LANDSCAPE PERFORMANCE SERIES

2016 Case Study Investigation

EPA Region 7 Headquarters

Lenexa, Kansas

Methods Document for Landscape Performance Benefits

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This Methods Document was produced to accompany a *Landscape Performance Series* case study brief on landscapeperformance.org. The Case Study Brief and this Methods Document were produced as part of the Landscape Architecture Foundation's Case Study Investigation program, a unique research collaboration that matches LAF-funded faculty-student research teams with leading practitioners to document the benefits of exemplary high-performing landscape projects.

The Case Study Brief for this project can be found at
https://landscapeperformance.org/case-study-briefs/epa-region-7-headquarters

Landscape Performance Benefits

Environmental Benefits

- ***E1 - Reduces peak stormwater runoff rates by an estimated 49% (48.81 cfs) and runoff volume by 44% (approximately 1.57 million gallons) for a 2-year, 24-hour design storm as compared to a conventional turf landscape with no BMPs.***

Background

Prior to development, the study site was an open grass-covered field that drained into a series of aesthetic lakes which serve as stormwater runoff retention for the Southlake Technology Park in suburban Lenexa, Kansas. In 2007, the Applebee's International Support Center was constructed. BNIM performed the initial site design work which incorporated the use of a green infrastructure treatment train to better manage and treat stormwater runoff. The treatment train consists of rain gardens, bioswales, forebays, a sand sediment filtration basin, and a constructed wetland. Additionally, the 31-acre site receives 5.2 acres of off-site public water inlet from Renner Boulevard. The monitoring team, composed of BNIM, URS Corporation, and Kansas State University (bio-Agriculture engineers and landscape architects), installed instruments for analyzing water outflow and quality emerging from the treatment train. Data and results were summarized in a March 2011 report submitted to the U.S. Green Building Council (USGBC).

The Applebee's site was sold to the EPA, and the Region 7 Headquarters was completed in 2012. Additional site improvements included parking lot re-configurations, placement of large limestone security barriers, additional bioswales to treat parking lot runoff, and large security swales/check-dams installed in the north and south open fields (**Figures E1-1, E1-2, and E1-3**).

Figure E1-1: BMP Features and Treatment Train for the EPA Reg. 7 Headquarters (BNIM 2012).

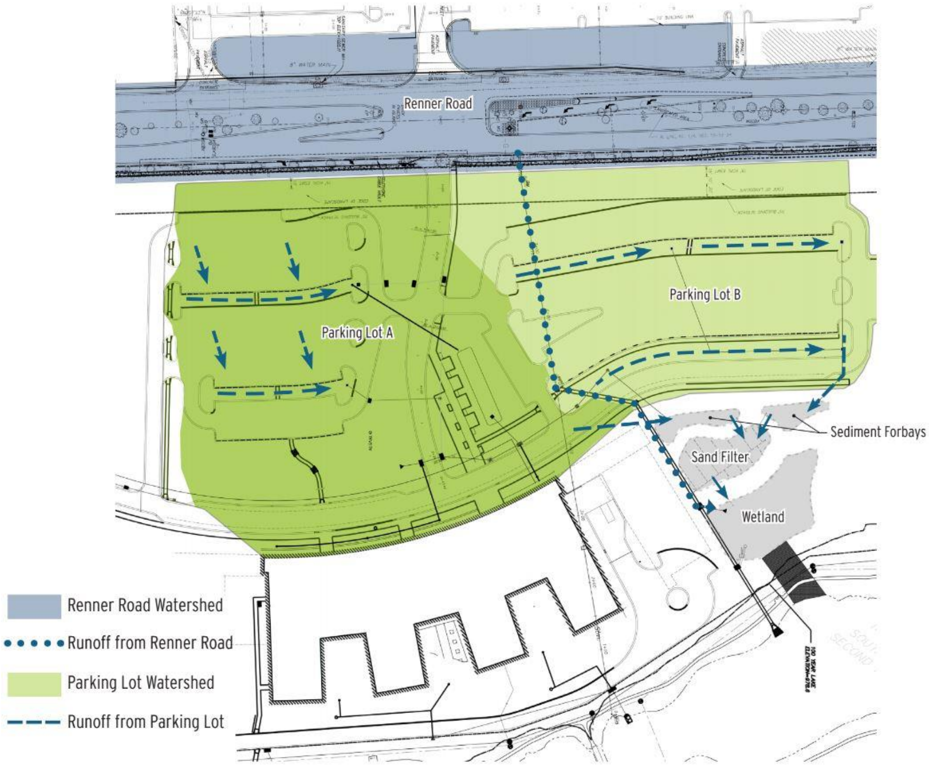


Figure E1-2: Water Flow Diagram over Controlled Surfaces (BNIM et al. 2011).

Figure E1-3: Watershed BMP Layout Diagram (BNIM et al. 2011).

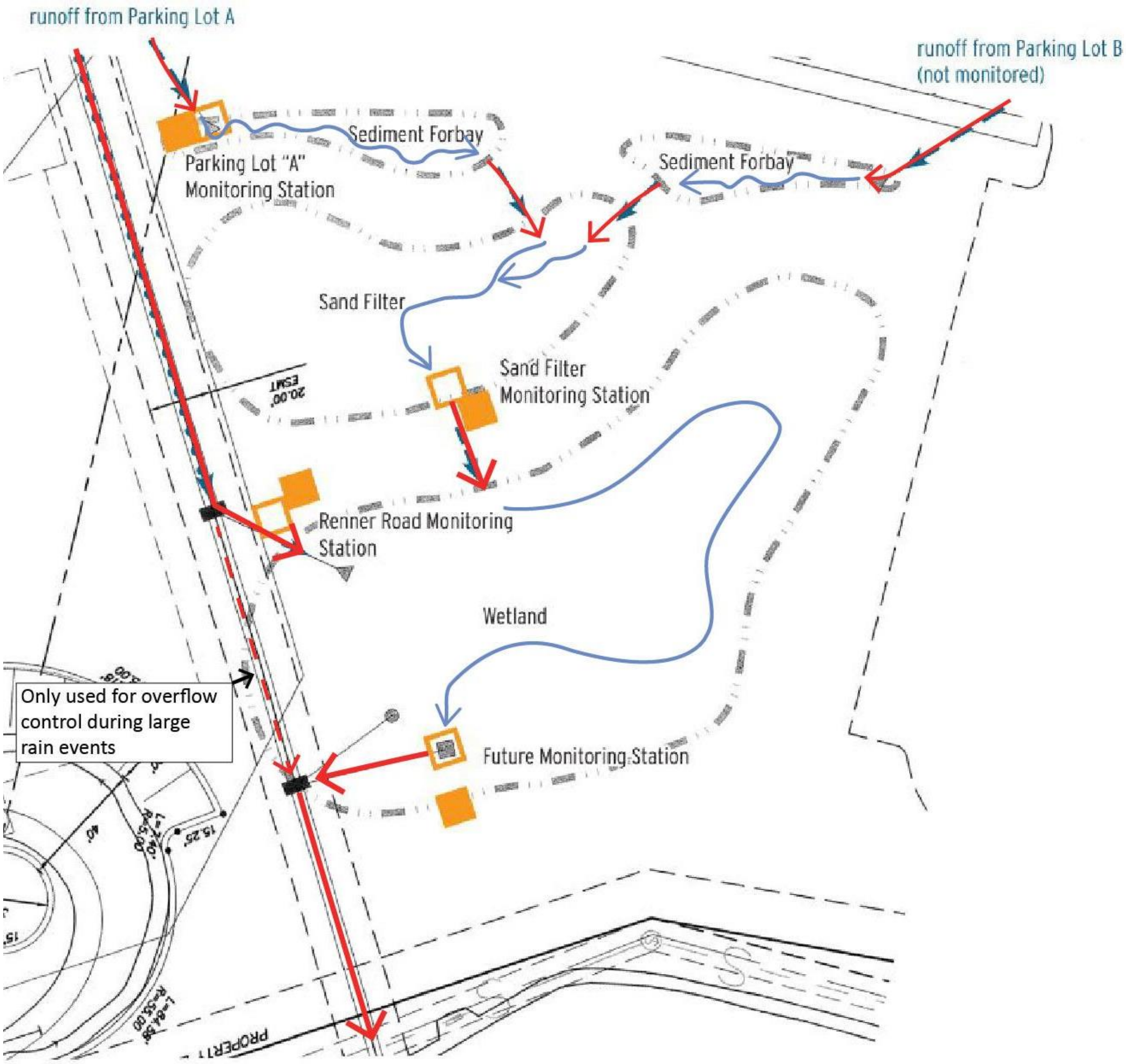


Figure E1-4: Monitoring Equipment Location Diagram (BNIM et al. 2011, adapted by Timothy Kellams).

Methods

BMP Green Infrastructure Approach (Modeled): In September 2012, to support the SS 6.1 credit for LEED Certification, Walter P. Moore and Associates conducted stormwater modeling for 2007 conditions (Applebee's) and 2012 conditions (EPA) using Bentley PondPack V8i [08/11/01.54] by Bentley Systems, Inc. Haestad Methods Solution Center. Model parameters were set for a Type II, 2-yr storm event over 24-hours (3.6" rainfall). The diagrammatic model is represented in **Figure E1-5**. The upper portion of the model reflects the additional bioswale check dams added in 2012. Detailed model calculations for a 2-yr time-depth curve were performed for each catchment, check-dam, rain garden, forebay, the sand filter, and wetland relative to the hydrograph volume (ac-ft), time to peak (hours), and peak flow (cfs).

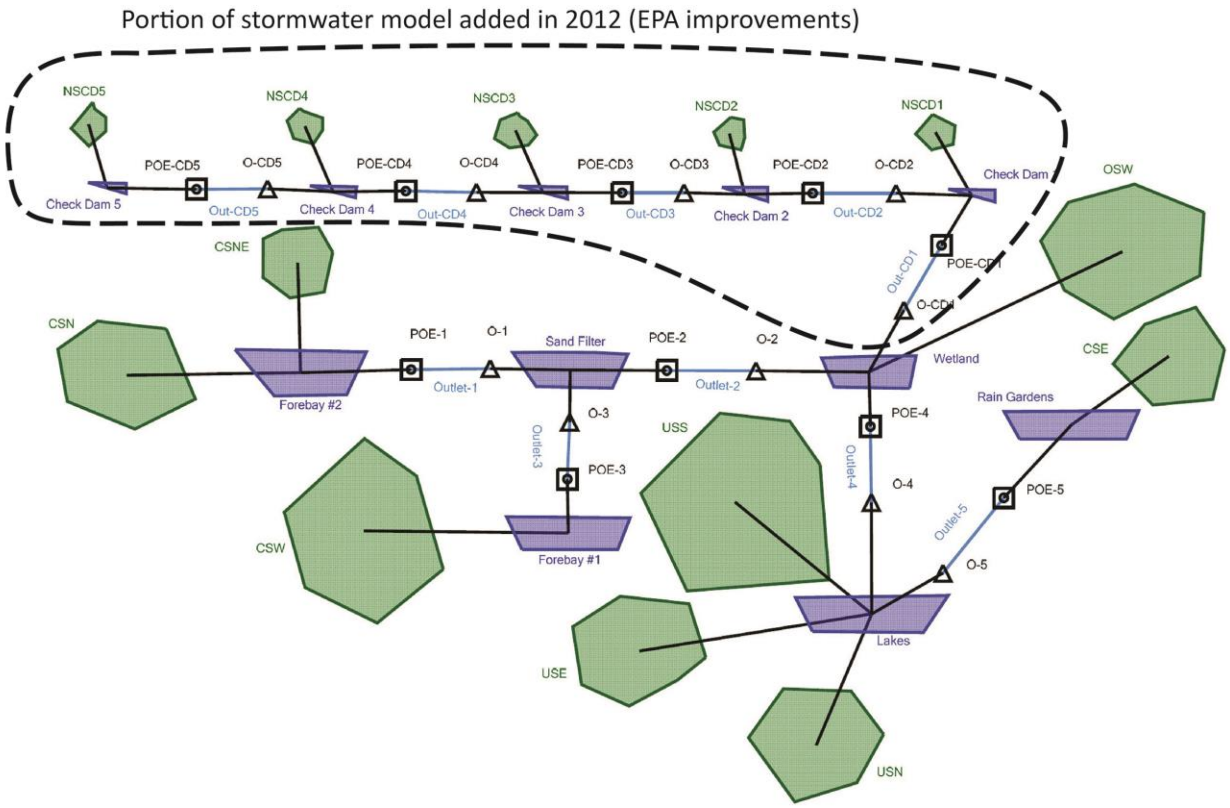


Figure E1-5: Stormwater Model Diagram (Source: Walter P. Moore & Associates, Inc. 2012)

Total Stormwater Areas

Total On-Site Stormwater Area: 31.22 ac
Total Off-Site Stormwater Area: 5.2 ac
Total Stormwater Area (100%): 36.42 ac

Estimated from Google Earth (Hahn 2016), a further breakdown was compiled for controlled and uncontrolled impervious surfaces:

Impervious Areas (Acres)

Total Impervious Surfaces--Paving (57%) & Roofs (43%): 9.8 ac (100%)
Total BMP Controlled Impervious Surfaces (81.2%): 7.96 ac
Total Uncontrolled Impervious Surfaces (18.8%): 1.84 ac

Note: “Controlled” runoff denotes site areas where stormwater is being diverted into BMPs. “Uncontrolled” runoff is discharged directly to the retention lake (a portion of this summary is listed under “sustainable features”).

Modeled results from the report (2012 EPA conditions) are summarized in **Table E1-1**. The total stormwater area was 36.42 acres, including 5.2 acres of off-site contribution.

Table E1-2: BMP Green Infrastructure Approach - Estimated runoff from EPA site (and 5.2 ac off-site) using Bentley Pondpack V8i Modeling software (2-yr, 24-hr, 3.6" Type II storm event) (Adapted from Walter P. Moore and Associates, Inc. 2012).

Green Infrastructure BMP Improvements (2012 EPA Model) EPA Site 31.23 ac + 5.2 ac offsite = 36.43 ac					
2-Year, 24-Hour Design Storm	**Area (Acres)**	**SCS CN (Comp.)**	**Tc (hr)**	**Peak runoff rate (cfs)**	**Quantity of runoff (cf)**
Catchment Summary - Controlled (Bioswales, bioretention areas & check dams; then to treatment train)					
CSE - to rain gardens	2.91	91	.2813	8.64	27,756
CSN - to forebay #2,	4.07	88	.7304	6.32	34,552
CSNE - to forebay #2	1.50	50	.4245	0.09	1,185
CSW - to forebay #1	7.41	89	.8820	10.47	65,188
NSCD1 - to wetland	0.28	50	.0833	0.04	222
NSCD2 - to wetland	0.17	50	.0833	0.03	135
NSCD3 - to wetland	0.17	50	.0833	0.03	135
NSCD4 - to wetland	0.17	50	.0833	0.02	126
NSCD5 - to wetland	0.23	50	.0833	0.03	183
OSW - to wetland	5.20	92	.2484	16.61	51,436
Total	22.11			42.28	180,918
Catchment Summary - Uncontrolled (Meadows & adapted/native grasses around building)					
South (USS) - meadow	7.96	77	.2530	14.29	43,320
East (USE) - bldg. grasses	3.38	89	.0833	12.83	30,026
North (USN) - meadow	2.98	78	.1689	6.39	16,980
Total	14.32			33.51	90,326
Controlled Runoff (Sequential treatment train: inflows/outflows per BMP)					
Forebay #1 -In	In			10.47	65,188
	Out			10.44	64,730
Forebay #2	In			6.41	35,737
	Out			6.40	35,528
Sand Filter	In			16.8	100,258
	Out			16.64	97,914
Wetland (incl. OSW)	In			20.36	149,355
	Out			19.32	145,721
East Rain Gardens	In			8.64	27,756
	Out			8.62	27,651
Final Discharge to Lake				**51.89**	**263,699**

Cross-check: Uncontrolled + Wetland Out + Rain Gardens Out = 263,698

Conventional Turf Landscape Approach with No BMPs: No detailed modeling was conducted by the engineers in 2012 reflecting a conventional turf landscape approach with no BMPs for comparison. Access to the model created in 2012 is not available for modification or reruns using alternate configurations. However, a rough estimate of peak flow and quantity was generated by using online TR-55 calculators to establish the baseline "conventional" approach. To the extent possible, storm event parameters from the 2012 model were matched. Impervious areas were estimated from Google Earth, and the equivalent area for off-site water (OSW) coming from Renner Boulevard, in addition to total landscape area, was derived from the 2012 model. A summary is presented in **Table E1-2**.

Table E1-2: Conventional Turf Landscape Approach with No BMPs - Estimated runoff from EPA site (and 5.2 ac off-site) using online TR-55 calculators (2-yr, 24-hr, 3.6" Type II storm event) (Hahn. 2016. Landscape Architecture Foundation Case Study Series).

2-Year, 24-Hour Design Storm	Area (Acres)	SCS CN	Tc (hr)	Peak runoff rate (cfs)[1]	Quantity of runoff (cf)[2]
Impervious roof (via Google Earth)	4.20	98	0.1	24.03	54,886
Impervious paving (via G. Earth)	5.6	98	0.1	30.9	73,180
OSW (off-site water) via Moore 2012	5.2	92	.2484	16.2	65,340
Cross-check w/ 2012 model				(16.61)	(51,436)
Turf landscape	21.43	77	.367	29.57	280,047
Total	36.43			100.70	473,453

[1]Peak run-off rate (cf/s): http://onlinecalc.sdsu.edu/onlinetr55.php

[2]Quantity of run-off (cf): http://onlinecalc.sdsu.edu/onlinetr55detention.php

Calculations (Projected Reductions)

Peak stormwater runoff rate calculated using conventional approach: 100.70 cfs
Peak stormwater runoff rate calculated using 2007 green infrastructure improvements: 51.89cfs
Reduction: (100.70 cfs - 51.89)/100.7 cfs = 48.5%

Stormwater runoff volume calculated using conventional approach: 473,453 cf
Stormwater runoff volume using 2007 green infrastructure improvements: 263,699 cf
Reduction: (473,453 cf - 263,699 cf)/473,453 cf = = 44.3%

Limitations

Predictive computer modeling for peak flow and runoff volume is useful for design and sizing stormwater treatment components but is not a substitute for actual field measurements to provide verifiable data on landscape performance, which in turn, is used to calibrate the predictive models. In 2009 and 2010, Teledyne ISCO, Inc., Model 6700/6712 with 730 Bubbler Flow monitoring equipment was installed to measure "in-out" flows for the forebays, sand filter and wetland. Unfortunately, flow quantity data was compromised by water overflows on the north forebay and bank erosion of the sand filter during large storm events.

Assessing landscape performance is often limited by a lack of field measurements representing baseline, pre-development conditions of stormwater runoff. Most commonly, as typified by this case study, pre-construction monitoring is not done ahead of tight construction schedules, budgets, and site access. It would also have been desirable to install additional instrumentation at intermediate points throughout the treatment train to assess stormwater treatment performance relative to each BMP component.

Sources

BNIM, URS, and KSU. 2011. "Multi-Variate Study of Stormwater BMPs Final Report." 2008 Green Building Research Fund Grants.

Google. 2016. Google Earth Pro aerial imagery and polygon creation/measurement tool.

Moore, Walter P. and Associates. 2012. "EPA Region 7 Headquarters Existing (and Proposed) Stormwater Runoff Model." September 12. In support of LEED 2009 for New Construction and Major Renovations SS Credit 6.1: Stormwater Design-Quantity Control, Project #1000021832, submitted by BNIM.

San Diego State University. ND. Online TR-55 peak discharge calculator. Accessed August 3, 2016: http://onlinecalc.sdsu.edu/onlinetr55.php

San Diego State University. ND. Online TR-55 detention calculator. Accessed August 3, 2016: http://onlinecalc.sdsu.edu/onlinetr55detention.php

- ***E2a - Removes an estimated 47% of nitrogen, 41% of phosphorus, and 66% of total suspended solids as stormwater passes through the system.***

  Reduces total nitrogen by an estimated 47%, total phosphorus by 41.2%, and total suspended solids by 65.7% passing through the BMP forebay/sand filter basin where in- and out-measurements used matched rainfall events.

Methods

Water quality monitoring took place from June 2009 through July 2010. Water sample measurements were taken at the forebay inflow ("sand filter in") and sand filter basin outflow "sand filter out") points (**Figure E1-4**) for various precipitation events as shown in **Table E2-1.** Water quality measurements were also taken at the wetland outlet, but are not included here since the wetland was still being established in 2010, plants had not matured to absorb bacteria, and waterfowl were introducing bacterial contamination.

Table E2-1: Water quality sample measurements (2009-2010) for the sand filter basin at the EPA Region 7 Headquarters site (formerly Applebees) (BNIM et al. 2011, p 67).

Applebee's Sand Filter "In"											
Rain Event	Event	Note	Precip	TN ppm	TP ppm	Zn ppm	Cl ppm	S ppm	pH	EC µS	TSS
6/27/2009		First Flush	0.48	3.17	0.29	0.04	42.95	16.26	7.4	315	47
9/21/2009		First Flush	0.97	5.02	0.32	0.09	21.37	11.57	7.3	282	45
4/2/2010			0.43	No Sample							
4/23/2010	2	First Flush	0.46	1.10	0.07	ND	62.40	15.78	7.36	348	116
4/23/2010		First Flush	0.46	1.10	0.07	ND	112.70	13.61	7.41	449	48
4/24/2010	3	First Flush	0.47	2.37	0.05	0.02	148.30	28.92	7.14	654	48
5/10/2010	4	First Flush	1.06	3.53	0.12	0.02	143.40	32.62	7.62	695	160
5/10/2010		First Flush	1.06	1.63	0.07	ND	64.30	11.23	7.51	312	172
5/12/2010	5	First Flush	0.58	1.13	0.05	ND	47.90	9.26	7.51	267	444
5/13/2010			0.88	No Sample							
5/15/2010			0.35	No Sample							
5/19/2010	6	First Flush	0.9	1.12	0.02	0.02	100.50	18.25	7.43	489	90
5/20/2010	7	First Flush	0.26	2.07	0.27	ND	22.10	4.19	7.21	149	480
5/26/2010	8	First Flush	0.34	2.99	0.24	ND	26.53	19.72	7.79	337	168
6/1/2010	9	First Flush	0.16	2.09	0.13	ND	12.87	7.70	8.02	201	196
6/2/2010	10	First Flush	0.49	3.69	0.23	ND	57.57	25.38	8.28	499	136
6/2/2010		Bottle 6	0.49	2.73	0.36	ND	48.25	7.05	8.17	235	480
6/8/2010	11	First Flush	1.60	3.02	0.10	ND	20.73	15.12	7.90	514	128
6/8/2010		First Flush	1.60	2.43	0.50	ND	40.47	8.44	7.92	257	752
6/14/2010			1.31	No Sample							
6/14/2010			1.31	No Sample							
7/11/2010			0.85	No Sample							
7/11/2010			0.85	No Sample							
7/16/2010	12	First Flush	0.7	0.97	0.04	ND	2.70	0.33	7.55	18	32
7/16/2010			0.7	No Sample							
7/20/2010		First Flush	0.83	0.75	0.03	ND	2.60	0.30	7.33	18	40

Applebee's Sand Filter "Out"											
Rain Event	Event	Notes	Precip	TN ppm	TP ppm	Zn ppm	Cl ppm	S ppm	pH	EC µS	TSS
6/27/2009		First Flush	0.48	2.92	0.07	0	63.92	17.57	7.5	442	12
4/2/2010	1	First Flush	0.43	3.77	0.22	ND	208.00	56.87	7.52	940	80
4/23/2010	2	First Flush	0.46	0.56	0.06	ND	91.20	9.85	7.42	361	20
4/23/2010			0.46	No Sample							
4/24/2010	3		0.47	No Sample							
5/10/2010	4	First Flush	1.06	0.65	0.06	0.01	81.30	9.16	7.37	343	108
5/12/2010	5		0.58	No Sample							
5/26/2010	8	First Flush	0.34	3.46	0.06	ND	631.90	69.06	7.85	2590	24
5/26/2010	8	Composite	0.34	1.62	0.07	ND	97.96	16.41	7.54	496	36
5/26/2010		First Flush	0.34	1.98	0.09	ND	118.36	18.66	7.62	578	72
6/2/2010	10	First Flush	0.49	1.29	0.09	ND	59.44	10.78	8.06	343	44
6/8/2010	11	First Flush	1.60	1.36	0.08	ND	68.76	14.69	8.08	489	60
7/11/2010			0.85	No Sample							
7/11/2010			0.85	No Sample							
7/16/2010			0.7	No Sample							
7/16/2010			0.7	No Sample							
7/20/2010	13	Grabbed	0.83	1.13	0.09	ND	42.30	8.87	7.46	324	15

Chemical constituents generally decreased between inflows and outflows. To compare TN, TP, and TSS, matched rainfall events were used so water quantities affecting concentrations would be consistent (**Table E2-2**). The constituent percentage reductions for each rainfall event were then averaged to arrive at a composite reduction.

Table E2-2: Sand filter basin water quality results for Total Nitrogen (TN), Total Phosphorus (TP), and Total Suspended Solids (TSS) for matched 2010 precipitation events at the EPA Region 7 Headquarters site. (BNIM et al. 2011)

Total Nitrogen (TN)						
Rain Date	Event #	Location	Precip (in)	In (ppm)	Out (ppm)	% Diff.
4/23/2010	2	First flush	0.46	1.1	0.56	-49.1%
5/10/2010	4	First flush	1.06	3.53	0.65	-81.6%
5/26/2010	8	First flush	0.34	2.99	3.46	15.7%
6/2/2010	10	First flush	0.49	3.69	1.29	-65.0%
6/8/2010	11	First flush	1.60	3.02	1.36	-55.0%
					Avg	-47.0%

Total Phosphorus (TP)						
Rain Date	Event #	Location	Precip (in)	In (ppm)	Out (ppm)	% Diff.
4/23/2010	2	First flush	0.46	0.07	0.07	0.0%
5/10/2010	4	First flush	1.06	0.12	0.06	-50.0%
5/26/2010	8	First flush	0.34	0.24	0.06	-75.0%
6/2/2010	10	First flush	0.49	0.23	0.09	-60.9%
6/8/2010	11	First flush	1.6	0.10	0.08	-20.0%
					Avg	-41.2%

Total Suspended Solids (TSS)						
Rain Date	Event #	Location	Precip (in)	In (mg/l)	Out (mg/l)	% Diff.
4/23/2010	2	First flush	0.46	116	12	-89.7%
5/10/2010	4	First flush	1.06	160	108	-32.5%
5/26/2010	8	First flush	0.34	168	24	-85.7%

6/2/2010	10	First flush	0.49	136	44	-67.6%
6/8/2010	11	First flush	1.6	128	60	-53.1%
					Avg	-65.7%

Calculations
TN, TP, and TSS reduction: (“In” measurement - “Out” measurement)/ “In” measurement x 100

Limitations
To prevent sediment clogging, “upstream” BMPs should be well established to prevent erosion prior to establishing “downstream” treatment train BMPs. As all BMPs are well- established, renewed monitoring took place in summer/fall 2016 (See E3, below).

Sources
BNIM, URS, and KSU. 2011. “Multi-Variate Study of Stormwater BMPs Final Report”. 2008 Green Building Research Fund Grants.

- ***E2b – Also removes an estimated 59% of chloride, 29% of calcium, and 56% of sodium.***

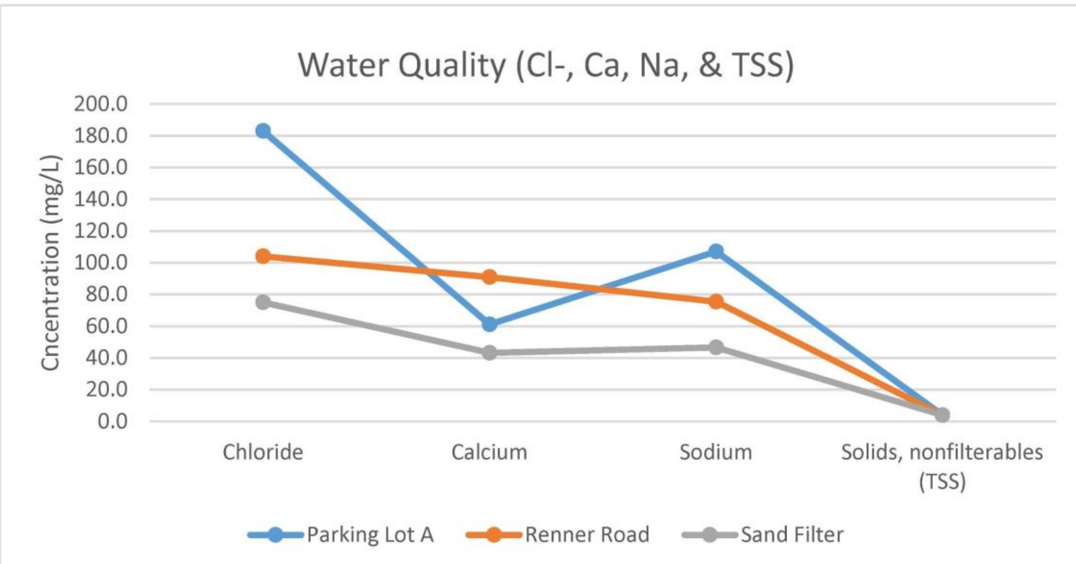
  In 2016, reduced the top three highest concentration constituents in runoff water passing through the BMP forebay/sand filter basin by 59.0% for chloride, 29.4% for calcium, and 56.4% for sodium corresponding to a 0.41-in rainfall event.

Methods
2016 Conditions (Measured): Another attempt was made to monitor water quality in 2016. During a 0.41-in rainfall event on September 16 at 12:45 p.m., manual “grab” samples were taken by EPA staff from the Parking Lot A, Renner Boulevard, and sand filter monitoring stations (**Figure E1-4**). Parking Lot A runoff is directed into the BMP forebay/sand filter, whereas off-site water from Renner Boulevard by-passes the forebay/sand filter and empties directly into the wetlands for filtration. (Grab samples are defined by the EPA as individual discrete samples collected over a period of time not exceeding 15 minutes.)

Grab samples, including field blanks, were sent to the EPA Region 7 laboratory for analysis. Results are presented in **Table E3-1** and **Figure E3-1**, and the original report in Appendix A. (Field blanks are used to check on potential sources of contamination resulting from exposure to the ambient air or from improperly cleaned sampling equipment. The field blank water sample is taken into the field and exposed to the atmosphere of the site for a period of time.)

Table E3-1: Water quality results from EPA Region 7 Headquarters site corresponding to grab samples taken during September 16, 2016, 12:45 p.m. for 0.41-in rain event (EPA Region 7 Laboratory 2016, p 6) .

Constituent	RLAB Method	Concentrations (mg/L) Parking Lot A	Sand Filter	Parking Lot A Reduction	Renner Road
Chloride	3135.15B	183.0	75.0	59.0%	104.0
Calcium	3122.3F	61.2	43.2	29.4%	91.0
Sodium	3122.3F	107.0	46.6	56.4%	75.4
Solids, nonfilterables (TSS)	3142.3H	4.000	4.000	0.0%	4.000
N,NO3+ NO2		0.476	0.330	30.7%	0.440
Total Kjeldahl Nitrogen	3133.3H	0.439	0.200	54.4%	0.442
Phosphorus	3133.4G	0.100	0.116	-16.0%	0.100
Ammonia as nitrogen	3133.11B	0.100	0.100	0.0%	0.100



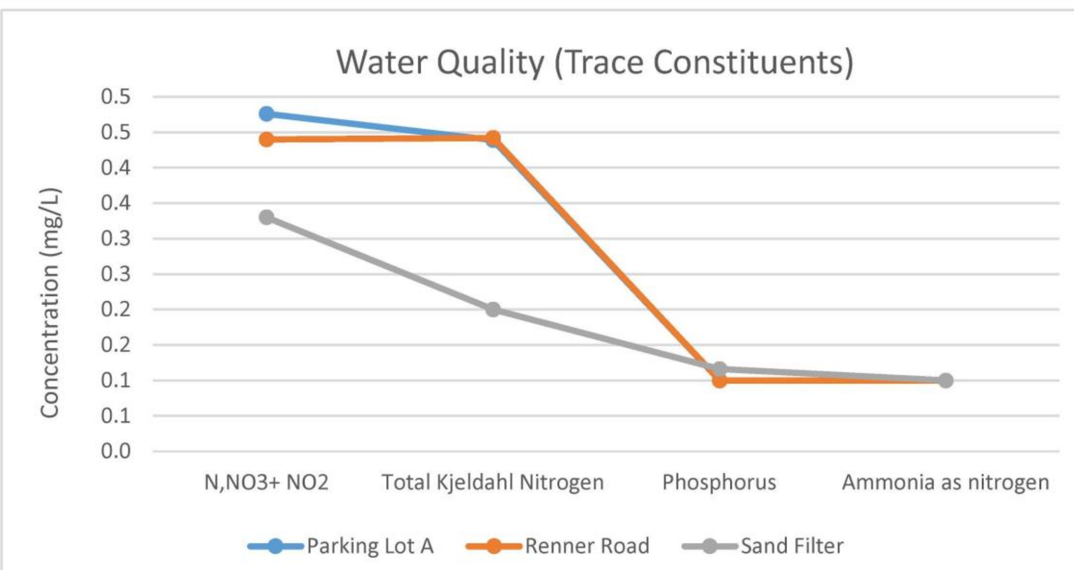


Figure E3-1: Constituent concentrations of grab samples taken during September 16, 2016 for 0.41-in rain event from Parking Lot A, Renner Road, and Sand Filter monitoring stations.

Calculations
Parking Lot A top three constituent concentration reductions after sand filtration:
Chloride Reduction: (183.0 mg/L -75.0 mg/L)/183.0 mg/L x 100 = 59.0%
Calcium Reduction (61.2 mg/L - 43.2 mg/L)/61.2 mg/L x 100 = 29.4%
Sodium Reduction (107.0 mg/L - 46.6 mg/L)/107.0 mg/L x 100 = 56.4%
(see Table E3-1 for concentration reductions of lesser water constituents).

Limitations
No water samples were taken from Parking Lot B runoff which also empties into the forebay/sand filter (Fig. E1-4), but constituent concentrations are likely similar to Parking Lot A.

Sources
Environmental Protection Agency (EPA) Region 7, Laboratory Technology & Analysis Branch, Environmental Sciences & Technology Division, Kansas City Kansas. Analytical Service Request (ASR) #7212, Project ID: WPD145. November 3, 2016.

U.S. Environmental Protection Agency Handbook for Sampling and Sample Preservation of Water and Wastewater, page 19. Accessed May 2, 2017: nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30000QSA.TXT

Sciencing, Difference between a trip bland and a field blank. Accessed May 16, 2017: http://sciencing.com/difference-trip-blank-field-blank-7813940.html

New York State Department of Environmental Conservation Technical Procedure Guidance: Quality Assurance/Quality Control Procedures, page 2.4-2. Accessed May 16, 2017: http://www.dec.ny.gov/docs/remediation_hudson_pdf/2x4.pdf

- ***E3 – Saves approximately 19.8 million gallons of potable water annually through the use of native grasses, saving about $105,800 in municipal water costs.***

Methods
Turf water requirements are roughly estimated using 1-in per week over a 24-wk growing season assuming an irrigation water application efficiency of 67%. WaterOne (Johnson County, KS) provides water to the Southlakes Technology Park and rates were used for 2016.

Calculations
Water Cost Estimate:
((Irrigation season x Average water application rate x (1 ÷ Inefficiency compensation) ÷ 12in)) x landscape area in square feet) x (7.48 gallons per cubic foot) x (current water rate)) = water cost estimate in dollars

Irrigation season: (Apr-Sept) = 24 weeks
Average water application rate = 1-in/wk
Application inefficiency compensation = .67
Landscape area = 20.41 ac @ 43,560 sq ft/ acre = 889,060 sq ft
Current water rate = $5.34/1,000 gallons

((24 x 1" x (1/.67) ÷12") x 889,060) x (7.48 gal/1 cu ft) x $5.34/1,000 gal)
24" x 1.49 ÷12" = 2.98'
2.98 x 889,060 = 2,649,398.80 cubic feet x 7.48 gal/cu ft = 19,817,503 gallons
19,817,503/1000 = 19,817.50 x $5.34 = $105,825.47 (or $5,185 per acre)

Limitations
*Applie*d landscape water may be far different than *required* water. Although traditional turf landscapes do require more water than native-skewed plant palettes, the applied water may not be optimized for healthy plant growth (either too much or too little water) or plant survivorship. Planting designs may not sufficiently group plants of similar water requirements together, and irrigation zones may be programmed with relatively uniform water application times irrespective of plant grouping requirements or current precipitation patterns. Despite improvements in irrigation distribution efficiency and moisture sensors, potable water is probably still wasted unless zone run times and plant health are carefully monitored. To some degree, the amount of water reduction between a native and traditional landscape may be attributable to design and water application choices rather than monitored water requirements. Native landscapes offer the advantage that many species can go into dormancy during high stress conditions and still survive.

Sources
Hahn, Howard. 2016. *Landscape Architecture Foundation* Case Study Investigation.
WaterOne. 2016. Metered water usage (2012 and 2015). Lenexa, KS: Johnson County Water District #1.

- ***E4 - Sequesters an estimated 33,970 lbs of atmospheric carbon annually through the planting of 235 trees, equivalent to driving a single passenger vehicle 36,930 miles. The tree canopies also intercept an estimated 65,220 gallons of stormwater runoff annually.***

Methods
Referencing 2007 and 2011 planting plans, a current tree inventory was conducted in the field. Since the original planting 4-9 years ago, multiple trees have died. Some dead trees were replaced with the same species or undocumented species. Species identification and diameter breast height (DBH) were recorded, then the carbon dioxide sequestration (lbs) and intercepted stormwater runoff (gal) per tree species and number of trees were calculated using the

National Tree Benefit Calculator (NTBC). The inventory, along with NTBC estimated metrics, is included in Appendix B.

Calculations
Calculations were conducted using the National Tree Benefit Calculator (NTBC). The tree type, diameter, tree location by region, and land-use are entered into the NTBC. The NTBC then uses an internal formula to to develop stormwater, property value, energy, air quality, and atmospheric carbon reduction metric. These all help produce an overall benefit of the tree in U.S. dollars. More information concerning the approach and internal calculation methods can be found at:

http://www.itreetools.org/streets/resources/Streets_Reference_Cities_Science_Update_Nov2011.pdf

Limitations
There are a few limitations using this method. Some of the inventoried trees were not included in the National Tree Benefit Calculator/i-Tree database, so appropriate substitutions were made. This is also a projected, not measured metric.

Sources
Schuessler, Jim and Timothy Kellams. 2016. Tree inventory conducted as part of *Landscape Architecture Foundation* Case Study Investigation. Lenexa, KS: EPA Region 7 Headquarters.

http://www.treebenefits.com/calculator/treeinfor.cfm?zip=&city=&state=&climatezone=Midwest

United State Environmental Protection Agency Greenhouse Gas Equivalencies Calculator. Accessed May 16, 2017: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Social Benefits

- ***S1 – Promotes a level of familiarity with the site's green infrastructure for 64% of 61 surveyed employee respondents. 46% of respondents have pointed out green infrastructure features to visitors.***

  Provides awareness of the site's green infrastructure: 64% of surveyed employee respondents are very familiar or somewhat familiar with features of the green infrastructure treatment chain on the EPA campus and how it works and 46% of employee respondents have pointed out these features to visitors. (Survey questions 4 & 5)

- ***S2 – Provides outdoor dining and social space for 70% of 61 surveyed employee respondents.***

Provides an aesthetic outdoor dining, contemplative, and social space for 70% of surveyed employee respondents who use the exterior courtyards at least 1-3 times per month during comfortable weather. (Survey questions 9 & 11)

- ***S3 – Provides exercise opportunities for 64% of 61 surveyed employee respondents.***

  64% of surveyed employee respondents use the walking paths around the South Lakes 1-3 times per month or more. (Survey question 7).

- ***S4 – Educates an average of 85 annual visitors who participate in site tours about sustainable landscape and the LEED Platinum building.***

  Educates an average 85 annual visitors (316 total visitors to date) who participate in site tours to learn more about this LEED platinum certified building and sustainable landscape.

Methods

For social benefits S1- S3, an online survey was prepared and distributed to employees of the EPA Region 7 Headquarters. Since the survey involved human subjects, solicited opinions, and research results would be published, the survey was submitted to the Kansas State University Institutional Review Board (IRB) to ensure that no significant risks were anticipated and proper research protocols were followed. After review, the survey was determined to be exempt under the category 45 CFR 46.101 (b)(2) (Proposal #8332). The survey was also reviewed and approved by the EPA Employees Union. An email introducing the project and containing a survey hyperlink was distributed to all employees through the EPA liaison. The survey consists of thirteen questions and was administered through the KSU Qualtrics online system. Although the full range of questions will be useful to the CSI research team, only a subset of questions/responses was used for LAF publication. The full survey results can be found in Appendix C.

For social benefit S4, the EPA Region 7 Headquarters maintains a visitor tour log (Appendix D).

Calculations

Average annual visitors: (84 (Yr 2013) + 91 (Yr 2014) + 79 (Year 2015))/3 = 85 visitors per year
Total tour visitors to date: 84 (Yr 2013) + 91 (Yr 2014) + 79 (Year 2015) + 62 (Yr 2016) = 316

Limitations

None.

Sources

Hahn, Howard. 2016. "Survey of EPA Region 7 Headquarters Employees' Response to Sustainable Landscape." Landscape Architecture Foundation Case Study.

EPA. 2016. "Visitor Tour Log." Region 7 Headquarters, Lenexa, KS.

Economic Benefits

- ***Ecn1 – Reduces maintenance costs by approximately 89% and saves around $87,500 annually with the use of native grass as compared to traditional turf landscaping.***

  Reduces maintenance costs by 88.8% for native grass areas compared to a traditional turf landscape. This amounts to an annual maintenance cost savings of $4,287 per acre for a total of $87,498 derived by comparing turf landscape maintenance records from two other sites in the Southlakes Technology Park.

Methods
Signature Landscape and Hermes Landscape of Kansas City are contracted to provide landscape maintenance services for both the EPA Region 7 Headquarters (Signature) and two comparison properties (Signature and Hermes) within the Southlakes Technology Park. Average landscape maintenance costs per acre for 2012 and 2015 were then compiled for both the EPA site (native grasses) and two other Southside Lakes sites (traditional irrigated turf) which are shown in **Table Ecn1-1**.

Table Ecn1-1: Estimated contracted maintenance costs per landscaped acre for the EPA landscape (natural) and comparison landscapes (traditional) for 2015 in Lenexa, KS.
Sources: Signature and Hermes Landscape 2016

Average Landscape Maintenance Cost per Landscape Acre (2015)		
Task	Times/Season	Total Cost ($)
EPA Landscape (natural) (18.95 landscape acres)		
Mow prairie grasses (2-step process)	1	$530
Mow buffalo grass	2	$1,850
Fertilizer application (buffalo grass)	4	$4,400
Plant bed and swale area weed control*	5	$1,700
Perennial cutback/ spring cleanup*	1	$620
Total Maintenance Cost		$9,100 ($480/ac)
EPA Landscape (traditional) (1.46 landscape acres)		
Mow & trim (Fescue)	21	$8,400
Fertilizer application	4	$2,100

Tree/shrub trimming	2	$980
Plant bed and swale area weed control	5	$1,975
Perennial cutback/ spring cleanup*	1	$620
Total Maintenance Cost		$14,075 ($9,640/ac)
Comparison Site #1 - 16505 W. 113th St. (10.04 landscape acres) (Traditional Landscape)*		
Mowing - Area A	28	$11,620
Mowing - Area B	14	$1,820
Turf fertilization, weed control, insect control	1-5	$10,186
Shrub bed weed control, tree/shrub pruning, bark mulching, perennial cutback, perennial maintenance	1-10	$3,625
Irrigation: turn-on, maintenance, winterization	Up to 6	$1,765
Total Maintenance Cost		$29,016 ($2,890/ac)
Comparison Site #2 - 11250 Corporate Ave. (2.75 landscape acres) (Traditional Landscape)*		
Mowing, irrigation, pruning, mulching, irrigation start-up/shutdown		~ $18,000 ($6,545/ac)

Calculations
To determine the comparative maintenance cost of all traditional turf landscape areas:
Site Area ÷ Total Turfed Area × Site Area Cost
Total Turfed Area = 1.46 ac + 10.04 ac + 2.75 ac = 14.25 ac

Weighted average maintenance cost (traditional turf landscape) to account for economies of scale:
(1.46/14.25 x $9,640/ac) + (10.04/14.25 x $2,890/ac) + (2.75/14.25 x $6,545/ac)
$987.68/ac + $2,036.18 + $1,263.07= $4,286.93/ac
$4,287 per turfed acre

Maintenance Cost Reduction:
To determine the percent decrease for natural landscape maintenance costs versus traditional turf:

((y-x)/x) *100
X = traditional turf cost ($4,287/ac)
Y = native cost ($480/ac)

(($480 – $4,287) / $4,287) * 100
-3,807/4,287 = .8880 *100 = 88.8% decrease

Limitations
None.

Sources

Signature Landscape. 2016. Landscape maintenance costs for EPA landscape and comparable landscape in Southlakes Technology Park, Lenexa, KS.

Hermes Landscape. 2016. Landscape maintenance costs for comparable landscape in Southlakes Technology Park, Lenexa, KS.

Cost Comparison

The cost of green infrastructure approach used at the EPA Region 7 Headquarters was compared to a "traditional" approach in two main areas: 1) Installation cost of a native/low impact landscape (native grasses, rain gardens, bioswales, bioretention) versus a traditional landscape of irrigated turf, and 2) Installation cost of the treatment train versus a traditional detention basin.

The estimated installation cost for the native landscape was 44% less expensive than comparable turf and irrigation, with the native landscape estimated at $619,097 ($32,670 per acre) and the traditional turf landscape at $1.1 million ($58,332 per acre).

The estimated installation cost for the green infrastructure stormwater treatment train was $340,933. For similar site conditions, a traditional detention basin was estimated at $311,335. Although more expensive, the green infrastructure treatment chain provides additional water quality benefits.

Installation Cost of Native/Low Impact Landscape vs. Traditional Landscape
The landscape cost of the EPA/Applebee's was $423,898 which included rock excavation, irrigation, temporary watering of seeded areas, rock walls, and wetlands planting. Since costs were aggregated, and some items might not be considered "typical", a comparison will only be made between native grass areas and traditional turf/irrigation. For large acre sites like this

one, traditional turf/irrigation would be one of the most expensive installation costs, and would have significant on-going operational expenses for maintenance and water. On-going expenses are not covered here, but are estimated annually under Environmental Benefit E4 and Economic Benefit Ecn1.

The estimated cost of installing the native grass-dominated landscape of the EPA/Applebee's site (18.95 ac) is $619,097 ($32,670/acre) which includes seeding, and temporary water for establishment at $6.75/SY (CSFE 2016). By comparison, the typical estimated composite cost of a traditional turf irrigated landscape is $58,332/acre for a total $1.1 million for an equivalent 18.95 acres. This cost was derived by using the current local cost of $5.30/SY for sod with establishment and $7.00/SY for turf irrigation (CSFE 2016). For the purposes of this comparison, the following items were considered common to the native vs. traditional approach and were not included: site preparation, soil amendments, trees, shrubs, mulching/weed control, fertilization at time of installation, and inlets/pipes to convey excess runoff to the treatment train/detention basin.

Installation Cost of Treatment Train vs Detention Basin

The actual cost of construction for the treatment train cannot be directly determined from bid records since costs were aggregated and spread across multiple categories. As a substitute, an engineering estimate was prepared for 2 forebays, the sand filter, and wetland (**Appendix E**, **Table CC-1**). No concrete pipes or inlets are included since they elements would be common to the detention basin alternative. The estimated installation cost for the EPA/Applebee's treatment train is $340,933 +/- 5%.

As a comparison, the estimated installed cost of a detention basin sized to accommodate the EPA/Applebee's site is $311,335 +/- 5% (**Appendix E**, **Table CC-2**). This estimate includes the same amount of storm sewer piping, inlet structures, and rock excavation requirements encountered during prior trenching and wetlands construction.

Calculations

Landscape Installation Cost Reduction: ($1.1 million Traditional Landscape Cost - $619,097 Native Landscape Cost)/$1.1 million Traditional Landscape Cost = 43.7%

Stormwater Treatment Cost Increase: ($ 340,933 Treatment Train cost - $311,335 Detention Basin cost)/ $311,335 Detention Basin cost = 9.5%

Limitations

Even though the total landscape cost for the EPA/Applebees site is known, no line item breakdown exists, so typical native grass, turf, and irrigation costs were estimated based on local Kansas City prices.

Sources

CSF Engineers. Cost Estimate for Stormwater Treatment Train, 2016.

CSF Engineers. Cost Estimate for Traditional Detention Basin, 2016.

Appendix A

2016 Water Quality Report for Parking Lot A, Renner Boulevard and Sand Filter Monitoring Stations

United States Environmental Protection Agency
Region 7
300 Minnesota Avenue
Kansas City, KS 66101

Date: 11/03/2016

Subject: Transmittal of Sample Analysis Results for ASR #: 7212
Project ID: WPD145
Project Description: Regional Office Storm Water Sampling Project

From: Margaret E.W. St. Germain, Chief
Laboratory Technology & Analysis Branch, Environmental Sciences & Technology Division

To: David Pratt
ENST/EFCB

Enclosed are the analytical data for the above-referenced Analytical Services Request (ASR) and Project. The Regional Laboratory has reviewed and verified the results in accordance with procedures described in our Quality Manual (QM). In addition to all of the analytical results, this transmittal contains pertinent information that may have influenced the reported results and documents any deviations from the established requirements of the QM.

Please contact us within 14 days of receipt of this package if you determine there is a need for any changes. Please complete the enclosed Customer Satisfaction Survey and Data Disposition/Sample Release memo for this ASR as soon as possible. The process of disposing of the samples for this ASR will be initiated 30 days from the date of this transmittal unless an alternate release date is specified on the Data Disposition/Sample Release memo.

If you have any questions or concerns relating to this data package, contact our customer service line at 913-551-5295.

Enclosures

cc: Analytical Data File.

Page 1 of 7

Project Manager: David Pratt **Org:** ENST/EFCB **Phone:** 913-551-7552

Project ID: WPD145

Project Desc: Regional Office Storm Water Sampling Project

Location: Lenexa **State:** Kansas **Program:** Ambient Water Quality

Purpose: Ambient Monitoring

GPRA PRC: 501E44

Storm water sampling performed at the regional office to support the region's LEED program and to provide assistance to BNIM Architects and Kansas State University.

Explanation of Codes, Units and Qualifiers used on this report

Sample QC Codes: QC Codes identify the type of sample for quality control purpose.

__ = Field Sample
FB = Field Blank

Units: Specific units in which results are reported.

mg/L = Milligrams per Liter

Data Qualifiers: Specific codes used in conjunction with data values to provide additional information on the quality of reported results, or used to explain the absence of a specific value.

(Blank)= Values have been reviewed and found acceptable for use.
J = The identification of the analyte is acceptable; the reported value is an estimate.
U = The analyte was not detected at or above the reporting limit.

ASR Number: 7212 **Sample Information Summary** **11/03/2016**

Project ID: WPD145 **Project Desc:** Regional Office Storm Water Sampling Project

Sample No	QC Code	Matrix	Location Description	External Sample No	Start Date	Start Time	End Date	End Time	Receipt Date
1 -	__	Water	Parking Lot A (#1)		09/16/2016	12:45			09/16/2016
2 -	__	Water	Sand Filter (#2)		09/16/2016	13:15			09/16/2016
3 -	__	Water	Renner Road (#3)		09/16/2016	12:55			09/16/2016
6 -	FB	Water	Nutrients Field Blank		09/16/2016	15:10			09/16/2016
7 -	FB	Water	Metals Field Blank		09/16/2016	15:09			09/16/2016

Analysis **Comments About Results For This Analysis**

1 Ammonia in Water

Lab: Region 7 EPA Laboratory - Kansas City, Ks.

Method: EPA Region 7 RLAB Method 3133.11B

Samples: 1-__ 2-__ 3-__ 6-FB

Comments:

1 Anions in Water by Lachat Ion Chromatography

Lab: Region 7 EPA Laboratory - Kansas City, Ks.

Method: Region 7 RLAB Method 3135.15B

Samples: 1-__ 2-__ 3-__

Comments:

1 Metals in Water by ICP-AES

Lab: Region 7 EPA Laboratory - Kansas City, Ks.

Method: EPA Region 7 RLAB Method 3122.3F

Samples: 1-__ 2-__ 3-__ 7-FB

Comments:
(N/A)

1 NFS or Nonfilterable Solids

Lab: Region 7 EPA Laboratory - Kansas City, Ks.

Method: EPA Region 7 RLAB Method 3142.3H

Samples: 1-__ 2-__ 3-__

Comments:

1 Nitrogen, Nitrate+Nitrite in Water

Lab: Region 7 EPA Laboratory - Kansas City, Ks.

Method: RLAB Method for acidified samples (for total NO3+NO2 analysis)

Samples: 1-__ 2-__ 3-__ 6-FB

Comments:
Nitrate + Nitrite was J-coded in sample 1. Although the analyte in question has been positively identified in the sample, the quantitation is an estimate (J-coded) due to high recovery of this analyte in the laboratory matrix spike duplicate. The actual concentration for this analyte may be lower than the reported value. (UCL: 108; % Rec: 111)

1 Total Kjeldahl Nitrogen in Water Colorimetric

Analysis	Comments About Results For This Analysis

Lab: Region 7 EPA Laboratory - Kansas City, Ks.
Method: EPA Region 7 RLAB Method 3133.3H
Samples: 1-__ 2-__ 3-__ 6-FB
Comments:
(N/A)

1 Total Phosphorus in Water, Colorimetric

Lab: Region 7 EPA Laboratory - Kansas City, Ks.
Method: EPA Region 7 RLAB Method 3133.4G
Samples: 1-__ 2-__ 3-__ 6-FB
Comments:
(N/A)

ASR Number: 7212 **RLAB Approved Sample Analysis Results** **11/03/2016**

Project ID: WPD145 **Project Desc:** Regional Office Storm Water Sampling Project

Analysis/ Analyte	Units	1-__	2-__	3-__	6-FB
1 Ammonia in Water					
Ammonia as Nitrogen	mg/L	0.100 U	0.100 U	0.100 U	0.100 U
1 Anions in Water by Lachat Ion Chromatography					
Chloride	mg/L	183	75.0	104	
1 Metals in Water by ICP-AES					
Calcium	mg/L	61.2	43.2	91.0	
Sodium	mg/L	107	46.6	75.4	
1 NFS or Nonfilterable Solids					
Solids, nonfilterable	mg/L	4.00 U	4.00 U	4.00 U	
1 Nitrogen, Nitrate+Nitrite in Water					
Nitrate + Nitrite as Nitrogen	mg/L	0.476 J	0.330	0.440	0.0400 U
1 Total Kjeldahl Nitrogen in Water Colorimetric					
Total Kjeldahl Nitrogen	mg/L	0.439	0.200 U	0.442	0.200 U
1 Total Phosphorus in Water, Colorimetric					
Phosphorus	mg/L	0.100 U	0.116	0.100 U	0.100 U

Page 6 of 7

ASR Number: 7212 **RLAB Approved Sample Analysis Results** **11/03/2016**

Project ID: WPD145 **Project Desc:** Regional Office Storm Water Sampling Project

Analysis/ Analyte	Units	7-FB
1 Metals in Water by ICP-AES		
Calcium	mg/L	2.00 U
Sodium	mg/L	5.00 U

APPENDIX B

Tree Inventory of EPA Region 7 Headquarters, Lenexa, KS
Conducted on July 31, 2016 by Jim Schuessler and Timothy Kellams
Metrics calculated using the National Tree Benefit Calculator

Tree Common Name	Other Tree (if used)	Caliper at 6-inches (in)	Stormwater interception by one tree (gal)	CO2 reduction by one tree (lbs)	Benefit of one tree ($)	Number of tree found on site	Total Intercepted stormwater runoff (gal)	Total CO2 reduction (lbs)	Total benefit ($)
Aristocrat Pear	Pear	2	18	24	3	1	18	24	3
Aristocrat Pear	Pear	4.5	69	75	9	1	69	75	9
Aristocrat Pear	Pear	5.75	123	120	16	2	246	240	32
Aristocrat Pear	Pear	6.25	145	138	18	1	145	138	18
Aristocrat Pear	Pear	6.5	156	147	20	4	624	588	80
Aristocrat Pear	Pear	7	177	165	22	1	177	165	22
Aristocrat Pear	Pear	7.25	188	174	23	1	188	174	23
Aristocrat Pear	Pear	7.5	199	183	25	2	398	366	50
Aristocrat Pear	Pear	8	221	201	27	1	221	201	27
Aristocrat Pear	Pear	8.5	243	219	30	1	243	219	30
Bald Cypress	Juniper	2.25	64	15	7	3	192	45	21
Bald Cypress	Juniper	2.5	77	18	7	1	77	18	7
Bald Cypress	Juniper	4	157	34	13	2	314	68	26
Bald Cypress	Juniper	5	236	49	18	1	236	49	18
Bald Cypress	Juniper	5.5	289	58	21	4	1156	232	84
Bald Cypress	Juniper	6.75	421	81	48	1	421	81	48
Bald Cypress	Juniper	7	448	85	30	3	1344	255	90
Bald Cypress	Juniper	8	553	103	36	1	553	103	36
Bald Cypress	Juniper	8.5	606	112	38	1	606	112	38
Bald Cypress	Juniper	10	822	139	48	1	822	139	48
Canarti Juniper	Juniper	6	342	67	24	9	3078	603	216
Colorado Green Spruce	Blue Spruce	4.5	256	60	21	1	256	60	21
Colorado Green Spruce	Blue Spruce	5	312	70	24	5	1560	350	120
Colorado Green Spruce	Blue Spruce	6	423	88	30	15	6345	1320	450
Colorado Green Spruce	Blue Spruce	7	534	107	36	3	1602	321	108
Colorado Green Spruce	Blue Spruce	8	645	126	42	2	1290	252	84
Crabapple	Apple	1.75	13	19	2	1	13	19	2
Crabapple	Apple	2	18	24	3	1	18	24	3
Crabapple	Apple	2.25	23	29	3	1	23	29	3
Crabapple	Apple	2.5	28	35	4	1	28	35	4
Crabapple	Apple	3	38	45	5	5	190	225	25
Crabapple	Apple	3.25	43	50	6	1	43	50	6
CrabApple	Apple	3.5	48	55	7	1	48	55	7
Crabapple	Apple	4	58	65	8	1	58	65	8
Eastern Red Cedar		5.5	289	58	21	1	289	58	21
Eastern Red Cedar		6.5	395	76	27	1	395	76	27
Eastern Redbud		2.25	23	29	3	3	69	87	9
Eastern Redbud		2.5	28	35	4	1	28	35	4
Eastern Redbud		3.5	48	55	7	1	48	55	7

Eastern Redbud		4	58	65	8	3	174	195	24
Eastern Redbud		4.5	69	75	9	3	207	225	27
Eastern Redbud		5	90	93	12	1	90	93	12
Eastern Redbud		5.5	112	111	15	3	336	333	45
Eastern Redbud		6	134	129	17	3	402	387	51
Eastern Redbud		6.5	156	147	20	1	156	147	20
Eastern Redbud		6.75	167	156	21	1	167	156	21
Eastern Redbud		7	177	165	22	1	177	165	22
Eastern Redbud		9	264	238	32	1	264	238	32
Elm?		4	146	103	16	1	146	103	16
Elm?		4.5	172	123	19	1	172	123	19
Elm?		5	220	150	23	1	220	150	23
Ginkgo		2.25	26	17	3	1	26	17	3
Juniper		5.5	289	58	21	1	289	58	21
Linden	Littleleaf linden	2	21	35	4	1	21	35	4
Linden	Littleleaf linden	2.25	29	42	5	1	29	42	5
Linden	Littleleaf linden	3.5	65	76	10	1	65	76	10
London Plane Tree	American Sycamore	6	317	204	31	1	317	204	31
London Plane Tree	American Sycamore	6.5	366	231	35	1	366	231	35
London Plane Tree	American Sycamore	7	414	258	39	3	1242	774	117
London Plane Tree	American Sycamore	7.5	462	285	43	1	462	285	43
Oak		2	44	26	6	2	88	52	12
Oak		2.25	56	36	7	3	168	108	21
Oak		2.75	82	55	10	2	164	110	20
Oak		3.25	108	74	12	1	108	74	12
Oak		3.5	120	84	14	1	120	84	14
Oak		3.75	133	94	15	1	133	94	15
Oak		4	146	103	16	5	730	515	80
Oak		4.5	172	123	19	3	516	369	57
Oak		4.75	196	136	21	2	392	272	42
Oak		5.5	269	177	27	2	538	354	54
Oak		5.75	293	190	29	1	293	190	29
Oak		6	317	204	31	1	317	204	31
Oak		10.25	779	461	68	4	3116	1844	272
Oak		11.5	965	562	81	13	12545	7306	1053
Red Sunset Maple	Red Maple	1.25	22	17	3	1	22	17	3
Red Sunset Maple	Red Maple	2	33	24	4	2	66	48	8
Red Sunset Maple	Red Maple	2.25	43	32	5	5	215	160	25
Red Sunset Maple	Red Maple	2.5	54	39	7	1	54	39	7
Red Sunset Maple	Red Maple	2.75	64	47	8	13	832	611	104
Red Sunset Maple	Red Maple	3.5	95	69	12	1	95	69	12
Red Sunset Maple	Red Maple	3.75	106	77	13	1	106	77	13

Red Sunset Maple	Red Maple	6.25	327	197	34	2	654	394	68
Red Sunset Maple	Red Maple	6.5	354	211	36	1	354	211	36
Red Sunset Maple	Red Maple	7	408	238	41	9	3672	2142	369
Red Sunset Maple	Red Maple	8	517	294	51	1	517	294	51
Red Sunset Maple	Red Maple	10.5	870	491	80	2	1740	982	160
Red Sunset Maple	Red Maple	12	1115	631	99	1	1115	631	99
Red Sunset Maple	Red Maple	13	1278	725	111	1	1278	725	111
River Birch		2.5	62	62	9	3	186	186	27
River Birch		2.75	75	74	11	1	75	74	11
River Birch		3.5	113	11	15	2	226	22	30
River Birch		5	210	186	25	15	3150	2790	375
Total						**235**	**65,220**	**33,970**	**5,953**
							(gal)	**(lbs)**	**($)**

Appendix C

"Survey of EPA Region 7 Headquarters Employees' Response to Sustainable Landscape"
Administered June 28-July 12, 2016 through the KSU Qualtrics Online system

1. Please indicate your level of overall satisfaction with the attractiveness of the outdoor environment surrounding the EPA Region 7 Headquarters building:

Response	*%*	*Response options*
12	20%	Very satisfied
20	33%	Satisfied
14	23%	Neutral
11	18%	Unsatisfied
4	7%	Very unsatisfied
61		Total respondents

2. From an aesthetic viewpoint, what is your preference concerning the natural landscape in the parking areas, open fields, and front of the EPA building?

Response	*%*	*Response options*
25	42%	Appealing
26	43%	Acceptable
8	13%	Do not like: I prefer the appearance of irrigated lawns and traditional landscaping like I see around the other buildings in the office park
1	2%	No opinion
60		Total respondents

3. Please indicate your level of overall satisfaction with the exterior environment of parking areas, building approach/entrance, open fields, green infrastructure features, and three courtyards?

Response	*%*	*Response options*
12	20%	Very satisfied
21	34%	Satisfed
14	23%	Neutral
13	21%	Unsatisfied
1	2%	Very unsatisfied
61		Total respondents

4. Are you familiar with the green infrastructure treatment train (sequence of bioswales, rain gardens, sand infiltration area, and wetlands) on the campus and how it works?

Response	*%*	*Response options*
18	30%	Very familiar
21	34%	Somewhat familiar
12	20%	I know what it is, but am not familiar with how it works
10	16%	I have never heard of it, or it has not been pointed out to me on campus
61		Total respondents

5. Have you ever pointed out or explained any of the green infrastructure features to visitors?

Response	*%*	*Response options*
28	46%	Yes
33	54%	No
61		Total respondents

6. Do you feel safe walking around the parking lot and property?

Response	*%*	*Response options*
56	92%	Yes
5	8%	No
61		Total respondents

7. Weather permitting, how often have you used the walking paths around the South Lakes development over the past 12-months?

Response	*%*	*Response options*
5	8%	Most days
8	13%	2 or more times per week
6	10%	Once a week
22	36%	1-3 times per month
20	33%	I have not used them
61		Total respondents

8. Do you anticipate using the walking paths this summer and fall?

Response	*%*	*Response options*
43	70%	Yes
18	30%	No
61		Total respondents

9. Weather permitting, how often have you used the outdoor courtyards over the past 12-months?

Response	*%*	*Response options*
2	3%	Most days
4	7%	2 or more times per week
8	13%	Once a week
28	47%	1-3 times per month
18	30%	I have not used them
60		Total respondents

10. Do you anticipate using the outdoor courtyards this summer and fall?

Response	*%*	*Response options*
45	75%	Yes
15	25%	No
60		Total respondents

11. What activities do you enjoy when using the outdoor courtyards (check all that apply):

Response	*%*	*Response options*
21	36%	Socialize with coworkers on breaks
29	49%	Attend office or group events/functions
36	61%	Get fresh air
24	41%	Eat snack or lunch
8	14%	Read
16	27%	Spend time alone/reflect
14	24%	I do not use the exterior courtyards
8	14%	Other: (work, brief phone calls, looking for pollinators)
59		Total respondents

12. Considering your choice of activities in the courtyards, do you enjoy the natural landscape?

Response	*%*	*Response options*
27	44%	Appealing
25	41%	Acceptable
5	8%	Do not like: I prefe the appearance of a more traditional manicured landscape to support the activities I enjoy
4	7%	No opinion
61		Total respondents

13. If the EPA campus was designed all over again, what ONE THING would you most like to provide input on?

Response	*%*	*Response options*
2	3%	Prefer more mowed turf
14	23%	Location and design of the parking lots
29	48%	More shade within outdoor areas
3	5%	Accesibility to outdoor environments
2	3%	Accesibility to outdoor recreation
1	2%	More walking trails on the EPA property
9	15%	Undecided
60		Total respondents

Appendix D

EPA Region 7 Headquarters: Visitor Tour Log (2013-2016).

Tour No.	Tour Date	Organization	Organization Type	Tour Type	Number of Attendees
2013					*Total = 84*
1	25-Jan-13	Environmental Excellence Business Network	Professional	Invited	40
2	5-Feb-13	EPA Office of Sustainable Communities	Government	Invited	1
3	12-Feb-13	Univ. of Missouri Kansas City (Arch Student)	Education	Unsolicited	1
4	8-Mar-13	Univ.y of Missouri Kansas City (Law Students)	Education	Unsolicited	10
5	10-Apr-13	Regional Tribal Operation Committee (RTOC)	Government	Invited	15
6	13-Jun-13	State Storage Tank Program Managers	Government	Invited	15
7	7-Nov-13	Generaal Services Administration (Director of High Performance Bldgs & Region 6 Sustainability Program Manager)	Government	Unsolicited	2
2014					*Total = 91*
8	15-Apr-14	Kansas State University Architecture Dept	Education	Unsolicited	11
9	24-Jun-14	Standard Beverage	Industry	Unsolicited	1
10	16-Jul-14	Federal Executive Board HR Sub-Committee	Government	Invited	11
11	30-Jul-14	Assistant Director; KC National Benefits Center	Government	Unsolicited	2
12	17-Sep-14	Suburban Green Infrastructure Tour (One Water Leadership Summit)	Industry	Unsolicited	13
13	25-Sep-14	Kansas City Community College; Honor Society	Education	Unsolicited	10
14	26-Sep-14	Assoc. of Energy Engineers; KC Chapter Mtg	Industry	Invited	43
2015					*Total = 79*
15	5-Mar-15	UMKC Student	Education	Unsolicited	2
16	17-Jun-15	Federal Executive Board	Government	Invited	2
17	7-Jul-15	EPA Deputy Administrator	Government	Invited	2
18	10-Aug-15	GSA's EPA Portfolio Manager	Government	Unsolicited	2
19	14-Sep-15	EPA CIO	Government	Unsolicited	1
20	13-Oct-15	USGBC Central Plains Chapter	Industry	Invited	59
21	14-Oct-15	STEM Student	Education	Invited	1
22	22-Oct-15	Local Grade School Students and Parents	Education	Unsolicited	10
2016					*Total (to date) = 62*
23	10-Feb-16	KCEEN Meeting	Industry	Unsolicited	12
24	24-Feb-16	FEB Wellness Committee	Government	Unsolicited	15
25	5-Apr-16	EPA Budget Technical Workshop	Government	Unsolicited	28
26	6-Apr-16	JCCC Sustainability	Education	Unsolicited	7

Appendix E

Table CC-1: Cost Esimate for Stormwater Treatment Train for EPA Region 7 Headquarters in Lenexa, KS
(Source: Jim Schuessler, CFS Engineers and Chad Brungardt, McCown Gordon Construction 2016)

Site Preparation	Quantity	Unit	Unit Cost			Cost
Clear and Grub	1.77	acre	$1,875.00	/acre	$	3,314
Machine excavation; cut (earth)	12,477	cy	$3.10	/cy	$	38,680
Machine excavation; cut (rock w/removal)	967	cy	$11.00	/cy	$	10,637
Machine excavation; fill	13,444	cy	$3.60	/cy	$	48,400
Sediment Trap Forebay						
Perforated 6" Pipe Riser	10	lf	$24.00	/lf	$	240
90 degree elbo	2	ea	$20.00	/ea	$	40
Solid 6" Pipe	55	lf	$18.00	/lf	$	990
6-12" trap rock fill (24" thick)(5,300 SF)	395	cy	$26.50	/cy	$	10,468
Filter Fabric under entire system	588	sy	$7.75	/sy	$	4,557
Spillway						
Spillway Permanent Erosion Mat (755 SF)	28	sy	$4.50	/sy	$	126
Fescue seeding with establishment	28	sy	$2.65	/sy	$	74
Side Slopes						
Topsoil placement, 6" (8,700 SF)	162	cy	$17.70	/cy	$	2,867
Fine grade for landscaping	970	sy	$1.70	/sy	$	1,649
Fescue seeding with establishment	970	sy	$2.65	/sy	$	2,571
Sand Filter						
(14) 26" tall Solid 6" Pipe Risers	31	lf	$22.00	/lf	$	682
90 degree elbo	14	ea	$20.00	/ea	$	280
6" Screw on Pipe Riser Caps	14	ea	$25.00	/ea	$	350
6" Perforated Subdrainage Pipe	400	lf	$20.00	/lf	$	8,000
Filter Fabric under entire system	1,050	sy	$7.75	/sy	$	8,138
22" sand fill (7900 SF)	536	cy	$45.00	/cy	$	24,120
3" Missouri River rock (top cover)	80	cy	$175.00	/cy	$	14,000
Solid 6" Outlet Pipe (to wetland)	50	lf	$20.00	/lf	$	1,000
Spillway						
Filter Fabric under rip rap	20	sy	$8.00	/sy	$	160
12-18" riprap (18" thick)	36	cy	$155.00	/cy	$	5,580
Side Slopes						
Topsoil placement, 6" (6,175 SF)	114	cy	$17.70	/cy	$	2,018
Fine grade for landscaping	686	sy	$1.70	/sy	$	1,166
Fescue seeding with establishment	686	sy	$2.65	/sy	$	1,818
Wetland						
Topsoil placement, 6" Thick (15,000 SF)	280	cy	$17.70	/cy	$	4,956
Fine grade for landscaping	1,670	sy	$1.70	/sy	$	2,839
Single Stray erosion net (like DS75 by North American Green)	1,670	sy	$6.50	/sy	$	10,855
Seeding of native grass mix	1,670	sy	$5.30	/sy	$	8,851
Plug of wetland plant at 36" OC	2,000	ea	$7.00	/ea	$	14,000
Adjacent Landsaping						
Topsoil placement, 6" (4,939 SY)	825	cy	$17.70	/cy	$	14,603
Fine grade for landscaping	4,939	sy	$1.70	/sy	$	8,396
Fescue seeding with establishment	4,939	sy	$2.65	/sy	$	13,088
(To equal detention basin area of 9,778 SY)						
Subtotal					$	269,513
General requirements, overhead & profit	15%				$	40,427
Total					$	309,940
Design services/Engineering	10%				$	30,994
Target Grand Total			+/- 5%		**$**	**340,933**

Table CC-2: Cost Estimate for Traditional Detention Basin for the EPA Region 7 Headquarters Site in Lenexa, KS. (Source: Chad Brungardt, McCown Gordon Construction 2016)

"Traditional" Detention Basin Cost Estimate			
Task	**Amount**	**Unit Cost**	**Installation Cost ($)**
Clear and grub	1.77 ac	$1,875/ac	$3,314
Machine excavation; cut (earth)	12,477 cy	$3.10/cy	$38,680
Machine excavation; cut (rock w/ removal)	967 cy	$11.00/cy	$10,637
Machine excavation; fill	13,444 cy	$3.60/cy	$48,400
Import fill	967 cy	$12.00/cy	$11,604
Topsoil placement, 6"	1,630 cy	$17.70/cy	$28,844
Fine grade for landscaping	9,778 sy	$1.70/sy	$16,622
Sod with establishment	9,778 sy	$5.30/sy	$51,822
Vinyl coated chain link fence; 6' tall	940 lf	$38.50/lf	$36,190
Subtotal			$246,114
General requirements, overhead & profit (15%)			$36,917
Total			$283,032
Design services/engineering (10%)			$28,303
Grand Total (+/- 5%)			$311,335