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# SMSU SOLAR GREY- WATER RECLAMATION

# Portland State University

- ◎ Sustainability Leadership
- ◎ LEED building designs
- ◎ Sustainability Institute
- ◎ Old Buildings
- ◎ Large, flat rooftops

# Portland Solar Data

	Unit	Climate data location	Project location
Latitude	°N	45.6	45.6
Longitude	°E	-122.6	-122.6
Elevation	ft	108	108
Heating design temperature	°F	28.6	
Cooling design temperature	°F	87.1	
Earth temperature amplitude	°F	29.0	

Month	Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	°F	%	kWh/m <sup>2</sup> /d	kPa	m/s	°C	°C-d	°C-d
January	41.4	81.9%	1.18	101.8	4.3	3.5	397	0
February	43.3	76.1%	1.87	101.7	4.1	4.0	328	0
March	47.8	75.4%	2.98	101.6	3.5	5.8	285	0
April	52.2	72.7%	4.19	101.7	3.2	8.0	204	36
May	57.9	69.9%	5.29	101.7	3.1	11.6	112	136
June	63.1	67.0%	5.90	101.6	3.2	15.2	21	219
July	68.2	63.9%	6.27	101.6	3.3	19.0	0	313
August	68.5	64.1%	5.42	101.5	3.1	19.0	0	319
September	63.7	68.2%	4.14	101.5	2.9	15.8	12	228
October	54.7	77.6%	2.54	101.7	2.8	10.5	167	81
November	46.4	82.2%	1.35	101.7	3.8	5.7	300	0
December	40.5	81.1%	0.99	101.8	4.3	3.1	412	0
<b>Annual</b>	54.0	73.3%	3.52	101.7	3.5	10.1	2,238	1,332
Measured at	ft				32.8	0.0		

# Smith Memorial Student Union



# Smith Memorial Student Union

## Bathroom Use

Unit	Flushes per Day	Number of People	Total Gallons
Toilet @ 1.6 GPF	0.86	2843.5	3912.6*
Urinal @ 1.0 GPF	0.94	2843.5	2672.9*
Handwashing @ 0.11 GPU	**	2843.5	569.2
Drinking Fountain @ 0.11 GPU		2843.5	569.2

\* These were calculated when we used the total visitor number and half the employee number, based on SMSU use.

\*\* This is calculated using the total number of flushes per day from both urinals and toilets, having a total of 5175 uses per day.

# Smith Memorial Student Union

## Kitchen Use

Unit	Gal per Day	Number of People	Total Gallons
Kitchen	4	2843.5	11374
Total Grey Water Use			12566.4
Total Black Water Use			6585.5
Difference of Water			5980.9

# Smith Memorial Student Union

## ◎ Water Need per Day

- 6585.5 gal (black water)
  - $6585.5\text{gal} / 14\text{hrs} / 60\text{min} = 15.5\text{gpm}$

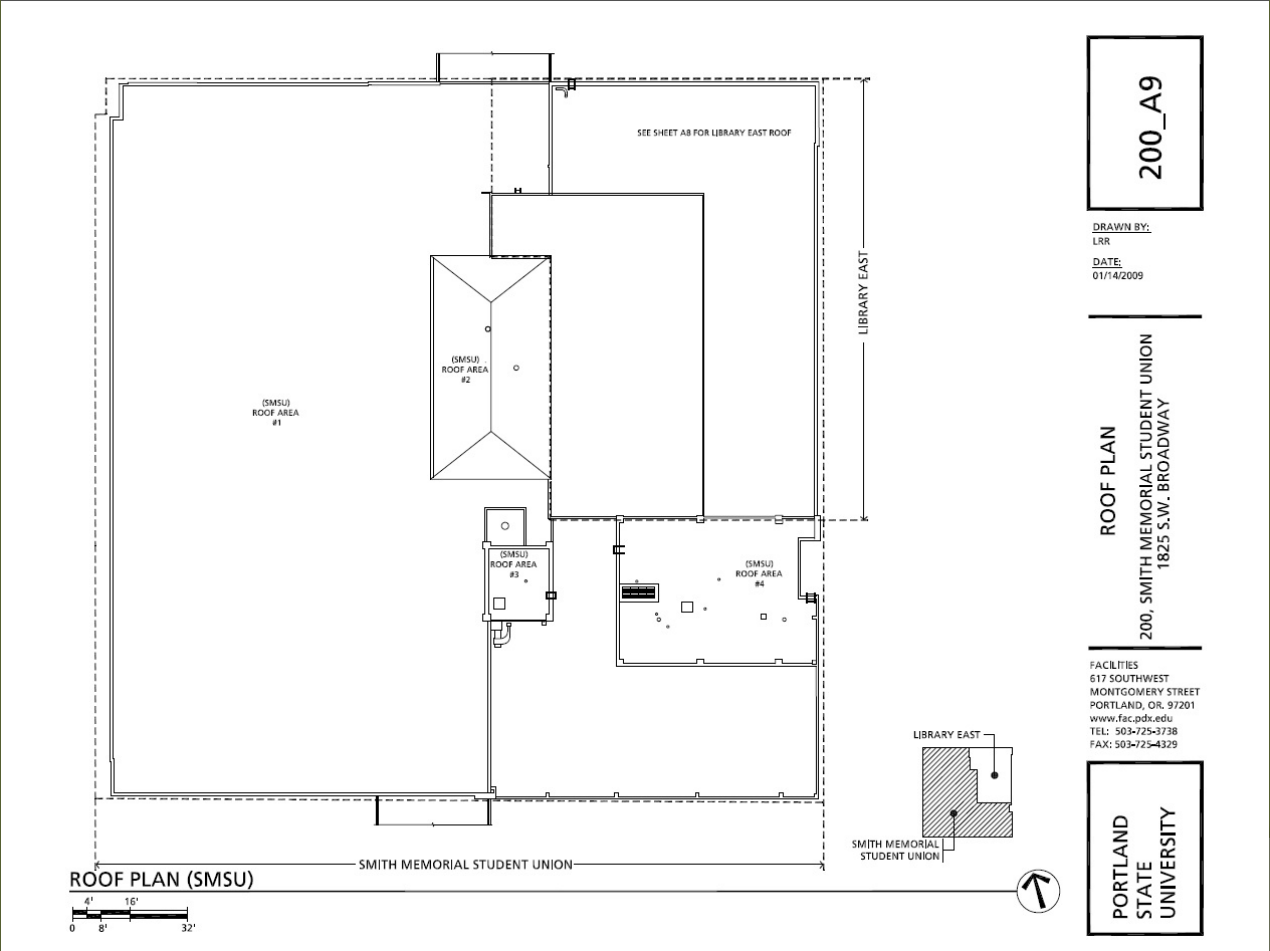
## ◎ Sewage

- \$3.086/ccf (1ccf = 748 gal)

## ◎ Roof Construction

- Panel Weight- 900lbs.
- Aluminum panel mounts

# Smith Memorial Student Union





# Decisions

- ⦿ No battery storage for solar power
  - Augmentation, not replacement
  - Most use is during daylight
- ⦿ Overflow/underflow problems
  - Too much sink, not enough toilet
    - And visa-versa

# Smith Memorial Student Union

- ◎ Building height = 84ft.
- ◎ Piping
  - 20ft. Run from tanks to vertical pipe
- ◎ Sewage lines
  - 1.5in. – building code
- ◎ Flow
  - 9.1gpm

# Solar Reclamation

- ◎ Grey/Black Water separation
  - Toilet/sink count and use calculation
- ◎ Lower and Upper Storage
- ◎ Grey Water dispersion

# Solar Set-up

- ④ 4132W installed power

- 2.47% wire loss

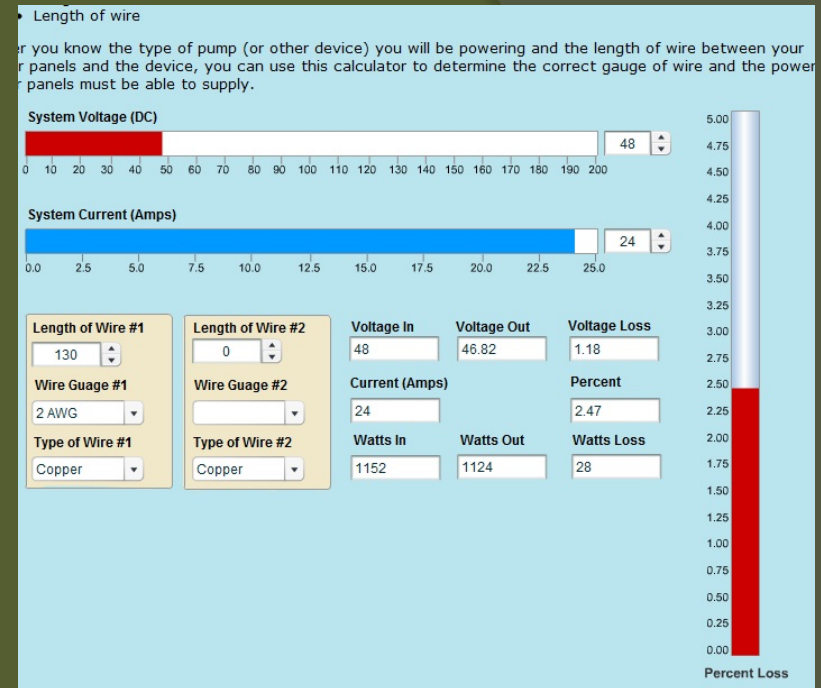
- 130ft. @ 2awg

- TDH

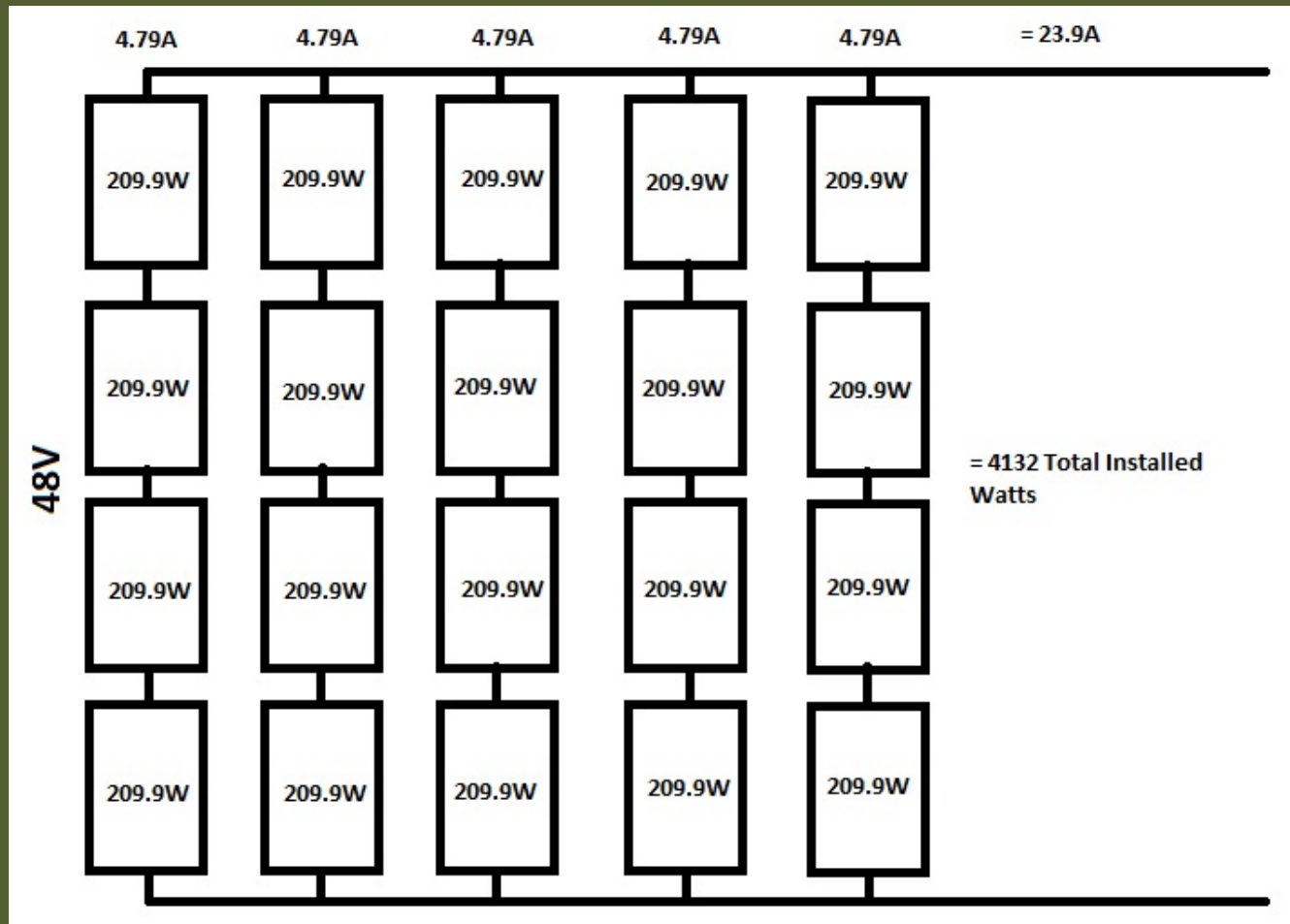
- 84 vertical ft. + (~40ft. x 5% friction loss) = 86ft.

- $(1115W \times 10h) / (3.52PSH \times 85.36\%$   
efficiency loss) = 3711Wp

- ④ 230W panel (206.6W real) x 20 panels



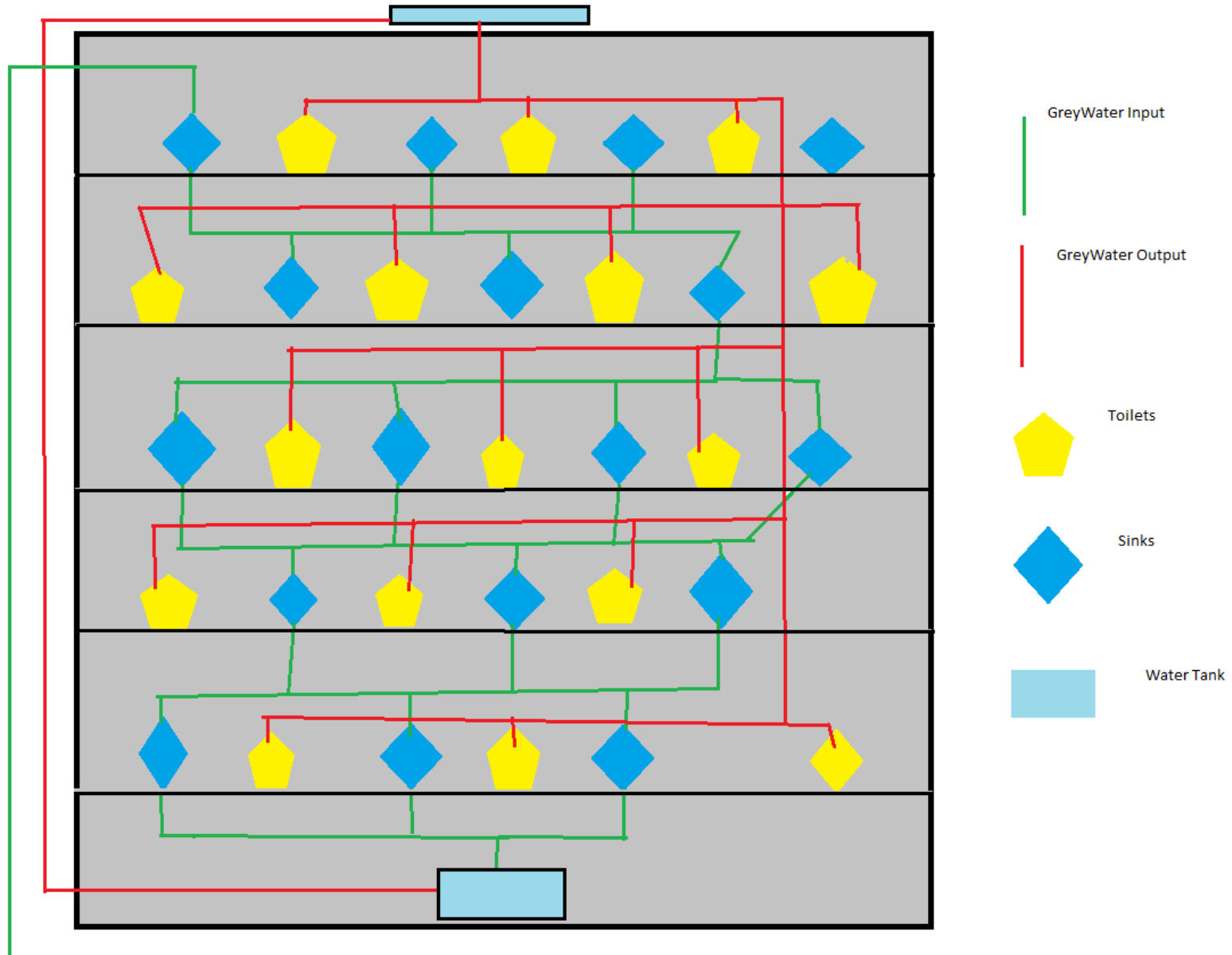
# Solar Array



# Parts List

- ◎ Yingli Solar YL 230 P-29b 230 Watts Solar Panel (x 20)
- ◎ All Power Supply ADJ-28 Adjustable Solar Panel Tilt Mount (x 20)
- ◎ Dankoff Solar Force Piston Pump
- ◎ MTW-2AWG (19XBC) Machine Tool Wire
- ◎ Apex Valves Pump Buddy
- ◎ 1000 Gallon Norwesco Septic Tank-Basement
- ◎ Norwesco 1500 Gallon Above Ground Water Tank – Roof

# Piping Diagram



# Plumbing Parts

74 toilets and urinals

10" x 1.5" i.d. Steel Nipple Pipe



25 x \$7.42 = \$185.50

90° Steel Elbow (1.5" i.d.)



76 x \$11.67 = \$886.92

2" x 1.5" i.d. Steel Nipple Pipe



78 x \$2.86 = \$223.08

1.5" Rain-tight Connector



250 x \$4.65 = \$1162.50

10ft x 1.5" i.d. Steel Pipe



84 x \$36.75 = \$3,087



# Total Cost

- ◎ Installation Cost
  - Plumbing- \$5,321.92
  - Panels- \$4,870.60
    - Mounts- \$1,920
  - Pump- \$1,281.15
  - Wiring- \$2/ft. x 130ft. = \$260
  - Sensors- \$234.96
  - Basement Tank- \$991.99
  - Roof Tank- \$615.95
  - **Total= \$15,496.57**
- ◎ Savings to PSU
  - \$9,912/year
- ◎ Payback period- 1.5 years

# References

- ⦿ Noel Mingo, Utilities Manager, Portland State University
- ⦿ Ernest Tipton
- ⦿ Mr. MacLean
- ⦿ [http://www.pacinst.org/reports/urban\\_usage/appendix\\_d.pdf](http://www.pacinst.org/reports/urban_usage/appendix_d.pdf)
- ⦿ <http://www.civicsolar.com/product/yingli-solar-yl-230-p-29b-230watt-solar-panel>
- ⦿ [http://www.wireandsupply.com/product\\_p/mtw-2g.htm](http://www.wireandsupply.com/product_p/mtw-2g.htm)
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- ⦿ [http://www.gemssensors.com/Products/Level/Multi-Point-Level-Switches/Float/Small-Size/~/\\_media/GemsNA/CatalogPages/LS-700-cat.ashx](http://www.gemssensors.com/Products/Level/Multi-Point-Level-Switches/Float/Small-Size/~/_media/GemsNA/CatalogPages/LS-700-cat.ashx)
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