESIGN PHILOSOPHY

Wet-Conveyance Based Systems

The rainwater catchment systems in this manual are based on a wet-conveyance system. This type of system retains water in the conveyance plumbing (between the structure and the tank) even when it is not raining. This differs from a dry-conveyance system in that it does not retain water. A dry-conveyance system is based on elevated or overhead plumbing that continually drains into the tank during rain events. However, elevated plumbing is heavy when it is full of water, poses a safety risk and lacks the secondary function of filtration.

A wet-conveyance system works on the principle that water always finds level. As water enters the system from the gutter it fills the lower horizontal plumbing and then subsequently fills both



vertical pipes at the same level line. It will continue to rise on both sides until it spills into the storage tank (minimum level-line). Therefore, the input bulkhead of the storage tank must be at a lower elevation than the water source (gutter) in order for the tank to fill.

The back-flow prevention (set at the maximum level-line) is an integrated redundant system to ensure that rainwater does not backup into the gutter and damage it or the attached structure. This could occur if the horizontal pipe is long and creates a large amount of frictional loss on the flowing water through the pipe or if the rainwater entering the system is at a greater rate than the water flowing into the tank. To prevent this, the back-flow preventer is designed with a bypass fitting that will allow rainwater to drain out as it would with a standard downspout.

As mentioned before, wet-conveyance also acts as a filter to ensure that the water being stored is as clean as possible. As water fills both vertical pipes sediment falls out of suspension and is trapped in the horizontal pipe. This portion of the wet-conveyance acts as a first-flush mechanism, trapping the built up material from the roof and gutter and allowing it to be flushed through the integrated valve into a site of infiltration along with the overflow such as a rain garden or orchard.

DESIGN CONSIDERATIONS

Prior to Installation

1. Design a system that is appropriate to your water needs and the catchment surface. Make sure you are using materials that do not pose a threat to human or ecological health.
2. Design a system that incorporates primary and secondary filtration prior to the tank.
3. Design a system that integrates rainwater harvesting (site of infiltration into soil) with the excess overflow.
4. Rainwater catchment systems are for non-potable use.
5. Rainwater catchment systems require ongoing maintenance. Ensure that you are able to provide the seasonal monitoring and maintenance of your system. Establish a maintenance checklist.
6. Check with local regulatory agencies to determine if permits are required and what specific codes apply to your system.

7. If you are excavating, “Call Before You Dig”. Call 811 to have utilities marked.
8. Ensure that your system meets the required setbacks from a structure’s foundation, septic system, surface water course or other infrastructure that may be impacted or damaged.
9. Site tanks on stable ground, away from steep slopes. Do not elevate tanks. Tanks must be on a stable location and placed on-grade (ground level).
10. Place tanks high in the landscape if possible to utilize gravity for conveying water to places of use.
11. Clean roofs, gutters and gutter drops regularly. In areas where leaf litter is high install a debris screen in the gutters or downspout connections.

During Installation

1. Mock-up your system. Layout all the fittings and reevaluate your design plan. You can’t “unglue” fittings.
2. Get help. Tanks can be heavy and awkward to handle. Measuring, cutting and gluing pipe can be a two person job.
3. Secure tanks to structures that have a small base of support relative to their height (*Slim-Line* tanks and rain barrels).
4. Check the weather. Pipe glue is best to work with in dry conditions to ensure proper adhesion and curing time.
5. Use pipe cutters instead of a saw to cut pipe to avoid the production of micro-plastic waste.
6. Remove threaded parts from fittings during the gluing process to avoid gluing them into place.
7. Install threaded parts such as plugs, nipples and threaded fittings by hand, do not use a wrench. Wrap threads with teflon tape prior to installing.
8. Barbed fittings that connect to poly-pipe require a hose clamp to prevent leaks and disconnection.

After Installation

1. Check fittings for proper adherence.
2. Make sure the tank is level.
3. Check that all caps and plugs are installed.
4. Check that all valves are set to the correct orientation.

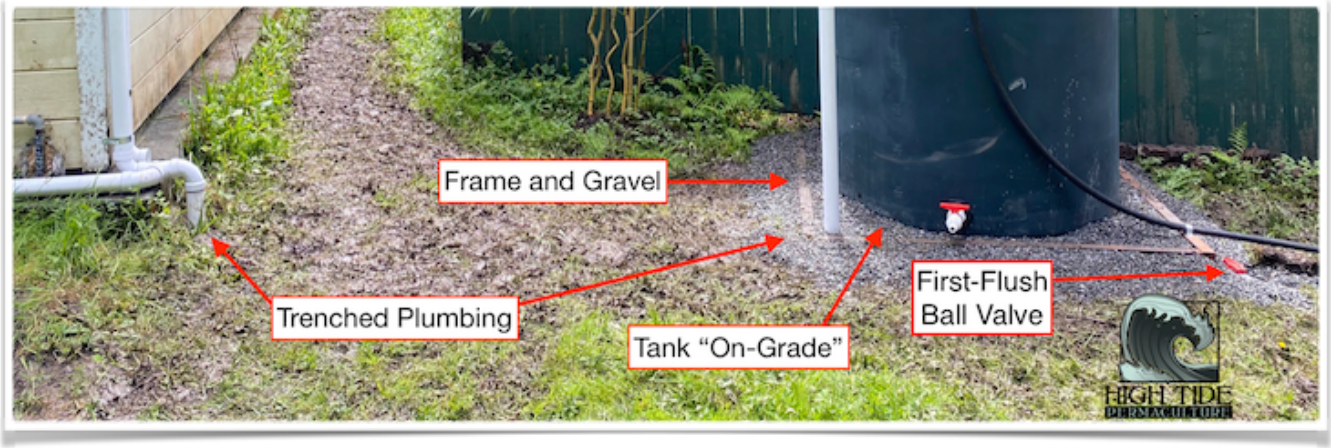
5. Run through the maintenance check list.

DESIGN RECOMMENDATIONS

Conveyance Trenching and Tank Foundation

1. Mark out the tank foundation area with flags or stakes.
2. Build out the tank foundation frame to extend beyond the tank diameter by at least 8-inches.
3. Excavate the area so that the tank bottom and frame top will sit flush with the natural grade.
4. Using the design diagram and a string-line, dig trenches for the wet-conveyance and/or overflow pipes if necessary.
5. Install pipe and fittings within the tank foundation area and backfill with soil.

6. Set the frame in place and check for level. Adjust as necessary.
7. Fill the frame with gravel and rake to level.
8. Lay 2'x4's across the gravel surface to act as rails so that when the tank is installed it does not "plow" the level gravel surface.
9. Set the tank into place atop the 2'x4's. Adjust so that the bulkheads are in the correct orientation. Carefully remove the 2'x4's.



Conveyance System

1. Using the design diagram, cut pipe and mock-up the system by dry fitting all the parts.
2. Using a *Sharpie* marker, make a mark on the pipe and the corresponding fitting so that

   when they are glued together the orientation is correct.
3. Deconstruct the mock-up and prime all pipe ends and inside the fittings.
4. Starting at the gutter, glue and install the plumbing in phases. Hold pieces together for at least 30-seconds to avoid parts from migrating apart.
5. Install pipe straps where necessary.
6. Use a 4-foot level with a 1-inch block attached to one end to ensure that horizontal pipes meet the minimum 2% slope. Use the opposite side of the level and ensure that vertical pipes are level.
7. Use teflon tape on threaded parts as necessary.
8. Backfill all trenches.
9. Install plugs with pipe thread tape after the glue has cured. Hand-tighten only, do not use a wrench.

Tank System

1. Ensure that the tank lines up with the conveyance plumbing and is level.
2. Using the design diagram, cut pipe and mock-up the system as you did in the conveyance portion of the installation.
3. Ensure that the overflow will discharge into an appropriate location and not promote erosion or undermining any structure.
4. If this is a “jumper tank” make sure that there is a redundant overflow and that the distribution plumbing to the main storage tank is of sufficient diameter so as not to restrict flow.

Final Systems Check

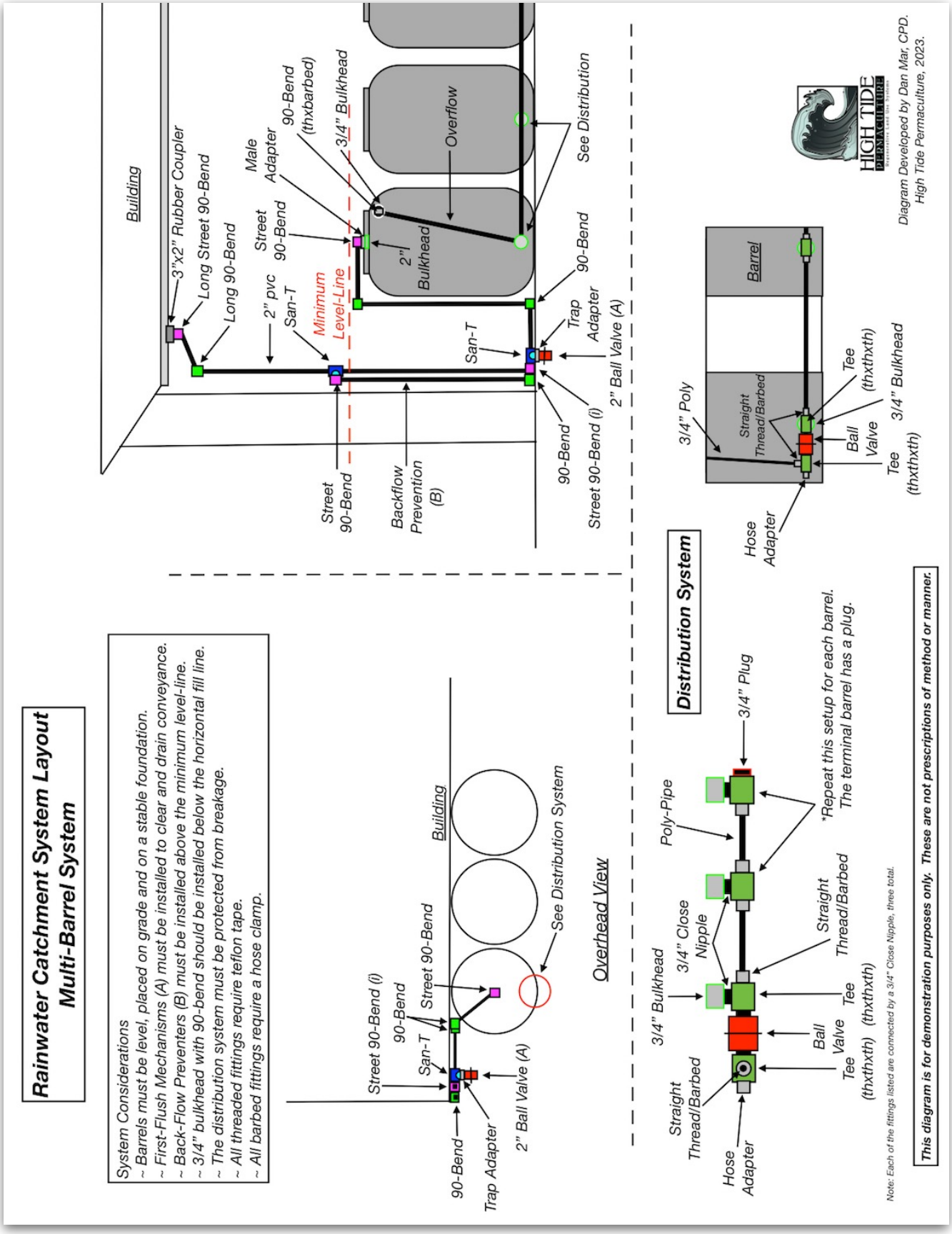
1. Ensure that all pipes are secured with straps or buried in trenched areas.
2. Check that plugs and caps are installed and hand tightened.
3. Set valves to the correct position.
4. Walk through the system as though it was raining and water was present.

Systems Maintenance

1. After the first rain of the season empty the First-Flush Mechanism.
2. Any time there is a lapse in rain events during the wet-season of two weeks or more, empty the First-Flush Mechanism.
3. Check that the system is functioning. 1) Are there any leaks? 2) Is there a plug in the conveyance by evidence that water has come out of the Back-Flow Preventer? 3) Is the tank full (tap on the side or look into the top cap)? 4) If the tank is full, is the overflow functioning?
4. Empty the First-Flush at the end of the wet-season.

TOOLS AND MATERIALS

1. Pipe cutter.
2. 4-foot level with a 1-inch block taped to one end.
3. 1-foot level.
4. PVC primer and glue.
5. Pipe thread tape.
6. Sharpie marker.
7. Tape measure.
8. Screw gun and screws.
9. Pipe straps.
10. Tank Foundation: Redwood 2'x4's, screws, gravel.
11. Shovel, pick, hard rake.
12. PVC pipe and fittings.


Rainwater Catchment System Layout
Multi-Barrel System
System Considerations
~ Barrels must be level, placed on grade and on a stable foundation.
~ First-Flush Mechanisms (A) must be installed to clear and drain conveyance.
~ Back-Flow Preventers (B) must be installed above the minimum level-line.
~ 3/4" bulkhead with 90-bend should be installed below the horizontal fill line.
~ The distribution system must be protected from breakage.
~ All threaded fittings require teflon tape.
~ All barbed fittings require a hose clamp.
Building
3"x2" Rubber Coupler
Long Street 90-Bend
Long 90-Bend
2" pvc
San-T
Minimum Level-Line
Street 90-Bend
Male Adapter
Street 90-Bend
90-Bend (thxbarbed)
3/4" Bulkhead
2" Bulkhead
Overflow
See Distribution
Backflow Prevention (B)
San-T
Trap Adapter
90-Bend
2" Ball Valve (A)
Street 90-Bend
90-Bend (i)
Street 90-Bend (i)
90-Bend
San-T
Street 90-Bend
Building
Trap Adapter
2" Ball Valve (A)
See Distribution System
Overhead View
Distribution System
3/4" Plug
Poly-Pipe
3/4" Bulkhead
3/4" Close Nipple
Straight Thread/Barbed
Hose Adapter
Ball Valve
Tee (thxthxth)
Straight Thread/Barbed
*Repeat this setup for each barrel. The terminal barrel has a plug.
Note: Each of the fittings listed are connected by a 3/4" Close Nipple, three total.
3/4" Poly
Straight Thread/Barbed
Barrel
Hose Adapter
Ball Valve
Tee (thxthxth)
Tee (thxthxth)
3/4" Bulkhead
HIGH TIDE PERMACULTURE
Diagram Developed by Dan Mar, CPD.
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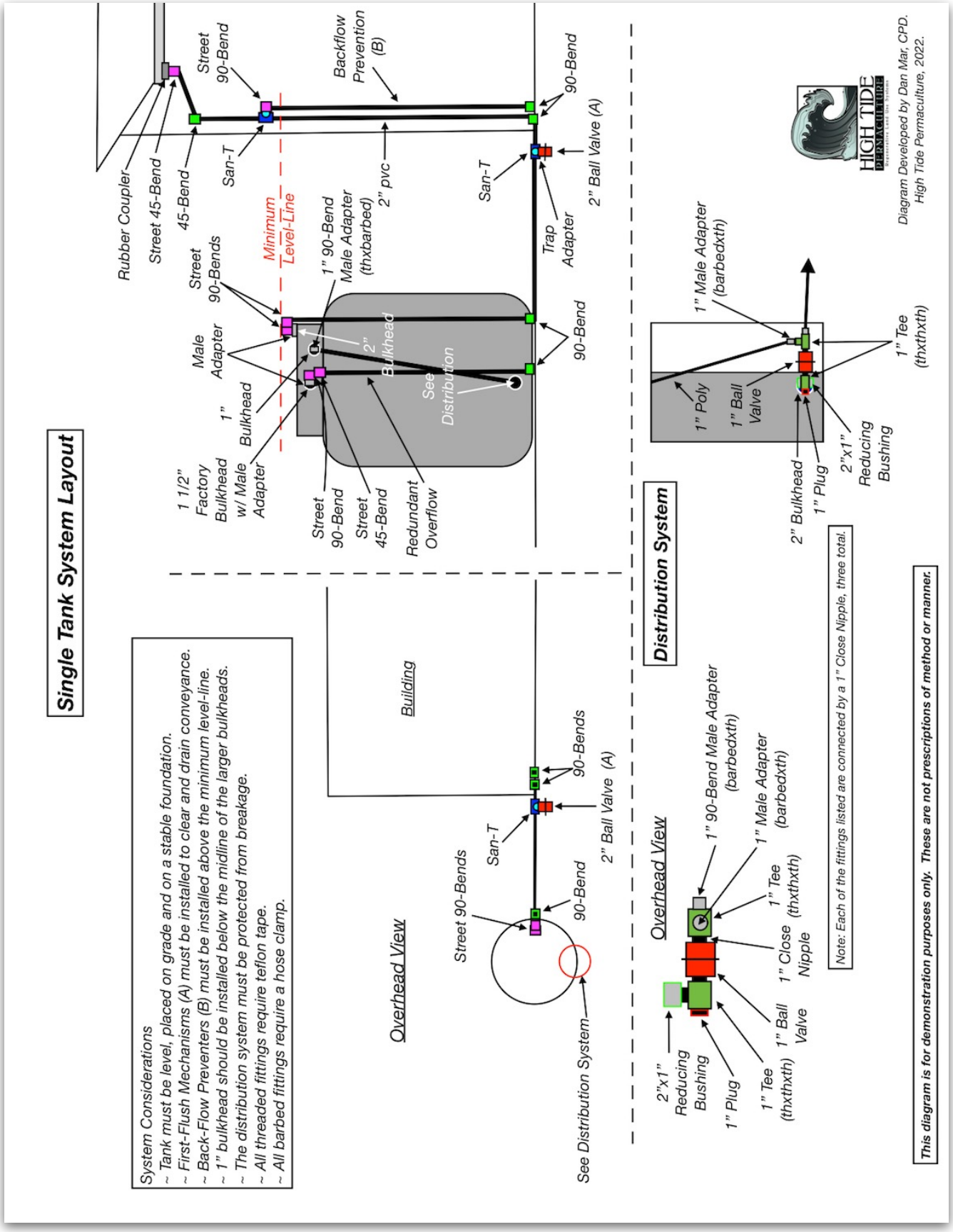
Single Tank System Layout
System Considerations
~ Tank must be level, placed on grade and on a stable foundation.
~ First-Flush Mechanisms (A) must be installed to clear and drain conveyance.
~ Back-Flow Preventers (B) must be installed above the minimum level-line.
~ 1" bulkhead should be installed below the midline of the larger bulkheads.
~ The distribution system must be protected from breakage.
~ All threaded fittings require teflon tape.
~ All barbed fittings require a hose clamp.
Rubber Coupler
Street 45-Bend
45-Bend
Street 90-Bend
San-T
Backflow Prevention (B)
2" pvc
Minimum Level-Line
Street 90-Bends
Male Adapter
1" Bulkhead
1 1/2" Factory Bulkhead w/ Male Adapter
1" 90-Bend Male Adapter (thxbarbed)
2" Bulkhead
See Distribution
Street 90-Bend
Street 45-Bend
Redundant Overflow
San-T
Trap Adapter
90-Bend
90-Bend
2" Ball Valve (A)
Building
Overhead View
Street 90-Bends
San-T
90-Bends
90-Bend
2" Ball Valve (A)
See Distribution System
Distribution System
Overhead View
2"x1" Reducing Bushing
1" Plug
1" Tee (thxthxth)
1" Ball Valve
1" Close Nipple
1" 90-Bend Male Adapter (barbedxth)
1" Male Adapter (barbedxth)
1" Tee (thxthxth)
Note: Each of the fittings listed are connected by a 1" Close Nipple, three total.
1" Male Adapter (barbedxth)
1" Poly
1" Ball Valve
2" Bulkhead
1" Plug
2"x1" Reducing Bushing
1" Tee (thxthxth)
HIGH TIDE PERMACULTURE
Diagram Developed by Dan Mar, CPD.
High Tide Permaculture, 2022.
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Images from pvcfittingsonline.com
Sanitary-T (San-T)
Plug
Poly-Pipe
Bulkhead
Standard Bend
Trap Adapter
Tee (thxthxth)
Street Bend
Ball Valve
Close Nipple
Male Barred Insert Adapter
Male Adapter