SAN DIEGO
AMERICAN SOCIETY OF
LANDSCAPE ARCHITECTS
CHAPTER

Sustainable Design
Return On Investment - Case Study

PERMEABLE PAVERS VS NON-POROUS ASPHALT PAVING (LARGE SCALE AREA)

September, 2013

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As landscape architects, architects, civil engineers, geotechnical engineers, or other design professionals, it should be our responsibility to advise our clients, to the best of our abilities, on the most sustainable design solutions. However, when "sustainability" is mentioned, our clients, whether they are developers, homeowners or even other consultants on the design team, commonly respond negatively with the belief that "sustainable" materials or "sustainable site design" is too expensive. A positive return on investment (ROI) is often believed to take too long to realize and without a full understanding of ALL of the costs (added and/or subtracted) associated with such sustainable solutions, it can be difficult to make a good counter argument for sustainability.

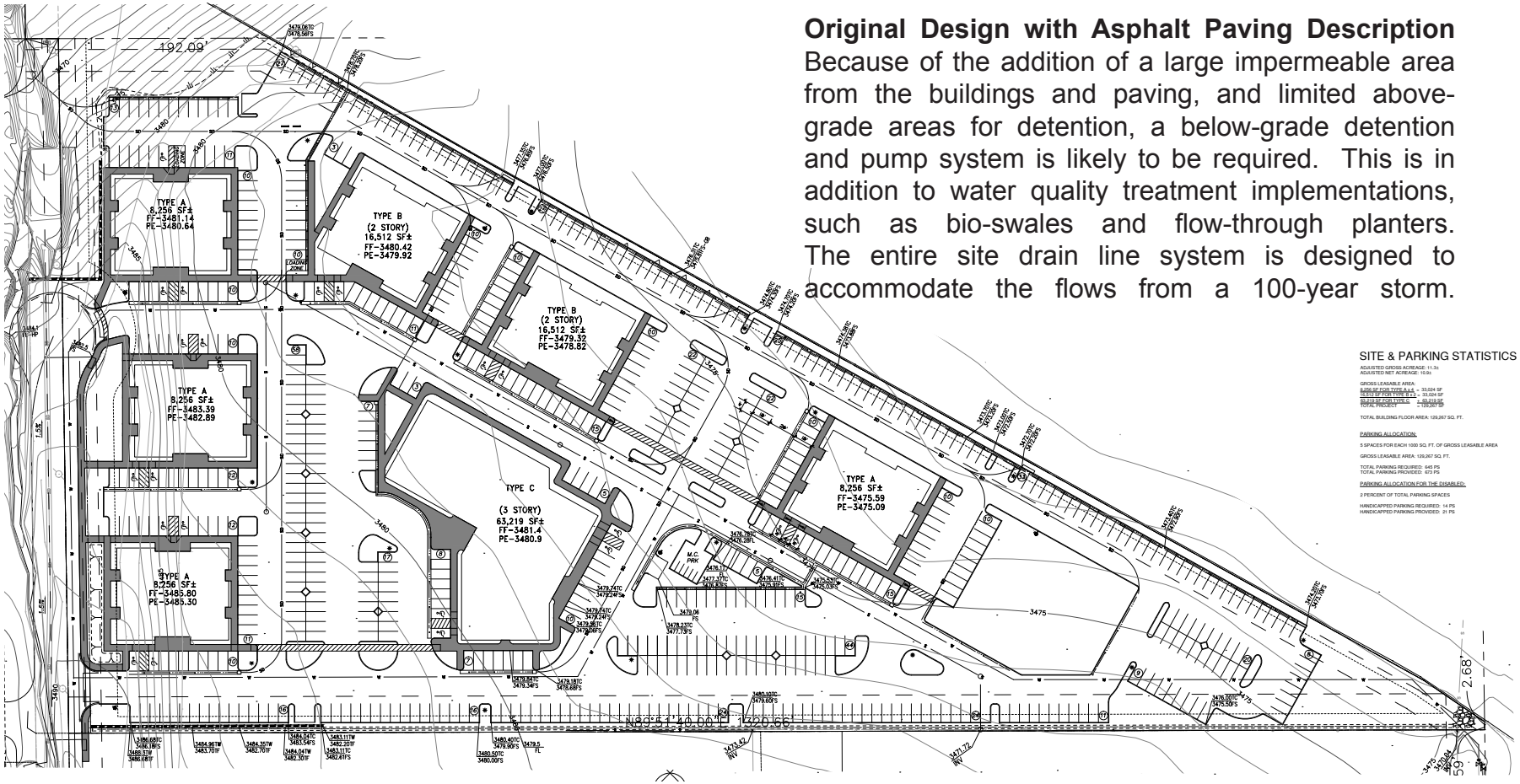
To assist design teams in understanding the monetary costs of sustainable design choices, the ASLA San Diego Stewardship Committee is compiling a series of ROI case studies that will allow more informed decisions regarding the potential costs of various sustainable design solutions. This study, comparing the costs of permeable pavers and non-porous asphalt paving in a large parking lot, marks our first case study regarding sustainable design. It is important to recognize that the study and cost estimates are intended to be used as guides only and that experienced design professionals should be able to recognize which line items in each cost estimate will likely apply or not apply to a project based on the unique characteristics of the project site. For example, a project that uses non-porous paving may not have a need for an underground storm water storage system and this will certainly affect the choice of materials if a positive ROI is required on the day of project completion. Think of the cost estimates as more of a check list of common potential items and costs that may be associated with a project. Then decide whether pursuing a more sustainable material choice will show a greater Return On Investment in the short or long term.

Based on an 11.3 acre Business Park previously designed using traditional concepts including non-porous asphalt, the Stewardship Committee organized a one day design charette that resulted in 5 different design solutions. The most effective design resulting from the charette that included landscape architects, civil engineers, landscape contractors and landscape architecture students was then refined for accuracy and used to begin our study on the ROI of sustainable design solutions.

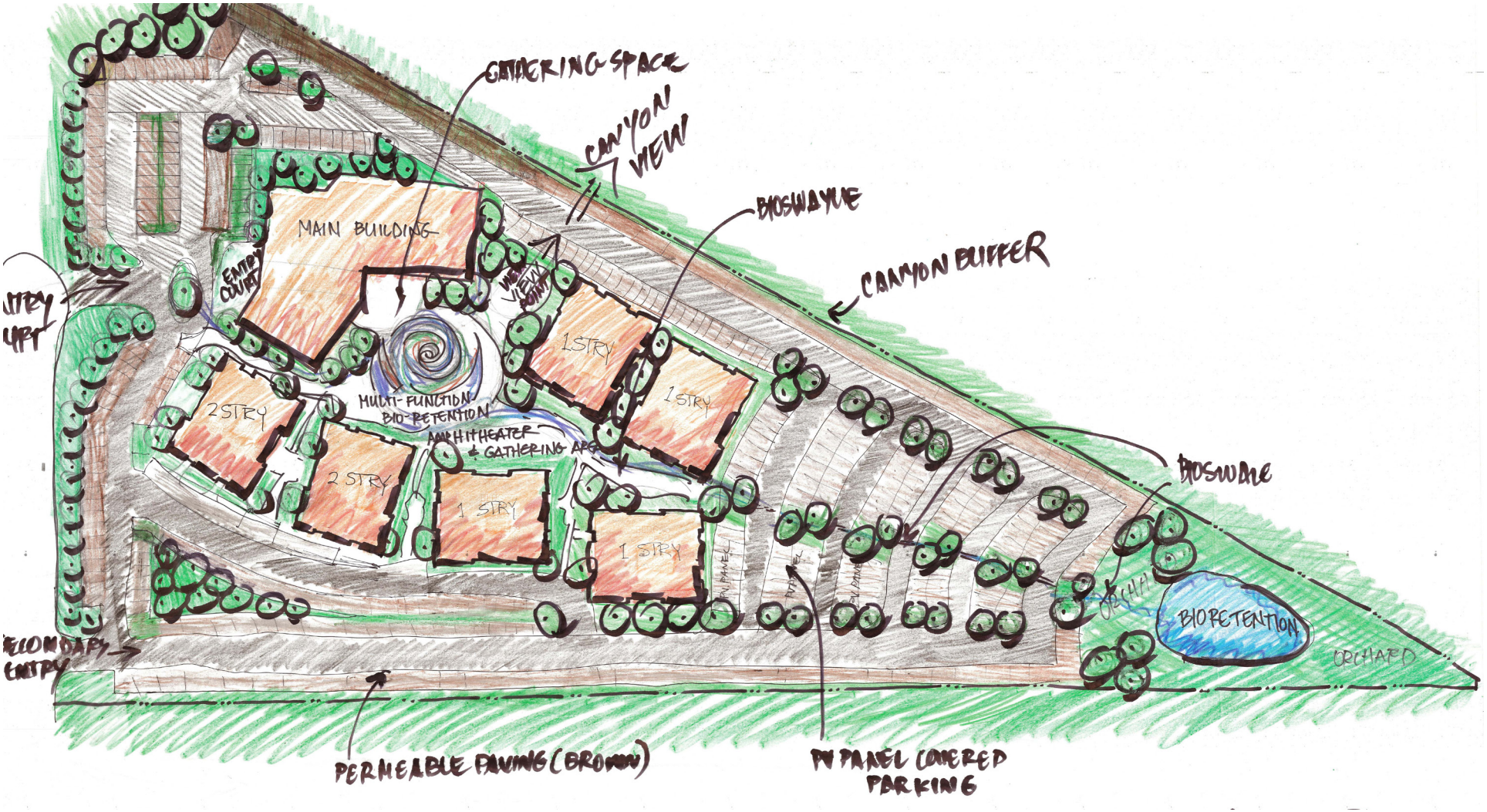
Multi-disciplinary design teams brainstorm to develop creative sustainable design solutions.

The following graphics represent the original design based on traditional design concepts and the five proposed revisions to the site plan incorporating sustainable design concepts. The study is limited to the parking lot paving materials. Future studies will examine other aspects of the site with regard to sustainability.

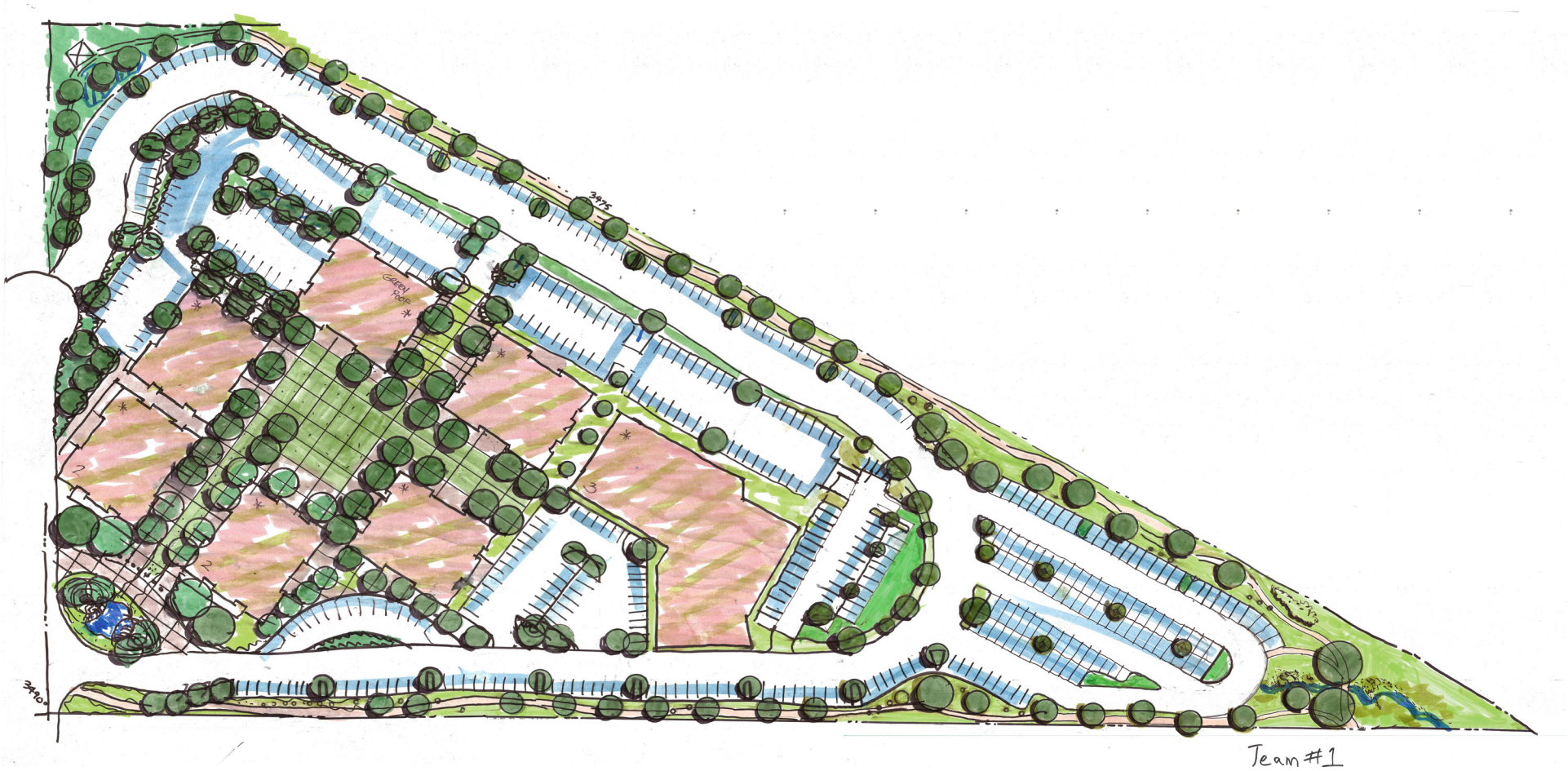
Original Design with Asphalt Paving Description
Because of the addition of a large impermeable area from the buildings and paving, and limited above-grade areas for detention, a below-grade detention and pump system is likely to be required. This is in addition to water quality treatment implementations, such as bio-swales and flow-through planters. The entire site drain line system is designed to accommodate the flows from a 100-year storm.



Original Site Plan Using Traditional Paving Materials - Asphalt, Curb/Gutters and Ribbon Gutters


GATHERING SPACE
CANYON VIEW
BIOSWALE
CANYON BUFFER
MAIN BUILDING
ENTRY COURT
MULTI-FUNCTION BIO-RETENTION
AMPHITHEATER & GATHERING AREA
2 STRY
1 STRY
BIOSWALE
BIORETENTION
ORCHARD
PERMEABLE PAVING (BROWN)
PV PANEL COVERED PARKING

Concept One



Concept Two

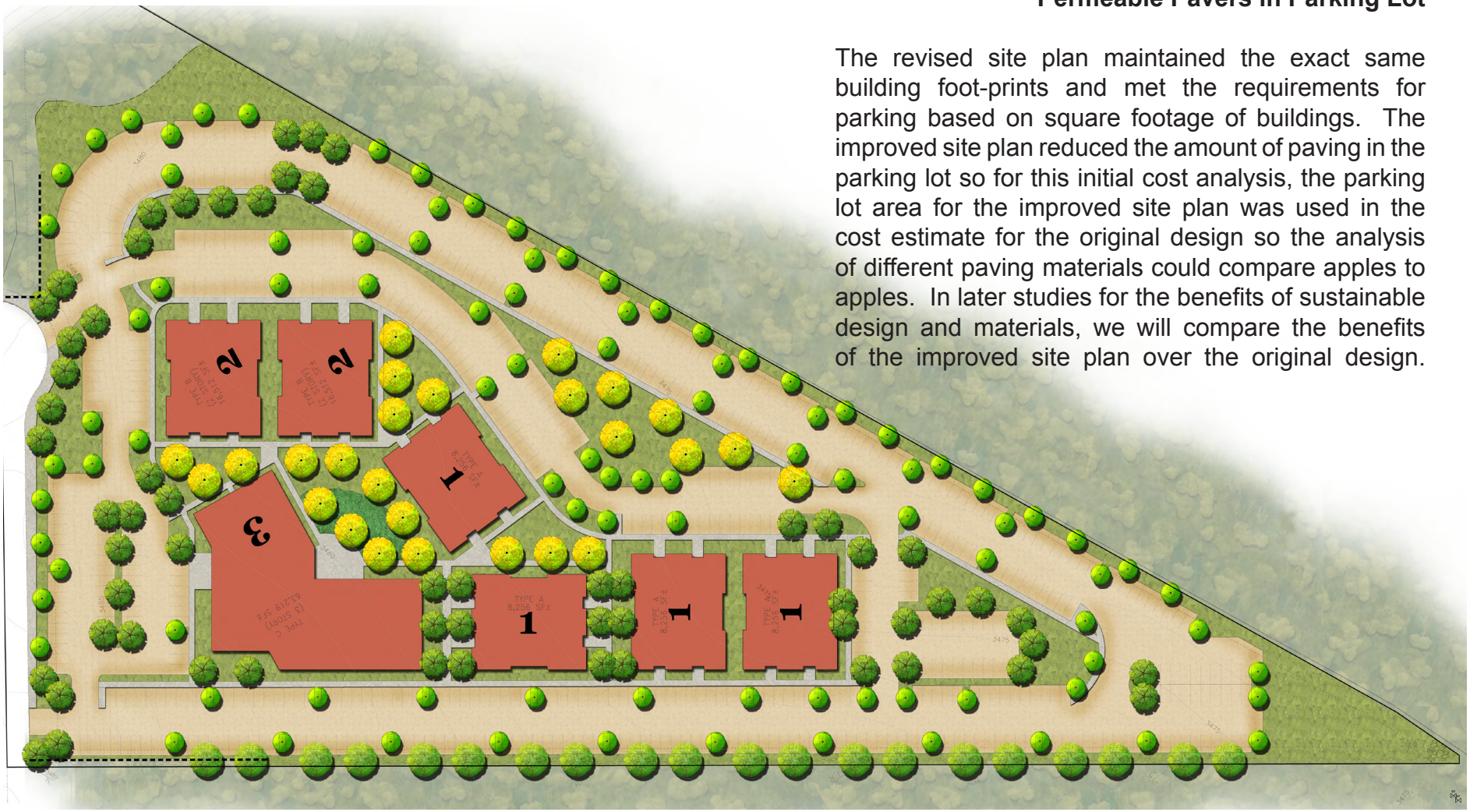
Concept Three

Concept Four

Concept Five

New Design with Improved Site Planning and Permeable Pavers in Parking Lot

The revised site plan maintained the exact same building foot-prints and met the requirements for parking based on square footage of buildings. The improved site plan reduced the amount of paving in the parking lot so for this initial cost analysis, the parking lot area for the improved site plan was used in the cost estimate for the original design so the analysis of different paving materials could compare apples to apples. In later studies for the benefits of sustainable design and materials, we will compare the benefits of the improved site plan over the original design.



Refined Concept Plan

The potential costs of construction were prepared under two scenarios. The first scenario reflects the site and parking lot developed by conventional methods. The second reflects the use of a permeable paver system. Because the soil permeability has a substantial impact on maximum stormwater runoff potential, we evaluated the effect of 3 different soil infiltration types for the permeable paver system scenario, for a total of 4 site conditions.

In the following cost estimates, only those items that were unique to at least one of the four site conditions were included. There are a number of other site costs that are the same for all scenarios, which were not included. Under all the scenarios, it is assumed that Hydromodification and Water Quality regulations must be followed so that ultimate runoff rates must be equal to or less than those prior to construction and that water quality impacts must be mitigated to the maximum extent practicable.

See Cost Estimates Below.

Open discussions during Design Charette on Sustainable Materials.

Design Charette brainstorming.

ORIGINAL DESIGN W/ ASPHALT

Item No.	Item	Quantity	Unit	Unit Price	Cost
1	Asphalt Paving	203,477	SF	$3.65	$742,691.05
2	Concrete Curb and Gutter + 4 Cross Gutters	11,065	LF	$23.00	$254,495.00
3	Liner	0	SF	$0.65	$0.00
4	Filtration (Bioretention Areas used in example)	24,500	SF	$4.00	$98,000.00
5	Pump System	1	EA	$30,000.00	$30,000.00
6	Excavate/Export and Grade Detention Areas	1,100	C.Y.	$30.00	$33,000.00
7	Underground Storage/Detention System	50,000	CF	$7.00	$350,000.00
8	36" Drain Line	650	LF	$189.00	$122,850.00
9	24" Drain Line	500	LF	$143.00	$71,500.00
10	18" Drain Line	800	LF	$124.00	$99,200.00
11	12" Drain Line	1,000	LF	$80.00	$80,000.00
12	6/8" Drain Leads	800	LF	$40.00	$32,000.00
13	4" Perforated PVC collectors (below paving system)	0	LF	$25.00	$0.00
14	4" Perforated PVC Feeders (from rooftops)	0	LF	$25.00	$0.00
15	Minor Drain Boxes/Cleanouts	11	EA	$2,000.00	$22,000.00
16	Major Drain Boxes/Cleanouts	7	EA	$6,500.00	$45,500.00
17	Attenuation Control Structures	2	EA	$5,000.00	$10,000.00
18	Headwall/Discharge Structure	1	EA	$7,000.00	$7,000.00
19	Miscellaneous Drainage Facilities	1	EA	$15,000.00	$15,000.00
		Estimate			$2,013,236.05

Note that the yellow rows represent line items that went up in cost compared to the parking lot with non-porous asphalt. The green rows represent line items that dropped in cost and the rows in white did not change compared to the asphalt parking lot.

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Case 1 - Clayey Soil, Low to Zero Permeability, Hydrologic Soil Type = D (WITH liner)

Item No.	Item	Quantity	Unit	Unit Price	Cost	
1	Permeable Pavers	203,477	SF	$5.86	$1,192,375.00	
2	Concrete Header (Flush Curb, Deeper Sections)	10,232	LF	$20.00	$204,640.00	
3	Liner	203,477	SF	$0.65	$132,260.05	
4	Filtration (Bioretention Areas used in example)	24,500	SF	$4.00	$98,000.00	
5	Pump System	0	EA	$30,000.00	$0.00	
6	Excavate/Export and Grade Detention Areas	1,100	C.Y.	$30.00	$33,000.00	
7	Underground Storage/Detention System	0	CF	$7.00	$0.00	
8	36" Drain Line	0	LF	$189.00	$0.00	
9	24" Drain Line	650	LF	$143.00	$92,950.00	
10	18" Drain Line	400	LF	$124.00	$49,600.00	
11	12" Drain Line	500	LF	$80.00	$40,000.00	
12	6/8" Drain Leads	800	LF	$40.00	$32,000.00	
13	4" Perforated PVC collectors (below paving system)	3,750	LF	$25.00	$93,750.00	
14	4" Perforated PVC Feeders (from rooftops)	0	LF	$25.00	$0.00	
15	Minor Drain Boxes/Cleanouts	11	EA	$2,000.00	$22,000.00	
16	Major Drain Boxes/Cleanouts	7	EA	$6,500.00	$45,500.00	
17	Attenuation Control Structures	2	EA	$5,000.00	$10,000.00	
18	Headwall/Discharge Structure	1	EA	$7,000.00	$7,000.00	
19	Miscellaneous Drainage Facilities	1	EA	$15,000.00	$15,000.00	
			Estimate Case 1A - Clayey w/Liner		$2,068,075.05	3.7% HIGHER

Case 1 – Clayey Soil and Permeable Pavers Throughout the Parking Lot

Under clay soil conditions, we assume that the permeable paver system is capable of detention/storage of rain water, and we have no expectation of infiltration. A liner and additional cutoff walls are proposed to discourage water in the system from saturating the clay soils and threatening structures on and adjacent to the property. A number of the project's drain lines can be reduced in size due to the detention capacity. It should be noted that in some cases with special geotechnical considerations, that the liner can be deleted and the system can contribute the added benefit of water quality treatment to the site's overall treatment plan.

Case 2 - Moderate, Some Permeability, Hydrologic Soil Type = B or C

Item No.	Item	Quantity	Unit	Unit Price	Cost
1	Permeable Pavers	203,477	SF	$5.86	$1,192,375.00
2	Concrete Header (Flush, some shallow, some deeper)	10,232	LF	$18.00	$184,176.00
3	Liner	0	SF	$0.65	$0.00
4	Filtration (Bioretention Areas used in example)	10,000	SF	$4.00	$40,000.00
5	Pump System	0	EA	$30,000.00	$0.00
6	Excavate/Export and Grade Detention Areas	1,100	C.Y.	$30.00	$33,000.00
7	Underground Storage/Detention System	0	CF	$7.00	$0.00
8	36" Drain Line	0	LF	$189.00	$0.00
9	24" Drain Line	0	LF	$143.00	$0.00
10	18" Drain Line	1,050	LF	$124.00	$130,200.00
11	12" Drain Line	500	LF	$80.00	$40,000.00
12	6/8" Drain Leads	800	LF	$40.00	$32,000.00
13	4" Perforated PVC collectors (below paving system)	3,750	LF	$25.00	$93,750.00
14	4" Perforated PVC Feeders (from rooftops)	0	LF	$25.00	$0.00
15	Minor Drain Boxes/Cleanouts	14	EA	$2,000.00	$28,000.00
16	Major Drain Boxes/Cleanouts	4	EA	$6,500.00	$26,000.00
17	Attenuation Control Structures	1	EA	$5,000.00	$5,000.00
18	Headwall/Discharge Structure	1	EA	$7,000.00	$7,000.00
19	Additional Protective Cutoff Wall	2,100	LF	$15.00	$31,500.00
20	Miscellaneous Drainage Facilities	1	EA	$10,000.00	$10,000.00
			Estimate Case 2 - Moderate		$1,853,001.00

8% SAVINGS

Case 2 – Moderate Soil with Permeable Pavers Throughout the Parking Lot

Under this scenario, some infiltration is anticipated, and the liner and special cutoff walls are deleted from the estimate. The storm drain lines can be further reduced by not just the detention capacity, but by the additional infiltration rate expected. The system is likely to directly mitigate water quality in the parking areas due to the moderate permeability.

Case 3 - Sandy Soil, High Permeability, Hydrologic Soil Type = A (and some B soils)

Item No.	Item	Quantity	Unit	Unit Price	Cost
1	Permeable Pavers	203,477	SF	$5.86	$1,192,375.00
2	Concrete Header (Flush Curb, Shallow)	10,232	LF	$14.00	$143,248.00
3	Liner	0	SF	$0.65	$0.00
4	Filtration (Bioretention Areas used in example)	0	SF	$4.00	$0.00
5	Pump System	0	EA	$30,000.00	$0.00
6	Excavate/Export and Grade Detention Areas	300	C.Y.	$30.00	$9,000.00
7	Underground Storage/Detention System	0	CF	$7.00	$0.00
8	36" Drain Line	0	LF	$189.00	$0.00
9	24" Drain Line	0	LF	$143.00	$0.00
10	18" Drain Line	0	LF	$124.00	$0.00
11	12" Drain Line	0	LF	$80.00	$0.00
12	6/8" Drain Leads	800	LF	$40.00	$32,000.00
13	4" Perforated PVC collectors (below paving system)	0	LF	$25.00	$0.00
14	4" Perforated PVC Feeders (from rooftops)	2,000	LF	$25.00	$50,000.00
15	Minor Drain Boxes/Cleanouts	6	EA	$2,000.00	$12,000.00
16	Major Drain Boxes/Cleanouts	0	EA	$6,500.00	$0.00
17	Attenuation Control Structures	0	EA	$5,000.00	$0.00
18	Headwall/Discharge Structure	0	EA	$7,000.00	$0.00
19	Miscellaneous Drainage Facilities	1	EA	$8,000.00	$8,000.00
		Estimate Case 3 - Sandy			$1,446,623.00 28% SAVINGS

Case 3 – Sandy Soil with Permeable Pavers Throughout the Paking Lot

Under this ideal condition, the soil is capable of receiving the entire volume of storm water through infiltration, including storm water from portions of the site outside of the parking lot area (such as from rooftops). The number and size of storm drain lines are significantly reduced or eliminated. The paver system itself is entirely capable of addressing the site's water quality requirements.

From this study, it is clear that to understand the true cost of one material over another, one must analyze all of the resulting material and labor costs associated with each material. For a large area, the unit cost for permeable pavers is substantially lower due to volume pricing, but more importantly, because of the ability to use mechanical installation methods.

This study shows that, while the unit cost of permeable pavers is higher than asphalt, the overall cost, given certain circumstances, can be less with the elimination of storm water drainage systems required with asphalt paving.

As stated earlier, it is important to understand the site's needs and which line items, as shown in the cost estimates, would likely apply to a project. In some cases, an asphalt parking lot will be much cheaper in the short run but it is not necessarily so all of the time.

One of the purposes of this study was to determine the ROI of permeable pavers compared to asphalt upon completion of the construction project as apposed to looking at the long term savings or costs typically associated with "sustainable" design approaches. Future studies conducted by the Stewardship Committee will look at the long term ROI of permeable pavers.

Additionally, our efforts will focus on the ROI of smaller paved areas including residential projects.

The ASLA San Diego Chapter thanks **Belgard** and **Coffey Engineering** for their significant rolls in the development of the cost analysis. For questions or comments about this study, please contact Tim Smith, PLA, ASLA at tim@wynn-smith.com.