**LANDSCAPE
PERFORMANCE
SERIES** presented by the
Landscape Architecture Foundation

TAXI II Redevelopment, Denver, CO
Methodology for Landscape Performance Benefits
Case Study Investigation 2017

Prepared by:

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Environmental Benefits

● Intercepts, infiltrates, and evaporates 80% of annual rainfall, or 1,839,500 gallons, equivalent to 2.8 Olympic-sized swimming pools, in bioswales, rain gardens, and newly-planted trees.

As introduced in the Case Study Brief, TAXI II was one of the first projects in the metro-Denver area to utilize a curbless surface system to manage stormwater runoff. The entire 6.18-acre site "surface drains" to a system of surface swales and seven stormwater gardens that convey, infiltrate and cleanse stormwater runoff from roofs, streets, and parking areas (Figure 1 through 3), eliminating the need to install any curb and gutter or underground storm sewer.

We applied the National Stormwater Calculator (SWC) version 1.2.0.0 Beta (MSI)[E1] to quantify the stormwater benefits of the landscape. Table 1 explains the sources or calculations of the model parameters used.
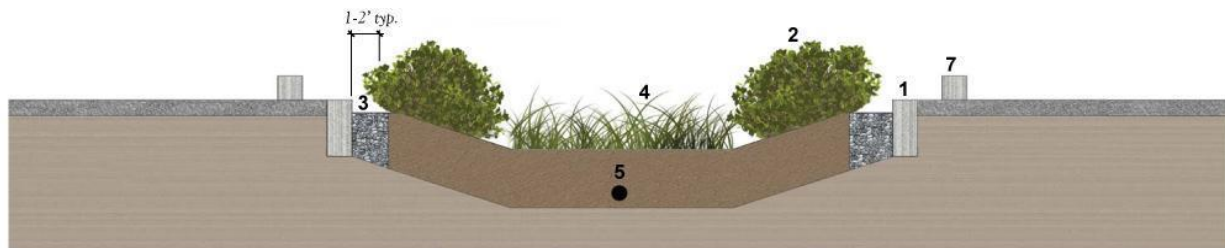
Figure 1. The stormwater system diagram illustrating the direction of stormwater through the bioswales and rain gardens to the detention ponds.
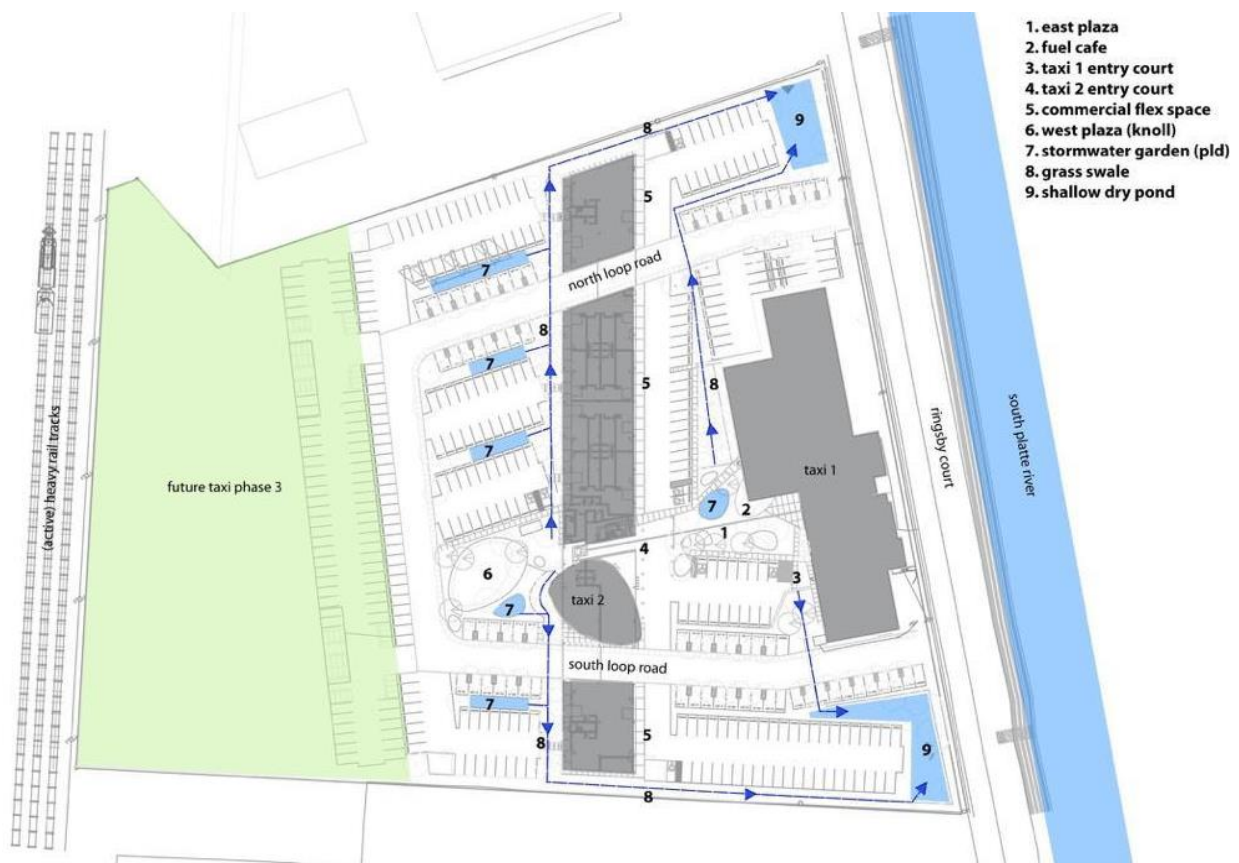
Figure 2. The Porous Landscape Detention gardens (left) and stormwater conveyance areas (right).

Figure 3. Design details of the Porous Landscape Detention gardens integrated into the parking lot.
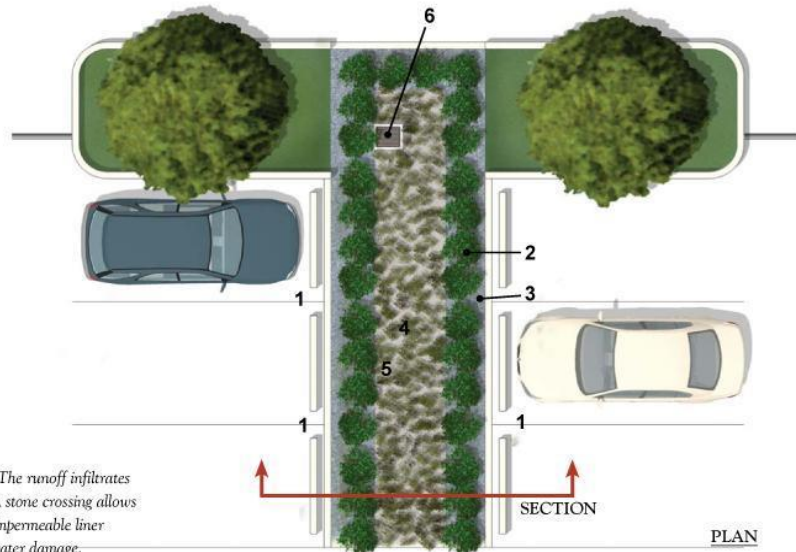

1 **Inlet:** *Curb flush to pavement; depress mulch three inches below curb in median to provide for sediment accumulation*
2 **Planting:** *Wet/Dry tolerant, ornamental plantings*
3 **Sediment Trap:** *Gravel mulch collects sediments before accumulating at the bottom of the median*
4 **Planting:** *Native grasses allow for periodic sediment removal and replacement*
5 **Infiltration Matrix:** *Consists of well-drained engineered or hydrologic soils Type A; Subdrain if required by geotechnical engineers*
6 **Outlet/Overflow:** *Provide overflow above WQv for large storm event; sheet flow overland to storm drain*
7 **Curb Stop:** *Median needs to be protected from vehicular traffic. Curb stops or slotted curbs allow drainage to flow into median with minimal concentration of flow*

SECTION

A narrow median strip receives runoff from two bays of parking. The runoff infiltrates and supports the native grasses, shrubs, and trees planted there. A stone crossing allows pedestrians to cross the median without trampling plantings. An impermeable liner extending three feet below each curb protects the pavement from water damage.

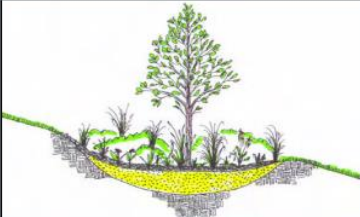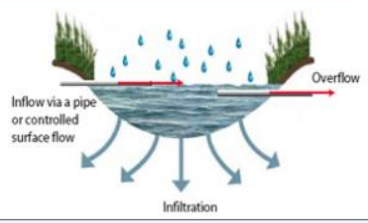SECTION

PLAN

Table 1. Inputs for the National Stormwater Calculator.

Location	Topography
Site Name (Optional) TAXI II Search for an address or zip code: 3457 Ringsby Ct., Denver, CO 80216 Site Location (Latitude, Longitude) 39.77271,-104.98143 Site Area (acres - Optional) 6.2	Describe your site's topography: ☐ View soil survey data 🟦 ◉ Flat (2% Slope) 🟩 ○ Moderately Flat (5% Slope) 🟨 ○ Moderately Steep (10% Slope) 🟪 ○ Steep (above 15% Slope)
Soil Type	**Soil Drainage**
What type of soil is on your site? ☐ View soil survey data 🟦 ○ A - low runoff potential 🟩 ○ B - moderately low 🟨 ◉ C - moderately high 🟪 ○ D - high runoff potential	How fast does standing water drain from your site (inches/hour)? 0.15 (Default = 0.4) ☐ View soil survey data 🟦 <= 0.01 inches/hour 🟩 > 0.01 to <= 0.1 inches/hour 🟨 > 0.1 to <= 1.0 inches/hour 🟪 > 1 inches/hour
No listing of the Hydrologic Soil Group (HSG) data was available from the NCRS at the time of this research. Assumptions based on those provided in the Denver Storm Drainage Master Plan[E2].	No infiltration rate data was available at the time of this research. Assumption was made based on 1) HSG C soil saturated hydraulic conductivity ranges from 0.05-0.15in/hr [E3]) the higher end of 0.15 in/hr was chosen because the site was applied with a well-drained loamy sand topsoil with 30-50% sand, 30-50% silt, and 5-30% clay.
Precipitation (from the nearest station)	**Evaporation**
Select a rain gage location to use as a source of hourly rainfall data: 1 - DENVER WATER DEPARTMENT (1997-2006) 15.00" 2 - WHEAT RIDGE 2 (1981-2006) 18.38" 3 - DENVER STAPELTON (1970-2006) 15.33" 4 - LAKEWOOD (1970-2006) 16.92" 5 - NORTHGLENN (1984-2006) 14.19"	Select a weather station to use as a source for evaporation rates: 1 - DENVER WATER DEPARTMENT (1998-2006) 0.23 inches/day 2 - WHEAT RIDGE 2 (1982-2006) 0.21 inches/day 3 - DENVER STAPELTON (1970-2006) 0.22 inches/day 4 - LAKEWOOD (1970-2006) 0.22 inches/day 5 - NORTHGLENN (1985-2006) 0.22 inches/day

Land Cover

Describe the site's land cover for the development scenario being analyzed:

% Forest	11
% Meadow	10
% Lawn	0
% Desert	0
% Impervious	79

Tree canopy total area was calculated as the "Forest" area; all other vegetation (short-grass prairie, mixed grass prairie, wildflower mix, wet meadow in PLDs, and perennials /ornamental grasses) were counted as "Meadow"; <1% sodded lawn excluded.

LID Controls

What % of your site's impervious area will be treated by the following LID practices?

Disconnection	30
Rain Harvesting	0
Rain Gardens	44
Green Roofs	0
Street Planters	0
Infiltration Basins	26
Permeable Pavement	0

Calculation of the **% of Disconnection**: 63412 sf (building rooftop area)/212059 sf (total imperviousness) = 30%

% of Rain Gardens (PLDs): 92533 sf (PLD total contributing area)/212059 sf (total imperviousness) = 44%

% of Infiltration Basins: 1-44%-30%=26%

LID Control Parameters

Disconnection:
1. 82% Capture Ratio = 51900 sf (stormwater conveyance area)/63412sf (contributing building rooftops);

Rain Garden:
1. Ponding Height and Soil Media Thickness as specified by construction documents;
2. Soil Media Conductivity based on best professional knowledge from project civil engineer;
3. 3% capture ratio = 2483 sf (PLD total area)/92523 sf (PLD total contributing area)

Infiltration Basin:
1. Basin Depth: defaulted maximum depth;
2. 4% Capture Ratio = 2120 sf (pond total area)/56124 sf (pond total contributing area)

Figure 4. Outputs from the National Stormwater Calculator.
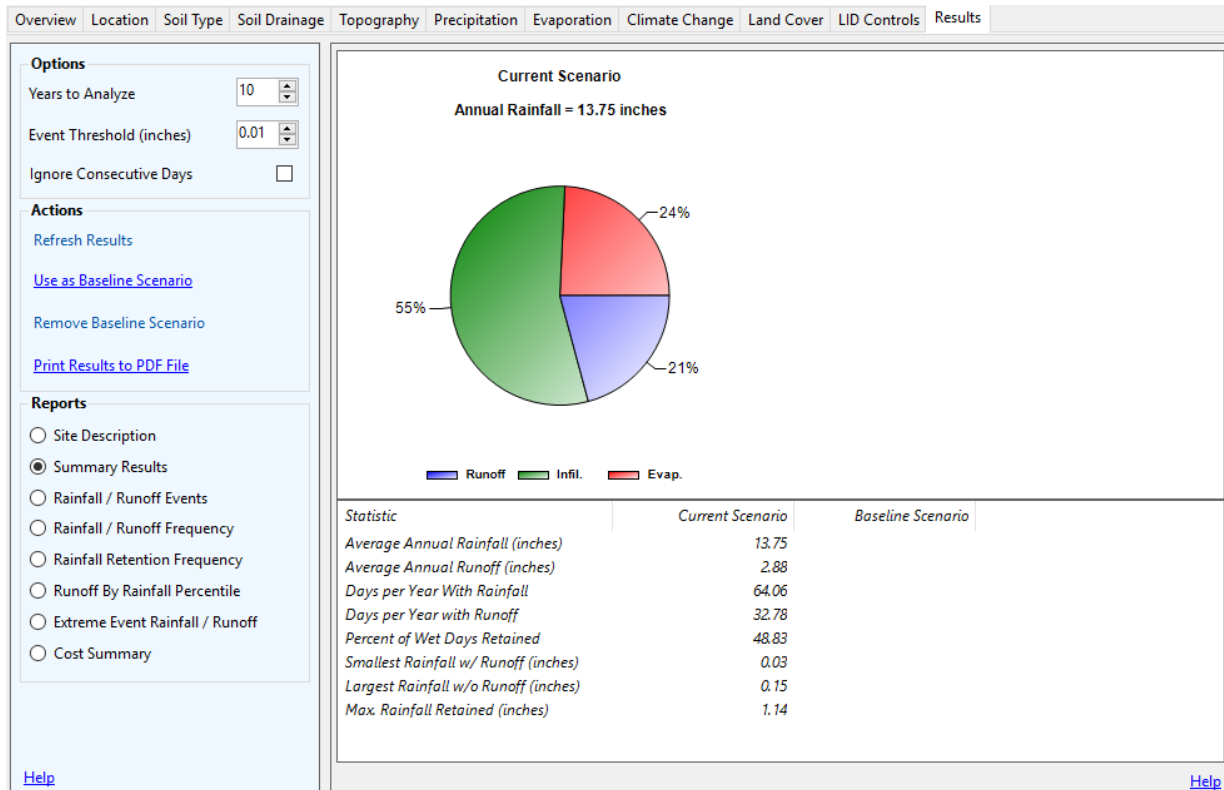
The modeling results (Figure 4) suggested that the landscape infiltrates (55%) and evaporates (24%) a total of 79% of the site's annual rainfall. Because the National Stormwater Calculator does not yet take into account of tree canopy interception and transpiration, we applied the i-Tree Design v6.0 online tool[E4] to calculate the amount of rainfall intercepted by the trees within the Taxi II site. Based on construction drawings (pages L2 - Planting Plan) [E5] and a revised planting specification (dated from April 2007)[E6], species, caliper, and locations of trees (Table 2), together with the building footprints, were entered into i-Tree Design as key inputs (Figure 5) (see Appendix I for the detailed list of trees generated by i-Tree). It is worth mentioning that the i-Tree tool does not allow entering historical data; instead, it only calculates "projected" performance into the future. Therefore, the tree information from the year of 2007 was entered as that of 2017, and the "projected" benefits from the decade of 2017-2027 (Appendix I) should in fact be the *estimated* benefits for the past decade of 2007-2017.

Table 2. Species, quantities, and caliper of trees as input for the i-Tree Design tool.

	# of Units	2007 Caliper ('')
Narrowleaf cottonwood	52	1''
Narrowleaf cottonwood	12	2''
Narrowleaf cottonwood	10	3''
Plains cottonwood	14	3''
Shademaster honeylocust	23	2''
Swamp white oak	9	2''
Autumn purple ash	9	2''
Red maple	6	2''

Figure 5: Trees considered for the i-Tree Design calculations (building footprints in blue).

Lat: 39.77146
Lng: -104.98060

The i-Tree calculator reported that an average of 16,265 gallons (1%) of annual rainfall had been intercepted by the tree canopy since establishment. Therefore, the landscape overall intercepts, infiltrates, and evaporates about 80% of the annual rainfall, totaling 1,839,470 gallons per year (Table 3). It is worth mentioning that the tree interception performance grows over time as the trees mature, so the overall percentage of rainfall retained on site will gradually increase in the future.

Table 3. Rainfall volume reduction calculation.

Calculation by the National Stormwater Calculator	Avg. Annual Rainfall (in)	13.75 in
	Total Rainfall Volume/Year (gal)	13.75 in x 6.18 ac = 2,307,855 gal
	% (Infiltration + Evaporation)	79%
	Volume (Infiltration + Evaporation) (gal)	79% x 2,307,855 = 1,823,205 gal
Calculation by i-Tree Design	Volume (Interception) (gal)	16,265 gal
	Total Volume (Infiltration + Evaporation + Interception) (gal)	1,823,205 + 16,265 = 1,839,470 gal
	% of annual rainfall	= 1,839,470/2,307,855 = 80%
	Volume of Olympic-sized pool	50m x 25m x 2m = 660,430 gal
	# of pools	1,839,470/660,430 = 2.8

Limitations:

Ideally, the actual stormwater management benefit would have been quantified through long-term monitoring of the flow discharges at the TAXI II outfall to understand the actual percentage of annual runoff discharged into the South Platte River. Even better, water quality sampling would reveal how well the stormwater system functions for water quality treatment. However, such methods remained infeasible within the timeframe of this research.

The National Stormwater Calculator assessments had several limitations related to both the data inputs and the software itself (*limitations of the i-Tree Design calculation itself will be elaborated in the section that follows*).

➢ Although the i-Tree Design tool could compensate for the SWC's 2017 version for the missing component of tree canopy interception, it remained unclear how compatibly these two tools work together because, for starters, the two models likely use different rainfall records[E3, E7] to run their calculations.

➢ **DATA:** An accurate characterization of the soils, including the permeability of the PLD soil media, the HSG type and permeability of the native soils on the former landfill, as well as those of the topsoil applied during construction, remained unavailable within the timeframe of this research.

➢ **SWC:** It would have been ideal if more recent rainfall data from the years of 2008-2017 (available from the National Weather Service) could be plugged into SWC to calculate the actual Stormwater benefits over the life of the project.

➢ **SWC:** The model assumes that each type of LID controls manages a certain portion of the imperviousness; however, in the case of TAXI II, all the LID controls are interconnected, with one system draining into another. In order to run the model, assumptions had to be made to separate the impervious areas into independent contributing areas for each LID. This could result in an under-estimation of stormwater benefits in the case of one system compensating for another. However, how exactly this affects the modeling results requires further investigation.

➢ **SWC:** The *Infiltration Basin* LID control prototype (with a maximum depth of 24'') may not be an accurate representation of the detention ponds at TAXI II (average depth = 36'').

Sources:
[E1] *National Stormwater Calculator 1.2.0.0 Beta (MSI) (version 05/01/2017), software developed by USEPA. Downloaded from https://www.epa.gov/water-research/national-stormwater-calculator on 2017/7/22;*
[E2] *City and County of Denver Storm Drainage Master Plan, September 2014. Retrieved from: https://www.denvergov.org/content/dam/denvergov/Portals/711/documents/StormMasterPlan/Master%20Plan%20Final%20September%202014%20Corrections%20for%20Web.pdf, 2017/07/28;*
[E3] *U.S. EPA. (2017) National Stormwater Calculator User's Guide Version 1.2. Publication No. EPA/600/R-13/085d;*
[E4] *i-Tree Design online tool, available at https://design.itreetools.org;*
[E5] *TAXI II Construction Drawings - Planting Plan (pages L2), by M. A. Mortenson Company, version 2006/11/22;*
[E6] *Revised planting specification of trees dated from April 2007 by Wenk Associates.*
[E7] *Xiao, Q. et al. (1998). Rainfall Interception by Sacramento's Urban Forest. Journal of Arboriculture 24 (4) (i.e., the basis for the rainfall interception model used in i-Tree Design).*

- *Sequesters 7,700 lbs of atmospheric carbon annually in newly-planted trees, equivalent to driving a mid-sized sedan 8,400 miles.*

We used the i-Tree Design online tool (version 6.0) again to quantify the amount of atmospheric carbon dioxide sequestered by the trees and avoided by reducing buildings heating and cooling demand through tree shade around the Taxi I and II buildings. Please refer to the stormwater section above for the detailed set-up of the i-Tree tool (Table 2 and Figure 5), as the exact same input was used for calculations in this section.

Over the past 10 years, the i-Tree estimated that 77,160 pounds (7,716 lbs/year) of CO_2 were reduced, either by tree canopy sequestration or by reducing emissions associated with power production due to the reduced building heating and cooling demand through shading or wind breaking. This is equivalent to driving a mid-sized sedan for 84,000 miles, based on the estimation that one mid-sized sedan generates 11,000 pounds of CO_2 every 12,000 miles driven. This distance of 84,000 miles is equal to crossing the USA from coast to coast approximately 31 times, with the U.S. horizontal width measured at 2,680 miles.

The monetized benefits of cooling cost savings during summers and air quality improvements were also generated (Table 4). Throughout the first decade of operation, TAXI I and II buildings saved a total of $2,420 (an average of $242 per year) in cooling costs due to the cottonwoods shading the west-facing facades. It is worth mentioning that, due to the small sizes of the saplings planted in 2007, the early years' estimated savings were small, with the first year (2007), for instance, in the amount of $57.94. Such savings grew substantially as the trees mature, and annual savings are expected to exceed $642.28 after 10 years' of operation in 2017. In addition, the TAXI II site also saved a total of $546 over the past decade because of air quality improvements by trees intercepting and absorbing pollutants such as ozone, sulfur dioxide, nitrogen dioxide, and particulate matter.

Table 4. i-Tree reports on various benefits including CO2 reduction, summer energy savings, and air quality improvement.

	i-Tree Design v6.0 Tree Benefit Report - 07/17/2017 Denver, CO, USA Trees Evaluated: 135
	Total Projected Benefits (2017-2027)
Atmospheric Carbon Dioxide Reduction	• $749 of savings by reducing 77,160 lbs. of atmospheric carbon dioxide through CO_2 sequestration and decreased energy production needs and emissions
Summer Energy Savings	• $2,420 of summer energy savings by direct shading and air cooling effect through evapotranspiration

Air Quality Improvement	• $546 of air quality improvement savings by absorbing and intercepting pollutants such as ozone, sulfur dioxide, nitrogen dioxide, and particulate matter; reducing energy production needs; and lowering air temperature

Limitations:

The major limitation of the i-Tree Design assessments was that, field measuring of tree survival, growth, and possible replacement remained infeasible within the timeframe of this research, therefore calculations had to be based on the Planting Plan from 10 years ago.

Social Benefits

The evaluation of the social benefits provided by the TAXI II landscape is aligned with the purpose of broadening our understanding of public use and perception of designed landscapes in order to inform future design and decision-making (Yang et al., 2015[S1]). Among the three broad types of benefits explored in this document, the social benefits - a critical aspect of landscape sustainability - have been the least assessed in recent case studies.

For investigations of social benefits, we used a combination of methods including site investigations (3/9 -3/13, 2017), literature search, online social survey (June & July, 2017), as well as in-person or email interviews. With regard to the survey design, research questions related to social benefits were identified through discussions with Wenk Associates. Given the mixed-use nature of the entire TAXI site (Figure 6), the instrument was designed with three different survey flows for: 1) those who own a business/residence property at TAXI; 2) those who live and/or work at TAXI; and 3) visitors. Main topics explored included: frequency, timing, duration of outdoor space use, means of transportation, primary activities, understanding of the environmental features, perception of potential environmental, social, and economic benefits, satisfaction with the overall design, and so on (see Appendix II for the survey instrument). In addition, because of the relatively small open space at the TAXI II site itself, we focused on exploring the aesthetic perception of the naturalistic landscape and how that and other factors had influenced business/residence owners' decision to locate here.

Figure 6. TAXI Map indicating different phases of development, mixed-use character, and locations of green space and amenities.
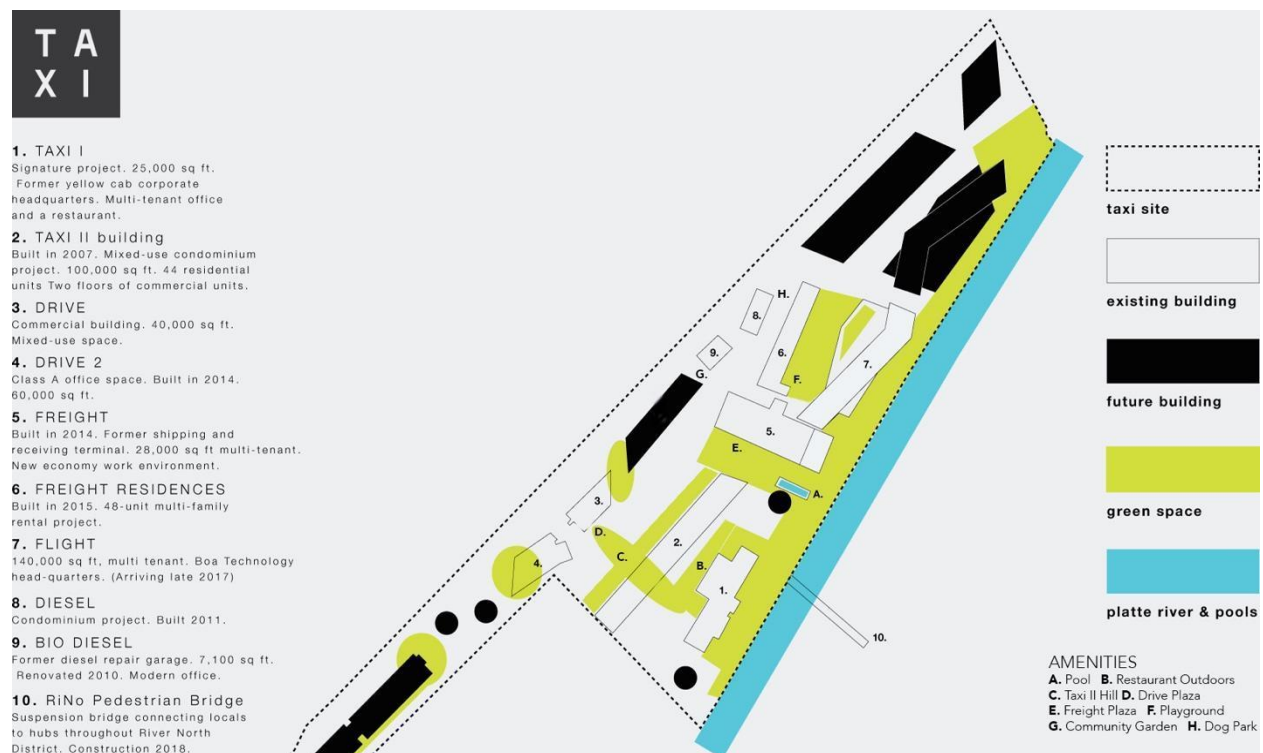
The survey was submitted to the Office of Research Protections at Penn State University on May 15, 2017 and officially approved by the Institutional Review Board (IRB) on May 24, 2017. The online version was developed on the Penn State Qualtrics Software platform from which a link was generated for distribution. The link was posted on the TAXI Community Facebook Page[S2] and sent by emails to each individual company[S3] as well as major contacts at the property management company and Homeowners Association. We also called individual companies to obtain help with survey distribution among their employees.

We received a total of 18 responses (15 complete, 3 partial) to the online survey. All of the 18 respondents work at TAXI (16 full-time, 2-part time) for a varied length of time – 1 month to 7.5 years, two live full time at TAXI, and another two own businesses at TAXI. 14 people filled out their demographic information: 1) 50% Female, 50% Male; 2) 79% under the age of 35, youngest being 23 years old; 3) 86% hold a Bachelor's degree or Master's degree (29%); and 4) their professions range from Architecture, Landscape, and/or Interior Design, Education, Marketing, Biotechnology/Technology, to Property Management and Development.

With regard to transportation, except for the 2 living on site, all the other 16 workers live >2 miles away, with 63% (10 out of 16) living >5 miles away. Predictably, 15 out of these 16 people drive to work, with only 1 taking public transit and then biking to work. People also specifically commented that the lack of public transportation infrastructure made it really difficult to choose a more sustainable commuting mode.

In the section that follows, we outline and elaborate on the social benefits of the TAXI II landscape.

- *Improves workplace satisfaction and encourages social interaction according to 94% of 18 survey respondents who work at TAXI. The landscape is a very or extremely important contributor to maintaining a sense of community according to 73% of respondents.*

Because one of the most important site planning and design goals for TAXI was to build a sense of community, we asked people to rate on the importance of various community features and factors for their contribution. "The landscape design" ranked the 3rd with 73% of respondents stating it as being "Very" or "Extremely Important" in building a sense of community (Table 7). The interesting fact that "building design" and "indoor and outdoor amenities" ranked higher aligns well with the dominant indoor use of the respondents, emphasizing the importance of indoor-outdoor connections.

Table 7. Importance of features/factors for sense of community (*sample size = 15, landscape importance shaded in blue*).

Features/factors contributing to sense of community	% of pp. reporting as "Very" /"Extremely Important"
The building design that facilitates indoor-outdoor movement.	87%
The variety of indoor and outdoor amenities including fitness center, pool, early childhood education center, restaurant, etc.	80%
The landscape design that integrates vehicle and pedestrian circulation.	73%
The mixed-use nature of the campus and the mix of businesses and residences.	67%
The variety of social events including evening movies, food truck gatherings, etc.	60%
The general casual/informal character of the site.	53%

According to the survey results, workers perceived the following major benefits from the landscape (Table 8):
  ➢ 94% of the respondents agree that the landscape improve overall workplace satisfaction, with 69% considering it a "Very" or "Extremely Important" benefit to themselves;
  ➢ 94% of the respondents agree that the landscape encourages social interactions, although that did not appear to be a very important benefit to them;
  ➢ 88% of the respondents agree that the landscape improves their mood/attitude by providing contact with nature, with 50% considering it a "Very" or "Extremely Important" benefit;
  ➢ 88% of the respondents agree that the landscape improves their mood/attitude by providing pleasant views of nature while they are working in the office, with 69% considering it a "Very" or "Extremely Important" benefit;
In addition:
  ➢ 69% of the respondents agree that the landscape reduces the perceived level of noise from

adjacent railways/roads and improves their health by encouraging physical activities;
➢ 63% of the respondents agree that the landscape screens undesirable views and recalls the industrial memories of the site.

Table 8. Benefits of outdoor spaces use recognized by users (*sample size = 16*).

Potential Benefits	% of pp. perceiving this benefit	% of pp. reporting as "Very"/"Extremely Important"
Improve overall workplace satisfaction	94%	69%
Encourage social interactions	94%	38%
Improve my mood/attitude by providing contact with nature	88%	50%
Improve my mood/attitude by providing pleasant views of nature while I am working in the office	88%	69%
Reduce the perceived level of noise from adjacent railways/roads	69%	38%
Improve my health by encouraging physical activities	69%	44%
Screens undesirable views	63%	31%
Recall the industrial memories of the site	63%	19%

● ***Encourages regular use of outdoor spaces, with 29% of 18 survey respondents who work at TAXI reporting that they use the TAXI II Hill at least once a week. The area is used for 11 different types of outdoor activities.***

We used a series of five survey questions (Appendix II) to understand the location, frequency, timing, duration, and primary activities of outdoor space use. Because the TAXI II landscape is only part of the entire TAXI development (Figure 7), we included all the outdoor spaces of the entire parcel into the survey to avoid confusion, and then extracted specific information about use of the TAXI II landscape.

Important background information to understand the use of the TAXI landscape is that workers lead a busy work life during the daytime. 71% (12 of 17) of the respondents commented that they are too busy to get outdoors due to lack of time between work (e.g., only 30 min. lunch break) throughout the day. Another 18% (3 of 17) indicated that they did not feel the need to be outdoors because they prefer to spend outdoor time close to home.

Despite the workers' busy daytime schedule, people do get outside for a variety of activities. The survey and site visit recorded a total of 12 types of outdoor activities (Table 5), with eating, relaxing/hanging out, working/meeting, reading, and socializing as the top 5 primary activities. Although this list pertains to activities reported for the entire TAXI parcel, site visit confirmed that TAXI II supports 11 of them (excluding #9 swimming pool activities).

Table 5. Outdoor activities engaged by users (sample size = 17).

#	Outdoor activity	% of respondents reporting as one primary activity
1	Eating	81%
2	Relaxing/hanging out	53%
3	Working/meeting	47%
4	Reading	41%
5	Socializing	41%
6	People-watching	29%
7	Walking dog(s)	29%
8	Strolling around	24%
9	Going to the swimming pool	24%
10	Taking kids out to play	12%
11	Sunbathing	6%
12	Outdoor Yoga	Observed during site visit

76% of respondents reported that they have used the TAXI II Hill and the Comal restaurant outdoor eating area (within the TAXI II site) before. In terms of frequency, 29% reported to have used the TAXI II Hill at least weekly, whereas 12% stated at least weekly usage of the restaurant outdoor eating area (Figure 7, Table 6).

Figure 7. Taxi II Hill (left) and Comal restaurant outdoor eating area (right).

Table 6. Frequency of outdoor space use (sample size = 17, Taxi II spaces shaded in blue).

	% of pp. reporting using this space	% of pp. reporting > weekly usage
DRIVE Plaza	88%	47%
TAXI II Hill	76%	29%
Comal restaurant outdoor	76%	12%
Pool	53%	12%
Outdoor Cinema	41%	12%
Community Garden	35%	**12%**
Dog Park	24%	18%
Playground	18%	18%

- ***Reduces traffic speeds according to 73% of 15 survey respondents who work at TAXI.***

With regard to perceptions towards the curbless design and resultant intermingling of vehicular and pedestrian traffic:

➢ 73% of the respondents consider "reducing traffic speeds" as a benefit of the curbless design strategy (Table 9);

➢ 67% of the respondents consider "reducing site coverage by pavement and allowing for higher density" as a benefit;

Table 9. Benefits of the curbless design approach recognized by users (*sample size = 15*).

Potential Benefits of Curbless Design	% of pp. perceiving this benefit
Reduces traffic speeds	73%
Reduces site coverage by pavement and allows for higher density	67%
Increases potential for casual social interactions among residents, employees, and visitors	47%
Improves site aesthetics	27%
Children from the daycare love to see the vehicles	7%

Limitations:

The major limitation for the social survey methods was the low number of respondents. The lack of personnel to conduct an onsite intercept survey, malfunctioning TAXI Facebook Page, and the strict email distribution policy by Property Management restricting sending out the survey link to the community listserve all contributed to the small sample size. All the responses were collected through emails or phone calls to individual companies, lacking the business/property owner type and completely missing the visitor type. The small sample size resulted in unanswered and yet important research questions, including how the landscape had influenced business/residence owners' decision to locate here, how people perceive the aesthetics of the naturalistic landscape, and so on.

Second, due to the difficulty separating the TAXI II landscape from the other phases of the entire development in the survey instrument, it was difficult to tease out specific use and perceptions of the TAXI II landscape although certain questions achieved this separation, as the section above shows. On the one hand, the survey as it is provides an interesting array of insights about the use of the entire TAXI parcel. On the other hand, perceptions of other parts of TAXI, especially of those areas with a higher imperviousness, inevitably influence the assessment of TAXI II alone.

● ***Has provided educational opportunities for at least 160 professionals and students in landscape architecture, architecture, and planning.***

As the first project in the metro-Denver area approved by the City of Denver to use Porous Landscape Detention (PLD) gardens as a means to manage stormwater quality, TAXI II has been a valuable educational resource for professionals and students in the region.

According to interviews with Wenk Associates and the Colorado Urban Drainage and Flood Control District (UDFCD), the project has been frequently referenced in UDFCD's BMP design manuals, as well as by the Denver City Department of Economic Development, city planners, and local architects as a local model for planning of economically, socially, and environmentally responsible urban redevelopment. In addition, an estimate of >160 professionals and students from 6 organizations in the region have toured TAXI II to learn about its piloting stormwater management strategy (Table 10).

Table 10. Records of educational tours offered at the TAXI II site[S4, S5].

Organizations	Attendees	Estimate of Attendance
Colorado Association of Stormwater and Floodplain Managers (CASFM)	Professionals in LA, Architecture, and Planning	70 people from 3 annual field trips
ASLA, Colorado Chapter	Professionals in LA, Architecture, and Planning	~20 people, 1 tour
Harvard GSD Alumni	Professionals in LA, Architecture, and Planning	40 people, 1 tour
Colorado State University	Students	~10 students, 1 tour
University of Colorado	Students	~10 students, 1 tour
Iowa State University	Students	~10 students, 1 tour

Limitations:

Evaluation of this benefit had to rely on phone/email interviews because no other official records of the tours were available. The final estimate is likely an underestimate because tours mentioned by the interviewees but without attendance estimates, as well as those lead by other people, were not recorded in the table above.

Sources (for the entire Social Benefits Section):
[S1] *Yang et al. (2015). A research frontier in landscape architecture: landscape performance and assessment of social benefits. Landscape research.*

[S2] *The TAXI Facebook Webpage. Available at https://www.facebook.com/taxicommunity/. Accessed 12 March 2017.*

[S3] *Official Website of TAXI Development. Available at http://www.taxibyzeppelin.com. Accessed 09 June 2017.*

[S4] *Interview with Mr. Greg Dorolek, PLA, ASLA, Principal, Wenk Associates;*

[S5] *Interview with Ms. Holly Piza, P.E., Project Manager, Urban Drainage and Flood Control District; Stormwater Quality Committee Chair, Colorado Association of Stormwater and Floodplain Managers (CASFM).*

Cost Comparison

> ● **Site construction costs were reduced by around $2.55 million through various design strategies including elimination of curb and gutter and subsurface stormwater infrastructure, application of native seeding, and use of recycled materials.**

As mentioned in the Case Study Brief, the 550'-long TAXI building made it extremely cost-prohibitive to manage stormwater with a traditional piped stormwater system, which would have required importing substantial amounts of expensive fill material (estimated cost = **~$40,000**[CC1]) to raise the building finished floor elevation (FFE) by an average of four feet. However, site development costs had to be kept to an absolute minimum to work through the recession at that time and reduce rental and purchase prices to encourage creative enterprises to locate in this emerging arts district, which was extremely important to sustain development of TAXI's later phases. This was an important context to be kept in mind that has led to many of TAXI II's cost reduction strategies, including the most important surface stormwater management approach.

Ideally, a comparative scenario with a traditional piped stormwater system would have been assessed to compare the specific savings achieved by the no-curb-and-gutter approach. However, such a complex calculation requires a research project on its own, so we had to rely on best professional knowledge in terms of how much a typical mixed-use development project would have cost around 2007-2008. Based on an estimate of $15/sf[CC2], we calculated the overall construction cost savings ($2,557,875) as shown in Table 11.

Table 11. Construction cost comparison.

	Construction cost/sf	Total Cost
Actual (surface)	$5.5	$ 5.5/sf x 269250 sf = $1,480,875
Traditional (piped)	$15	$15/sf x 269250 sf = $4,038,750
	Savings	= $4,038,750-$1,480,875 **= $2,557,875**

The total savings were achieved by a combination of design strategies, including the surface stormwater management approach, dominant use of native seeding instead of ornamental grass plantings,

application of recycled and low-cost industrial materials, and etc. In the next section, we calculate the specific savings achieved by the planting strategy.

Limitations:
As mentioned above, ideally, a comparative scenario with a traditional piped stormwater system could have been constructed to compare the specific savings achieved by the curbless approach. The major limitation of the method we used above is that we had to rely on best professional knowledge to get the $15/sf cost of a typical mixed-use development in 2007-2008. Similarly, no official records beyond the interview with the firm could be found for the ~$40,000 estimated cost of the hypothetical fill material.

Sources:
[CC1] *Interview with Mr. Greg Dorolek, PLA, ASLA, Principal, Wenk Associates;*
[CC2] *Best professional knowledge provided by Wenk Associates.*

- ***Groundcover planting material cost was reduced by 76%, or $90,400, by using native seeding in most landscape areas while limiting ornamental grass usage to only highly visible areas.***

By reducing ornamental grass planting areas to only highly visible areas, the project achieved material savings in both the ornamental grasses themselves and bark mulch. Based on the document "Taxi - Phase II Site Cost Reduction - Landscape[ECON3]" (dated from August 1st, 2005) provided by Wenk Associates, replacing ¾ of the ornamental grass planting area designated in an older design with native seeding (which does not require mulch) resulted in a total of $90,400 savings in planting materials (Table 12).

Table 12. Savings in planting materials.

	Planting Material	Area (sf)	Cost	Total
Original design	Ornamental grass plantings	4450 sf	$ 89,000	$ 119,100
	Native seeding	8420 sf	$2,900	
	Mulch		$ 27,200	
Revised design	Ornamental grass plantings	1100 sf	$ 22,000	$ 28,700
	Native seeding	11,770 sf	$4,200	
	Mulch		$ 2,500	
Savings				**$ 90,400 (76%)**

Limitations:
Another potentially significant benefit (both environmental and economic) of native seeding over ornamental grasses is reduction of irrigation demand over the life of the project. It would have been ideal if such benefits could be quantified through comparisons of TAXI II's summer vs. winter water bills. However, such information remained inaccessible to us within the timeframe of this research.

 Source:
[ECON3] *The "Taxi - Phase II Site Cost Reduction - Landscape" document, provided by Wenk Associates, version 2005/08/01.*

Additional Cost Information

- ***Saved $15,750 in construction costs for TAXI's most recent phase – the Flight Office Building development - by eliminating the need to build additional detention ponds on the Flight site.***

TAXI's most recent development, the Flight Office Building (expected to be completed in 2017), was not required by the city to provide any additional stormwater quality or detention because water quality and detention volumes at the TAXI II site exceeded the needs for both projects. According to the "Flight Office Building Final Drainage Report[ECON4]" prepared by project civil engineers in 2016, the 100-year runoff generated from the Flight site as well as the existing Freight/Diesel sites will be piped to the detention pond located on the TAXI II site, eliminating the need to build an otherwise 9,000 cubic feet[ECON5] additional detention pond. If this hypothetical pond were to be built with a 4' average depth (similar to the deeper 3.83'-deep TAXI II pond), its construction would have cost ~$15,750 in 2017 (Table 13).

Table 13. Cost estimate of Flight's hypothetical pond.

Calculations:	
Volume required	9,000 cu.ft.
Avg. Depth	4'
Surface area (sf)	2,250 sf
Unit construction cost	$7/sf
Total =	2,250 sf x $7/sf = $15,750

Limitations:

Elimination of the need to build an additional detention pond at Flight not only eliminated the construction expenses of the pond itself, but also yielded more developable land (i.e., 2,250 sf) for the Flight Office Building. It would have been ideal if the future annual leasing revenue gained through this floor area increase could be estimated and provided by the developers. However, such information remained inaccessible to us within the timeframe of this research.

Sources:
[ECON4] *Flight Office Building Final Drainage Report, Wilson & Company, Inc., version 2016/11/03;*
[ECON5] *Interview with Mr. James M. Godwin, Denver Site/Civil Operations Manager, Wilson & Company, Inc., Engineers & Architects.*

APPENDIX I: List of trees used in i-Tree analysis

i-Tree Design v6.0
Tree Benefit Report - 07/17/2017
Denver, CO, USA
Trees Evaluated: 135

Individual Tree Benefits

Tree	DBH (in)	Condition	Location to Structure	Benefits			
				Current Year (2017)	Future Year (2027)	Projected Total (2017-2027)	Total to Date
1. Narrowleaf cottonwood	1	Excellent	1: Northeast (18 ft) 2: North (193 ft)	$0.14	$11.90	$30	$0
2. Narrowleaf cottonwood	1	Excellent	1: Northeast (7 ft) 2: North (185 ft)	$0.14	$11.90	$30	$0
3. Narrowleaf cottonwood	1	Excellent	1: Northeast (9 ft) 2: North (193 ft)	$0.14	$11.69	$30	$0
4. Narrowleaf cottonwood	1	Excellent	1: Northeast (6 ft) 2: North (188 ft)	$0.14	$11.86	$30	$0
5. Narrowleaf cottonwood	1	Excellent	1: Northeast (6 ft) 2: North (194 ft)	$0.14	$11.82	$30	$0
6. Narrowleaf cottonwood	1	Excellent	1: Northeast (6 ft) 2: North (199 ft)	$0.14	$11.88	$30	$0
7. Narrowleaf cottonwood	1	Excellent	1: Northeast (6 ft) 2: North (206 ft)	$0.14	$11.65	$30	$0
8. Narrowleaf cottonwood	1	Excellent	1: Northeast (17 ft) 2: North (214 ft)	$0.14	$11.88	$30	$0
9. Narrowleaf cottonwood	1	Excellent	1: Northeast (3 ft) 2: North (200 ft)	$0.14	$11.71	$30	$0
10. Narrowleaf cottonwood	1	Excellent	1: Northeast (5 ft) 2: North (146 ft)	$0.14	$11.83	$30	$0
11. Narrowleaf cottonwood	1	Excellent	1: North (13 ft) 2: Northwest (153 ft)	$0.15	$12.38	$32	$0
12. Narrowleaf cottonwood	1	Excellent	1: North (10 ft) 2: Northwest (150 ft)	$0.15	$12.02	$32	$0

13. Narrowleaf cottonwood	1 Excellent	1: North (9 ft) 2: Northwest (149 ft)	$0.15	$12.93	$33	$0
14. Narrowleaf cottonwood	1 Excellent	1: Northeast (3 ft) 2: Northwest (143 ft)	$0.14	$11.78	$30	$0
15. Narrowleaf cottonwood	1 Excellent	1: North (3 ft) 2: Northwest (148 ft)	$0.15	$12.47	$33	$0
16. Narrowleaf cottonwood	1 Excellent	1: North (6 ft) 2: Northwest (152 ft)	$0.15	$12.93	$33	$0
17. Narrowleaf cottonwood	1 Excellent	1: Northwest (2 ft) 2: Northwest (153 ft)	$0.19	$13.20	$38	$0
18. Narrowleaf cottonwood	1 Excellent	1: North (6 ft) 2: Northwest (154 ft)	$0.15	$12.93	$33	$0
19. Narrowleaf cottonwood	1 Excellent	1: North (21 ft) 2: Northwest (169 ft)	$0.14	$12.54	$32	$0
20. Narrowleaf cottonwood	1 Excellent	1: Northwest (14 ft) 2: Northwest (165 ft)	$0.19	$13.16	$38	$0
21. Narrowleaf cottonwood	1 Excellent	1: West (4 ft) 2: Northwest (161 ft)	$-0.07	$4.65	$-14	$0
22. Narrowleaf cottonwood	1 Excellent	1: East (54 ft) 2: North (54 ft)	$0.10	$16.99	$37	$0
23. Narrowleaf cottonwood	1 Excellent	1: East (54 ft) 2: North (54 ft)	$0.10	$17.24	$37	$0
24. Narrowleaf cottonwood	1 Excellent	1: East (52 ft) 2: North (53 ft)	$0.10	$16.41	$36	$0
25. Narrowleaf cottonwood	1 Excellent	1: East (51 ft) 2: North (45 ft)	$0.10	$17.15	$37	$0

26. Narrowleaf cottonwood	1	Excellent	1: East (52 ft) 2: North (37 ft)	$0.10	$17.58	$39	$0
27. Narrowleaf cottonwood	1	Excellent	1: East (57 ft) 2: North (31 ft)	$0.10	$16.73	$37	$0
28. Narrowleaf cottonwood	1	Excellent	1: East (60 ft) 2: North (20 ft)	$0.15	$12.88	$33	$0
29. Narrowleaf cottonwood	1	Excellent	1: East (65 ft) 2: North (13 ft)	$0.15	$12.92	$33	$0
30. Narrowleaf cottonwood	1	Excellent	1: East (63 ft) 2: North (16 ft)	$0.15	$12.93	$33	$0
31. Narrowleaf cottonwood	1	Excellent	1: East (67 ft) 2: North (14 ft)	$0.15	$12.40	$33	$0
32. Narrowleaf cottonwood	1	Excellent	1: East (70 ft) 2: North (13 ft)	$0.15	$12.71	$33	$0
33. Narrowleaf cottonwood	1	Excellent	1: East (72 ft) 2: Northwest (13 ft)	$0.19	$13.19	$38	$0
34. Narrowleaf cottonwood	1	Excellent	1: East (58 ft) 2: North (51 ft)	$0.10	$18.43	$40	$0
35. Narrowleaf cottonwood	1	Excellent	1: East (65 ft) 2: North (35 ft)	$0.14	$12.54	$32	$0
36. Narrowleaf cottonwood	1	Excellent	1: East (70 ft) 2: North (17 ft)	$0.15	$12.93	$33	$0
37. Narrowleaf cottonwood	1	Excellent	1: East (77 ft) 2: North (1 ft)	$0.15	$12.93	$33	$0
38. Narrowleaf cottonwood	1	Excellent	1: East (80 ft) 2: North (1 ft)	$0.15	$12.59	$33	$0
39. Narrowleaf cottonwood	1	Excellent	1: East (76 ft) 2: North (6 ft)	$0.15	$12.93	$33	$0
40. Narrowleaf cottonwood	1	Excellent	1: East (83 ft) 2: North (1 ft)	$0.15	$12.86	$33	$0
41. Narrowleaf cottonwood	1	Excellent	1: Southeast (82 ft) 2: Northwest (4 ft)	$0.19	$13.20	$38	$0

42. Narrowleaf cottonwood	1	Excellent	1: Southeast (74 ft) 2: Northwest (15 ft)	$0.19	$12.85	$38	$0
43. Narrowleaf cottonwood	1	Excellent	1: Southeast (83 ft) 2: Northwest (7 ft)	$0.19	$13.20	$38	$0
44. Narrowleaf cottonwood	1	Excellent	1: Southwest (18 ft) 2: West (267 ft)	$-0.24	$-2.68	$-54	$0
45. Narrowleaf cottonwood	1	Excellent	1: Southwest (21 ft) 2: West (263 ft)	$-0.03	$-0.03	$-17	$0
46. Narrowleaf cottonwood	1	Excellent	1: Southwest (19 ft) 2: West (257 ft)	$-0.24	$-3.69	$-56	$0
47. Narrowleaf cottonwood	1	Excellent	1: Southwest (21 ft) 2: West (252 ft)	$-0.03	$-0.78	$-17	$0
48. Narrowleaf cottonwood	1	Excellent	1: Southwest (9 ft) 2: West (257 ft)	$-0.24	$-4.71	$-56	$0
49. Narrowleaf cottonwood	1	Excellent	1: Southwest (9 ft) 2: West (250 ft)	$-0.24	$-4.71	$-56	$0
50. Narrowleaf cottonwood	1	Excellent	1: Southwest (9 ft) 2: West (246 ft)	$-0.24	$-4.32	$-56	$0
51. Narrowleaf cottonwood	1	Excellent	1: Southwest (6 ft) 2: West (241 ft)	$-0.24	$-4.71	$-56	$0
52. Narrowleaf cottonwood	1	Excellent	1: Southwest (11 ft) 2: West (253 ft)	$-0.24	$4.22	$-22	$0
53. Narrowleaf cottonwood	3	Excellent	1: West (68 ft) 2: Northwest (232 ft)	$0.84	$4.43	$23	$1

54. Narrowleaf cottonwood	3	Excellent	1: West (50 ft) 2: Northwest (218 ft)	$4.01	$12.97	$74	$1
55. Narrowleaf cottonwood	3	Excellent	1: West (32 ft) 2: Northwest (196 ft)	$2.02	$10.62	$49	$-2
56. Narrowleaf cottonwood	3	Excellent	1: Southeast (111 ft) 2: West (13 ft)	$-0.03	$4.83	$11	$-5
57. Narrowleaf cottonwood	3	Excellent	1: Southeast (115 ft) 2: West (28 ft)	$2.02	$10.64	$49	$-2
58. Narrowleaf cottonwood	3	Excellent	1: Southeast (101 ft) 2: West (18 ft)	$0.01	$9.31	$28	$-5
59. Narrowleaf cottonwood	3	Excellent	1: Southeast (88 ft) 2: Northwest (7 ft)	$4.93	$13.51	$89	$2
60. Narrowleaf cottonwood	3	Excellent	1: Southeast (84 ft) 2: West (21 ft)	$2.17	$11.95	$57	$-2
61. Narrowleaf cottonwood	3	Excellent	1: South (43 ft) 2: West (64 ft)	$4.19	$3.07	$60	$1
62. Narrowleaf cottonwood	3	Excellent	1: South (74 ft) 2: West (37 ft)	$2.02	$10.62	$49	$-2
63. Narrowleaf cottonwood	2	Excellent	1: South (58 ft) 2: West (50 ft)	$0.33	$17.36	$80	$0
64. Narrowleaf cottonwood	2	Excellent	1: Southeast (89 ft) 2: West (18 ft)	$-1.83	$8.06	$5	$-1
65. Narrowleaf cottonwood	2	Excellent	1: Southeast (105 ft) 2: West (14 ft)	$-1.83	$8.52	$14	$-1
66. Narrowleaf cottonwood	2	Excellent	1: Southeast (92 ft) 2: West (10 ft)	$-1.83	$5.29	$-3	$-1

67. Narrowleaf cottonwood	2	Excellent	1: West (96 ft) 2: West (271 ft)	$0.42	$3.69	$17	$0
68. Narrowleaf cottonwood	2	Excellent	1: West (72 ft) 2: West (251 ft)	$0.42	$3.69	$17	$0
69. Narrowleaf cottonwood	2	Excellent	1: West (96 ft) 2: Northwest (265 ft)	$0.42	$3.69	$17	$0
70. Narrowleaf cottonwood	2	Excellent	1: West (88 ft) 2: West (266 ft)	$0.42	$3.69	$17	$0
71. Narrowleaf cottonwood	2	Excellent	1: West (66 ft) 2: West (244 ft)	$0.42	$3.69	$17	$0
72. Narrowleaf cottonwood	2	Excellent	1: West (70 ft) 2: Northwest (236 ft)	$0.42	$3.69	$17	$0
73. Narrowleaf cottonwood	2	Excellent	1: West (53 ft) 2: Northwest (219 ft)	$0.33	$11.84	$51	$0
74. Narrowleaf cottonwood	2	Excellent	1: West (50 ft) 2: Northwest (220 ft)	$0.33	$11.86	$51	$0
75. Cottonwood	3	Excellent	1: West (61 ft) 2: West (238 ft)	$0.77	$3.04	$17	$2
76. Cottonwood	3	Excellent	1: Southeast (70 ft) 2: Northwest (23 ft)	$4.31	$13.47	$67	$2
77. Cottonwood	3	Excellent	1: South (49 ft) 2: West (60 ft)	$4.07	$10.34	$55	$2
78. Cottonwood	3	Excellent	1: South (40 ft) 2: West (83 ft)	$4.12	$8.94	$52	$2
79. Honeylocust	2	Excellent	1: South (110 ft) 2: Southwest (71 ft)	$0.50	$3.70	$18	$0
80. Honeylocust	2	Excellent	1: South (89 ft) 2: Southwest (88 ft)	$0.50	$3.70	$18	$0

81. Honeylocust	2	Excellent	1: South (66 ft) 2: Southwest (108 ft)	$0.50	$3.70	$18	$0
82. Honeylocust	2	Excellent	1: South (45 ft) 2: West (127 ft)	$0.50	$6.43	$38	$0
83. Honeylocust	2	Excellent	1: South (145 ft) 2: Southwest (48 ft)	$-0.21	$3.26	$18	$0
84. Honeylocust	2	Excellent	1: South (167 ft) 2: Southwest (41 ft)	$-0.21	$3.21	$18	$0
85. Honeylocust	2	Excellent	1: South (190 ft) 2: Southwest (41 ft)	$-0.21	$3.40	$18	$0
86. Honeylocust	2	Excellent	1: South (211 ft) 2: Southwest (40 ft)	$-0.21	$3.20	$18	$0
87. Honeylocust	2	Excellent	1: South (232 ft) 2: South (43 ft)	$0.50	$6.44	$38	$0
88. Honeylocust	2	Excellent	1: South (66 ft) 2: West (99 ft)	$0.50	$3.70	$18	$0
89. Honeylocust	2	Excellent	1: South (88 ft) 2: Southwest (77 ft)	$0.50	$3.70	$18	$0
90. Honeylocust	2	Excellent	1: South (109 ft) 2: Southwest (57 ft)	$-0.21	$3.20	$18	$0
91. Honeylocust	2	Excellent	1: South (45 ft) 2: West (120 ft)	$0.50	$6.43	$38	$0
92. Honeylocust	2	Excellent	1: Northeast (53 ft) 2: North (84 ft)	$0.50	$7.04	$38	$0
93. Honeylocust	2	Excellent	1: East (73 ft) 2: North (76 ft)	$0.50	$3.70	$18	$0

94. Honeylocust	2	Excellent	1: East (95 ft) 2: Northeast (78 ft)	$0.50	$3.70	$18	$0
95. Honeylocust	2	Excellent	1: East (116 ft) 2: Northeast (78 ft)	$0.50	$3.70	$18	$0
96. Honeylocust	2	Excellent	1: East (135 ft) 2: Northeast (77 ft)	$0.50	$3.70	$18	$0
97. Honeylocust	2	Excellent	1: East (159 ft) 2: Northeast (79 ft)	$0.50	$3.70	$18	$0
98. Honeylocust	2	Excellent	1: East (107 ft) 2: Northeast (42 ft)	$0.50	$7.00	$38	$0
99. Honeylocust	2	Excellent	1: East (126 ft) 2: Northeast (43 ft)	$0.50	$7.04	$38	$0
100. Honeylocust	2	Excellent	1: East (66 ft) 2: North (49 ft)	$0.50	$7.05	$38	$0
101. Honeylocust	2	Excellent	1: Northeast (50 ft) 2: North (62 ft)	$0.50	$7.03	$38	$0
102. Cottonwood	2	Excellent	1: East (129 ft) 2: Northeast (163 ft)	$0.37	$2.34	$11	$0
103. Cottonwood	2	Excellent	1: East (160 ft) 2: Northeast (174 ft)	$0.37	$2.34	$11	$0
104. Cottonwood	2	Excellent	1: East (164 ft) 2: Northeast (130 ft)	$0.37	$2.34	$11	$0
105. Cottonwood	2	Excellent	1: East (164 ft) 2: Northeast (108 ft)	$0.37	$2.34	$11	$0

106. Cottonwood	2	Excellent	1: East (141 ft) 2: Northeast (105 ft)	$0.37	$2.34	$11	$0
107. White ash	2	Excellent	1: North (121 ft) 2: Northwest (264 ft)	$0.33	$1.95	$9	$0
108. White ash	2	Excellent	1: North (99 ft) 2: Northwest (244 ft)	$0.33	$1.95	$9	$0
109. White ash	2	Excellent	1: North (78 ft) 2: North (225 ft)	$0.33	$1.95	$9	$0
110. White ash	2	Excellent	1: North (59 ft) 2: North (209 ft)	$0.33	$1.95	$9	$0
111. White ash	2	Excellent	1: North (35 ft) 2: North (188 ft)	$3.68	$11.53	$61	$0
112. White ash	2	Excellent	1: North (108 ft) 2: Northwest (248 ft)	$0.33	$1.95	$9	$0
113. White ash	2	Excellent	1: North (84 ft) 2: Northwest (224 ft)	$0.33	$1.95	$9	$0
114. White ash	2	Excellent	1: North (61 ft) 2: Northwest (202 ft)	$0.33	$1.95	$9	$0
115. White ash	2	Excellent	1: North (35 ft) 2: North (178 ft)	$3.68	$11.53	$61	$0
116. Cottonwood	2	Excellent	1: South (266 ft) 2: Southwest (160 ft)	$0.37	$2.34	$11	$0
117. Cottonwood	2	Excellent	1: South (238 ft) 2: Southwest (79 ft)	$0.37	$2.34	$11	$0
118. Cottonwood	2	Excellent	1: South (255 ft) 2: South (68 ft)	$0.37	$2.34	$11	$0

119. Cottonwood	2	Excellent	1: South (236 ft) 2: Southwest (159 ft)	$0.37	$2.34	$11	$0
120. Cottonwood	2	Excellent	1: South (246 ft) 2: Southwest (124 ft)	$0.37	$2.34	$11	$0
121. Oak	2	Excellent	1: West (90 ft) 2: West (308 ft)	$0.37	$3.34	$15	$0
122. Oak	2	Excellent	1: West (132 ft) 2: West (379 ft)	$0.37	$3.34	$15	$0
123. Oak	2	Excellent	1: North (119 ft) 2: Northwest (258 ft)	$0.37	$3.34	$15	$0
124. Oak	2	Excellent	1: North (99 ft) 2: Northwest (239 ft)	$0.37	$3.34	$15	$0
125. Oak	2	Excellent	1: Northwest (128 ft) 2: Northwest (269 ft)	$0.37	$3.34	$15	$0
126. Oak	2	Excellent	1: Northwest (99 ft) 2: Northwest (250 ft)	$0.37	$3.34	$15	$0
127. Oak	2	Excellent	1: Northwest (117 ft) 2: Northwest (268 ft)	$0.37	$3.34	$15	$0
128. Oak	2	Excellent	1: Northwest (117 ft) 2: Northwest (271 ft)	$0.37	$3.34	$15	$0
129. Oak	2	Excellent	1: North (182 ft) 2: North (338 ft)	$0.37	$3.34	$15	$0
130. Norway maple	2	Excellent	1: West (59 ft) 2: West (253 ft)	$0.31	$5.84	$42	$0
131. Norway maple	2	Excellent	1: Southwest (38 ft) 2: West (236 ft)	$-2.23	$-3.71	$-12	$-2
132. Norway maple	2	Excellent	1: West (81 ft) 2: West (272 ft)	$0.44	$3.26	$15	$0
133. Norway maple	2	Excellent	1: West (84 ft) 2: West (293 ft)	$0.44	$3.26	$15	$0
134. Norway maple	2	Excellent	1: West (59 ft) 2: West (271 ft)	$0.31	$5.84	$42	$0
135. Norway maple	2	Excellent	1: Southwest (39 ft) 2: West (255 ft)	$-2.23	$-3.71	$-12	$-2
Total				$59.37	$962.79	$3,078	$4

APPENDIX II: Survey Instrument - Use and Perceptions of the TAXI Landscape

1. Do you own a business/property at TAXI?
   - ❍ Yes, I own a business and office here.
   - ❍ Yes, I own a business and rent an office here.
   - ❍ Yes, I own a residence here.
   - ❍ No.

[Business Owners Only]					
❍ If you are a business owner, which year did you establish your business here at TAXI?					
❍ How important were the following factors in influencing your decision to locate your business here?					
	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Competitive leasing rates/property price;					
The creative businesses cluster envisioned/present at the time of my decision;					
Mixed-use nature of the site;					
Low-density work environment;					
Aesthetically-pleasing outdoor environment;					
Ideal interior office space;					
Environmentally responsible landscape design (e.g., sustainable stormwater management, low-cost/low-maintenance planting design, etc.);					
Location of TAXI (e.g., in RiNo, adjacent to the South Platte River, etc.);					
Personal relationship with the developer;					
❍ Please specify any other factors that may have influenced your decision to locate your business here.					

2. Do you work at TAXI?
   - ○ Yes, I work here full time.
   - ○ Yes, I work here part time.
   - ○ No.

3. Do you live at TAXI?
   - ○ Yes, I live here full time.
   - ○ Yes, I live here part time.
   - ○ No.

[Questions for Employees and Residents]

4. How long have you been working/living at TAXI?
5. How far away do you live from TAXI? [Employees Only]
   - ○ Less than 1 mile
   - ○ 1 - 2 miles
   - ○ 2 - 5 miles
   - ○ 5 - 10 miles
   - ○ More than 10 miles

6. How do you usually get to work? [Select all that apply] [Employees Only]

	Most often	Sometimes
Walk		
Bike		
Motorcycle		
Private car		
Carpool		
Taxi, Uber, Lyft		
Public transportation + walk/bike		
Park and Ride		
Other combinations (please specify):		

7. How often do you use each of the following OUTDOOR SPACES (green areas on Map) at TAXI?

	Multiple times a day	5-7 times /week	1-4 times /week	1-4 times /month	Less than once/month	Never
[Location A on Map] DRIVE Plaza (Black Black Coffee and Refuel Sandwich outdoor eating area)						
[B] TAXI II Hill						
[C] Comal restaurant outdoor eating area						
[D] Swimming Pool (during Pool season)						
[E] FREIGHT Plaza (Outdoor Cinema)						
[F] Community Garden						
[G] Dog Park						
[H] Playground						
Other (Please Specify):						

8. How much time per day on average do you spend OUTDOORS at TAXI, excluding the time walking from/to your vehicle when you arrive/leave?
   ○ NONE
   ○ Less than half an hour
   ○ 30 minutes - 1 hour
   ○ 1 - 2 hours
   ○ 2 - 4 hours
   ○ More than 4 hours

9. Typically, at what time of the day would you be OUTDOORS at TAXI? [Select all that apply]
   ❑ NONE
   ❑ Before 6:00 am
   ❑ 6:00 - 9:00 am
   ❑ 9:00 am - noon
   ❑ Noon - 3:00 pm
   ❑ 3:00 - 6:00 pm
   ❑ After 6:00 pm
   ❑ Other (Please specify): _____

10. What type of OUTDOOR ACTIVITIES do you usually engage in at TAXI? [Select all that apply]
    ❑ NONE
    ❑ Working/meetings
    ❑ Eating (breakfast/lunch/dinner/snack)
    ❑ Relaxing & hanging out
    ❑ Socializing
    ❑ Reading
    ❑ People-watching
    ❑ Yoga
    ❑ Sunbathing
    ❑ Going to the swimming pool
    ❑ Strolling around (by yourself or with family)
    ❑ Taking kids out to play
    ❑ Walking dog(s)
    ❑ Other (Please specify): _____

11. If you consider yourself to not have spent enough time outdoors, please indicate your reasons. [Select all that apply]

- ❑ I do not feel the need to be outdoors.
- ❑ I am too busy.
- ❑ I cannot find an ideal space for me to spend time outside.
- ❑ Other (Please specify): _____

[Visitors Only]
❍   In what year did you first visit TAXI?
❍   How often do you visit TAXI? ❍ Multiple times a day ❍ 5 - 7 times/week ❍ 1 - 4 times/week ❍ 1 - 4 times/month ❍ Less than once/month
❍   Typically, what is/are the purpose(s) of your visits? [Select all that apply] ❑ Business ❑ Leisure ❑ Visiting family/friends ❑ Other (Please specify): _____
❍   Typically, what is your travel distance to TAXI? ❍ Less than 1 mile ❍ 1 - 2 miles ❍ 2 - 5 miles ❍ 5 - 10 miles ❍ More than 10 miles ❍ It depends on each trip

❍   How do you usually get to TAXI? [Select all that apply]

	Most often	Sometimes
Walk		
Bike		
Motorcycle		
Private car		
Carpool		
Taxi, Uber, Lyft		
Public transportation + walk/bike		
Park and Ride		
Other combinations (Please specify):		

○   Typically, do you spend time in the OUTDOOR SPACES of TAXI during your visits?
- ○ Yes
- ○ No

○   Typically, how much time do you spend OUTDOORS at TAXI during each visit, excluding the time from/to your vehicle when you arrive/leave?
- ○ Less than half an hour
- ○ 30 minutes - 1 hour
- ○ 1 - 2 hours
- ○ 2 - 4 hours
- ○ More than 4 hours

○   Please select up to THREE outdoor spaces that you use the most frequently at TAXI. [Select up to 3]
- ❏ DRIVE Plaza (Black Black Coffee and Refuel Sandwich outdoor eating area)
- ❏ TAXI II Hill
- ❏ Comal restaurant outdoor eating area
- ❏ Pool (during Pool season)
- ❏ FREIGHT Plaza (Outdoor Cinema)
- ❏ Community Garden
- ❏ Dog Park
- ❏ Playground
- ❏ Other (please specify): _____

○   What type of OUTDOOR ACTIVITIES do you usually engage in at TAXI? [Select all that apply]
- ❏ Working/meetings
- ❏ Eating (breakfast/lunch/dinner/snack)
- ❏ Relaxing & hanging out
- ❏ Socializing
- ❏ Reading
- ❏ People-watching
- ❏ Yoga
- ❏ Sunbathing
- ❏ Going to the swimming pool
- ❏ Strolling around (by yourself or with family)
- ❏ Taking kids out to play
- ❏ Walking dog(s)
- ❏ Other (Please specify): _____

12. What BENEFITS do you think the outdoor spaces provide and how important are these benefits to you?

	I DID NOT perceive this benefit	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Improve my health by encouraging physical activities						
Improve my mood/attitude by providing contact with nature						
Improve my mood/attitude by providing pleasant views of nature while I am working in the office						
Improve overall workplace satisfaction						
Recall the industrial memories of the site						
Reduce the perceived level of noise from adjacent railways/roads						
Screens undesirable views						
Support the sustainable production of food in the Community Garden						
Encourage social interactions						
Other (please specify):						

13. How would you rate the IMPORTANCE of the following features/factors based on their contribution for building a SENSE OF COMMUNITY?

	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
The mixed-use nature of the campus – the mix of businesses and residences.					
The general casual/informal character of the site.					
The variety of indoor and outdoor amenities including fitness center, pool, early childhood education center, restaurant, etc.					
The variety of social events including evening movies, food truck gatherings, etc.					
The building design that facilitates indoor-outdoor movement.					
The landscape design that integrates vehicle and pedestrian circulation.					
Other (Please specify):					

14. How would you rate the IMPORTANCE of the following outdoor spaces based on their contribution for building a SENSE OF COMMUNITY?

	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Comal Restaurant outdoor eating area					
TAXI II Hill					
DRIVE Plaza (Black Black Coffee & Refuel Sandwich outdoor eating area)					
FREIGHT Plaza (Outdoor Cinema)					
Swimming Pool					
Community Garden					
Dog Park					
Playground					
Other (Please specify):					

The following questions are specifically about the landscape area between TAXI I, II and DRIVE.

You may have noticed that the drives and parking in this area were designed with no curbs and gutters. Stormwater runoff from the roofs, parking lot, and driveways is collected into a series of surface stormwater gardens and then 2 detention ponds instead of pipes. This approach is often described as "Sustainable Stormwater Management". It allows stormwater to infiltrate and passively irrigate the gardens, improving the water quality of runoff discharged into the South Platte River.

15. During your time at TAXI, have you ever had problems with standing water after a storm?
    ❍ No, I have never seen ponding water on the driveways/parking lot.
    ❍ Yes, sometimes the gardens overflow, with ponding water in adjacent areas.
    ❍ Yes, sometimes the detention ponds overflow, with ponding water in adjacent areas.
    ❍ I am not quite sure.
    ❍ Other (Please specify): _____

16. How did the stormwater design of TAXI influence your understanding of Sustainable Stormwater Management? [Select all that apply]
    ❑ I was already very familiar with the concept of Sustainable Stormwater Management before my time at TAXI.
    ❑ It significantly improved my understanding of how stormwater can be managed more sustainably.
    ❑ I noticed the stormwater design, but was not exactly sure how the system worked until now.
    ❑ I did not notice the stormwater design here.
    ❑ Other (Please specify): _____

As you may have noticed, the stormwater gardens in this area were planted with native wetland and riparian species, whereas the non-stormwater areas with xeric native and adapted species to reduce water use. While some people like this "naturalistic planting approach", others may perceive the resultant landscape as being too wild and unattractive.

17. How would you rate the overall AESTHETIC VALUE of this particular landscape in its current condition?
   ○ Extremely high
   ○ Moderately high
   ○ Medium
   ○ Moderately low
   ○ Extremely low

18. Since planted in 2008, the landscape in this area has changed due to either natural succession or human modifications. Do you like how it has become more natural?
   ○ Yes
   ○ No, because it appears poorly maintained.
   ○ I have not been at TAXI long enough to develop an opinion.
   ○ It appeared the same to me.
   ○ It does not matter to me.
   ○ Other (Please specify): _____

19. If you consider the aesthetic value of this landscape in its current condition to be medium to low, what are the reasons for your evaluation? [Select all that apply]
   ❏ The design of plant materials is not visually appealing.
   ❏ I do not care for the industrial appearance of site furniture/features (concrete seating blocks, etc.).
   ❏ There is too much parking and driveways and not enough green space.
   ❏ The landscape was appealing in its early years, but appears to lack maintenance over the years.
   ❏ Other reasons (Please specify): _____

20. Please share any other comments you may have about the aesthetics of this landscape:

21. The curbless design of this area also led to an intermingling of vehicular and pedestrian traffic. Check the items you consider as the BENEFITS of this design strategy. [Select all that apply]
   ❏ Reduces site coverage by pavement and allows for higher density
   ❏ Reduces traffic speeds
   ❏ Increases potential for casual social interactions among residents, employees, and visitors
   ❏ Improves site aesthetics
   ❏ Other benefits (Please specify): _____
   ❏ I don't see any benefits of this strategy

22. Please rate the SAFETY in this area given the integration of vehicular and pedestrian traffic.
    - ○ Extremely unsafe
    - ○ Moderately unsafe
    - ○ Neutral
    - ○ Moderately safe
    - ○ Extremely safe

23. Please share any other comments you may have about the traffic safety in this area.

24. If you think the outdoor spaces at TAXI needs improvement, which of the following potential improvements would likely enhance your experience here? [Select all that apply]
    - ❑ More green spaces
    - ❑ More space to sit/relax
    - ❑ More space for outdoor recreation/activities
    - ❑ More space for outdoor meetings/places to hang out
    - ❑ Higher plant variety
    - ❑ Other (Please specify): _____

25. Please leave any comments you may have about potential improvements that could be made to the outdoor spaces here to enhance your experience.

About Yourself

We would like to know a little about you. This information will remain completely confidential.

26. Are you? [Select one]
    - ○ Male
    - ○ Female
    - ○ Other

27. What year were you born?

28. What is your highest level of formal education?
    - ○ Less than high school diploma
    - ○ High school diploma or GED
    - ○ Technical/vocational degree
    - ○ Some college
    - ○ Bachelor's degree
    - ○ Master's degree
    - ○ Doctoral degree

29. What industry do you work in?
   ○ NOT APPLICABLE, I am not working right now.
   ○ Graphic Arts
   ○ Architecture, Landscape, and/or Interior Design
   ○ Digital Design
   ○ Video Production
   ○ Music
   ○ Biotechnology/Technology
   ○ Software Design
   ○ Construction
   ○ Retail
   ○ Property Management and Development
   ○ Marketing
   ○ Banking/Finance
   ○ Insurance
   ○ Food
   ○ Education
   ○ Law
   ○ Healthcare
   ○ Other (Please specify): _____