Blue Hole Regional Park – Wimberley, TX
Methodology for Landscape Performance Benefits
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Environmental

Protects 93 acres or 96% of the undisturbed area of the site, which was identified as potential habitat for 19 different endangered, threatened, or species of concern.

PBS&J conducted an in-depth species inventory and submitted a report summary to Design Workshop in October 2010. The following is an excerpt from the report (PBS&J, 2010):

> "Prior to conducting field surveys, PBS&J ecologists reviewed the Texas Parks and Wildlife Department (TPWD)'s Natural Diversity Database (TXNDD) (TPWD, 2010a) to identify previously recorded occurrences of endangered, threatened and species of concern within Hays County. The U.S. Fish and Wildlife Service (USFWS)'s threatened and endangered species county list was also reviewed (USFWS, 2010). Additionally, staff ecologists reviewed the soil surveys for Hays County, Texas (NRCS, 2006) and U.S. Geological Survey (USGS) topographic maps (USGS, 1998). The project area was assessed for potentially suitable habitat for 17 of 18 species listed in TPWD's Environmental Addendum [see Table 1-1 below] on May 5, May 20, May 24, and July 21, 2010."
>
> "PBS&J botanists conducted presence/absence surveys in appropriate habitat during the blooming period for each plant species listed as a 'species of concern'. A complete list of plant species found within the area was recorded and is included in [PBS&J's report]. PBS&J aquatic and wildlife biologists assessed appropriate habitats and sampled areas, as appropriate, for the potential presence of animal species listed in [Table 1-1]."

A primary design goal was to constrict new development to extend no more than 2% beyond existing soils so as to limit disturbance to sensitive ecological areas and potential habitat for endangered, threatened, and species of concern. Site disturbance (ie previously disturbed soils) included former ranch land, sweet potato cropland, RV park, septic field, and foundations of old houses. Although this site was formerly private property, site usage was "classic rural" and hosted many different undocumented uses. The performance achieved measures that new development was kept to 4% beyond previous disturbance. Thus 96% of valuable habitat was protected.

Calculations:

- Area of soil disturbance prior to implementation: 28.06 ac (CAD site plan area takeoff)
- Area of soil disturbance after implementation: 33.10 ac (CAD site plan area takeoff)
- 33.10 ac – 28.06 ac = 5.04 ac of new disturbance

- Undisturbed soil prior to design implementation: 126 ac – 28.06 ac = 97.07 as
- Undisturbed soil after design implementation: 126 ac – 33.10 as = 92.90 ac
- 92.90 ac / 97.07 ac = **96%** of previously undisturbed soils were preserved

Table 1-1: Endangered, Threatened, and Species of Concern with potential habitat on site (adapted from PBS&J, 2010)

		Species		Habitat	Potential	
		Common Name	***Scientific Name***	**On-Site?**	**to Occur**	**Observed On-Site during field surveys**
Federal & State-listed Endangered	Birds	Golden-cheeked Warbler	*Dendroica chrysoparia*	yes	N/A	No, sightings 0.35mi from site
State-listed Threatened	Birds	Zone-tailed Hawk	*Buteo albonotatus*	yes	Low	No, sightings in neighboring counties
	Reptiles	Texas horned lizard	*Phrynosoma cornutum*	yes	High	No, sightings in Hays Co.
Species of Concern/Rare Species	Amphibians	Blanco River Springs Salamander	*Eurycea pterophila*	yes	High	No, sightings 0.5mi from site
	Reptiles	Cagles' map turtle	*Graptemys caglei*	yes	High	No, sightings 1.35mi from site
		Spot-tailed earless lizard	*Holbrookia lacerata*	yes	High	No, sub-species sightings in Hays Co.
		Texas garter snake	*Thamnophis sirtalis annectens*	yes	High	No, sightings 15mi from site
	Birds	Western Burrowing Owl	*Athene cunicularia hypogaea*	yes	Low	No, no recorded sightings nearby
	Mammals	Plains spotted skunk	*Spilogale putorius interrupta*	yes	High	No, sightings in Hays Co.
	Mollusks	Creeper (squawfoot)	*Strophitus undulatus*	yes	Low	No, may be present downstream
		False spike mussel	*Quincuncina mitchelli*	yes	Low	No, may be present downstream
		Golden orb	*Quadrula aurea*	yes	Low	No, may be present downstream
		Pistolgrip	*Tritogonia verrucosa*	yes	Low	No, may be present downstream
		Texas fatmucket	*Lampsilis bracteata*	yes	Low	No, may be present downstream
		Texas pimpleback	*Quadrula petrina*	yes	Low	No, may be present downstream
	Plants	Canyon mock-orange	*Philadelphus ernestii*	yes	Unlikely	No, sightings 8.3mi from site
		Hill Country wild-mercury	*Argythamnia aphoroides*	yes	Unlikely	No, sightings 6.35mi from site
		Warnock's coral root	*Hexalectris warnockii*	yes	Unlikely	No, sightings 0.66mi from site
		Chatterbox orchid	*Epipactic gigantea*	yes	-	Yes, creekside/bluff ecosystem

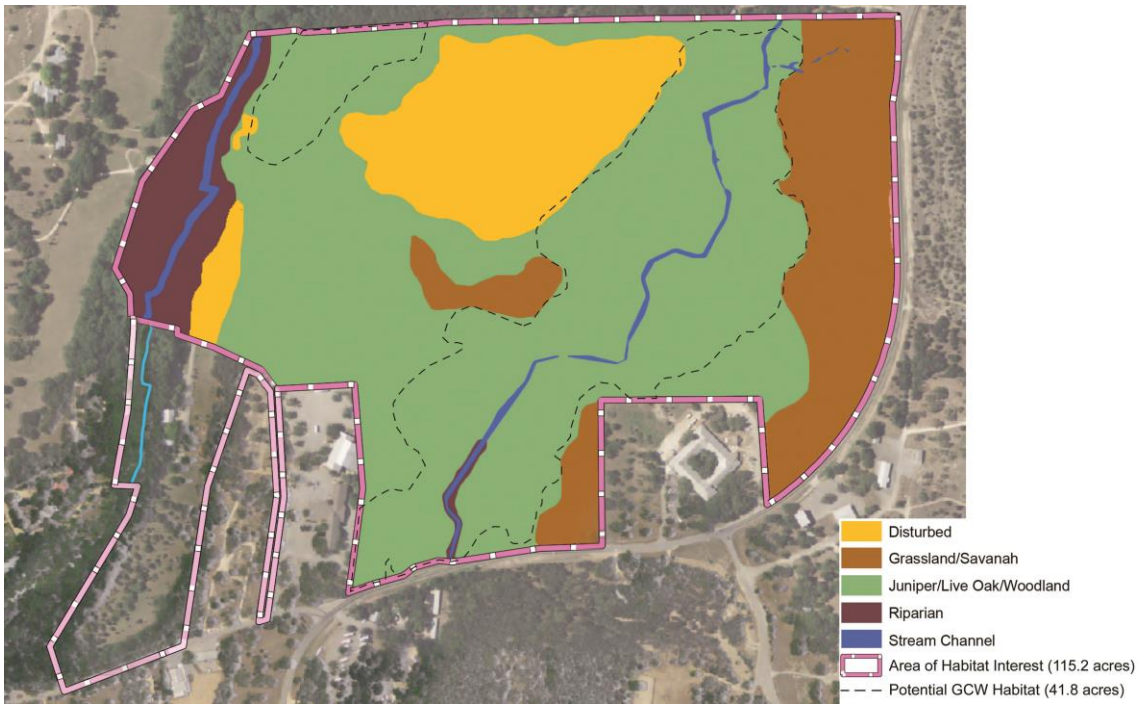

Figure 1-1: Site plan showing GIS-derived vegetative communities and habitat types for all potential endangered, threatened, and species of concern (see Table 2-1) (adapted from PBS&J, 2010 and PBS&J, 2009a)

"A major design parameter of park improvements is that the impervious cover total does not exceed **10%** of the site (see Figure 1-2, reference "New Building/Hardscape Footprint") to avoid potentially impacting groundwater and aquifer recharge. Additionally, design features adjacent to the Blue Hole swimming area within Cypress Creek do not result in discharge of fill material; rather, the improvements in this area will stabilize areas to reduce erosion and provide bank stabilization. For these reasons, downstream impacts to any mussels and Blanco River springs salamander are not expected" (PBS&J, 2010). The 10% goal was met and exceeded when only

7.8% of the site was constructed with impervious surfaces (as stated by and confirmed in CAD area takeoff).

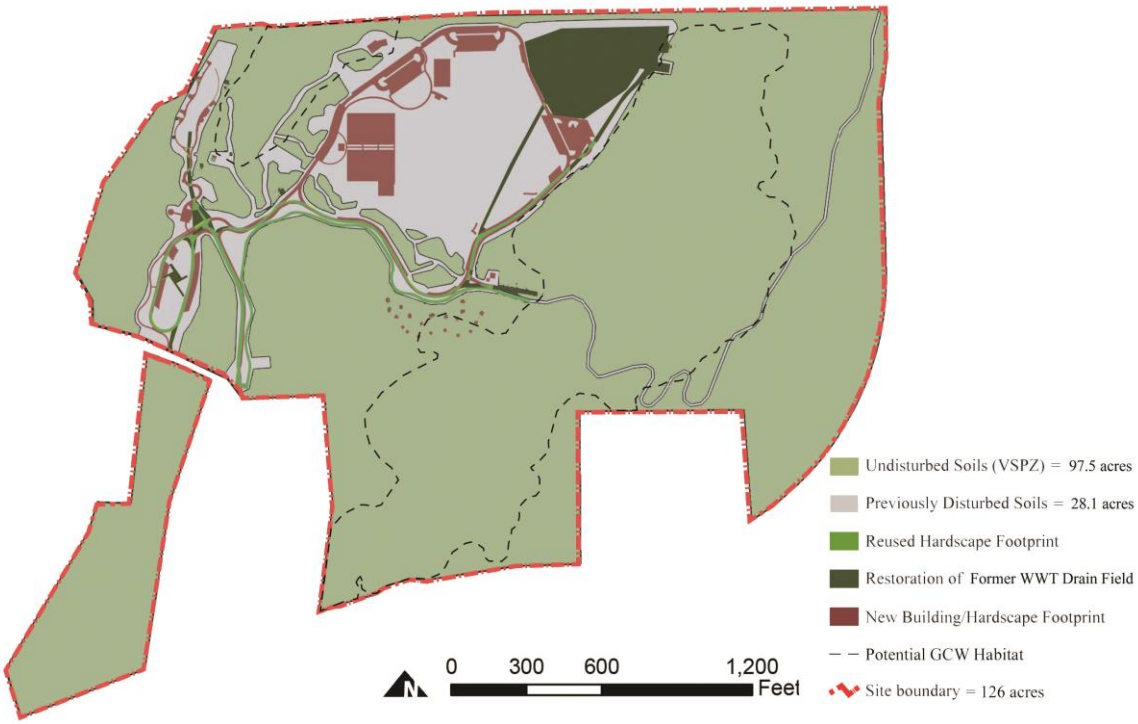

Figure 1-2: Site plan survey of soil disturbance and building/hardscape footprint (adapted from Design Workshop, PBS&J, and Baker Aiklen Survey)

Calculations:

- 9.8 ac of hardscape and building footprint (see Fig. 1-2) / 126 ac total site area (CAD site plan area takeoff)
- 9.8 ac/126 ac = **7.8%** impervious coverage of the total site area

Increased plant species richness by 17% with the addition of 31 ecologically valuable native hardwood, prairie grass, and forb species.

Table 2-1: Summary of pre-implementation and planted species on site (PBS&J, 2010) and Design Workshop planting palette

	Existing species observed on-site	Planting Palette species	New species	**Total # of species on-site post-implementation**
Trees	26	15	3	**29**
Shrubs	31	6	1	**32**
Grasses	30	16	11	**41**
Forbs	84	23	16	**100**
Ferns	3	0	0	**3**
Vines	9	0	0	**9**
Cacti	3	1	0	**3**
Total	**186**	**61**	**31**	**217**

Calculation: Total new species (31)/ Total Existing species (186) = 17% increase

Maintains or reduces stormwater runoff flow rates sitewide, despite the addition of 320,000 sf of new park development.

An XPSWMM hydrologic model was set up by PBS&J to calculate the existing and proposed condition flows generated by the 2-year and 25-year storm events for the study area (Figure 3-1). The model was computed based on the methodology described in the Natural Resource Conservation Service (NRCS)'s Technical Release 55 (TR-55, Urban Hydrology for Small Watersheds, 1986) (PBS&J, 2009b).

Figure 3-2 shows the drainage area delineation for the existing condition where Drainage Area (DA) 1 drains to Deer Creek, and DA2 and DA3 drain to Cypress Creek. Figure 3-3 shows the drainage area delineation for the proposed condition where DA1 and DA2 cover the same area as in the existing condition and DA3 is subdivided into eight drainage areas to accommodate for the alterations in drainage patterns made by development. Note that DA8 and DA9 are re-routed to Deer Creek in the designed condition. Despite the additional drainage area, runoff velocities in DA1 are maintained.

Runoff velocity reduction is achieved through the series of rain gardens (microdetention pools) and bioswales strategically located to capture impervious surface runoff and slow it down before discharging it into Cypress Creek and Deer Creek. The model was also run to include a scenario where the designed 5.5 acres of impervious cover was implemented but not the rain gardens or bioswales. In this case, the absence of rain gardens would have little effect for the 25-year peak flows but the 2-year peak flows at Cypress Creek would be higher than the existing flows (PBS&J, 2009b).

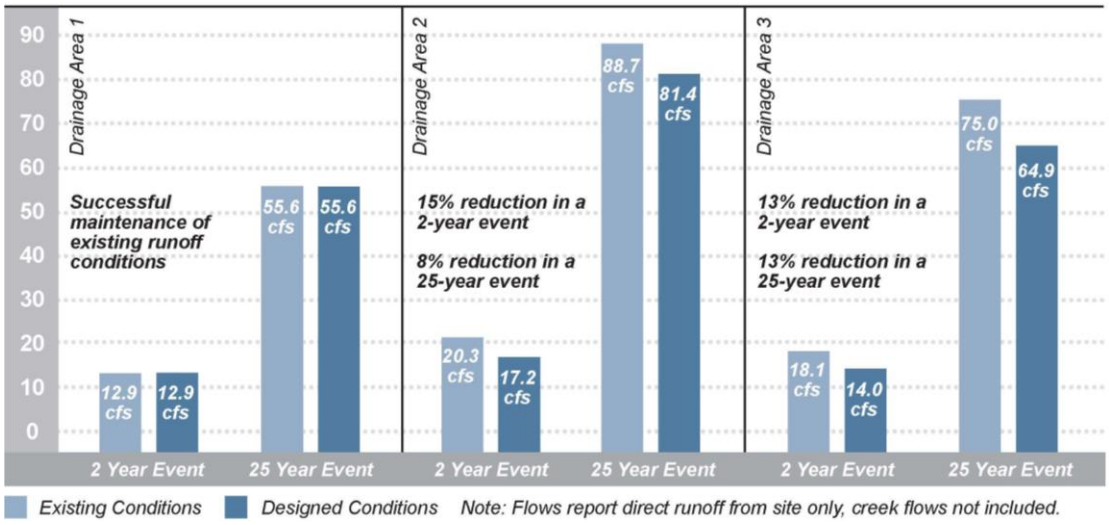

Figure 3-1: Before and after stormwater discharge (stream flow) (Design Workshop)

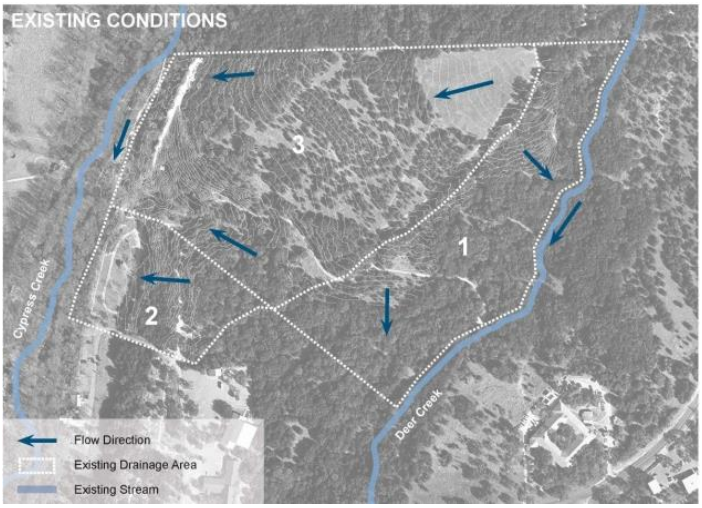

Figure 3-2: Pre-Implementation stormwater runoff conditions (adapted by Design Workshop from PBS&J, 2009b)

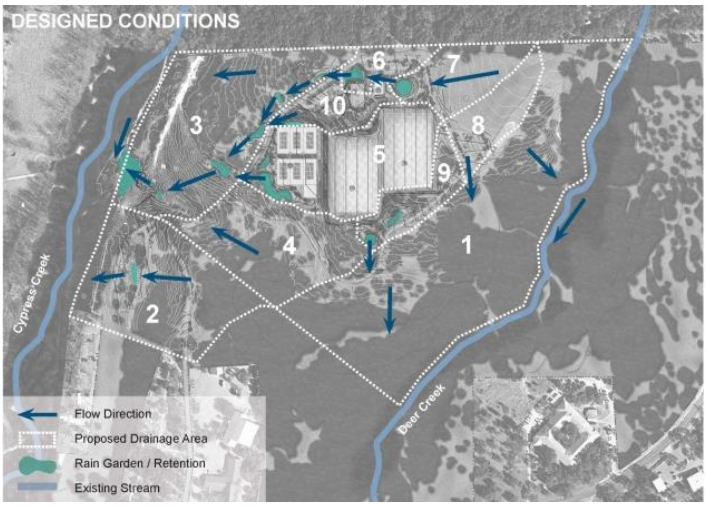

Figure 3-3: Designed stormwater runoff conditions (adapted by Design Workshop from PBS&J, 2009b)

Table 4-1: Calculation of stormwater discharge

	2-year event			25-year event		
	Pre-Implementation Discharge (cfs)	Designed Conditions Discharge (cfs)	reduction in discharge (cfs)	Pre-Implementation Discharge (cfs)	Designed Conditions Discharge (cfs)	reduction in discharge (cfs)
DA2	20.3	17.2	3.10	88.7	81.4	7.30
DA3	18.1	14.0	4.10	75.0	64.9	10.10

Discharge in Drainage Area 1 is maintained while the discharge volumes for Drainage Areas 2 and 3 (both entering Cypress Creek) decrease for both the 2-year and 25-year events.

In addition to reducing discharge (stream flow), the rain gardens (microdetention pools) and vegetated swales are also capturing and treating runoff from all impervious surfaces. In every case where justified, bioswales were implemented as close to impervious surfaces as possible and were directly connected to rain gardens which allowed water to get into the rain gardens as quickly as possible. Where there was a small amount of sheet flow coming off of an impervious surface (ie. one-half the driveway draining on to the gravel parking and then into existing natural landscape), bioswales were not implemented because they would have triggered additional

disturbance and the calculations did not require extensive detention. On the other hand, bioswales and were implemented immediately adjacent to the basketball court (Spears, 2012). The rain gardens have the potential to capture a volume of approximately 0.5 ac-ft. The first inch of runoff from the 5.5 acres of impervious surface requires 0.46 ac-ft. After the first inch, the vegetated swales adjacent to impervious surfaces slow, capture, and treat additional runoff (PBS&J, 2009b).

Saves an estimated 600,000 gallons of potable water per month by using drought tolerant turf and on-site well water for recreation field irrigation. This results in an estimated annual cost savings of $25,500.

Table 4-1: Soccer Field Water Requirement (adapted from EPA WaterSense Water Budget Tool, 2010)
Evapotranspiration Rate (July) ET_0 = 8.19

Average Monthly Rainfall (July) R = 1.28 inches

Landscape Type	Irrigation Type	Distribution Uniformity DU_{LQ}	Total Area (2 fields at 73,100 sq.ft. each)	Landscape Coefficient K_L	Conversion Factor (ga/month) C_U	Total Water Requirement (ga/month)
Turfgrass	Drip - Standard	70%	146,200	0.6	0.6233	598,049.94

At $3 per 1,000 gallons plus a $2,450 flat rate for a large commercial meter (Wimberley Water Supply Corporation), this equates to $4,244.15 per month. Assuming that the Texas Hill Country climate requires 6 months of irrigation, the soccer fields would cost $25,464.90 annually.

However, because the soccer fields at Blue Hole are planted with drought tolerant turf, they require little to no irrigation, except during periods of drought. Additionally, when the fields are irrigated during drought, on-site well water is used at no cost. It should be noted that during establishment, the soccer fields were regularly irrigated with on site well water, at no cost. In coming years (once the necessary infrastructure is in place) the irrigation supply will be switched from well water to recycled waste water (provided by the municipal treatment plant.

Social

Improved user satisfaction with new park amenities by 165%, perceptions of safety by 101%, and perceptions of visual appeal by 75%, as compared to previous conditions.

After construction, the City of Wimberley requested a survey of park users to assess the success of the Blue Hole Regional Park project. The Design Workshop team crafted a brief 15-question Likert-type and open-ended survey that assessed user satisfaction for new program elements, improvements in safety, public access and parking, the stabilization of Cypress Creek's banks, and the incorporation of local materials that add to the 'Hill Country feel' of the site.
Surveys were administered in the park on two separate occasions. Convenience sampling was used and no target respondents were identified prior to conducting the surveys. The survey was first administered on Saturday, July 16, 2011 from approximately 10:00am – 2:00pm (a peak usage time during the park's hours of operation), resulting in 27 completed surveys. The survey was again administered on Saturday, August 18, 2012 (from 10:00am – 2:00pm) resulting in 21 completed surveys.

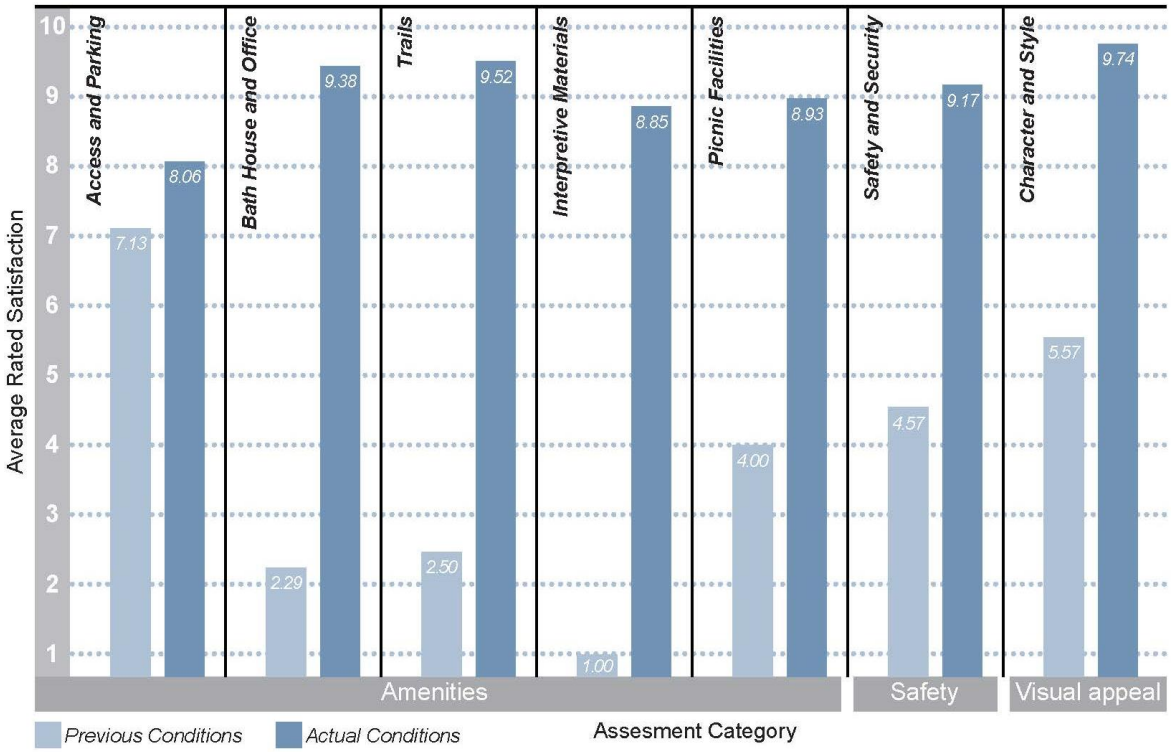

Figure 7-1: User satisfaction survey results from 2011 and 2012 surveys (adapted from Design Workshop, 2011 and Design Workshop, 2012b)

Notes: Questions were measured on a Likert-type scale of 1-10, with 1 being “least satisfied” and 10 “most satisfied.” N=48 Respondents

Percent change in satisfaction of amenities was calculated by comparing total average preference scores for ‘access and parking,’ ‘bath house and office,’ ‘trails,’ ‘interpretive materials,’ and ‘picnic facilities’ of previous conditions to those of actual conditions.
((7.13+2.29+2.50+1.00+4.00)/5)= 3.38 average rating for satisfaction of amenities, previous condition
((8.06+9.38+9.52+8.85+8.93)/5)= 8.95 average rating for satisfaction of amenities, actual condition
((8.95 actual condition - 3.38 previous condition) / 3.38 previous condition) = 165%

Percent change in perceptions of safety were calculated by comparing total preference scores for ‘safety and security’ of previous conditions to those of actual conditions.
(9.17 actual condition - 4.57 previous condition) / 4.57 previous condition) = 101%

Percent change in visual appeal was calculated by comparing total average preference scores for ‘character and style’ of previous conditions to those of actual conditions.
(9.74 actual condition - 5.57 previous condition) / 5.57 previous condition) = 75%

Increased visitation by 60% in the first year, generating an estimated $112,000 in entry fee revenue. In the second year, visitation nearly doubled again to 31,000, generating an estimated $217,000.

Table 8-1: Attendance and estimated park revenue

		# Visitors	Avg entry fee $/person	Estimated Revenue
pre-construction	2010	10,000	$7.00	$70,000
1st year open	2011	16,000	$7.00	$112,000
2nd year open	2012	31,000	$7.00	$217,000

Visitor totals provided by Blue Hole Regional Park
Average entry fee estimated by Steven Spears, Design Workshop

Economic

Saved approximately $230,000 in mulch costs by double-shredding the trunks of invasive cedars removed from the site and using this to cover all designed mulch areas.

4.957 ac (23,992 sq yd) of mulch used on site (DW Layout Plan, 2010b)
23,992 sq yd @ avg 5" depth = 3332 cu yd
3332 cu. yd. @ $69/cubic yard (Spears, 2012) = $229,908 saved

Note: Enough cedar mulch was created to cover all designed mulch areas as specified plus an additional 1 – 2", and to create a stockpile on site for future freshening of the mulch areas.

Saved approximately $40,000 by reusing excavated limestone found on-site instead of purchasing boulders.

Approximately 400 boulders reused @ ~$100 each = ~$40,000 saved (Spears, 2012).

Cost Comparison Methods

A prefabricated "typical" playground element cost $46,700 for the equipment, installation, fall surface material, and drainage work. The total cost for the six "nature-based" play elements made from materials found on the site was $102,350.

The playground area was designed with seven different treatments. One was a typical prefabricated playground assembled on site (per the community's request). The other six were designed to represent the regional character while teaching children about the hydrology and geology of the Texas Hill Country. It was important to demonstrate the creative reuse of materials found on site to visitors. This recycling of materials also prevented the need for off-site disposal of the removed cedar trees, the excavated limestone, and the utility poles.

Typical playground (equipment, installation, fall surface material, and drainage work) = **$46,700**

8 Balance poles (reused power poles staked to the ground) = $32,000
Stepping stones *(similar to hopscotch)* (reused stones laid in a pattern) = $5,000
Hydrology demonstration sand table (table, footing, and water source) = $15,000
4 Cedar teepees *(rootballs turned upside down)* (small footings and installation) = $14,000
Boulder climbing wall (Drystack boulder walls for play area) = 33,750
Sand play area (10" of sand over gravel base) = $2,600

Total for reused materials playground = **$102,350**

(DW, Probable Costs sheet, 2010a)

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References

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