



SEATTLE HOUSING AUTHORITY

Denny Terrace

Addendum to Energy and Water Survey

12/10/2010

This document represents a summary of the energy and water saving measures represented in the design documents for the Denny Terrace Apartments retrofit. This is an addendum to the original report by ArchEcology, LLC issued on October 21, 2009.

**Addendum to Energy and Water Survey
For Denny Terrace Apartments**

Table of Contents

I.	Description of Scope.....	3
II.	Summary of Revisions to Energy and Water Simulation.....	3
	A. Envelope.....	3
	B. Lighting.....	3
	C. HVAC.....	3
	D. Domestic Hot Water.....	4
	E. Water Fixture and Appliances	4
III.	Results	4
IV.	Energy Simulation Inputs	5
V.	Energy Simulation Results – Run 1 - As Designed	9
VI.	Energy Simulation Results – Run 2	11

I. Description of Scope

The Denny Terrace project was awarded funding and is proceeding. While many of the recommendations in the report dated 10/21/2009 were implemented in the design, there are a number of elements which differ. ArchEcology was asked to revise the proposed building energy simulation to match the construction documents, as confirmation that the building would achieve the projected energy and water savings.

In addition, the Owner sought to assess the effectiveness of increasing the exterior insulation thickness to improve the thermal performance of the building envelope.

The following information is based on the construction documents from DKA Architecture, and Wood Harbinger mechanical and electrical engineers as well as product data submitted by the contractor.

II. Summary of Revisions to Energy and Water Simulation

A. Envelope:

1. Exterior Insulation Finish System (EIFS) EPS foam as specified achieved an R-value of 7.7, instead of R-10.5 in the original model
2. Windows were revised to double glazed with argon throughout the building, instead of higher performance glass on the West and South facades. Windows specified have a thermal performance of $U=0.31$ and $SHGC=0.63$.
3. Roof insulation is being replaced with R-38 polyisocyanurate, which is improvement from the existing roof of R-30. The roof is specified as a built-up modified bitumen roof.

B. Lighting:

1. Residential light fixtures are all being replaced with fluorescent fixtures as recommended, however the lighting power density is higher than the 0.3 W/SF in the proposed model. Lighting power density in residential units is an average of 0.6 W/SF.
2. Lighting in corridors and common areas is also being replaced, but the designed lighting power density (0.85 W/SF) is higher than originally modeled (0.75 W/SF).
3. Exterior light fixtures are being replaced with more efficient fixtures; however new lighting was added to the building façade. The overall designed lighting power is approximately 2.26 kW, which is higher than the 1.2 kW in the proposed model.

C. HVAC:

1. As recommended, all residential baseboard heaters are being replaced with new lower wattage heaters. In the proposed model the heaters were "auto-sized" since the exact equipment capacity was not known. The model has been revised to reflect that designed heater capacity.
2. As recommended, the corridor AHUs are being replaced with more efficient equipment. In the proposed model the heaters were "auto-sized" since the exact equipment capacity was not known. The model has been revised to reflect that designed AHU's air volumes and heating capacity.

D. Domestic Hot Water:

1. Existing electric water heaters are being replaced with new electric water heaters. The model was updated to reflect the designed capacity and efficiency of the water heaters.

E. Water Fixtures and Appliances:

1. Water closets are being replaced with high efficiency pressure assist water closets. The water consumption is 1.0 GPF, which is lower than the recommended water consumption of 1.28 GPF.
2. Shower heads are being replaced with new 1.5 GPM fixtures, which is lower consumption than the recommended 1.8 gpm fixtures.
3. Kitchen faucets are being replaced with new 0.5 GPM fixtures, which is lower consumption than the recommended 1.8 gpm fixtures.
4. Laundry equipment is being replaced. New high efficiency washers use 13.3 gallons per cycle on average (per Energy Star website).

III. Results

The “as designed” case looked at two simulation runs. Run 1 represents the building as it is designed. Run 2 included an additional ½ of EPS foam to the building exterior. All other elements of Run 2 are the same as Run 1. The results of these runs were then combined with the results of the water reduction calculations. Details of the energy simulation runs and the combined energy/water conservation results are found in at the end of this addendum. A summary of the results is listed below.

The combined energy/water conservation percentage for each of the runs is calculated according the formula provided by HUD:

$$(\% \text{ energy savings} \times 70\%) + (\% \text{ water savings} \times 30\%) = \text{Total percentage of energy/water consumption savings.}$$

Summary of Results:

Run 1 – As Designed

Energy Savings:	33.3%
Water Savings:	47%
Combined Energy/Water Savings:	37.4%

Run 2 - As Designed + ½” added EPS insulation

Energy Savings:	33.9%
Water Savings:	47%
Combined Energy/Water Savings:	37.9%

Although not all energy saving measures were implemented as recommended in the original report, there are substantial increases in water conservation measures. The combination of the measures implemented are projected to exceed the required 35% combined energy and water savings.

IV. Energy Simulation Inputs

Denny Terrace Input Data - As Designed

General Project Site Description

Building Description	Baseline SF	Run 1 - As Designed	Run 2
Site/Utility Data			
Building Location	Seattle, WA	Same	Same
Weather File	TMY3 Boeing Field	Same	Same
Natural Gas Provider	None	None	None
Electricity Provider	Seattle, City Light	Same	Same
Water Provider	Seattle Public Utilities	Same	Same
Building Operation Hours	24/7, year round	Same	Same
Space Type/Use			
Residential Dwelling Units	85,735 SF	Same	Same
Office	657 SF	Same	Same
Common Areas (Lounge, kitchen)	4,100 SF	Same	Same
Corridors/Maintenance	27,250 SF	Same	Same
Parking	xx	Same	Same

Occupant/Schedule Data

Occupancy Type	Baseline	Run 1 - As Designed	Run 2
Residents	220 Full Time Residents	Same	Same
Working Residents	22	Same	Same
Office	2.2 FTE's	Same	Same
Counselor	8 hr/week	Same	Same
Chore Workers	10 per day	Same	Same
Visitors	15 per/hr; 165 daily	Same	Same

Energy Simulation Input Data

Building Component	Baseline	Run 1 - As Designed	Run 2
Building Shell			
Exterior Wall Construction	8" brick partially grouted - filled with "Zonolite" , 7/8" metal channels w/ 1/2" foam insulation and 5/8" GWB on interior	2" EPS R-10 2" EPS R-7.7 foam insulation w/ acrylic finish system over 8" brick partially grouted - filled with "Zonolite", 7/8" metal channels w/ 1/2" foam insulation and 5/8" GWB on interior (Effective R-1.4) Note: original model did not have insulation over floor slab edges - "as designed" was modeled with all exterior surfaces insulated.	2-1/2" EPS R-9.6 foam. The rest of the construction is the same as designed.
Roof Construction	8" Concrete, built-up medium SRI, R-30 insulation	8" Concrete, built-up med SRI, R-38 Polyiso insulation	Same as designed
Floor/Slab Construction	6" uninsulated SOG, 8" uninsulated Floor Slabs (2" rigid insulation at parking)	Same as baseline	Same as baseline
Shading Devices	None	Interior horizontal blinds	Same as designed
Fenestration			
Window-to-gross wall ratio	17%	Same as baseline	Same as baseline
Fenestration type	Air Filled, Double Glazed, Clear	Low-E Argon Filled, Double Glazed Clear	Same as designed
Fenestration U-factor	U = 0.57	S/W U 0.14; N/E: U 0.30 U=0.31 all orientations	Same as designed
Fenestration SHGC	SHGC = 0.76	S/W/E: SHGC = 0.39 N: SHGC = 0.49 SHGC = 0.63 all orientations	Same as designed

Denny Terrace
 Addendum to Energy and Water Survey

Lighting and Equipment			
Area Lighting			
Interior Lighting Power Density (W/SF)	Residential Units: 1.00 Office: 1.24 Mech/Elec: 0.81 Corridor: 0.85 Computer Room: 0.43, Vocational: 0.43 Lobby: 1.77 Restrooms: 0.77, Kitchen: 1.28 Community: 1.24 Storage: 1.19 Laundry: 1.74	Residential Units: 0.3 0.60 W/sf avg. , Common Areas 0.65 0.85 W/sf avg.	Same as designed
Daylighting Controls	None	Step-Down Daylight Sensors added to Corridors	Same as designed
Other Lighting Controls	None	Occupancy Sensors in Stairs, Community Room and Common Bath Rooms	Same as designed
Exterior Lighting Power (kW)	2.4 KW	Replace existing fixtures with new lower Wattage fixtures - 4.2 2.26 kW	Same as designed
Process Lighting	None	None	None
Receptacle Equipment Power Density (W/SF)	Residential Units: 0.30 Office: 1.50 Mech/Elec: 0.10 Computer Room: 1.50 Vocational: 1.00 Lobby 0.00 Restrooms: 0.00 Kitchen: 1.00 Community: 0.30	Same as baseline	Same as baseline
Appliance Power Density (W/SF)	Residential Units: 0.02	Same as baseline	Same as baseline

Denny Terrace
Addendum to Energy and Water Survey

HVAC			
Heating System Description	Residential: Electric Baseboard Heaters, no thermostat Common Areas: Rooftop Air Handling Units with electric heat.	Residential: Replace with new lower wattage electric baseboards with thermostats. Common Areas: New rooftop air handling units with electric heat.	Same as designed
Cooling System Description	None	None	None
Cooling Equipment Efficiency	NA	NA	NA
Ventilation System Description	Units: Intermittent bath fans at 70 CFM. Most units bath fans exhaust to roof 54 units exhaust horizontally; Common Areas: fresh air from rooftop AHU.	Continuously operating bath fans at 35 CFM. Most to roof. 54 units vent horizontally. Fans may be increased to 80 CFM by occupant.	Same as designed
Fan Power Efficiency	Standard	High Efficiency	Same as designed
Domestic Hot water			
Domestic Hot Water loop and pump parameters	3 electric water heaters with recirculation pump. Assume constant flow. 125 degrees with loss of 15 degrees.	Replace with 2 new 800 gallon electric water heaters. 120 degrees with loss of 15 degrees.	Same as designed

Water Use Input Data

Water Fixtures	Baseline	Run 1 - As Designed	Run 2
Flush Fixtures			
Water Closets	1.6 gpf	New 4-28 1.0 gpf pressure assist water closets	Same as designed
Urinals	NA	NA	NA
Flow Fixtures			
Lavatories	2.2 gpm	0.5 gpm faucet	Same as designed
Kitchen Faucets	2.2 gpm	1.5 gpm faucet at community kitchen <u>0.5 gpm in residential units.</u>	Same as designed
Showers	2.5 gpm	New 4-8 1.5 gpm	Same as designed
Washers	18 gal per cycle	New 44 13.3 gal per cycle	Same as designed

V. Energy Simulation Results: Run 1 - As Designed

Denny Terrace - Run 1 Data

As Designed Case Data

Energy Summary by End Use

End Use		Electric	Gas	Steam	Energy Use	Cost
		[kWh]	[MBtu]	[MBtu]	[10 ³ Btu]	[\$]
Area Lighting	Electricity	257,802.00			879,878.23	\$14,088.11
Space Heating	Electricity	419,091.00			1,430,357.58	\$22,902.07
Pumps & Aux	Electricity	706.00			2,409.58	\$38.58
Ventilation Fans	Electricity	156,201.00			533,114.01	\$8,535.92
Domestic Hot Water	Electricity	283,355.00			967,090.62	\$15,484.50
Misc. Equipment (plug loads & appliances)	Electricity	189,674.00			647,357.36	\$10,365.12
Exterior Usage	Electricity	7,891.00			26,931.98	\$431.22
TOTAL BUILDING CONSUMPTION		1,314,720.00	0.00	0.00	4,487,139.36	\$71,845.50
						Electric \$71,845.50
						Gas \$0.00

Baseline Case Data

Energy Summary by End Use

End Use		Electric	Gas	Steam	Energy Use	Cost
		[kWh]	[MBtu]	[MBtu]	[10 ³ Btu]	[\$]
Area Lighting	Electricity	466,203.00			1,591,150.84	\$25,476.60
Space Heating	Electricity	788,146.00			2,689,942.30	\$43,069.81
Pumps & Aux	Electricity	13.00			44.37	\$0.71
Ventilation Fans	Electricity	65,147.00			222,346.71	\$3,560.09
Domestic Hot Water	Electricity	450,713.00			1,538,283.47	\$24,630.11
Misc. Equipment (plug loads & appliances)	Electricity	189,544.00			646,913.67	\$10,358.01
Exterior Usage	Electricity	11,562.00			39,461.11	\$631.83
TOTAL BUILDING CONSUMPTION		1,971,328.00	0.00	0.00	6,728,142.46	\$107,727.16
						Electric \$107,727.16
						Gas \$0.00

Denny Terrace - Run 1 Performance

Energy Summary by End Use

End Use	Energy Type	Proposed Building Energy [10 ³ Btu]	Baseline Building Energy [10 ³ Btu]	Optimized Energy Performance [%]
Area Lighting	Electricity	879,878.23	1,591,150.84	55%
Space Heating	Electricity	1,430,357.58	2,689,942.30	53%
Pumps & Aux	Electricity	2,409.58	44.37	5431%
Ventilation Fans	Electricity	533,114.01	222,346.71	240%
Domestic Water Heating	Electricity	967,090.62	1,538,283.47	63%
Misc. Equipment	Electricity	647,357.36	646,913.67	100%
Exterior Usage	Electricity	26,931.98	39,461.11	68%
TOTAL BUILDING CONSUMPTION		4,487,139.4	6,728,142.5	67%
By Fuel				
	Gas/Steam	0.0	0.0	
	Electricity	4,487,139.4	6,728,142.5	

Energy and Cost Summary by Fuel Type

Type	Proposed Use [10 ³ Btu/hr]	Proposed Cost [\$]	Baseline Use [10 ³ Btu/hr]	Baseline Cost [\$]
Electricity	4,487,139	\$71,846	6,728,142	\$107,727
Natural Gas	-	\$0	\$0	\$0
Total Nonrenewable	4,487,139	\$71,846	6,728,142	\$107,727
Renewable				
Total including Renewable	4,487,139	\$71,846	6,728,142	\$107,727
Percent Cost Savings				33.3%
Percent Energy Savings				33.3%

Water and Energy Combination Savings Calculation

(% energy savings x 70%) + (% water savings x 30%)

Energy Savings	33.3%
Water Savings	47.0%
70% of Energy Savings	23.3%
30% of Water Savings	14.1%
Total Energy/Water savings	37.4%

VI. Energy Simulation Results: Run 2

Denny Terrace - Run 2 Data

Run 2 Data

Energy Summary by End Use

End Use		Electric	Gas	Steam	Energy Use	Cost
		[kWh]	[MBtu]	[MBtu]	[10 ³ Btu]	[\$]
Area Lighting	Electricity	257,802.00			879,878.23	\$14,088.11
Space Heating	Electricity	407,097.00			1,389,422.06	\$22,246.63
Pumps & Aux	Electricity	706.00			2,409.58	\$38.58
Ventilation Fans	Electricity	155,813.00			531,789.77	\$8,514.71
Domestic Hot Water	Electricity	283,327.00			966,995.05	\$15,482.97
Misc. Equipment (plug loads & appliances)	Electricity	189,674.00			647,357.36	\$10,365.12
Exterior Usage	Electricity	7,891.00			26,931.98	\$431.22
TOTAL BUILDING CONSUMPTION		1,302,310.00	0.00	0.00	4,444,784.03	\$71,167.33
						Electric \$71,167.33
						Gas \$0.00

Baseline Case Data

Energy Summary by End Use

End Use		Electric	Gas	Steam	Energy Use	Cost
		[kWh]	[MBtu]	[MBtu]	[10 ³ Btu]	[\$]
Area Lighting	Electricity	466,203.00			1,591,150.84	\$25,476.60
Space Heating	Electricity	788,146.00			2,689,942.30	\$43,069.81
Pumps & Aux	Electricity	13.00			44.37	\$0.71
Ventilation Fans	Electricity	65,147.00			222,346.71	\$3,560.09
Domestic Hot Water	Electricity	450,713.00			1,538,283.47	\$24,630.11
Misc. Equipment (plug loads & appliances)	Electricity	189,544.00			646,913.67	\$10,358.01
Exterior Usage	Electricity	11,562.00			39,461.11	\$631.83
TOTAL BUILDING CONSUMPTION		1,971,328.00	0.00	0.00	6,728,142.46	\$107,727.16
						Electric \$107,727.16
						Gas \$0.00

Denny Terrace - Run 2 Performance

Energy Summary by End Use

End Use	Energy Type	Proposed Building Energy [10 ³ Btu]	Baseline Building Energy [10 ³ Btu]	Optimized Energy Performance [%]
Area Lighting	Electricity	879,878.23	1,591,150.84	55%
Space Heating	Electricity	1,389,422.06	2,689,942.30	52%
Pumps & Aux	Electricity	2,409.58	44.37	5431%
Ventilation Fans	Electricity	531,789.77	222,346.71	239%
Domestic Water Heating	Electricity	966,995.05	1,538,283.47	63%
Misc. Equipment	Electricity	647,357.36	646,913.67	100%
Exterior Usage	Electricity	26,931.98	39,461.11	68%
TOTAL BUILDING CONSUMPTION		4,444,784.0	6,728,142.5	66%
By Fuel				
		Gas/Steam	0.0	0.0
		Electricity	4,444,784.0	6,728,142.5

Energy and Cost Summary by Fuel Type

Type	Proposed Use [10 ³ Btu/hr]	Proposed Cost [\$]	Baseline Use [10 ³ Btu/hr]	Baseline Cost [\$]
Electricity	4,444,784	\$71,167	6,728,142	\$107,727
Natural Gas	-	\$0	\$0	\$0
Total Nonrenewable	4,444,784	\$71,167	6,728,142	\$107,727
Renewable				
Total including Renewable	4,444,784	\$71,167	6,728,142	\$107,727
Percent Cost Savings				33.9%
Percent Energy Savings				33.9%

Water and Energy Combination Savings Calculation

(% energy savings x 70%) + (% water savings x 30%)

Energy Savings	33.9%
Water Savings	47.0%
70% of Energy Savings	23.8%
30% of Water Savings	14.1%
Total Energy/Water savings	37.9%