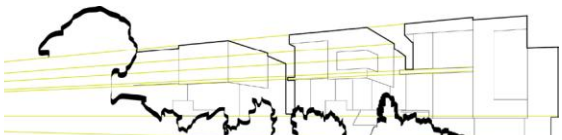
Seattle Built Green Portfolio

Single Family Housing

Analysis and Projections: Strategies and Resource Savings



2008 – 2011

city green building
Seattle Department of Planning & Development

www.seattle.gov/greenbuilding

Introduction

The City of Seattle Built Green portfolio is part of a wide-ranging, collaborative effort led by City Green Building to identify and measure the effectiveness of emerging approaches to sustainable development in the city.

The innovative projects included in the Built Green study range from individual single-family homes to large-scale townhome developments. All share a common theme: they are designed and built to respond more efficiently to the environment around them, providing more comfort for occupants while consuming fewer resources.

The report assesses homes within four categories of performance: indoor water use, stormwater control, energy use and construction waste. The projected performance of the homes is measured against an assumption of baseline performance established using available, sourced industry data and projections. Paladino and Company, Inc. developed the database methodology used to generate the report.

We hope the identified trends - in strategies pursued and projected resource savings - inspire, prompt discussion, and help propel innovation in green building. By providing a snapshot of the leading edge of residential green building today, we hope to help further “green” the homes designed for tomorrow.

----- City Green Building

The Seattle Department of Planning and Development City Green Building established this project with the assistance of Built Green.

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2008 - 2011 Built Green Certified Single Family & Townhome Projects

Credit Achievement Summary: Section 2 - Site & Water (2008 Checklist)

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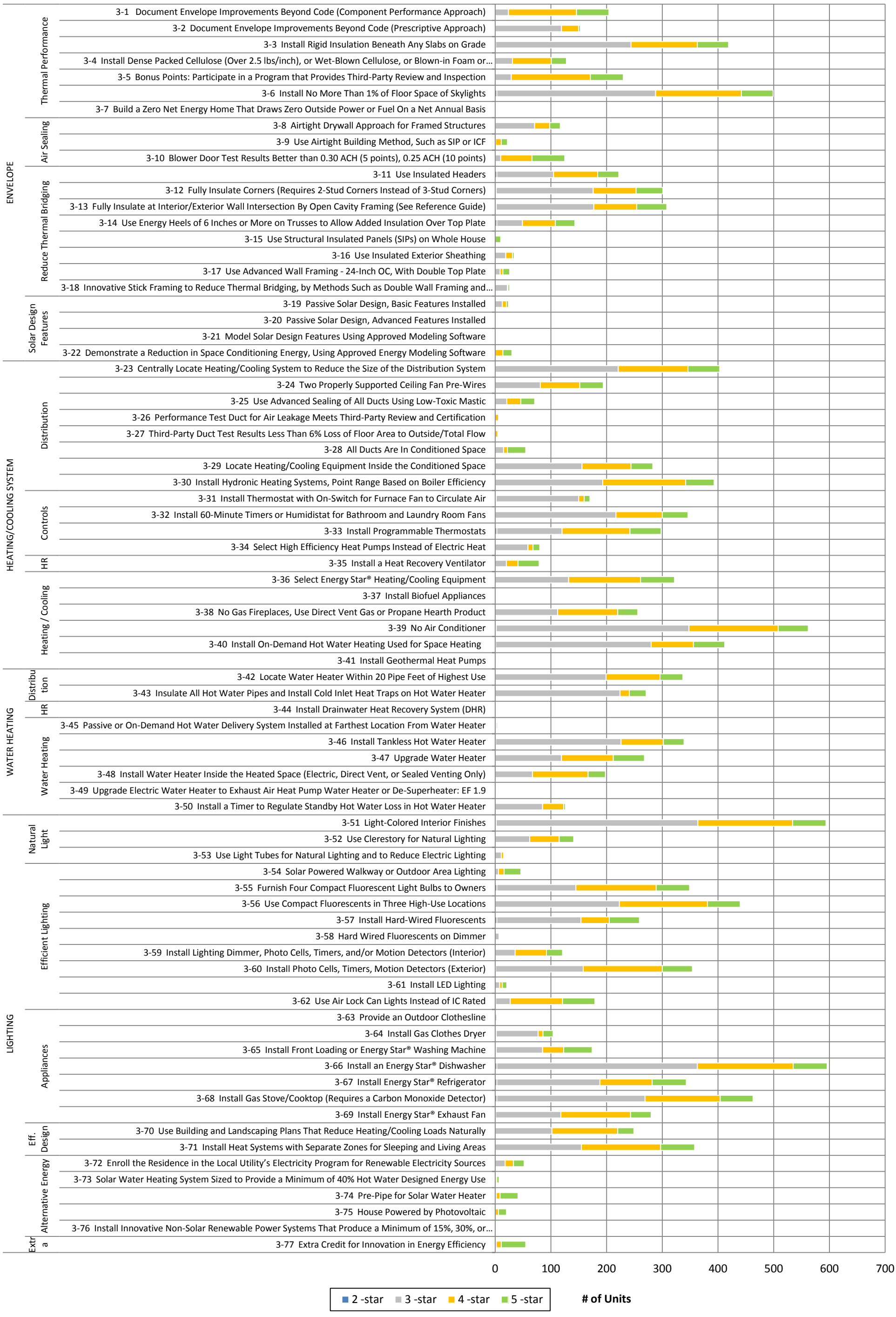
2008 - 2011 Built Green Certified Single Family & Townhome Projects

Credit Achievement Summary: Section 3 - Energy Efficiency (2008 Checklist)



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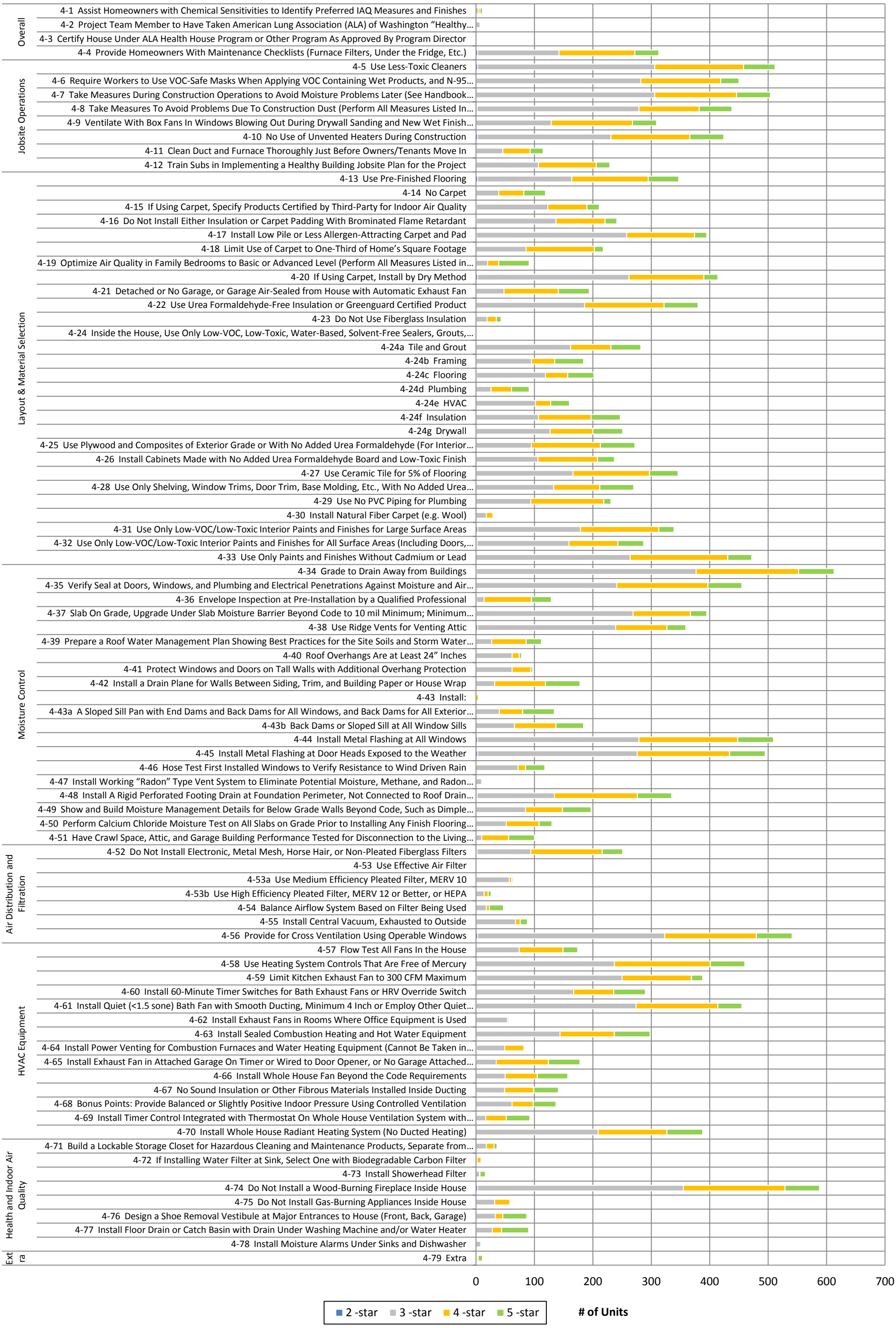
2008 - 2011 Built Green Certified Single Family & Townhome Projects

Credit Achievement Summary: Section 4 - Health & Indoor Air Quality (2008 Checklist)



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2008 - 2011 Built Green Certified Single Family & Townhome Projects

Credit Achievement Summary: Section 5 - Materials Efficiency I (2008 Checklist)

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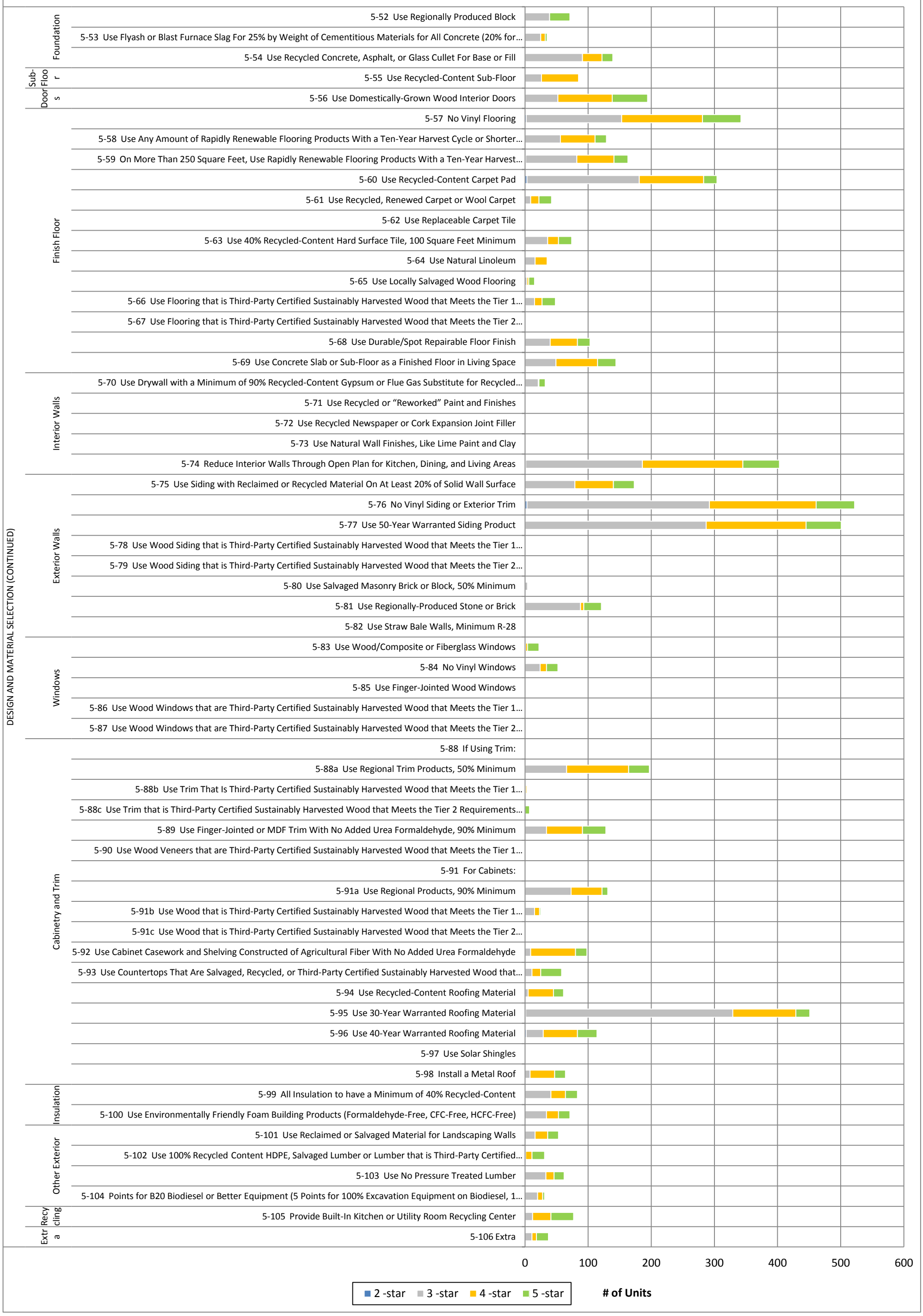
2008 - 2011 Built Green Certified Single Family Projects

Credit Achievement Summary: Section 5 - Materials Efficiency II (2008 Checklist)



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Seattle Built Green Single Family & Townhome Projects 2008 - 2011

INDOOR WATER USE

Introduction

Achievement of these credits maximizes water efficiency within the home to reduce the burden on municipal water supply and wastewater systems. This analysis evaluates the percentage of projects achieving the credits and estimates the total water savings (in gallons per year). The analysis also categorizes the strategies implemented and estimates water saved by each strategy (in gallons per year).

KEY FINDINGS

Baseline

Total Projects	629 units

Indoor Plumbing Faucet Fixtures

Units with Built Green Bathroom Faucet Credit	236 units
Units with Built Green Kitchen Faucet Credit	196 units
Units with Both Faucet Credits	181 units
Units with Either or Both Faucet Credits	251 units

Baseline Bathroom Faucet Volume	5,346,400 gallons per year
Baseline Kitchen Faucet Volume	5,346,400 gallons per year
Total Baseline Faucet Volume	10,692,800 gallons per year

Installed Bathroom Faucet Volume	4,544,000 gallons per year
Installed Kitchen Faucet Volume	4,680,000 gallons per year
Total Installed Faucet Volume	9,224,000 gallons per year

Savings Due to Built Green Faucets	1,468,800 gallons per year

Indoor Plumbing Toilet Fixtures

Units with Built Green High Eff Credit	195 units
Units with Built Green Dual Flush Credit	241 units
Units with Built Green Composting Credit	0 units
Units with Built Green Grey Water Credit	16 units

Baseline Toilet Volume	4,266,600 gallons per year

Total Installed Toilet Volume	3,743,600 gallons per year

Savings due to Built Green Toilets	523,000 gallons per year

Indoor Water Appliances

Units with Built Green Clothes Washer Credit	166 units
Units with Built Green Dishwasher Credit	586 units
Units with Both Appliance Credits	131 units

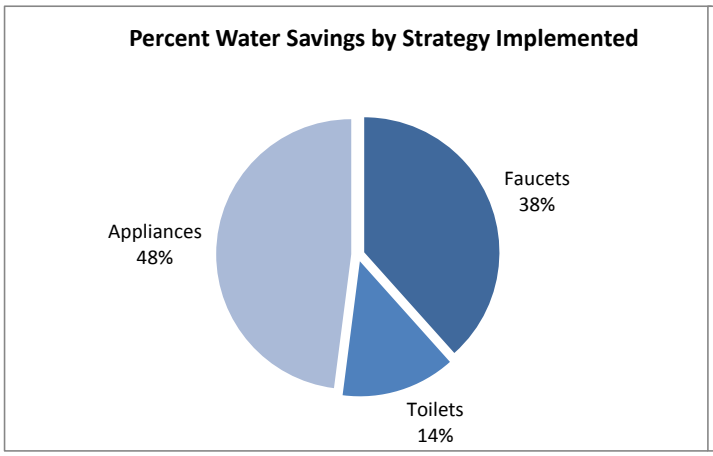
Baseline Clothes Washer Volume	3,017,400 gallons per year
Baseline Dishwasher Volume	4,192,500 gallons per year
Total Baseline Appliance Volume	7,209,900 gallons per year

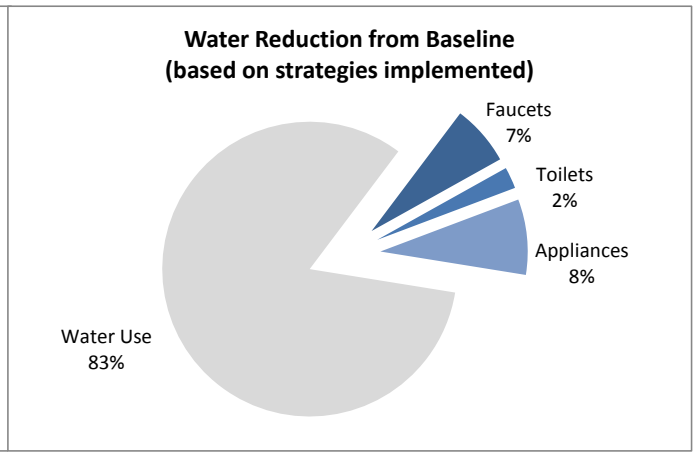
Installed Clothes Washer Volume	2,579,400 gallons per year
Installed Dishwasher Volume	2,795,000 gallons per year
Total Installed Appliance Volume	5,374,400 gallons per year

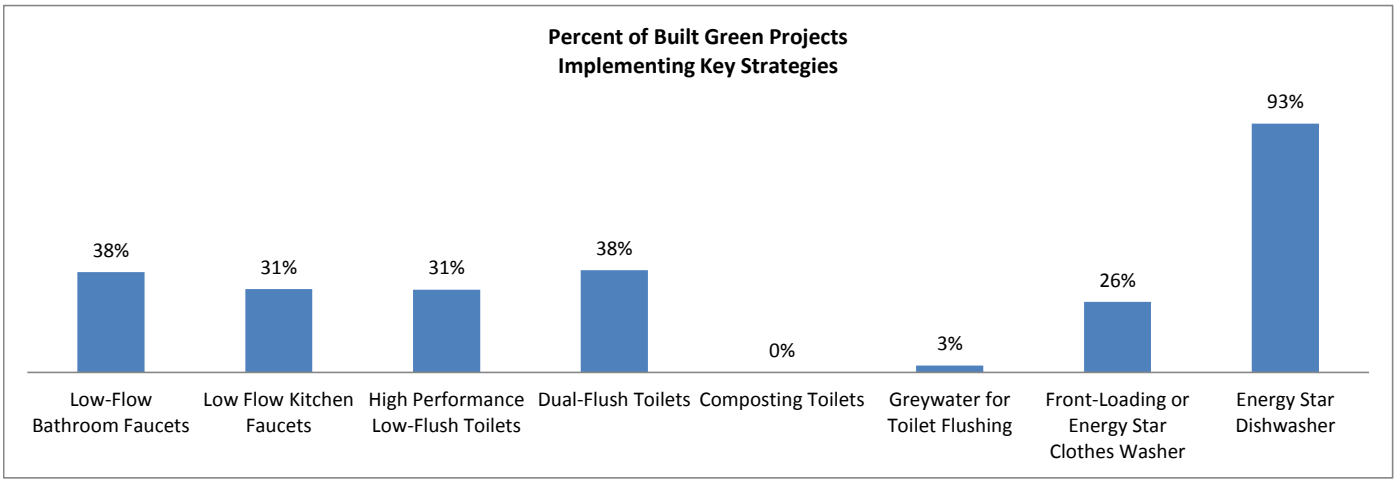
Savings due to Built Green Appliances	1,835,500 gallons per year

Indoor Plumbing Fixtures Water Savings

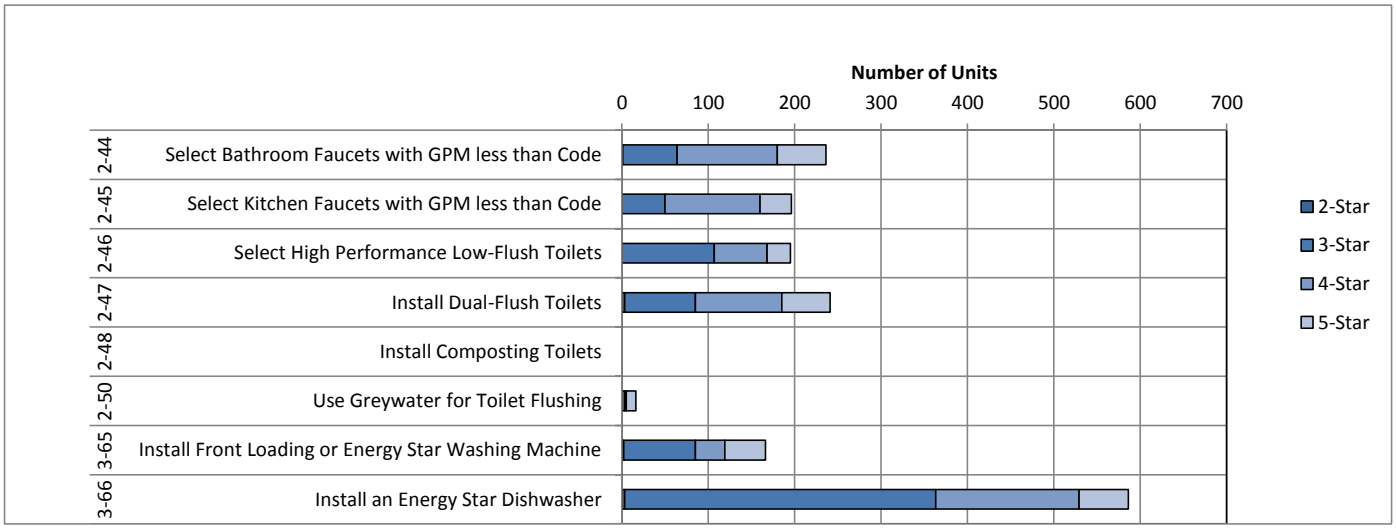
Annual Percent Water Savings	17%
Annual Water Savings	3,827,300 gallons per year







CREDIT ACHIEVEMENT SUMMARY



ASSUMPTIONS AND CONSTANTS

Constant	Value	Units	Source
Dwelling Occupancy	2.3	occupants per dwelling	Seattle Public Utilities
Dwelling Faucet Use	8.1	flow minutes per day per dwelling	AWWARF [1]
Percent Kitchen Faucent Use	50%	ratio of kitchen faucet use to total faucet use	Paladino Assumption
Toilet Use	5.05	flushes per occupant-day	AWWARF [1]
Standard Faucet	2.5	gallons per minute	Seattle Municipal Code
Built Green Faucet	1.5	gallons per minute	US EPA Water Sense
Standard Toilet	1.6	gallons per flush	Seattle Municipal Code
High Efficiency Toilet	1.28	gallons per flush	US EPA Water Sense
Dual Flush Toilet	1.28	average gallons per flush	US EPA Water Sense
Composting Toilet	0	gallons per flush	US EPA Water Sense
Greywater for Toilets	0	gallons per flush	Paladino Assumption
Calendar Occupancy	365	dwelling-days per year	Paladino Assumption

Derived Constant	Value	Units	Source
Percent Lavatory Faucet Use	50%	ratio of lavatory faucet use to total faucet use	Paladino Assumption
Lavatory Faucet Use	4.05	flow minutes per occupant-day	AWWARF [1]
Kitchen Faucent Use	4.05	flow minutes per occupant-day	AWWARF [1]

Toilet Assumptions for Calcuations	Source
Greywater credit: all toilets are considered greywater	Paladino Assumption
Composting credit: one toilet is composting	Paladino Assumption
High Effeciency credit: all toilets are high effeciency unless other credits are taken	Paladino Assumption
Dual Flush credit: calculate # of DF toilets based on number of points achieved	Built Green Rating System
Remaining toilets, if any, are considered standard flush	Paladino Assumption

Constant	Value	Units	Source
Clothes Washer Use	0.1	Washes per day per occupant	Flex Your Power: CA Energy Efficiency Marketing Outreach Campaign Product Guides for Washers & Dishwashers www.fypower.org
Standard Clothes Washer	40.0	gallons per wash	
Ave Energy Star Clothes Washer	18.0	gallons per wash	
Dishwasher Use	0.9	Washes per day per occupant	
Standard Dishwasher	9.0	gallons per wash	
Ave Energy Star Dishwasher	6.0	gallons per wash	

[1] American Water Works Association Research Foundation

Seattle Built Green Single Family & Townhome Projects 2008 - 2011

STORMWATER

Introduction

Achievement of these credits limits disruption of natural hydrology by reducing impervious cover and stormwater runoff from buildings. This analysis evaluates the percentage of projects achieving the credits and estimates the total stormwater runoff savings (in gallons per year). The analysis also categorizes the strategies implemented and estimates water saved by each strategy (in gallons per year).

KEY FINDINGS

TOWNHOME PROJECTS STORMWATER PERFORMANCE

The following key findings are for townhomes only. Seattle Municipal Code was used to estimate the area of the site required for building footprint and landscaping, when that information was not available. It is assumed that any remaining area of the site was impervious. Savings are a reduction of impervious area based on Built Green credits achieved.

Baseline

Total Number of Townhome Units	457 units

Building Runoff

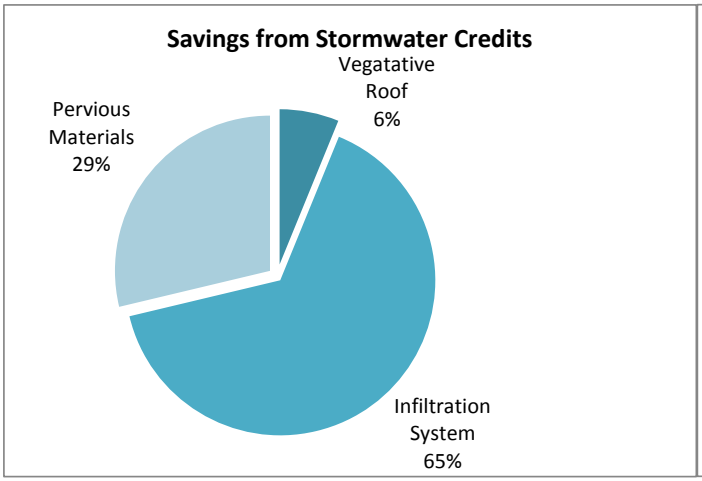
Townhomes with vegatative roofing	25 units
Townhomes with roof infiltration system	85 units
Baseline Building Runoff	4,760,445 gallons per year
Savings in Runoff from Installed Vegetative Roofing	143,883 gallons per year
Savings in Runoff from Installed Roof Infiltration System	1,516,481 gallons per year

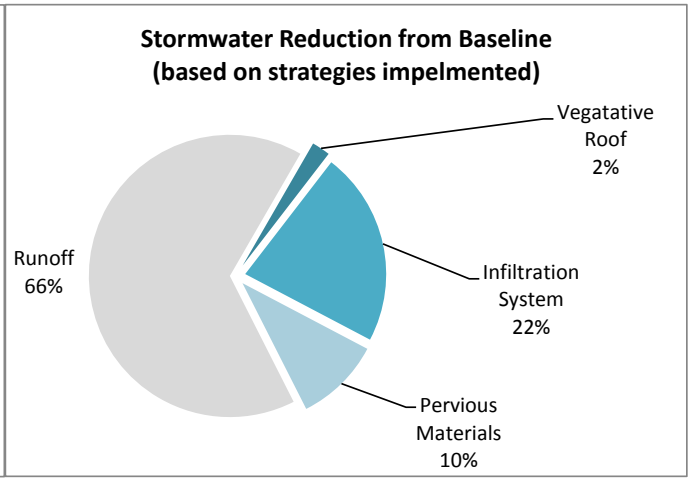
Non-Roof, Impervious Surface Runoff

Townhomes with at least one third pervious surfaces	162 units
Baseline Runoff for Patio, Path, Driveway Impervious Surfaces	2,052,008 gallons per year
Savings from Installed Pervious Surfaces	669,264 gallons per year

Total Stormwater Runoff Savings

Percent Savings to Baseline	34%
Annual Stormwater Savings	2,329,628 gallons per year

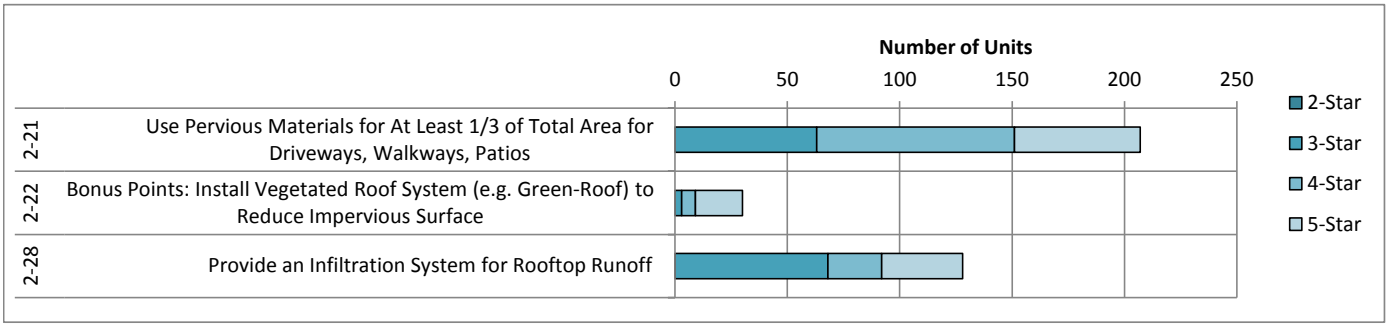




CREDIT ACHIEVEMENT SUMMARY

ALL PROJECTS

The credit achievement summary graph is for both project types: single-family houses and townhomes.



ASSUMPTIONS AND CONSTANTS

Constant	Value	Units	Source
Maximum Lot Coverage (for structures)	50%	Percent	SMC 23.45.010
Ratio of width to depth	1.0	(Lots assumed square)	
Minimum Landscape area per perimeter	3.0	Square Feet Per Linear Foot of Perimeter (feet^2 / foot)	SMC 23.45.015
Percent of non-building, non-landscaped covered by pervious	33%	Percent	Built Green Minimum Requirement
Percent of non-building, non-landscaped covered by impervious	67%	Percent	Built Green Minimum Requirement
Percent of water infiltrated for a green roof	50%		Built Green Handbook
Percent of water infiltrated for a pervious surface	70%	Percent	U.S. EPA NPDES [1]
Average footprint coverage of green roof installations	30%	Percent	
Average percipitation for King and Snohomish County	39	inches per unit area	NOAA Climate Data for Seattle
Percent overflow of roof infiltration systems	0%	Percent	

[1] U.S. EPA National Pollutant Discharge Elimination System (NPDES) - Infiltration
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=137&minmeasure=5

Represents a Placeholder Value

Seattle Built Green Single Family & Townhome Projects 2008 - 2011

ENERGY

Introduction

Achievement of these credits reduces overall energy use and improves energy efficiency to meet the heating/cooling load more effectively. The analysis estimates the average savings per unit (in MWH per year), the total energy savings provided by all participating units (in MWH per year), and also estimates the energy saved by each strategy (in MWH per year or k Therms per year). For overall comparisons the energy savings are reported in MBTU (million BTU).

KEY FINDINGS

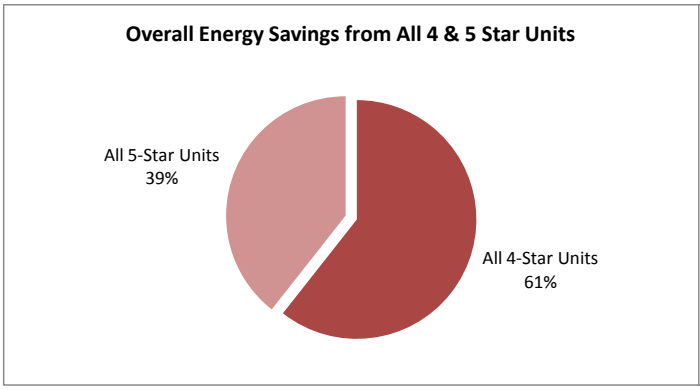
4-STAR & 5-STAR RATED UNITS ENERGY PERFORMANCE

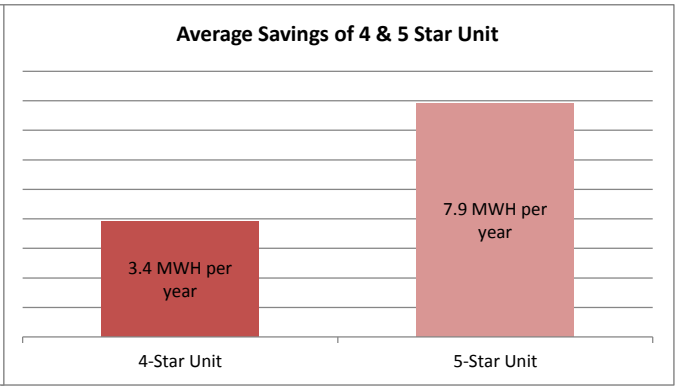
The following energy savings information is reported only for 4-Star and 5-Star rated units. Projects achieving a 4-Star or 5-Star rating must meet Energy Star performance requriements, and the savings from these types of homes has been quantified in a report by Ecotope (please see Assumptions and Constants).

Number of 4-Star Units	177
Number of 5-Star Units	57

Total Energy Saving from 4-Star Units	695 MWh per year	2370.6 MBTU per year
Total Energy Saving from 5-Star Units	451 MWh per year	1539.8 MBTU per year

Average Saving per 4-Star Unit	3.9 MWH per year
Average Saving per 5-Star Unit	7.9 MWH per year





2-STAR & 3-STAR RATED UNITS: ESTIMATED ENERGY SAVINGS FROM INDIVIDUAL CREDITS

The following key findings show estimated energy savings from specific credits for units achieving a 2-Star or 3-Star rating. There are no Ecotope energy saving calculations for 2-Star or 3-Star units and therefore savings for these units were estimated using the following calculations and assumptions.

Equipment

High Efficiency Heat Pumps (3-34)

Units Achieving Credit	59
Lowest Estimated Savings	44.4 MWH per year
Average Estimated Savings	173.1 MWH per year

Tankless Hot Water Heater (3-46)

Units Achieving Credit	226
Estimated Savings	16.7 k Therms per year

High Efficiency Hot Water Heater (3-47)

Units Achieving Credit	119
Estimated Savings	7.6 k Therms per year

Lighting

Use CFL in Three High-Use Areas (3-56)

Units Achieving Credit	223
Estimated Savings	22.1 MWH per year

Appliances

Install Front Loading or Energy Star® Washing Machine (3-65)

Units Achieving Credit	85
Lowest Estimated Savings	2.2 MWH per year
Average Estimated Savings	15.3 MWH per year

Install an Energy Star® Dishwasher (3-66)

Units Achieving Credit	363
Lowest Estimated Savings	3.6 MWH per year
Average Estimated Savings	28.3 MWH per year

Install Energy Star® Refrigerator (3-67)

Units Achieving Credit	188
Lowest Estimated Savings	17.1 MWH per year
Average Estimated Savings	43.4 MWH per year

Lowest 2-Star & 3-Star Units Estimated Energy Savings	2736.5 MBTU per year

Estimated Total Energy Savings (4 & 5 Star Units Total Energy Savings + Lowest 2-Star & 3-Star Units Estimated Energy Savings from Individual Credits)	6646.8 MBTU per year

ADDITIONAL SAVINGS CALCULATIONS

4-STAR & 5-STAR RATED UNITS: ESTIMATED ENERGY SAVINGS FROM INDIVIDUAL CREDITS

The following key findings show estimated energy savings from specific credits for units achieving a 4-Star or 5-Star rating.

Equipment

High Efficiency Heat Pumps (3-34)

Units Achieving Credit	17
Lowest Estimated Savings	12.8 MWH per year
Average Estimated Savings	49.9 MWH per year

Tankless Hot Water Heater (3-46)

Units Achieving Credit	107
Estimated Savings	7.9 k Therms per year

High Efficiency Hot Water Heater (3-47)

Units Achieving Credit	142
Estimated Savings	8.2 k Therms per year

Lighting

Use CFL in Three High-Use Areas (3-56)

Units Achieving Credit	208
Estimated Savings	20.6 MWH per year

Appliances

Install Front Loading or Energy Star® Washing Machine (3-65)

Units Achieving Credit	81
Lowest Estimated Savings	2.1 MWH per year
Average Estimated Savings	14.6 MWH per year

Install an Energy Star® Dishwasher (3-66)

Units Achieving Credit	223
Lowest Estimated Savings	2.2 MWH per year
Average Estimated Savings	17.4 MWH per year

Install Energy Star® Refrigerator (3-67)

Units Achieving Credit	145
Lowest Estimated Savings	13.2 MWH per year
Average Estimated Savings	33.5 MWH per year

ALL UNITS: ESTIMATED ENERGY SAVINGS FROM INDIVIDUAL CREDITS

The following key findings show estimated energy savings from specific credits for all units

Equipment

High Efficiency Heat Pumps (3-34)

Units Achieving Credit	76
Lowest Estimated Savings	57.2 MWH per year
Average Estimated Savings	223.0 MWH per year

Tankless Hot Water Heater (3-46)

Units Achieving Credit	333
Estimated Savings	24.6 k Therms per year

High Efficiency Hot Water Heater (3-47)

Units Achieving Credit	261
Estimated Savings	16.5 k Therms per year

Lighting

Use CFL in Three High-Use Areas (3-56)

Units Achieving Credit	431
Estimated Savings	42.7 MWH per year

Appliances

Install Front Loading or Energy Star® Washing Machine (3-65)

Units Achieving Credit	166
Lowest Estimated Savings	4.3 MWH per year
Average Estimated Savings	29.9 MWH per year

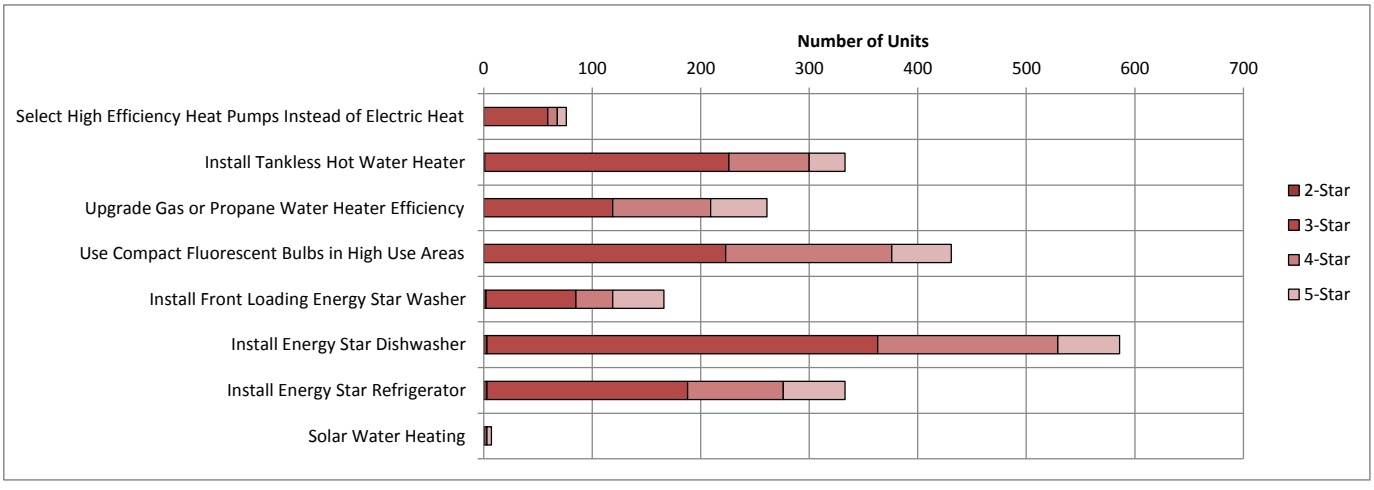
Install an Energy Star® Dishwasher (3-66)

Units Achieving Credit	586
Lowest Estimated Savings	5.9 MWH per year
Average Estimated Savings	45.7 MWH per year

Install Energy Star® Refrigerator (3-67)

Units Achieving Credit	333
Lowest Estimated Savings	30.3 MWH per year
Average Estimated Savings	76.9 MWH per year

CREDIT ACHIEVEMENT SUMMARY (ALL PROJECTS)

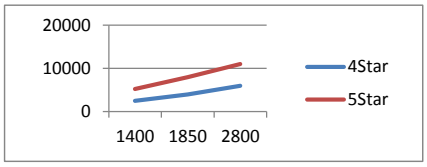


ASSUMPTIONS AND CONSTANTS

Units achieving the 3-46 Tankless hot water heater are gas

2008 Town Homes (TH) are assumed to be 1400 square feet
2008 Single Family (SF) homes are assumed to be 1850 square feet
Based on data from Ecotope Report[1], a linear relationship between energy savings and building square footage is assumed for 4-Star and 5-Star projects.
4-Star projects assume 2 kWh/sf/year and 5-Star projects assume 4 kWh/sf/year savings

KWatt Hour per Year[1]		
SqFt	4Star	5Star
1400	2500	5250
1850	4000	8000
2800	6000	11000



Constant	Value	Units	Source
4-Star Savings per SqFt	2.1	Kilowatt Hours per Year Savings	Ecotope Report (2008) [1]
5-Star Savings per SqFt	4.0	Kilowatt Hours per Year Savings	Ecotope Report (2008) [1]
kWh to BTU	3,412	BTUs per kWh	
BTU to Therm	100,067	BTUs per Therm (100 ccf of natural gas)	
Lowest-Saving of the High-Eff Heat Pump	752	Kilowatt Hours per Year Savings	RTF Forum [2]
Average-Savings of the High-Eff Heat Pumps	2934	Kilowatt Hours per Year Savings	RTF Forum [2]
Savings per gas tankless hot-water heater	74	Therms per year	Energy Star [3]
Savings per unit achieving any credits for 3-56 CFL lighting	99	kWh savings per unit	Seattle City Light
Lowest-Saving of the Eff Clothes Washers	26	Kilowatt Hours per Year Savings	RTF Forum [2]
Average-Savings of the Eff Clothes Washers	180	Kilowatt Hours per Year Savings	RTF Forum [2]
Lowest-Saving of the Energy Star Dishwashers	10	Kilowatt Hours per Year Savings	RTF Forum [2]
Average-Savings of the Energy Star Dishwashers	78	Kilowatt Hours per Year Savings	RTF Forum [2]
Lowest-Saving of the Energy Star Refrigerators	91	Kilowatt Hours per Year Savings	RTF Forum [2]
Average-Savings of the Energy Star Refrigerators	231	Kilowatt Hours per Year Savings	RTF Forum [2]
Water Heater Upgrade Savings 3-47, 2 Credits	18	Therms per year	Energy Star [3]
Water Heater Upgrade Savings 3-47, 4 Credits	74	Therms per year	Energy Star [3]
Water Heater Upgrade Savings 3-47, 7 Credits	74	Therms per year	Energy Star [3]

[1] Ecotope Residential Energy Comparison: Built Green and LEED; prepared for the City of Seattle; October 16, 2008

[2] Regional Technical Forum - Planning, Tracking, and Reporting System v2.0

[3] Energy Star Residentail Water Heaters: Draft Criteria Analysis
http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/WaterHeaterDraftCriteriaAnalysis.pdf

Seattle Built Green Single Family & Townhome Projects 2008 - 2011

CONSTRUCTION WASTE

Introduction

Achievement of these credits diverts construction and demolition debris from disposal in landfills and incinerators. Recycling waste reduces disposal fees and overall construction costs, and provides "stock" for new materials to be manufactured. This analysis categorizes the method of recycling (source separated or commingled), the percentage of each waste stream diverted, and estimates the total waste diverted from the landfill (in tons).

KEY FINDINGS

COMMINGLED RECYCLING CREDITS

Construction Waste Recyled

Unit Diverting Waste to 50% Recycling Facility (5-24)	120 units
Unit Diverting Waste to 75% Recycling Facility (5-25)	123 units
Unit Diverting Waste to 85% Recycling Facility (5-26)	93 units

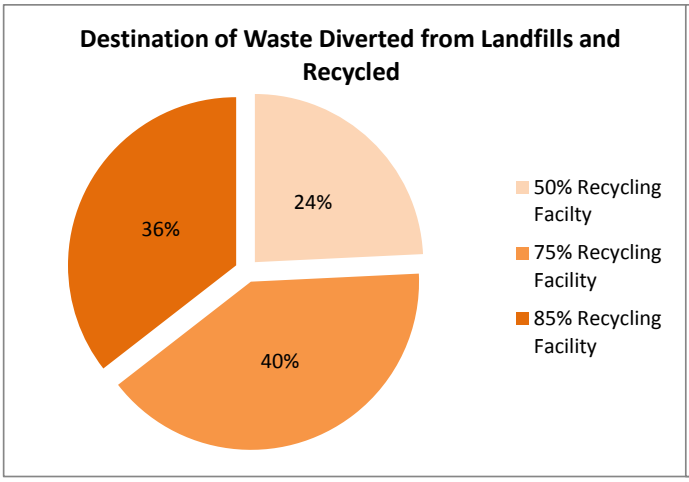
Construction Waste Recyled

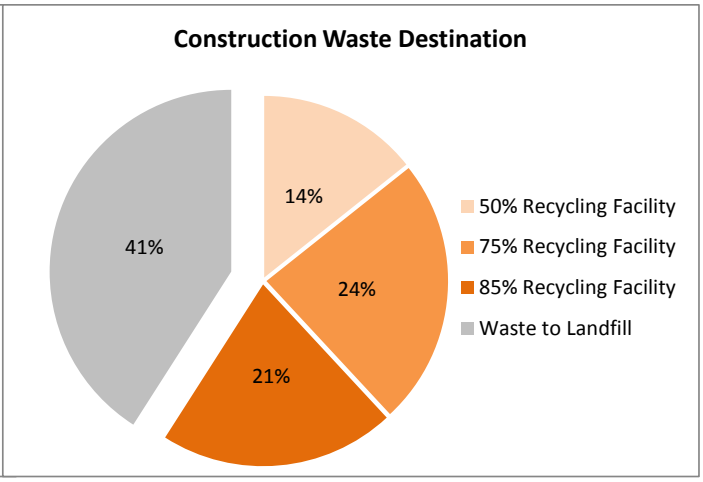
Square Footage of Units Diverting Waste to 50% Recycling Facility (5-24)	210,825 Sq Ft
Square Footage of Units Diverting Waste to 75% Recycling Facility (5-25)	233,452 Sq Ft
Square Footage of Units Diverting Waste to 85% Recycling Facility (5-26)	181,696 Sq Ft

Actual Construction Waste to Landfill *	578 Tons

Total Waste Diverted from Land Fill and Recycled

From 50% Recycling (5-24)	202 Tons
From 75% Recycling (5-25)	336 Tons
From 85% Recycling (5-26)	296 Tons
Total	834 Tons



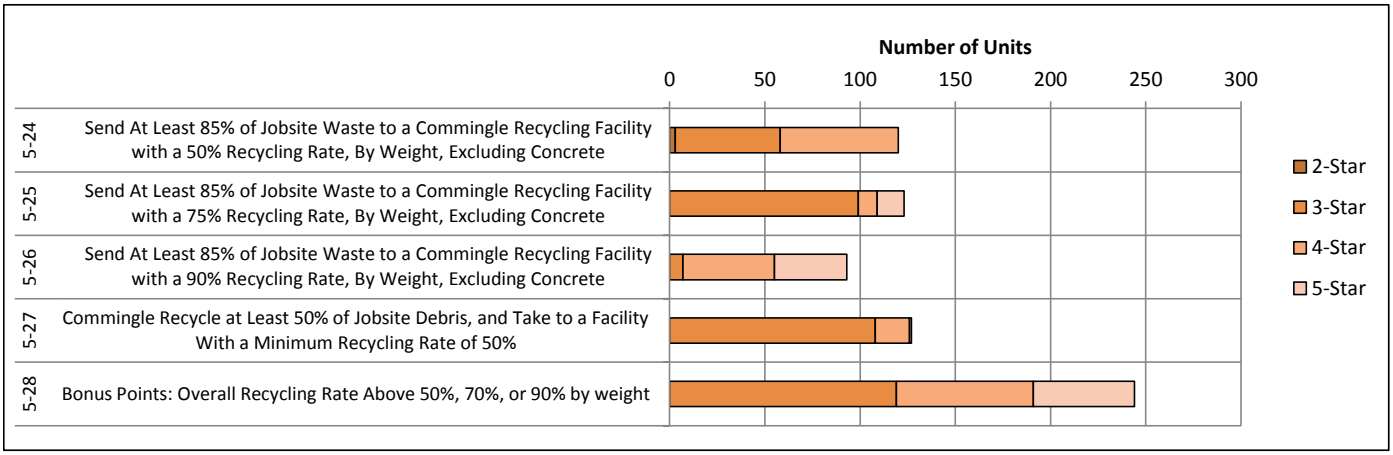


* Does not include information on projects not achieving any credits related to construction waste

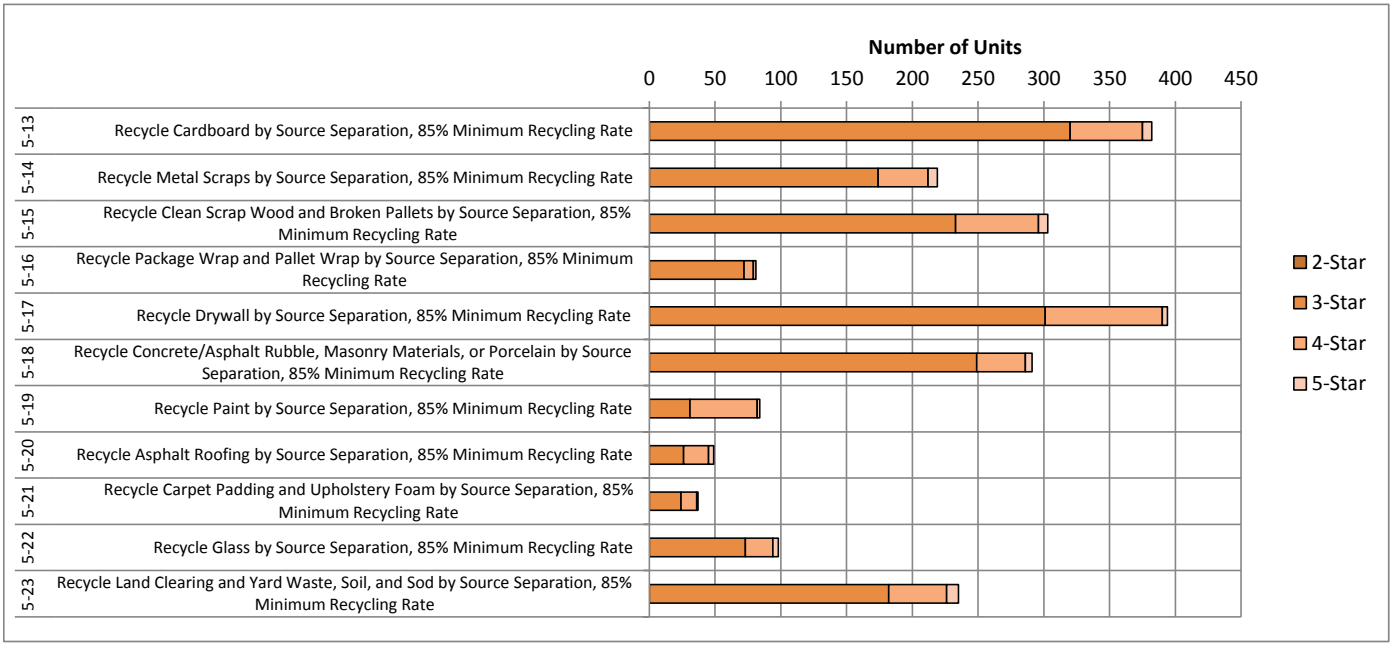
Calculation Method: 85% x (Unit Area x Unit Waste Rate x Facility Recycling Rate)/(Pounds Per Ton)

CREDIT ACHIEVEMENT SUMMARY

COMMINGLED RECYCLING CREDITS



SOURCE SEPARATED RECYCLING CREDITS



ASSUMPTIONS AND CONSTANTS

Constant	Value	Units	Source
Unit Waste Rate	4.5	Pounds per Square Foot	U.S. EPA [1]
5-24 Recycling Rate	50%	Percent	
5-25 Recycling Rate	75%	Percent	
5-26 Recycling Rate	85%	Percent	
Pound to Ton Conversion	2000	Pounds per Ton	

[1] EPA Characterization of Building Related C&D Debris in the United States, December 2005