AMERICAN
SOCIETY OF
LANDSCAPE
ARCHITECTS

(https://www.asla.org/stormwatercasestudies.aspx)

In [1]:

```
import warnings
warnings.filterwarnings('ignore')
%matplotlib inline
```

In [2]:

```
import sys
import types
import pandas as pd
pd.options.display.float_format = '{:20,.2f}'.format
from botocore.client import Config
import ibm_boto3

def __iter__(self): return 0

# @hidden_cell
# The following code accesses a file in your IBM Cloud Object Storage. It incl
udes your credentials.
# You might want to remove those credentials before you share your notebook.
client_48928a04ca8e42ed87d1026e6bbfe31a = ibm_boto3.client(service_name='s3',
    ibm_api_key_id='cKFY8NgVSr8IZPnKreuUVxKwpoOS2EHpqYpoZ-xM69NF',
    ibm_auth_endpoint="https://iam.ng.bluemix.net/oidc/token",
    config=Config(signature_version='oauth'),
    endpoint_url='https://s3-api.us-geo.objectstorage.service.networklayer.co
m')

body = client_48928a04ca8e42ed87d1026e6bbfe31a.get_object(Bucket='courseracaps
tone-donotdelete-pr-fxod1bkevlkezk',Key='ASLA-1.csv')['Body']
# add missing __iter__ method, so pandas accepts body as file-like object
if not hasattr(body, "__iter__"): body.__iter__ = types.MethodType( __iter__,
body )

asla = pd.read_csv(body)
asla['Size/ Capture area (Sq. feet)'] = asla['Size/ Capture area (Sq. feet)'].
astype(float)
asla['GI COST (2)'] = asla['GI COST (2)'].astype(float)
```

```
In [3]: asla.head()
```

Out[3]:

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	GI PROJECT FINANCED	Size/ Capture area (Sq. feet)	
0	Cincinnati	Ohio	Lick Run	Public funding	NaN	Bioretention facility, rain garden, bioswale, ...	217,800.00	12
1	Atlanta	Georgia	Emory University Stormwater Master Plan	Private funding	NaN	Bioretention facility, rain garden, bioswale, ...	217,800.00	90
2	Portland	Oregon	Tabor To The River Program	Public funding	NaN	Bioretention facility, rain garden, green roof...	217,800.00	80
3	Seattle	Washington	Taylor 28	Private funding	NaN	Bioretention facility, rain garden, cistern, p...	130,680.00	38
4	Los Angeles	California	South Los Angeles Wetland Park Site Plan	Public funding	NaN	Bioretention facility, bioswale, and porous pa...	130,680.00	24

Cleaning and selecting only the relevant cases

```
In [4]: columns = ['STATE','FINANCIAL SOURCE']

        for column in columns:
            asla[column] = asla[column].str.lstrip()  #removing leading spaces
```

```
In [5]: print('Initial Row Count: ',asla.shape[0])

        Initial Row Count:  461
```

Filtering out Canadian cases

In [6]:

```
asla=asla[asla['STATE']!='Canada']
```

In [7]:

```
print('New Row Count:',asla.shape[0])
print('Lost:',461-asla.shape[0],'rows')
```

```
New Row Count: 454
Lost: 7 rows
```

Cutting critical null values

In [8]:

```
print('There are',sum(asla['FINANCIAL SOURCE'].isnull()),'cases missing financ
ial source data')
```

```
There are 5 cases missing financial source data
```

In [9]:

```
asla[asla['FINANCIAL SOURCE'].isnull()]
```

Out[9]:

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	GI PROJECT FINANCED	Size Captur are (Sq feet
456	San Diego	California	La Jolla Shores Area of Special Biological Sig...	NaN	NaN	NaN	nan
457	Gainesville	Florida	Madera - Community and Model Center	NaN	NaN	NaN	nan
458	Ruston	Louisiana	City of Ruston-Louisiana Research Park Streets...	NaN	NaN	NaN	nan
459	Philadelphia	Pennsylvania	Shissler Rec. Center (Big Green Block)	NaN	NaN	NaN	nan
460	Southeastern	Pennsylvania	T-VSSI Regional Stormwater BMP Database	NaN	NaN	NaN	nan

In [10]:

```
asla = asla[asla['FINANCIAL SOURCE'].notnull()]
```

In [11]:

```
print('New Row Count:',asla.shape[0])
print('Lost:',454-asla.shape[0],'rows')
print('Total Lost Rows:',7+(454-asla.shape[0]))
```

```
New Row Count: 449
Lost: 5 rows
Total Lost Rows: 12
```

```
In [12]: print('There are',sum(asla['Size/ Capture area (Sq. feet)'].isnull()),'cases m
         issing project size')
```

```
There are 5 cases missing project size
```

```
In [13]: asla[asla['Size/ Capture area (Sq. feet)'].isnull()]
```

Out[13]:

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	GI PROJECT FINANCED	Size/ Capture area (Sq. feet)	GI
212	San Mateo	California	San Mateo County Sustainable Green Streets	Public funding	NaN	Technical stormwater design guidebook of green...	nan	300,0
412	Sussex County	Kentucky	EPA Technical Assistance and Design Guidebooks	Private funding	NaN	Bioretention facility, rain garden, bioswale, ...	nan	30,0
421	New York	New York	Greenstreets - Furmanville Ave	Public funding	Grant	Bioretention facility, bioswale, gravel reserv...	nan	30,0
427	Portland	Oregon	SE 21st and Tibbetts Green Street	Public funding	NaN	Green roof, downspout removal, stormwater curb...	nan	30,0
455	Upland	California	Cucamonga Basin #6	Public funding	NaN	NaN	nan	0.00

```
In [14]: asla = asla[asla['Size/ Capture area (Sq. feet)'].notnull()]
```

```
In [15]: print('New Row Count:',asla.shape[0])
         print('Lost:',449-asla.shape[0],'rows')
         print('Total Lost Rows:',12+(449-asla.shape[0]))
```

```
New Row Count: 444
Lost: 5 rows
Total Lost Rows: 17
```

In [16]:

```
print('There are',sum(asla['GI COST (2)'].isnull()),'cases missing project cost')
```

```
There are 0 cases missing project cost
```

Summary Statistics

In [17]:

```
asla[['Size/ Capture area (Sq. feet)','GI COST (2)']].describe()
```

Out[17]:

	Size/ Capture area (Sq. feet)	GI COST (2)
count	444.00	444.00
mean	143,427.68	1,901,670.60
std	632,797.91	8,450,122.80
min	1,300.00	3,000.00
25%	24,280.00	75,000.00
50%	130,680.00	300,000.00
75%	130,680.00	2,081,250.00
max	13,068,000.00	122,000,000.00

In [18]:

```
print('Total awards =',sum(asla['GI COST (2)']))
```

```
Total awards = 844341748.0
```

State Distribution

In [19]:

```
print('Total states represented = ',len(asla['STATE'].unique()))
```

```
Total states represented =  44
```

```
In [20]: asla.groupby('STATE')['GI COST (2)'].sum().sort_values(ascending=False)
```

```
Out[20]: STATE
         Ohio                         140,161,100.00
         New York                     103,263,528.00
         Georgia                      101,277,000.00
         Oregon                       100,437,000.00
         California                    92,363,441.00
         Washington                    48,709,473.00
         Illinois                      36,605,117.00
         Indiana                       20,427,000.00
         Pennsylvania                  18,756,257.00
         Iowa                          17,751,328.00
         Louisiana                     16,440,000.00
         Colorado                      15,637,000.00
         Michigan                      15,311,410.00
         Wisconsin                     14,715,000.00
         Minnesota                     11,644,968.00
         Arizona                       10,200,000.00
         Tennessee                      9,000,000.00
         Alabama                        8,151,840.00
         Missouri                       8,077,000.00
         Kentucky                       7,306,226.00
         Massachusetts                  6,733,850.00
         Maryland                       4,972,000.00
         Connecticut                    4,955,000.00
         New Mexico                     4,730,000.00
         New Jersey                     4,068,466.00
         North Carolina                 3,485,857.00
         South Carolina                 3,300,000.00
         District of Columbia           3,087,000.00
         Florida                        2,768,600.00
         New Hampshire                  1,650,000.00
         Virginia                       1,304,000.00
         Arkansas                       1,125,000.00
         Texas                          1,063,000.00
         Kansas                         1,031,282.00
         Idaho                            865,000.00
         Rhode Island                     800,000.00
         Mississippi                      678,600.00
         Alaska                           460,000.00
         Oklahoma                         410,000.00
         Maine                            300,000.00
         Utah                             150,000.00
         Montana                           75,000.00
         Nebraska                          69,585.00
         Vermont                           24,820.00
         Name: GI COST (2), dtype: float64
```

```
In [21]: asla.groupby('STATE')['CITY'].count().sort_values(ascending=False)
```

```
Out[21]: STATE
         New York                56
         California              49
         Pennsylvania            32
         Illinois                26
         Oregon                  25
         Ohio                    20
         Michigan                16
         Louisiana               15
         Missouri                13
         Alabama                 12
         Washington              12
         District of Columbia    11
         Wisconsin               11
         Minnesota               11
         Idaho                   10
         Florida                  9
         North Carolina           9
         Georgia                  8
         Maryland                 8
         Colorado                 7
         Massachusetts            7
         Indiana                  7
         Kentucky                 6
         Kansas                   6
         Connecticut              6
         Arizona                  5
         New Mexico               5
         New Jersey               5
         New Hampshire            4
         Iowa                     4
         Oklahoma                 3
         Texas                    3
         Tennessee                3
         Mississippi              3
         Virginia                 3
         Arkansas                 3
         Utah                     2
         South Carolina           2
         Alaska                   2
         Nebraska                 1
         Maine                    1
         Vermont                  1
         Rhode Island             1
         Montana                  1
         Name: CITY, dtype: int64
```

Size and Cost Distribution

These were the bins specifically requested

```
In [22]: print('< 20,000:',sum(asla['Size/ Capture area (Sq. feet)']<20000))
         print('20,000 - 40,000:',sum(asla['Size/ Capture area (Sq. feet)'].between(200
         00,40000)))
         print('40,000 - 200,000:',sum(asla['Size/ Capture area (Sq. feet)'].between(40
         000,200000)))
         print('> 200,000:',sum(asla['Size/ Capture area (Sq. feet)']>200000))
```

```
< 20,000: 45
20,000 - 40,000: 144
40,000 - 200,000: 153
> 200,000: 102
```

```
In [23]: print('< $10,000:',sum(asla['GI COST (2)']<10000))
         print('$10,000 - $50,000:',sum(asla['GI COST (2)'].between(10000,50000)))
         print('$50,000 - $100,000:',sum(asla['GI COST (2)'].between(50000,100000)))
         print('$100,000 - $500,000:',sum(asla['GI COST (2)'].between(100000,500000)))
         print('$500,000 - $1,000,000:',sum(asla['GI COST (2)'].between(500000,1000000
         )))
         print('$1,000,000 - $5,000,000:',sum(asla['GI COST (2)'].between(1000000,50000
         00)))
         print('> $5,000,000:',sum(asla['GI COST (2)']>5000000))
```

```
< $10,000: 3
$10,000 - $50,000: 61
$50,000 - $100,000: 63
$100,000 - $500,000: 137
$500,000 - $1,000,000: 63
$1,000,000 - $5,000,000: 110
> $5,000,000: 11
```

Cost/Sq Ft

```
In [24]: asla['Cost/Sqft'] = asla['GI COST (2)'] / asla['Size/ Capture area (Sq. feet)'
         ]
         asla[['Cost/Sqft']].describe()
```

Out[24]:

	Cost/Sqft
count	444.00
mean	24.16
std	63.66
min	0.02
25%	2.00
50%	6.33
75%	22.96
max	626.00

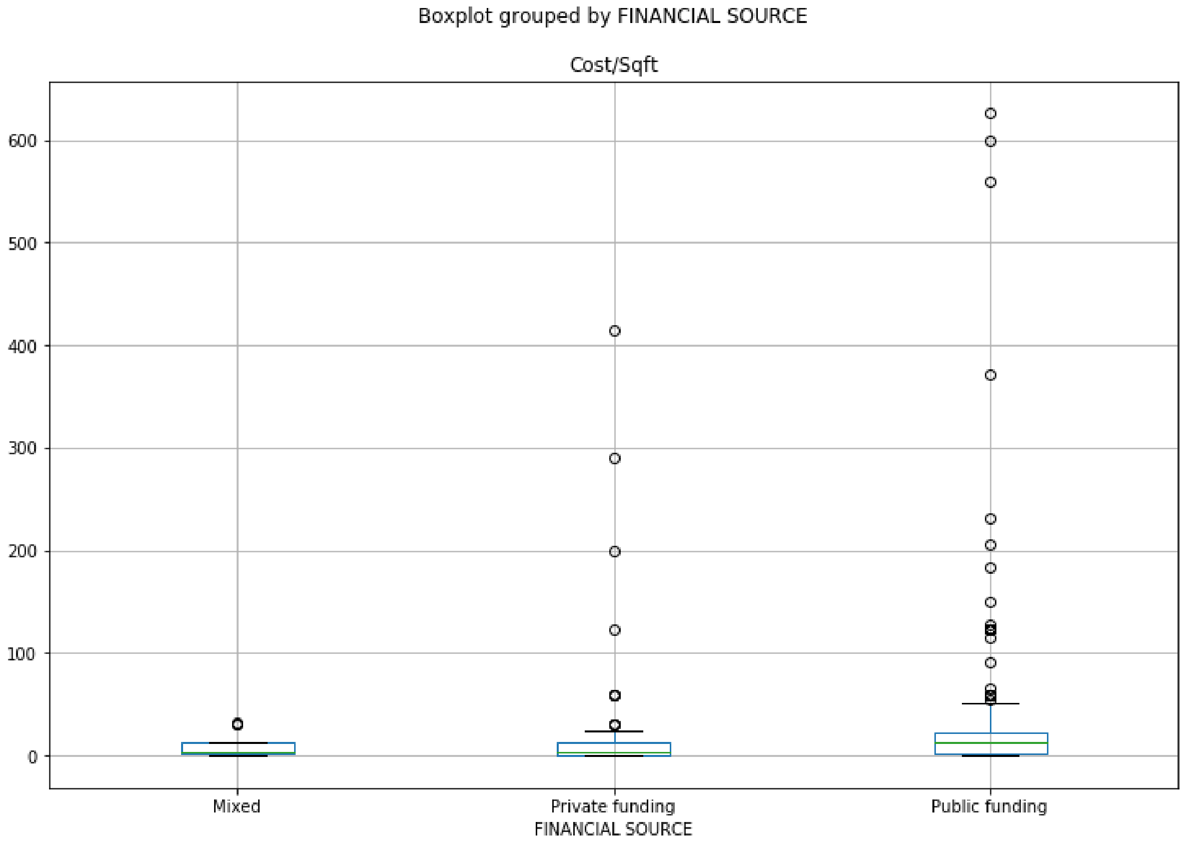
```
In [25]: asla_types = asla.groupby('FINANCIAL SOURCE')
         asla_types['Cost/Sqft'].describe()
```

Out[25]:

	count	mean	std	min	25%	50%	75%	max
FINANCIAL SOURCE								
Mixed	15.00	9.45	12.10	0.08	1.36	3.25	12.36	32.95
Private funding	116.00	17.25	51.35	0.02	0.90	3.16	12.36	414.14
Public funding	313.00	27.42	68.83	0.14	2.30	12.36	22.96	626.00

```
In [26]: asla.boxplot('Cost/Sqft', by='FINANCIAL SOURCE', figsize=(12, 8))

Out[26]: <matplotlib.axes._subplots.AxesSubplot at 0x7f6eb99a2ef0>
```



Testing the Cost/Sq Ft by Financial Source

```
In [27]: import scipy.stats as stats

         mixed = list(asla[asla['FINANCIAL SOURCE']=='Mixed']['Cost/Sqft'].values)
         public = list(asla[asla['FINANCIAL SOURCE']=='Public funding']['Cost/Sqft'].values)
         private = list(asla[asla['FINANCIAL SOURCE']=='Private funding']['Cost/Sqft'].values)

         stats.f_oneway(mixed,public,private)

Out[27]: F_onewayResult(statistic=1.4974108427694688, pvalue=0.22484380848319827)
```

```
In [28]: stats.ttest_ind(public,private)

Out[28]: Ttest_indResult(statistic=1.4484402208074285, pvalue=0.1482278673107445)
```

```
In [29]: any_priv = private + mixed
         stats.ttest_ind(public,any_priv)

Out[29]: Ttest_indResult(statistic=1.6732829893294674, pvalue=0.094979130268016909)
```

In [30]:

```
asla[asla['FINANCIAL SOURCE']=='Public funding']['Cost/Sqft'].values
```

```
Out[30]: array([  5.60146924e+02,   3.71533517e+02,   1.83654729e+02,
                  8.22620141e+00,   4.15579798e+01,   3.81294261e+01,
                  3.67309458e+01,   5.12473217e+01,   2.80073462e+01,
                  2.05930807e+02,   2.29568411e+01,   2.29568411e+01,
                  2.29568411e+01,   2.29568411e+01,   2.29568411e+01,
                  2.29568411e+01,   2.29568411e+01,   2.29568411e+01,
                  3.82614019e+01,   2.29568411e+01,   3.82614019e+01,
                  2.29568411e+01,   3.59657178e+01,   2.15794307e+01,
                  2.13503030e+01,   1.79063361e+01,   1.69880624e+01,
                  1.60697888e+01,   2.44872972e+01,   2.44872972e+01,
                  1.43919559e+01,   6.26000000e+02,   1.27677100e+02,
                  1.37741047e+01,   1.37741047e+01,   2.29568411e+01,
                  2.29568411e+01,   1.23558484e+02,   1.37741047e+01,
                  1.37741047e+01,   2.29568411e+01,   1.37741047e+01,
                  1.23558484e+02,   2.29568411e+01,   1.37741047e+01,
                  2.29568411e+01,   2.29568411e+01,   2.29568411e+01,
                  2.29568411e+01,   1.37741047e+01,   2.29568411e+01,
                  1.37741047e+01,   2.29568411e+01,   1.37741047e+01,
                  2.29568411e+01,   2.29568411e+01,   1.23558484e+02,
                  2.29568411e+01,   1.23558484e+02,   2.29568411e+01,
                  1.23558484e+02,   2.29568411e+01,   1.23558484e+02,
                  1.23558484e+02,   1.23558484e+02,   2.29568411e+01,
                  1.23558484e+02,   1.23558484e+02,   2.29568411e+01,
                  1.23558484e+02,   2.29568411e+01,   2.29568411e+01,
                  2.29568411e+01,   6.00000000e+02,   1.23558484e+02,
                  1.37741047e+01,   2.29568411e+01,   1.23558484e+02,
                  1.23558484e+02,   1.23558484e+02,   2.29568411e+01,
                  5.29773257e+00,   1.37741047e+01,   1.37741047e+01,
                  2.29568411e+01,   2.29568411e+01,   1.37741047e+01,
                  2.29568411e+01,   2.29568411e+01,   1.37741047e+01,
                  1.37741047e+01,   1.15321252e+02,   1.23966942e+01,
                  1.76002449e+01,   1.60697888e+01,   1.58784818e+01,
                  9.18273646e+00,   6.58978583e+01,   5.47775947e+01,
                  1.00452862e+01,   5.50964187e+00,   9.01020049e+00,
                  4.43985308e+00,   3.74794069e+01,   6.58402204e+00,
                  3.49585255e+01,   6.29017447e+00,   3.71951331e+00,
                  3.68227732e+00,   3.15897858e+01,   3.14353377e+01,
                  5.73921028e+00,   5.73921028e+00,   3.75000000e+01,
                  3.44352617e+00,   5.73921028e+00,   3.08896211e+01,
                  5.73921028e+00,   5.73921028e+00,   5.73921028e+00,
                  3.44352617e+00,   5.73921028e+00,   3.08896211e+01,
                  3.08896211e+01,   3.08896211e+01,   1.50000000e+02,
                  5.73921028e+00,   5.73921028e+00,   3.08896211e+01,
                  3.44352617e+00,   5.73921028e+00,   3.44352617e+00,
                  3.08896211e+01,   2.56979565e+00,   5.73921028e+00,
                  5.73921028e+00,   5.73921028e+00,   2.98438935e+00,
                  2.93847567e+00,   4.86482247e+00,   2.89144169e+00,
                  2.20345964e+01,   1.97281713e+01,   3.54300582e+00,
                  9.12452000e+01,   3.44352617e+00,   2.52525253e+00,
                  2.29568411e+00,   2.29568411e+00,   1.23558484e+01,
                  2.29568411e+00,   3.44352617e+00,   1.23558484e+01,
                  6.00000000e+01,   2.29568411e+00,   2.29568411e+00,
                  1.23558484e+01,   1.37741047e+00,   6.00000000e+01,
                  2.29568411e+00,   1.37741047e+00,   2.29568411e+00,
                  2.30769231e+02,   2.29568411e+00,   2.29568411e+00,
                  2.29568411e+00,   2.29568411e+00,   2.29568411e+00,
                  2.29568411e+00,   1.37741047e+00,   6.00000000e+01,
                  1.23558484e+01,   1.37741047e+00,   1.37741047e+00,
                  1.37741047e+00,   2.29568411e+00,   1.37741047e+00,
                  1.23558484e+01,   2.29568411e+00,   2.29568411e+00,
                  1.37741047e+00,   1.23558484e+01,   1.37741047e+00,
                  2.29568411e+00,   1.23558484e+01,   1.37741047e+00,
                  6.00000000e+01,   6.00000000e+01,   1.23558484e+01,
                  2.29568411e+00,   1.23558484e+01,   1.23558484e+01,
                  1.23558484e+01,   1.23558484e+01,   1.23558484e+01,
                  1.23558484e+01,   1.23558484e+01,   6.00000000e+01,
                  1.23558484e+01,   1.37741047e+00,   2.29568411e+00,
                  2.29568411e+00,   1.72176309e-01,   1.23558484e+01,
                  1.37741047e+00,   1.23558484e+01,   1.23558484e+01,
                  1.23558484e+01,   1.23558484e+01,   1.23558484e+01,
                  1.23558484e+01,   2.29568411e+00,   1.23558484e+01,
                  1.23558484e+01,   1.23558484e+01,   1.23558484e+01,
                  1.23558484e+01,   1.23558484e+01,   1.23558484e+01,
                  1.23558484e+01,   1.23558484e+01,   2.29568411e+00,
                  1.23558484e+01,   1.23558484e+01,   1.23558484e+01,
                  2.14263851e+00,   1.07084020e+01,   1.02965404e+01,
                  1.87480869e+00,   9.34378089e+00,   1.60697888e+00,
                  4.00000000e+01,   7.34618916e-01,   9.87144169e-01,
                  9.18273646e-01,   8.76186103e-01,   7.65228038e-01,
                  6.88705234e-01,   1.77618000e+01,   3.90266299e-01,
                  1.70000000e+01,   1.60000000e+01,   5.73921028e-01,
                  5.73921028e-01,   3.08896211e+00,   5.73921028e-01,
                  3.08896211e+00,   1.66666667e+01,   3.44352617e-01,
                  3.08896211e+00,   3.08896211e+00,   5.73921028e-01,
                  3.08896211e+00,   5.73921028e-01,   5.73921028e-01,
                  3.08896211e+00,   1.50000000e+01,   5.73921028e-01,
                  5.73921028e-01,   3.08896211e+00,   1.50000000e+01,
                  3.08896211e+00,   3.08896211e+00,   5.73921028e-01,
                  3.08896211e+00,   3.08896211e+00,   3.08896211e+00,
                  1.50000000e+01,   1.50000000e+01,   3.19490358e-01,
                  2.61532125e+00,   2.57825371e+00,   2.47116969e+00,
                  1.08000000e+01,   3.97918580e-01,   2.05930807e+00,
                  2.03760297e+00,   2.81910009e-01,   2.44872972e-01,
                  1.23558484e+00,   2.29568411e-01,   1.23558484e+00,
                  6.00000000e+00,   2.29568411e-01,   2.29568411e-01,
                  1.37741047e-01,   2.29568411e-01,   1.23558484e+00,
                  1.23558484e+00,   1.37741047e-01,   2.29568411e-01,
                  6.00000000e+00,   1.23558484e+00,   6.00000000e+00,
                  1.23558484e+00,   6.00000000e+00,   2.29568411e-01,
                  6.00000000e+00,   1.23558484e+00,   1.23558484e+00,
                  1.23558484e+00,   1.23558484e+00,   2.29568411e-01,
                  1.23558484e+00,   1.14909390e+00,   4.96400000e+00,
                  5.70428336e-01,   5.26441516e-01,   2.00000000e+00,
                  2.00000000e+00,   2.00000000e+00,   2.00000000e+00,
                  2.99176277e-01])
```

```
In [31]: asla[asla['FINANCIAL SOURCE']=='Private funding']['Cost/Sqft'].values
```

```
Out[31]: array([  4.14141414e+02,   2.90786654e+02,   2.29568411e+01,
                  2.29568411e+01,   1.37741047e+01,   1.37741047e+01,
                  2.29568411e+01,   1.37741047e+01,   1.37741047e+01,
                  1.37741047e+01,   2.29568411e+01,   2.29568411e+01,
                  2.29568411e+01,   1.37741047e+01,   1.23558484e+02,
                  1.86715641e+01,   6.79981635e+00,   6.37281910e+00,
                  2.00000000e+02,   6.84879094e+00,   4.08236915e+00,
                  3.44352617e+00,   5.73921028e+00,   5.73921028e+00,
                  3.08896211e+01,   5.73921028e+00,   3.08896211e+01,
                  3.08896211e+01,   5.73921028e+00,   5.73921028e+00,
                  3.08896211e+01,   2.98820018e+00,   4.73267524e+00,
                  2.47116969e+01,   4.43832262e+00,   3.09152127e+00,
                  1.72176309e+00,   1.37741047e+00,   1.37741047e+00,
                  2.29568411e-02,   1.23558484e+01,   1.23558484e+01,
                  2.29568411e+00,   1.23558484e+01,   6.00000000e+01,
                  2.29568411e+00,   1.23558484e+01,   2.29568411e+00,
                  2.29568411e+00,   1.23558484e+01,   6.00000000e+01,
                  2.29568411e+00,   1.23558484e+01,   2.29568411e+00,
                  1.23558484e+01,   2.29568411e+00,   1.23558484e+01,
                  1.23558484e+01,   2.29568411e+00,   1.23558484e+01,
                  1.37741047e+00,   4.91932310e-01,   6.00000000e+01,
                  6.00000000e+01,   2.29568411e+00,   1.23558484e+01,
                  1.18204283e+01,   1.13261944e+01,   1.14784206e+00,
                  7.80532599e-01,   9.18273646e-01,   8.41750842e-01,
                  4.59136823e-01,   3.29489292e+00,   3.23723229e+00,
                  5.73921028e-01,   5.73921028e-01,   3.44352617e-01,
                  5.73921028e-01,   3.08896211e+00,   3.44352617e-01,
                  5.73921028e-01,   5.73921028e-01,   3.44352617e-01,
                  5.73921028e-01,   5.73921028e-01,   3.08896211e+00,
                  1.50000000e+01,   5.73921028e-01,   5.73921028e-01,
                  3.44352617e-01,   3.44352617e-01,   3.08896211e+00,
                  9.00000000e+00,   8.60000000e+00,   2.29568411e-01,
                  2.29568411e-01,   1.37741047e-01,   6.00000000e+00,
                  1.23558484e+00,   2.29568411e-01,   6.00000000e+00,
                  1.23558484e+00,   1.23558484e+00,   1.23558484e+00,
                  1.23558484e+00,   1.23558484e+00,   2.29568411e-01,
                  1.11202636e+00,   4.94233937e-01,   4.11861614e-01,
                  2.00000000e+00,   4.11861614e-01,   2.00000000e+00,
                  7.20000000e-01,   6.00000000e-01])
```

```
In [32]: asla[asla['FINANCIAL SOURCE']=='Mixed']['Cost/Sqft'].values
```

```
Out[32]: array([  6.42791552,  32.94892916,  30.88962109,   0.43044077,
                 30.88962109,   2.75482094,   3.25221916,  12.35584843,
                 12.35584843,   2.29568411,   3.76029654,   2.96540362,
                  0.22956841,   0.0765228 ,   0.0765228 ])
```

Save the Rain

(http://savetherain.us/green-project-list/)

```
In [33]: body = client_48928a04ca8e42ed87d1026e6bbfe31a.get_object(Bucket='courseracaps
         tone-donotdelete-pr-fxod1bkevlkezk',Key='SaveRain-2.csv')['Body']
         # add missing __iter__ method, so pandas accepts body as file-like object
         if not hasattr(body, "__iter__"): body.__iter__ = types.MethodType( __iter__,
         body )

         rain = pd.read_csv(body)
         rain['Size/ Capture area (Sq. feet)'] = rain['Size/ Capture area (Sq. feet)'].
         astype(float)
         rain['GI COST (2)'] = rain['GI COST (2)'].astype(float)
```

```
In [34]: print('Initial Row Count: ',rain.shape[0])

         Initial Row Count:  150
```

```
In [35]: columns = ['CITY','STATE','FINANCIAL SOURCE']

         for column in columns:
             rain[column] = rain[column].str.lstrip()  #removing leading spaces
```

```
In [36]: rain['FINANCIAL SOURCE'].unique()

Out[36]: array(['Public financing', 'Mixed', nan, 'Public Funding',
                'Public funding', 'Public funding & financing', 'Public Financing',
                'Private funding', 'Public funding '], dtype=object)
```

In [37]:

```
# Standardizing

rain['FINANCIAL SOURCE'][rain['FINANCIAL SOURCE']=='Public Financing'] = 'Public'
rain['FINANCIAL SOURCE'][rain['FINANCIAL SOURCE']=='Public financing'] = 'Public'
rain['FINANCIAL SOURCE'][rain['FINANCIAL SOURCE']=='Public Funding'] = 'Public'
rain['FINANCIAL SOURCE'][rain['FINANCIAL SOURCE']=='Public funding'] = 'Public'
rain['FINANCIAL SOURCE'][rain['FINANCIAL SOURCE']=='Public funding & financing'] = 'Public'
rain['FINANCIAL SOURCE'][rain['FINANCIAL SOURCE']=='Private funding'] = 'Private'
```

```
In [38]: rain[rain['FINANCIAL SOURCE'].isnull()]  #these cases have no information atta
         ched
```

Out[38]:

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	Size/ Capture area (Sq. feet)	GI COST (
2	Pontiac	Michigan	Oakland County Campus	NaN	NaN	6,141,960.00	204,000.00
36	Ann Arbor	Michigan	Ann Arbor District Library, Mallets Creek Branch	NaN	NaN	108,900.00	70,000.00
125	City of Troy	Michigan	Kresge Foundation Headquarters	NaN	NaN	nan	1,116,000.0
129	City of Inkster	Michigan	Inkster Valley Constructed Wetlands Project	NaN	NaN	nan	464,826.00
143	Bloomfield Township	Michigan	Meadowlake Farms Bioswale	NaN	NaN	nan	63,000.00
147	City of Wayne	Michigan	Constructed Linear Sand Filter	NaN	NaN	nan	10,000.00
149	Mount Clemens	Michigan	Macomb County Public Works Riparian Corridor P...	NaN	NaN	nan	nan

```
In [39]: print('These are all Michigan cases; ',(rain[rain['FINANCIAL SOURCE'].isnull
         ()]['STATE'].count())/(rain[rain['STATE']=='Michigan']['STATE'].count()) * 100
         ,'% of them')
```

```
These are all Michigan cases;  35.0 % of them
```

```
In [40]: rain = rain[rain['FINANCIAL SOURCE'].notnull()]
```

In [41]:

```
print('New Row Count:',rain.shape[0])
print('Lost:',150-rain.shape[0],'rows')
```

```
New Row Count: 143
Lost: 7 rows
```

In [42]:

```
print('There are',sum(rain['Size/ Capture area (Sq. feet)'].isnull()),'cases m
issing project size')
print('There are',sum(rain['GI COST (2)'].isnull()),'cases missing project cos
t')
```

```
There are 24 cases missing project size
There are 1 cases missing project cost
```

In [43]:

```
rain[rain['Size/ Capture area (Sq. feet)'].isnull()]
```

Out[43]:

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	Size/ Capture area (Sq. feet)	GI C
121	St. Paul	Minnesota	The Metro Green Line	Public funding	Grants	nan	5,114
122	Aiken	South Carolina	Sand River Headwaters Green Infrastructure Pro...	Public	Grants (Various)	nan	3,759
123	Portland	Oregon	SW Texas Green Street	Mixed	Private donations and sponsorships, and grants	nan	2,319
124	Milwaukee	Wisconsin	Menomonee Valley Industrial Center	Public	Grants	nan	1,600
126	South Shore	Massachusetts	North and South Rivers Watershed Association R...	Public	Grant	nan	825,1
127	Lancaster	Pennsylvania	Lancaster Parking Lot Transformations	Mixed	Grant, loan	nan	640,0
128	New York	New York	Queens Botanical Garden	Mixed	Public funding and private donations	nan	568,0
130	Waltham	Massachusetts	Waltham Watch Factory	Mixed	Taxes, loans and private funding	nan	434,6
131	Syracuse	New York	Lysander Tree Planting, Manhole Repair & Pipe ...	Public	Grants	nan	400,0
132	Grand Rapids	Michigan	Plainfield Avenue	Mixed	Grants, PPP, private donations & sponsorships	nan	330,8

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	Size/ Capture area (Sq. feet)	GI C
133	St. Landry Parish	Louisiana	St. Landry Parish Visitor's Center	Public	NaN	nan	330,0
134	Syracuse	New York	Town of Dewitt – Willis Carrier Recreation Center	Public	Grants	nan	300,0
135	Toledo	Ohio	Maywood Ave, Green Streets Revitalization	Public	Loans	nan	278,0
136	Syracuse	New York	Town of Geddes – Bergner Road Porous Pavement ...	Public	Grants	nan	210,0
137	San Francisco	California	Mint Plaza	Mixed	Taxes, bonds, private donations	nan	150,0
138	Syracuse	New York	Street Tree Plantings	Public	Grants	nan	122,3
139	Syracuse	New York	Solvay Highway Garage	Public	Grants	nan	110,0
140	Syracuse	New York	Street Tree Contract	Public	Grants	nan	108,8
141	Syracuse	New York	Solvay Trump & Power	Public	Grants	nan	80,00
142	Seattle	Washington	14th Avenue Neighborhood Street Fund Project	Public	Taxes	nan	75,00
144	Syracuse	New York	Rain Barrel Program	Public	Grants	nan	35,93
145	City of Wayne	Michigan	Nankin Mills Interpretive Center Grow Zone Pro...	Mixed	Grant, Private donations and sponsorships	nan	18,11

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	Size/ Capture area (Sq. feet)	GI C
146	Syracuse	New York	Tree Enhancement in Burnet Park	Public	Grants	nan	11,48
148	City of Wayne	Michigan	Ford Road	Mixed	Private donations and sponsorships	nan	8,584

In [44]:

```
rain[rain['GI COST (2)'].isnull()]
```

Out[44]:

	CITY	STATE	CASE STUDY TITLE	FINANCIAL SOURCE	FINANCIAL TOOL	Size/ Capture area (Sq. feet)	GI COST (2)
28	Ann Arbor	Michigan	Washtenaw County West Service Center	Public	Bonds	133,293.60	nan

In [45]:

```
rain = rain[rain['Size/ Capture area (Sq. feet)'].notnull()]
rain = rain[rain['GI COST (2)'].notnull()]
```

In [46]:

```
print('New Row Count:',rain.shape[0])
print('Lost:',143-rain.shape[0],'rows')
print('Total Rows Lost:',7+(143-rain.shape[0]))
```

```
New Row Count: 118
Lost: 25 rows
Total Rows Lost: 32
```

In [47]:

```
rain[['Size/ Capture area (Sq. feet)','GI COST (2)']].describe()
```

Out[47]:

	Size/ Capture area (Sq. feet)	GI COST (2)
count	118.00	118.00
mean	439,329.80	521,435.27
std	2,811,356.63	1,429,508.70
min	282.00	2,875.00
25%	13,090.00	106,688.25
50%	39,500.00	212,102.50
75%	129,264.25	439,951.75
max	29,620,800.00	14,700,000.00

In [48]:

```
rain['Cost/Sqft'] = rain['GI COST (2)'] / rain['Size/ Capture area (Sq. feet)'
]
rain[['Cost/Sqft']].describe()
```

Out[48]:

	Cost/Sqft
count	118.00
mean	14.12
std	47.94
min	0.02
25%	2.79
50%	5.91
75%	10.60
max	500.00

In [49]:

```
syracuse = rain[rain['CITY']=='Syracuse']
syracuse[['Size/ Capture area (Sq. feet)','GI COST (2)']].describe()
```

Out[49]:

	Size/ Capture area (Sq. feet)	GI COST (2)
count	96.00	96.00
mean	117,355.70	361,419.03
std	250,713.07	555,741.13
min	560.00	2,875.00
25%	13,840.00	102,344.50
50%	39,000.00	208,400.00
75%	101,685.50	385,000.00
max	1,966,000.00	4,519,790.65

In [50]:

```
other = rain[rain['CITY']!='Syracuse']
other[['Size/ Capture area (Sq. feet)','GI COST (2)']].describe()
```

Out[50]:

	Size/ Capture area (Sq. feet)	GI COST (2)
count	22.00	22.00
mean	1,844,307.68	1,219,687.95
std	6,419,409.88	3,059,442.85
min	282.00	33,042.00
25%	12,000.00	147,000.00
50%	98,010.00	398,500.00
75%	300,564.00	1,000,000.00
max	29,620,800.00	14,700,000.00

In [51]:

```
print('Total awards =',sum(rain['GI COST (2)']))
print('Total Syracuse awards =',sum(syracuse['GI COST (2)']),'(',round((sum(sy
racuse['GI COST (2)'])/sum(rain['GI COST (2)'])*100),2),'%)')
print('Total non-Syracuse awards =',sum(other['GI COST (2)']),'(',round((sum(o
ther['GI COST (2)'])/sum(rain['GI COST (2)'])*100),2),'%)')
```

```
Total awards = 61529361.720000006
Total Syracuse awards = 34696226.72 ( 56.39 %)
Total non-Syracuse awards = 26833135.0 ( 43.61 %)
```

In [52]:

```
print('Total states represented = ',len(other['STATE'].unique()))
```

```
Total states represented =  9
```

In [53]:

```
other.groupby('STATE')['GI COST (2)'].sum().sort_values(ascending=False)
```

Out[53]:

```
STATE
Washington           14,700,000.00
Michigan              4,962,600.00
New Mexico            2,000,000.00
Pennsylvania          1,377,000.00
Illinois              1,300,000.00
New York                948,717.00
Oregon                  624,818.00
Arizona                 500,000.00
Colorado                420,000.00
Name: GI COST (2), dtype: float64
```

In [54]:

```
other.groupby('STATE')['CITY'].count().sort_values(ascending=False)
```

Out[54]:

```
STATE
Michigan        9
Oregon          5
Pennsylvania    2
Washington      1
New York        1
New Mexico      1
Illinois        1
Colorado        1
Arizona         1
Name: CITY, dtype: int64
```

In [55]:

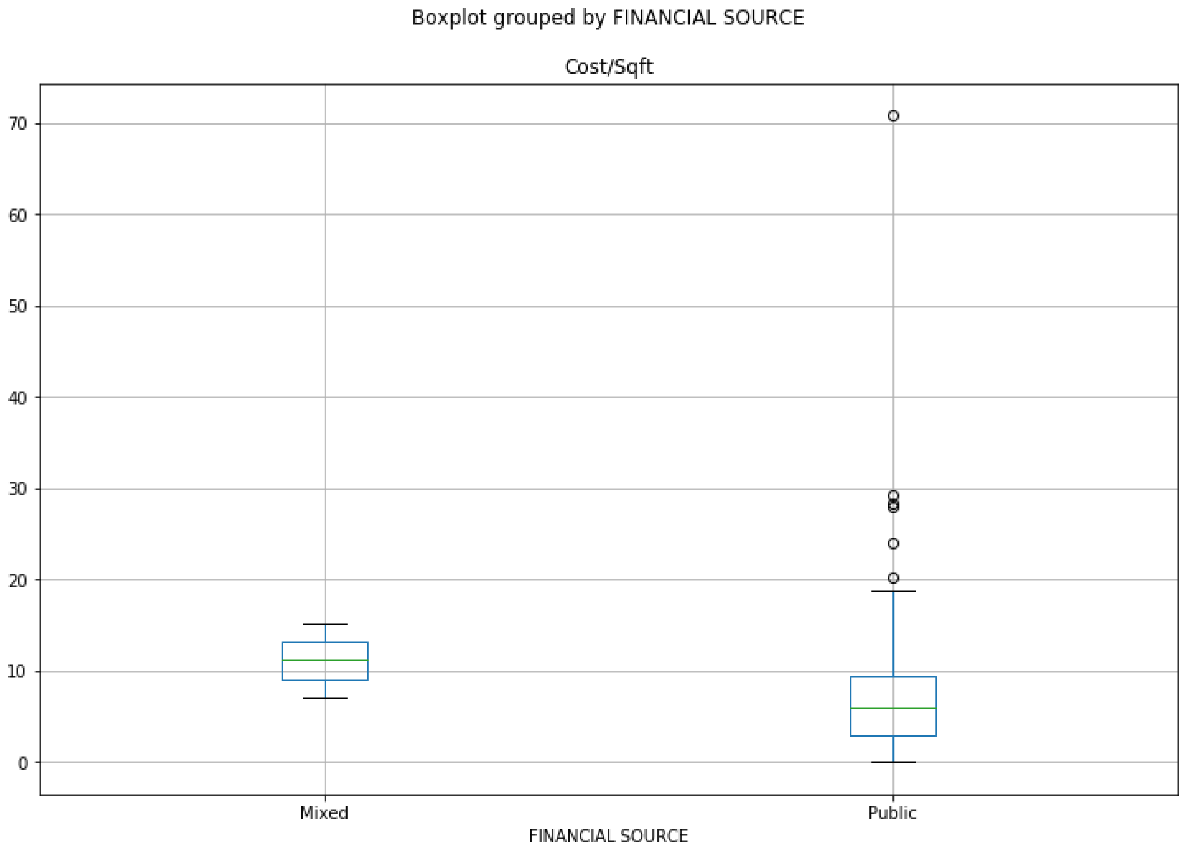
```
syracuse_types = syracuse.groupby('FINANCIAL SOURCE')
syracuse_types['Cost/Sqft'].describe()
```

Out[55]:

	count	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
FINANCIAL SOURCE								
Mixed	2.00	11.17	5.79	7.07	9.12	11.17	13.22	15.26
Public	94.00	8.07	9.26	0.02	2.93	5.91	9.39	70.74

```
In [56]: syracuse.boxplot('Cost/Sqft', by='FINANCIAL SOURCE', figsize=(12, 8))
```

```
Out[56]: <matplotlib.axes._subplots.AxesSubplot at 0x7f6ea21da860>
```



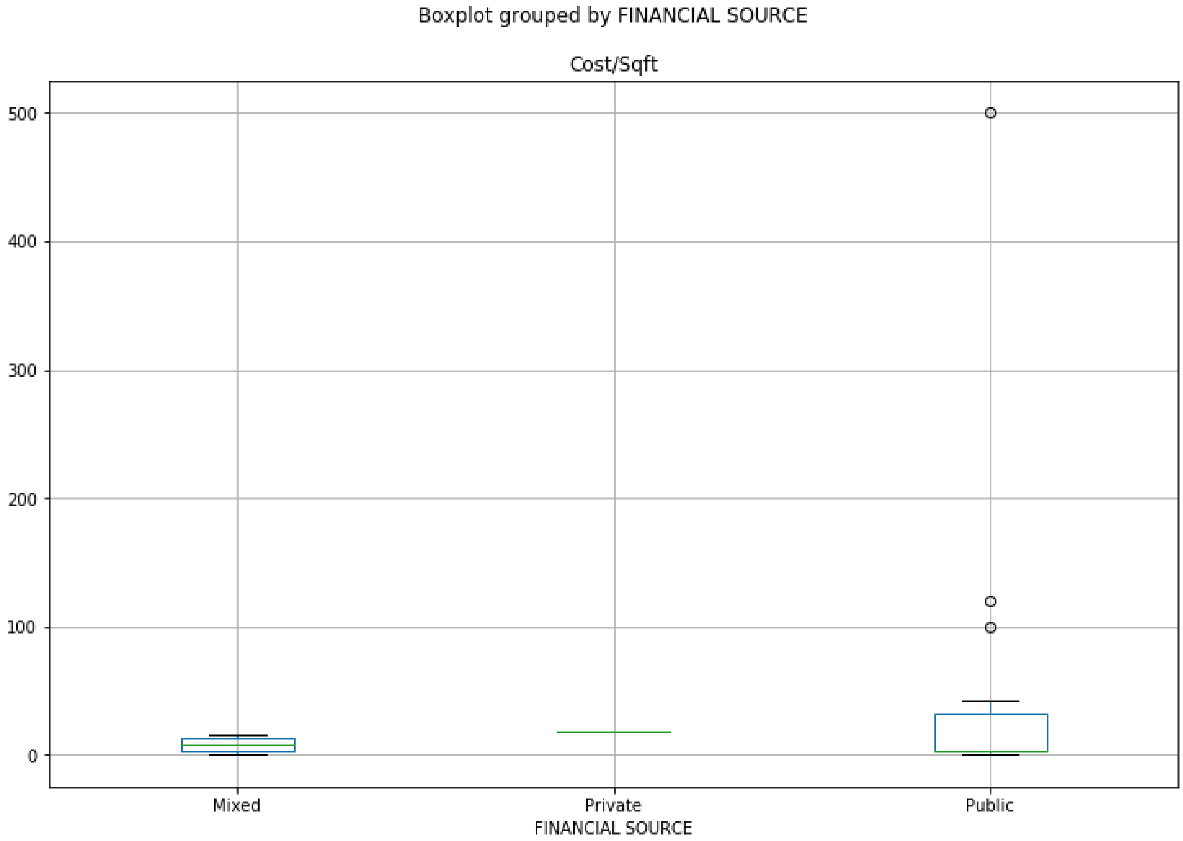
```
In [57]: other_types = other.groupby('FINANCIAL SOURCE')
         other_types['Cost/Sqft'].describe()
```

Out[57]:

	count	mean	std	min	25%	50%	75%	max
FINANCIAL SOURCE								
Mixed	4.00	7.66	7.17	0.05	2.40	7.80	13.05	14.98
Private	1.00	18.27	nan	18.27	18.27	18.27	18.27	18.27
Public	17.00	49.21	121.50	0.14	2.30	2.91	31.58	500.00

```
In [58]: other.boxplot('Cost/Sqft', by='FINANCIAL SOURCE', figsize=(12, 8))
```

```
Out[58]: <matplotlib.axes._subplots.AxesSubplot at 0x7f6ea21e5e80>
```



Boxplot grouped by FINANCIAL SOURCE

Cost/Sqft