City of Bellingham WASHINGTON

Towards Net Zero Water (2012 - 2015)

Project Overview: EV-0102

The Towards Net Zero Water project will retrofit the Public Works Operations facility with a rainwater catchment system. The retrofit will serve as a model for commercial facilities for stormwater management and water conservation by managing 500,000 gallons of rainwater per year for irrigation and non-potable uses, reducing both peak stormwater flows and drinking water use.

Total project cost is $179,000. In 2012, the City of Bellingham Public Works Department was awarded a Stormwater Implementation Grant by the Washington Department of Ecology in the amount of $134,250. The $44,750 match required by the City will be funded by both the water conservation and stormwater utility funds.

Project Details

- Status - Cancelled
- Contract Awarded -
- Contract Amount -
- Contractor -
- Completion Date:
- Final Contract Amount:
- Vicinity Map

Documents

- Pre-Design Report
- Preliminary Schematic
- Project Area Site Map

Affected Neighborhoods

- Roosevelt

Participating Departments

- Public Works

contacts

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Toward Net-Zero Water Use

Fiscal Year 2012 Statewide Stormwater Grant Program

Agreement #G1200580

Pre-Design Report

January 22, 2014

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Introduction

The City of Bellingham uses treated, potable water for all municipal operations and maintenance activities, including street sweeping, sewer jetting, saw cutting, irrigation, and equipment wash-down water. The City's Public Works Operations Facility at 2221 Pacific St is a primary point-of-use for municipal operations water, with an annual usage of approximately 1.5 million gallons per year. The use of treated water for non-potable uses at the site exceeds 1.2 million gallons per year. Comparatively, roof areas on the site generate approximately 1.4 million gallons of stormwater runoff per year.

This retrofit project aims to utilize rainwater harvesting and reuse to address the most accessible non-potable uses on the site, with the intention of offsetting up to 33% of the annual non-potable use. In tandem with this project, the City would be able to reduce runoff from roof areas entering Whatcom Creek, a 303(d)-listed water body, by upwards of 33%. Design of the project, then, requires attention to two connected, but not interdependent, goals.

From the rainwater harvesting perspective, the project will address runoff from approximately 26,015 square feet of existing roof area, which would generate approximately 442,803 gallons of harvestable water per year. This entire volume - representing 36% of current demand - will be captured, stored, and reused on site through this project, exceeding the 33% re-use goal.

From the on-site stormwater management perspective, this project would fully mitigate for 31.6% of all stormwater volumes generated by on-site roofs which currently flow directly into Whatcom Creek. This leaves 1.4% (24,300 gallons, annually) which would need to be addressed to meet the 33% reduction goal. This remainder represents approximately 1,400ft^2 of roof area (out of 56,313ft^2 available) which would need to be infiltrated, treated, or detained in accordance with Department of Ecology Stormwater Management Best Management Practices (BMPs). We hope to incorporate this work into a greater plan for other site improvements which is currently under development. Therefore, details regarding these proposed BMPs will be provided in the 90% design submittal. Potential strategies include bioretention, infiltration trenches, sand filters, or additional rainwater capture and reuse devices.

Due to the fact that non-potable fixtures/demands on-site are not necessarily associated with the largest or most accessible roof areas, systems were designed to maximize the re-use component of the project and minimize overflow events. This approach involves a centralized, 18,000 gallon rainwater harvesting system connected to roof areas from throughout the site, instead of individual tanks associated with each roof area. Re-use fixtures will be designed to mirror the existing condition, with rainwater substituted for potable water, to minimize disturbance or impacts to fixture users. Pumping and pressurization will be necessary to maximize rainwater re-use.

General Basin Description

The Public Works Operations Facility lot coverage is essentially impervious surfaces throughout. Impervious surfaces cover 96% of the site. Of the on-site impervious surfaces, approximately 37% are roof areas with the remaining 63% maintained as conventional asphalt and concrete pavement. Due to pollution generated by historical uses on site (materials storage, fuel station, vehicle maintenance, car wash), a select portion of the pavement (10,000ft^2) drains to sanitary sewer. The remaining impervious lot coverage is directed to storm drains which convey the runoff directly to Whatcom Creek.

Lawn and landscaping occupies only about 4% of the site. Small pockets of landscaping adjacent to property boundaries are present, but many of these areas are in the public right-of-way. All landscaped areas drain into public rights-of-way, where runoff is captured by the municipal stormwater infrastructure.

The basin in which this retrofit will occur includes the entire Public Works Operations Facility, but does not include the southwest parcel occupied by the City of Bellingham Natural Resources Division. This area is not included under this project because a) the Natural Resources Division does have significant needs for non-potable water use, b) the roofing materials associated with the Natural Resources Building are not appropriate for rainwater reuse, and c) the Natural Resources Building is on a separate parcel from the Operations Facility.

Site Maps

1. Utility Map W/Existing Conditions

    Description: Known utilities overlaid on aerial photo with specific site areas named based on non-standardized naming conventions. Useful for utility locations. Building names standardized in pre-design report shown on map #2.

    Created By: City of Bellingham GIS Department

2. Simplified Site Map for Descriptive Purposes/Reference

    Description: Standardized naming for site areas to be used in references within pre-design report and for discussion with consultants, permitting agencies, and public works administration and crews. Red outline is for roof areas (applicable for project) while blue outline is for paved areas (not applicable for rainwater harvesting and re-use).

    Created By: City of Bellingham Public Works Department, Natural Resources Division

Detailed Site Description

Basin Areas

	Acres	% of Total
Total Basin Area (Pre-Retrofit, includes areas not proposed for retrofitting)	5.04	100%
Impervious Surface	4.83	95.8%
Roof	1.89	37.5%
Paving	2.94	58.3%
Pervious Surface	0.21	4.2%
Lawn and Landscaping	0.21	4.2%
	Acres	% of Total
Retrofit Basin Area (Pre-Retrofit)	1.89	100%
Roof	1.89	100%
Retrofit Basin Area (Post-Retrofit)	1.89	100%
Roof	1.89	100%
Rainwater Harvesting and Reuse	0.60	31.5%
Other LID BMPs	0.03	1.7%
Roof Not Addressed	1.26	66.8%

Current Uses

The facility is currently used as the Operations Center for the City of Bellingham's Street, Stormwater, Water, and Sewer maintenance crews. Crews report to the Operations Center to access heavy equipment, stockpiles of materials, and water for non-potable uses. Each building or site area has its own planned use, as detailed on the attached site map #2 titled "Simplified Site Map for Descriptive Purposes/Reference".

- **Materials Storage Shed (Wash Bay) - NON-LEACHING ROOF -** Located along the west property line, this shed roof covers a variety of bulk materials associated with municipal operations. This includes de-icing salt, topsoil, leaf debris removed from ditches, crushed drain rock, and gravel. The equipment wash bay is located in the center of the structure and provides access for potable water use for equipment fill-up, clean out, wash down, and maintenance.
- **Warehouse Building - NON-LEACHING ROOF -** Located along the north property line, this building houses the City of Bellingham Warehouse, a division under the Operations Section of Public Works. Delivery, storage, and stockpiling of specialty materials occur at or in this building.
- **Purchasing Building - ASPHALT SHINGLE ROOF -** Located directly adjacent to the warehouse building, this structure houses the staff training room as well as the offices for Bellingham's purchasing department.
- **Administration Building - ROLLED TAR ROOF -** Located along the east property line, this structure houses the professional Operations staff (management for water, sewer, stormwater, and street maintenance) as well as administrative support and other various office use. City of Bellingham Records (Archives) and Traffic units are housed in the administration building as well.
- **Fleet Building - GALVANIZED METAL ROOF -** Located in the center of the site, this building houses the repair and maintenance operation for City of Bellingham's fleet of publically-owned vehicles.
- **Equipment Shed - GALVANIZED METAL ROOF -** Along the south edge of the property, this shed building houses large pieces of heavy equipment and accessories which are not able to be stored outside.
- **Wash Rack - GALVANIZED METAL ROOF -** Just west of the equipment shed, the City maintains a wash rack which is utilized to provide pressurized wash water for equipment which is not typically washed out in the wash bay in the materials storage shed. This building contains a boiler and a pump to provide high-pressure hot water for cleaning of vehicles.
- **Heavy Equipment Storage Area - PAVING -** To the east of the materials storage shed, a collection of oversized parking stalls are home to the majority of City of Bellingham heavy trucks, trailers, and equipment.
- **Fuel Station Area - PAVING -** Adjacent to the fleet building, two gas pumps provide regular unleaded, on-road diesel, and biodiesel for municipal use. This area is confined by an asphalt berm to ensure that any overfill or spillage is directed to sanitary sewer, and not the storm system.
- **Delivery Vehicle Access Area - PAVING -** Adjacent to the warehouse building, a number of wide-berth parking spots are provided for offloading of large trucks directly into the warehouse. These parking areas are not generally used for municipal vehicles.
- **General Vehicle Parking Areas - PAVING -** Throughout the site, there are parking spaces available for municipal vehicles for inspectors, management, and non-construction uses.

Existing Stormwater Controls - Basic

The City of Bellingham's municipal facility was previously (historically) connected to sanitary sewer, resulting in very few stormwater controls existing on the site. Disconnecting portions of the site from the sanitary sewer system necessitated the installation of a complex series of separate storm drains. This conveyance system contains catch basins and slot drain inlets for sediment removal. No stormwater treatment structures currently exist on site.

The stormwater infrastructure carries stormwater runoff generated on Orleans Street beneath the yard and into existing pipe systems south of the facility. Stormwater from the portions of the site not still connected to sanitary sewer is collected and conveyed directly to a vegetated ditch along Nevada Street along with runoff from surrounding areas.

Existing Stormwater Controls - Enhanced

None.

Soil Suitability

Geotechnical investigations will be performed to evaluate the infiltration capacity for stormwater as well as bearing capacity for potential tank foundations. These investigations will be performed once the final tank configuration, type and location are confirmed.

Vegetation

Small pockets of grass and approximately 10 trees exist on the project site.

Critical Areas

Slope. No critical slopes or known geo-hazards exist within or adjacent to the project.

Shoreline. No shorelines regulated under the City of Bellingham's Shoreline Master Program, or their buffers, are impacted by the project.

Wetlands. No wetlands regulated under the City of Bellingham's Critical Areas Ordinance, or their buffers, are impacted by the project.

Design Alternatives and Analysis

Ranking	Approach	Pros	Cons	Discussion	Decision
1	Harvest and Re-use runoff from **Materials Storage Shed** and **Warehouse** in **centralized** location	Provides the proper supply to meet 1/3 demand and addresses nearly 1/3 roof runoff. Moves water to ideal location for runoff control and water quality BMPS.	Requires additional piping and pumping to move water to centralized location.	Appears to meet both goals of grant project with minimum impact to day-to-day activities.	Preferred alternative
2	Harvest and Re-use runoff from **Materials Storage Shed** and **Warehouse** in **distributed** location(s)	Provides the proper supply to meet 1/3 demand and addresses nearly 1/3 roof runoff. Does not necessitate additional piping or pumping.	Necessitates change in location of water withdrawal on site. Requires distributed BMPs which result in additional disturbance and/or additional utilization of site areas.	Appears to meet both grant project goals, but impacts day-to-day activities at site to a degree to which services could be affected.	Not chosen due to limitations which would require large-scale work on site with limited benefits to water quality or function.
3	Harvest and Re-use runoff from **Materials Storage Shed** Only	Does not require additional piping or pumping to collect rainwater from multiple locations. Tank can be placed in convenient location for harvesting and reuse for some of the annual use. Overflow management BMPs will fit in available space.	Does not provide the proper supply to meet 1/3 demand and does not address 1/3 roof runoff. Would require additional collection and reuse elsewhere on site.	Does not meet both grant project goals.	Not chosen due to insufficiency of water supply in this location.

4	Harvest and Re-use runoff from **Warehouse** Only	More water available than materials storage shed. Does not require additional piping or pumping to collect rainwater from multiple locations.	No current withdrawal point from this building or adjacent areas. Does not provide the proper supply to meet 1/3 demand and does not address 1/3 roof runoff. Would require additional reuse elsewhere on site.	Does not meet both grant project goals.	Not chosen due to insufficiency of water demand in this location.
5	Harvest and Re-use runoff from **Other** roofs	Additional availability for connections to rainwater.	Roof surfaces not preferred for reuse applications due to treatment requirements. Access to downspouts and drains problematic or requires demolition of structure or foundation work. No demand for reclaimed water adjacent to much of this roof.	Evaluation of accessible locations for installation of tanks and fixtures was limited to areas which would not necessitate deconstruction, demolition, or modifications to existing buildings. This, in concert with the roofing types analysis, led to the preferred alternative choice.	Not chosen due to insufficiency of both supply and demand at these locations.

Preferred Alternative Description

The preferred alternative includes collecting rainwater from the roofs of both the Materials Storage Shed and Warehouse, and storing the collected rainwater in a pair of adjacent cisterns near the point of use in the Materials Storage Shed. Rainwater from the Warehouse will be collected in an underground sump, and pumped to the cisterns.

Flow Reduction Calculations

Potable Water Reduction

The largest demand for water onsite is a standpipe fixture in the wash bay. Water from this standpipe is used to wash down vehicles and to fill water trucks used for jetting out storm or sewer pipes as well as other uses around the City, and is not required to be potable. The water usage for these two activities has been monitored for the past eight years, as shown in Table 1 below.

Table 1: Historical Wash Bay Water Demands

Year	Annual Demand	
	CCF	Gallons
2006	1,407	1,052,436
2007	1,557	1,164,636
2008	1,752	1,310,496
2009	1,807	1,351,636
2010	1,675	1,252,900
2011	1,566	1,171,368
2012	1,207	902,836
2013	2,070	1,548,360
Average:	1,630	1,219,334
Average Daily Weekday Demand (gpd):		**4,690**

It is known that the wash bay activities are limited to week days, and are fairly consistent throughout the year. The average annual demand from the historic data was divided by 52 weeks/year and 5 days/week to determine the average weekday water demand for the standpipe, 4,690 gpd.

Methods of Flow Reduction

By collecting and reusing rainwater from two onsite roof surfaces, stormwater flows from the overall site will be reduced. Rainfall data has been collected at the project site for over a decade. In order to estimate how much rainfall could be captured from the two roof surfaces, the daily rainfall data from the last 10 years (2004-2013) was averaged as shown in Table 2 in Appendix A, showing an average annual rainfall amount of 35.36”.

Through evaporation and other losses, it is understood that 100% of the rainfall cannot be collected and stored. By comparing the daily rainfall amounts to the daily runoff volumes generated by the Western Washington Hydrology Model (WWHM) 2012, daily collection efficiencies were calculated with the following equation:

$$Collection\ Efficiency\ (\%) = 1 - \left(\frac{Volume\ of\ Rainfall - Volume\ of\ Runoff}{Volume\ of\ Rainfall}\right)$$

This collection efficiency represents the fraction of rainfall volume that is estimated to runoff the roof surface according to the assumptions built into the WWHM 2012 model. These daily collection efficiencies were applied to the average daily rainfall amounts calculated from the 10 year historical data of the site resulting in an overall collection efficiency of 77% annually resulting in 27.31" of rain capable of being collected over the 26,015ft^2 roof area.

Rainwater will be collected from 26,015ft^2 of the total 82,328 ft^2 roof areas that currently drain to the stormwater system. This represents 31.6% of the total roof runoff from the site. This nearly meets the 33% reduction goal of this project. The remaining 1.4% or 24,300 gallons/year of stormwater will be managed onsite by other BMPs. It is possible in the future to collect and reuse rainwater from other roof surfaces as well once they are replaced with suitable materials.

Modeling Discussion

Based on the rainwater demand calculated in Table 1, and the average rainfall data calculated in Table 2, Table 3 in Appendix A shows the fluctuation of rainwater in and out of the cistern. Table 3 shows the daily average rainfall amounts, and calculated daily collection efficiencies resulting in the daily rainwater collection volumes. The graphs below the Table 3 show the fluctuation in water level in the cistern each day based on the influent rainfall and the effluent water demand. By analyzing these relationships, a cistern volume of 18,000 gallons maximizes the collection potential from both roof surfaces. Looking at the 'Ending Daily Storage Balance' row in Table 3, none of the values exceed 18,000 gallons, meaning that the cistern does not overflow based on average rainfall amounts. An overflow pathway will be installed for the case of a very large rain event or an extended period of no rainwater reuse, but it can be assumed that on average, all of the rainwater is collected and reused without overflowing. This shows us that the annual total 'Daily Rainfall Runoff' of 442,803 gallons will be reused. **This volume accounts for 36.2% of the total annual demand of the standpipe (1,224,023 gallons) therefore exceeding the 33% potable water reduction target for non-potable uses.**

If empty, the 18,000 gallon cistern could store rainwater from up to 1.11" of rain on the 26,015ft^2. collection area before overflowing. It would be rare for more than 1.11" of rain to fall between times when the standpipe is in use, but to maximize the rainwater storage potential it may be an option for staff to fill as many trucks as possible at the end of each day to empty the cistern. This will allow for the maximum storage potential during times when the standpipe is not in use, particularly on the weekends.

Design Drawings (30%)

Sheet RW 1.0: Preliminary Site Plan

Sheet RW 2.0: Rainwater System Schematic

Initial Cost Estimate

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
SCHEDULE A - MOBILIZATION, TESC				
Mobilization	1	LS	$5,799.35	$5,799.35
Erosion Control Measures	1	LS	$2,500.00	$2,500.00
Spill Prevention, Control, and Countermeasures	1	LS	$1,000.00	$1,000.00
Traffic Control	1	LS	$1,000.00	$1,000.00
TOTAL SCHEDULE A				**$10,299.35**
SCHEDULE B - DEMOLITION				
Remove old Gutters and Downspouts	1	LS	$500.00	$500.00
Sawcut existing AC pavement	750	LF	$3.00	$2,250.00
Pavement excavation including haul	128	SY	$4.00	$512.00
TOTAL SCHEDULE B				**$3,262.00**
SCHEDULE C - SITE PREPARATION				
Pipe Trenching and Backfill	375	LF	$10.00	$3,750.00
Reinforced Concrete Slab	400	SF	$5.00	$2,000.00
Pavement Restoration	750	SF	$2.00	$1,500.00
Connect to Storm Drain	2	EA	$500.00	$1,000.00
TOTAL SCHEDULE C				**$8,250.00**
SCHEDULE D - RAINWATER SYSTEM COMPONENTS				
9,000 Gallon Cistern (incl. floating intake, penetrations, installed)	2	EA	$21,250.00	$42,500.00
Sump with Transfer Pump	1	EA	$15,000.00	$15,000.00
Gutter with Gutter Screens	560	LF	$15.00	$8,400.00
Prefilter	3	EA	$750.00	$2,250.00
Isolation Valve	1	EA	$50.00	$50.00
Insulated Enclosure	1	EA	$750.00	$750.00
Booster Pump with Controls	1	EA	$15,000.00	$15,000.00
Bag Filter	1	EA	$100.00	$100.00
Water Meter	1	EA	$250.00	$250.00
2" Backflow Preventer, RPBA	1	EA	$650.00	$650.00
Automated Valve	1	EA	$150.00	$150.00
6" Storm Drain Pipe	100	LF	$35.00	$3,500.00
2" Pressurized Rainwater Pipe	425	LF	$15.00	$6,375.00
TOTAL SCHEDULE D				**$94,975.00**
SCHEDULE E - ELECTRICAL				
Junction Boxes, Cable, Trenching, etc.	1	LS	$5,000.00	$5,000.00
TOTAL SCHEDULE E				**$5,000.00**
			TOTAL - ALL SCHEDULES	**$121,786**
			CONTINGENCY (20%)	**$24,357**
			Sales Tax @8.7%	**$10,595**

TOTAL ESTIMATE INCLUDING SALES TAX	**$156,739**

Proposed Schedule

Phase	Project Action	Status/Schedule
Pre-Design	Consultant Selection	Completed
	SEPA Pre-Determination	Completed, does not require SEPA
	Department of Archeological and Historical Preservation EZ01 Form	Completed, no comments from Tribes regarding additional review or inadvertent discovery planning
	Pre-Design Report	In Process
	Ecology Review and Comment on Pre-Design	In Process
	Survey	To be completed by Sub-consultant. Scheduled for February 2014
	Geotechnical Investigations	To be completed by Sub-consultant. Scheduled for February 2014
	SEPA Final	Not Required
Final Design	Construction Quality Assurance Plan	March-April, 2014
	Final Site Design	April-May, 2014
	Permitting/Local Review	May-June, 2014
	Ecology Review and Comment	June-July, 2014
Construction	Bid Process and Selection	July, 2014
	Site Prep, Utility Marking	July, 2014
	Facility Installation	Start: August, 2014
		Substantially Complete: September, 2014
		Fine Grading/Adjustments (if needed): March-April, 2015
Education	Public Outreach	Ongoing

Appendix A

Table 2: Historic Rainfall Data

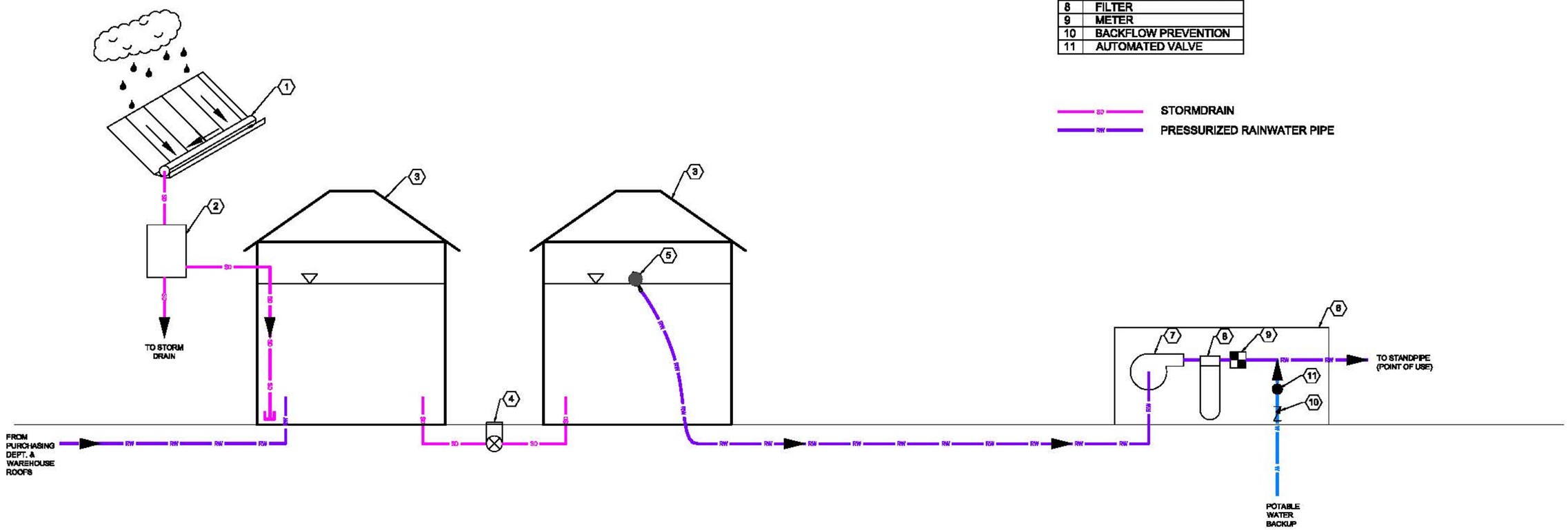
Table 3: Water Balance

Table 4: Site Roof Runoff Analysis

PARTS LIST	
1	GUTTER SCREEN
2	PRE-FILTER
3	9,000 GALLON CISTERN
4	ISOLATION VALVE
5	FLOATING INTAKE
6	INSULATED ENCLOSURE
7	PUMP WITH CONTROLS
8	FILTER
9	METER
10	BACKFLOW PREVENTION
11	AUTOMATED VALVE

SD — STORMDRAIN

RW — PRESSURIZED RAINWATER PIPE



PRELIMINARY
NOT FOR CONSTRUCTION
JANUARY, 2014

NO.	DATE	BY	APPR.	REVISION

ENGINEER:	C. MITHCELL		
DESIGNED BY:	C. MITHCELL	DATE:	1-21-14
DRAWN BY:	J. FORD	DATE:	1-21-14
CHECKED BY:		DATE:	
PROJ. MNGR:	C. MITCHELL		
PROJ. NO:	665C08		
FILE NAME:	665_Schematic.dwg		
SCALE:	1" = 40'		

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PRELIMINARY

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PUBLIC WORKS
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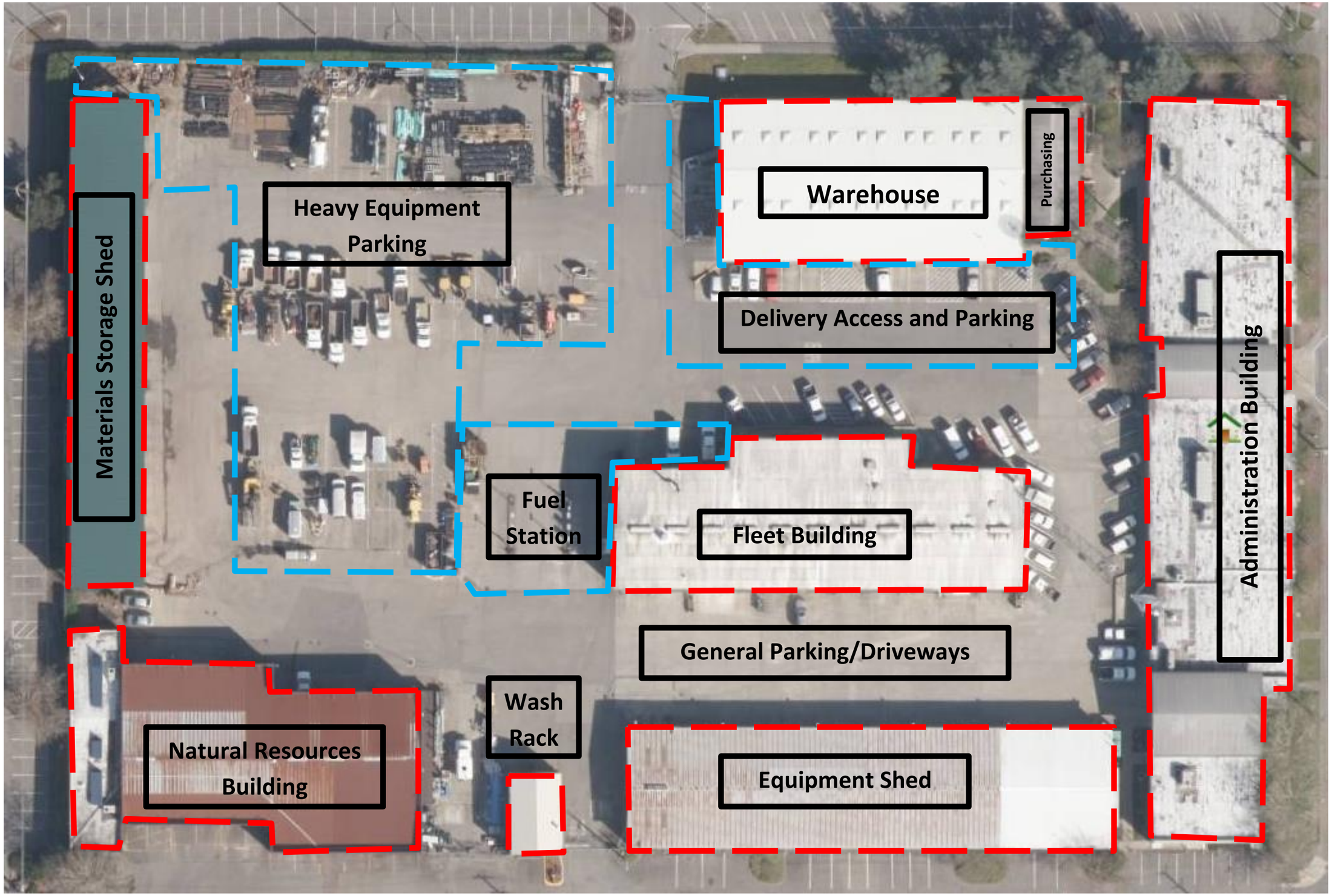
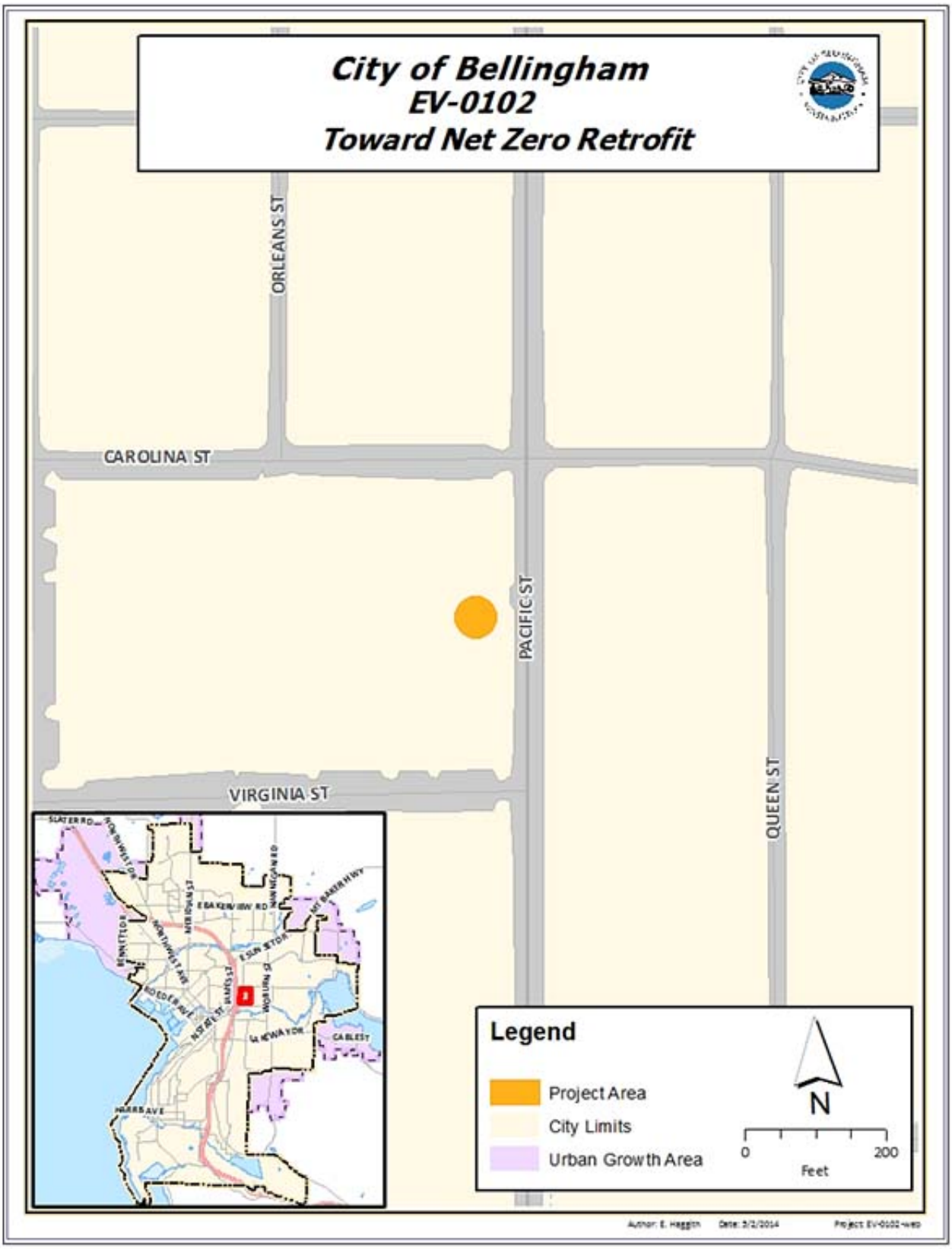
BELLINGHMAM, WA 98225

TOWARDS NET ZERO WATER

RAINWATER SYSTEM SCHEMATIC

SHEET: RW2.0


Materials Storage Shed
Heavy Equipment Parking
Warehouse
Purchasing
Delivery Access and Parking
Administration Building
Fuel Station
Fleet Building
General Parking/Driveways
Wash Rack
Natural Resources Building
Equipment Shed


City of Bellingham
EV-0102
Toward Net Zero Retrofit
ORLEANS ST
CAROLINA ST
PACIFIC ST
QUEEN ST
VIRGINIA ST
Legend
Project Area
City Limits
Urban Growth Area
N
0
200
Feet