LANDSCAPE ARCHITECTURE FOUNDATION

Pete V. Domenici US Courthouse Sustainable Landscape Retrofit

Albuquerque, NM

Figure 1. Rendered site plan for the Courthouse Retrofit. *Image courtesy Rios Clementi Hale Studios.*

Methodology for Landscape Performance Benefits
Landscape Architecture Foundation
2014 Case Study Investigation

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I. Introduction

The Pete V. Domenici U.S. Courthouse Sustainable Landscape Retrofit in Albuquerque, New Mexico reconnects an existing site with its historical and geographic context through an evocative and sustainable design. Located in the downtown district, the design was to convert a water intensive turf landscape into a landscape that provides a dignified setting for court operations while enhancing environmental efficiency. Design strategies include rainwater harvesting, stormwater management, energy-efficient lighting, on-site solar panels, native and drought-tolerant plants, and extensive use of repurposed materials. The renovated landscape is a model for the Government Services Administration (GSA) demonstrating how a municipal site can more efficiently use public and natural resources.

Project Goals and Research Approach

The goals of the project were to minimize the use of potable water for irrigation, slow the flows of storm water runoff through the site, reuse existing materials, and increase the availability of urban habitat through a combination of water conserving and native plants. These goals were already evaluated when the park was certified as part of the Sustainable Sites Initiative (SITES) Pilot Program. This provided the research team with a wealth of baseline information regarding the documented sustainable qualities of the park. However, many of the credits for SITES are written to emphasize sustainable decision-making in the design process; whereas, the goal of the LAF Case Study Initiative is to evaluate the performance of design decisions. This created an opportunity for the research team to utilize calculations and estimates from SITES as a platform to validate or improve upon the information from the performance benefits.

Originally the research team elected to focus on benefits that would be easier to measure from a distance because the Domenici Courthouse opportunities to travel to the site were limited. Early attempts to distribute a survey to Courthouse employees to measure social benefits of the landscape retrofit were not able to move forward. The research team also attempted to utilize other on-site measurements, such as the meters installed to monitor rainwater capture and irrigation water use to verify SITES calculations with real world use. However, at the time of documentation some of these monitoring components were non-functional or data was not yet available. Instead, the research team decided to utilize and expand upon data generated for SITES documentation. This helps to add clarity to some SITES calculations that can tend to be quite scientific. While the research team would agree that great care was taken in the design process to incorporate sustainable methods, on-site observations indicate that not all of these techniques may be performing as intended.

Project Context

The project site is located within the high desert Albuquerque Basin. During the year, over 3418 hours of sunshine creates an arid climate. During winter, average daily minimum temperatures are as low 26^{o}F. The Albuquerque basin is within USDA Hardiness Zone 7. Like other arid regions, Albuquerque receives an average of 9.4in of rainfall each year with a significant portion of that falling during the North American monsoon season from July to October in the form of thunderstorms.

The site can be found within the downtown Albuquerque district. This district is heavily urbanized with significant amounts of heat conducting materials such as asphalt and concrete. Available areas for landscape plantings within the district are quite limited.

II. Landscape Performance Benefits

Environmental

PB1	**Reduces the volume of stormwater runoff by 90% when compared to existing conditions. A combination of rain gardens, bioswales, rock gardens, and filtering devices treat stormwater for pollutants of concern for 95% of the site area.**

Managing stormwater on-site was a unique challenge for the design team. This was due to regulations established by the state of New Mexico that restrict developments from detaining stormwater on site, with the intention of ensuring downstream water rights. Therefore, the design team had to focus on strategies that would increase site permeability and slow water flow through the site.

Calculations using the TR-55 Method from the civil engineer were provided for Sustainable Sites Initiative (SITES) documentation to confirm the percentage of runoff volume reductions. The method involves calculating and comparing the curve number for the existing and post-development conditions (Table 4). A graph provided by the Sustainable Sites Initiative (SITES) Guidelines and Performance Benchmarks indicates the percentage of runoff reduction based upon the calculated curve numbers (Table 5).

Table 4. Existing vs. Post-development hydrologic conditions. *(Reproduced from RCHS SITES Documentation)*

Land Use	**Hydrologic Soil Group**	**Existing Conditions**		**Post-Development Conditions**	
		Area (ac)	**Curve Number**	**Area (ac)**	**Curve Number**
Open Space; grass cover >75%	B	0.70	61	0.04	61
Paved parking lots, roofs, driveways	B	2.78	98	2.19	98
Desert shrub	B	0.56	68	1.69	68
Newly graded area (Post-development only)	B		0	0.1	86
Totals		**4.04**	**87**	**4.02**	**85**

Table 5. Initial vs. Post-development curve numbers. *(Reproduced from SITES Guidelines and Performance Benchmarks)*

GREYFIELD / Target Curve Number = 85														
Final Curve Number														
Initial Curve Number	98	97	96	95	94	93	92	91	90	89	88	87	86	85
98														
97														
96														
95														
94														
93														
92														
91														
90														
89														
88														
87														
86														
85														

5 points = 30 percent reduction in runoff volume

7 points = 60 percent reduction in runoff volume

10 points = 90 percent reduction in runoff volume

A majority of the stormwater that falls on site is treated by bio-infiltration methods involving soil and vegetation (Figure 2). In the parking lot, vegetated bioswales slow water flow and allow sediments to settle out (Figure 3). The rock garden at the entry acts in a similar fashion allowing water to percolate through the rock garden before being transported to the municipal stormwater system. Stormwater that falls on the roof is treated by a RINKER- Stormceptor, Model STC 900 prior to entering the rainwater cisterns. Both of these methods have been shown to reduce total suspended solids (TSS) to a concentration of less than 25mg/L, a value recommended in the SITES Guidelines and Performance Benchmarks. Of the total site area, 175,959sq ft, only 7,832sq ft of the site, located in the parking lot, will be directed straight to the stormwater system without treatment. This equates to a total of 95% of the total site stormwater treated to remove pollutants of concern.

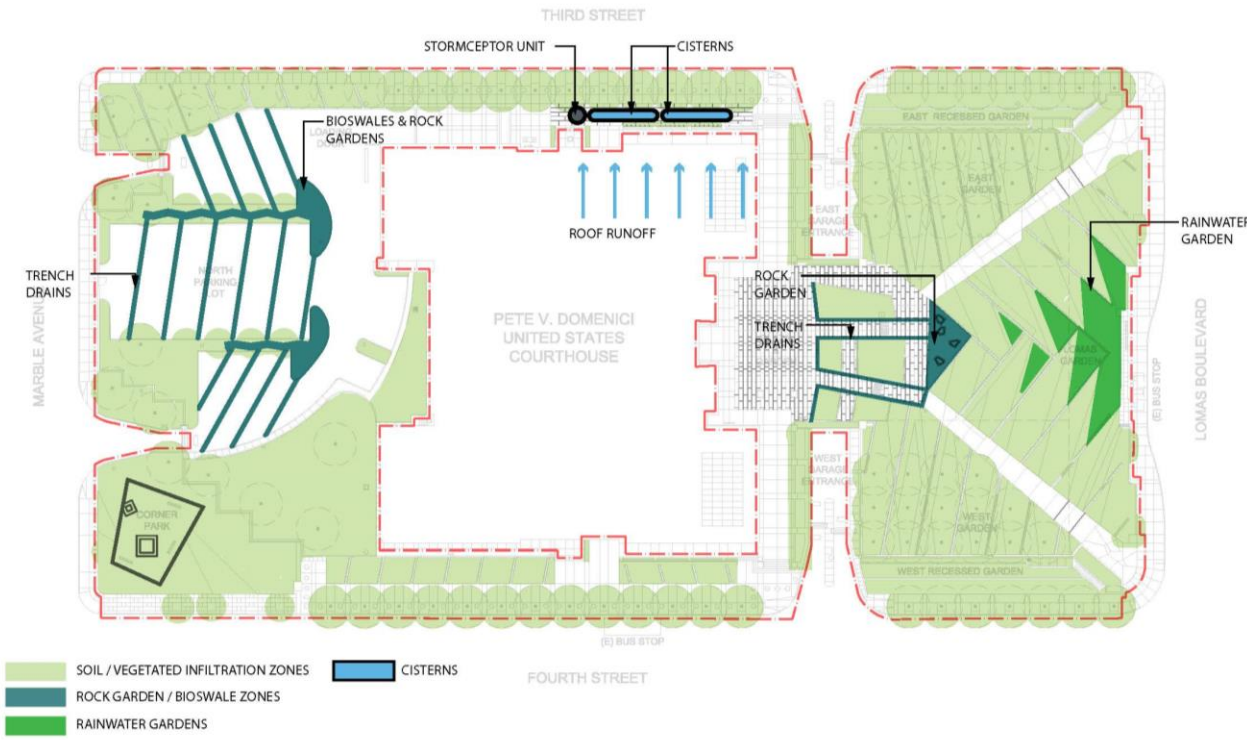

Figure 2. Water treatment diagram. *Image courtesy Rios Clementi Hale Studios.*

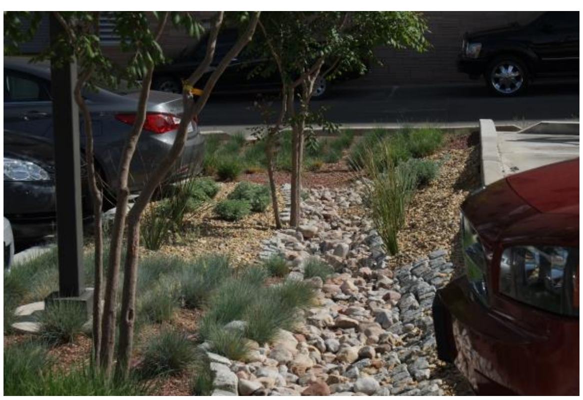

Figure 3. Bioswale at parking lot. *Photo by: Colter*

Figure 4. Rock garden at entry plaza. *Photo by: Colter*

PB2	**Reduces potable water use for irrigation by 86% compared to an established baseline through the use of a low-water plant palette and rainwater harvesting.**

In arid regions such as Albuquerque, water is a limited resource and requires careful management. Yet irrigation, usually from potable water supplies is a common and widely distributed practice to water designed landscapes. In recognition of this concern the Government Services Administration (GSA) desired a water system for the landscape retrofit that would minimize use of potable water resources for landscape irrigation. The design team achieved this reduction by utilizing drought tolerant and native plant species, installing efficient drip irrigation water delivery systems, and by supplementing potable irrigation water with rainwater harvested from the courthouse rooftop.

Documentation quantifying the percentage of water reduction was generated by the design team as part of their submittal to the Sustainable Sites Initiative (SITES). The method and calculations below are reproduced from that documentation. Overall the reduction is quantified by calculating a baseline water demand to compare to the water demand of the new design, including any offsets provided by non-potable water sources.

First, the Baseline Landscape Water Requirement (Table 1) was calculated using the following equation generated by SITES.

$$BLWR = ET_0 \times A \times C_u$$

Where:

BLWR = Baseline Landscape Water Requirement (gallons/month)

ET_0 = average evapotranspiration for the site's peak watering month (June) in inches/month

A = area of irrigated landscape in square feet

C_u= conversion factor (0.6233 for results in gallons/month)

Table 1. Courthouse Calculated BLWR

ET_0 (inches/month)	**A (square feet)**	**C_u**	**Calculated BLWR**
7.17	75,439	0.6233	337,142

The second step was to generate the Designed Landscape Water Requirement (Table 2) using the following equation generated by SITES.

$$DLWR = RTM \times [(ET_0 \times K_L) - R_a] \times A \times C_u$$

Where:

DLWR = Designed Landscape Water Requirement (gallons/month)

RTM = Run time multiplier, equal to 1/low quarter distribution uniformity (D_U)

ET_0 = average evapotranspiration for the site's peak watering month (June) in inches/month

K_L = Landscape coefficient for type of plant in that hydrozone

R_A = Allowable rainfall (25% of average monthly rainfall for the peak watering month (June))

A = area of hydrozone (sf)

C_u= conversion factor (0.6233 for results in gallons/month)

Table 2. Courthouse Calculated DLWR

Common Values; ET_0 = 7.17; R_A = 0.3275; C_U= 0.6233; RTM = 1.11				
Hydrozone	**D_U**	**K_L**	**A**	**Water Req.**
Planting Area	0.9	0.20	21,345.18	16357.08
Planting 1 – Turf	0.9	0.80	1,812.24	6788.08
Planting 2 – Arroyo Riparian	0.9	0.20	5,130.39	3931.48
Planting 3 – Native Shrubs/G.C.	0.9	0.20	3,943.46	3021.92

Planting 4 – Mesa Shrubs/G.C.	0.9	0.20	9,292.91	7121.28
Planting 5a – High Desert Shrubs	0.9	0.20	26,184.34	20065.39
Planting 5b – High Desert Shrubs	0.9	0.20	7,730.58	5924.04
			Total	**63,209**

The last step was to determine the percentage reduction, incorporating the volume of rainwater collected by the cisterns (Table 3). This value was determined by the total capacity provided by the rainwater cisterns, 16,000 gallons. The following equation generated by SITES was utilized for this purpose.

Percentage Water Use Reduction = (BLWR – (DLWR-NPS))/BLWR

Table 3. Courthouse Calculated Percentage of Water Use Reduction

Baseline Landscape Water Requirement (Table 1)	337,141.94
Designed Landscape Water Requirement (Table 2)	63,209.28
Non-Potable Water (Rainwater Cistern Volume)	16,000
Percentage Water Use Reduction	**86%**

This methodology for estimating how much a designed landscape can reduce potable water use for irrigation water is fairly standard for SITES and other sustainability rating programs such as LEED. However, there are a few caveats associated with this method. First, the evapotranspiration rate utilized represents the most extreme summertime condition (month of July); this value will fluctuate throughout the year and would not be truly representative of the entire year. Second, this method relies on a baseline condition from which to compare the designed condition. In this case, the amount of water required by the fictional baseline assumes a very consumptive landscape plant palette (comparable to an all turf lawn). The comparison could be more accurate by calculating the water use for a more realistic baseline case. Finally, a fluctuation in the amount of water collected by the rainwater cisterns is certain to occur. The quantity of rainwater collected would be affected by the timing and size of storm events in cooperation with the amount of water used by the landscape. Ultimately the best way to determine how much water is collected and how much water is used throughout the year would be to meter water use. While there are currently meters installed at the Courthouse, data from them was not available at the time of our study.

PB3	**Generates an estimated 43,100 kWh of solar power annually, 99% of the net energy needed for outdoor lighting. This saves $3,750 in energy costs each year.**

Rios Clementi Hale Studios (RCHS) originally generated the documentation supporting the reduction of energy use for Sustainable Sites Initiative (SITES) documentation. The results were achieved by comparing the annual energy consumption of the utilized fixtures with the annual energy output of the renewable energy source (Table 6).

Table 6. Fixture based energy demand. *(Reproduced from RCHS SITES Documentation)*

Quantity	Fixture Used	Watts/Hour	Average Daily Runtime (Hrs)	Days Per Year	Total kWh
12	F-1	50	10	365	2,190.00
9	F-2	71	10	365	2,332.35
4	F-2A	71	10	365	1,036.60
1	F-2B	71	10	365	259.15
4	F-3	50	10	365	730.00
40	F-4	26	8	365	3,036.80
778 LF	F-5	6W/LF	12	365	20,445.84
9	F-6	320	12	365	12,614.40
4	F-7	50	8	365	584.00
				Total	**43,229.14**

To offset power used to operate electrical fixtures on-site the Courthouse includes renewable power generated by photovoltaic solar panel system. A total of 2 solar arrays were installed on the lower level roof, one 12.81 kW array on the southeast corner and one 14.04 kW array on the southwest. The Courthouse is an excellent example of a way to incorporate renewable energy in a retrofit scenario. The lower roof areas were selected because there were fewer conflicts with existing equipment and because there was enough area to provide an array large enough to offset the exterior landscape demand.

Estimated values for the energy generated by the solar panel array, are derived from calculations provided by the electrical engineer (Table 7). Their calculations also include an estimated cost per kWh, generated from regional conditions.

Table 7. Annual solar power output. *(Reproduced from RCHS SITES Documentation)*

Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value (¢11.8 /kWh)
1	3.57	2,355	$204.88
2	4.52	2,698	$234.73
3	5.58	3,691	$321.12
4	7.01	4,327	$376.45
5	7.97	4,959	$431.43
6	8.04	4,695	$408.46
7	7.80	4,686	$407.68
8	7.09	4,295	$373.66
9	6.03	3,563	$309.98
10	5.07	3,212	$279.44
11	3.94	2,454	$213.50
12	3.31	2,157	$187.66
Total	**5.83**	**43,093**	**$3,749.09**

The overall reduction in energy by percent is calculated by dividing the solar energy output by the total energy demand.

43,093 kWh/43,229.14 kWh = 99.69% Energy Reduction

Results from this calculation are based upon estimates for actual conditions throughout the year. To improve upon this information it would be ideal to have monitoring in place, measuring the actual efficiency of the installed system. It is also important to note that these calculations represent net energy generation for the year. The percentage of energy offset when determined by monthly demand 3,602 kWh (43,229.14 kWh/12 = 3,602 kWh) would vary from 96%.

The energy reduction achieved by the selected fixtures on site was originally calculated by RCHS for Sustainable Sites Initiative (SITES) documentation. The results were achieved by comparing the annual energy consumption of the utilized fixtures with the annual energy consumption of the lowest cost comparable fixture. Calculations account for the quantity of each fixture, wattage of each fixture, and time of operation (Table 8).

Table 8. Fixture based energy reduction. *(Reproduced from RCHS SITES Documentation)*

Qty	Fixture Used	Annual Energy Use (kWh/year)	Comparable Fixture	Annual Energy Use (kWh/year)	Percent Reduction
12	LED 40W Pole	600	High Pressure Sodium (HPS) Pole	1,200	**50%**
9	LED 60W Pole	639	HPS Pole	900	**29%**
4	LED 60W Pole	284	HPS Pole	400	**29%**
1	LED 60W Pole	71	HPS Pole	100	**29%**
4	LED 40W Pole	200	HPS Pole	400	**50%**
40	Compact Florescent 26W	1,040	Incandescent 100W	4,000	**74%**
778 LF	LED 6W Linear	4,668	LED 6W Linear	4,668	**0%**
9	Metal Halide Pole	2,880	HPS Pole	3,240	**11%**
4	MR-16 In Grade	200	R-20 Incandescent	400	**50%**
1	Orenco Pump	2,438	Comparable	3,312	**26%**
	Total	**13,020**		**18,620**	**30%**

PB4	**Diverted 480 tons of demolition and construction waste from the landfill by repurposing materials on site and recycling unused materials. This saved $9,949 in landfill fees.**

To prevent excessive waste generation the design team created a strategy for diverting waste generated during demolition and construction from the landfill. When possible waste was diverted to recycling centers where it would eventually be reused. Reusing existing materials as part of the new design also minimized waste generation. Concrete that would otherwise have been removed was instead utilized as a building material. A summary of materials diverted is provided in Table 9.

Table 9. Quantity of waste diverted. *(Reproduced from RCHS SITES Documentation)*

Material	**Material Category**	**Name of Receiving Agent**	**Waste Diverted (in Tons)**
Concrete	Road/Infrastructural	Harold Grading & Trucking	239.73
Rebar	Structural Materials	Acme Iron & Metal Group	2.5
Metal Tree Grates	Structural Materials	Born Free Scrap Metal	6.99
Concrete Paving Reused On-site	Roads/Infrastructural Materials	On-site	221
Foam Fill	Structural Materials	On-site	10
		Total Waste Diverted	**480.22**

Using the concrete on site and recycling materials when possible greatly reduced the amount of concrete that needed to be disposed of during demolition. This also eliminated the costs associated with disposing concrete. A report from the Waste Business journal estimates the average cost of disposing waste in U.S. landfills at $45.02 per ton. Multiplying the disposal cost per ton by the quantity of waste diverted from the landfill can provide an estimate of total disposal cost savings.

221 tons waste x $45.02 per ton = $9,949.42

III. Sustainable Features

- **The hardscape materials palette includes 23,240sq ft (31.9%) of materials with an SRI value greater than 29 and provides shade for 31,033sq ft (42.6%) of hardscape surfaces.**

Urban heat island effect is exasperated by the addition of paved surfaces. One method of mitigating the effect is to utilize hardscape surfaces that have a high Solar Reflectance Index (SRI). The Sustainable Sites Initiative (SITES) guidelines recommend an SRI value of at least 29 in order for the surface to contribute to heat island mitigation. To achieve credit for heat island mitigation under the SITES process a project can use a combination of high SRI surfaces and providing shade to hardscape surfaces. The design team provided one of these two treatments for a total of 74.5% of hardscape surfaces (Figure 5).

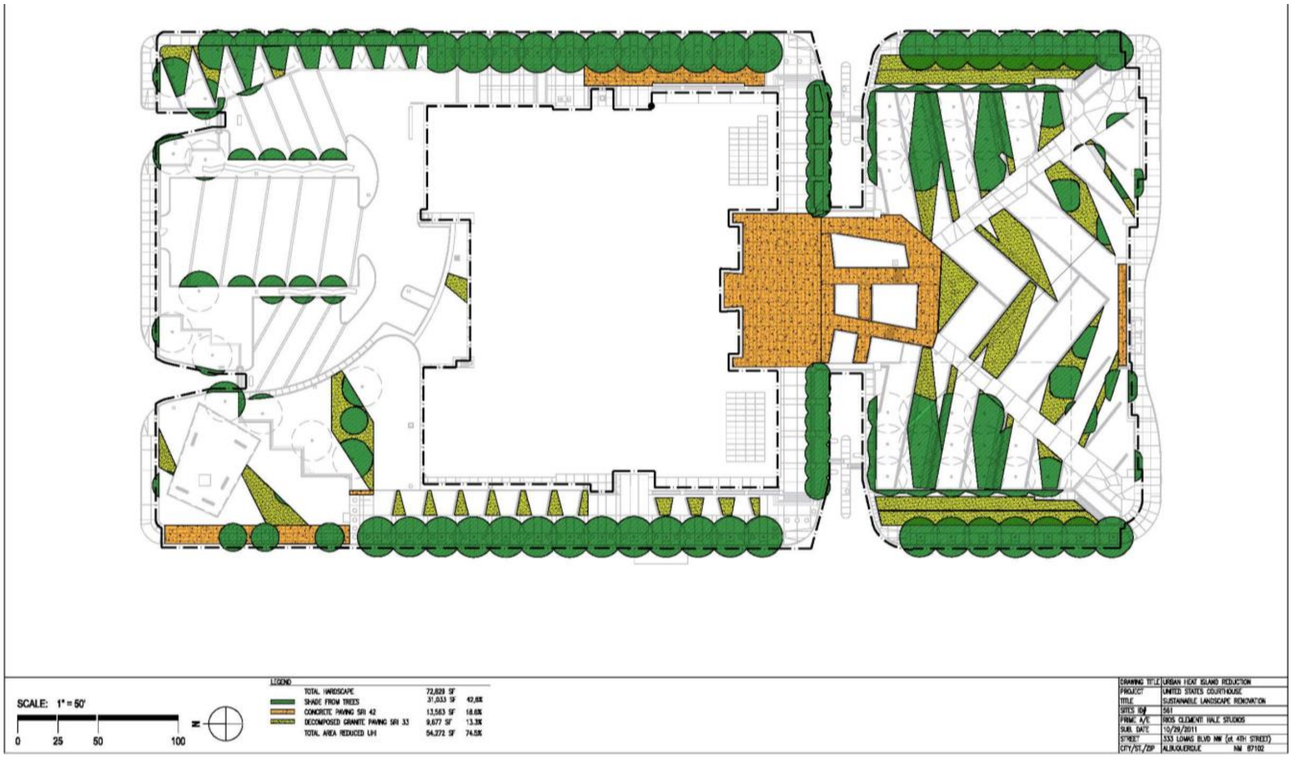

Figure 5. Surfaces treated for heat island mitigation. *Image courtesy Rios Clementi Hale Studios.*

Urban Heat Island is an aggregate of conditions in a given urban area and therefore it is quite difficult to measure the impact of just one project. However, it is worth identifying as a sustainable feature.

- **Provides a prevailing wage per Davis-Bacon Act for 100% of the 45 construction workers and a living wage per Living Wage Calculator for 58% of workers.**

Federal projects are required to follow particular guidelines for building contracts, which result in clearly recorded records for construction employees. The Rios Clementi Hale Studios design team took this documentation a step further by comparing the employee data to the living wage criteria established by the Sustainable Sites Initiative (SITES). SITES recommends the use of the online Living Wage Calculator, created by the Massachusetts Institute of Technology (Table 10).

Table 10. Living wages for Albuquerque, NM *(Reproduced from Living Wage Calculator)*

Hourly Wages	1 Adult	1 Adult, 1 Child	1 Adult, 2 Children	1 Adult, 3 Children	2 Adults	2 Adults, 1 Child	2 Adults, 2 Children	2 Adults, 3 Children
Living Wage	$8.47	$18.45	$22.79	$29.45	$13.62	$17.12	$18.50	$22.61
Poverty Wage	$5.21	$7.00	$8.80	$10.60	$7.00	$8.80	$10.60	$12.40
Minimum Wage	$7.50	$7.50	$7.50	$7.50	$7.50	$7.50	$7.50	$7.50

The Living Wage Calculator provides values for a recommended wage based upon a single income earner and varying partners and children. Wages can be determined by the state or more specifically for the city. For SITES documentation, the recommended family size for comparison is the two adult, two children household. In the case of Albuquerque this wage would be $18.50/hr. If an employee were to have a family structure that varies from this model a different household type might be more applicable wage.

The federal government has also developed wage minimums to ensure that employees are paid fairly. These wages are determined in a different manner from the Living Wage Calculator but are also available online as part of the Davis Bacon Act. All construction employees are guaranteed the Davis-Bacon wage and the wages vary based upon the trade. Due to this extra record keeping the research team was able to compare living wages established by Davis Bacon with those established by the Living Wage Calculator. The Davis Bacon wage does not always match the amount prescribed by the Living Wage Calculator but all wages provided exceed the established values for poverty and minimum wage.

Table 11. Hourly wages for construction employees. *(Reproduced from RCHS SITES Documentation)*

Trade/Employee	**Number of Employees**	**Hourly Wage**
Laborer: Demolition	2	$15.20
Laborer: Common or General	8	$17.87
Carpenter (Form Work)	6	$21.02
Painters	7	$18.65
Electrician	6	$28.80
Operators	4	$20.72
Power Equipment Operator/Bulldozer	2	$21.83
Laborer: Landscape and Irrigation	9	$17.89
Landscape Supervisor	1	$21.02
Number of employees	**45**	
Number of employees above living wage ($18.50)	**26**	**58%**

- **Salvaged 25% of building materials and plants for reuse in the landscape renovation, preventing the addition of materials to the landfill.**

Integrating existing materials as part of the new design was a primary goals for the design team. Some features were preserved in their original locations such as the established Honey Locust and Sycamore trees. Other materials such as the repurposed concrete sidewalks were removed and manipulated to create a new material. A summary of the materials salvaged and repurposed on-site is provided in Table 12.

Table 12. Percent of Salvaged Materials by Cost. *(Reproduced from RCHS SITES Documentation)*

Material	**Quantity**	**Cost Per Unit**	**Cost/Replacement**

			Value
Existing Honey Locust Trees	30.00	$1,170 ea	$35,100.00
Existing Sycamore Trees	48.00	$1,170 ea	$56,160.00
Existing Sycamore Trees	9.00	$1,170 ea	$10,530.00
Backflow Preventer & Irrigation Mainline	1200 ft of pipe	$2,590.42 ls	$2,590.42
Recycled Concrete Blocks	8,500 blocks	$12 block	$102,000.00
Structural Foam Fill	4,400 ft^2	$8,800 ls	$8,800.00
Total Salvaged Material Costs			**$215,180.42**
Total Materials Costs			**$845,7545.00**
Percent of Salvaged Materials			**25%**

IV. Cost Comparison

One of the most highly visible sustainable features of the Courthouse is the series of site walls constructed of repurposed concrete blocks. Existing concrete sidewalks were cut into block size modules to create 1,796 linear feet of site walls. The design team was able to utilize three different colors of concrete and the method of saw cutting the blocks exposed an interesting concrete finish. Records of actual costs for installing the concrete block walls was difficult to uncover given the time elapsed since construction. Instead, the research team estimated the cost of the salvaged concrete walls with a replacement cost provided by the contractor as part of SITES Documentation. Due to the finish and quality of the blocks, the contractor based their estimate on an integral color exposed aggregate finish CMU block. The contractor provided a replacement cost of $12 per block for the recycled concrete block walls. To get the cost of the recycled concrete walls, the cost per block was multiplied by the total number of blocks harvested used for wall construction.

$12 per block x 8,500 blocks = $102,000

A comparable alternative to the recycled concrete walls would be a standard finish concrete site wall. The contractor also provided an estimate of the cost for a natural grey, concrete wall at $84.94 per linear foot. To estimate the cost of all new concrete walls the total linear feet of walls built was multiplied the cost per linear foot.

$84.94 per linear foot x 1,796 linear feet = $152,552.24

In this instance a standard concrete wall slightly more expensive than the recycled concrete block walls. This cost would certainly increase if a finish and color similar to that achieved by the recycled concrete walls were utilized. Recycling the concrete allowed the design team to increase permeable surfaces on site without generating an excessive amount of waste and providing a site wall with a premium finish.

A challenge of this calculation was the ability to establish a firm cost per linear foot of the recycled concrete walls. One could consider demolition, storage, relocating, and construction all part of the costs associated with constructing the walls. However, it was difficult to uncover this detailed information from construction and so the more accessible replacement costs provided by the contractor were utilized.

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