Westerly Creek at Stapleton – Denver, CO
Methodology for Landscape Performance Benefits

Environmental

- ***Decreased existing sub-watershed floodplain from approximately 183 acres to 66 acres by increasing flood storage capacity.***

Floodplain area was referenced from the 2001-Request for Conditional Letter of Map Revision report (2001-CLOMR).

- ***Improved the site's water conveyance capacity from 1,500 cubic feet per second (28% of the predicted 100-year flood flow) to 6,000 cfs (113% of predicted 100-year flood flow) by removing over 4,000 linear feet of culverts and restoring the stream to a surface flowing water body.***

Existing condition design capacity flow rates (1,500 cfs) were referenced from the 2001-CLOMR report, as was the predicted 100-year flood flow rate (5,300 cfs). The design capacity flow rates of the restored stream were reported by landscape architect design team. The lengths of existing culverts were referenced from the 2001-CLOMR report.

- ***Conveys a base flow of 3 cfs, a low flow of 200 cfs, and an annual peak flow of 800 cfs through the single-thread meandering stream. Flood flows (for 2, 5, 10, 50, and 100-year flood events) were reduced by an average of 44%.***

Flow rates were reported by the landscape architect design team and referenced from the 2001-CLOMR report. The 1995-Stapleton Area Stormwater Outfall Systems Plan was referenced to find peak flows for the sub-watersheds affecting Westerly Creek. Peak flows were averaged for 2-year, 5-year, 10-year, 50- year, and 100-year flood events for both existing conditions and developed conditions.

Existing: 2yr (103.42) + 5yr (147.3) + 10yr (165.75) + 50yr (290.16) + 100 yr (376.5) =
1082.93/ 5 = 216.59 cfs
Developed: 2yr (59.5) + 5yr (85.6) + 10yr (96.5) + 50yr (166.8) + 100 yr (199.53) =
607.93/ 5 = 121.59 cfs

The difference between the existing conditions average (216.59 cfs) and the developed conditions average (121.59 cfs) is 95 cfs, or a 44% decrease.

- ***Reduced water velocities to an estimated 1-5 fps at low flow, and 3-5 fps at peak flow, thereby reducing the stream's shear stress/erosive force.***

Velocity rates were referenced from the 2001-CLOMR report.

- ***Increases stormwater infiltration in sub-watershed by 9%, or 8.7 acre feet, by adding 35 acres of pervious surfaces.***

Hydrological data, for both existing conditions and anticipated developed conditions, was referenced from the 1995-Stapleton Area Stormwater Outfall Systems Plan. The sub-watersheds

of Westerly Creek (as it flows through the Stapleton) were identified and their areas totaled, for both existing conditions (797.8 acres)and developed conditions (1076.8 acres). To assess change in infiltration, pervious surface area was totaled for both existing conditions (376.8 acres) and developed conditions (411.7 acres). Pervious surface totals were then multiplied by an infiltration rate of .25 acre feet/hour, or 3 inches/acre, which was listed in the 1995-Stapleton Area Stormwater Outfall Systems Plan. Pervious conditions infiltrate at 94.2 acre feet/hour (376.8 acres x .25 acre feet) while developed conditions infiltrate at 102.93 acre feet/hour (411.7 acres x .25 acre feet), which is an 8.7 acre feet increase or 9%.

- ***Improves water quality of downstream fluvial systems by increasing dissolved oxygen and decreasing suspended sediment.***

Westerly Creek water quality information was sourced from the 2008-Environmental Quality Division Denver Department of Environmental Health, Water Quality Report City and County of Denver Rivers and Streams.

- ***Sequesters up to 240 tons of carbon annually from 50 acres of native prairie vegetation cover, 24 times more carbon than if bluegrass sod had been used.***

The rate of carbon sequestration for established prairie was found to be 4.85 tons per acre, source: Tilman, D., Hill, J., Lehman, C. (2006). Carbon-Negative Biofuels from Low-Input High Diversity Grassland Biomass. Science. 314:1598-1600.

Westerly Creek park has approximately 50 acres of native prairie species, as calculated from the original planting plan. This totals to be 242.5 tons of carbon sequestered per year (50 acres x 4.85 tons of carbon per acre per year = 242.5 tons of carbon), while if that same 50 acres had been planted bluegrass sod (bluegrass sequesters 0. 2005 tons of carbon per acre per year) it would sequester only 10 tons per year (50 acres x .2005 tons carbon per acre per year = 10 tons of carbon), a difference of 24 times.

Social

- ***Provides over 3 miles of ADA walking trails, 1.3 miles of compacted soil jogging and horseback riding trails, and a direct connection to Denver's regional trail system of over 50 miles of off-street trails. Of 262 Stapleton residents surveyed, 67% use the park at least once a week and 22% every day.***

As part of the 'Canfield, Gibson 2011 Stapleton Park Preference Study,' a mail survey was sent to approximately one quarter (1000) of all Stapleton households. Using Denver GIS data, a stratified sample was employed to ensure residents of all distinct development phases and dwelling types were proportionally represented. The survey was designed to gauge frequency of use, perceived safety, and scenic qualities for each of Stapleton's parks. 262 households responded. Results showed that 67% of residents utilize Westerly once a week, and that 22% utilize it on a daily basis. Project construction documents were used to classify trail types and calculate trail lengths.

Economic

- ***Saved nearly $989,000 in hauling costs by reusing 860,000 cubic yards of excavated soil onsite as architectural berms instead of hauling it offsite for disposal.***

The original quantity estimate for earthwork excavation was reported by the project design firm to be 860,000 cubic yards. Unit cost for earthwork hauling was found in original cost estimate documents to be $1.15 per cubic yard. Total cubic yards of soil was multiplied by the per unit cost

savings of keeping the soil on site (860,000 cubic yards x $1.15 = $989,000), resulting in a total cost savings of $989,000.

Cost Comparison Methods

- ***By planting 50 acres of native prairie grasses instead of bluegrass sod, the annual water budget was reduced by approximately 27.9 million gallons per year, saving an estimated $72,000 in annual irrigation costs. In 2008, the park's irrigation system was switched over to supply non-potable water, creating an additional annual cost savings of approximately $2.23 per 1,000 gallons as compared to cost of potable water.***

Original planting plan was referenced to find total area of native prairie grasses (~50 acres). Original project water budget documents were referenced to find inches/week irrigation requirements for native prairie grasses after establishment (~ .48 inches/week). The Denver Water website (http://www.denverwater.org/Conservation/TipsTools/Outdoor/WateringYourLawn/) was referenced to find inches/week irrigation requirement for maintaining a healthy bluegrass lawn in the Denver Metro Area (~1.26 inches/week). Annual irrigation period was calculated for 26 weeks of water application, from May 1 through October 31. Denver Water Recycled Water division provided irrigation costs.

The City & County of Denver pays the following for water:

Potable water irrigation rates: $1.03/1,000 gallons (winter); $2.58/1,000 gallons (summer)
Recycled water rate: $0.35/1,000 gallons.

A coefficient of 0.62 gallons of rainfall per one square foot of land was used to calculate gallons per 1 inch of rainfall.

Bluegrass Annual Irrigation Requirements:

1.2" x 5 weeks (May) + 1.5" x 4 weeks (June) + 1.5" x 5 weeks (July) + 1.2" x 5 weeks (August)+ 1" x 4 weeks (September) + .67" x 5 weeks (October)**= 32.85"** of irrigation required per growing season to water 1 square foot of land.

32.85"/ 26 weeks **= 1.26"** of irrigation per week required per growing season per 1 s of land.

.62 (coefficient) x 1.26 (inches required per week) = **.78** gallons of irrigation required per 1 square foot of land per week.

.78 (gallons of irrigation per 1sq ft of land per week) x 26 (weeks) = **20.31** gallons of irrigation required per 1 square foot of land per year.

20.31 (gallons of irrigation per 1 square foot of land per year) x 2,178,000 (square foot area of prairie grasses) = **44,235,180** gallons of irrigation required per year.

Native Prairie Grasses Annual Irrigation Requirements:

0.48" of irrigation required per week per square foot of land.

.62 (coefficient) x.48 (inches required per week) = **.29** gallons of irrigation required per 1 square foot of land per week.

.29 (gallons of irrigation per 1 square foot of land per week) x 26 (weeks) = **7.5** gallons of irrigation required per 1 square foot of land per year.

7.5 (gallons per year per 1 sq ft of land) x 2,178,000 (square foot area of native prairie grasses) = **16,335,000** gallons of irrigation required per year.

Water Savings per Year Between Bluegrass and Native Prairie Grasses:

44,235,180 (gallons of irrigation required per year for bluegrass sod - 16,335,000 gallons of irrigation required per year for prairie grasses) = **27,900,180** gallons of required irrigation saved per year.

Cost Savings per Year Between Bluegrass and Native Prairie Grasses:

27,900,180 (gallons of required irrigation saved per year) x $.00258 (irrigation cost per potable gallon) = **$71,982** per year savings

Cost Savings per 1,000 gallons of Non-Potable Water per Year

Potable water costs $2.58/1,000 gallons – Non-potable water costs $0.35/1,000 gallons = **$2.23** per 1,000 gallon cost savings of non-potable over potable water.

- **By using a Natural Areas adaptive maintenance and management regime for the park's native prairie vegetation, the city saves on average $2,240 per acre per year over the cost of maintaining a typical Denver city park. The savings result from an annual decrease per acre of 155 labor hours, 130 gallons of fuel, 131 lbs of fertilizer, and 24 lbs of herbicides.**

The Denver Parks and Recreation Maintenance Standards were referenced to find a list of all maintenance and management tasks required for the upkeep of city parks. Each task that was unique to a "typical park", and not applicable to an open space park, was estimated for annual savings in labor hours, fertilizer, herbicides, and fuel. Costs were then associated to each of these savings to determine a total per acre per year maintenance cost for maintaining an open space as compared to a typical park.

Task:	Level Blue	All calcs are per acre				Sources
Turf Management	Frequency	Labor Cost (Man Hours/Year)	Fertilizer (lbs. N)	Fuel (Gallons)	Herbicides (lbs)	http://www.lawnsite.com/showthread.php?referrer
Mowing	3/ Month	11.25	0	22.5	0	http://www.oaklandnet.com/community/ChapterE
Trimming/Roundup	2/ Year	2	0	4	0	
Fertilizer	1/ Year	4	130.6	2	0	
Aeration	1/ Year	4	0	2	0	http://www.homeownershub.com/maintenance/ho
Post-Emergent Herbicide	As Needed (1)	4	0	4	4	http://ohioline.osu.edu/for-fact/0023.html
Pre-Emergent Herbicide	As Needed (1)	4	0	4	4	
Edging	2/ Year	2	0	2	0	
Overseeding	2/ Year	2	0	2	0	http://www.bluegrasse.com/seeding/index.html
Topdressing	As Needed (1)	7	0	14	0	http://www.walltriprecycling.com/overseed.html
Filling Low Spots with Soil	As Needed (1)	3	0	1	0	
Mulching/Sweeping	3/ Month	72	0	72	0	
Horticulture Maintenance						
Plan Annual Flower Beds	2/ Year	6	0	0	0	
Preperation of Annual Bed Soil	1/ Year	0.34	0	0	0	
Annual Bed Planting	1/ Year	0.34	0	0	0	
Annual Flower Maintenance	1/ Day	3	0	0	0	
Add Organics to Beds	1/ Year	0.2	0	0	0	
Remove Annual flowers	1/ Year	0.2	0	0	0	
Spade Annual Flower Beds	1/ Year	0.34	0	0	0	
Annual Bed Weeding	2/ Week	4.37	0	0	0	
Rose Bed/Perennial Maint.	2/ Week	4	0	0	0	
Pre-Emergent Herbicide	As Needed (1)	4	0	0	4	
Post-Emergent Herbicide	3/ Year	12	0	0	12	
Shrub Pruning	1/ 5 Years	5	0	0	0	
Shrub Bed Mulching	1/ Year	0.34	0	0	0	
Total		155.38	130.6	129.5	24	http://fuelgaugereport.aaa.com/?redirectto=http://
Dollar Amount Saved ($):		1,709.80	32.65	479.25	14.88	
Total Dollars Saved/Acre:	2,236.48					

- **The cost of using the "Staplestone" (recycled runway concrete) was approximately 75% of the cost of using cast-in-place concrete for short retaining walls and the floors**

of the forebays. Savings resulted from onsite recycling of an onsite concrete product, as compared to crushing or hauling offsite for different recycling purposes.

Project design firm estimated the cost savings and reported this figure.